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To cite this version:

Kabinet Kaba, Justin Yifu, Mary-Françoise Renard. Structural Change And Trade Openness in sub-Saharan African Countries. The World Economy, 2022. hal-03678971

HAL Id: hal-03678971

https://uca.hal.science/hal-03678971v1

Submitted on 25 May 2022

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Structural Change And Trade Openness in sub-Saharan African Countries

Kabinet KABA* Justin Yifu LIN† Mary-Françoise RENARD ‡

May 25, 2022

Abstract

In this paper, we study the role of trade openness in the economic reallocation from the agriculture to the manufacturing sector in 34 sub-Saharan African countries between 1970-2016. The results show that the long term evolution of trade openness negatively impacts the long-run and the short-run dynamics of structural change. Moreover, this impact goes through aggregate exports not aggregate imports. By breaking down global exports, we find that commodities exports have a negative impact while manufacturing exports positively impact structural change. These results are explained by the fact that, contrary to Asian countries, African countries have failed to put trade at the service of industrialization by following the logic of comparative advantage. More precisely, they have failed to invest the revenues from commodities exports to improve the quality of infrastructure in order to remove the constraints on the relocation to labor-intensive manufacturing activities. Unlike previous studies, we address the endogeneity problem by using a dynamic ordinary least squares method after a pooled mean group method.

JEL Classification: F10, L16, N17, N15

Keywords: Structural Change, Trade Openness, Industrialization, Comparative Advantage, State, Infrastructure, Africa, Asia

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Acknowledgment: We thank Annie Krautkraemer and Muhammad Naseem for the proofreading and valuable suggestions that are contributed to improve the paper. This work was supported by the Agence Nationale de la Recherche of the French government through the program "Investissements d'avenir "ANR-10-LABX-14-01".

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1 Introduction

Most research on economic development began with questions on structural change (SC) from agriculture to industry (Atolia et al. 2020; Murphy et al. 1989*b*; Kuznets & Murphy, 1966; Lewis, 1954). Indeed, SC means reallocation of economic activity from the low productivity sector (agriculture) to the high productivity sector (industry).[1] Thus, it is an industrialization process that leads to total factor productivity growth even if productivity has not increased within sectors (McMillan & Rodrik, 2011). For example, if workers move from agriculture to industry, total factor productivity will increase because the labor force moved from the low productivity sector to the high productivity sector (Lewis, 1954). So, the magnitude of the SC's effect on economic development will depend on its direction and the speed at which economic reallocation to industry occurs. In addition, economic development is a conditional process of continuous industrial and technological upgrading (Lin, 2012).

The main determinants of the nature of SC are the industrial and trade policies implemented by the states. These policies can lead to a SC involving either industrialization or de-industrialization depending on how they are implemented. During the nineteenth century, the countries of Asia, Africa, and Latin America underwent a process of de-industrialization. Their total share in the world manufacturing output fell from 60.5% in 1830 to 7.5% in 1913 (Nayyar, 2019). This period being the colonial era, it was marked by a massive global investment in their natural resources sectors and a concentration of the global manufacturing investment in the United States and Europe, which were the colonizers. Although this de-industrialization was a common phenomenon to all the previously mentioned three regions during colonization, the period of 1970-2016 was marked by some divergences among them in terms of industrialization. Between 1970-2016, the share of manufacturing value-added in GDP increased from 10% to 23% in Asia while that of East Asia in the global manufacturing value-added increased from 4% to 41% (Nayyar, 2019). In sub-Saharan Africa (SSA), the manufacturing value-added share in GDP fell from about 13% in 1980 to 10% in 2016, its share in the global manufacturing production fell from 3% in 1970 to less than 2% in 2010 (Page et al. 2016). As a result, SC has been growth-enhancing in Asia while it has been growth-reducing in SSA (McMillan et al. 2014). However, the de-industrialization in SSA is puzzling because this region has the lowest average wage in the world so it should benefit more from economic reallocation to labor-intensive manufacturing industries compared with other regions.

Another difference between Asian and SSA countries lies in the industrial and trade policies as a support for industrialization. During the 1950s and 1960s, some Asian countries, like many developing countries in other parts of the world, opted for trade protection policies because of the de-industrialization of the colonial period. On the one hand, these trade strategies took the form of import substitution policies aimed at protecting the local manufacturing sector development.

[1] In this paper, the term industry and industrialization refer only to manufacturing sector according to the literature about industrialization (Rodrik, 2016*b*; Gui-Diby & Renard, 2015; Kang & Lee, 2011).

On the other hand, it took the form of state intervention in order to guide the firms in the labor-intensive primary manufacturing industries following their comparative advantage (Lin, 2009). Although a large majority of these countries opened up to international trade during the 1980's, their particularity lies in the progressive modification of the content of their exports. In some cases, they began to export agricultural raw materials, and then a significant share of these exports was gradually made up of labor-intensive manufacturing goods and later of capital-intensive manufacturing products. After their independence, some SSA leaders had the ambition to industrialize their countries to no longer depend on their former colonial power. Thus, their idea was to create the same capital-intensive industries as in developed countries. These policies were initially accompanied by an industrial dynamism in some SSA countries. In 1960, the shares of the manufacturing value-added in GDP were 9%, 10%, 14%, 16% and 20%, in Kenya, Senegal, Congo, Zimbabwe and South Africa, respectively (Austin et al. 2016). For many SSA countries, the end of the 1980s was marked by a trade openness that allowed them to export sizeable natural resources with a low rate of diversification. As a result, the annual growth rate of the manufacturing sector, which was 8% between 1961-1970 in SSA, was reduced to 5.1%, 1.9% and 1.1%, between 1971-1980, 1981-1990, and 1991-2000, respectively.

At some points in their history, Asia and SSA have implemented first trade protection and then trade openness policies. However, the trade measures taken by the governments of these two regions have been different as the nature of their SC. Thus, the purpose of this paper is to understand how trade openness and industrial policies explain the nature or the direction of SC in 34 SSA countries between 1970-2016.[2] Our interest in this period is determined by the fact that it includes both a large part of trade protection (1970- the end of the 1980s) and trade liberalization periods (after the end of the 1980s) in Africa. Due to data constraints, we do not consider the periods before 1970 and after 2016.

Given the importance of SC in the process of economic growth and development, it is the subject of many research papers. The first half of this literature studies the nature of SC and its implications in terms of growth and poverty reduction in Africa (McMillan & Rodrik, 2011; De Brauw et al. 2014; Christiaensen & Todo, 2014). The second half is based on the constraints related to the SC (Bräutigam & Tang, 2014; Collier & Dercon, 2014; Harrison et al. 2014).[3] According to McMillan & Headey (2014), the research on this issue remains poor in terms of empirical analysis in the case of Africa which implies that our knowledge about this question in SSA is very limited. Indeed, some of these papers are based on descriptive statistics, which are correlation and not causality analyses (De Brauw et al. 2014; Dorosh & Thurlow, 2014; McMillan & Headey, 2014; Collier & Dercon, 2014; Bräutigam & Tang, 2014). In addition, the papers that perform econometric analyses use ordinary least squares as estimate method (Christiaensen & Todo, 2014; Harrison et al. 2014; McMillan & Rodrik, 2011), which does not consider endogeneity bias. Also, these papers study a limited num-

[2] See 10 for the list of countries studied.

[3] McMillan & Headey (2014) provide an overview about the literature of structural change in Africa.

ber of African countries due to a lack of data related to manufacturing employment for most of SSA countries.

In order to fill the methodological gap, we perform pooled mean group (PMG) and dynamic ordinary least squares (DOLS) to model the long-run and short-run relationships between SC and trade openness. The relevance of the empirical methods lies in the fact that SC is a dynamic process during which there is a reallocation of economic activity from agriculture to industry. In addition, they also make it possible to take into account endogeneity bias (DOLS) and the fallacious regression.[4] Concerning the measurement gap, we measure SC by the ratio between the manufacturing value-added and the agriculture value-added; the availability of these data allows to study an important number of countries in SSA. In addition, we contribute to the literature through a theoretical and historical discussion on trade and industrial policies in Asia and SSA. This allows us to examine how differences in industrial and trade policies have led to different patterns of structural transformation between these two regions.

The empirical results show that trade openness is a barrier to SC and thus to industrialization in SSA. Indeed, the long-term evolution of trade openness negatively affects the long-run and short-run dynamics of SC and this negative impact goes through aggregate exports, but not aggregate imports. By breaking down global exports, we find that commodities exports have a negative impact while manufacturing exports have a positive impact on SC. This surprising result can be explained mainly by bad decisions in industrial and trade policies. First, the post-independence industrial policies focused on the creation of capital-intensive industries while the comparative advantage of African countries is in labor-intensive industries. Second, the trade policies of the end of the 1980s were based on a deep specialization in the exports of raw materials without investing exports' resources in the development of a competitive domestic industrial sector. Indeed, SSA countries suffer from significant infrastructure constraints, which represent a significant transaction cost for the industrial activities. Consequently, the return on investment in manufacturing activities will be low and may be lower than that in imports activities. Still, as a result of infrastructure constraints and the poor business environment, the risk associated with the creation of a new industry will be high relative to the risk associated with import activities. In this context, even with a comparative advantage in low-skilled labor-intensive industries, the entrepreneurs in SSA will prefer to import rather than invest in manufacturing sector. Therefore, a trade openness based on commodities exports without a resources-investment policy will crowd out the manufacturing sector. This effect will be amplified by the rise of GDP per capita due to commodities exports, which will increase the domestic demand, but with a weak industrial base, the rise of the domestic demand will lead to an increase in the demand for foreign products.

