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# The application of knowledge stylised facts in West Africa Economic and Monetary Union (WAEMU)

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## Abstract

Sub-Saharan Africa has one of the dynamic economies in the world. Unfortunately, the performance achieve has not led to a reduction of social issues. So, the government are making massive investment to overcome social issues. This massive public investment highlights the exogenous nature of the current economic growth. So, a change of the strategy in the economic management of sub-Saharan Africa is required. One solution remains the change of economic paradigm: the transition from exogenous economic with decreased return to endogenous economic with increased return. The theoretical explanation of such arguments are supported by New Growth Theory. However, the implementation of the new theory required compliance to a set of indicators known as stylized facts. In 2009, Romer and Jones have developed a list of stylized corresponding to the need of New Growth Theory. The stylized facts of the West African Economic and Monetary Union (WAEMU) have been compared to the standard facts of Romer and Jones in order to apply the recommendations of New Growth Theory in this area. To reach that aim, the stylized facts have been described and analysed with econometric panel model. As result, we find that the description of the stylized facts in WAEMU fitted perfectly with that of Romer and Jones for the same period. Unfortunately, when using data, institution don't work as expected by Romer and Jones. This study strengthens the argument for the implementation of economic policy based on the valorisation of knowledge economic in WAEMU.

**Keywords:** Economic growth, Economic development, Knowledge economic, Macroeconomic Analyses, Africa

**JEL classification codes:** O40, O17, D83, O11, N17

## Introduction

The economic facts of Sub Saharan countries have been stylized by Ferreira and Ravallion (2008) based on the data collected. The authors established three key stylized facts: (i) the absence of a correlation between growth rates and changes in inequality among developing countries; (ii) the strong (positive) correlation between growth rates and rates of poverty reduction, and (iii) the importance of inequality to that relationship (Ferreira & Ravallion, 2008, p. 4). It emerges that economic growth is not sufficient to fight against poverty in Sub Africa. In fact, 41% of the people living in Sub African countries

were poor in 2015 (World Bank Group, 2018, p. 10) while the region had grown by more than 5% during the last fifteen years (Imf, 2016, p. 1).

In order to reconcile economic growth, and social issues, the authorities are implementing several social actions to target the most disadvantaged social groups. Ben Hammouda (2002) cites five sectors identified by social policies in Central Africa: health, education, basic infrastructure, governance, and rural development (Ben Hammouda, 2002, p. 103). So, the massive implementation of social policies on Sub Africa highlights the exogenous nature of the economic growth model applied in this area.

A change of course is required (IMF, 2016) in the economic growth model. This change could be achieved by changing the current exogenous growth model into a strong endogenous one. The transition from an exogenous economy to endogenous economic is possible with the use of knowledge as production factor (Romer, 1986) instead of physical capital. "The use of knowledge is justified by the existence of increasing returns and a significant amount of externalities" (Nogbou Andetchi Aubin et al., 2017, p. 4). The increasing return leads to the sustainability of the economic growth and the externalities ensure the empowerment of related sectors of activity.

Knowledge has an explicit part and an implicit part. Explicit knowledge is obtained through academic production and implicit knowledge is produced locally by the interaction among people. Explicit knowledge is available on the book and can be transmitted while implicit knowledge is difficult to collect as the owner do not mastered the rules that lead them (Tsoukas, 2005). By mobilizing and leveraging the local knowledge produced, countries could produce local innovations (Nonaka & Takeuchi, 1995) that would induced endogenous economic growth. The field that focus on knowledge in economic growth is the called: New Growth Theory.

The New Growth Theory promises inclusive and sustainable growth but it requires compliance with a set of indicators known as stylized facts. In fact, the notion of stylized facts was introduced into economics by Nicolas Kaldor in the 1960s. In 1989, Romer added five stylized facts to Kaldor's. Jones completed the list with three new facts in 2001. Romer and Jones will finally develop a new list in 2009, about 50 years after the primary stylized facts of Kaldor. The list of the six stylized facts established by Jones and Romer (2010) is: (i) Increases in the extent of the market; (ii) Accelerating growth (iii) Variation in modern growth rates; (iv) Large income and total factor productivity (TFP) differences; (v) Increases in human capital per worker; (vi) Long-run stability of relative wages. These new stylized facts were established on four variables: ideas, population, human capital and institution.

## Methodology

The methodology of the article is twofold: the description of knowledge stylized facts and the empirical analysis of the stylized facts. Each methodology has its own targets and used its own tools. The description of stylised facts aims to match stylised facts in WAEMU and stylized facts of Jones and Romer (2010) in order to make some similar recommendations for economic growth in WAEMU. The main tool used to make this description is the figures based on empirical data collected by World Development Indicators (WDI) 2018, International Monetary Fund (IMF) (GFS & WEO) 2011, Penn World Tables and Barro & Lee, (2013). So, the analysis of stylised facts aims to establish

some relationship between proxies of stylized facts based in order to advise some priorities based on the empirical data collected by World Development Indicators (WDI). The main tool used for this analysis is the econometric model of RAO (2010). The model allows the inference of coefficients based on empirical data and showed the importance of each variable for economic growth.

### **Description of knowledge stylized facts in WAEMU**

It's important to analyse the stylized facts of the area and compared them to the standard facts of Jones and Romer (2010) in order to apply the recommendations of the new economic growth theory to the WAEMU. To reach that end, the facts will be categorized into two groups: overall growth and overall income. Each group will contain three facts.

#### ***Overall growth***

The notion of overall growth covers three stylized facts: (1) increase in the extent of the market, (2) accelerating growth and (3) variation in modern growth. These stylized facts are addressed below.

*Increases in the extent of the market* After the Second World War, many markets (goods and services, financial, ideas and innovations...) were in hyperactivity all over the world. These activities accentuated the phenomenon of globalization and urbanization. So, the level of globalization and urbanisation was different from an area to others. This difference can be explained by local realities.

Globalisation is seen as the integration of several markets and the connexion of people from different areas. In the context of the WAEMU, globalization was intended on the one hand and imposed on the other. The desire for globalization is seen through economic integration and is expressly reflected in the objectives assigned to the integrated area. Eight countries have joined WAEMU in order to increase the extent of their local markets through integration (Objective 3 of WAEMU): Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. To facilitate the reach of this objective, WAEMU has implemented a number of policies concerning: (i) a customs union; (ii) a regional financial market; (iii) a common commercial policy and (iv) community competition legislation.

