Globalization, Labour productiviy and convergence in Africa

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GLOBALIZATION, LABOUR PRODUCTIVITY AND CONVERGENCE IN AFRICA

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Summary

The topic of convergence has caught attention of many researchers. For a long time, economic literature on convergence asserted that less developed countries (regions) should grow faster to catch-up wealthy countries. Globalization and technology transfer appears to be among the drivers of convergence. However, for some decades, empirical researches emphasize that countries diverge and there is club convergence phenomenon. The latter finding stresses that within a same group, countries converge while groups diverge. This raises the question of the conditions of convergence. This essay investigates the role of globalization to economic convergence. We assume that the degree of openness will contributes to the labour productivity growth and therefore will promote convergence.

We rely on the case of Africa. This choice comes from the claim that different regions may have their own production frontier. We extend the Kumar & Russel (2002), Henderson & Russel (2005), and Badunenko, Henderson & Houssa (2014) approaches by integrating the globalization intensity in the analysis of convergence. Our analysis stands on a panel of 41 countries over 19 years (2001 to 2019). We use the DEA production frontier methodology to assess the technical efficiency and to compute the Malquist Index of Productivity (MPI) that allows decomposing labour productivity into its components. Findings reveal that globalization is a source of labour productivity growth in Africa and ignoring it into the analysis of convergence overstates the role of physical capital accumulation and understates that of human capital accumulation. We use the Kernel density estimation to check whether African countries converge and plot regression lines to grasp the contribution of each component to convergence. The results show the polarization in Africa since the distribution of labour productivity is bimodal. Technological progress and human capital accumulation are the sources of divergence and polarization of African economies while technological catch-up (efficiency change), physical capital accumulation and globalization intensity change are the drivers of convergence in Africa.

This study has also the merit to use a "holistic" measure of globalization that takes into account different dimensions of globalization. Hence, this study highlights the role that globalization plays in labour productivity convergence in a developing context. However, this study has some limits including the lack of a depth analysis per sector to grasp how the spillover effects from globalization disseminate across sectors. Second, the period analysis is very short (19 years). Extending the analysis to a long period would provide interesting insights.

Table des matières

Acronym & Abbreviation

AMU	Arab Maghreb Union
BHH	Badunenko, Hernderson & Houssa
CEN-SAD	Community of Sahel-Saharan States
COMESA	Common Market for Eastern and Southern Africa
DEA	Data Envelopment Analysis
EAC	East African Community
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
EFF	Efficiency Change
FDI	Foreign Direct Investment
GIC	Globalization Intensity Change
HACC	Human Capital Accumulation
HR	Henderson & Russel
IGAD	Intergovernmental Authority on Development
KACC	Physical Capital accumulation
KDE	Kernel Density Estimation
KR	Kumar & Russel
MPI	Malquinst Productivity Index
PWT	Penn World Table
SADC	Southern African Development Community
SSA	Sub-Saharan Africa
TECH	Technological change

Introduction

Globalization is a determinant of economic stability (Mallick, 2013). Since the 1970s, it has become the dominant development paradigm. This claim comes from several seminal works since the 19th century (see Ricardo, Hekcher-Ohlin, Hume, etc.) which emphasize that countries earn better by trading with each other. International economic forces play then a key role in determining domestic growth (Rowthorn & Kozul-Wright, 1998). Recent literature studies recognize that globalization strictly determines the country economic growth (Chang & Lee, 2010). But, the effect of globalization depends on intensity of integration into the global economy (McMillan & Rodrik, 2011; Flassbeck & La Marca, 2009; Bonga-Bonga & Kinfack, 2019). For many economists, there is a trilogy: greater openness, faster growth and economic convergence (Rowthorn & Kozul-Wright, 1998). Along the same lines, De Long (1988) pointed out that economists in the 19th and 20th centuries were optimistic about future convergence.

Globalization has changed the philosophy of firms through the emergence of new production models such as offshoring, outsourcing, etc. This has changed both the role of international capital and the characteristics of international trade (De Benedictis & Tajoli, 2011), and raises the importance of human capital in the international production process (Rowthorn & Kozul-Wright, 1998). These facts make international trade a more complex network (De Benedictis & Tajoli, 2011). Countries have become more deeply interconnected over the years, and trade flows and geographical composition of trade dramatically changed. This growing globalization and interconnectedness has caused spatial and temporal dependency that drastically affects the production process of each country (Mastromarco & Simar, 2018). This interconnectedness has been an engine of convergence of economies. For example, Mallick (2015) pointed out that the strong productivity growth recorded in the BRICS countries could be attributed to the pressure of globalization.

The neoclassical growth model predicts convergence in average income. According to this growth model, countries with similar conditions do converge in the long run to a common steady state (Rowthorn & Kozul-Wright, 1998; Alkathiri, 2021; Solow, 1957; Sala-i-Martin, 1996). This implies that economies can show a polarization (clubs convergence) when some (group of) counties display certain heterogeneity (Gáspár, 2012; Walheer, 2021). However, scholars agree that globalization enables technology to spread across countries (Mallick, 2015; 2013). Hence, countries may have identical technology and then could converge. However, although countries become increasingly interconnected (Gygli, Haelg, Potrafke, & Sturm, 2019), recent studies reveal that labour productivity has shifted from a unimodal to a bimodal distribution with a high mean indicating a divergence of economies (Henderson & Russel, 2005; Kumar & Russel, 2002; Walheer, 2018; 2021).

There is a lack of consensus on the effect of globalization. Despite this divergence in the empirical literature on globalization, technology transfer is one of important advantages of globalization (McMillan & Rodrik, 2011; Bonga-Bonga & Kinfack, 2019; Gammadigbe, 2021; Flassbeck & La Marca, 2009; Mastromarco & Simar, 2018). This can be a channel for disseminating knowledge, innovation and technical progress, and would have an effect on the convergence of countries in terms of labour productivity. Over the three past decades, globalization has spurred in developing countries, especially in Africa. Although there is a close relationship between labour productivity and economic growth, African countries, particularly those in SSA, have recorded low labour productivity compared to that of other developing countries, and this has been declining for three decades (Rowthorn & Kozul-Wright, 1998; Wamboye & Tochkov, 2014; Badunenko, Henderson, & Houssa, 2014). Likewise, McMillan & Rodrik (2011) and Mallick (2015) assert that even within the same group, there are very significant gaps in labour productivity between different sectors.

Economic growth and convergence topic have attracted more attention form economists. Some studies reveal the positive effect of integration on convergence while others show the opposite. However, results may hinge on the methodology used, the sample and the period analyzed. For example, Gaulier, Hurlin, & Jean-Pierre (1999), using a panel data for three different samples from 1960 to 1990, noted a process of absolute convergence for GDP per capita in the European Union, a conditional convergence in the OECD whereas no process of convergence at the world scale. Existing studies for Africa rely on Regional Economic Communities – RECs–(e.g. Songwe, 2021 Gammadigbe, 2021). To our knowledge, the only work that exists on labour productivity using a nonparametric approach in Africa is Badunenko, Henderson, & Houssa, 2014). This study considered a panel of 35 countries over 38 years (1970-2007) to examine the source of labour productivity divergence in Africa by relying on the labour productivity decomposition procedure suggested by Kumar and Henderson. This study shows that physical and human capitals are the main drivers of productivity growth at the country level. On the other hand, they assert that the low total factor productivity growth is the main impediment to the poor economic performance in Africa.

Despite the increase in globalization intensity since few decades, not much has been done at the cross-country level to test empirically the role of globalization on labour productivity convergence. Chang & Lee (2010), Gammadigbe (2021), Songwe (2021), Flassbeck & La Marca (2009), Mallick (2015), Rowthorn & Kozul-Wright (1998), Mastromarco & Simar (2018), Mallick (2013) are some exceptions. Their evidence reveals that globalization affect positively labour productivity via improvement resource allocation and the Total Factor Productivity (TFP). However, most of these (except Mastromarco & Simar, 2018) rely on parametric approach. These authors partially captured globalization information the FDI as the proxy of globalization.

This research aims to fill this gap by using on a nonparametric approach to model convergence in Africa. It extends the existing literature by incorporating globalization into the production frontier approach suggested by Kumar & Russel (2002) and Henderson & Russel (2005). Since Africa can have its own production frontier (Badunenko, Henderson, & Houssa, 2014), we rely only on African countries. Globalization intensity is used to multiplicative augment physical capital. The intuition behind this way of modeling is supported by the literature on the link between globalization and financial development and the role of financial development in the allocation of resources. Hence, one unit of capital is expected to be more productive in a country with high globalization intensity. This modeling strategy will provide a conceptual basis for analysis in a production frontier framework of the role of globalization on the convergence of labour productivity.

The main objective of this research is to develop a link between globalization and macroeconomic convergence and to assess macroeconomic convergence based solely on a developing context. To the best of our knowledge, this is the first study that explicitly assesses the role of globalization on labour productivity convergence using a production frontier framework. The advantage of this non-parametric approach over the parametric approach is that it is a purely data-driven technique and then doesn't require assumptions in terms of functional specification (Arcelus & Arocena, 2000; Walheer, 2018). Furthermore, this approach requires neither any specification of a particular production function technology nor the existence of perfectly competitive markets or neutral technological change according to Hicks. Second, we account the multidimensional feature of globalization using the KOF index of globalization. This index, developed by (Dreher, 2006) and improved (Gygli, Haelg, Potrafke, & Sturm, 2019), grasps different aspects of globalization into three dimensions: economic social and political. Third, this essay by introducing the globalization into the analysis of convergence in Africa extends (Badunenko, Henderson, & Houssa, 2014) by relying on the African production-frontier.

To achieve these objectives, we use the Penn-World Table and the KOF databases for respectively macroeconomic variable and globalization. We merge these databases and extract 41 countries. The final database is a balanced-panel data base for the period from 2001 to 2019. Data are processing using the Kernel Density Estimation (KDE) to assess the convergence and production frontier Data Envelopment Analysis (DEA) nonparametric approach and Malmquist Productivity Index (MPI) to measure the efficiency and analyze the productivity decomposition.

In addition to this introduction and the conclusion, the remainder of this study is organized as follows. Chapter 1 presents the literature review and the theoretical framework of globalization and convergence nexus. Chapter 2 discusses the methodology and constructs our technology frontiers in 2001 and 2019 for each of the 41 countries. Chapter 3 provides results and discussions.

Chapter 1 Literature review

This chapter has three sections. The first section introduces the concept of globalization. The second section discusses the theoretical literature of growth and convergence. The third section presents some stylized facts and discusses the link that may exist between globalization, growth and convergence.