The rest of this paper is organized as follows: we present in Section 2 the history, debate and the measures of SC; the literature review will be presented in Section 3; stylized facts, variables

[4]The endogeneity bias in this case arises because there may be reverse causality between SC and trade openness. In addition, we study a macroeconomic model in which the variables can be explained by each other.

and data description are presented in Section 4; empirical strategy will be discussed in the Section 5; the results will be presented in Section 6 and Section 7 will be the concluding remarks.

2 Structural change and trade policies: history, debate, and measures

This section is summarized in three main parts. First, it describes the industrial and trade policies undertaken in some Asia and SSA countries and their consequences on the nature of SC. Second, it presents the debate between services and industrialization as key driver of total factor productivity growth. Third, we will discuss the measures of SC.

2.1 Structural change and trade policies: Asia versus sub-Saharan Africa

Although industrialization was an important objective of the independence period in Asia and SSA, the policies to achieve this goal led to two different results in terms of SC. The aim of this subsection is to present how trade measures and state intervention have explained the nature of SC in the two regions.

2.1.1 Structural change and trade policies in Asia

The SC performance in Asia has been accepted as the result of its trade and industrial policies. State intervention had built the bases of industrialization in this region (Wade, 2004). Indeed, the industrial policies in the post-colonial period can be understood in the context of colonization. According to Nayyar (2019), the colonial era has been marked by trade openness which was accompanied by de-industrialization. Hence, after their independence, the purpose of the industrial policies was to protect the local manufacturing sector. Although some individual particularities can be noted, the industrial strategies were threefold. First, the manufacturing firms in the labor-intensive activities have benefited from the import substitution policies. In some economies like Korea and Taiwan, the aim of trade policies was to protect the export manufacturing sector by an undervaluation of the exchange rate and a restriction of trade to other sectors. Second, there have been strategies for guiding and coordinating firms. This has taken shape in public investments in hard and soft infrastructure and an incentive for banks to provide long-term credit for investments that are oriented towards the industrial sector.[5] For example, in Korea, banks have been encouraged to charge differentiated interest rates depending whether investments are oriented towards the sector of comparative advantage or not; while in Taiwan, there were credit taxes. Given the scarcity of resources, these policies aimed at allocating them to well identified sectors. Third, in some economies like China, South Korea, Taiwan, and Vietnam, some agrarian and land redistribution reforms have been implemented. As a result of these reforms, the exports of agricultural

[5] Hard infrastructure: energy, transport, telecommunication. Soft infrastructure: finance

products increased in these countries. (Wade, 2004). According to Rodrik (1995), the plausible explanation of the Asian miracle can be understood through the previous measures mentioned above. Indeed, given the high return on physical capital in Taiwan and Korea, the interventionist policies of their governments were to coordinate the investment decisions of the economic agents. Thus, the trade openness of the 1960s was the result of a strong import-demand for inputs in order to support the investment demand.

Trade openness in most Asian countries was marked by an increasing share of the world trade and an upgrade of their exports content (Lin, 2012; Nayyar, 2019). The eight best performing economies in East Asia recorded a growth in their share of world exports, from 7.9% in 1965 to 13.1% in 1980, and 18.2% in 1990 (Page, 1994). The contribution of manufacturing exports was the main reason for this trade performance. Between 1965-1990, Japan became the leading exporter of manufacturing products in the world, its share increasing from 8% to 12%, between 1970-1980 (Page, 1994). In the same time, the world share of manufactured exports from the four tigers has grown almost four times faster than that of Japan.[6] According to Lin (2012), in the 1990s, China was a major exporter of raw materials but in the 2000s, it moved from this type of export to sophisticated goods exports. India also is following this path. In Malaysia, the Philippines and Thailand, the share of primary commodities in total exports was 80% in 1980 and then about 20%-30% in 2016; their shares of medium and high-technology industrial products have been 50%, 75% and 50% in 2016 (Nayyar, 2019). In Indonesia, the share of primary commodities in total exports was 80% in 1980 and then about 30% in 2016 while it decreased from 60% to 20% in Sri Lanka. Concerning resource-based and low-technology industrial products, their share in total exports for the same years increased from 18% to 50% in Indonesia and from 35% to 70% in Sri Lanka.

2.1.2 Structural change and trade policies in sub-Saharan Africa

After their independence, the leaders of SSA countries were convinced that the economic development of African nations should go through industrialization. «Industry...is the means by which rapid improvement in Africa's living standards is possible...» Kwame Nkrumah (1965).[7]

To achieve this goal, they have put in place two strategies of industrialization. On the one hand, the state was the initiator of industrialization, which motivated it to create and invest heavily in state-owned industries. On the other hand, to ensure a balance between domestic demand and production, trade protection policies have been implemented through very high customs tariffs. These import substitution policies were implemented both by the " socialist states like Ghana under Kwame Nkrumah; Guinea under Sekou Touré; Tanzania under Julius Nyerere; and the " capitalist states like Côte dIvoire under Houphouët-Boigny and Kenya under Jomo Kenyatta (Austin et al. 2016). Unlike Asian countries, the objective of these policies was that the local industrial production should serve domestic consumption instead of export. In line with these measures, there has

[6]The four tigers: South Korea, Hong Kong, Singapour and Taïwan

[7]Kwame Nkrumah is the first president of Ghana and the hero of this country's independence.

been an industrial development in some SSA countries. In fact, the industrial sector has grown by 14.6% per year in SSA between 1965-1973, and this was more than double the GDP growth which was 6.6% per year over the same period (Newman et al. 2016). From 1965 to 1970, manufacturing production increased by more than 7% in 7 SSA countries (Newman et al. 2016).[8] This manufacturing growth was about 8% in Ethiopia and Ghana, 10% in Tanzania and Uganda. Although the interventionist strategy led to growth in the manufacturing sector, the success of trade protection policies and the massive investment in state-owned enterprises quickly became short-lived. These industrialization programs were based on the production of capital-intensive goods, while SSA is characterized by a scarcity of capital and an abundance of less skilled labor. For example, in the 1970s, one of the industrial ambition of the Democratic Republic of Congo was the construction of an automobile factory while its main competitor was the United States with a large gap in terms of income per capita and capital availability (Lin, 2012). Over the same period, the capital intensity doubled in Senegal as industrial production declined (Meier et al. 1989). After their independence, the government of Ghana invested in the electronic and machinery industries in order to produce domestically the production inputs. Although import substitution policies have been implemented by most SSA countries, there have been some differences in their application. Indeed, a large majority of the French colonies remained in the colonial monetary zone at the time called " franc des Colonies Fançaises d'Afrique ", while most British colonies together with Guinea opted for monetary independence. In the case of the second group of countries, exchange rate overvaluation policies were put in place. Theoretically, exchange rate overvaluation would act as an indirect subsidy to manufacturing firms, allowing them to import intermediate inputs and capital goods below world prices. This strategy reduced the incentive to invest in the agricultural export activities, which in turn led to a shortage of foreign exchange reserves for imports of intermediate inputs. Moreover, the industrial development strategy was based on a massive public investment in state-owned enterprises, rather than on the improvement of their productivity. This resulted in public expenditures far greater than the tax-raising capacity of governments. As a result of these measures, the high level of customs duties contributed to reducing the efficiency of the domestic production of nished goods. In fact, the cost of importing intermediate inputs exceeded the import price of finished manufactured goods (Newman et al. 2016). The ineffectiveness of public spending and trade measures forced SSA governments to consolidate their public finances. Thus, the 1980s marked the end of public intervention in favor of economic liberalization advocated by the international institutions.

In the context of debt unsustainability, the international institutions including the World Bank (WB) and the International Monetary fund (IMF) advocated for some reforms. Known as " Structural Adjustment Programs ", these reforms were followed by de-industrialization in SSA. Over the mid-1990s, the manufacturing growth rate was lower than that of the period 1985-1990 in eight

[8]The 7 SSA countries: Ethiopia, Ghana, Kenya, Nigeria, Senegal, Tanzania and Uganda.

SSA countries (Newman et al. 2016).[9] From 1980 to 1985, the manufacturing growth became negative in Ghana, Nigeria, and Tanzania, it remained at 4% in Ethiopia, Kenya, Senegal and Uganda. The average growth rate of manufacturing in Ghana fell from 7.5% at the end of the 1980s to -7.4% at the beginning of the 1990s. Furthermore, the manufacturing value-added per worker decreased for many SSA countries between 1995-2010: from 100 to 64; 56; 36; 66, in Ethiopia, Kenya, Mozambique, and Senegal, respectively (Page et al. 2016). Although in the case of other developing countries the manufacturing share in the global exports was from 10% in 1980 to 29.6% in 2011, it was from 3% to 2.8% in Africa (Newman et al. 2016). One characteristic of this period was that most SSA countries exported sizeable natural resources with a high level of concentration.

