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Productive Capacities, Economic Vulnerability and Growth Volatility in Sub-Saharan Africa

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ABSTRACT: Sub-Saharan Africa (SSA) countries, like most developing countries, face major challenges to achieve strong, sustainable, and inclusive growth with the view to reduce significantly persistent poverty and inequality. Many of these challenges results from a high level of economic vulnerability due to simultaneous shocks, notably the Covid-19 pandemic, climate change and the multiplicity of armed conflicts. Hence the need to study policies and means of strengthening economic resilience to shocks. This paper analyzes the effects of productive capacities on the volatility of economic growth in SSA countries when faced with significant vulnerability. The study covers the period 2000-2018 for 43 SSA countries. Using Generalized Method of Moments (GMM), the results show that economic vulnerability contributes to growth volatility in SSA. However, this effect varies according to the performance of productive capacities. Countries with high productive capacities have greater opportunities to mitigate the effect of economic vulnerability on growth volatility. Some specific dimensions of productive capacities (Institutions, ICT) seem to matter more than others. The results of this study provide important recommendations to policy makers.

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* "The author(s) would like to thank" footnote, as applicable.

WORKING PAPERS

Productive Capacities, Economic Vulnerability and Growth Volatility in Sub-Saharan Africa

Prepared by Aminou Yaya

Contents

FIGURES

TABLES

I. Introduction

The frequency and severity of economic, financial and health crises in recent decades have raised important questions about countries' macroeconomic vulnerability and the appropriate policies needed to build economic resilience to future shocks, particularly in developing countries (see Azomahou et al., 2021; Gnangnon, 2021). The latter are generally disproportionately affected by negative shocks and do not have adequate resources to overcome them. This increases the volatility of their production, thereby amplifying the vulnerability of their economies to exogenous shocks.

The economic literature argues that strengthening the productive capacities of these countries would help them improve the resilience of their economies to shocks and promote sustainable development (Andreoni, 2011, 2011; Cornia and Scognamillo, 2016; Freire, 2011; Gnangnon, 2018; UNCTAD, 2006). However, the lack of comparable cross-country data on productive capacities has made it difficult to empirically assess the role of productive capacities in improving the resilience of developing economies.

In 2021, UNCTAD launched a new productive capacities index to help researchers and policymakers assess the performance of productive capacities. The latter is defined as "the productive resources, entrepreneurial capabilities and production linkages that together determine a country's ability to produce goods and services and enable it to grow and develop" (UNCTAD, 2006; 2021.). This paper seeks to empirically assess the effects of productive capacities on growth volatility in sub-Saharan Africa, in a context of high vulnerability.

In Africa, economic growth is unstable and the high level of economic vulnerability represents an obstacle to growth and poverty reduction (Guillaumont, 2006, 2014). According to the economic vulnerability index drawn up by the United Nations Committee for Development Policy (UNCDP) and the Foundation for International Development Studies and Research (FERDI), Africa is the continent with the highest proportion of vulnerable countries; African countries have a significantly higher structural economic vulnerability index than other developing economies(Azaroual, 2022). When only sub-Saharan Africa is taken into account, the gap is even greater. Furthermore, analysis of historical data shows that SSA has relatively low and volatile growth rates compared to other regions of the world (appendix Figure 1). Economies marked by high volatility record poor growth performance (Aghion et al., 2010; Aizenman et al., 2018; Imbs, 2007; Ramey and Ramey, 1995) which in turn affects poverty, unemployment (Camarena et al., 2019; Carr and Wiemers, 2018; Guillaumont et al., 2009) income inequality and human capital accumulation (Aye et al., 2020; Chauvet et al., 2019; Fang et al., 2015; Hausmann and Gavin, 1996).

Nevertheless, Briguglio et al. (2009) explain that there are small economies that manage to achieve a relatively high level of GDP per capita despite their high exposure to exogenous economic shocks. They refer to this phenomenon as the "Singapore paradox", referring to the case of Singapore, which has managed to record high rates of economic growth and achieve a high GDP per capita, despite its high exposure to exogenous shocks. This is mainly due to factors likely to offset the disadvantages associated with economic vulnerability, particularly productive capacities. In this context of volatile growth induced by high economic vulnerability, the question arises as to whether strengthening productive capacities could mitigate the effects of vulnerability on growth volatility in SSA. This paper specifically tackles this question.

The ability of sub-Saharan African countries to reduce the vulnerability of their economies by identifying relevant adjustment factors to shocks is crucial for a key reason. The experience of recent crises has shown

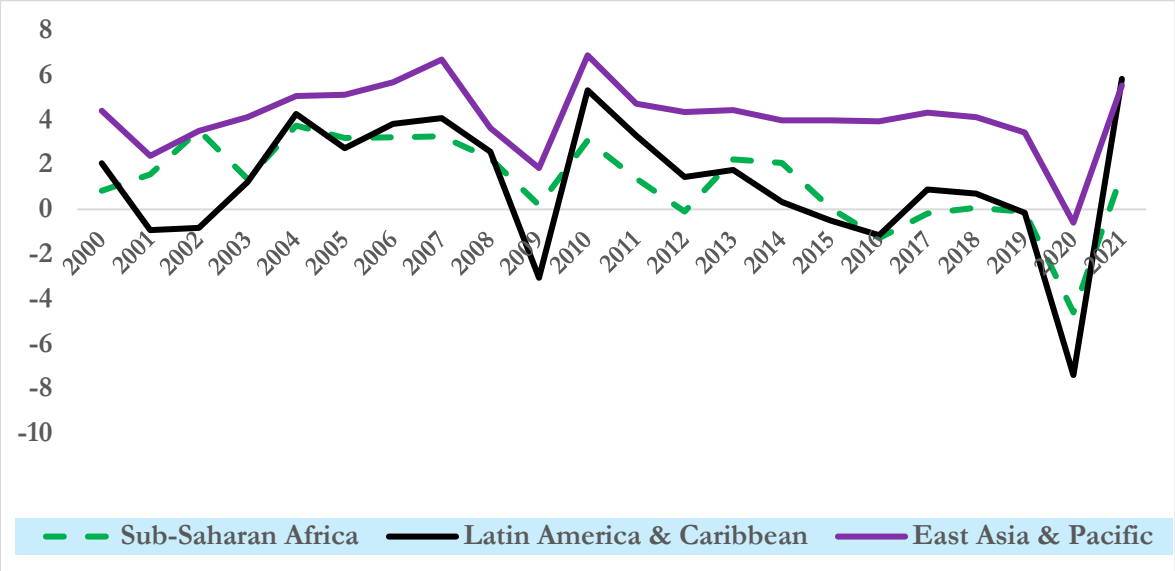
that the ability to cope with a crisis and quickly return to high levels of growth after a shock is a characteristic that is not widely shared by all the world's economies. Yet, a rapid recovery of growth after the shock is crucial for sub-Saharan African countries in order to maintain the increase in their average income and to contain the social tensions that structural changes and disruptions can provoke. This article therefore contributes to the literature in three ways. First, it examines the interaction between economic vulnerability and productive capacities and the interaction between productive capacities and growth volatility. Second, as a first attempt in SSA to measure productive capacities, we use the recently updated UNCTAD Productive Capacities Index (2021), which captures several multidimensional aspects of productive capacities. Third, this study assesses the direct and indirect effects of economic vulnerability on macroeconomic volatility in SSA countries.
The remainder of this article is organized as follows: after this introductory section, Section 2 below presents the stylized facts, Section 3 discusses the theoretical background and the review of the empirical literature. Section 4 presents the methodology and data. The results and discussion are presented in section 5, followed by the conclusion in section 6.

II. Stylized Facts

A. Growth trends and economic vulnerability in Sub-Saharan Africa

Figure 1 compares growth trends in SSA with other regions of the world. An analysis of growth trends in SSA reveals three main periods. The first period, 2000-2008, was marked by significant economic growth. GDP per capita in the region reached 3.2% in 2007. According to the African Development Bank (AfDB, 2015), this increase is mainly due to a series of interdependent factors. Some of these factors are exogenous and beyond the control of governments, while others are endogenous and depend mainly on the decisions taken and strategies adopted by governments. With regard to exogenous factors, the surge in commodity prices as well as the marked increase in Foreign Direct Investment have contributed considerably to the acceleration of growth during this period (AfDB, 2015). As far as endogenous factors are concerned, these relate to trade with the rest of the world: SSA has intensified its trade partnerships, which has led to a stronger expansion of exporting sectors. This growth can also be explained by the improvement in the quality of governance in Africa (McMillan and Harttgen, 2014). However, as in other regions of the world, sub-Saharan Africa's rapid economic growth was brought to an abrupt halt by the 2009 financial crisis. Economic growth fell considerably, from 3.2% of GDP per capita in 2007 to 0.19% in 2009.

Figure 1: Real GDP growth in SSA compared with other regions



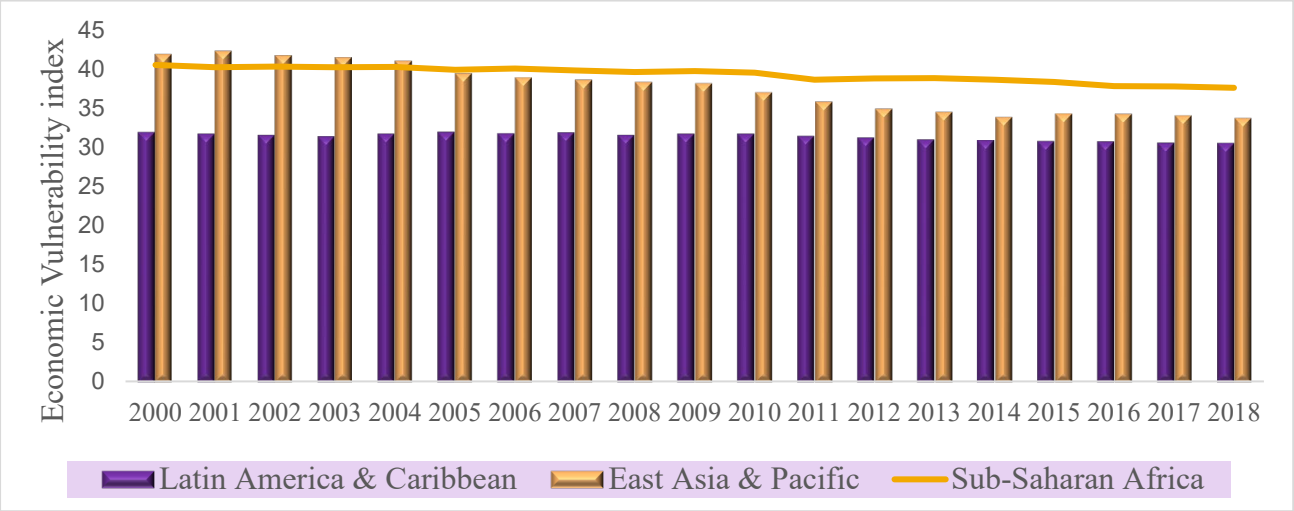
Source: Author, based on WDI

Note: In the current context of the Russo-Ukrainian crisis, we are witnessing economic and financial shocks throughout the world. According to the (AfDB, 2021) these shocks are transmitted through three main channels: energy and non-energy commodity prices, supply chain disruptions and financial markets.

The second period runs from 2010 to 2015, during which economic growth averaged 3.1% in 2010. In 2016, falling commodity prices destabilized many resource-dependent countries. In 2018, however, GDP growth slowly recovered to positive levels, thanks in part to resilient domestic demand and higher oil prices. The COVID-19 pandemic also highlighted SSA's vulnerability to shocks. SSA experienced a recession, with GDP per capita falling by 4.6% in 2020, although this effect is less marked than in Latin America and the Caribbean, where growth fell by 7.3% of GDP.

It can be seen from the above that the international financial, economic, health and geopolitical crises have not spared sub-Saharan Africa from their devastating effects. Indeed, Africa is very exposed and remains vulnerable to external shocks that destabilize and slow down its economic and social development, and as Figure 2 shows, on average, economic vulnerability in SSA is higher than in other regions of the world.