1.1 Theories of globalization and measures

The term "globalization" is a multidimentional concept. It is defined according to the context, field, civilization, etc. More generally, it refers to an openness of national economies, cultures and governance to foreign influences (Dreher, 2006; Kellner, 2002; Gygli, Haelg, Potrafke, & Sturm, 2019). Specifically, it refers to economic barriers removal, which makes countries interdependent (Gygli, Haelg, Potrafke, & Sturm, 2019). It then promotes information and knowledge diffusion and enables the mobility of physical and human capital as well as the dissemination of social capital through creation of networks (Dreher, 2006; Kellner, 2002). Hence, globalization process impacts all aspects of nations by eroding local culture and traditions, political and economic models (Gygli, Haelg, Potrafke, & Sturm, 2019).

Globalization is seen as a way of expanding egalitarian institutions, smoothing inequalities and then increasing welfare around the world (Kellner, 2002; Dreher, 2006). It enables better allocation of resources (Kellner, 2002), fosters reforms and bring out fresh economic opportunities (Kellner, 2002; Mishkin F. S., 2009; Liang, Marquis, & Sun, 2014), which impacts the structure of production and the trade pattern. Since globalization increases competition between foreign and local firms, it fosters local firms to be more innovative and productive (Mallick, 2015; Alkathiri, 2021; Mishkin F. S., 2007; Liang, Marquis, & Sun, 2014; Dreher, 2006). In sum, globalization enforces standardization and fosters economic convergence across countries. The economic literature emphasizes the role of globalization in the physical and human capital convergence process (Mastromarco & Simar, 2018).

On the other hand, some scholars support that the effects of globalization are mixed (Klein & Olivei, 1999; Kose, Prasad, & Terrones, 2009; Stiglitz J. E., 2002). According to these authors, globalization increases inequalities and hegemony of wealthier countries over poor ones. These authors argue that the competition between foreign (wealthier) firms and local firms in developing countries can stifle local firms, especially SMEs given their lack of economic scale and their low capacity to innovate and to adapt themselves to the fast changes on the market (Mishkin F. S., 2007; Stiglitz J. E., 2002). Despites their comparative advantage in labor-intensive production and wage (Liang, Marquis, & Sun, 2014), local firms in developing countries cannot withstand on the market due to their fragility and high cost since they are less likely to rapidly adapt themselves to the technological changes as well as the market demands such as quality norms, etc. (Stiglitz J. E., 2002). Moreover, as globalization erodes national boundaries, shocks are easily disseminated across countries. In this vein, scholars agree that economic globalization is an important channel for the contagion of shocks (Klein & Olivei, 1999; Mishkin F. S., 2007; Stiglitz J. E., 2010b). There is a threshold beyond which integration increases risk sharing and makes countries more vulnerable to external shocks (Kose, Prasad, & Terrones, 2009; Stiglitz J. E., 2010a; 2010b; Noumba, Noula, & Nguea, 2022). The recent corona virus pandemic and the 2008 financial crisis are the best illustrations.

Since globalization is a fuzzy concept (Chang & Lee, 2010), there is a range of terms that are used as synonyms for globalization such as internationalization, integration, openness, etc. while being different[1]. Therefore, several measures are used in the literature to grasp globalization. Most of studies rely on FDI, the volume of trade, investment portfolio, level of trade restriction, the degree of openness, etc. However, this way is less global since globalization is a complex and multifaceted phenomenon (Dreher, 2006; Gygli, Haelg, Potrafke, & Sturm, 2019). To overcome the lack of robustness of using one proxy (Pierucci & Ventura, 2012), some authors used simultaneously several proxies. However, this can lead to some biases given the strong correlation that can exist between proxies (Dreher, 2006; Pierucci & Ventura, 2012). To overcome the limits of using several proxies simultaneously, recent literature suggest aggregating these information into a composite index. The well-known globalization index is the KOF index of globalization. This is one of powerful globalization index because it is constructed from several indicators based on both *de jure* and *de facto* information.

De jure measures refers to policies and conditions that are taken in the line with globalization (Kose, Prasad, & Terrones, 2009; Liang, Marquis, & Sun, 2014; Gygli, Haelg, Potrafke, & Sturm, 2019). These policies are implemented by policymakers generally through a bilateral or multilateral approach and indicate, therefore, the degree of globalization through regulation (Mukulu, 2020). These measures derive from variables related to policies, resources and institutions that facilitate mobility and promote flows and activities between countries (Kose A. M., Prasad, Rogoff, & Wei, 2006; Bekaert, Harvey, Kiguel, & Wang, 2016; Gygli, Haelg, Potrafke, & Sturm, 2019). Regarding de facto measures, they relate to actual flows and activities (Tovar García, 2012; Liang, Marquis, & Sun, 2014; Bekaert, Harvey, Kiguel, & Wang, 2016; Gygli, Haelg, Potrafke, & Sturm, 2019). Hence, De facto measures capture the outcomes of globalization rather than exogenous changes that have occurred (Kose, Prasad, & Terrones, 2009).

The KOF index of globalization contains the overall globalization index which combines both de jure and de facto variables of the three main dimensions of the KOF globalization: economic, political and social.

1. *Economic globalization*

The economic dimension of globalization is the widely used dimension in the globalization literature. It describes the flows in goods, capital, services and information as well as the perception of the market liberalization (Dreher, 2006; Pierucci & Ventura, 2012; Gygli, Haelg, Potrafke, & Sturm, 2019). *De jure* measures associated with this dimension refer to restrictions in trade and capital through hidden import barriers, tariff and taxes on international trade and capital controls. *De facto* measures relate to actual flows of foreign direct investment, trade, portfolio investment, a reward of foreign capital (wage, interest, and dividend), etc. (Dreher, 2006; Pierucci & Ventura, 2012; Gygli, Haelg, Potrafke, & Sturm, 2019).

Economic globalization has two sub-dimensions: trade liberalization and financial openness. The trade liberalization relates to actual flows of goods and services (Pierucci & Ventura, 2012; Gygli, Haelg, Potrafke, & Sturm, 2019). It refers to the trade network between countries (Bekaert, Harvey, Kiguel, & Wang, 2016), and is measured through the inward and outward of goods and services as a share of GDP. As for financial openness, it refers to the integration of the local financial sector into the global financial system. It is measured by capital flows and the stock of foreign assets and liabilities (Bekaert, Harvey, Kiguel, & Wang, 2016; Gygli, Haelg, Potrafke, & Sturm, 2019). While

[1] These globalization, openness and liberalization are used interchangeably in this work

the implementation and effects of financial globalization are more controversial than those of trade liberalization (Rajan & Zingales, 2001; Mishkin F. S., 2007), these two dimensions are nevertheless strongly interdependent (Rajan & Zingales, 2001; Bekaert, Harvey, Kiguel, & Wang, 2016).

2. Social globalization

Social globalization describes how social values and norms spread across countries (Dreher, 2006; Liang, Marquis, & Sun, 2014; Gygli, Haelg, Potrafke, & Sturm, 2019). It refers to how countries influence each other. This dimension of globalization consists of three sub-dimensions, namely interpersonal globalization, informational globalization and cultural globalization. The interpersonal dimension refers to how people are connected across the world. It gathers data on personal contacts such as international tourism, Internet users, number of radios, telephone calls and costs and foreign population in a country (Pierucci & Ventura, 2012). The informational globalization is the pervasive form of social globalization (Keohane and Nye, 2000 in Dreher, 2006). It refers to the way people communicate and access information (local and international). This sub-dimension is measured by several variables such as daily newspapers, telephones mainline, Internet hosts and users, etc. (Pierucci & Ventura, 2012). For the cultural dimension, it is linked to the transmission cultural values through cultural goods and services such as TV series, music, food behaviors, etc. across countries (Pierucci & Ventura, 2012; Gygli, Haelg, Potrafke, & Sturm, 2019). Social globalization improves opinion freedom, human welfare, and tolerance which can ensure economic and political stability (Noumba, Noula, & Nguea, 2022).

However, social globalization is hard to pin down since it is more related to subjective norms (Dreher, 2006; Pierucci & Ventura, 2012). For example, some authors find in this dimension an excess of Americanization or westernization of the society (Such, 2000 in Dreher, 2006; Gygli, Haelg, Potrafke, & Sturm, 2019). *De jure* measures associated to these sub-dimensions refer to the way and to what extent these flows are obstructed. It is about how policymakers protect freedom and ensure access to appropriate infrastructures that enable these flows.

Political globalization refers to how government policies are diffused (Dreher, 2006; Gygli, Haelg, Potrafke, & Sturm, 2019). It indicates the extent to which a country contributes to the dynamics of politics on a global. This can also be a signal of the degree of foreign influence and resources that a country is willing to accept. *De jure* measures relating to this dimension refer to the ability of a country to engage in international political cooperation through the diversity of partner treaty and the laws and official texts in line with theses participations (Gygli, Haelg, Potrafke, & Sturm, 2019). *De facto* measures refer to the number of embassies in a country, the number of international organization in which it involves and the number of UN peace missions in which a country partakes, number of NGOs active in a country (Dreher, 2006; Gygli, Haelg, Potrafke, & Sturm, 2019; Pierucci & Ventura, 2012). According to Noumba, Noula, & Nguea (2022) political globalization is likely to have positive outcomes on economic and social activities. As a stable country is likely to record better economic performance (Mallick, 2013), countries with identical political patterns should converge to a common steady state. However, this may have opposite effect when for example two countries have different structures in terms of culture, habit, etc.

2.2 Globalization, Growth and convergence

In economics, convergence refers to the ability of countries to move toward the same levels of income per capita (references). The literature distinguishes absolute (unconditional) convergence from conditional convergence. Unconditional or absolute convergence exists when a country converges to the same steady state in which all economies converge (Mathur, 2005; Gaulier, Hurlin, & Jean-Pierre, 1999). This is grasped when comparing a country with other countries in terms of (absolute) income per capita level. Conditional convergence occurs when a country converges to its steady state (Mathur, 2005; Gaulier, Hurlin, & Jean-Pierre, 1999). It is captured by comparing to its previous level of income, which is the income growth rate. Hence, conditional convergence is the convergence in growth rate while unconditional convergence is the convergence in levels.