Clearly, at some points in their history, Asia and SSA have implemented industrialization policies, based sometimes on trade protection and sometimes on trade liberalization while the nature of their SC has been different. The explanation of the results of these policies can be understood through the role of states in the implementation of industrial strategy. The post-independence industrial policies have failed to generate sustainable growth in SSA because they were not based on countries comparative advantages. In most SSA countries, the state has been unable to guide and coordinate the local entrepreneurs towards the comparative advantage sector. Indeed, countries with a relative natural resources abundance or unskilled labor force and scarcity of human and physical capital must create labor-intensive and natural resource-intensive industries. The liberalization policies have also failed because most African governments didn't use the commodities exports' revenues to reduce the constraints related to soft and hard infrastructure deficits that lead to high transaction costs, inhibiting the development of a local manufacturing sector.

2.2 Debate on structural change in sub-Saharan Africa

According to Gui-Diby & Renard (2015), at least 26 African countries had an industrialization strategy in 2017. In July 2016, the United Nations General Assembly adopted a resolution announcing the third decade of the industrial development in Africa. Although it is an important issue for African policy-makers, some observers argue that SSA can experience a growth miracle with SC between agriculture and services (McMillan & Harttgen, 2014). In fact, a reallocation of economic activity from agriculture to manufacturing can be a real driver of poverty reduction and employment (Rodrik, 2016*a*). However, SC between agriculture and services is less likely to impact the total factor productivity in SSA. Indeed, the type of services - for example information technology - that impacts the overall productivity requires a very skilled labor force. As an illustration, it takes several years of study and institutional quality improvement to transform a farmer into a programmer or into a call center operator. However, it only takes manual dexterity and physical capital to transform a farmer into a worker in a labor-intensive manufacturing industry multiplying his productivity by two or three (Rodrik, 2016*a*). It is the case of China, people moving from agriculture

[9] The 8 countries: Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Senegal, Tanzania, and Uganda.

to industry and from industry to services. However, it should be noted that these services represent inputs for the primary sector in some developing countries. For instance, the introduction of mobile phones in the city of Kerala in India would have allowed fishermen to make price arbitration between different markets increasing their profit by 8% (Jensen, 2007). The Kenyan mobile banking system (M-Pesa) has reportedly allowed some very poor women to leave the agricultural to the non-agricultural activities (Suri & Jack, 2016). Thus, these examples show that high-tech services could facilitate structural transformation from agriculture to industry but they are not a driver of overall productivity growth and unemployment reduction (Rodrik, 2018).

The manufacturing sector in Africa has both advantages and disadvantages. One undeniable advantage is its competitiveness in terms of labor costs. As labor costs are increasing in Asian countries, SSA could be the future area of relocation of labor-intensive production and/or assembly activities (Lin, 2012). In this context, SSA could benefit from the global value chains (GVCs) by integrating it more fully into global markets. The other advantage of the African manufacturing industry is the high young population growth on this continent. According to the African Development Bank (AfDB) Groups report - Strategy of the Bank Group for Youth Employment in Africa 2016-2025 -, the young African population will double in 2050 reaching 830 million. This demographic growth is a boon to industrialization both in terms of labor availability and in terms of demand for African manufacturing goods.

Despite the previous advantages, this sector is still undermined by several problems related to the business environment. In SSA, most companies recognized business environment constraints such as power outages and regulatory burden as a major problem. For example, the losses associated with power outages can reach 10% of firms sales in some countries (Gelb et al. 2014). About 1/3 of the enterprises report poor conditions of transport networks as a major constraint. On average, 40% of firms in SSA report that bribery practices are common.

2.3 Measures of structural change

According to Rodrik (2016*b*), Gui-Diby & Renard (2015), Kang & Lee (2011), industrialization is measured by the manufacturing value-added share in GDP or by the manufacturing employment share in total employment. From the new structural economics perspective, it is equally important to measure the employment and the value-added share of manufacturing industries with different capital intensities (Lin, 2011). SC is defined as a reallocation of economic activity between agriculture, manufacturing and services (Herrendorf et al. 2014). Starting from this definition, the authors stipulate that SC from the production perspective is measured either by the evolution of the sectoral value-added shares in GDP or by the evolution of the sectoral employment shares in total employment. According to them, the main limitation of using employment as a SC proxy is that the change in employment may not reflect the real changes in labor as input. Indeed, employment is determined either by the number of workers or by the number of hours worked. However,

there may be differences between the number of hours worked and human capital between sectors due to countries' level of development (Herrendorf et al. 2014). In addition, data for manufacturing employment exist for few SSA countries. Hence, SC between agriculture and manufacturing is measured in this paper by the ratio of their value-added. This measure typically corresponds to a reallocation of economic activity between these two sectors. The ratio between manufacturing and agriculture reflects the way in which the value-added of manufacturing increases (decreases) over time compared to that of agriculture. Thus, the variations in such a ratio show how the manufacturing sector contributes to GDP relative to agriculture, reflecting a reallocation of economic activity between the two sectors.

$$SC_{i,t} = \frac{MANUFACTURING_VALUE_ADDED_{i,t}}{AGRICULTURE_VALUE_ADDED_{i,t}} \tag{1}$$

With: i and t representing the country and year index, respectively.

This ratio tells us when a SC is in the right or in the wrong direction. A decrease in $SC_{i,t}$ over time shows a structural change based on de-industrialization and an increase in this indicator over time is considered as a SC involving industrialization. If the value of SC is lower than 1, the share of agriculture in GDP is higher than that of manufacturing (poor performance of SC). Conversely, if its value is higher than 1, we will say that the share of manufacturing in GDP is higher than that of agriculture (good performance of SC).

3 Literature review

Many papers have studied the determinants and the impacts of SC but few of them focus on the case of Africa. The literature that has studied SC in Africa can be organized into two main categories. The first focuses on the characteristics and the nature of economic reallocation and the second studies the constraints related to the SC.

3.1 The nature of structural change in Africa

According to the Lewis dual economy model, developing countries are characterized by a traditional sector with low productivity level and a modern sector with high level of productivity. Thus, SC that leads to economic development is defined by a reallocation of economic activity from the traditional to the modern sector. Nevertheless, the evolution has been different in Africa (McMillan & Headey, 2014; McMillan & Rodrik, 2011). Based on disaggregated data on sectoral employments, McMillan & Rodrik (2011) show that SC has been growth-reducing from 1990 to 1999 in the case of Latin America and Africa. According to the authors, one of the factors that helps to understand this result is the natural resources endowment. Indeed, in countries with a high share of natural resources in total exports, SC is a source of reduced economic growth and productivity. One of the main reasons is that the natural resources sector - mineral resources - is a highly productive sector that cannot

absorb a significant amount of unskilled labor. Another explanation about the reduction of growth by SC could be the type of urban migration that SSA countries have experienced (Rodrik, 2016*b*; De Brauw et al. 2014). In the case of many developing countries, rural areas are composed of low-productive agricultural activities while urban areas are characterized by the existence of non-agricultural activities particularly industrial activities. Thus, labor migration from rural to urban areas should take the form of a SC involving industrialization. However, De Brauw et al. (2014) show that a significant proportion of African population resides in rural places. Although cities abound in activities that can provide better returns than agricultural sector, the migration rate towards them is still very low in several African countries. Specifically, the annual migration rate in these countries was estimated at 1% from 1990 to 2000 (De Brauw et al. 2014). In many SSA countries, the experience of labor migration from rural to urban areas has resulted in a concentration of labor in traditional services instead of industrial sector (Rodrik, 2016*b*). Moreover, in some countries, there has been a movement of labor from the manufacturing sector to the traditional sector, particularly agriculture (McMillan & Headey, 2014). In this section, one conclusion can be summarized: in the case of most SSA countries, SC was in the wrong direction and its impact on economic growth and the living standard depends on its nature.

3.2 The constraints related to structural change in Africa

Although manufacturing industries are more productive than agriculture, SSA has not experienced a real reallocation of economic activity from the traditional to the modern sector to allow a significant improvement in the standard of living. For example, a large part of the labor force is concentrated in the agricultural sector in Africa. More precisely, the share of agricultural employment reaches 80% of the active population in some African countries (McMillan & Headey, 2014). If manufacturing is more productive than agriculture, why does Africa not experience an economic reallocation towards manufacturing? Using samples including African and non-African cross-country firm level data, Harrison et al. (2014) show that manufacturing industries in Africa perform less than those elsewhere. According to the authors, manufacturing firms in Africa have a low level of productivity; they sell, export, and invest less than others. However, when they control for infrastructure and the quality of institutions, it appears that African firms perform better than others. The business environment - especially the quality of infrastructure and institutions - needs to be improved so as to increase the competitiveness and the labor absorption capacity of the manufacturing sector in Africa. In this context, Bräutigam & Tang (2014) have done a qualitative analysis of how foreign direct investment - especially Chinese investments - may result in SC in Africa. According to the authors, foreign investments in Africa can lead to a SC if they are attracted in special economic zones (SEZs). In addition, Harrison et al. (2014) find that the impact of foreign ownership is higher in Africa than in other developing economies. The papers by Harrison et al. (2014) and Bräutigam & Tang (2014) highlight the constraints related to manufacturing industry in Africa to

explain why a real SC does not occur. In this sense, Collier & Dercon (2014) study the constraints related to the African agricultural sector. They show that a real SC can occur if productivity increases in agriculture; this would lead to a movement of labor from agriculture to manufacturing. So, the policymakers in Africa should make the agricultural sector more marketable. Finally, Dorosh & Thurlow (2014) highlighted the role of state in the process of SC in Ethiopia and Uganda. They wonder in which sector state must invest more to force a real structural transformation. Developing dynamic economy-wide models, they conclude that public investment in cities is an important determinant of SC in the long term, because the modern sectors are located in cities. However, in the short term, for an imperative of poverty reduction, they suggest further public investment in agriculture.