Figure 2: Comparative trends in the level of economic vulnerability in SSA with other regions and countries (2000-2018)

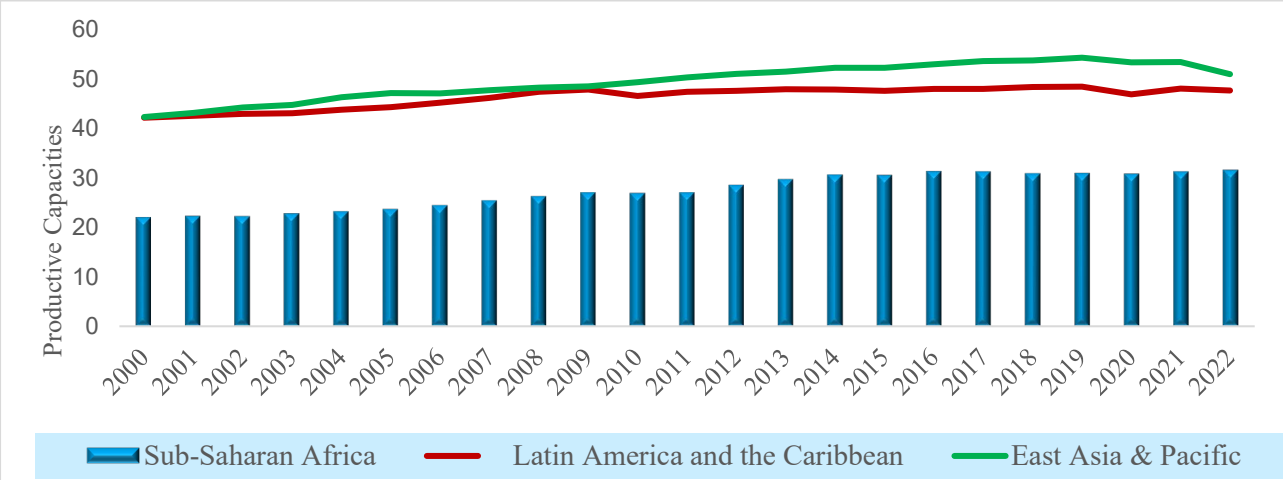


Source: Author, based on FERDI

B. Productive capacities

Although SSA's productive capacities is growing, its level remains low compared with other regions of the world. Figure 3 shows that SSA has much to do to improve its productive capacities. In 2018, the region had a productive capacities level of around 31, compared with 49, and 53 respectively for Latin America and Caribbean, and East Asia and Pacific. When countries are considered individually, performance varies from country to country (Figure 3 appendix). For example, landlocked countries such as Chad, Niger and Mali performed poorly in 2018, while Mauritius, Seychelles, Botswana and Cape Verde topped the rankings in most categories (table 8 appendix). However, it should be noted that performance in the productive capacities categories is not uniform. For example, Zimbabwe comes last in the institution’s category, but ranks seventh in the structural change category (table 8 appendix).

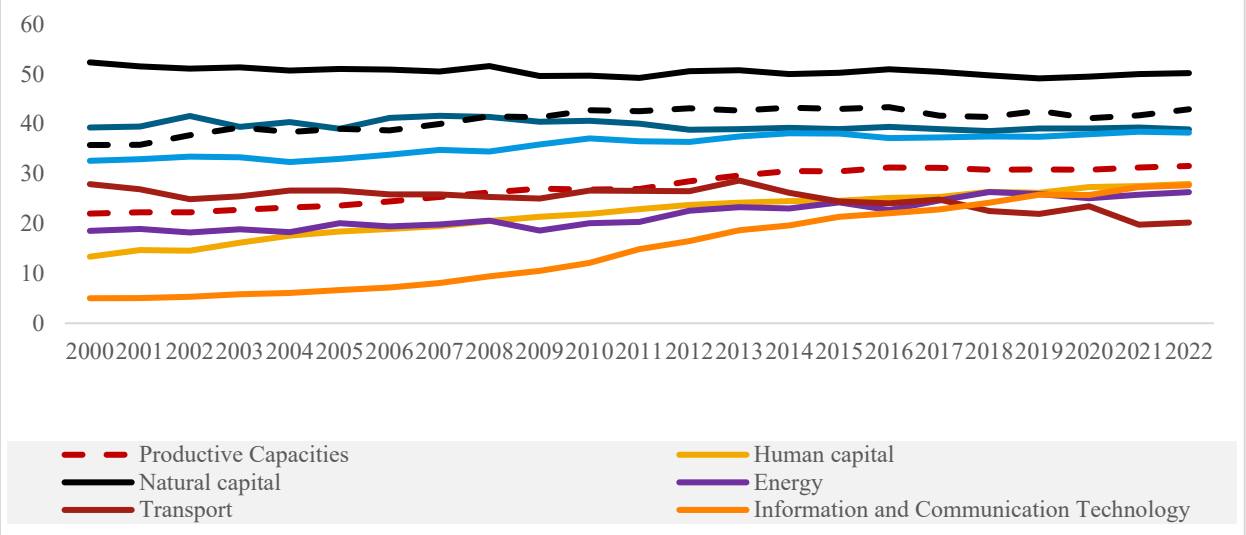
Figure 3. Comparison of productive capacities index in SSA and other regions



Source: Author, based on WDI

Furthermore, Figure 4 reveals that performance is not uniform across all dimensions of productive capacities. One of the areas where SSA has significant gaps in productive capacity is Information and Communication Technology (ICT). This area measures the accessibility and integration of communication systems within the population. It includes the use of fixed and mobile telephones, Internet access by the population and the security of servers. The figure also shows that in terms of transport infrastructure (TR), energy (EN) and human capital (HC), SSA has a deficit. These capacities are all below the average level. While ICT, energy and human capital have been growing since 2000, transport infrastructure has tended to deteriorate since 2013. This low level in these categories may lead to a drop in investment, particularly FDI, but it may also discourage policies in favor of inclusive growth. However, the categories of natural capital (NC), structural change (SCH), institutions (INST), and the private sector are above average. It should be pointed out that institutions have shown a downward trend since 2012. This deterioration is explained by the various political and security crises that several SSA countries have experienced in recent years.

Figure 4: Evolution of the productive capacities of SSA



Source: Author, based on UNCTAD

III. Theoretical background and review of the literature

A. Economic vulnerability and growth volatility

Economic vulnerability refers to a country's risk of exposure to unforeseen exogenous shocks (Guillaumont, 2006). In the literature, three components determine a country's vulnerability. Firstly, the magnitude of exogenous shocks such as natural hazards or global economic crises. Secondly, the country's exposure to these shocks and its ability to cope with them, also known as its resilience. While the first component is purely exogenous, the last two depend on the country's internal conditions. Volatility refers to the variability over time of a series in relation to its mean value or its deviation from the trend value (Aizenman et al., 2005a). According to (Nooruddin, 2010), it comprises two closely related aspects: stability and predictability. Applied to economic growth, stability refers to a country's ability to return to its normal levels of performance following a shock to the system. Predictability, on the other hand, indicates the ability to forecast future performance based on the past. Consequently, predictable states have future growth rates that are accurately predicted by their current growth rate and macroeconomic conditions. The main factors in this indicator are population size, remoteness from world markets, export concentration, the share of agriculture, forestry and fisheries in GDP, the environment, and export instability.

In the literature, a country with a small population is likely to be open to international trade, which increases its exposure to trade shocks. Easterly et al. (2000) have shown that small countries have more volatile growth rates due to greater volatility in their terms of trade. Furthermore, the fact that a country is far from world markets represents a structural handicap for growth and poverty reduction. The further a country is from the main world markets, the higher its transport costs will be. Encontre (1999) explains that remoteness is likely to delay the delivery of essential goods, and this accentuates vulnerability. Malik & Temple (2009) have shown that countries far from the coast are more likely to have non-diversified exports and to experience greater growth volatility. Furthermore, countries that depend on the agricultural sector are more vulnerable to fluctuations in international commodity prices and climatic shocks, which can increase the volatility of production. From this literature, we can see that countries with a high level of vulnerability are likely to experience greater growth volatility. In the following section, the literature will focus on the link between productive capacities and growth volatility.

B. Productive capacities and growth volatility

By definition, productive capacities refer to "the productive resources, entrepreneurial capabilities and production linkages that together determine a country's ability to produce goods and services and enable it to grow and develop" (UNCTAD, 2006). UNCTAD summarizes the factors at the heart of capacity development in eight components. These factors include structural change, human capital, natural capital, energy, ICTs, transport, institutions and the private sector.

Structural change refers to the movement of labor and other low-productivity productive resources into high-productivity activities. According to UNCTAD, structural transformations are characterized by the sophistication and diversification of exports, the intensity of fixed capital and changes in the weight of sectors of activity in GDP (agriculture, industry, services). From the point of view of exports, it is accepted that the nature of

diversification and sophistication of exports are essential criteria for the development of a country's productive capacity in the context of globalization. Indeed, dependence on exports of a few low value-added products, coupled with the high volatility of the prices of these products, increases a country's vulnerability to external shocks and consequently reduces its competitiveness and its chances of taking off. Moro (2015) has shown that the expansion of the services sector reduces the volatility of economic growth. Furthermore, Moro (2012), in a two-sector general equilibrium model, found that structural transformation can explain almost 28% of the great moderation experienced by the US economy since the early 1980s. Da-Rocha and Restuccia (2006) examined the interaction between structural transformation and business cycle fluctuations in a two-sector computed general equilibrium model. Their results suggest that as economies undergo structural transformation, business cycle fluctuations between countries tend to converge. However, Harchaoui (2021) found that macroeconomic volatility decreases with development in developing countries only when structural transformation is excluded.

Physical capital has also been analyzed in the literature. In the composition of the productive capacity index, physical capital refers to energy, ICT and transport. For example, ICT plays an important role in accelerating economic growth. Eminent theories, such as neo-Schumpeterian growth (Schumpeter, 1934) and neoclassical growth (Solow, 1956), have identified the involvement of ICT in economic growth. According to these theories, ICTs enter the economic supply in the form of capital and improve the production process by deepening capital and producing high-quality technology and labour. As a result, ICT generates value added at the firm and sector level, which translates into increased productivity and economic growth at the national level (Aghaei and Rezagholizadeh, 2017; Quah, 2002). Technologies are found to have an indirect impact on output fluctuations, potentially creating a basis for research into the driving impact of ICT diffusion on output volatility. King and Rebelo (1999) show that trade fluctuations can be attributed to technology shocks. To some extent, output volatility is correlated with ICT technologies.

Another part of the literature attaches importance to institutional factors in economic fluctuations. Generally speaking, numerous studies have examined the effect of the quality of institutions on economic development (Acemoglu and Johnson, 2005). From a theoretical point of view, good institutions encourage people to innovate, take risks, save for the future, find better ways of doing things, learn and educate themselves, solve collective action problems and provide public goods (Acemoglu and Johnson, 2005). According to North (1993), the major role of institutions in a society is to reduce uncertainty by establishing a stable structure for human interaction. Institutions reduce uncertainty and create a stable exchange structure. Thus, improved economic institutions increase economic growth by lowering transaction and production costs and increasing gains from trade. Empirically, Mobarak (2005) examines the effect of institutions on growth volatility and finds that democracy reduces volatility. Thus, in a democracy, low volatility is expected due to the strong constitutional and institutional constraints on leaders (Nooruddin, 2010). Democracies not only establish economic policies by consensus (Mobarak, 2005; Rodrik, 1999), but they also allow for greater diversification in the decision-making process (Chandra, 1998), which leads to economic stability. Furthermore, democratic institutions can ensure the stability of an economy through political competition and voters' preference for risk avoidance, because risk-averse voters punish the government in power for its economic instability (Quinn and Woolley, 2001). Thus, institutional quality can have a profound impact on growth stability. Furthermore, Klomp and De Haan (2009) provide evidence that instability and uncertainty increase economic volatility. From the above, we can expect institutions to reduce volatility.