The customs union concerns the liberalisation of intra-zone trade and the establishment of the Common External Tariff (CET). The CET was gradually introduced in the 2000s and is intended to be an instrument for harmonising the trade policy of member countries vis-à-vis the outside world. The importance of the intra-zone trade was also addressed from July 1996 and is mainly reflected in tariff reductions on intra-zone trade in the WAEMU.

The common trade policies implemented in WAEMU have a bilateral and a multilateral component. The bilateral component concerns trade relations between countries. In terms of bilateral relations, the Union has standardized the bilateral relations of the member countries by substituting the bilateral agreements concluded by each member country with multilateral agreements of WAEMU with third countries. The multilateral component concerns trade relations between member countries and international

organisations. Under multilateral agreements, WAEMU has undertaken to notify its multilateral trade and investment agreements to the World Trade Organization (WTO).

The purpose of Community competition legislation is to ensure a better functioning of the common market. The Community's anti-competitive legislation, which came into force in January 2003, prohibits agreements between companies, the abusive exploitation of dominant positions, aid granted by member countries to companies likely to distort competition, anti-competitive practices attributable to member countries.

The effective establishment of WAEMU's regional financial market took place in September 1998 with the creation of the Regional Stock Exchange (BRVM). The BRVM aimed to collect internal savings as an alternative to bank loans. In accordance with Articles 4, 16(d), 96 and 97 of the WAEMU Treaty, capital movements between WAEMU Member countries are free and without any restrictions.

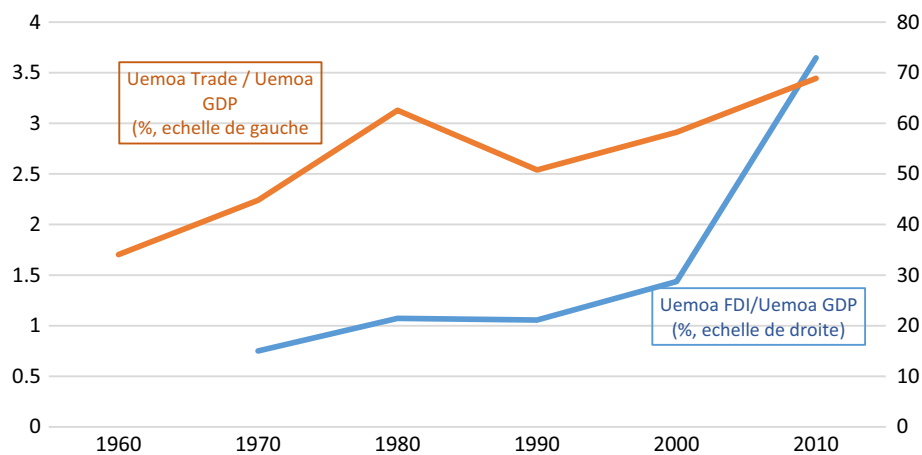
Unfortunately, the current extent of the globalization in WAEMU cannot be explained solely by the economic integration of WAEMU member countries. This statement is true if we took into account the low level of intra-zone trade in the WAEMU compared to that of others integrated areas of the world. The share of intra-zone exports between WAEMU Member States is estimated at 12.6% in 2015 compared to 20.9% in the Southern African Development Community (SADC) and 61.6% in the European Union (CNUCED & UNCTAD, 2016).

Notwithstanding the efforts of member countries to achieve integrated markets, the stylized facts of Jones and Romer (2010) showed an upward trend in the size of all global markets (integrated and non-integrated) driven by globalization. To highlight this observation, globalization is approximated by international trade and foreign capital. International trade is described as the value of a country's imports and exports. The WAEMU organisation includes eight countries with economic internal and external transactions. The value of trade in the area have been synthesized by the arithmetic average of the annual imports and exports of each country in the area as a percentage of Gross domestic product (GDP). The value of the foreign capital is represented by Foreign Direct Investment (FDI) as a percentage of GDP. The arithmetic average of the FDI of each country in the area made it possible to obtain the average FDI of the whole area.

**Result and discussion** Figure 1 shows that the trends in international trade and foreign capital investment in WAEMU are upward in accordance with the general observation made by Jones and Romer (2010) over the period 1960–2010. According to Jones and Romer (2010), the world international trade as a percentage of GDP has doubled between 1960 and 2010. In the WAEMU countries, the level of international trade has also doubled over the period 1960–2010. The average in 1960 was 34.059 compared to 68.887 in 2010, representing an annual average change of 0.01%.

Jones and Romer (2010) have shown that the FDI increased in the world over the period 1960–2010. The FDI has also increased from 0.7504 in 1960 to 3.6472 in 2010 in WAEMU for an average annual variation of 3.86% over the period. The FDI has increased overall for the region, demonstrating the dynamism of the region's markets.

Urbanization, on the other hand, is defined as the concentration of the population in urban areas. Seen as a market potential, urbanization in the WAEMU is a challenge to overcome because the member countries are struggling to cope with an uncontrolled



**Fig. 1** International trade and foreign capital investment in WAEMU. Source: World development Indicators, 2018

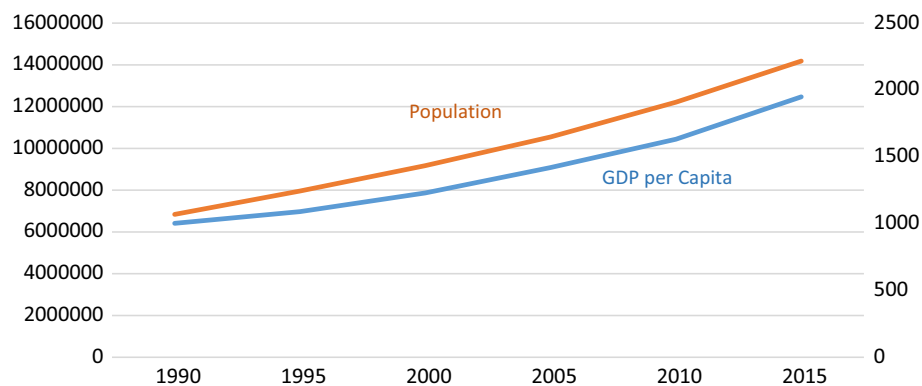
exodus. Among the challenges caused by urbanization are the problem of access to drinking water, sanitation, electricity, health and the environment. The amount of investment required to ensure a minimum level of well-being remains a constraint for government budget under pressure.