4 Stylized facts, variables and data description

We focus here on the stylized facts and the description of variables and data, respectively.

4.1 Stylized facts

This sub-section presents different stylized facts about SC and trade in our sample. Between 1970-2016, SSA experienced on average two periods of SC between agriculture and manufacturing (see the first graph of Figure 1). First, a slight increase appears in the share of manufacturing value-added in GDP and and a decrease appears in the agriculture share from 1970 to the end of the 1980s (the first graph of Figure 1). This can be interpreted as a structural transformation leading to industrialization even if the increase of manufacturing and the decrease of agriculture are very weak. However, at the end of the 1980s, we can see a slight SC involving de-industrialization because manufacturing decreased while agriculture increased. Although the above graphs are simple correlations, these two types of SC correspond to two different periods of trade policy. On the one hand, the period of SC involving industrialization corresponds to that of protectionist policies in SSA. On the other hand, the period of SC leading to de-industrialization corresponds on average to the period of trade liberalization of the SSA countries. Also, it appears that the share of agriculture in GDP is still on average higher than that of manufacturing which in the case of SSA reflects a poor performance of SC. Although it is the key sector of economic development, the share of manufacturing in GDP was still very low in SSA from 1970 to 2016 (about 10% in 2016).

The first graph of Figure 1 does not provide information about the productivity difference between agriculture and manufacturing. To address this, we collect data for 11 SSA countries on the sectoral shares in GDP and in total employment from the Groningen Growth and Development Centre database. This database is relevant because it provides sectoral employment for 11 SSA countries in addition to the sectoral value-added.[10] Hence, the second graph of Figure 1 shows

[10]The 11 SSA countries for which data on manufacturing employment exist are: Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South Africa, Tanzania, and Zambia.

the average shares of manufacturing and agriculture in GDP and in total employment between 1970-2000 and 2000-2011.[11] It appears that from 1970 to 2000, the share of agriculture in total employment was higher than its share in GDP and it was the opposite for the manufacturing sector. Arithmetically, this reflects the higher productivity in manufacturing sector. The important fact that emerges from Figure 1 is that manufacturing is more productive than agriculture in SSA but its share in total employment is still very small. Consequently, a reallocation of economic activity from agriculture to manufacturing should be an important source of economic growth in Africa. Indeed, a significant number of workers would leave the low productivity (agriculture) to the high productivity sector (manufacturing). This will lead to an increase in overall productivity in SSA even if productivity within sectors does not increase. A more precise analysis clearly shows the low technological level of African industries (Table 9). From 2000 to 2015, 87% of employment was in manufacturing industries with low level of technology and only 1.47% was in manufacturing industries with high level of technology.[12]

Over the period of trade openness policies (1995-2000), the exports from SSA remained highly concentrated in a small number of products compared with other regions in the world (with a concentration index of about 0.25).[13] Over the period 2001-2018, the exports were still more concentrated with 0.37 as the average concentration index (see the first graph of Figure 2).[14] With an average concentration index of just over 0.06 and 0.08 between 1995-2000 and 2001-2018, respectively the imports in SSA are less concentrated than those in Asia and North America (see the second graph of Figure 2).

4.2 Variables and data description

Table 1 presents the variables of our econometric models. The ratio between the manufacturing and agriculture value-added is the SC measure. The de facto trade openness index is the variable of interest while aggregate exports and imports are its transmission channels. In order to study the transmission channels of aggregate exports, they are broken down into commodities and manufacturing exports. Our variables of control are: exchange rate overvaluation, market size, public investment, private investment, the quality of institutions and the financial globalization.

[11] We look at the period before and after 2000 because McMillan & Rodrik (2011) show that the contribution of SC to economic growth is different in the two periods. Also, 2011 is the end of period because of data constraint.

[12] The data come from the United Nations Industrial Development Organization (UNIDO) database. The average number of people employed in each sector is calculated for our countries where data are available. The period 2000-2015 is considered because of the availability of data. Finally, South Africa is excluded because of its industrial weight relative to other SSA countries.

[13] The concentration index provides information on whether exports are concentrated on a small number of products or are homogeneously distributed over several products. This index ranges from 0 (exports are homogeneously distributed among products) to 1 (exports are highly concentrated in a small number of products). No data are available on export and import concentration indexes before 1995.

[14] The export concentration index is represented over the period 2001-2018 in order to understand how the degree of export concentration has changed in the time.

Table 1: Data and variables description

Variables	Description	Source
Structural change	The structural change indicator represents our dependent variable. It is determined from the ratio between the value-added of the manufacturing and agricultural sector. To allow comparison between countries and to control the effect of inflation, these two variables are in constant 2010 dollar prices (https://unstats.un.org/unsd/snaama/Basic).	United Nations Statistics Division database.
Trade openness	Trade openness represents our variable of interest, it is measured by the de facto KOF trade globalization index. This index is calculated as the weighted average between trade in goods, trade in services, and the diversity of trading partners. Trade in goods represents the weighted share of exports and imports of goods in GDP. Trade in services represents the weighted share of exports and imports of services in GDP. Finally, the diversity of trading partners is measured by the inverse of the Herfindahl-Hirschman's market concentration index for exports and imports of goods - which is also weighted - . The relevance of this index as measure of trade openness lies in the fact that unlike the usual measures of trade openness, it makes it possible to take into account the diversity of trading partners which is an additional information. About the contributions relating to the KOF trade globalization index see Gygli et al. (2019) and Dreher (2006). In order to explain the transmission channels of trade openness, exports and imports are introduced. In order to explain the transmission channels of exports they are disaggregated into primary commodities in the SITC 0 + 1 + 2 + 3 + 4 + 68 + 667+ 971 classification and manufactured goods in the SITC 5 to 8 less 667 and 68 classification (https://www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html).	KOF Swiss Economic Institute database for trade openness indicator. United Nations Statistics Division database for aggregate exports and aggregate imports. United Nations Conference on Trade and Development for primary commodities and manufactured goods exports.
Real exchange rate overvaluation	This variable allows to understand how the under- or overvaluation of the real exchange rate affects SC. We refer to authors who show that an undervaluation of exchange rate positively impacts while an overvaluation negatively affects manufacturing competitiveness in developing countries (Rodrik, 2008; McMillan et al. 2014). To measure the real exchange rate overvaluation index, we use the method of Rodrik (2008), which is summarized in three steps. For more information about the calculation method of this index, see Rodrik (2008).	Penn World table 9.1.
Market size	According to Murphy et al. (1989*a*), in developing countries, market size is an important determinant of a SC that leads to industrialization. Indeed, exports, particularly those of mineral and/or agricultural natural resources increase national income. Thus, if income is distributed and concentrated in the hands of the middle class, then manufacturing products demand will increase since the latter is the class that consumes the most industrial products. Empirically, a number of studies on industrialization (Rodrik, 2016*b*; Gui-Diby & Renard, 2015; Kang & Lee, 2011; Kaya, 2010; Rowthorn & Ramaswamy, 1999) measure market size or income level by GDP per capita. GDP per capita is calculated as the ratio between GDP in constant 2010 dollar terms and population size (https://unstats.un.org/unsd/snaama/Basic).	United Nations Statistics Division database.
Public investment	The share of public investment in GDP (in percentage terms) is used to take into account public intervention. According to Newman et al. (2016), an important dimension of post-independence industrial policies was massive public investment in state-owned industries in some African countries. In addition, according to Dorosh & Thurlow (2014), public investment in cities is a source of SC in some African countries. Noted «Public investment», this variable is in international dollar constant 2005 prices (https://www.imf.org/external/np/fad/publicinvestment/data/data.xlsx).	International Monetary Fund database.
Private investment	According to Murphy et al. (1989*b*), firms' transition from the traditional to the industrial sector must take the form of simultaneous private investment in order to increase market size. Empirical studies such as Kang & Lee (2011), Kaya (2010), Rowthorn & Ramaswamy (1999) find that investment has a positive impact on industrialization. However, in the context of dutch disease, economic resources are directed towards the natural resources sector to the detriment of the manufacturing sector. As proof, Gui-Diby & Renard (2015) find that investment negatively impacts industrializalition in Africa. Then the effect of private investment is taken into account by using the share of private investment in GDP (in international dollars constant 2005 prices) and is noted «Private investment» (https://www.imf.org/external/np/fad/publicinvestment/data/data.xlsx).	International Monetary Fund database.
Institutions	Some studies about the natural resources curse explain that natural resources boom has a deleterious effect on industrialization only in countries with poor quality of institutions (Mehlum et al. 2006). Thus, the impact of exports could be explained by the quality of institutions. Hence, the effect of institutional quality is controlled. The quality of institutions is determined as the difference between the democracy and autocracy variables. It ranges from +10 (highly democratic country) to -10 (highly autocratic country).	POLITY4 database.
Services	According to Gui-Diby & Renard (2015), in the context of structural change, the evolution of one sector can affect the dynamics of other sectors. In this sense, the effect of the share of services' value-added in GDP (Services) is controlled (https://unstats.un.org/unsd/snaama/Basic).	United Nations Statistics Division database.
Financial flows	According to Gui-Diby & Renard (2015), FDI at best have no effect on industrialization, and at worst, have a negative effect in the case of Africa. Moreover, Kose et al. (2009) show that external debt flows have a negative impact on total factor productivity. Thus, to control the effect of international capital flows, we use the de facto KOF index of financial globalization (https://www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html). It is calculated as the weighted average between foreign direct investment, portfolio investment, international debt, international reserves, and international income payment. The expected sign of this variable can be both positive and negative depending on whether or not foreign capital is directed towards the manufacturing sector.	KOF Swiss Economic Institute database.