The topic of convergence has caught attention of many researchers. Two strands have emerged in the literature. The first asserts that countries within the same region should converge in the long-run (Martin & Sunley, 1998; Martin R. , 1999). The neoclassical theory that predicts convergence asserts as all countries within the same integration area will face strong pressures that will erode barriers of factors mobility. The convergence theory from the factor-price equalization theorem that predicts factor returns within an integration area will converge since trade barriers falls (Martin R. , 1999; Rassekh, 1998). This theory assumes that laggards grow faster than the first leader (Rassekh, 1998; Sala-i-Martin, 1996; Lopez, De Lucas, & Delgado, 2021). Therefore, poor countries will catch-up with rich ones in the long run. This stylized fact can be explained by the law of diminishing marginal return. Hence, since rich countries have a large stock of capital, capital would flow from less remunerated space (developed countries) toward better remunerated space (developing countries). Another interesting stylized fact is related to globalization. Indeed, scholars agree that less developed countries can improve their catch-up effect by opening up their economies (Lopez, De Lucas, & Delgado, 2021). Hence, opening up their economies strengthens poor countries' capabilities to attract and absorb new technology and capital.

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The second strand supports the divergence. This comes from an amount of criticisms of neoclassical theory. According to this strand, there is no necessary reason of economy convergence, even in the long run (Martin & Sunley, 1998). Since there is an uneven spatial distribution of economic activities, market forces themselves cannot lead to price equalization due to certain economic phenomena such as returns to scale, externalities, initial endowment, etc. (Martin R. , 1999; Martin & Sunley, 1998). Furthermore, this spatial imbalance fosters uneven development that tends to self-reinforce rather than being corrected (Martin & Sunley, 1998).

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If divergence rather than convergence characterized the world economy in the two previous centuries (Rassekh, 1998), countries have been increasingly converging but with a polarization. Recent empirical studies have pointed out the club convergence (references). These studies show that instead of countries converging to a common steady-state, countries converge within the same group but diverge across groups. This pushes several scholars (e.g. Badunenko, Henderson, & Houssa, 2014) to conclude in favour of the existence of different production frontiers according to regions.

The goal of understanding the source of growth as well as that of different levels of growth has run through the history of growth literature and divides different waves of theories. According to the neoclassical growth model, income (output) growth is mainly driven by the level of technology, while the new growth theorists point out that both human' desire and unlimited willingness promote productivity and therefore economic growth (Williamson, 1996). The literature on accounting growth attributes the source of growth to the technical change, the so-called Solow residual (Mastromarco & Simar, 2018).

Two main concepts have emerged to measure convergence: beta and sigma convergence. There is a beta convergence when the regression coefficient of the growth rate in income per capital at the beginning of the period is negative (Williamson, 1996; Martin & Sunley, 1998; Sala-i-Martin, 1996). This implies that countries within the same group tend to have the same level of income per capita. Regarding the sigma convergence, this refers to the decline in the income per capita gap across countries. Hence, one can say there is a sigma convergence when the income per capita dispersion (variance) tends to decrease over time (Martin & Sunley, 1998; Sala-i-Martin, 1996). Since the sigma convergence, besides depending on beta convergence, hinges on the error terms, beta convergence is a necessary condition for sigma convergence but not sufficient (Martin & Sunley, 1998; Sala-i-Martin, 1996).

Among the channel of convergence, the literature of convergence points out technology and globalization[2]. Scholars agree that globalization facilitates the transfer and adoption of technology across countries (Mallick, 2015). The neoclassical growth model predicts that if countries have a similar savings and population growth, they should converge in the long run to a common steady state (Rowthorn & Kozul-Wright, 1998; Alkathiri, 2021). Intuitively, since globalization fosters countries to have identical technology, it may therefore contribute to countries convergence. Hence, less

[2] For more details see Rassekh (1998)

wealthy (poor) countries should grow faster than wealthier countries since they have higher marginal productivity of capital (Rowthorn & Kozul-Wright, 1998; Alkathiri, 2021).

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There is a large literature on the effect of globalization on economic growth. Recent studies emphasize the role of globalization on economic growth using either proxies or the index of globalization. Relying on a parametric approach and using the KOF overall globalization index, Dreher (2006) and Chang & Lee (2010) highlight the positive effect of globalization on economic growth on the global scale and in the OECD area, respectively. Some authors such Chang & Lee (2010) and Songwe (2021) pointed out that the causal effect of globalization on economic growth is very weak in the short-run but strong in the long run both for the overall index and different dimensions of globalization. This sheds light on how the effect of globalization can explode over time.

From a historical perspective, Williamson (1996) asserts that globalization played a crucial role in the convergence of economies. The parametric approach literature distinguishes conditional to unconditional convergence and beta to sigma convergence (Sala-i-Martin, 1996). The unconditional or absolute convergence (convergence in levels) means that there is a common steady state to which all countries will converge while conditional convergence (convergence in growth rate) implies that each country converges to its own steady state (Mathur, 2005; Gaulier, Hurlin, & Jean-Pierre, 1999). The sigma convergence refers to the fall in gaps between countries while the beta convergence implies that poor countries should grow faster than rich (Williamson, 1996; Sala-i-Martin, 1996).

For a few decades, the production frontier non-parametric approach has become popular in convergence analysis. This approach has gained in popularity as it is a data-driven approach and does not impose prior assumptions. Kumar & Russel (2002) developed the decomposition of technical efficiency into three components: efficiency change, technological change and capital accumulation. Later, Henderson & Russel (2005) introduce a fourth dimension – the human capital – into the Kumar & Russel model. Unlike Solow (1957), these authors found that technological change is non-neutral and productivity growth is driven primarily by physical capital accumulation (KR) and both physical and human capital accumulation (HR). These studies reveal that the productivity growth moves from unimodal to bimodal shape and this polarization is primarily driven by capital deepening. By integrating human capital in the KR model, Henderson & Russel (2005) showed that physical capital accumulation was overstated in the KR study. Moreover, these studies conclude to non-neutrality contribution of technological change. The same findings are partially found by Badunenko et al. (2014) when analyzing convergence using the African production frontier instead of the world one. These authors found that African countries depict efficiency losses that hamper productivity growth. Physical capital accumulation appears to not significantly contribute to labour productivity growth in Africa and technological change is nonexistent. They found that human capital accumulation is the major and only driving force behind labour productivity in Africa.

For a few years, some researchers are extending this KR-HR model by integrating other variables. For example, Badunenko & Romero-Avila (2013) tested the role of financial development on growth and convergence and show that capital accumulation is formally overstated when the model doesn't integrate the efficiency of capital. Walheer (2018) tested respectively the role of energy (renewal and non-renewal) on labour productivity convergence in Europe and Walheer (2021) checked the technology heterogeneity in the European production frontier. He showed that less wealthy countries in Europe converge toward wealthier countries and highlighted the presence of club convergence due to technological heterogeneity. Hence, European countries show a convergence within clubs and divergence across clubs.

The rare studies focused on globalization in the economic convergence analysis relied on proxies. Foellmi & Oechslin (2014), exploring the impact of international trade on a monopolistic competitive economy in developing countries, reveal that partial trade openness leads to a negative impact on productivity and overall output. Hence, echoing these authors, countries should fully open their economies to gain from liberalization. Mallick (2015), using cross-country regression, found that globalization measured by international trade and FDI has a significant impact on the upsurge of labour productivity in BRICS. Mastromarco & Simar (2018), using a nonparametric location scale, found that FDI both enhance technological changes and has a scale effect and complements labour through skill acquisition. For Africa, Songwe (2021) assesses the effect of trade openness on convergence in ECOWAS region. The results reveal that trade openness has a positive effect in the short run but the negative in the long run. The approach of Gammadigbe (2021) is more general as he compared convergence within and across different RECs in Africa. The found some evidence of convergence within RECs and divergence between RECs.

To sum up, the main conclusions that can be drawn from the above empirical literature are globalization may play a role in the convergence. The outcomes of convergence hinge on variables used in the model, the methodology employed, and the sample and timeframe considered. Hence, ignoring some variables such as globalization overstates the role of physical capital accumulation in productivity gain.

Chapter 2 Methodology and data source

This chapter has two sections. The first section presents data and the scope of this research. The second section presents the methodology.

3.1 Data source and scope

We use two databases in this research. The Peen-World Table version 10 (PWT) database provides insights on country GDP, physical capital (cn), human capital (hc), and labour (emp). The Penn-Table 10 provides both the GDP according to the living standard (based on consumption) and productive capacity approaches. We use the constant-price output RGDP because it allows a comparison both across countries and over time (Feenstra, Inklaar, & Timmer, 2015). We choose the productive capacity approach as we are interested in labour productivity. Physical capital is measured by the stock of capital at the current PPP. These two variables are measured in 2017 international price. These authors have measured human capital index following the Barro & Lee (2013) procedure based on Mincer equation estimates around the world. The human capital index ranges from 1 to 100. Labour is measured by the number of employees for each year. This is more convenient as it only relies on the active workforce instead of the total of the population that encompasses both active and inactive populations. Globalization insights come from the KOF globalization database version 2021.

The PWT 10 contains 52 African countries. Moreover, due to the lack of data on the human capital of some countries, 11 countries are dropped from the database. We merge the KOF index of the globalization database with the PWT 10 database. The final database used in this research is a sub-sample of 41 countries. Data is observed on 19 years ranging from 2001-2019. Hence, we have a balanced panel database of 779 observations. To proceed with data, we use MATLAB linear programming.

3.2 Methodology

First, this section develops the approach to grasping labour productivity growth and its decomposition. Next, this section presents methods and technics for processing data.

1. *Labour productivity convergence and decomposition*

There exists a great deal of literature on convergence. Two approaches have been developed: the first used a parametric approach that imposes some assumptions in terms of the function form of the production function. The second used a nonparametric production frontier approach that doesn't need any assumption on the production frontier technology (Rogge, 2019; Walheer, 2018; 2021). We use the second approach to measure labour productivity growth and make labour productivity decomposition.

To construct the production frontier, we assume that the production function is quasi-concave, continuous, strictly increasing, and satisfies constant returns-to-scale. This research extends the existing literature by adding external forces captured by globalization. The output (Y) is a function of four main inputs: physical capital (K), labour (L), human capital (H), and globalization (G). The amount of human capital and physical capital are captured in terms of an efficiency unit. Hence, following Badunenko & Romero-Avila (2013), Walheer (2018), (Rogge, 2019), and others, the human capital enters the technology as a multiplicative augmentation of labour input, i.e. $\hat{L} = L * H$. For the augmented value factor (H), Feenstra, Inklaar, & Timmer (2015) adopt the Barro and Lee (2013) human capital index. These authors improve the accuracy of education by disaggregating

gender and age groups and relaxing the assumption of uniform mortality rates across all age groups. This procedure overcomes the downward bias suffered by previous estimates of educational attainment (Barro and Lee, 2013 in Feenstra, Inklaar, & Timmer, 2015). Hence for a country j at time t, the labour in efficiency units is defined by

$$\hat{L}_{jt} = L_{jt} * H_{jt} = L_{jt} * h(u_{jt}) = L_{jt} * e^{\emptyset(u_{jt})} \quad (1)^3$$

where u_{jt} is the average number of years of education of the adult population in country i at time t, and $\emptyset$ is the marginal return of education. This is a piecewise linear function with a zero intercept and a slope of 0.134 for the fourth year of education, adding 0.101 for the next four years from the previous slope, and 0.068 beyond eight years of education from the four to eight schooling year slope (Barro & Lee, 2013 in Feenstra, Inklaar, & Timmer, 2015).