To face the urbanization issues, WAEMU has set up the Regional Indicative Programme for Urban Development (PIRDU) for a period of 10 years (2009–2018). This programme aimed to strengthen the driving role of the Union's cities in terms of attractiveness and competitiveness; to improve the living conditions and environment of urban populations within the Union; to facilitate the emergence of secondary cities and equipped relay cities; to strengthen decentralisation processes, governance and civic participation of local authorities and the various stakeholders in the life of their cities.

The globalization and rapid urbanization of the WAEMU make it possible to explain the expansion of markets, but not its impact, because of the enormous challenges of efficient intra-zone trade and controlling urbanization issues. A gap between the potential of the region and the use of this potential therefore arises for decision-makers. The concern for challenges must not overshadow the potential of a rapidly expanding market with an ever-increasing urban population. The integration of the countries of the WAEMU is undoubtedly an opportunity that the member countries have not yet exploited. The large population and the flow of foreign innovation and technologies should make it possible to improve the region's performance by taking them into account.

The pace of the area's performance must be able to inform us about the effects of globalization. Successful globalization will therefore result in accelerated and inclusive growth and virtual globalization will lead to slow and non-inclusive growth. To analyse the rate of growth according to population, Jones and Romer's Fact 2 is studied below.

*Accelerating growth* The facts of economic growth in United States of America and twenty Western European countries have been empirically studied by Maddison (2007). He showed that GDP increased slowly before the 2000s and grown rapidly ( $\times 100$ ) over the last two centuries. Jones and Romer (2010) noted that this strong contemporary eco-



**Fig. 2** Population and GDP per capita. Source: World development Indicators, 2018

economic growth is characterized by a concomitant increase of population and per capita income. The linkage between growth and population highlighted by the authors is indirect. According to them, the increase in population rate lead to the increase of the stock of knowledge held individually by these populations and then, the used of the knowledge improve the growth rate. Jones (2005) have already established the linkage between knowledge stock and economic growth under the title of “Sources of US economic growth in a world of ideas”.

In WAEMU, the concept of population includes all individuals living in the Member countries. With a population of over 100 million, the area provides lot of ideas. According to the New Growth Theory, the large stock of ideas leads to a dynamic efficiency of economic growth. To estimate the link between population and economic growth in WAEMU, the number of individual living in the area was used as a proxy of population and GDP per capita was used as proxy of population well-being. An increase in GDP per capita is considered to be an increase in the well-being of the population notwithstanding inflation rate.

**Result and discussion** Figure 2 shows that the population trend and the GDP per capita of the WAEMU upward together. A large and growing population with increasing incomes means an efficient and hard-working population. Well-being is also valued through the general level of poverty. On the basis of national poverty lines, the incidence of poverty in WAEMU for 2010 is estimated at 49.4%. Considering the US\$1.25 per day threshold recommended by the World Bank, the poverty rate would be reduced to 39.8% in the WAEMU (BCEAO, 2012).

This analysis shows that GDP per capita grown in many countries of WAEMU in the area while poverty affects nearly 40% of the population. The incidence of GDP per capita on poverty rate is very weak, which suggest that growth in the WAEMU is not inclusive. However, the degree of inclusion of populations differs from one country to another. The choice of indicator for calculating the incidence of poverty clearly influences the extent of economic performance at the social level. However, the improvement in the economic framework remains absolutely positive, and the sustainability of the integration of the WAEMU area therefore requires collective actions and targeted individual actions in order to ensure the effectiveness of economic convergence among member countries.

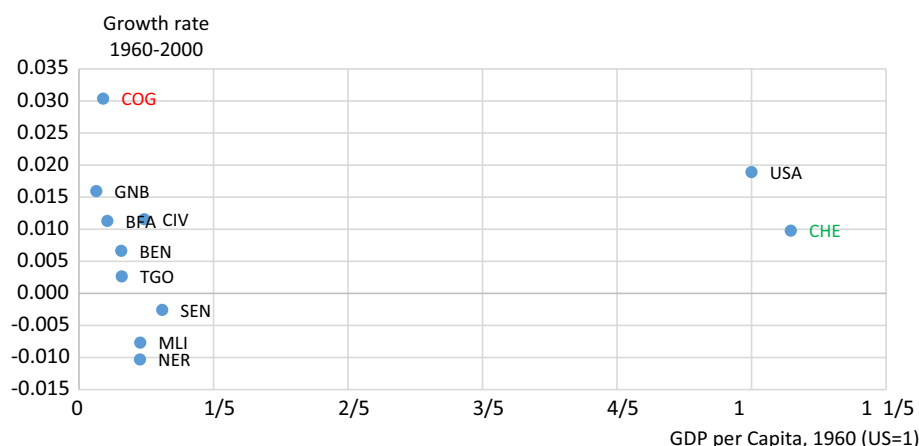
Moreover, the size of the population is not sufficient to explain the WAEMU's economic performance. The economic performance in the area can also be explained by the rhythm of the ideas transmission. The ease of intra-zone migration and the adoption of harmonised legislation are economic policies that facilitate the flow of ideas within the area. In 2009, WAEMU adopted a regulation that facilitate the movement of persons, residence, provision of services and the right of establishment. This recognition was aimed at two approaches: the internal approach and the external approach.

The internal approach concerns union citizens' migration. The free movement of persons, residence, provision of services and the right of establishment is accepted within the treaty establishing WAEMU in 1995. To this end, some corporations have been submitted to specific directives and regulations. These directives and regulations include students who are citizens of the Union (Directive No. 01/2005/CM/UEMOA), Union doctors (Directive No. 06/2005/CM/UEMOA), Union architects (Directive No. 07/2005/CM/UEMOA), Union accountants (Regulation No. 05/2006/CM/UEMOA), Union lawyers (Regulation No. 10/2006/CM/UEMOA), Union pharmacists (Directive No. 06/2008/CM/UEMOA), Union dentists (Directive No. 07/2008/CM/UEMOA). However, the effectiveness of free movement seems to be a problem in practice.

The external approach concerns non-union citizens' migration. The standardisation of legal policy towards non-union citizens is reflected in the harmonisation of Member States' external policies with the countries outside WAEMU. This desire for uniformity has resulted in the establishment of specific directives and regulations. Additional Act No. 01/2009 / CCEG/ UEMOA of 17 March 2009 made it possible to establish a common WAEMU policy on the migration and residence of non-citizens of the Union and Regulation No. 06/2009/CM/UEMOA of 26 June 2009 granted mutual recognition to visas issued by WAEMU Member countries. The external approach can be subdivided into two dimensions. Non-citizens who are members of the Economic Community of West African States (ECOWAS) and non-ECOWAS nationals. In this regard, Article 4 of Regulation No. 06/2009/CM/UEMOA clearly states that citizens of ECOWAS are exempt from the requirement for entry visas into the territory of WAEMU, unlike non-ECOWAS citizens. The purpose of mutual recognition of visas is to implement a single WAEMU visa.