5 Empirical strategy

We use PMG and DOLS estimation methods in our analysis. These techniques allow for modeling the long-run and the short-run relationships between SC and trade openness. However, we are only interested in the long-term effects of the explanatory variables, although these effects are studied on both the short-run and the long-run evolution of the dependent variable. The PMG and the DOLS also make it possible to consider the endogeneity issue and the fallacious regression. The endogeneity bias in this case is manifested by the fact that there could be a causal relationship between the explanatory variables and the error term. Thus, the PMG method is used first as estimation method and then the DOLS method is applied in robustness. However, before performing these two methods, it is necessary to verify the stationarity of the individual variables and the cointegration of their combinations. Thus, some unit root and cointegration tests are carried out prior to the PMG and the DOLS.

5.1 Units root and cointegration tests

According to Mignon & Hurlin (2005), there are mainly two generations of panel unit root tests. The first one (Bai & Ng, 2004; Levin & Lin, 1993; Hadri 1999; Harris & Tzavalis, 1999; Maddala & Wu, 1999; Choi; 2001; Levin et al. 2002; Im et al. 2003) is based on an absence of inter-individual correlation in any form (Mignon & Hurlin, 2005) . The second generation (Phillips & Sul, 2003; Moon & Perron, 2004; Choi, 2002; Pesaran, 2007) attempts to control all inter-dependencies that could exist between the individuals.

In this paper, we apply three unit root tests from the aforementioned generations. We first perform two tests from the first generation (Im et al., 2003 and Choi, 2001) and then one test from the second generation (Pesaran, 2007). The choice of Im et al. (2003) and Choi (2001) is explained by the following reasons. Indeed, Im et al. (2003) and Choi (2001) consider the unit roots as heterogeneous across individuals, which is relevant in a macroeconomic study such as this one (see Hurlin & Mignon, 2005). Moreover, Im et al. (2003), postulate a heterogeneity of in the existence of unit roots across individuals. These assumptions are realistic and plausible in our study because some heterogeneous characteristics between countries can generate different unit roots and can imply the occurrence of the unit root in some countries and not in other countries. The test from Choi (2001) applies a fisher-type test on each panel separately (meta-analysis) while considering the combination of the p-values from the individual tests as an overall test. Such an approach is consistent with the time series approach, which is different from the rest of the first generation tests. The test of Pesaran (2007) is performed because its approach remains substantially close to the DOLS which is the robustness estimation method in this paper.[15] Indeed, unlike some second-generation tests that transform the series to be tested, Pesaran (2007) keeps the raw variable to be

[15]The similarity between the Pesaran (2007) method and the DOLS approach is based on the fact that the latter also stores the raw data of the variables while adding the first advanced and delayed difference (Mignon & Hurlin, 2007).

tested. The authors introduce into the Augmented-Dicker-Fuller model (ADF) the individual means of the variable that is delayed by period and the first differences of the latter in instantaneous (Mignon & Hurlin, 2005). For the sake of consistency, we will consider a variable as stationary if all the three tests simultaneously reject the null hypothesis of non stationarity.

Similar to the unit root tests, two generations of cointegration tests exist. The first one concerns the assumption of homogeneous cointegration relationships between individuals. It postulates that the cointegration relationship cannot exist between some individuals in the panel without existing between other individuals in the same panel. (Kao; 1999; Pedroni, 1999). The second generation of tests stipulates the existence of heterogeneous cointegration relations (Westerlund, 2005). More precisely, it considers that a cointegration can exist between one group of individuals without being the case for other individuals in the same panel. Thus, to consider a combination of variables as cointegrated, all the three tests must simultaneously reject the null hypothesis of no cointegration.

5.2 Estimation method

The PMG method is an econometric technique applied to cointegrated panels. According to Blackburne III & Frank (2007), the main characteristic of cointegrated variables is their reactivity to any deviation from the long-run equilibrium. This feature allows using an error-correction model for cointegrated panels that links the long-run and short-run dynamics. In this type of model, the short-run dynamics will be influenced by any deviation from the long-term equilibrium (Blackburne III & Frank, 2007). Thus, the PMG allows estimating an error-correction model by the maximum likelihood method:

$$\Delta y_{i,t} = \phi_i(y_{i,t-1} - \theta_i X_{i,t}) + \sum_{j=1}^{p-1} \lambda_{i,j} \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \sigma_{i,j} \Delta X_{i,t-j} + \mu_i + \epsilon_{i,t} \tag{2}$$

where i=1,2,N represents the group number and t represents the time period. The first term $(y_{i,t-1} - \theta_i' X_{i,t})$ in equation (2) represents the long-term dynamics while the first difference variables reflect the short-term dynamics. ϕ_i is the error correction term that reflects the speed at which there is a return to the long-term equilibrium. Then, the long-term relationship exists if ϕ_i is different from zero; there is a return to the long-term equilibrium if ϕ_i is negative and significant. Thus, it is not necessary to test the cointegration of the model if ϕ_i is negative and significant (Blackburne III & Frank, 2007). Hence, the condition for using an error correction model is that the error correcting coefficient becomes negative and significant. $\Delta y_{i,t}$ represents the dependent variable (SC). The first difference of SC is the dependent variable in the PMG models because the error correction coefficients show that we cannot apply the PMG on the models in which the SC, as a dependent variable, is in level form. However, this is relevant as it allows for studying the long run dynamics' effects of the explanatory variables on the short-run dynamics of SC in the PMG while the effects on the long term dynamics of SC will be studied in the DOLS models.

$X_{i,t}$ represents the vector of explanatory variables. It should be noted that only the first-order integrated explanatory variables are included in both the long-run and short-run dynamics. The variables that will eventually be stationary in level form will be in the short term dynamics, therefore they will be only in first difference. To understand the transmission channels of trade openness' effect, we will replace it by the variables named ńExports and Importsż. Then, in order to explain the sign of Exports, we replace it by the variables named ńCommodities exports and Manufacturing exportsż. θ_i is the vector of the long-term coefficients and $\sigma_{i,j}$ is the vector of the short-term coefficients. $\lambda_{i,j}$ is a scalar corresponding to the coefficients of the delay of the first difference of the dependent variable. μ_i corresponds to the country fixed effects and $\epsilon_{i,t}$ is the identically and independently distributed error term.

Before estimates, the Hausman test is applied. It allows for a comparison between the estimator of the mean group (MG) and that of the PMG in order to choose the best model. The difference between these two methods comes from the fact that the long term dynamics is supposed to be homogeneous in all groups of the panel for PMG while it is heterogeneous in MG (Blackburne III & Frank, 2007). The null hypothesis of this test corresponds to the efficiency of the PMG estimator compared to the MG estimator.

Although the PMG introduces the lagged values of the variables in first difference, this is insufficient to fully address the endogeneity problem between the explanatory variables and the error term. To overcome this, another cointegrated panel estimation method which takes this issue well into account is performed for robustness.

5.3 Robustness check

In this study, we test the robustness of the PMG results by performing the DOLS method in order to correct for endogeneity. DOLS is a cointegrated panel estimation technique that consists of introducing into a cointegrating relationship the advanced and delayed values of the first difference of the explanatory variables. The introduction of the two previous terms consists of controlling the possible endogeneity of the explanatory variables by eliminating the correlation between them and the error term. Kao & Chiang (2000) studied the finite-sample properties of estimators from homogeneous cointegrated panel estimation methods. Their investigation concerned the Ordinary Least Squares (OLS) method, Fully Modified Ordinary Least Squares and DOLS. They concluded that DOLS substantially improved the estimators from the other two methods.

$$y_{i,t} = \alpha_i + \beta X_{i,t} + \sum_{k=-\infty}^{\infty} \delta_{i,k} \Delta X_{i,t+k} + \epsilon^*_{i,t} \tag{3}$$

Where $X_{i,t}$ represents a vector grouping all of explanatory variables. The first-order integrated explanatory variables will be in level form and in first difference while the variables stationary in level form will be in the short-term dynamics, so in first difference.

$y_{i,t}$ corresponds to the structural change measure noted SC. β represents the vector of the long run coefficients along the explanatory variables. The introduction of the term $\sum_{k=-\infty}^{\infty} \delta_{i,k} \Delta X_{i,t+k}$ in equation (3) allows for controlling the correlation between the explanatory variables and the error term. The DOLS estimators are obtained by estimating equation (3) using the OLS.

6 Results

This section presents all the results obtained from the empirical strategy. The results of the unit root and cointegration tests are presented initially, followed by those of the PMG and the DOLS.

6.1 Results of the unit root and the cointegration tests

Tables 2, 3 and 4 report the results of the unit root tests from Im et al. (2003), Choi (2001) and Pesaran (2007), respectively. The null hypothesis of non stationarity (in level form) is simultaneously rejected by the three tests in the case of four variables (Overvalue, Private investment, Public investment and Institutions). Thus, these variables are considered as stationary and they will only be introduced in the short run part of the PMG and the DOLS. Therefore, the variables: Structural change, Trade openness, Market size, Services, Financial flows, Exports, Imports, Commodities exports and Manufacturing exports are considered as first-order integrated variables. It should be noted that the threshold of significance considered in the present tests is 1%. More precisely, we reject the null hypothesis of non stationarity only if the p-value is less than or equal to 1%.