For physical capital, we integrate the degree of globalization into physical capital. This yields globalization augmented physical capital K^=L*G. The intuition behind this approach comes from the well-known role that globalization plays in the innovation spillover effect and that of investment in economic growth. For instance, (Badunenko, Henderson, & Houssa, 2010) assert that access to trade and FDI improves technology and efficiency in Mauritius in the last decades. Since globalization facilitates investment (Pellegrino, Spolaore, & Wacziarg, 2022), this affects the physical capital efficiency allocation (McMillan & Rodrik, 2011; Asongu, Nnanna, & Tchamyou, 2020). Globalization can affect the physical capital efficiency directly by adopting capital-intensive technology and indirectly through spillover effects from foreign firms towards domestic firms (Mallick, 2013).

On the one hand, since globalization erodes boundaries and therefore increases competition, it fosters firms (countries) to better allocate their resources (e.g. Alcala & Ciccone, 2004) and rationalize their operations (McMillan & Rodrik, 2011). On the other hand, globalization increases capital mobility (Rowthorn & Kozul-Wright, 1998; Kose A. M., Prasad, Rogoff, & Wei, 2006) allowing capital costs abatement that makes firms (countries) access to cheap credit. Abundant literature underlines the role of globalization in financial sector development that makes banks more innovative and reduces information asymmetries, which lowers the cost of capital (Rowthorn & Kozul-Wright, 1998; Kose A. M., Prasad, Rogoff, & Wei, 2006; 2009; Mishkin F. S., 2009; Rajan & Zingales, 1998; 2001). The efficiency unit of physical capital of a country j at time t is defined by:

$$\hat{K}_{jt} = K_{jt} * G_{jt} \quad (2)$$

Where $G_{jt} \in]0,1]$ is the degree of globalization.

Once defined the augmented factors of physical capital ($\hat{K}$) and human capital ($\hat{H}$), we derive from a four inputs production to a two inputs production function is given by $Y(\hat{K}, \hat{L}, G)$, and the production possibility set by:

$$T = ((Y, \hat{L}, \hat{K}) \in R_+^3 | Y \leq Y(\hat{L}, \hat{K}) \qquad (3)$$

From this expression, since the production function Y and the production possibility set T is a one-to-one relationship, defining one implies defining the other (Walheer, 2018). Instead of the traditional version of the nonparametric model that considers technologies to be obsolete over time, we assume

[3] One can notice that when the (average) years of education is 0, $h(0) = 1$

that technological degradation is impossible. Hence, we rely on a sequential version of the nonparametric frontier method which allows including previous technologies in subsequent periods and thus precluding the implosion of the frontier over time (Rogge, 2019; Walheer, 2018; Alkathiri, 2021). This way to construct the production possibility set has been suggested by Diewert et al. and used by several researchers (e.g. Walheer, 2018; Rogge, 2019; Alkathiri, 2021, etc.). The production possibility set satisfies these axioms: monotonicity, convexity, and constant return-to-scale. The sequential production set is defined by

$$T_t = \left\{ \left(Y, \hat{L}, \widehat{K}\right) \middle| \begin{array}{c} Y \leq \sum_{j=1}^{J} \sum_{t=}^{T} \varphi_{tj} Y_{tj} \\ \hat{L} \geq \sum_{j=1}^{J} \sum_{t=1}^{T} \varphi_{tj} \hat{L}_{tj} \\ \widehat{K} \geq \sum_{j=1}^{J} \sum_{t=1}^{T} \varphi_{tj} K_{tj} \\ \varphi_{\tau j} \geq 0 \ \forall j, \forall t \end{array} \right\} \qquad (4)$$

Where φ_{tj} are the intensity variables that help to form the frontier as it envelops the data with the smallest convex free disposal cone.

The technical efficiency captures the maximal expansion of the output (potential output given actual input quantities). We rely on a Farrell-Debreu output-based efficiency index for each country j at time t, defined by

$$TE_{jt}\left(Y_{jt}, \hat{L}_{jt}, \widehat{K}_{jt}\right) = \min\left\{\gamma \middle| \left(\frac{Y_{jt}}{\gamma}, \hat{L}, \widehat{K}\right) \in T_t(D)\right\} \qquad (5)$$

The inverse of $TE_{jt}\left(Y_{jt}, \hat{L}_{jt}, \widehat{K}_{jt}\right)$ grasps the maximal output Y_{tj} that can be reached while keeping the inputs constant. Technically, this Farrell-Debreu output-based efficiency index can be obtained by solving this linear programming model:

$$\max_{\theta_{jt}, \varphi_{jt}} \theta_{jt}$$

$$subject\ to$$

$$\theta_{jt} Y_{jt} \geq \sum_{\tau \leq t} \sum_{j} \varphi_{j\tau}\, Y_{j\tau} \qquad (6)$$

$$\widehat{K}_{jt} \leq \sum_{\tau \leq t} \sum_{j} \varphi_{j\tau}\, \widehat{K}_{j\tau}$$

$$\hat{L}_{jt} \leq \sum_{\tau \leq t} \sum_{j} \varphi_{j\tau}\, \hat{L}_{j\tau}$$

$$\varphi_{jt} \geq 0 \ \forall j$$

Geometrically, it measures the radial distance between the output quantity of country j at time t and the reconstructed frontier of the reconstructed production possibility set T_t (Walheer, 2018). The output efficiency takes values between 0 and 1, and a smaller value implies more inefficient behaviour. This means that a country can expand its aggregate output using the same amount of inputs and available technology to reach the production frontier. Similarly, when the output efficiency takes a value of unity, this means that country is on the production frontier and can serve as a benchmark.

The literature on labour growth mainly decomposes the labour productivity growth into four components: technical (efficiency) change, technological catch-up, capital accumulation, and human capital change (Rogge, 2019; Walheer, 2018; Alkathiri, 2021). The three first components were introduced by Kumar & Russel (2002) while the last was introduced by Henderson & Russel (2005). Technological change grasps movements of the global production frontier while technological catch-up captures movements to or from the frontier. The physical capital and human capital accumulation measure the effect of changes in capital intensity and grasp the movement along the frontier (Henderson & Russel, 2005; Walheer, 2018; 2021; Rogge, 2019; Kumar & Russel, 2002). The novelty of this study is to grasp the contribution of globalization to the labour productivity convergence process.

As discussed in chapter 1, instead of measuring globalization partially using a proxy (or a set of proxies), we prefer using the index of globalization since it allows us to capture the different components of globalization and then overcome the problem of omitted variable bias. The KOF overall index of globalization encompasses a large amount of information from de jure and de facto measures of globalization. However, according to Kose A. M., Prasad, Rogoff, & Wei (2006; 2009), de jure measures are less robust for country comparison due to their relative implementation and application across countries. Furthermore, de jure measures hinge on country-specific macroeconomic characteristics, which raises the problem of endogeneity (Rose et al., 2018). Likewise, de facto measures suffer from the problem of endogeneity as they also hinge on macroeconomic characteristics, but they are best suited to assess the benefits (direct and indirect) of globalization since they come from real flows and activities (Kose A. M., Prasad, Rogoff, & Wei, 2006). Therefore, we consider only the de facto overall index of globalization (KOFGIdf).

As the labour productivity at time *t* is given by $y_t = {Y_t}/{L_t}$, relying on the constant return to scale assumption of the technology, the labour production frontier can then be rewritten as $(\widehat{y_t}, \hat{k}_t)$ where the production function $\widehat{y_t}(\hat{k}_t)$ is the technology by defining $\widehat{y_t} = Y_t/\hat{L}_t$ and $\hat{k}_t = \widehat{K_t}/\hat{L}_t$, respectively the ratios of output to effective of labour and efficiency augmented physical capital to effective of labour.

Using a comparative analysis that allows comparing the labour productivity at the base period b and current period c, the aim is to decompose $\frac{y_c}{y_b}$ into the five components as describe above. Since, by definition, the efficiency index is the ratio of actual output to potential output at actual input quantities, the benchmark output level for country *j* per human capital augmented unit of labour that denotes efficiency output at time t is given by: $\bar{y}_t(\hat{k}_t) = \hat{y}_t/\theta_t$ where θ_t is the efficiency indexes for $t = \{b, c\}$ as defined in (5). The difference in productivity is then given by this equality:

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{\theta_c}{\theta_b}\frac{\bar{y}_c(\hat{k}_c)}{\bar{y}_b(\hat{k}_b)} \qquad (7)$$

To isolate the effect of each component of labour productivity growth, following Rogge (2019), Walheer (2018), Badunenko & Romero-Avila (2013) and others, we define counterfactual benchmarks through four scenarios. Hence, we define $\tilde{k}_c^{Glob} = (K_c G_b)/(L_C H_b)$ which denotes the ratio of capital to labour measured in efficiency units by assuming that both human capital and globalization intensity remain unchanged from their base period, $\tilde{k}_c^{HC} = (K_c G_c)/(L_C H_b)$ the ratio of capital to labour measured in efficiency units by assuming that only human capital didn't change from its base period. Similarly, $\tilde{k}_b^{Glob} = (K_b G_c)/(L_b H_c)$ the ratio of capital to labour measured in efficiency units by assuming that, at the base period, both human capital and globalization intensity were at the same levels of their current period, and $\tilde{k}_b^{HC} = (K_b G_b)/(L_b H_c)$ the ratio of capital to labour measured in efficiency units by assuming that, at the base period, human capital was at the same levels of its current period. Hence, $\bar{y}_c\left(\tilde{k}_c^{Glob}\right)$ and $\bar{y}_c\left(\tilde{k}_c^{HC}\right)$ are respectively the potential outputs per efficiency unit of labout at $\tilde{k}_c^{Glob}$ and $\tilde{k}_c^{HC}$, while $\bar{y}_b\left(\tilde{k}_b^{Glob}\right)$ and $\bar{y}_b\left(\tilde{k}_b^{HC}\right)$ are the potential outputs per efficiency unit of labout at $\tilde{k}_b^{Glob}$ and $\tilde{k}_b^{HC}$. Implementing this transformation based on these counterfactual assumptions, the difference in labour productivity can be defined by varying from the denominator to the numerator, for each term, only the variable under interest varies. Accordingly, it is written as:

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{\theta_c}{\theta_b} \times \left(\frac{\bar{y}_c(\hat{k}_c)}{\bar{y}_b(\hat{k}_c)}\right) \times \left(\frac{\bar{y}_b(\tilde{k}_c^{Glob})}{\bar{y}_b(\hat{k}_b)}\right) \times \left(\frac{\bar{y}_b(\hat{k}_c)}{\bar{y}_b(\tilde{k}_c^{HC})}\right) \times \left(\frac{\bar{y}_b\left(\tilde{k}_c^{HC}\right)}{\bar{y}_b\left(\tilde{k}_c^{Glob}\right)}\right) \qquad (8)$$

and

$$\frac{\hat{y}_c}{\hat{y}_b} = \frac{\theta_c}{\theta_b} \times \left(\frac{\bar{y}_c(\hat{k}_b)}{\bar{y}_b(\hat{k}_b)}\right) \times \left(\frac{\bar{y}_c(\hat{k}_c)}{\bar{y}_c(\tilde{k}_b^{Glob})}\right) \times \left(\frac{\bar{y}_c(\tilde{k}_b^{HC})}{\bar{y}_c(\hat{k}_b)}\right) \times \left(\frac{\bar{y}_c\left(\tilde{k}_b^{Glob}\right)}{\bar{y}_c\left(\tilde{k}_b^{HC}\right)}\right) \qquad (9)$$

As we are interested in the labour productivity $\left(y_t = {}^{Y_t}/_{L_t}\right)$ and since the labour productivity growth is equal to the human capital growth multiplied by the output growth per efficiency unit of labour $\left(\frac{y_c}{y_b} = \frac{H_c}{H_b}\frac{\hat{y}_c}{\hat{y}_b}\right)$, the labour productivity can then written as follow:

$$\frac{y_c}{y_b} = \frac{\theta_c}{\theta_b} \times \left(\frac{\bar{y}_c\left(\hat{k}_c\right)}{\bar{y}_b\left(\hat{k}_c\right)}\right) \times \left(\frac{\bar{y}_b\left(\tilde{k}_c^{Glob}\right)}{\bar{y}_b\left(\hat{k}_b\right)}\right) \times \left(\frac{\bar{y}_b\left(\hat{k}_c\right)}{\bar{y}_b\left(\tilde{k}_c^{HC}\right)} \times \frac{H_c}{H_b}\right) \times \left(\frac{\bar{y}_b\left(\tilde{k}_c^{HC}\right)}{\bar{y}_b\left(\tilde{k}_c^{Glob}\right)}\right) \qquad (10)$$

$$\equiv EFF \times TECH^c \times KACC^b \times HACC^b \times GIC^b$$

and

$$\frac{y_c}{y_b} = \frac{\theta_c}{\theta_b} \times \left(\frac{\bar{y}_c\left(\hat{k}_b\right)}{\bar{y}_b\left(\hat{k}_b\right)}\right) \times \left(\frac{\bar{y}_c\left(\hat{k}_c\right)}{\bar{y}_c\left(\tilde{k}_b^{Glob}\right)}\right) \times \left(\frac{\bar{y}_c\left(\tilde{k}_b^{HC}\right)}{\bar{y}_c\left(\hat{k}_b\right)} \times \frac{H_c}{H_b}\right) \times \left(\frac{\bar{y}_c\left(\tilde{k}_b^{Glob}\right)}{\bar{y}_c\left(\tilde{k}_b^{HC}\right)}\right) \qquad (11)$$

$$\equiv EFF \times TECH^b \times KACC^c \times HACC^c \times GIC^c$$

The expressions (10) and (11) decompose the labour productivity growth into change in efficiency (EFF), technology (TECH), capital deepening (KACC), human capital accumulation (HACC) and globalization intensity change (GIC). These expressions give alternative decompositions of labour productivity growth when taking year c or b as the reference year for the technology. The interpretation of these components and their values are unaffected by these adjustments (Rogge, 2019). However, these two expressions will give different values[4]. In fact, when the assumption of neutrality of technology is relaxed, this ambiguity makes difficult the growth accounting exercise (Henderson & Russel, 2005). To overcome this shortcoming, several scholars suggest to use the Fisher ideal index to avoid arbitrariness in computation. This is a geometric mean of the aforementioned expressions, which is given by:

$$\frac{y_c}{y_b} = EFF \times \left(TECH^b \times TECH^c\right)^{1/2} \times \left(KACC^c \times KACC^b\right)^{1/2} \times \left(HACC^c \times HACC^b\right)^{1/2} \times \left(GIC^c \times GIC^b\right)^{1/2} \quad (12)$$

$$\equiv EFF \times TECH \times KACCC \times HACC \times GIC$$

2. Methods and techniques of estimation

To assess the labour productivity convergence, empirical studies rely either on parametric or nonparametric production frontier techniques. The former makes some restrictive assumptions that can bias the results (Arcelus & Arocena, 2000). The nonparametric technique has the advantage that it is a data-driven approach that doesn't need prior assumptions in terms of functional specification (Walheer, 2018; Arcelus & Arocena, 2000).

This research follows three main objectives. We first assess if the labour productivity trend in Africa exhibits a unimodality or bimodality (twin-peak) shape. In doing so, we follow several scholars (e.g. Ezcurra & Pascual, 2009; Walheer, 2018; Rogge, 2019) using the Kernel density estimation (KDE) by comparing two distributions. The KDE is a nonparametric method of estimating the probability density function. Second, we measure efficiency by constructing the production frontier. The non-parametric approach is a more realistic approach to studying productivity growth and convergence (Rogge, 2019). The most nonparametric deterministic frontier method used in the econometric literature is the Data Envelopment Analysis (DEA). It provides the efficiency estimates against best practices assuming the technology is fixed at the current level (Lee & Leem; Arcelus & Arocena, 2000). This method derives from the production possibilities set using a linear combination of outputs-inputs observations. It assumes that outputs should be expanded while inputs shrunk (Wang, Du, & Zhang, 2022). Compare to other methods, the DEA method outperforms others when there is functional form misspecification and as well when measurement errors become large (Alkathiri, 2021). Hence, although it is a deterministic approach, this method is still robust even in presence of stochastic noise. The (i)efficiency is measured by the distance of each observation to the frontier (Arcelus & Arocena, 2000).

[4] These two expressions are equal only under the Hicks neutral technology. Technological change is Hicks neutral if the production frontier shifts vertically by the same proportional factor at all values of efficiency capital to effective abour. It is Harrod neutral when it shifts radially by a constant proportional factor (Henderson & Russel, 2005).

Third, we decompose the labour productivity efficiency into different components to grasp the contribution of each component to the labour productivity growth. For computing labour productivity decomposition into efficiency catch-up, technical change, capital accumulation, human capital accumulation and globalization intensity change, we rely on the Malmquist Productivity Index (MPI). This index is constructed using DEA technologies (Tone, 2004; Badunenko & Mozharovskyi, 2016). It evaluates the productivity change between two periods and allows for comparing the production technology of two economies.

Chapter 3 Results and discussion

This chapter has two main sections. The first section presents the results and the last discusses these results and gives some implications.

3.1 Results

First, this section presents some descriptive statistics. Then, it comes up with results of growth and convergence in Africa.

1. **Descriptive statistics**

This section gives an overview of the trend of the variables over the period from 2011 to 2019. First, table 1 gives the median growth (row 2) for 2001 and 2019 of the real output GDP (Y), the number of employees (L), labour productivity (Y/L), stock of capital (K), the intensity of integration (G), labour efficiency ($\hat{L}$), capital efficiency ($\hat{K}$), capital deepening (K/L) and unit-efficiency capital deepening ($\hat{K}/\hat{L}$). The rest of the table gives the growth of these variables over the same period per REC.

Table 1 Descriptive statistics: Median Growth

	Y	L	Y/L	K	G	$\hat{L}$	$\hat{K}$	K/L	$\hat{K}/\hat{L}$
Africa	146.26	68.17	46.27	172	19.45	95.7	248.94	69.54	70.58
SADC	107.01	55.44	29.74	149.82	22.32	83.64	217.34	67.24	65.99
ECOWAS	157.26	74.28	64.35	172.73	12.16	105.89	265.83	56.61	46.83
EAC	211.03	76.00	86.59	254.89	28.41	113.38	280.03	69.54	72.81
CEN-SAD	163.02	78.52	64.35	185.24	25.17	117.00	298.46	70.61	104.58
COMESA	122.22	56.65	34.39	192.36	25.18	95.70	227.77	87.58	72.81
ECCAS	175.05	75.06	55.37	198.47	20.63	98.91	232.57	85.34	67.24
AMU	82.01	41.95	31.24	82.82	29.16	84.58	154.44	10.51	25.69
IGAD	199.43	89.56	88.27	262.76	17.91	128.80	366.21	103.05	104.80

Source: Own computation

The median is preferred to compute the growth of these variables given their robustness. Table 1 informs that African countries have increased their degree of openness. This may be a result of the expansion of globalization due to the end of the cold war and could therefore reflect the willingness of African countries toward openness. This increase in the level of globalization must have strengthened their networks and could hence act on the quality and quantity of capital. Next, this table shows that physical capital accumulation has almost tripled in 19 years, which highlights the role of physical capital in the growth of labour productivity. We can learn from this table that the output growth has more contributed to labour productivity growth than labour growth. The growth of augmented labour and that of the unit of efficiency of physical capital are greater than the growth of labour and that of physical capital. This shows the positive role of human capital and globalization over this period. Checking these variables per REC, this table reveals that the North Africa group has the weakest indicators for almost all of these variables except the degree of openness for which it has the lead.

Regarding technical efficiency, table 1 (appendix) reveals the median efficiency score in 2019 falls from 0.58 to 0.45 when including globalization intensity. This means that when integrating globalization, the augmented physical capital with globalization intensity increases, on the median, the distance from the best-practice production frontier. However, when we include globalization intensity, one country (Rwanda) stands on the production frontier in 2001, and two countries (Nigeria and Ethiopia) have improved their position concerning median. Figure 1 (appendix) plots the KDE which shows a fall in median efficiency between 2001 and 2019. Furthermore, this Kernel density estimate depicts a shift of probability mass away from near the frontier towards the upper end of the distribution. A careful inspection of this figure shows that these two distributions are unimodal. This tells us that there is not much difference in Technical efficiency between African countries.

One should be noted that these insights are descriptive and should therefore be interpreted with caution. Although these descriptive statistics show important insights into labour productivity and other key variables, they do not tell how each variable contributes to growth and convergence in African countries. The next section analyzes the role of globalization in labour productivity growth and convergence in Africa.