Another strong action of integration is the harmonization of economic activities. Harmonisation allows companies to move easily around the area. Companies wishing to get closer to the areas where the resources of ideas and/or human capital are easily produced. Whether geographical or virtual proximity, the removal of legal constraints in the business world facilitates the mobilization of local knowledge. Within the framework of the WAEMU, two (02) sectors will influence the improvement of the business world: commercial enterprises and insurance. The most significant contributions have been done by the Organisation for the Harmonisation of Business Law in Africa (OHADA) and the Inter-African Conference on Insurance Markets (CIMA). So, the analysis of the impact of these reforms will be carried out in the WAEMU territory.

The growth of the area is not experienced in the same way by each country. An analysis of each country's individual performance over time will be carried out through Fact 3 proposed by Romer and Jones on the heterogeneity of growth rates and the impact on performance.



**Fig. 3** Variation in modern growth rates for WAEMU Countries. Source: Penn World Tables 6.1

*Variation in modern growth rates* The economic growth in the whole world accelerated from the 1990s onwards. This acceleration was attributed to the existence of a residual factor. Solow (1956, 1957) concluded that technological change and later technological change could be this residual factor. The residual factor evoked by the neoclassic is an exogenous factor not induced by human voluntary action. Solow's model, which results from taking into account the residual factor, like all neoclassical growth models, admits the existence of decreasing returns in the use of factors of production whose lead is ensured by the capital factor.

One of the consequences of the existence of decreasing returns is the possibility that poor countries catch up rich countries. According to catch-up theory, rich countries (leaders) should see their growth rates fall as a result of capital depreciation. For a given level of labour and capital factor, investment must stop so as not to create waste due to its inefficiency. We are talking about a stationary state. At this level, the country must rely on exogenous technology to trigger new growth. If so, it will simply be caught up by the poor countries (followers).

In addition, poor countries are expected to experience strong growth. The growth rate of poor countries is expected to exceed that of rich countries. On the other hand, the income from this growth would follow the opposite trend, because in absolute terms, the annual GDP of rich countries remains much higher for a small variation. GDP per capita remains high while growth variation is low in rich countries.

These observations are challenged by the stylised facts of Jones and Romer (2010). According to them, empirical analysis shows a heterogeneity of growth rates within rich and poor countries. They added that the level of investment in factors of production such as physical capital and labour does not guarantee immediate efficiency in production. In other words, poor countries are not only poor because they have lower levels of physical capital and labour, but also because they use their inputs less efficiently (Jones & Romer, 2010, p. 18).

*Result and discussion* Figure 3 compares the average growth level of different countries according to data published by the Centre for International Comparisons of the Univer-

sity (CICUP) in October 2002 on the period between 1960 and 2000. This data shows that the GDP per capita of Senegal and Côte d'Ivoire have increased on average each year by 12.39% and 9.7% respectively, based on the evolution of the United States.<sup>1</sup>

Two control countries have been added to the analysis: Switzerland and the Republic of Congo. Switzerland is considered as rich country with an average annual growth rate of 105% (higher than that of the United States) and the Republic of Congo is considered as poor country outside WAEMU, with an average annual growth rate of 3.6%.

The analysis shows that the growth rates of Côte d'Ivoire, Burkina Faso and Guinea (poor countries) are higher than that of Switzerland (rich country). These observations are consistent with catch-up theory. This is all right because Guinea-Bissau, which is the least performing country in the WAEMU zone, is the country with the highest growth rate. Guinea-Bissau's average growth rate over the period 1960 to 2000 was 1.6% compared to -0.3% for Senegal and 1.2% for Côte d'Ivoire at the domestic level. Externally, Guinea-Bissau (the poorest in the WAEMU) has a higher growth rate than Switzerland (a rich country) with a rate of 0.9%.

However, this neoclassical trend in economic growth is not the norm. Inconsistencies are found in this type of analysis. In terms of the catching-up relationship between poor and rich countries, it can be seen that United States (rich country) has a higher average growth rate than all the WAEMU countries, which are considered relatively poor. The relatively strong growth of a rich country compared to a poor country is a departure from the natural catching-up trend. This observation is also true between poor countries with different performance. The Republic of Congo has a strong performance relative to Guinea-Bissau. The GDP per capita of the Republic of Congo and Guinea-Bissau increased on average by 3.6% and 2.6% respectively each year. However, the Republic of Congo has a higher growth rate than Guinea-Bissau. Similarly, Côte d'Ivoire's growth rate is higher than that of Senegal by 15 points over the period 1960 to 2000 although Senegal was more advanced than Côte d'Ivoire at the beginning of 1960.

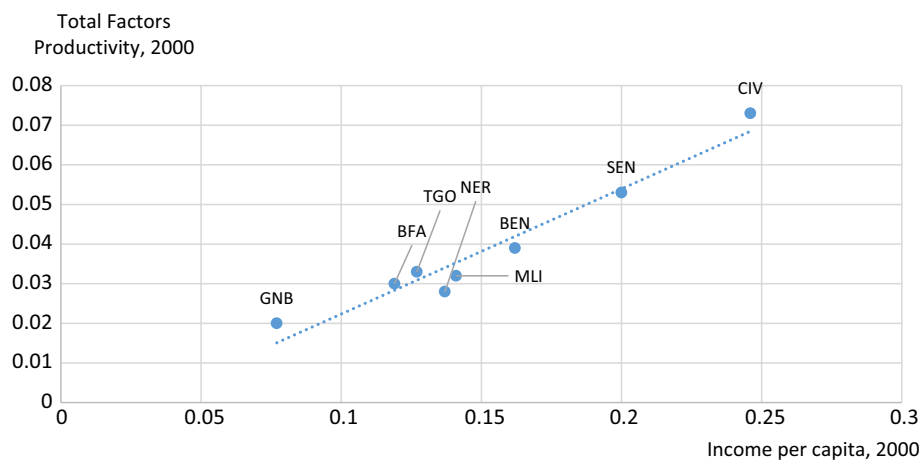
These observations showed that in the WAEMU too, countries' growth is not only linked to their initial allocation of production factors. The area thus confirms its non-conformity with neoclassical growth theory as observed by Jones and Romer (2010) in many countries of the world. The analysis of the causes of the difference in performance will be analysed in Fact 4 of Jones and Romer (2010).