Table 5 presents the results of the three cointegration tests related to the combinations of variables estimated by the DOLS. The combinations of variables considered are all cointegrated because the null hypothesis of non cointegration is rejected in all cases.[16]

6.2 Results of pooled mean group estimations

Table 6 presents the results of the PMG estimates. The variables that are stationary in first difference are simultaneously in the long-run dynamics and in the short-run dynamics (Trade openness, Market size, Services, Financial flows, Exports and Imports). The variables that are stationary in level form are only in the short-run dynamics (Private investment, Public investment, Institutions, Overvalue). In all combinations of variables, the error correction coefficients (Speed adjustment) are negative and significant (column 1-4). Therefore, the long term relationships exist and there is a return of variables to the long-run equilibrium.[17] From columns 1 to 4, the results of the Hausman tests are reported. Note that the Hausman test could not be applied on the complete models including all the explanatory variables. This is because the number of iterations of MG exceeded what our data allowed due to the high number of explanatory variables. To perform the Hausman test,

[16]The Stata command (xtcointtest) that allows to run the three cointegration tests does not support more than seven explanatory variables.

[17]Note that we are only interested in the effect of the long-run dynamics of the variables of interest.

we applied the estimates of the PMG and the MG on two different models. The first is the model without the share of services' value-added in GDP and the second without the variable of financial flows. The choice to gradually remove these two variables - in order to perform the Hausman test - is explained by the following reason. They are the only control variables that are in both the long-run and short-run dynamics, thus, by gradually removing them, the number of explanatory variables is reduced so that the MG and therefore the Hausman test can be applied. From columns 1 to 4, in the two models, the p-values of the Hausman test do not reject the null hypothesis which states that the PMG estimator is more efficient compared to the MG one. Based on the previous conclusion, we apply the PMG on the complete model with all explanatory variables.

The first column reports the combination of variables in which trade openness is the variable of interest. In column 1, the indicator of trade openness (in level form) negatively and significantly impacts the first difference of SC. Thus, the long-term evolution of trade openness negatively impacts the short-run dynamics of SC.

To understand the transmission channels of trade openness' effect, we replace it by the share of exports and that of imports in GDP. Hence, the columns 2, 3 and 4 present these effects when the share of exports and that of imports in GDP replace the trade openness index. Column 2 considers the combination of variables in which the share of exports in GDP is the variable of interest while column 3 reports the combination in which the share of imports in GDP is the variable of interest. Finally, the column 4 presents the set of variables with the share of exports and that of imports in GDP as variables of interest. The long run dynamics of exports negatively and significantly affects the short run dynamics of SC - columns 2 & 4 - while the long term dynamics of imports positively and significantly impacts SC (in first difference; column 4). The coefficient of trade openness (-.0021107) is considerably lower than those of exports (-.1527709 & -.1518654) and that of imports (.057296). This could be explained by the fact that the trade openness indicator encompasses many things including diversity of trading partners and trade in services in addition to trade in goods. Moreover, the effects of exports are larger and more significant than those of imports. Therefore, exports could be the single variable through which the negative impact of trade openness passes.

From the previous findings, it appears that trade openness negatively affects the short run dynamics of SC and that this negative effect is driven by exports. As the PMG method allows for studying the long run dynamic effects of trade on the short run dynamics of SC, it is important to understand the long term dynamics of trade on the long term dynamics of SC. In this sense, the DOLS method is applied, which also allows for good control of the endogeneity issue compared to the PMG method.

6.3 Robustness check

The present subsection considers the combinations of variables estimated by the DOLS method, these results are reported in Table 7. As in PMG, the variables that are stationary in first differ-

ence are simultaneously in the long term dynamics and in the short term dynamics while those stationary in level form are only in the short run dynamics. Hence, the dependent variable is in level form allowing to study the long run dynamics' effects of the variables of interest on the long term dynamics of SC. However, the short term effects of the variables in level form are automatically considered in the DOLS estimates, so their coefficients will not appear in Table 7.

In the DOLS estimates, we consider the default lag (2) and the default lead (1) as well as the default level (95). Column 1 is the combination of variables in which the trade openness indicator corresponds to the variable of interest. From this column, it appears that the long-term evolution of trade openness negatively and significantly affects the long-run dynamics of SC.

The transmission channels are studied in columns 2, 3 and 4. The share of exports in GDP (in level form) negatively and significantly impacts the long term evolution of SC (columns 2 & 4) while the share of imports in GDP has no significant effect. As explained previously, the coefficients of exports are higher than that of trade openness.

In addition, the long term coefficients of trade openness and exports in the DOLS estimates are higher than their long run coefficients in the PMG models. This may be explained by the fact that the two methods have two different measures of the dependent variable. In the PMG, the first difference of SC is the dependent variable while it is considered in level in the DOLS. Hence, this shows that the long run dynamics of trade openness and that of exports influence more the long term dynamics of SC than its short run evolution.

From the PMG and the DOLS estimates, the share of exports in GDP is the channel through which trade openness affects SC. Therefore, the exports are disaggregated into commodities exports and manufacturing exports. Table 8 presents the results of DOLS estimates when the exports of commodities and manufacturing products are considered as variables of interest while controlling the effects of imports. From column 2 to column 9, the commodities exports (in level form) negatively and significantly affect the long run dynamics of SC while manufacturing exports positively impact it. However, the effect of commodities exports (column 9) is more significant than that of manufacturing exports. This could be explained by the weak industrial base of African countries. In addition, it could explain why the overall effects of exports - the effects of total exports in GDP - are negative. Moreover, the coefficients of manufacturing exports are higher that those of commodities exports showing that the magnitude of manufacturing exports is more important. In the first column, the effect of commodities exports is positive but it becomes negative when the effect of market size is controlled, this may be explained through the spending effect discussed in the next subsection.

From the previous results, it appears that the negative effect of the long-run dynamics of trade openness passes through commodities exports.

6.4 Theoretical discussion

Our results show that the long-run effect of trade openness on the long-term and the short-run dynamics of SC is negative and passes through commodities exports. Therefore, trade openness is a barrier to SC and then to industrialization in SSA. This surprising conclusion can be mainly explained by two mistakes in the industrial and trade policies. First, the post-independence industrial policies focused on the creation of capital-intensive industries while the comparative advantage of African countries is in labor-intensive industries. Second, trade policies of the end of the 1980s were based on a deep specialization in the exports of raw materials without investing exports' resources in the development of a competitive domestic industrial sector. Indeed, SSA countries suffer from significant infrastructure constraints, which represent significant transaction costs for the industrial activities. Consequently, the return on investment in manufacturing activities will be low and may be lower than that in import activities. Still, as a result of infrastructure constraints and the poor business environment, the risk associated with the creation of a new industry will be high relative to the risk associated with import activities. In this context, even with a comparative advantage in low-skilled labor-intensive industries, the entrepreneurs in SSA will prefer to import rather than invest in the manufacturing sector. Therefore, a trade openness based on commodities exports without a resources-investment policy will crowd out the manufacturing sector. This effect will be amplified by the rise of GDP per capita due to commodities exports, which will increase the domestic demand, but with a weak industrial base, the rise of the domestic demand will lead to an increase in the demand for foreign products.

7 Concluding remarks

Economic openness has been considered by the main international institutions and many economists as the best way for African countries to develop. Nevertheless, the situation in most of these countries does not confirm this idea. Economic development may be approximated by structural change which illustrates a country's ability to move from agriculture to industry. Considering the importance of this subject and its consequences in terms of political economy, we studied how trade openness has impacted the structural change. We find in this paper that trade openness has negatively affected structural change in 34 SSA countries between 1970-2016, and this negative impact goes through exports and not imports. This is explained by the fact that states in Africa have failed to put trade policy at the service of industrialization by following the logic of comparative advantage. More precisely, they have failed to invest the exports revenues to improve hard and soft infrastructure in order to remove the constraints on relocation to labor-intensive manufacturing activity.

Therefore, industrial and trade policies are the roots of this mechanism. As argued in the New Structural Economics (Lin, 2011), the comparative advantages based on factorendowment only

determine the factor costs of production for an industry. The competitiveness of an industry in domestic and international markets also depends on transaction costs, which are determined by infrastructure and business environment, in addition to the factor costs of production. If African governments can help reduce the transaction costs with good infrastructure and business environment for the labor-intensive industries, African countries will be able to produce and export labor-intensive manufacturing goods as East Asian countries have done.