1. Role of globalization in labour productivity growth and convergence

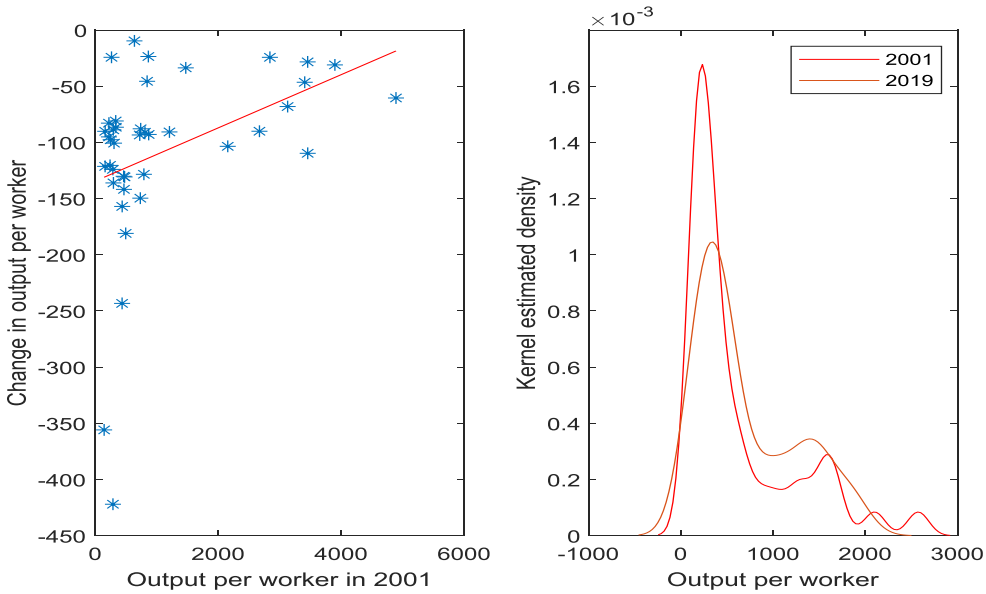
This section consists of two parts. First, it analyzes the convergence of labour productivity of African countries. Second, we assess the contribution of the globalization intensity change to labour productivity growth. For comparison purposes, we present the result of the decomposition when globalization is included in the analysis and when it is not. Next, we make a comparison with some previous studies.

- *Labour productivity convergence*

We compute a kernel density estimation (KDE) to investigate whether African countries converge or not in terms of output per worker. We plot, in figure 1, the density function estimated for labour productivity in 2001 and 2019.

The results from figure 1 inform that the productivity distributions in 2001 and that of 2019 labour are both left-skewed, but the distribution in 2019 slightly shifts on the right. This indicates that labour productivity has increased over time, which confirms the results found by descriptive statistics. Furthermore, from this figure, one can notice that the distribution in 2001 seems to be multimodal (4 modes) while the distribution in 2019 is bimodal. This reveals that there would be a process toward club convergence in Africa. The "poor" mode has less mass in 2019 and the distribution in 2019 appears smoother compared to that of 2001, meaning that fewer countries are poor in 2019. This implies that some countries which belonged to the lower-income group in 2001 have moved to the higher-income group in 2019. This supports the claim that the convergence process in Africa is getting stronger over time. These insights are confirmed by the positive slope of the regression model (left fig. 1). Indeed, one can notice that the (negative) change in output per worker has decreased over time from the base year 2001.

Figure 1. Output per worker: regression and distributions



Source: own computation

Although the kernel density estimate provides important insights, one cannot explain the dynamics of these distributions and the source of these changes. To better understand these dynamics and grasp the contribution of each factor, we compute the labour productivity decomposition. This is the aim of the next section.

- *Production growth and labour productivity decomposition*

This section investigates the role of the five components in the convergence of the African countries. We present in the Table 2 contributions of each component in percentage (columns 3 to 7). The second column reports the change in labour productivity. For comparison purposes, the results are reported for both with and without globalization. Thus, the first line for each country presents the results of the decomposition of productivity with globalization, while the second line presents the results of the decomposition without globalization.

Table 2: Labour productivity growth decomposition indexes

Country	Productivity Change	(EFF-1) X 100	(TECH-1) X 100	(KACC-1) X 100	(HACC-1) X 100	(GIC-1) X 100
Algeria	-11.3	-29.2	-10.2	13.5	21.5	1.2
	-11.3	-30.1	-8.5	14.1	21.6	
Angola	215.4	81.4	1.3	58.4	2.8	5.4
	215.4	77.0	9.3	63.2	-0.1	
Benin	85.9	-2.2	0.2	35.2	13.1	24.1
	85.9	41.0	-9.8	34.0	9.1	
Botswana	36.4	-31.8	2.6	70.4	8.1	5.9
	36.4	-28.7	9.0	63.3	7.5	
Burkina Faso	89.3	-32.0	-3.9	126.1	-2.5	31.3
	89.3	-6.1	-7.9	124.2	-2.4	
Burundi	8.5	-30.6	-16.3	33.0	-3.5	45.6
	8.5	12.1	-3.9	4.6	-3.7	
Cameroon	23.8	-28.5	-2.2	57.6	-5.3	18.6
	23.8	-13.2	-10.4	71.2	-7.0	
Central African Republic	-6.4	-70.9	-7.2	169.3	-9.3	41.7
	-6.4	-61.1	-8.1	180.4	-6.5	
Congo, Dem Rep	123.7	101.6	-4.5	1.7	-6.9	22.8
	123.7	167.8	-6.4	1.9	-12.3	
Congo, Rep	63.9	-41.7	-2.5	188.4	-11.0	12.4
	63.9	-35.2	-1.5	192.3	-12.2	
Côte d'Ivoire	137.3	-13.6	-3.8	138.1	3.7	15.6
	137.3	-22.2	-2.1	201.4	3.4	
Egypt	91.0	-13.3	-2.2	76.8	15.8	10.0
	91.0	-12.8	1.3	92.1	12.5	
Eswatini	-10.3	-28.3	-5.5	8.8	17.5	3.6
	-10.3	-32.3	0.2	10.1	20.1	
Ethiopia	245.1	-7.0	-11.2	202.7	-0.7	39.2
	245.1	5.3	-4.4	250.5	-2.1	
Gabon	46.9	-6.0	-4.9	23.7	26.2	5.2
	46.9	-2.9	0.2	19.1	26.8	
Gambia, The	-11.7	-40.0	1.0	10.7	6.8	23.2
	-11.7	-21.0	-9.8	21.9	1.7	
Ghana	61.7	27.8	0.4	7.0	6.4	10.7
	61.7	48.3	-7.5	18.4	-0.4	

Continued

Country	Productivity Change	(EFF-1) X 100	(TECH-1) X 100	(KACC-1) X 100	(HACC-1) X 100	(GIC-1) X 100
Kenya	86.6	-12.1	-2.1	70.9	1.0	25.5
	86.6	-4.0	-7.6	114.1	-1.7	
Lesotho	30.3	-23.5	-3.0	112.8	-28.0	14.6
	30.3	-26.7	0.9	150.5	-29.6	
Liberia	11.1	-34.6	-5.0	45.3	-1.6	25.0
	11.1	-34.3	-5.7	87.4	-4.4	
Madagascar	**-0.9**	-40.8	-11.8	45.4	-5.2	37.8
	-0.9	-19.2	-4.5	37.3	-6.5	
Malawi	15.9	71.6	-10.1	-54.2	8.3	51.7
	15.9	112.1	-4.0	-45.2	4.0	
Mali	62.1	-31.8	-5.0	92.9	-0.9	30.9
	62.1	-26.5	-6.6	141.3	-2.1	
Mauritania	42.5	-24.1	1.8	57.7	10.8	5.6
	42.5	-1.7	4.3	25.0	11.2	
Mauritius	29.7	-24.0	0.8	51.9	4.5	6.7
	29.7	-19.3	4.8	41.3	8.5	
Morocco	66.3	-11.9	-0.1	57.1	12.5	7.0
	66.3	-12.6	7.3	52.0	16.6	
Mozambique	46.3	-57.8	-8.2	203.7	-12.0	41.2
	46.3	-58.3	-4.9	325.9	-13.4	
Namibia	27.2	-23.6	3.1	50.2	1.2	6.2
	27.2	-19.5	9.3	45.7	-0.8	
Niger	24.3	-42.1	-1.7	89.3	-8.3	25.7
	24.3	-13.0	-10.0	72.1	-7.7	
Nigeria	370.8	183.3	-0.4	31.2	17.3	8.4
	370.8	163.1	6.4	51.7	10.9	
Rwanda	114.1	**-52.2**	-18.7	252.5	13.7	37.4
	114.1	-44.0	-1.4	238.9	14.4	
Senegal	4.9	-23.4	1.6	15.7	9.5	6.5
	4.9	-14.1	4.2	14.3	2.5	
Sierra Leone	77.1	40.7	-10.3	6.6	3.4	27.3
	77.1	110.5	-6.2	-11.4	1.2	
South Africa	18.0	-32.2	-4.5	35.4	29.2	4.2
	18.0	-35.5	5.0	36.0	28.2	

Continued

Country	Productivity Change	(EFF-1) X 100	(TECH-1) X 100	(KACC-1) X 100	(HACC-1) X 100	(GIC-1) X 100
Sudan	90.0	-16.3	-4.5	98.3	1.9	17.6
	90.0	4.2	-4.2	92.9	-1.4	
Tanzania	88.9	2.5	-1.9	56.6	-4.0	25.0
	88.9	22.5	-8.6	83.7	-8.1	
Togo	66.6	-27.7	-4.4	113.2	-13.9	31.3
	66.6	-7.3	-6.7	122.9	-13.6	
Tunisia	20.0	-12.2	-4.4	4.0	31.2	4.7
	20.0	-7.6	3.7	-3.1	29.3	
Uganda	32.4	-40.8	-9.5	51.0	20.9	35.4
	32.4	-28.2	-3.1	59.4	19.2	
Zambia	124.8	34.0	1.4	34.3	14.4	7.6
	124.8	31.2	5.2	50.4	8.2	
Zimbabwe	**-28.2**	-16.2	-5.5	-33.6	13.6	20.2
	-28.2	-0.7	-6.5	-28.3	7.8	
AVERAGE	63.7	-9.3	-4.2	66.1	4.9	20.0
	63.7	3.8	-2.2	76.0	3.1	

Source: own computation

From this table, we can learn that integrating globalization into the labour productivity analysis modifies substantially the outcomes obtained when it is not incorporated. On average, a substantial part of productivity growth assigned to physical capital accumulation should be explained by the intensity of globalization. This accords with the claim of the role of globalization in physical capital efficiency-enhancing. On average the contribution of physical capital accumulation falls from 76% to 66%. An interesting figure is a change in human capital accumulation. When globalization is taken into account, the contribution of human capital accumulation to the productivity change has increased on average by almost 60 percentage points. Since globalization enables technology transfer, this result accords with Haider, Kunst, & Wirl (2021) who stresses that investment in ICT can be considered as a form of capital deepening that can make labour more productive. This highlights that globalization enables knowledge dissemination. Paradoxically, the opening seems to negatively act on technological progress over the period analyzed. The same goes for efficiency. The results show an inefficiency when incorporating globalization (-9.3%) while African countries have shown an efficiency when globalization is not incorporated (3.8%). These large losses in efficiency and technological progress inform that part of the productivity which was attributed to them should, instead, be assigned to the allocative efficiency-enhancing effect of globalization.