As far as the private sector is concerned, it refers to domestic credit as well as the cost and duration of imports and exports. One strand of the literature has argued that a developed financial system improves the economy's ability to absorb shocks and helps to reduce output volatility (Acemoglu and Zilibotti, 1997). According to Acemoglu and Zilibotti (1997). the important link between the financial system and volatility is its ability to

diversify and reduce risk. The mechanism behind this argument can be found in portfolio theory. According to this theory, portfolio diversification reduces risk (Markowitz, 1999). Financial deepening thus offers opportunities to diversify risk, manage volatility and insure against unexpected events. Furthermore, some authors have put forward the idea that easier access to foreign financial markets and greater capital account openness could help a country to smooth the adjustment process to shocks, while reducing volatility. Greater financial openness creates more opportunities for risk sharing and portfolio diversification, which producers and investors can use to reduce risk (Kim, 2007; Kose et al., 2003). Gavin & Hausmann (1998) see developed financial markets as shock absorbers that help countries stabilise production in times of crisis. Better access to credit, coupled with greater integration of a country's financial market into the global market, supports demand during a negative shock to production (Aizenman et al., 2005).

Human capital accumulation could also influence the volatility of economic growth through diversification (Gnangnon, 2021). Studies have shown that complex goods have a high knowledge content and therefore a high human capital intensity (see Bustos et al., 2012; Hausmann and Hidalgo, 2011; Hidalgo & Hausmann, 2009). Moreover, complex economies tend to have low growth fluctuations (Güneri and Yalta, 2021; Maggioni et al., 2016; Miranda-Pinto, 2021). Human capital can therefore promote diversification, which in turn affects volatility (Agosin et al., 2012; Andersson and Johansson, 2010; Jetter & Ramírez Hassan, 2015).

With regard to natural capital, dependence on natural resources influences the volatility of economic growth through its effect on export diversification. In fact, an economy's high dependence on natural resources may be associated with a less diversified export basket (Djimeu and Omgba, 2019; Jetter and Ramírez Hassan, 2015; Ross, 2019), which in turn increases countries' vulnerability to external shocks, and hence volatility. Jetter and Ramírez Hassan (2015) obtained that the share of natural resources in gross domestic product is the second major determinant of export diversification (it negatively affects the diversification of export products) among the 36 potential factors explored.

In the light of the various analyses, we can therefore deduce that greater productive capacities are likely to help reduce fluctuations in economic growth, i.e., the volatility of economic growth. In other words, greater productive capacities help to ensure stable economic growth. However, given the effect of vulnerability on volatility, the following section presents the role that productive capacities can play in the relationship between economic vulnerability and volatility.

C. Relationship between economic vulnerability and growth volatility: the role played by productive capacities

As presented in the previous section, a vast literature has shown that economic vulnerability is a source of volatility. A number of research studies have addressed this issue in the literature. According to Loayza et al. (2007), volatility can be explained by various factors. On the one hand, domestic shocks caused by the instability intrinsic to the development process and; the volatility of fiscal policy (Fatás and Mihov, 2006), social conflicts, economic mismanagement and political instability (Raddatz, 2007). On the other hand, exogenous shocks induced by commodity price instability, the global interest rate and natural disasters (Aizenman et al., 2005).

However, the weakness and inefficiency of shock absorption mechanisms can amplify the effects of shocks and vulnerability (Loayza et al., 2007). These mechanisms, known as resilience factors, are at the heart of policies. It is in this sense that this study looked at productive capacities as resilience factors in the effect of economic

vulnerability on volatility. The basic hypothesis is that growth is less volatile when the economy is less vulnerable and productive capacities have developed.

In the literature, categories of productive capacities are known for their ability to moderate shocks and reduce volatility. For example, Rodrik (1999) has shown that the severity of a shock to growth or its volatility depends on the interaction between conflict management institutions and the shock. He explains that democratic institutions, by encouraging consensus on the political responses to be given to the various shocks, help to reduce the volatility of growth rates. According to this logic, democracies experience less volatility than non-democracies because they "induce a greater willingness to cooperate and compromise in the political sphere, thus generating greater stability" (Rodrik, 2000). According to Aizenman et al.(2012), corruption, lack of credibility, the risk of repudiation of government contracts and low levels of investment could render many government policies totally ineffective in dealing with external macroeconomic shocks (Aizenman et al., 2012).

In addition, the private sector, through bank credit, can reduce the effect of vulnerability on volatility. In fact, a developed financial system improves the economy's capacity to absorb shocks and helps to reduce the volatility of production (Acemoglu and Zilibotti, 1997). For example, in the event of economic vulnerability due to a deterioration in the terms of trade, there may be a contraction in the output of exporting companies, which could exacerbate financial constraints. By granting short-term loans, banks enable these companies to smooth out fluctuations in production.

The accumulation of human capital also influences the volatility of economic growth through diversification. Indeed, Koren and Tenreyro (2007) have shown that economic and export diversification can increase the resilience of low-income countries to external shocks, particularly by moving away from sectors that are highly volatile, such as mining and agriculture. On the other hand, the COVID-19 pandemic revealed that when overall scores in the categories of human capital, ICT and institutions are low, countries are more vulnerable to unexpected external shocks such as the pandemic and the effects of these on their socio-economic performance, and thus find it even harder to combat the spread of the virus and cope with its impact on their development (UNCTAD, 2021). Indeed, the availability of health professionals is vital and ICTs are indispensable tools for the delivery of business and other critical services (e-learning, distance medicine, teleworking, etc.). Thus, the development of ICTs and human capital can help reduce the effects of vulnerabilities on volatility.

Productive capacities are therefore important for reducing the effect of vulnerability on growth volatility. By developing their productive resources, entrepreneurial skills and production links, economies can improve their ability to grow and develop and reduce their vulnerability to external shocks, whether economic in nature or not. The following section presents the methodology used to specify the model and the estimation results.

IV. Methodology and data

A. Data and variables

The data used come from multiple sources, namely the World Bank; FERDI and UNCTAD. Our variables of interest are growth volatility, economic vulnerability and productive capacities. Control variables are also considered. A description of these variables and their sources is presented in the appendix, Table 7.

i. Growth volatility

In line with the volatility literature, we measure growth volatility by calculating the rolling standard deviations of GDP per capita growth rates over five-year periods (Le, 2020). Specifically, the observation given by the standard deviation of GDP per capita growth rates between periods t and t + 4 is followed by the observation obtained by applying the same calculation technique to the years between t + 1 and t + 5.

ii. Economic vulnerability

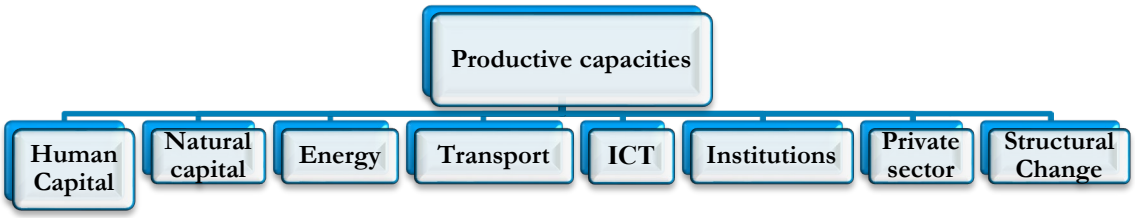
Economic vulnerability is the risk of a country's development being hampered by natural or external shocks (Guillaumont, 2008). The Economic Vulnerability Index (EVI) is used in this study. It was drawn up by the United Nations Committee for Development Policy (UNCDP) and the Foundation for International Development Studies and Research (FERDI).

The index has two components: The index of exposure to shocks and the index of shocks themselves. The shock exposure index reflects the risk of a country being affected by shocks in the future. The factors that make up this index are the size of the population, the export concentration ratio, the share of agriculture, forestry and fisheries in GDP, and remoteness from world markets. The shock index itself takes account of natural shocks on the one hand, and external or trade shocks on the other. These natural or climatic shocks are measured by two variables: the average annual percentage of the population displaced by natural disasters; and the instability of agricultural production, reflecting the impact of the frequency and severity of these shocks on agricultural production. Trade shocks, for their part, are approximated by the instability of exports of goods and services, and reflect exogenous events such as fluctuations in world supply and demand, or internal events independent of economic policy, such as climatic shocks (Guillaumont, 2008).

iii. Productive capacities

UNCTAD's Productive Capacities Index (PCI) is used in this study. The concept of productive capacities has several dimensions. UNCTAD summarizes the factors at the heart of capacity development in eight components. As Figure 5 shows, these are structural change, human capital, natural capital, energy, ICT, transport, institutions and the private sector.

Figure 5: Productive capacities index and its components



Source: author

For each of the eight components, a score is calculated with a value between 0 and 100 (excluding the bounds); values close to 0 reflect weak performance in the area concerned, while those close to 100 are synonymous with good performance. Thus, for the composite index, small values in the vicinity of 0 will reflect poor performance in terms of developing productive capacity, while values closer to 100 will correspond to cases of high-performing economies.

iv. Control variables

The control variables chosen come from the literature on the determinants of volatility. Thus, we considered inflation volatility, trade openness, credit, GDP per capita and government expenditure. The description and sources of these variables are presented in the appendix:

Inflation volatility: Volatile inflation, reflecting the occurrence of nominal or monetary shocks, leads to an increase in growth volatility (Yougbare, 2009). A positive sign of this variable is expected.

GDP per capita: Higher incomes tend to reduce output volatility in both developed and developing economies (Kpodar et al., 2019). Also, Sahay et al. (2015), used this indicator to show that the more developed (richer) a country is, the less volatile its growth is.

*Trade openness***:** the effect of openness on volatility is mixed. Openness can expose the economy to more external shocks, leading, all other things being equal, to greater growth volatility (Balavac and Pugh, 2016). However, it can provide better insulation against domestic demand shocks. Openness also strengthens the role of the real exchange rate, which can in turn act both as a stabilizing element and as a source of additional volatility (Aizenman et al., 2005).

Government expenditure: This is measured by government consumption expenditure (Yougbare, 2009). Its effect on volatility is not clear cut. Indeed, an increase in public spending may help to stabilize growth during a period of falling private spending. In this case, variations in public spending are negatively linked to growth volatility. However, they can lead to unstainable fiscal policy that undermines macroeconomic stability.

*Credit***:** A developed financial sector can strengthen the economy's adjustment capacity by contributing to the mobilization and efficient allocation of productive resources and by offering risk management mechanisms (Beck and Levine, 2005). It thus contributes to make growth more stable and therefore less volatile. But financial development is also accompanied by risks of increased instability in economic growth and may even be subject to threshold effects with volatility (Sahay et al.2015). Its effect is therefore mixed.

B. Model and estimation methodology

In this section, we present the model and estimation methodology. Drawing on the literature (Avom et al., 2021), the empirical equations are given by:

$$\sigma_{it} = \alpha\sigma_{i,t-1} + \beta' X_{it} + \gamma EVI_{it} + \theta PCI_{it} + \varepsilon_{it} \quad ...(1)$$

$$\sigma_{it} = \alpha\sigma_{i,t-1} + \beta' X_{it} + \gamma EVI_{it} + \theta PCI_{it} + \tau(PCI * EVI_{it}) + \varepsilon_{it} \quad ...(2)$$

Equation (1) analyses the effects of productive capacities and economic vulnerability on growth volatility, while equation (2) attempts to analyze the role played by productive capacities in the effect of economic vulnerability on growth volatility. In these two equations, i and t represent the country and the period respectively, σ_{it} represents the volatility of real GDP growth, EV and PCI represent the economic vulnerability index and the productive capacities index respectively. $(PCI * EVI_{it})$ is the interaction term between PCI and EVI. Their coefficient reflects the effect of productive capacities on the relationship between economic vulnerability and growth volatility. Specifically, we examine how productive capacities variables affect the relationship between economic vulnerability and volatility. From (2), we calculate the marginal effect of productive capacities as follows:

$$\frac{\partial \sigma}{\partial EV} = \gamma + \tau PCI \qquad (3)$$

This equation shows that the marginal effect of vulnerability on volatility depends on productive capacities. Productive capacities are expected to reduce the marginal effect of economic vulnerability, which should be reflected by a coefficient $\tau<0$. The standard approach in empirical studies to test for the existence of a non-linear effect is to examine the sign and statistical significance of the interaction coefficient τ . Thus:
If γ and τ are all positive (negative), then economic vulnerability has a positive (negative) effect on volatility, and productive capacities increases (worsens) this impact.
If $\gamma>0$ and $\tau<0$, economic vulnerability amplifies volatility, but productive capacities act as a mitigating factor.