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Table 2: Unit root tests of Im, Pesaran, and Shin (2003)

	Level		Difference	
	W-t-bar	P-value	W-t-bar	P-value
Structural change	-2.6254	0.0043	-23.6074	0.0000
Trade openness	-2.9560	0.0016	-34.6986	0.0000
Market size	0.9099	0.8186	-25.5303	0.0000
Overvalue	-3.2581	0.0006	-28.8503	0.0000
Private investment	-6.0642	0.0000	-32.6232	0.0000
Public investment	-5.0098	0.0000	-36.0397	0.0000
Financial flows	-0.2749	0.3917	-33.2385	0.0000
Institutions	-3.9899	0.0000	-30.2068	0.0000
Exports	-1.3713	0.0851	-37.5976	0.0000
Imports	-1.7427	0.0407	-31.7554	0.0000
Commodities exports	3.6320	0.9999	-18.1607	0.0000
Manufacturing exports	1.4972	0.9328	-20.1674	0.0000
Services	-1.4104	0.0792	-34.1483	0.0000

Cross-sectional means removed; Trend: included; ADF regressions: lags average (chosen by AIC)

Table 3: Unit root tests of Choi (2001)

	Level		Difference	
	Inverse chi-squared(68)	P-value	Inverse chi-squared(68)	P-value
Structural change	89.6186	0.0407	459.7901	0.0000
Trade openness	83.3658	0.0992	720.5550	0.0000
Market size	59.3147	0.7646	420.8672	0.0000
Overvalue	119.8320	0.0001	656.7123	0.0000
Private investment	172.0334	0.0000	768.7588	0.0000
Public investment	120.9433	0.0001	687.9636	0.0000
Financial flows	63.0972	0.6456	626.8327	0.0000
Institutions	125.4033	0.0000	622.5646	0.0000
Exports	55.4213	0.8633	594.8207	0.0000
Imports	93.7159	0.0211	684.0933	0.0000
Commodities exports	27.7861	1.0000	204.5625	0.0000
Manufacturing exports	52.2547	0.9211	272.6022	0.0000
Services	74.8380	0.2661	651.9471	0.0000

Cross-sectional means removed; Trend: included; ADF regressions: lags average (1)

Table 4: Unit root test of Pesaran (2005)

	Level		Difference	
	Z[t-bar]	P-value	Z[t-bar]	P-value
Structural change	-0.120	0.452	-16.820	0.000
Trade openness	-0.698	0.242	-16.924	0.000
Market size	-3.294	0.000	-15.310	0.000
Overvalue	-3.753	0.000	-17.835	0.000
Private investment	-5.889	0.000	-18.776	0.000
Public investment	-2.356	0.009	-17.386	0.000
Financial flows	-1.366	0.086	-17.598	0.000
Institutions	-4.534	0.000	-18.936	0.000
Exports	-0.976	0.165	-16.934	0.000
Imports	-1.914	0.028	-17.236	0.000
Commodities exports	-0.213	0.416	-6.822	0.000
Manufacturing exports	-0.829	0.203	-8.304	0.000
Services	-1.234	0.109	-17.197	0.000

Deterministics chosen: constant and trend. Augmented by 1 lags (average)

Table 5: Cointegration tests

	Statistic	P-value
Cointegration tests of Table 7 (Kao. 1999)		
Column 1	-8.1157	0.0000
Column 2	-8.2790	0.0000
Column 3	-8.1389	0.0000
Cointegration tests of Table 8 (Kao. 1999)		
Column 6	5.4411	0.0000
Cointegration tests of Table 7 (Pedroni, P. 1999)		
Column 1	3.5542	0.0002
Column 2	3.8541	0.0001
Column 3	2.6736	0.0038
Cointegration tests of Table 8 (Pedroni, P. 1999)		
Column 6	5.9021	0.0000
Cointegration tests of Table 7 (Westerlund, J. 2005)		
Column 1	4.2619	0.0000
Column 2	3.9368	0.0000
Column 3	5.1482	0.0000
Cointegration tests of Table 8 (Westerlund, J. 2005)		
Column 6	10.0863	0.0000
AR parameter: Panel specific. For all cointegration tests		
Panel means: Included. Lags(aic). For Kao. 1999		
Panel means: Included.Time trend: Included. For Pedroni, P. 1999		
Panel means: Included.Time trend: Included. For Westerlund, J. 2005		

Table 6: Results of pooled mean group regression (Trade, Exports and Imports=variables of interest). Dependent variable=Structural Change (SC) in first difference

	(1)	(2)	(3)	(4)
Variables	D.SC	D.SC	D.SC	D.SC
Long term				
Trade openness	-0.0021107***			
	(0.0004399)			
Market size	0.0001805***	0.0001462***	0.0002058***	0.0001472***
	(0.0000181)	(0.0000145)	(0.0000201)	(0.0000147)
Services	0.0844419***	0.0475774	0.1138835**	0.0800284**
	(0.0295534)	(0.037624)	(0.0538892)	(0.0383079)
Financial flows	-0.0005264	-0.0009145***	-0.0021849***	-0.0011364***
	(0.0004532)	(0.0003329)	(0.0004745)	(0.0003395)
Exports		-0.1527709***		-0.1518654***
		(0.0502625)		(0.0520921)
Imports			0.0532131	0.057296*
			(0.0484063)	(0.0337941)
Short term				
D.Trade openness	0.0009553			
	(0.0007692)			
D.Market Size	-0.0000439	-0.0000289	-0.0000521	-0.0000292
	(0.0001249)	(0.0001065)	(0.0000988)	(0.0000961)
D.Private investment	0.0058382	0.0065547	0.0041486	0.005646
	(0.0056816)	(0.0055025)	(0.0063938)	(0.0071945)
D.Public investment	0.0538132	0.052118	0.0535493	0.0520154
	(0.0537545)	(0.0531388)	(0.0533028)	(0.0529558)
D.Institutions	0.0183557	0.0186742	0.0163783	0.0150417
	(0.0149779)	(0.0171489)	(0.0150384)	(0.0167394)
D.Overvalue	0.4233416	0.3820578	0.5339482	0.438734
	(0.6543199)	(0.6740034)	(0.5998952)	(0.6139992)
D.Services	1.342541	1.529346	1.382024	1.588423
	(1.016762)	(1.179363)	(1.146947)	(1.310509)
D.Financial flows	0.0012726	0.000986	0.0022509*	0.0014937*
	(0.0011705)	(0.0008384)	(0.0013581)	(0.0009013)
D.Exports		0.4697152		0.480681*
		(0.298485)		(0.2713108)
D.Imports			0.4010649	0.3225534
			(0.2662685)	(0.2508033)
Speed adjustment	-0.1642026***	-0.1793462***	-0.1630352***	-0.184284***
	(0.0350534)	(0.0354316)	(0.0314962)	(0.03593)
Log likelihood	2477.415	2500.092	2491.72	2532.98
Hausman test p-value: Model with financial flows	0.88	0.37	0.61	0.79
Hausman test p-value: Model with services	0.61	0.96	0.86	0.27
Observations	1440	1441	1441	1441
Number of country	34	34	34	34

Notes: robust standard errors are in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7: Results of dynamic ordinary least squares (Trade, Exports and Imports=variables of interest). Dependent variable=Structural Change (SC)

	(1)	(2)	(3)	(4)
Variables	SC	SC	SC	SC
Long term				
Trade openness	-0.0076458**			
	(.0032351)			
Market size	0.0006705***	0.0006917***	0.0006687***	0.0006995***
	(0.0000275)	(0.0000275)	(0.0000274)	(0.0000272)
Services	1.974076***	1.56599***	1.871118***	1.440138
	(0.4477717)	(0.4603088)	(0.4448313)	(0.4569518)
Financial flows	0.0001524	0.0003297	-0.006175**	-0.0003084
	(0.0034178)	(0.0032161)	(0.0031567)	(0.0031748)
Exports		-0.8502828**		-0.9987805***
		(0.3342852)		(0.3491011)
Imports			0.2654616	0.416993
			(0.2630464)	(0.2771208)
Short term				
D.Private investment	-0.0077444	-0.0099882*	-0.0076349	-0.010517
	(0.0057618)	(0.0057713)	(0.0057411)	(0.005726)
D.Public investment	-0.0032855	-0.0055682	-0.0068059	-0.0059569
	(0.0077747)	(0.0077907)	(0.0077212)	0.0076903
D.Institutions	-0.0143746	-0.0181957	-0.0087786	-0.0161653
	(0.0114702)	(0.0115031)	0.0113962	(0.0113553)
D.Overvalue	-0.481386	-0.3757975	-0.5972287	-0.4780664
	(0.4713986)	(0.4722814)	(0.4683098)	(0.4664018)
R2	0.5578	0.5689	0.5617	0.5847
Wald chi2	665.58***	696.89***	686.62***	738.12***
Number of lags	2	2	2	2
Number of leads	1	1	1	1
Observations	1131	1131	1131	1131
Number of country	29	29	29	29