### **Overall income**

The notion of overall income covers also three stylized facts: (1) large income and total factor productivity difference, (2) increases in human capital per worker and (3) long-run stability of the relative wages. These stylized facts are addressed below.

*Large income and total factor productivity (TFP) differences* Physical capital and labour, which are the main factors of production used in neoclassical growth model, have shown their limits in the explanation of economic growth between countries in different areas. Quantitative analysis of physical capital and labour is not enough to explain the differ-

<sup>1</sup> United States was used as the reference country for the comparison. The coefficient of the United States is therefore 1 or 100%.



**Fig. 4** Total Factor Productivity and Income per capita in WAEMU. Source: World Development Indicators (WDI) 2018

ences in GDP variation between countries. If economic growth obtained from a given quantity of factors (capital and labour) is different from one country to another, we can think about the efficiency of the factors used during the production. This efficiency is analysed through the Total Factor Productivity (TFP). In the economic literature, the correlation between TFP and GDP per capita is positive and strong (Jones & Romer, 2010, p. 18). According to Jones and Romer (2010), the TFP has therefore an impact on country performance. A country with a high TFP has also a high GDP per capita in absolute terms and a country with a low TFP has a low GDP per capita in absolute terms. However, the direction of the variation is not yet clearly specified by the authors.

**Result and discussion** An analysis of the link between TFP and GDP per capita at WAEMU level also shows a strong correlation between TFP and per capita income (See Fig. 4). Côte d'Ivoire has the largest TFP and also enjoys a good economic performance (GDP per capita). Senegal's TFP is lower than that of Côte d'Ivoire and its GDP per capita is also higher too. Guinea-Bissau has the lowest TFP and has the lowest performance of the group.

After establishing the link between TFP and GDP per capita in the world and specifically in the WAEMU, it is useful to understand the components of TFP in order to reduce as much as possible the gap between countries' performances. The characterization of TFP allows investments to be targeted on elements with high growth potential and thus improve the efficiency of the local growth system.

In fact, the TFP is a black box that includes several heterogeneous elements. Some people put learning, technical change, technological change, know-how, education, ideas, institutions, infrastructure, health, training, etc. into this box. Anything that can increase labour productivity is welcome in TFP. However, recent literature acknowledges the relevance of two elements in explaining the difference in performance between countries: the fluidity of knowledge and the quality of institutions.

Knowledge affects the efficiency of labour and capital with increasing return to scale. As an economic good used for growth enhancement, knowledge is produced

and distributed (Machlup, 1962). The velocity of knowledge through the population shows the performance of knowledge on economic growth. Fluid knowledge with high speed has a greater impact on growth than inert knowledge.

Ideas are defined as partially exclusive non-rivalrous goods (Romer, 1992). The partial exclusivity of the idea prevents its financial profitability. The public authorities must therefore interfere in the market of ideas. This intervention is carried out through the institutions. If the quality of the institution is poor, the management and the circulation of the idea will suffer. An efficient institution facilitates the management and circulation of ideas within the territory.

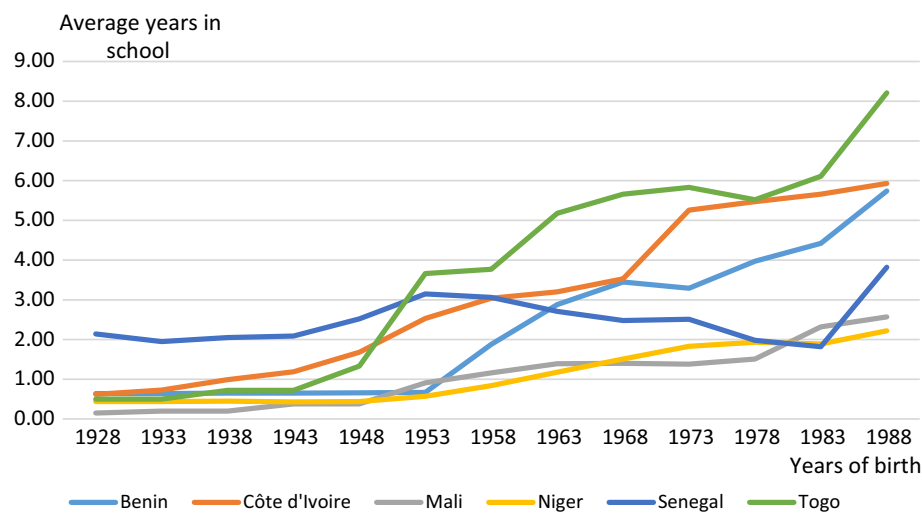
The quality of institutions is also important for economic growth. A good institution is a good framework for the implementation of growth model and a bad institution is a constraint for the implementation of growth model. The institution can also influence the flow of knowledge through the area. The notion of institution is a subjective one. Indeed, a certain amount of deficiency still persists in the establishment of an institution. This gap is either due to the diversity of institutions or to the inadequacy of institutions to adapt to cyclical developments. The diversity of institutions across countries is illustrated by the existence of different realities. An institution from developing countries may require less competences for its quality and challenge than an institution from developed countries.

Institution, ideas and technology developed are often different within countries with the same level of wealth, and this leads to specific organisation in each country. The inadequacy of institutions to adapt to cyclical changes is an obstacle to technological fluidity and the flow of ideas. Institutions in developing countries often lag behind global jurisdiction. The jurisdictions of developing countries do not generally allow innovations to be accommodated and innovators to be protected. This gap prevents the fluidity of ideas, technologies and knowledge in general.

It should be noted, however, that institutions are not explicitly modelled and knowledge remains a fairly new approach. On the other hand, human capital has been the subject of reflection on its link with growth. Fact 5 of Jones and Romer (2010) will therefore focus on human capital dynamics to identify a plausible explanation about the heterogeneity of growth.

*Increases in human capital per worker* The importance of TFP was highlighted by Kaldor through fact 2, which states that economic growth has grown in a sustainable way over time. This evolution can only be explained by labour and/or capital efficiency. Since the efficiency of capital is conditioned by exogenous technology, neoclassical theory concluded that labour efficiency is effective. The concept used to represent labour efficiency was that of human capital with education as the predominant variable. Jones and Romer (2010) showed that human capital has appreciated over time in countries around the world, with the United States as an example. To demonstrate this assertion, they used the average years in school according to date of birth. The duration of schooling indicates the time spent in school to improve human capital.