C. Estimation method

Estimating the model used to analyze the effects of productive capacities on volatility in SSA raises challenges. First, there may be unobservable factors affecting both productive capacities and economic vulnerability (i.e., the problem of omitted variables). Second, there may also be reverse causality, i.e., volatility may also affect productive capacities or economic vulnerability. For example, volatile economies are often vulnerable to shocks. The same applies to certain components of productive capacities. Indeed, growth instability could lead to a decline in credit to the private sector when risk-averse banks reduce lending in times of economic uncertainty (Kpodar et al., 2019). To address these issues, we use estimation methods based on the Generalized Moments (GMM) system developed by Arellano and Bover (1995) ; Blundell and Bond (1998). In this estimation, the level equations and the first difference equations are combined in a system and estimated using a system GMM estimator; the lagged differences and the lagged levels of the explanatory variables will therefore be used as instruments. We favor two-stage system GMM estimation of the model because it is asymptotically more efficient than single-stage estimation. However, Windmeijer (2005) has shown from Monte Carlo simulations that the estimated asymptotic standard deviations of the two-stage GMM estimator can be significantly downward biased at finite distance. Otherwise, the weighting matrix in the two-stage GMM estimator depends on the estimated parameters, the presence of which largely explains the difference between the standard deviations at finite distance and the asymptotic standard deviations. Windmeijer (2005) shows that this difference can be estimated and thus improve inference on the standard deviations estimated in the second stage. To guard against the possibility of such a bias, we use the second-stage finite-sample covariance matrix correction method proposed by Windmeijer (2005). In order to check the validity of the instruments, two specification tests will be carried out. The first is the Sargan/Hansen test for over-identification restrictions. The second examines the hypothesis that there is no second-order serial correlation in the first difference residuals. To avoid the problem of instrument proliferation (Roodman, 2009), the collapse option will be used, and the number of lags is set so that the number of instruments is less than the number of countries.

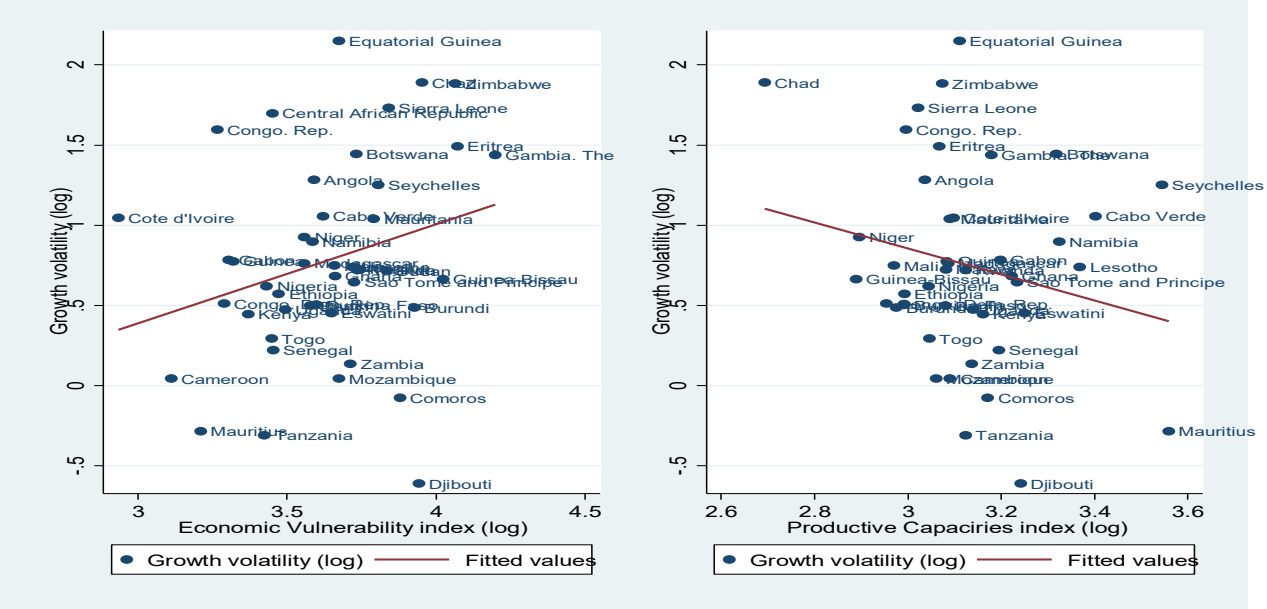
V. Results and discussions

A. Preliminary results

Figure 6 shows that there is a strong positive correlation between economic vulnerability and growth volatility. This suggests that the most vulnerable countries have the most volatile growth rates. On the other hand, in the right-hand panel of Figure 6, productive capacities are negatively correlated with growth volatility. In other words, countries that try to develop their productive capacities tend to have lower volatility. Generally speaking, the majority of countries with high vulnerability and/or low productive capacities are characterized by relatively high volatility. For example, Figure 6 shows that the Zimbabwean, Eritrean and Gambian economies have high

vulnerabilities, low productive capacities and increased growth volatility. In contrast, Mauritius and Tanzania have relatively high productive capacities, are less vulnerable and have relatively stable growth rates.

Figure 6: Correlations between the variables of productive capacity, economic vulnerability and growth volatility



Source: author

These preliminary results seem to support the hypothesis that productive capacities can play a role in managing macroeconomic volatility. In the light of these observations, an econometric analysis is needed to test these presumptions. Accordingly, the following section will discuss the results of the econometric estimates.

B. Statistics

Table 1 presents the results of the descriptive statistics for the variables used. Over the period considered, growth volatility has an average value of 3.13 for the region, with maximum and minimum values of 19.97 and 0.14 respectively for Equatorial Guinea (2001-2005) and Mauritius (2014-2018). Its dispersion in relation to the average is 2.96. In addition, the average value of the vulnerability index is 38.70, with corresponding maximum and minimum values of up to 70.04 for Gambia (2015) and 16.38 for Côte d'Ivoire in 2016.

With regard to the indicators of productive capacities, in addition to the average or median values, attention should be paid to the difference between the minimum and maximum values, the dispersion or standard deviations and the distribution of values in the eight categories. In fact, the table shows that the gap between the minimum and maximum values, i.e., between the countries ranked first and last, is particularly high for the categories of natural capital, institutions, private sector, transport, energy, human capital and, to a lesser degree, for ICT and structural change. Similarly, standard deviations show that dispersion is highest in the categories of institutions, human capital, natural capital and the private sector.

Table 1: Statistics

Variable	Mean	Std. Dev.	Min	Max
Volatility	3.1	3.0	0.1	20.0
Economic Vulnerability	38.7	10.3	16.4	70.0
GDP per capita	2182.8	2997.5	281.9	16628.1
Trade	73.5	41.5	1.3	348.0
Inflation volatility	4.6	12.4	0.2	237.0
Government expenditure	14.7	6.7	2.0	43.5
Credit	18.1	15.6	1.1	106.3
shock	38.9	17.4	2.4	88.2
Exposure to shock	38.3	9.3	22.8	64.7
PCI	23.1	4.1	12.6	37.4
Human capital	34.7	5.8	20.4	51.1
Natural Capital	57.9	8.7	32.9	96.7
Transport	12.1	5.6	4.4	46.6
ICT	5.2	2.5	2.8	17.1
Institutions	41.5	12.4	18.7	74.4
Private Sector	70.3	8.2	38.2	87.8
Structural Change	14.1	3.8	1.5	21.3
Energy	19.4	6.2	5.6	59.2

Source : Auteur

C. Results of econometric estimations

Table 2 presents the results of the estimates of the effect of economic vulnerability on growth volatility using the GMM. The tests associated with the model reveal its validity. The probability associated with the Sargan/Hansen test is well above 10%. Similarly, the probability associated with the Arellano-Bond test is above the 10% required for the model to be valid.

The table also shows that in all specifications, the coefficient associated with vulnerability is positive and statistically significant at the 1% threshold. In column 1, we have presented the results of the model linking economic vulnerability to growth volatility. In this column, the coefficient associated with the economic vulnerability variable is 0.04. This suggests that an increase of 10 units in the economic vulnerability index leads to an increase in growth volatility of around 0.4 units. This result is consistent with the work of Loayza et al. (2007); Guillaumont, (2006) who have shown that economic vulnerability induced by exposure to exogenous and internal shocks is the main source of growth volatility in developing countries. Next, in column 2, we introduce GDP per capita as a control variable. We find that the coefficient associated with the economic vulnerability index remains positive and statistically significant at the 1% level. In fact, the high vulnerability of SSA countries can be explained by the dependence on agricultural sectors that are vulnerable to fluctuations in international commodity prices and climatic shocks, which can increase the volatility of production. It can also be explained by the remoteness of world markets (Encontre, 1999). For example, Malik and Temple (2009) have shown that countries far from the coast are more likely to have non-diversified exports and to experience greater growth volatility. With regard to the GDP per capita variable, we find that the coefficient associated with this variable is negative and statistically significant at the 1% level. This result reflects the fact that growth volatility tends to decrease as income increases. This result is consistent with previous studies showing that an increased level of development tends to reduce output volatility in both developed and developing economies

(Kpodar et al., 2019). Column 3 takes trade openness into account. The coefficient associated with openness is positive and significant at 1%. This is in line with the work of Balavac and Pugh (2016) who showed that openness can expose the economy to more external shocks leading, ceteris paribus, to higher growth volatility.

Table 2: effects of economic vulnerabilities on growth volatility

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility
L.volatility	0.509***	0.696***	0.590***	0.564***	0.564***	0.534***
	(0.036)	(0.060)	(0.034)	(0.025)	(0.053)	(0.061)
Economic Vulnerability	0.039***	0.034***	0.023***	0.033***	0.037***	0.043***
	(0.005)	(0.010)	(0.007)	(0.004)	(0.007)	(0.011)
GDP per capita		-0.038***	-0.440***	-0.176***	-0.082	-0.297**
		(0.013)	(0.112)	(0.026)	(0.079)	(0.130)
Trade openness			0.304***	0.336***	0.239***	0.453***
			(0.108)	(0.032)	(0.079)	(0.136)
Inflation Volatility				0.025***	0.039***	0.038***
				(0.003)	(0.014)	(0.013)
Credit					-0.007**	-0.017***
					(0.003)	(0.004)
Government expenditure						0.066***
						(0.015)
Constant	-1.176***	-0.790**	1.323	-1.179***	-1.500*	-1.888
	(0.197)	(0.343)	(0.936)	(0.118)	(0.788)	(1.305)
Observations	597	595	565	553	513	500
Countries	45	44	42	42	41	41
Instruments	35	40	36	41	37	37
AR(2)	0.173	0.182	0.208	0.366	0.654	0.546
Hansen	0.270	0.367	0.242	0.365	0.316	0.339

Source: author

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively.

In column 4, we augment the existing variables with inflation volatility. As in the previous results, we find that the coefficient associated with economic vulnerability remains positive and statistically significant at the 1% level. For our control variable, we find that the coefficient associated with this variable is positive and statistically significant at the 1% level, with a magnitude suggesting that an increase in inflation volatility of 10 units leads to an increase in growth volatility of around 0.25 units. This result is consistent with the work of Yougbare, (2009) who showed that volatile inflation, reflecting the occurrence of nominal or monetary shocks, leads to an increase in growth volatility. In column 5 we introduce bank credit to the private sector as a measure of financial development. The negative coefficient associated with this variable indicates that easier access to bank credit could help a country to reduce volatility (Kim, 2007; Kose et al., 2003). In column 6, we have taken government expenditures into account. The coefficient associated with this variable is positive and significant at 1%. This result can be explained by the aggressive use of discretionary fiscal policies in developing countries, particularly in SSA (Fatás and Mihov, 2006). Estimates based on the components of the vulnerability index (Shock Index and Exposure Index) produce similar results (Appendix, Table 3 and Table 4).