In our sample, globalization appears as the main engine of productivity change in three countries (Burundi, Gambia and Zimbabwe) and stands at the second position in 25 countries. Although physical capital accumulation remains the first contributor to economic growth in Africa, our findings

show that globalization is also a great driver of economic growth. This records with theoretical models and empirical findings that claim countries perform better when they open their economies. These performances come from the role of globalization in resource allocation to the most productive uses. This conclusion is in line with Badunenko & Romero-Avila (2013) who stressed that the efficiency with which resources are allocated matters for productivity growth. Hence, physical capital accumulation appears to not be the only source of growth and convergence in Africa. Furthermore, our results show that the loss of efficiency and technological "regress" are the salient causes of Africa's dismal performance. This comforts the conclusions from several previous studies (Badunenko & Romero-Avila, 2013; Badunenko, Henderson, & Houssa, 2014).

By throwing a look on different RECs, the features are more interesting. The laboour productivity increased in Africa by 46% (median growth) during the period under consideration. However, this performance is unvenly distributed across different RECs (Table 2 appendix). We analyze the productivity gain in recognized RECs[5] and we add the SSA region and CFA region. EAC and IGAD regions have registered a productivity of almost 90%[6]. No suprisingly, these two regions have recored the high performance in terms of globalization intesity contribution to labour productivity growth (35.4% and 30.4%). One of plausible reason is the short distance between countries belonging to these regions in terms of culture, language, geography, etc. In addition, these regions are made up by tiny countries. This has led to the development of infrastructures that connect each other. However, the contribution of each component is different from one region to another. While physical capital accumulation is the main engine of productivity gain in these regions, the EAC region appears to be less efficient compared to IGAD in all of the four first components. Uganda is the worst performing country in the IGAD in terms of productivity growth (32%) while Burundi is in the EAC (8%). In the Burundian case, this may be explained by the cycle of political instability and civil wars that it has experienced for a long time.

- *Distribution analysis*

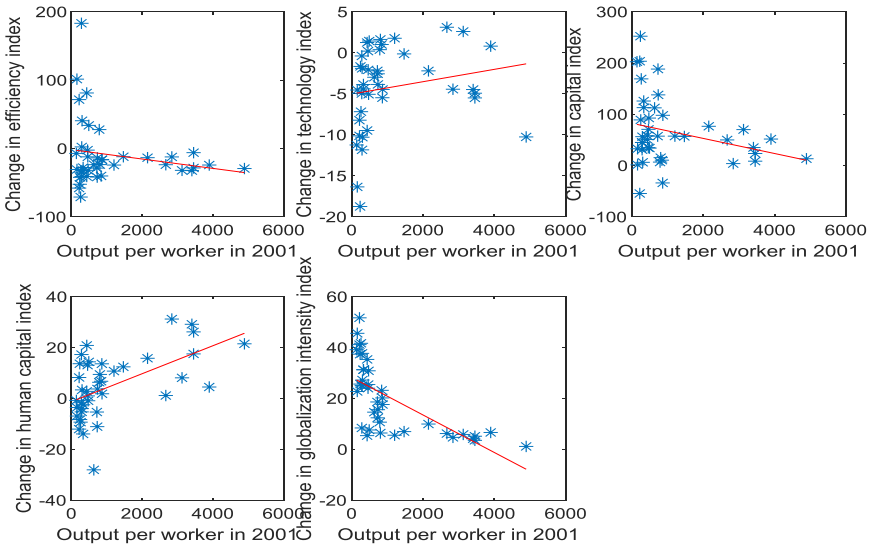
In order to assess the effect of each component on productivity growth, we follow Walheer (2018) by plotting the regression line for each of five components. The main interest of this study is to investigate the contribution of globalization in productivity gain. To avoid the bias of omitted variable, other components are included in the analysis. These components play hence a role of control variable. Figure 2 gives the contribution of each component.

A negative slope indicates that the component has contributed to the convergence between countries, while a positive slope indicates the opposite. As such, this figure reveals that technology index and human capital changes contribute to the divergence between countries in Africa (GLS t-stat 0.017). This means that relatively richer countries gain more from technology and human capital. On the other hand, the efficiency index, capital-deepening and the change in globalization intensity contribute to the convergence. This means that poor countries gain more in globalization in terms of labour productivity growth and richer countries record a contraction in labour productivity. This result is in line with the theoretical model and empirical literature that stress the positive effect of globalization on economic growth and convergence (Broitman & Czamanski, 2021; Dreher, 2006; Gammadigbe, 2021; Mastromarco & Simar, 2018).

[5] African union recognizes 8 RECs: AMU, CEN-SAD, COMESA, EAC, ECCAS, ECOWAS, IGAD, and SADC. For further details see Gammadigbe (2021)

[6] One should note that these two regions are made up of roughly the same countries. In this study, the EAC has Kenya, Tanzania, Uganda, Rwanda, and Burundi and IGAD includes Kenya, Uganda, Ethiopia, and Sudan.

Figure 2: Role of the components in convergence



Source: own computation

3.2 Discussion and implication

A deal of literature asserts that each region should have its own production frontier (Badunenko, Henderson, & Houssa, 2014). The results show that African countries converge over time. This can be observed in figure 1 that revealed African countries come from a multimodality shape to a twin-peak shape. This result is partially in accordance with Quah's claim who stressed that countries record a change in distribution shape from unimodality to a bimodality shape (Kumar & Russel, 2002; Henderson & Russel, 2005; Badunenko, Henderson, & Houssa, 2014; Rogge, 2019; Walheer, 2018; 2021). However, the case of Africa is different as, instead to have one mode at the base period, the convergence goes from a quadrimodality to a polarization.

Two plausible explanations can be evoked. The first explanation comes from the colonial legacy and political instability. One should remember that for a long time after colonization, African countries were embedded according to their "metropolis". Moreover, many of African countries experienced political instability and civil war in the last decades of the 20th century. However, since the early of this century, most African countries record relative stability. The second explanation is the structure of African economies. With the spread of ICT, the share of manufacturing and service sectors has increased in the last decades (Haider, Kunst, & Wirl, 2021; De Benedictis & Tajoli, 2011). This implies that African countries show an increasing homogenization trend. This may reinforce the homogenization of African countries.

These insights from the labour productivity decomposition reveal that physical capital accumulation is overstated when globalization is skipped. This result confirms to some extent the conclusion of Badunenko & Romero-Avila (2013) who found that integrating capital efficiency through financial development has revealed that the role of capital accumulation in productivity gain is overstated. However, physical capital accumulation remains the main driver of labour productivity gain in Africa. This result contradicts Badunenko, Henderson, & Houssa (2014) who pointed out that, albeit physical

capital accumulation is the main contributor to productivity growth elsewhere, this is not the case in Africa. The slope of physical capital accumulation is significant (GLS t-stat 0.000), meaning that physical capital accumulation is a significant contributor to productivity growth and convergence in Africa. A plausible reason is that this essay accounts for physical capital in its efficiency unit. This comforts our claim that ignoring the degree to which countries are integrated may bias conclusions.

More interestingly, results from Table 1 show that globalization comes in the second position which highlights that ignoring the degree of interconnectedness of countries may bias conclusions. This result is reinforced by the result from the regression plot. The last figure from figure 2 emphasizes that globalization intensity leads to convergence in Africa. This result confirms the theoretical model which stresses countries will perform better and converge when they are involved in the open economy. A deal of literature reaches the same conclusion (Broitman & Czamanski, 2021; Dreher, 2006; Lopez, De Lucas, & Delgado, 2021; Mukulu, 2020). By spurring competition (Mastromarco & Simar, 2018), efficiency-enhancing capital allocation (Lopez, De Lucas, & Delgado, 2021; Akm & Kose, 2008) and innovation through foreign firms' investment (Broitman & Czamanski, 2021; Mishkin F. S., 2009), globalization contributes to productivity gain and fosters the convergence of economies.

Keeping a look at the role of globalization, human capital accumulation is understated when globalization is not taken into account. This interesting finding comforts the claim of the existence of spillover effects in human capital thanks to globalization in terms of skill-enhancing and innovation. However, when analyzing the effect of human capital on the convergence by plotting regression, human capital accumulation appears to be a source of divergence in Africa. The same goes for the technology index and contradicts previous studies which pointed out a positive (Mastromarco & Simar, 2018) or a neutral (Badunenko, Henderson, & Houssa, 2014) role of technology change in convergence. The negative role of technological change and human capital accumulation on the convergence can be explained by the structure of African economies. African countries are dominated by primary sectors (agriculture, extractive mineral resources, oil resources, etc.). These countries are mainly exporters of natural resources with little or no processing. Therefore, they highly depend upon natural resource rents, which exposes them to the resource curse problem (Sachs & Warner, 2001; Noumba, Noula, & Nguea, 2022).

Although African countries have benefited from innovation and technology transfer as well as capital flows (Noumba, Noula, & Nguea, 2022), globalization seems to have been unable to foster desirable kinds of structural change in Africa, especially in sub-Saharan Africa (McMillan & Rodrik, 2011). In addition, African economies are characterized by a high level of informality (ILO, 2009). The qualified workforce moves to more productive sectors while less qualified workers are involved in less-productive sectors (ILO, 2009). Coupled with the high unemployment rate, this leads labour migrants from more productive to less-productive activities (McMillan & Rodrik, 2011). Although the extractive sector requires a huge physical capital investment, they do not generate sufficient "qualified" jobs (McMillan & Rodrik, 2011; Geenen, et al., 2021). In addition, as globalization fosters the migration of skilled labour from developing to developed countries (Bhorat & Lundall, 2004), this brain drain may exist in Africa. It can therefore be difficult for less productive sectors, notably the informal sector, to capture technological spillovers from other sectors and then makes human capital and technology engines of convergence in Africa.