The data collected in WAEMU are those for the persons between 20 to 24 years old. The average age of the group is 22 years. The average years in school analysed is only that of the age group selected. The analysis carried out is dynamic and concerns



**Fig. 5** Average years in school for population between 20 to 24 years old. Source: data from Barro & Lee (2013). NB: the date of birth is obtained from the average age and year of data collection

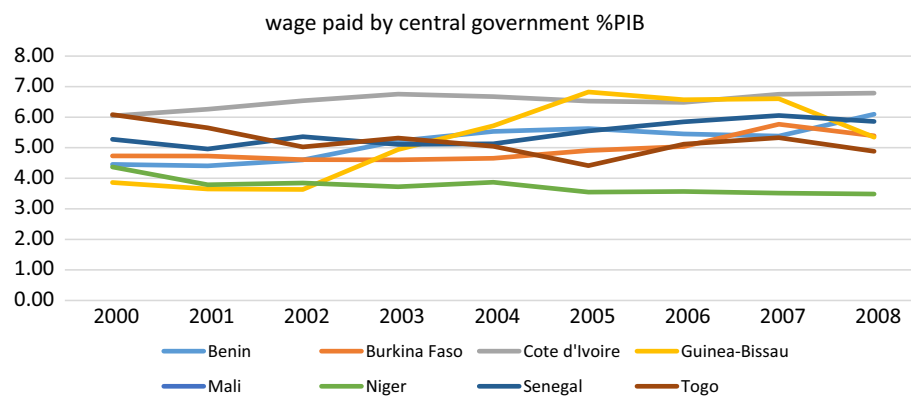
years from 1928 to 1988. Data from Burkina Faso and Guinea-Bissau are missing in the analysis.

**Result and discussion** Figure 5 shows the evolution of human capital for countries of WAEMU except Burkina Faso and Guinea-Bissau. This evolution is mainly due to the investment in education. The share of the budget (as a percentage of GDP or government expenditure) devoted to education in member countries is different. Togo has devoted about 20% of GDP, which corresponds to nearly 89% of public institution expenditure. On the other hand, Senegal, which has a low enrolment rate, spends about 21% of its GDP on the education sector which corresponds to nearly 92% of public institutions' expenditure. Efforts are made differently in each country.

So, it appears that the average years of school differs from one country to another and from one age group to another (See Fig. 5). In 1950, Senegal had an average years of school for young people between 20 to 24 years' old more than three times that of Côte d'Ivoire and Benin and four times that of Togo, its main challengers. In 2010, Togo had the highest average years of school which was more than eight (08) years followed by Côte d'Ivoire (5.94 years) and Benin (5.74 years). Senegal had almost stagnated from 2.14 years in 1950 to 3.82 years in 2010, an annual average variation of 10 days, which is the lowest of the Member States competing.

It is concluded that different school systems do not offer the same returns. The difference in performance is due to factors such as infrastructure, student supervision, quality of education, etc. Indeed, the education infrastructure in the WAEMU is not always sufficient in number and to international standards. Inadequate infrastructure is partly responsible for the high rate of illiteracy in the area. The adult literacy averaged rate was 40% in 2006 in WAEMU, compared to 62% in sub-Saharan Africa and 87% worldwide (Unistat, 2016).

The supervision of pupils and students remains problematic in WAEMU. In 2008, the average number of students per teacher was 50. The number of students



**Fig. 6** wage paid by central government per years. Source: data from FMI (GFS & WEO) 2011

supervised in the WAEMU remains below the average for sub-Saharan Africa (43), the OECD (16) and the Eurozone (13) (UNESCO, 2013). The quality of education in the WAEMU is also questioned. The poor quality of education is said to be the result of a combination of a lack of infrastructure and a lack of supervision.

*Long-run stability of relative wages* Jones and Romer (2010) showed that the number of graduates has grown steadily over time and across countries. This fact had led to an increase in the number of qualified workers. *Ceteris paribus*, the relative wage of qualified workers is supposed to decrease as the number of qualified workers increase. However, the authors find that the ratio of qualified workers per wages has been relatively constant over time and the amount of wage was higher for qualified workers than for less qualified workers. The positive relationship between the number of qualified workers and the relative wages of this workforce is an illustration of the value of human capital. Individuals can therefore improve the acquisition of human capital without fear of depreciation of their investment. The difference in salary between employees of the same firm with or without human capital can therefore be explained by a difference in employee productivity. An educated and trained worker is likely to earn a higher wage than an illiterate worker because they are supposed to be more efficient. The race towards human capital education is the ideal way to have a high wage.

Several studies showed that the relative price gap between graduated workers is widening. The return of the diploma is increasing. In 2013, young adults with a bachelor's degree earned more than twice as much as those without a high school credential (\$48,500 vs. \$23,900) and 62 percent more than young adult high school completers (\$48,500 vs. \$30,000) (Kena et al., 2015, p. 31). It is noted that the number of people with high salaries is an increasing function of the diploma. Graduates are not attained by poverty at the same level. In 2015, 26.3 percent (6.2 million) of people aged 25 and older without a high school diploma were in poverty compared to 12.9 percent (8.0 million) with a high school diploma but with no college and 9.6 percent of people with some college but no degree (Proctor et al., 2016, p. 16).

*Result and discussion* Within the WAEMU, wages paid by central governments have been a constant function of economic growth (see Fig. 6). This consistency is explained

not only by the stability of salaries in most countries in the region, but also by the rationed annual recruitment of new employees according to budget availability.

Human capital has also appreciated over time in the WAEMU. This is reflected in an increasingly long period of schooling over the years. However, many challenges remain to be met to support the efforts of the member countries. Among other things, we have the problem of adult literacy and the dropout of the youngest.

The low literacy rate in the WAEMU is coupled with a high dropout rate. In 2006, the educational structure of Mali showed that 93.1% of the population was not in school, 5.3% has been in school with an advanced age and 1.6% has dropped out of school at the primary level (World Bank, 2016). This structure is identical to that of Niger in 2006. However, Niger has made efforts in the area of primary school enrolment between 2006 and 2012, the rate of people who have never been to school has varied from 95 to 90.4%. This effort is tarnished by a 6.1 percentage point increase in the dropout rate. The dropout rate increases drastically in primary school after the age of 10. This high dropout rate is explained by the high opportunity cost of school, mainly due to the need to work and/or marry. Dropout is a subtle determinant of the bad quality of human capital in WAEMU and is mainly caused by age in Sub-Saharan Africa (Ricardo et al., 2010).