Table 3 presents the effects of productive capacities on growth volatility. In column (1) of the table, the productive capacities index is taken at the aggregate level. As can be seen, the coefficient is negative and statistically significant at 5%. This result shows that SSA countries that make an effort to improve their productive capacities experience less volatile growth rates. This result is in line with the predictions of UNCTAD (2006) and Gnangnon (2021), who consider that productive capacities can reduce vulnerability and hence volatility. Columns (2) to (9) then take into account the different components of the productive capacities index.

In column (2), the "human capital" variable is considered and the coefficient associated with this variable is negative and significant at 1%. This means that the development of human capital can help to reduce volatility. This result is consistent with existing research. Indeed, Hausmann and Hidalgo (2011) ; Hidalgo and Hausmann (2009) have shown that in general the most complex goods are those that are rich in high human capital intensity. In addition, Güneri and Yalta (2021) ; Maggioni et al. (2016) ; Miranda-Pinto (2021) have shown that the most complex economies experience low fluctuations in growth rates.
In column (3), natural capital is considered. The coefficient associated with this variable is positive, but not significant. However, taking this variable into account maintained the positive effect of economic vulnerability. In fact, an economy's high dependence on natural resources may be associated with a less diversified basket of export products (Djimeu and Omgba, 2019; Jetter and Ramírez Hassan, 2015; Ross, 2019), which in turn increases countries' vulnerability to external shocks, thus inducing high volatility. Moreover, the physical capital variables (transport, ICT, energy) all have expected and significant signs (with the exception of energy). The development of physical capital would help to reduce trade costs and promote the diversification of export products, which could reduce volatility. For example, Iwanow and Kirkpatrick (2009) found a positive effect of trade facilitation on bilateral exports of manufactured goods. In a similar vein, Hoekman and Shepherd (2017) found that trade costs in general, and export costs, tariffs and international transport costs in particular, are strongly associated with the geographical diversification of exports in developing countries. These positive effects of lower trade costs on diversification explain the negative effect on growth volatility. Column 7 includes the private sector as a variable. The coefficient associated with this variable is negative and significant, indicating that the development of the private sector, which reflects entrepreneurial opportunities, helps to reduce volatility[2]. Column 10 covers all categories of productive capacities. This column shows that some of the categories (ICT, institutions) appear to be more significant than others.
To sum up, the results show that productive capacities directly and negatively affect growth volatility. On the other hand, economic vulnerability has a positive effect on growth volatility.

[2] The theoretical explanation for this result comes from Rampini (2004). The author developed a model that postulates that entrepreneurial activity is likely to develop in more productive economies, as the latter help agents to be better able to share project-specific risks. The model predicts that when the domestic financial market is less developed in an economy (in such an economy, agents must bear all project-specific risks), the economy may experience more volatile output and lower output.

Table 3: Effects of Productive Capacities on growth volatility in SSA

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility	(10) Volatility
Economic Vulnerability	0.062***	0.028**	0.027***	0.033***	0.022**	0.123***	0.078***	0.025***	0.016**	0.031***
	(0.010)	(0.012)	(0.006)	(0.010)	(0.010)	(0.022)	(0.010)	(0.006)	(0.008)	(0.011)
Productive capacities	-0.064**									
	(0.029)									
Human Capital		-0.042**								0.091***
		(0.019)								(0.027)
Natural Capital			0.012							0.056**
			(0.019)							(0.025)
Transport				-0.037***						0.024
				(0.010)						(0.020)
ICT					-0.076***					-0.371***
					(0.026)					(0.074)
Institutions						-0.072***				-0.068***
						(0.021)				(0.019)
Private Sector							-0.064***			0.004
							(0.023)			(0.045)
Structural Change								-0.022		0.183***
								(0.025)		(0.057)
Energy									0.007	0.028
									(0.006)	(0.023)
Constant	-1.352	-0.719	-2.483*	1.350	-2.491***	-0.895	1.659	-1.392	-0.987	-4.760**
	(1.295)	(0.446)	(1.364)	(1.198)	(0.674)	(3.024)	(1.712)	(1.077)	(0.836)	(2.227)
Observations	466	466	466	466	466	466	466	466	466	466
Countries	39	39	39	39	39	39	39	39	39	39
No. of instruments	35	35	37	37	37	29	36	38	37	34
AR2 p-value	0.557	0.487	0.483	0.608	0.543	0.940	0.756	0.472	0.324	0.805
Hansen p-value	0.362	0.298	0.389	0.315	0.499	0.584	0.354	0.423	0.322	0.733

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, inflation volatility, Bank credit, and government expenditure.

Table 4: Consideration of interactive effects

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility
Economic Vulnerability	0.057*	0.065***	0.023***	0.037***	0.059***	0.158*	0.029**	0.117***	0.101***
	(0.031)	(0.011)	(0.005)	(0.012)	(0.014)	(0.083)	(0.012)	(0.042)	(0.036)
Productive capacities× EV	-0.003**								
	(0.002)								
Human Capital×EV		-0.002***							
		(0.001)							
Transport× EV			-0.001***						
			(0.000)						
ICT× EV				-0.001**					
				(0.001)					
Institutions× EV					-0.001***				
					(0.000)				
Private Sector× EV						-0.002*			
						(0.001)			
Structural Change × EV							0.003***		
							(0.001)		
Energy× EV								-0.001	
								(0.001)	
Natural Capital× EV									-0.001
									(0.001)
Constant	-3.457**	-4.822***	-1.028**	-4.338***	-6.322***	-0.491	-3.925***	-6.924**	0.461
	(1.652)	(1.471)	(0.422)	(1.225)	(0.911)	(2.111)	(1.446)	(3.284)	(2.700)
Observations	466	466	466	466	466	466	466	466	466
Countries	39	39	39	39	39	39	39	39	39
No. of instruments	33	34	38	35	35	31	36	25	28
AR2 p-value	0.854	0.462	0.657	0.577	0.723	0.594	0.623	0.488	0.473
Hansen p-value	0.353	0.448	0.363	0.513	0.466	0.255	0.541	0.574	0.162

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, inflation volatility, Bank credit, and government expenditure.

These results validate our first hypothesis, according to which increasing economic vulnerability tends to increase growth volatility, whereas improving productive capacities reduces growth volatility. However, productive capacities can also indirectly affect volatility by reducing the vulnerability effect. The results of the estimates of the indirect effects of productive capacities through vulnerability are presented in Table 4.[3] As expected, the coefficients of the interaction terms between the indicators of productive capacities and economic vulnerability are negative and statistically significant. These results suggest that productive capacities reduce the detrimental effect that economic vulnerability has on growth volatility.

These results are consistent with the findings of UNCTAD (2021) that productive capacities are associated with lower economic vulnerability. These results allow us not to reject our second hypothesis according to which the improvement of productive capacities reduces the effect of economic vulnerability on growth volatility.

D. Robustness analysis

Our results show that economic vulnerability contributes to growth volatility in SSA, but this effect varies according to the performance of productive capacities. Indeed, countries with high productive capacities have more opportunities to mitigate the effect of economic vulnerability on growth volatility. To check the robustness of our results, we carry out additional analyses. These analyses are carried out on two levels: firstly, in terms of alternative measures of volatility; secondly, in terms of sensitivity tests for outliers.

E. Alternative measure of volatility

We have used an alternative measure of volatility based on a filter. The most popular filter is the Hodrick and Prescott (HP) filter that allows to split a series into a transitory component (the cycle) and a trend (see appendix). It also has the advantage of making potentially integrated series stationary up to fourth order (King and Rebelo, 1999). The volatility is calculated as the standard deviation of the cycle. The results of the estimates are compiled in Tables 5, 6 and 7.

The results of Table 5, which concerns the effect of economic vulnerability on volatility, show that economic vulnerability positively affects growth volatility. Table 6 also shows that, with the exception of natural capital, energy and structural change, productive capacity indicators have a negative impact on growth volatility. In fact, we found that good institutional quality, better transport infrastructure, a good endowment in human capital, an adequate private sector and the use of ICT help to reduce volatility. These results confirm our previous findings. Table 7 also confirms the hypothesis that productive capacities reduce the effect of economic vulnerability on growth volatility. Our results are therefore robust to the use of an alternative measure of volatility.

[3] To guard against the risk of terror autocorrelation, autocorrelation tests were carried out ranging from order one to order four. These tests validate the absence of autocorrelation of errors of order 4.

Table 5: effects of economic vulnerabilities on growth volatility (using the HP filter as an alternative measure of volatility)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility
L.volatility	-0.094	0.068	-0.091	-0.122	-0.208***	-0.128***
	(0.212)	(0.051)	(0.360)	(0.163)	(0.063)	(0.035)
Economic Vulnerability	0.062**	0.060***	0.100**	0.068**	0.022**	0.035***
	(0.028)	(0.019)	(0.047)	(0.034)	(0.009)	(0.008)
GDP per capita		-0.992***	-0.875	-1.624*	0.472***	0.163
		(0.321)	(0.581)	(0.899)	(0.121)	(0.132)
Trade openness			1.887*	0.892***	0.600***	0.306**
			(1.105)	(0.275)	(0.084)	(0.121)
Inflation Volatility				0.267**	0.162***	0.279***
				(0.121)	(0.040)	(0.045)
Credit					-0.055***	-0.011
					(0.010)	(0.012)
Government expenditure						-0.037**
						(0.017)
Constant	-1.989*	5.075**	-4.908	5.620	-5.286***	-2.780**
	(1.072)	(2.426)	(5.509)	(6.615)	(0.887)	(1.122)
Observations	171	171	163	163	155	153
Countries	43	43	42	42	41	41
No. of instruments	15	23	13	21	37	39
AR2 p-value	0.741	1	0.938	0.452	0.917	0.206
Hansen p-value	0.117	0.541	0.425	0.748	0.509	0.418

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively.

Table 6: Effects of Productive Capacities on growth volatility in SSA (using the HP filter as an alternative measure of volatility)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility	(10) Volatility	(11) Volatility
Economic Vulnerability	0.056***	0.045*	0.096*	0.033*	0.042*	0.041**	0.046***	0.046***	0.034*	0.045***	0.082***
	(0.007)	(0.023)	(0.050)	(0.019)	(0.023)	(0.017)	(0.014)	(0.014)	(0.019)	(0.012)	(0.013)
Productive capacities	-0.102**										
	(0.045)										
Human Capital		-0.186**									0.093*
		(0.076)									(0.054)
Natural Capital			-0.191								-0.027
			(0.114)								(0.022)
Transport				-0.160***							-0.103**
				(0.047)							(0.043)
ICT					-0.345***						-0.329***
					(0.090)						(0.073)
Institutions						-0.035**					0.023
						(0.017)					(0.027)
Private Sector							-0.001	-0.001			-0.020
							(0.013)	(0.013)			(0.021)
Structural Change									0.094		0.057
									(0.079)		(0.106)
Energy										0.057	-0.030**
										(0.036)	(0.012)
Constant	-1.956***	10.342	3.515	0.873	7.273	4.114	-1.320	-1.320	-3.282	-0.540	-4.429
	(0.703)	(8.096)	(9.716)	(3.638)	(4.786)	(2.909)	(1.099)	(1.099)	(2.407)	(1.101)	(3.560)
Observations	144	144	144	144	144	144	144	144	144	144	144
Countries	39	39	39	39	39	39	39	39	39	39	39
No. of instruments	32	25	18	31	25	33	28	28	26	26	38
AR2 p-value	0.629	0.949	0.588	0.163	0.841	0.645	0.368	0.368	0.344	0.171	0.518
Hansen p-value	0.497	0.599	0.565	0.584	0.906	0.432	0.291	0.291	0.547	0.547	0.464

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, inflation volatility, bank credit and government expenditure.