Given this paradox of divergence, albeit the technologies transfer thanks to globalization, this essay agrees with Aghion, Howitt, & Mayer-Foulkes (2005) that technology transfer remains a puzzle. One can therefore assume that globalization and more specifically technology transfer don't bring out enough diversification of African economies. This result supports the existence of technological

heterogeneity in Africa (see Walheer, 2021). This implies that better-endowed economies in 2001 with human capital and technology have to gain more in productivity than less-endowed countries, and this has contributed to the polarization in Africa.

Conclusion

This essay attempts to grasp the contribution of globalization in convergence analysis. The core question that drives is whether globalization allows economic convergence in Africa. One of the motivations for this research is to check whether African economies can influence each other and therefore improve their labour productivity. Second, we aimed to assess different drivers of labour productivity, in particular the effect of globalization intensity on labour productivity. This research aimed to extend the existing literature on convergence by integrating the globalization variable into the production frontier analysis.

To reach our objectives, we split this study into three chapters besides the introduction and the conclusion. The first chapter discusses the literature review. It presents and discusses different approaches of globalization and that of growth and convergence. This chapter ends with a discussion of the link between globalization, growth and convergence, and presents some stylized facts. The second chapter presents the methodology used and the source of data. We use a panel data of 41 countries over 19 years (2001 to 2019). These data come from the PWT 10 (macroeconomic data) and the KOF Globalization database. We use the KOF index of globalization to grasp all information on globalization. In fact, this index has an advantage to take into account different facet of globalization. To check the process of convergence and to decompose the labour productivity growth, we rely respectively on the Kernel density estimation and the DEA production frontier methodology. The DEA approach has the advantage to overcome the misspecification problem from parametric estimation technics. Our model encompasses four variables including physical capital, labour, human capital, and globalization intensity. Physical capital and labour are computing in term of efficiency unit.

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Computing the median growth, there is a positive change in all these variables and the growth of augmented labour and that of the unit of efficiency of physical capital are greater than the growth of labour and that of physical capital, meaning that globalization has a positive effect on these factors. However, when investing the evolution of these variables into different RECs, results from descriptive statistics highlight that these performances are unevenly distributed across different groups. The result evolution of the technical efficiency has revealed that African countries didn't improve their technical efficiency. The findings showed a fall in its median value over the period considered. However, over this period, African countries record a productivity gain of 46.3% on the median.

The Kernel density estimation informs that African economies move towards convergence but there is polarization. The labour productivity distribution shows four modes in 2001 while this is bimodal in 2019. These results record several previous studies and theories that emphasize economies more and more characterized by a twin-peak convergence (Kumar & Russel, 2002; Henderson & Russel, 2005; Badunenko, Henderson, & Houssa, 2014; Walheer, 2018; 2021). Assessing the effect of each component on the productivity growth, the results from regression lines have revealed that technology index and human capital accumulation are the main drivers of divergence of African economies and therefore a source of polarization, while efficiency change, physical capital and globalization intensity are the sources of convergence.

Relying on developing countries, this essay has the merit of showing that globalization is an engine of convergence. Hence, ignoring globalization in convergence analysis will overstate the role of physical capital and understate that of human capital. To the best of our knowledge, this is the first attempt that integrates globalization when assessing convergence, especially in developing contexts by using a nonparametric approach. This study has also the merit to use a "holistic" measure of globalization that takes into account different dimensions of globalization. Therefore, it extends the existing literature including the KR, HR and BRH approaches. However, this study has some limits. First, since technology progress has both a negative effect on convergence and contribution to labour productivity growth, further studies can make depth analysis per sector to assess how technology transfer may exist across sectors. Second, extending the period of analysis and realizing an analysis per sub-period may allow to capture some structural change and shocks and to see how African countries have reacted. Third, future studies can integrate micro-foundations by analyzing how different markets react and contribute to the convergence. Overcoming these limits would constitute a good follow-up to this essay.

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Appendices

Table 1 Technical Efficiency index

	Without Globalization Intensity		With Globalization Intensity	
Country	2001	2019	2001	2019
Algeria	1.00	0.70	1.00	0.71
Angola	0.23	0.41	0.23	0.42
Benin	0.35	0.49	0.45	0.44
Botswana	0.84	0.60	0.87	0.59
Burkina Faso	0.62	0.58	0.74	0.50
Burundi	0.40	0.45	0.62	0.43
Cameroon	0.52	0.45	0.58	0.42
Central African Republic	0.44	0.17	0.62	0.18
Congo, Dem Rep	0.13	0.34	0.18	0.36
Congo, Rep	0.47	0.30	0.51	0.30
Côte d'Ivoire	0.91	0.71	0.84	0.73
Egypt	1.00	0.87	1.00	0.87
Eswatini	1.00	0.68	1.00	0.72
Ethiopia	0.46	0.48	0.51	0.47
Gabon	0.75	0.73	0.74	0.70
Gambia, The	0.64	0.50	0.75	0.45
Ghana	0.33	0.49	0.33	0.42
Kenya	0.48	0.46	0.45	0.40
Lesotho	0.39	0.28	0.44	0.34
Liberia	0.39	0.26	0.38	0.25
Madagascar	0.48	0.38	0.62	0.37
Malawi	0.38	0.81	0.36	0.62
Mali	1.00	0.73	1.00	0.68
Mauritania	0.45	0.44	0.55	0.41
Mauritius	1.00	0.81	0.99	0.75
Morocco	0.60	0.52	0.54	0.48
Mozambique	0.82	0.34	0.71	0.30

Namibia	0.88	0.71	0.82	0.63
Niger	0.29	0.26	0.43	0.25
Nigeria	0.16	0.43	0.17	0.48
Rwanda	0.92	0.51	1.00	0.48
Senegal	0.49	0.42	0.49	0.37
Sierra Leone	0.37	0.78	0.54	0.76

Continued

	Without Globalization Intensity		With Globalization Intensity	
Country	2001	2019	2001	2019
South Africa	0.96	0.62	0.82	0.56
Sudan	0.70	0.73	1.00	0.84
Tanzania	0.31	0.38	0.35	0.36
Togo	0.45	0.41	0.47	0.34
Tunisia	0.70	0.65	0.67	0.59
Uganda	0.66	0.48	0.75	0.44
Zambia	0.20	0.27	0.21	0.28
Zimbabwe	0.59	0.59	0.58	0.49
MEDIAN	0.49	0.49	0.58	0.45
AVERAGE	0.58	0.52	0.62	0.49

Table 2 Median *(Average)* Productivity growth decomposition and technical efficiency

Region	TE 2019	TE 2001	Productivity Change	(EFF-1) X 100	(TECH-1) X 100	(KACC-1) X 100	(HACC-1) X 100	(GIC-1) X 100
SADC	0.49	0.62	29.74	-23.61	-4.47	45.37	4.53	7.64
	(0.50)	*(0.61)*	*(47.07)*	*(-1.09)*	*(-3.73)*	*(43.68)*	*(4.33)*	*(16.94)*
ECOWAS	0.45	0.48	64.35	-25.57	-2.75	40.24	3.57	24.54
	(0.47)	*(0.55)*	*(81.61)*	*(0.36)*	*(-2.59)*	*(59.27)*	*(2.75)*	*(21.67)*
EAC	0.43	0.62	86.59	-30.59	-9.46	56.55	1.04	35.36
	(0.42)	*(0.63)*	*(66.10)*	*(-26.63)*	*(-9.70)*	*(92.79)*	*(5.61)*	*(33.78)*
CEN-SAD	0.45	0.58	64.35	-19.88	-3.02	58.09	3.57	23.64
	(0.50)	*(0.61)*	*(69.37)*	*(-8.91)*	*(-2.80)*	*(63.41)*	*(4.47)*	*(21.26)*
COMESA	0.48	0.64	34.39	-19.92	-4.46	51.44	3.68	18.94
	(0.51)	*(0.64)*	*(63.87)*	*(-7.80)*	*(-5.21)*	*(65.04)*	*(5.62)*	*(21.29)*
ECCAS	0.42	0.60	55.37	-29.55	-4.72	58.02	-4.42	20.71
	(0.41)	*(0.56)*	*(73.74)*	*(-5.85)*	*(-6.89)*	*(98.09)*	*(0.83)*	*(23.65)*
AMU	0.53	0.61	31.24	-18.13	-2.28	35.30	16.97	5.16
	(0.55)	*(0.69)*	*(29.38)*	*(-19.34)*	*(-3.25)*	*(33.08)*	*(18.98)*	*(4.63)*

IGAD	0.46	0.63	88.27	-14.19	-6.96	84.58	1.45	30.42
	(0.54)	*(0.68)*	*(113.51)*	*(-19.06)*	*(-6.80)*	*(105.70)*	*(5.76)*	*(29.42)*
SSA	0.44	0.58	46.28	-24.03	-3.85	51.92	2.82	22.78
	(0.47)	*(0.60)*	*(66.05)*	*(-8.46)*	*(-4.16)*	*(69.13)*	*(3.27)*	*(21.55)*
CFA Members	0.39	0.56	54.49	-30.14	-4.12	91.07	-2.06	25.35
	(0.46)	*(0.61)*	*(50.07)*	*(-25.96)*	*(-4.10)*	*(88.85)*	*(-0.83)*	*(22.63)*
Africa	0.45	0.58	46.28	-23.61	-3.85	51.92	3.75	18.65
	(0.49)	*(0.62)*	*(63.66)*	*(-9.26)*	*(-4.17)*	*(66.08)*	*(4.93)*	*(20.00)*

Table 3 Regional Economic Communities (RECs)[7]

SADC	Angola, Botswana, Congo Rep., Dem. Rep., Eswatini, Lesotho, Madagascar, Malawi, Mauritus, Mozambique, Namibia, South Africa, Tanzania, Zambia, Zimbabwe
ECOWAS	Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo
EAC	Burundi, Kenya, Rwanda, Tanzania, Uganda
CEN-SAD	Benin, Burkina Faso, Central Africa Republic, Côte d'Ivoire, Egypt, Gambia, Ghana, Kenya, Liberia, Mali, Niger, Nigeria, Senegal, Siera Leone, Sudan, Togo, Tunisia
COMESA	Angola, Botswana, Burundi, Congo Dem. Rep., Egypt, Eswatini, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Mauritus, Mozambique, Namibia, Rwanda, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe
ECCAS	Angola, Burundi, Central Africa Republic, Cameroon, Congo Rep, Congo, Dem. Rep., Gabon, Rwanda
AMU	Algeria, Mauritania, Moroco, Tunisia
IGAD	Ethiopia, Kenya, Sudan, Uganda
SSA	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central Africa Republic, Congo Rep, Côte d'Ivoire, Congo Dem. Rep., Eswatini, Ethiopia, Gabon, Gambia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritus, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

[7] All these subgroups are RECs except SSA and CFA members.