The analyses of the stylized facts of WAEMU showed that they are consistent with the stylized facts of Jones and Romer (2010). So, these stylized facts were established on the four variables (ideas, population, human capital and institution). As the stylized facts were what we hoped for, the contribution of the variables to economic growth must also be positive.

#### ***Empirical analysis of knowledge stylized facts in WAEMU***

It's difficult to use empirical approach to analyse stylized facts. Stylized facts are described through the appearance of a set of data curves. These curves are produced by proxies' variables. Knowledge stylized facts have been established on four variables (ideas, population, human capital and institution). These variables could be studied in order to analyse their contributions to economic growth. At the end, It will be possible to draw some systems and systems theory and demonstrate further this can be applied to knowledge (Carayannis et al., 2016).

It's also possible to deal with the stylized facts show the relationship between one or more variables. These relationships can be turned into hypothesis for the empirical studied. Along the same lines, each fact will be considered as a hypothesis about the relationship between two variables.

#### ***Variables and data***

Some data have been collected in different databases to illustrate the appearances of stylized facts. The collection of these variables and data is based on some assumptions. Each variable is described according to its importance in explaining a stylized fact. The relation between the variables are those interpreted as stylized facts. These relations can be analysed to identified the proxy's variables. Variables are measured in

databases in order to be studied. There are many databases available and some slight differences between them.

*Fact 1: Increases in the extent of the market* The increased in the extent of the market is illustrated by the relationship between the trade and investment (internal or external). According to Jones and Romer (2010), this relation is mainly important because it enhance the flow of local ideas through Foreign Direct Investment (FDI). Foreigner invest their money but also their knowledge to implement new activities. The same argument had already been used by Romer (1992) to explained how Mauritius, a poor country has used knowledge to perform his economic development. Based on this approach, trade can be considered has a good proxy of idea. Data about trade have been collected in World Development Indicator (WDI) database 2019.

*Fact 2: Accelerating growth* The fact 2 is more clear than fact 1 because it established a positive correlation between the population and economic growth. As population increases, the economic growth increased too. This positive correlation can be explained by the increase in the number of main power and the flows of ideas. The size of the population acts to the size of ideas produced and the sized of workers for local industries. As population fuelled economic growth, it can be considered as a factor of economic growth. Data about the population size have also been collected in the WDI database 2019.

*Fact 3/4: Variation in modern growth rates/Large income and total factor productivity (TFP) differences* These facts point out the efficiency of capital and labour. According to the both facts, capital and labour are efficient when associated with knowledge. This efficiency is mainly due to institution. A good quality of institution is better than a poor quality one. So, the institutions are acting more on capital than labour because capital can be listed and shown to populations. An investment in Gross Capital Formation (GCF) is a good indicator to justify the role and the importance of institutions. That's why, we resort to link the index of institution to the volume of GCF as a proxy for the capital efficiency. Political stability has been used as the index of institution and associated to GCF in a multiplicative relationship. Data about the Gross Capital Formation have been collected in WDI database and data about institution have been provided by the PRS Group's database 2019.

*Fact 5/6: Increases in human capital per worker/ Long-run stability of relative wages* The facts 5 and 6 are focus on the efficiency of labour force and its implication for well-being. In facts, human capital must be improved by education and health. Jones and Romer (2010) focus facts 5 and 6 on education and showed that people spend more times at school to learn. This learning improves their human capital and salaries. Education is individual before being collective because more educated you are and huge salary you received. So, education is important for workers than unemployed. In that case, the more important challenge is increase of educated people and that of teachers. That why, the ratio of pupil-teacher ratio in primary school has been associated to the size of labour force in a multiplicative relationship. Data about labour and the pupils-teacher ratio have both been collected in WDI database 2019.

### Econometric model

The econometric model of RAO (2010) has been used to illustrate the relationships described by stylized facts. The technology of the model is that of Cobb–Douglas. The basic form of the model is:

$$Y_{it} = C(NK)_{it}^{\gamma} K_{it}^{\alpha} L_{it}^{1-\alpha} \quad (1)$$

By applying the logarithm at each side of the equation, we obtain:

$$\ln Y_{it} = \ln(C) + \gamma \ln(NK)_{it} + \alpha \ln K_{it} + (1 - \alpha) \ln L_{it} \quad (2)$$

With  $Y_{it}$ : GDP/capita,  $(NK)_{it}$ : Knowledge variable,  $K_{it}$ : Capital,  $L_{it}$ : Labour and  $C$ : Constant.

In long term, the derived function of Eq. (2) allowed the calculation of the growth rate of each variable. The point on the variables indicates a derivative time.

$$\frac{\dot{Y}}{Y} = \frac{\dot{NK}}{NK} + \alpha \frac{\dot{K}}{K} + \beta \frac{\dot{L}}{L} \quad (3)$$

Knowledge variable is a set of four variables ideas, population, institution and human capital. These variables must be also approximated in order to collect data. The proxy used for ideas is trade, the proxy used for human capital are Pupil-teacher ratio in primary and the size of labour. As population, we resorted to the size of the population and finally, political stability and Gross Capital Formation has been used as proxy for institution. Equation (2) is rewritten as:

$$\ln Y_{it} = \ln(C) + \gamma [\phi \ln(Ideas)_{it} + \varphi \ln(Pop)_{it} + \eta \ln(Hum)_{it} + \chi \ln(Inst)_{it}] + \alpha \ln K_{it} + (1 - \alpha) \ln L_{it} \quad (2')$$

With  $Y_{it}$ : GDP/capita,  $(Pop)_{it}$ : Population,  $(Ideas)_{it}$ : Ideas,  $(Hum)_{it}$ : Human Capital,  $(Inst)_{it}$ : Government Institution,  $K_{it}$ : Capital,  $L_{it}$ : Labour and  $C$ : Constant.

### Results and discussion

Among the eight countries members of WAEMU, only six have been considered: Burkina Faso, Côte d'Ivoire, Mali, Niger, Senegal and Togo. Benin and Guinea-Bissau have been missed because of lack of data. Without these both countries the model has been more significant.

|        | Pooling       | GLS (random)   | FGLS           |
|--------|---------------|----------------|----------------|
| dgcf   | 0.0698144**   | 0.0698144*     | 0.0698144**    |
| dlabor | − 2.185686*** | − 2.185686***  | − 2.185686***  |
| dhum   | 0.0330378***  | 0.0330378***   | 0.0330378***   |
| dpop   | 2.264817***   | 2.264817***    | 2.264817***    |
| dideas | 0.0134598***  | 0.0134598***   | 0.0134598***   |
| dinst  | − 0.008562**  | − 0.008562*    | − 0.008562**   |
| cons   | − 0.0360827** | − 0.0360827*** | − 0.0360827*** |

\*p<0.1; \*\*p<0.1 and \*\*\*p<0.05

As result, we find that the capital, population, ideas and human capital have positives effects economic growth while labour and institution have negatives effects on economic growth. All the results are significant at 10%. There is no correlation and data are heteroscedastic.