Table 7: Consideration of interactive effects (using the HP filter as an alternative measure of volatility)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility
Economic Vulnerability	0.087***	0.105**	0.129***	0.049*	0.114***	0.097**	0.047***	0.091**	0.071**
	(0.027)	(0.049)	(0.025)	(0.027)	(0.040)	(0.037)	(0.016)	(0.041)	(0.027)
Productive capacities× EV	-0.003***								
	(0.001)								
Human Capital×EV		-0.003***							
		(0.001)							
Transport× EV			-0.002*						
			(0.001)						
ICT× EV				-0.006***					
				(0.002)					
Institutions× EV					-0.001*				
					(0.001)				
Private Sector× EV						-0.001*			
						(0.000)			
Structural Change × EV							-0.001		
							(0.001)		
Energy× EV								0.001	
								(0.001)	
Natural Capital× EV									-0.001
									(0.001)
Constant	-3.013	-2.429	-10.265***	3.187	-9.379	7.022*	-1.264	1.192	3.304
	(2.346)	(4.978)	(2.299)	(2.866)	(5.799)	(3.680)	(0.903)	(4.548)	(2.647)
Observations	144	144	144	144	144	144	144	144	144
Countries	39	39	39	39	39	39	39	39	39
No. of instruments	36	27	30	31	29	26	37	22	32
AR2 p-value	0.196	0.773	0.928	0.997	0.119	0.235	0.318	0.339	0.334
Hansen p-value	0.282	0.519	0.903	0.819	0.588	0.404	0.600	0.538	0.686

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, inflation volatility, bank credit and government expenditure.i.

i. Sensitivity tests for outliers

An analysis of Figure 6 and Table 6 (appendix) shows that some countries, such as Mauritius and Lesotho, dominate the rankings for many indicators of productive capacities. This raises the question of whether the results obtained are largely due to these countries. We test this hypothesis by excluding Mauritius and Lesotho from the sample (Tables 1 and 2; appendix). The results for the independent variables of interest (productive capacities variables, vulnerability variable and interaction terms) in the sub-sample are largely consistent with those for the full sample in the previous tables. This confirms that the power of productive capacities to reduce vulnerability and growth volatility is not due to these outliers.

VI. Conclusion and policy implication

The COVID-19 pandemic and its economic, social and financial repercussions have led to renewed interest in research into appropriate policies and means of strengthening economic resilience to shocks, particularly in developing countries. These countries are subject to negative shocks, but do not have adequate resources to overcome them, which increases the volatility of their growth, leading to significant costs. This raises the question of how to improve the resilience of economies in the face of economic vulnerability. This article examines the effect of productive capacities on growth volatility in SSA countries when faced with high levels of economic vulnerability. Using a sample of 43 SSA countries over the period 2000-2018, with the Generalized Method of Moments, the empirical results show that economic vulnerability contributes to growth volatility while productive capacities reduce growth volatility. We also find that the effect of vulnerability depends on the characteristics of countries in terms of the development of productive capacities. Indeed, countries with greater productive capacities have greater opportunities to mitigate the impact of economic vulnerability on growth volatility. Consequently, productive capacities appears to play a key mitigating role in the transmission of shocks in SSA.

The conclusions of this study have relevant implications. In order to build economic resilience and reduce vulnerability in SSA, countries should focus on policies that strengthen the development of productive capacities. Specifically, in the area of ICTs, policymakers can strengthen infrastructure and improve access to electronic communications services and reduce telecommunication costs. In the field of transport, it is important to work to open up production areas, develop access corridors to ports for landlocked countries, improve the quality of air transport and promote river transport. In the field of energy, we need to increase the supply of electricity, improve the quality of the product offered, reduce electricity costs and facilitate access to electricity services. As far as human capital is concerned, it is important to act to improve the quality of education, public health and research and development (R&D). Furthermore, given the role of the private sector, it is necessary to improve the business environment by strengthening the technical, human and financial capacities of institutions serving the private sector. It is also necessary to facilitate access to financial services by reducing the asymmetry of information concerning SMI/SMEs. This could help them to cope with shocks. To facilitate structural transformation, countries should promote: (i) the diversification and sophistication of exports; (ii) strengthening links between production, processing and consumption; (iii) building value chains; (iv) strengthening links between large and small companies on the one hand, and domestic and foreign companies on the other. In addition, countries should enhance the value of natural resources and improve the productivity of the agricultural sector and its resilience to climate shocks. Finally, it is important to improve institutions and governance. To achieve this, it is necessary to create a stable environment that is conducive to growth. This means tackling challenges such as strengthening the effectiveness of governance, reducing corruption, improving political stability, and eradicating insecurity and violence. Although our study provides insights into

the link between productive capacities, economic vulnerability and growth volatility in Sub-Saharan Africa, it also has some limitations. First, the study period is limited due to data availability; future research should cover longer time series. Secondly, we did not conduct the analysis at the individual country level. Future research can take this aspect into account.

Annex I. Hodrick and Prescott decomposition

Hodrick and Prescott decompose the evolution of a series into a non-stationary trend component (T_t) and a stationary cyclical component (C_t):

$$X_t = T_t + C_t$$

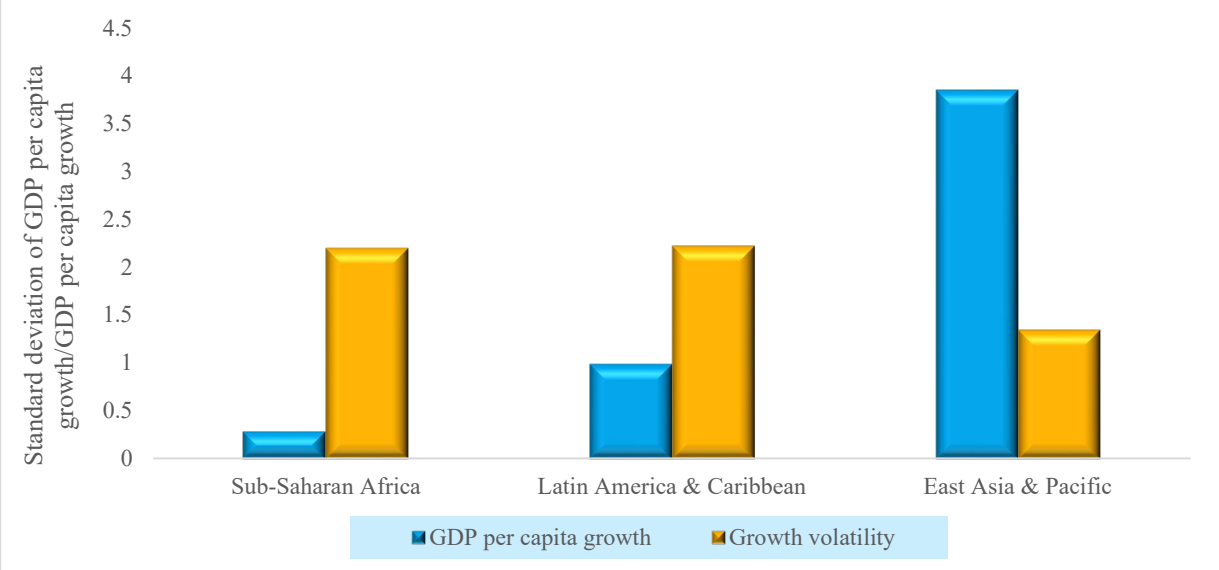
The HP filter therefore consists of isolating the cyclic component by optimizing the following program with respect to T_t:

$$min\left[\sum_{t=1}^{N}(X_t - T_t)^2 + \lambda \sum_{t=2}^{N-2}(\Delta^2 T_t)^2\right]$$

The first term of this equation minimizes the variance of the cyclical component, while the second term smoothes the evolution of the trend component. When λ tends towards infinity, the variance of the growth in the trend component tends towards 0, which implies that the trend component or the filtered series is approaching a simple linear time trend. Conversely, when λ tends towards 0, the filtered series approaches the original series. This implies that the choice of the smoothing parameter λ must be subject to a trade-off. While Hodrick and Prescott recommend a parameter λ equal to 100 for annual data, some studies suggest a higher value between 100 and 400 (Baxter and King, 1999), while others prefer much lower values, between 6 and 10 (Maravall and Del Rio, 2001). In this study, we considered a parameter λ=100.

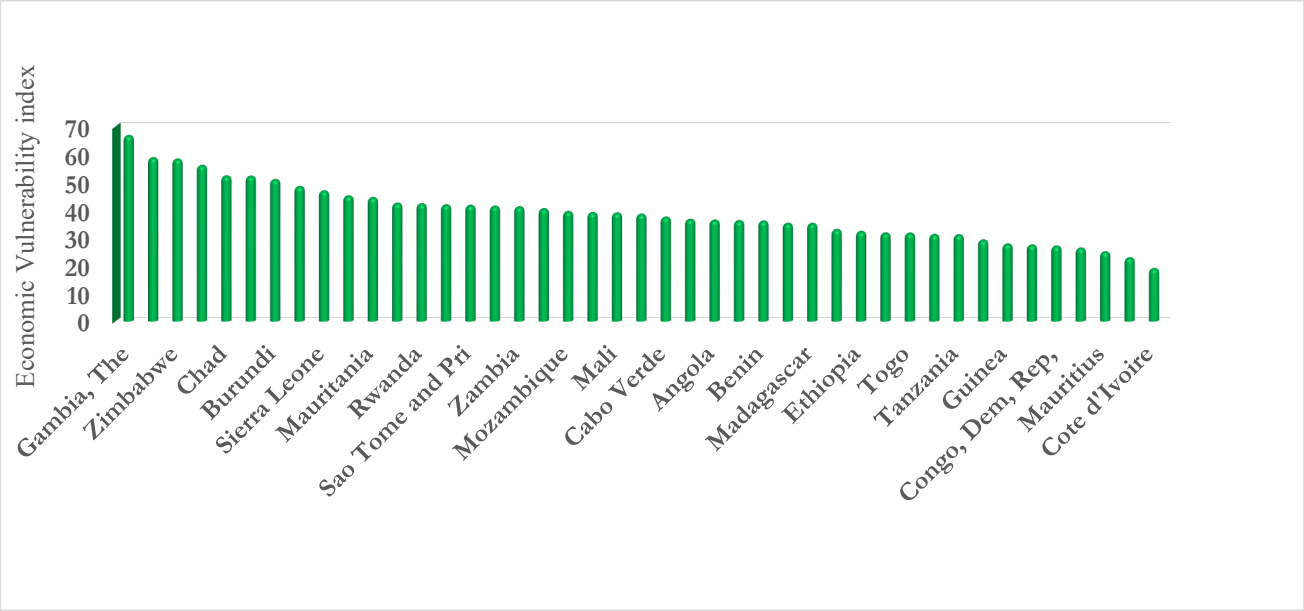
Annex II. Supplemental figures and tables

Annex II. Figure 1: Comparative average level of volatility and growth rates in SSA and other regions of the world (1980-2018)



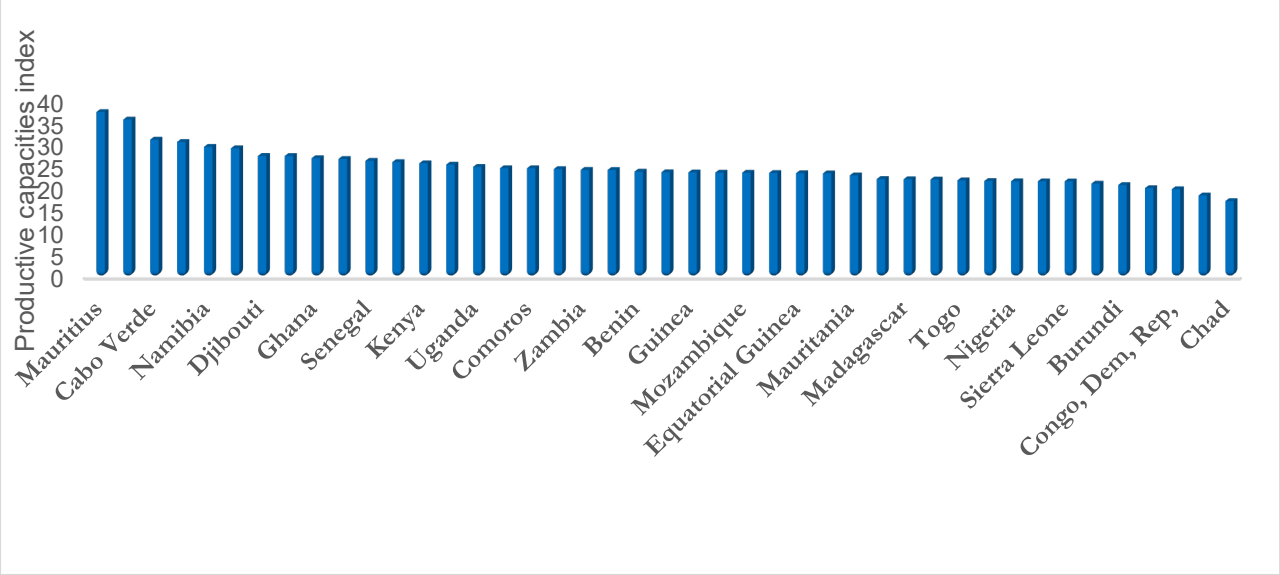
Source: Author, based on WDI

Annex II. Figure 2: Economic vulnerability index (2000-2018)



Source: Author, based on FERDI

Annex II. Figure 3: Productive capacities of SSA countries (2018)



Source: Author, based on UNCTAD

Annex II. Table 1: Effects of Productive Capacities on growth volatility in SSA (Robustness to the exclusion of outliers)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility	(10) Volatility
Economic Vulnerability	0.021*	0.051**	0.109**	0.023***	0.063***	0.114***	0.043***	0.031***	0.119***	0.031**
	(0.012)	(0.020)	(0.047)	(0.007)	(0.014)	(0.041)	(0.009)	(0.006)	(0.030)	(0.013)
Productive capacities	-0.064*									
	(0.038)									
Human Capital		-0.044*								0.060*
		(0.022)								(0.034)
Natural Capital			0.249*							0.042
			(0.146)							(0.029)
Transport				-0.057***						0.016
				(0.014)						(0.024)
ICT					-0.066*					-0.289***
					(0.036)					(0.094)
Institutions						-0.106**				-0.080***
						(0.042)				(0.020)
Private Sector							-0.048***			0.025
							(0.017)			(0.046)
Structural Change								0.051		0.172**
								(0.035)		(0.068)
Energy									-0.119***	0.047*
									(0.040)	(0.024)
Constant	-0.678	-3.679**	-33.059**	1.668	-5.148***	-8.696**	1.691	-3.236*	-5.542**	-4.936**
	(1.688)	(1.353)	(15.277)	(1.589)	(1.663)	(4.129)	(1.228)	(1.890)	(2.719)	(2.060)
Observations	440	440	440	440	440	440	440	440	440	440
Countries	37	37	37	37	37	37	37	37	37	37
No. of instruments	38	37	19	35	37	28	34	37	28	34
AR2 p-value	0.514	0.486	0.536	0.394	0.432	0.770	0.644	0.556	0.387	0.970
Hansen p-value	0.555	0.251	0.764	0.369	0.491	0.174	0.322	0.306	0.150	0.814

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, bank credit, inflation volatility, and government expenditure.

Annex II. Table 2: Consideration of interactive effects (Robustness to the exclusion of outliers)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility
Economic Vulnerability	0.057***	0.073***	0.082***	0.028***	0.020***	0.381***	0.070***	0.086***	0.106
	(0.016)	(0.019)	(0.016)	(0.009)	(0.006)	(0.129)	(0.009)	(0.006)	(0.072)
Productive capacities× EV	-0.002***								
	(0.001)								
Human Capital×EV		-0.001***							
		(0.000)							
Transport× EV			-0.002**						
			(0.001)						
ICT× EV				-0.001**					
				(0.001)					
Institutions× EV					-0.001**				
					(0.000)				
Private Sector× EV						-0.004**			
						(0.002)			
Structural Change × EV							-0.002***		
							(0.001)		
Energy× EV								-0.001**	
								(0.000)	
Natural Capital× EV									-0.001
									(0.001)
Constant	-1.095	-4.426**	-3.096	-1.591*	-2.602**	-13.565***	-5.804***	-5.524***	-2.389
	(1.445)	(1.687)	(3.039)	(0.833)	(1.026)	(3.297)	(1.434)	(0.983)	(2.433)
Observations	396	396	396	396	396	396	396	396	396
Countries	37	37	37	37	37	37	37	37	37
No. of instruments	36	30	25	34	35	35	35	35	26
AR2 p-value	0.233	0.224	0.504	0.312	0.348	0.874	0.188	0.276	0.285
Hansen p-value	0.413	0.824	0.626	0.633	0.847	0.609	0.745	0.901	0.675

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, bank credit, inflation volatility, Bank credit, and government expenditure.

Annex II. Table 3: Effect of exposure to shocks on growth volatility

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility
L.volatility	0.544***	0.835***	0.702***	0.727***	0.675***	0.679***
	(0.038)	(0.009)	(0.051)	(0.016)	(0.023)	(0.023)
Economic Vulnerability	0.067***	0.009**	0.017*	0.010***	0.035***	0.030**
	(0.012)	(0.004)	(0.009)	(0.002)	(0.009)	(0.012)
GDP per capita		-0.057***	0.082	-0.187***	0.011	-0.288*
		(0.017)	(0.136)	(0.024)	(0.123)	(0.152)
Trade openness			0.583***	0.379***	0.600***	0.822***
			(0.143)	(0.021)	(0.138)	(0.174)
Inflation Volatility				0.021***	-0.000	0.002
				(0.002)	(0.005)	(0.005)
Credit					-0.014***	-0.019***
					(0.003)	(0.005)
Government expenditure						0.051***
						(0.011)
Constant	-2.248***	0.144**	-3.437***	-0.503***	-3.432***	-2.688***
	(0.447)	(0.066)	(1.249)	(0.156)	(0.695)	(0.780)
Observations	613	610	574	555	513	500
Countries	43	43	43	42	41	41
No. of instruments	35	42	33	41	37	37
AR2 p-value	0.178	0.175	0.199	0.392	0.290	0.276
Hansen p-value	0.158	0.372	0.186	0.393	0.277	0.491

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively.

Annex II. Table 4: Effect of shocks on growth volatility

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility
L.volatility	0.559***	0.517***	0.592***	0.293***	0.499***	0.463***
	(0.036)	(0.024)	(0.035)	(0.020)	(0.061)	(0.066)
Economic Vulnerability	0.012***	0.024***	0.015***	0.044***	0.022***	0.026***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.004)	(0.006)
GDP per capita		-0.036**	-0.538***	-0.089***	-0.141**	-0.372***
		(0.014)	(0.140)	(0.022)	(0.064)	(0.105)
Trade openness			0.316***	0.394***	0.249***	0.434***
			(0.103)	(0.036)	(0.053)	(0.114)
Inflation Volatility				0.033***	0.054***	0.051***
				(0.004)	(0.016)	(0.015)
Credit					-0.008**	-0.016***
					(0.004)	(0.006)
Government expenditure						0.067***
						(0.015)
Constant	-0.172**	-0.304*	2.259**	-2.242***	-0.521	-0.591
	(0.084)	(0.155)	(1.075)	(0.125)	(0.663)	(1.014)
Observations	597	595	565	553	513	500
Countries	43	43	42	42	41	41
No. of instruments	35	39	36	41	37	37
AR2 p-value	0.187	0.164	0.198	0.336	0.823	0.633
Hansen p-value	0.189	0.304	0.248	0.615	0.393	0.342

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively.

Annex II. Table 5: Consideration of interactive effects (with exposure)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility r	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility
Exposure	0.079**	0.096***	0.053***	0.022***	0.033***	0.240**	0.127**	0.115**	0.089***
	(0.034)	(0.015)	(0.012)	(0.003)	(0.011)	(0.103)	(0.051)	(0.050)	(0.025)
Productive capacities× Exposure	-0.004**								
	(0.001)								
Human Capital×Eexposure		-0.002***							
		(0.000)							
Transport× Exposure			-0.002***						
			(0.000)						
ICT× Exposure				-0.003***					
				(0.001)					
Institutions× Exposure					-0.001***				
					(0.000)				
Private Sector× Exposure						-0.004***			
						(0.001)			
Structural Change × Exposure							0.005***		
							(0.001)		
Energy× Exposure								-0.001**	
								(0.000)	
Natural Capital× Exposure									-0.002***
									(0.001)
Constant	-5.060**	-5.386***	-0.558	-3.078***	-5.566***	2.813	-4.004	-0.317	3.945*
	(1.984)	(1.612)	(0.474)	(0.652)	(1.304)	(4.015)	(2.544)	(3.075)	(1.978)
Observations	466	466	466	466	466	466	466	466	466
Countries	39	39	39	39	39	39	39	39	39
No. of instruments	33	34	38	37	36	31	36	25	29
AR2 p-value	0.671	0.333	0.534	0.272	0.641	0.945	0.731	0.945	0.399
Hansen p-value	0.369	0.326	0.356	0.424	0.329	0.519	0.269	0.603	0.190

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, bank credit, inflation volatility, Bank credit, and government expenditure.

Annex II. Table 6: Consideration of interactive effects (with shock)

VARIABLES	(1) Volatility	(2) Volatility	(3) Volatility	(4) Volatility	(5) Volatility	(6) Volatility	(7) Volatility	(8) Volatility	(9) Volatility
Shock	0.051**	0.051***	0.016***	0.007***	0.028***	0.076***	0.010	0.060**	0.074**
	(0.022)	(0.010)	(0.004)	(0.003)	(0.009)	(0.027)	(0.009)	(0.024)	(0.037)
Productive capacities× shock	-0.002**								
	(0.001)								
Human Capital×Shock		-0.001**							
		(0.001)							
Transport× Shock			-0.001***						
			(0.000)						
ICT× Shock				-0.001**					
				(0.000)					
Institutions× Shock					-0.001**				
					(0.000)				
Private Sector× Shock						-0.001*			
						(0.000)			
Structural Change × Shock							0.002**		
							(0.001)		
Energy× Shock								-0.001	
								(0.001)	
Natural Capital× Shock									-0.001*
									(0.001)
Constant	-0.773	-3.339***	-0.627**	-0.929**	-5.412***	-5.251***	-4.042***	-5.600	2.877
	(1.054)	(1.150)	(0.276)	(0.343)	(0.821)	(1.620)	(1.275)	(3.449)	(1.900)
Observations	466	466	466	466	466	466	466	466	466
Countries	39	39	39	39	39	39	39	39	39
No. of instruments	35	34	38	37	36	27	36	25	29
AR2 p-value	0.486	0.533	0.680	0.394	0.669	0.529	0.686	0.637	0.473
Hansen p-value	0.453	0.392	0.295	0.429	0.361	0.306	0.416	0.516	0.133

Note: Values in brackets denote statistics. ***, **, * denote significance at significance at 1%, 5% and 10% respectively. All regressions include control variables, namely the lagged growth volatility, GDP per capita, trade openness, bank credit, inflation volatility, Bank credit, and government expenditure.