Gross Capital formation acts positively on economic growth in sub-Saharan countries (Uneze, 2013). Each investment in Gross Capital formation increased the economic growth in WAEMU. These investments are done mainly by government. The stability of government must have fuelled the investment in Gross Capital Investment. Unfortunately, it's not the case in WAEMU. When there is government stability, the investment decreased otherwise it increased. This fact could be explained by public aids. In fact, during the crisis, international institutions gave loans to afflicted countries and reduce their debts. All the countries in WAEMU have benefit from Heavily Indebted Poor Countries (HIPC) initiative (IME, 2014). This money has mostly been used to invest in capital formation immediately after the end of the conflicts. So, during stability, government had to pay for the debt and *ceteris paribus* reduce the amount for investment.

Labour has a negative effect on economic growth in WAEMU. This fact is due to numerous people that work in informal sector. These activities are done just to survive and the add values created are very low. Fortunately, when we increased the number of teachers in primary school, the effect of workforce on economic growth become positive. Education at primary school can then be considered as the key to improve the efficiency of labour in WAEMU.

Population acts positively on economic growth of WAEMU. This result is important because it's means that government have to think about the right way to manage the number of population. The size of population is an opportunity to enhance economic growth because people are exchanging many knowledge that act on economic growth. One of these knowledge is the trade. Trade openness has a positive effect on economic growth (Rao, 2010) and allowed an increase of economic growth. The exchange in border and out border leads to importation of innovation and technologies from developing countries to poor countries (Romer, 1992). And it's clear that, WAEMU benefit from trade openness.

## Conclusion and recommendations

Stylized facts of knowledge have been subdivided into two categories: overall growth and overall income. Each category is consistent with the standard analysis of Jones and Romer (2010). For the overall growth, it can be said that the markets in the area have expanded in line with world market trends. This expansion has led to a dynamic in economic growth that exceeds the natural growth of the population. The rate of economic growth and that of GDP per capita growth rates in the Member States is different according to each country over the period 1960–2000. This difference in growth rates is due to the difference in TFP. For overall income, we noticed that the world has seen a steady increase in income, which is an increasing linear function of TFP. It is also noted that the human capital in education used to approximate TFP allowed the explanation of the dynamic of economic growth rates and the market, but does not explain the difference between member countries. However, the stock of human capital leads to higher and stable wages in the area.

Whether it is global growth or global income, the analysis showed that the economic context of the WAEMU responds favourably to a change in economic policy. So, it's important to analyse the stylized facts on the empirical way. This fact is possible because stylized facts are established on four variables and set up some relationship between some variables. By using a proxy of ideas, population, human capital and institution, we noted that, they affect economic growth in WAEMU. Ideas act positively on economic growth (Jones, 2005) and Human capital acts positively on economic growth (Alawamleh et al., 2019); Unfortunately, institution act negatively on economic growth in WAEMU (Acemoglu et al., 2001) and population act positively on WAEMU economic growth (Troupa et al., 2020) in contrary of expected results. The positive impact of population can be explained by the negative impact of labor in the model. Then, government have to focus on population, capital human and ideas to improve economic growth in WAEMU because political instability (institutions) in WAEMU leads to a decrease in economic growth. It's also possible to make a combination between each factors of production to have interesting results (Maradana et al., 2017; Momeni et al., 2019; Okumu et al., 2019) about the relationship between each facts.

After empirical analysis; we are able to encourage governments to adopt knowledge economic in WAEMU because the standards stylized facts of Romer and Jones (2006) fits well with the results of stylized facts of WAEMU..

The promotion of knowledge would make it possible to achieve endogenous and rapid economic growth in WAEMU. This type of economic growth is a godsend because it would challenge the constraints associated with the old neoclassical growth models. This paper is an incentive to encourage the local government in WAEMU to focus on new factors of economic growth scoped by knowledge.

#### Abbreviations

|       |                                                              |
|-------|--------------------------------------------------------------|
| BRVM  | Regional Stock Exchange                                      |
| CICUP | Centre for International Comparisons of the University       |
| CIMA  | Inter-African Conference on Insurance Markets                |
| FDI   | Foreign Direct Investment                                    |
| GCF   | Gross Capital Formation                                      |
| GDP   | Gross domestic product                                       |
| HIPC  | Heavily Indebted Poor Countries                              |
| IMF   | International Monetary Fund                                  |
| OHADA | Organisation for the Harmonisation of Business Law in Africa |
| PIRDU | Regional Indicative Programme for Urban Development          |
| SADC  | Southern African Development Community                       |
| TFP   | Total factor productivity                                    |
| WAEMU | West African Economic and Monetary Union                     |
| WDI   | World Development Indicators                                 |
| WTO   | World Trade Organization                                     |

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#### Author contributions

ANAA is the main investigator. He has been at each level of the conception: brainstorming, writing, analysis and discussions. BZ is a senior lecturer. He has made a great support during the writing and the analysis and discussion of all the results. SGFT is a lecturer. He has made a great support during the data collection, the analysis and discussion of all the results. All authors read and approved the final manuscript.

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### Availability of data and materials

The datasets generated and/or analysed during the current study are available in the World Development Indicators (WDI) repository, <https://databank.worldbank.org/source/world-development-indicators>. The datasets generated and/or analysed during the current study are available in the Penn Word Tables 6.1 repository, <https://www.rug.nl/ggdc/productivity/pwt/pwt-releases/pwt-6.1?lang=en>. The datasets generated and/or analysed during the current study are available in the FMI (GFS & WEO) repository, <https://www.imf.org/external/pubs/ft/weo/2011/02/weodata/WEOSep2011all>. The datasets generated and/or analysed during the current study are available in the Word Development Indicators (WDI) repository, <https://databank.worldbank.org/source/world-development-indicators>. Data are available on line: see Barro-Lee 2016 repository, <http://www.barrolee.com/>.

### Declarations

#### Competing interests

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