Annex II. Table 7: Variable descriptions

Variable types	Variables	Description	Sources
Variable explained	Growth volatility	5-year rolling standard deviation of GDP per capita growth rate/ standard deviation of the cyclical component of the GDP growth from the HP filter	WDI
Explanatory variables	Economic Vulnerability (EV)	the risk that a country's economic development may be hampered by unforeseen exogenous shocks	FERDI
	Exposure index (exposure)	the exposure index reflects the risk of a country being affected by shocks in the future	FERDI
	Shock index	The shock index considers the effects of two categories of shock: natural shocks and external or trade shocks.	FERDI
	PCI	Productive capacity index	UNCTAD
	Human capital (HC)	Human capital encompasses the education, skills and health conditions of the population, as well as the overall integration of research and development within society through the number of researchers and spending on research activities. The gender dimension is reflected in the fertility rate, which reduces the human capital score with each increase.	UNCTAD
	Natural Capital (NC)	Natural capital estimates the availability of extractive and agricultural resources, including the rents generated by extracting the natural resource, minus the cost of extracting it. To capture commodity dependence, natural capital decreases as material intensity increases.	UNCTAD
	Transport (TR)	Transport measures a system's ability to move people or goods from one place to another. It is defined as the capillarity of the road and rail network and air connectivity.	UNCTAD
	ICT	Information and communication technologies allow us to estimate the accessibility and integration of communication systems within the population. It includes landline and mobile phone users, Internet accessibility and server security.	UNCTAD
	Institutions (INST)	The institutions aim to measure political stability and effectiveness through the quality and effectiveness of regulation, the success of the fight against crime, corruption and terrorism, and the safeguarding of citizens' freedom of expression and association.	UNCTAD
	Private Sector (PRVS)	The private sector is defined by the ease of cross-border trade, which includes the time and monetary costs of exporting and importing, and business support in terms of domestic credit, speed of contract execution and time to start a business.	UNCTAD
	Structural Change (SCH)	Structural change refers to the movement of labour and other productive resources from low-productivity to high-productivity economic activities. This change is currently captured by the sophistication and variety of exports, fixed capital intensity and the weight of industry and services in total GDP. Structural change can also occur in a given sector, provided that the sector's major constraints are identified and dealt with effectively.	UNCTAD
	Energy (EN)	This category measures the availability, sustainability and efficiency of energy sources. It is therefore composed of energy use and access, distribution losses and the renewable nature of energy components and sources, and includes the GDP generated by each unit of oil to further emphasize the importance of optimal energy systems.	UNCTAD
	GDP per capita	Ratio of nominal GDP divided by population size	WDI
	Government expenditure (GOV)	General government final consumption expenditure (% of GDP)	WDI
	Trade	Sum of exports and imports of goods and services over GDP	WDI
	Inflation volatility	5-year rolling standard deviation of the inflation rate	WDI
	Credit	Total amount of loans granted by deposit banks to the private sector divided by GDP	WDI

Source : author

Annex II. Table 8: Productive capacities: data and rankings for SSA countries

Rank	Country	PCI	Country	HC	Country	NC	Country	EN	Country	TR
1	**Mauritius**	**35.162**	**Mauritius**	**49.331**	**Lesotho**	**79.875**	**Lesotho**	**40.664**	**Seychelles**	**40.439**
2	Seychelles	34.603	Seychelles	46.221	Guinea	72.763	Mauritius	30.563	Mauritius	19.772
3	Cabo Verde	30.024	Cabo Verde	44.453	Mauritania	71.393	Seychelles	28.494	Comoros	17.009
4	Lesotho	29.076	Botswana	41.454	Burundi	69.722	Comoros	25.623	Djibouti	16.672
5	Namibia	27.818	Namibia	40.516	Niger	68.047	Cabo Verde	25.132	Cabo Verde	16.642
6	Botswana	27.700	Sao Tome and Pri	40.164	Togo	67.731	Gabon	23.052	Eritrea	15.983
7	Eswatini	25.823	Tanzania	38.706	Eritrea	65.379	Namibia	22.156	Sao Tome and Pri	15.932
8	Djibouti	25.611	Gabon	38.525	Ethiopia	63.649	Mauritania	22.094	Equatorial Guine	15.201
9	Sao Tome and Pri	25.383	Rwanda	38.524	Uganda	63.239	Angola	21.937	Lesotho	14.474
10	Ghana	25.145	Kenya	37.881	Nigeria	63.022	Botswana	21.873	Eswatini	13.631
11	Gabon	24.523	Comoros	37.609	Chad	62.923	Senegal	21.850	Gambia. The	12.798
12	Senegal	24.434	Djibouti	37.200	Madagascar	62.579	Eswatini	21.831	Rwanda	12.661
13	Gambia. The	24.028	Eswatini	36.994	Mali	61.854	Djibouti	21.715	Burundi	12.381
14	Comoros	23.848	Ghana	36.276	Rwanda	61.619	Ghana	21.616	Zimbabwe	12.288
15	Kenya	23.642	Malawi	36.250	Sierra Leone	60.281	Equatorial Guinea	21.245	Namibia	12.185
16	Uganda	23.149	Lesotho	36.129	Djibouti	59.971	Cameroon	20.811	Tanzania	12.105
17	Zambia	23.049	Togo	35.766	Tanzania	59.868	Gambia. The	20.207	Botswana	12.004
18	Rwanda	22.805	Uganda	35.136	Botswana	59.848	Nigeria	19.683	Guinea-Bissau	11.878
19	Tanzania	22.742	Sierra Leone	35.084	Burkina Faso	59.429	Cote d'Ivoire	19.474	Zambia	11.774
20	Equatorial Guinea	22.465	Senegal	35.051	Ghana	58.837	Madagascar	19.446	Ghana	11.478
21	Cote d'Ivoire	22.195	Zambia	34.627	Angola	57.748	Eritrea	19.238	Togo	11.225
22	Cameroon	22.019	Zimbabwe	34.373	Malawi	57.452	Sao Tome and Pri	18.628	Guinea	11.044
23	Mauritania	21.998	Benin	34.366	Zambia	57.401	Tanzania	18.572	Kenya	10.856
24	Madagascar	21.888	Madagascar	33.838	Namibia	57.347	Zimbabwe	18.092	Gabon	10.852
25	Guinea	21.873	Congo. Rep.	33.742	Comoros	57.133	Malawi	18.034	Uganda	10.836
26	Benin	21.841	Cameroon	33.412	Kenya	57.034	Kenya	17.800	Malawi	10.702
27	Malawi	21.832	Mauritania	33.202	Eswatini	56.412	Zambia	17.793	Sierra Leone	10.531
28	Zimbabwe	21.645	Ethiopia	32.790	Congo. Dem. Rep.	55.291	Uganda	17.652	Benin	10.509
29	Eritrea	21.476	Equatorial Guinea	32.504	Cote d'Ivoire	54.994	Guinea	17.182	Cote d'Ivoire	10.068
30	Mozambique	21.407	Gambia. The	32.450	Mozambique	54.737	Mali	16.657	Congo. Rep.	9.772
31	Togo	21.049	Burundi	32.293	Zimbabwe	53.943	Guinea-Bissau	16.606	Mozambique	9.224
32	Nigeria	21.018	Guinea-Bissau	31.610	Congo. Rep.	53.131	Mozambique	16.393	Chad	9.220
33	Angola	20.854	Cote d'Ivoire	31.422	Guinea-Bissau	52.734	Ethiopia	16.383	Angola	9.152
34	Sierra Leone	20.543	Mozambique	31.016	Gambia. The	52.423	Congo. Dem. Rep.	15.985	Nigeria	9.119
35	Congo. Rep.	20.060	Nigeria	30.554	Mauritius	51.392	Niger	15.166	Ethiopia	9.030
36	Ethiopia	20.048	Guinea	30.213	Senegal	51.088	Rwanda	15.010	Burkina Faso	9.016
37	Burkina Faso	19.990	Angola	30.038	Benin	50.583	Sierra Leone	14.858	Cameroon	8.955

38	Burundi	19.600	Mali	28.636	Equatorial Guinea	48.531	Burundi	14.637	Senegal	8.946
39	Mali	19.526	Burkina Faso	28.462	Cameroon	47.501	Chad	13.636	Congo. Dem. Rep.	8.539
40	Congo. Dem. Rep.	19.205	Eritrea	27.973	Cabo Verde	47.039	Burkina Faso	13.210	Madagascar	7.614
41	Niger	18.128	Congo. Dem. Rep.	27.872	Sao Tome and Principe	45.750	Benin	12.356	Mali	6.070
42	Guinea-Bissau	17.975	Chad	25.284	Gabon	44.534	Congo. Rep.	12.245	Niger	5.474
43	**Chad**	**14.861**	**Niger**	**23.702**	**Seychelles**	**33.287**	**Togo**	**9.084**	**Mauritania**	**5.323**

Annex II. Table 9: Productive capacities: data and rankings for SSA countries (Continued)

Rank	Country	ICT	Country	INST	Country	PRVS	Country	SCH
1	**Seychelles**	**14.199**	**Mauritius**	**72.929**	**Mauritius**	**85.931**	**Mauritius**	**20.737**
2	Mauritius	12.034	Botswana	70.714	Cabo Verde	81.388	Eswatini	19.450
3	Cabo Verde	8.130	Cabo Verde	66.029	Seychelles	79.338	Namibia	19.040
4	Botswana	7.557	Namibia	62.035	Gambia. The	78.975	Lesotho	18.848
5	Gabon	7.189	Seychelles	59.521	Djibouti	77.570	Djibouti	18.799
6	Namibia	6.497	Ghana	55.751	Togo	77.011	Eritrea	18.387
7	Gambia. The	5.790	Lesotho	50.754	Senegal	77.000	Zimbabwe	18.232
8	Ghana	5.766	Senegal	50.418	Namibia	76.846	Cabo Verde	18.012
9	Sao Tome and Pri	5.713	Rwanda	48.297	Comoros	76.199	Seychelles	17.717
10	Eswatini	5.581	Benin	48.198	Ghana	75.967	Senegal	17.704
11	Cote d'Ivoire	5.449	Sao Tome and Pri	47.633	Sierra Leone	75.706	Kenya	16.430
12	Senegal	5.410	Zambia	47.494	Guinea	75.598	Sao Tome and Pri	16.092
13	Lesotho	5.224	Burkina Faso	46.777	Benin	74.847	Cameroon	15.871
14	Zimbabwe	5.065	Malawi	46.434	Mozambique	74.384	Botswana	15.702
15	Mauritania	5.041	Mozambique	44.115	Madagascar	74.313	Uganda	15.564
16	Nigeria	4.987	Mali	42.742	Nigeria	74.281	Equatorial Guine	15.540
17	Kenya	4.934	Madagascar	41.976	Cameroon	73.921	Congo. Rep.	15.068
18	Congo. Rep.	4.910	Uganda	41.823	Sao Tome and Pri	73.517	Madagascar	14.919
19	Cameroon	4.812	Gabon	41.652	Mauritania	73.436	Zambia	14.851
20	Mali	4.805	Gambia. The	41.639	Cote d'Ivoire	73.253	Gabon	14.701
21	Equatorial Guine	4.795	Eswatini	41.015	Kenya	73.115	Benin	14.438
22	Zambia	4.775	Niger	40.964	Eswatini	72.964	Mauritania	14.422
23	Benin	4.676	Kenya	40.406	Gabon	72.450	Guinea	14.250
24	Uganda	4.435	Tanzania	38.757	Lesotho	70.548	Congo. Dem. Rep.	14.225
25	Togo	4.330	Djibouti	38.512	Equatorial Guine	69.541	Togo	14.093
26	Tanzania	4.285	Sierra Leone	38.154	Uganda	69.069	Cote d'Ivoire	14.052
27	Angola	4.282	Mauritania	37.759	Malawi	68.889	Gambia. The	13.876
28	Burkina Faso	4.281	Togo	35.191	Mali	68.412	Mozambique	13.332
29	Rwanda	4.240	Ethiopia	34.194	Ethiopia	67.595	Ghana	13.097
30	Sierra Leone	4.221	Cameroon	34.173	Botswana	67.446	Angola	12.691
31	Djibouti	4.195	Comoros	34.059	Tanzania	66.722	Rwanda	12.678
32	Guinea	4.148	Cote d'Ivoire	32.886	Burkina Faso	66.232	Tanzania	12.668
33	Comoros	4.128	Guinea-Bissau	32.191	Rwanda	65.507	Malawi	11.332

34	Mozambique	4.126	Angola	30.723	Eritrea	65.356	Comoros	10.683
35	Ethiopia	3.749	Congo. Rep.	30.581	Burundi	64.081	Ethiopia	10.593
36	Madagascar	3.682	Nigeria	30.163	Guinea-Bissau	63.172	Niger	10.443
37	Malawi	3.641	Congo. Dem. Rep.	29.854	Angola	63.011	Nigeria	10.237
38	Guinea-Bissau	3.599	Guinea	29.159	Congo. Dem. Rep.	60.451	Burkina Faso	9.890
39	Niger	3.567	Burundi	28.068	Niger	59.675	Mali	9.279
40	Chad	3.558	Equatorial Guine	25.424	Zambia	58.941	Burundi	8.997
41	Congo. Dem. Rep.	3.519	Chad	24.247	Zimbabwe	58.221	Sierra Leone	8.294
42	Burundi	3.447	Eritrea	22.996	Congo. Rep.	57.533	Guinea-Bissau	4.595
43	**Eritrea**	**3.006**	**Zimbabwe**	**22.859**	**Chad**	**41.346**	**Chad**	**3.633**

Source : author

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