Notes: robust standard errors are in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: Results of dynamic ordinary least squares (Commodities exports and Manufacturing exports=variables of interest). Dependent variable=Structural Change (SC)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	SC	SC	SC	SC	SC	SC	SC	SC	SC
Long term									
Commodities exports	7.461784***	-2.500147***	-2.356291**	-2.330151**	-2.350349**	-2.342119**	-2.886397***	-2.673329***	-3.104344**
	(1.300944)	(0.7617856)	(0.9779092)	(0.977993)	(0.9787037)	(0.9850031)	(0.9675338)	(0.9611609)	(0.9951719)
Manufacturing exports	8.92155*	5.646871**	5.698859**	5.737565**	5.71137**	5.581255**	6.169063**	6.790427**	4.967643*
	(4.874452)	(2.272052)	(2.691295)	(2.702651)	(2.7028)	(2.73495)	(2.686608)	(2.666392)	(2.680079)
Market size		0.0007507***	0.0007586***	0.0007589***	0.000759***	0.000768	0.0007868***	0.0007846***	0.000799
		(0.0000472)	(0.0000617)	(0.0000617)	(0.0000617)	(0.0000622)	(0.0000614)	(0.0000618)	(0.0000622)
Services							-1.103008	-1.061427	-1.352422
							(1.224092)	(1.213779)	(1.221038)
Financial flows								-0.0047392	-0.0078099
								(0.0079871)	(0.0080082)
Imports									1.163895*
									(0.6892334)
Short term									
D.Private investment			-0.0229423*	-0.0186855	-0.020132	-0.019114	-0.0103941	-0.0072953	-0.0240858*
			(0.0131471)	(0.0133312)	(0.013382)	(0.0134687)	(0.0133931)	(0.0132792)	(0.0133311)
D.Public investment				-0.0103331	-0.0104343	-0.009962	-0.011885	-0.0162152	-0.0114526
				(0.0187076)	(0.0187109)	(0.0188322)	(0.0184968)	(0.0183593)	(0.0183615)
D.Institutions					-0.0620709*	-0.055355*	-0.0548493*	-0.055315*	-0.0547462*
					(0.0321339)	(0.0323455)	(0.0318085)	(0.0315354)	(0.0315467)
D.Overvalue						0.7724858	0.7832072	0.5960143	0.0008766
						(1.007958)	(0.9899629)	(0.9882157)	(0.9887854)
R2	0.21458	0.6368	0.6103	0.6111	0.6140	0.6203	0.6103	0.6221	0.6279
Wald chi2	43.83***	339.12***	199.83***	198.97***	202.74	204.02	211.71	222.75	226.45***
Number of lags	2	2	2	2	2	2	2	2	2
Number of leads	1	1	1	1	1	1	1	1	1
Observations	612	612	510	510	510	510	510	510	510
Number of country	34	34	34	34	34	34	34	34	34

Notes: robust standard errors are in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

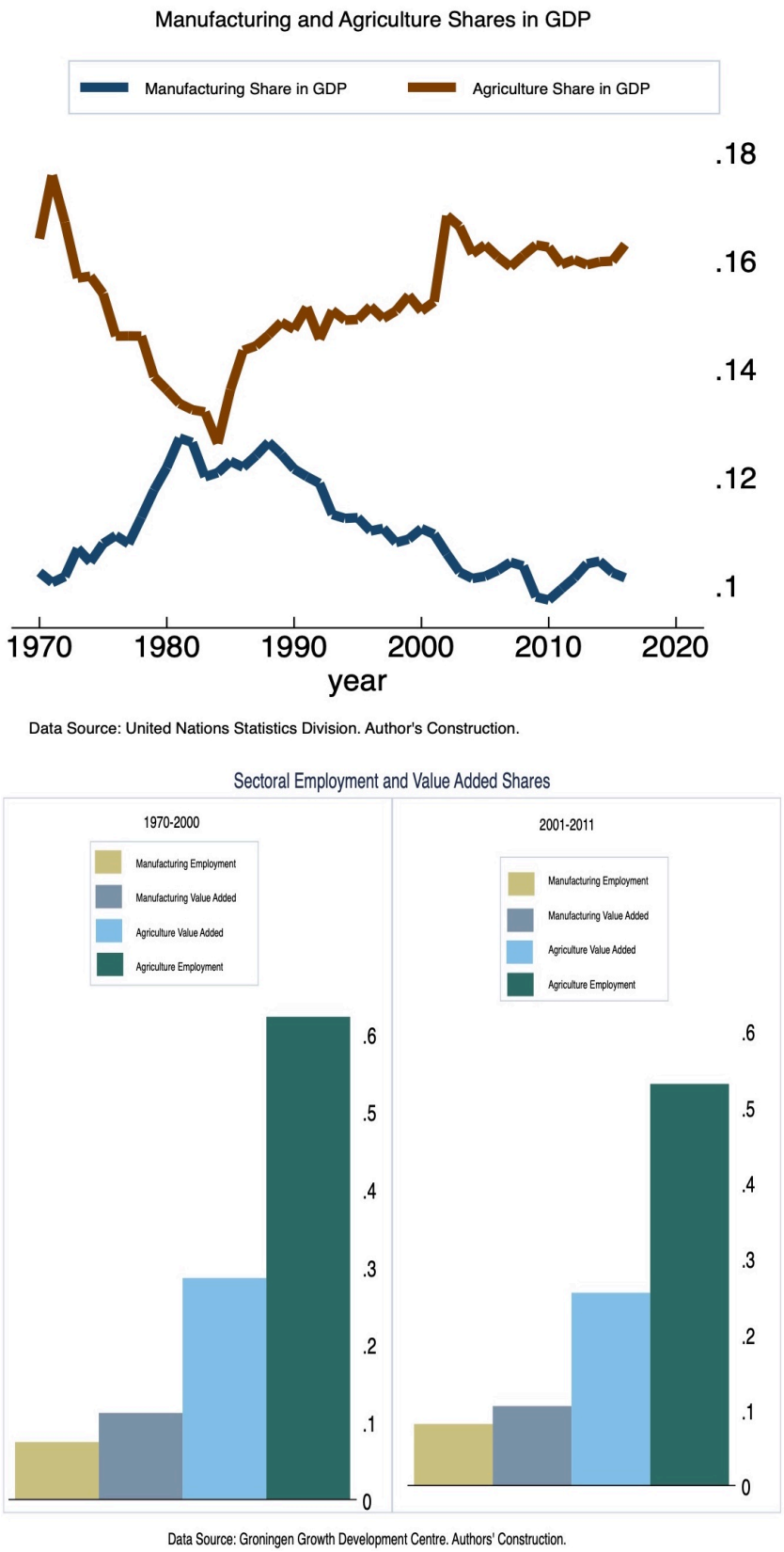
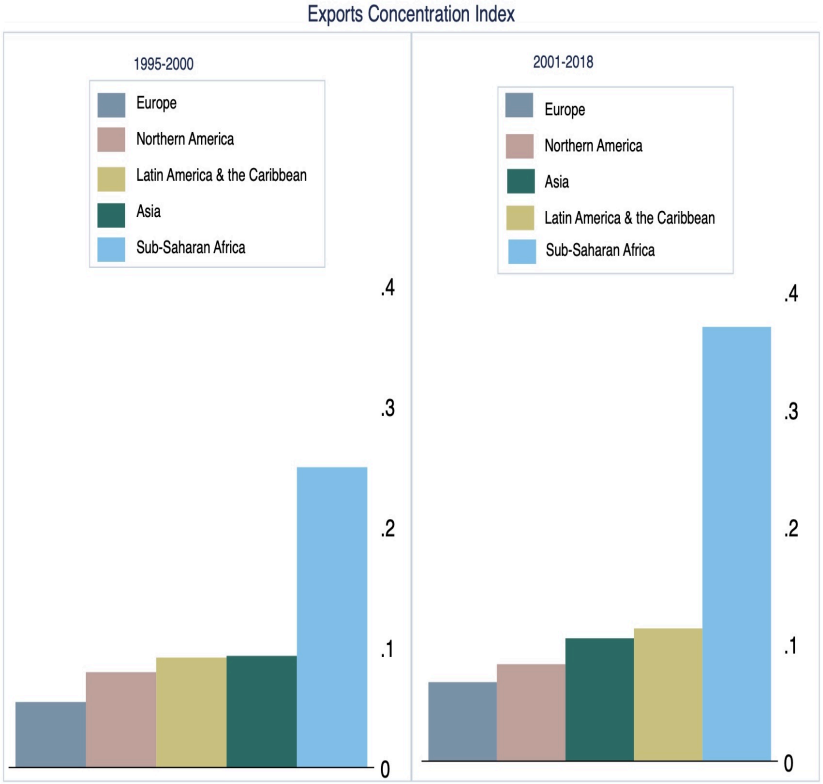


Figure 1: Structural Change and the Productivity Difference between Agriculture and Manufacturing

Table 9: The Structure of Manufacturing Employment 2000-2015

Manufacturing	Employment(%)	Manufacturing	Female Employment(%)
Sector of activity	103,52*	Sector of activity	29.94
Paper and paper products	2.00	Wood products (excl. furniture)	5.78
Tobacco products	3.49	Fabricated metal products	11.29
Leather. leather products and footwear	3.64	Rubber and plastics products	13.95
Fabricated metal products	5.11	Paper and paper products	20.95
Furniture; manufacturing n.e.c.	6.16	Food and beverages	22.60
Wood products (excl. furniture)	6.86	Furniture; manufacturing n.e.c.	23.41
Rubber and plastics products	8.05	Leather. leather products and footwear	31.05
Wearing apparel. fur	10.54	Tobacco products	38.92
Textiles	10.68	Textiles	48.05
Food and beverages	30.85	Wearing apparel. fur	89.11
Low technology manufactures	87.38	Low technology manufactures	
Other transport equipment	.20	Other transport equipment	7.02
Machinery and equipment n.e.c.	1.16	Machinery and equipment n.e.c.	11.43
Motor vehicles. trailers. semi-trailers	1.52	Motor vehicles. trailers. semi-trailers	13.38
Chemicals and chemical products	5.71	Chemicals and chemical products	23.69
Medium technology manufactures	8.59	Medium technology manufactures	
Medical. precision and optical instruments	.10	Coke.refined petroleum products.nuclear fuel	6.50
Office. accounting and computing machinery	.12	Medical. precision and optical instruments	10.92
Radio.television and communication equipment	.12	Electrical machinery and apparatus	18.79
Coke.refined petroleum products.nuclear fuel	.39	Office. accounting and computing machinery	33.64
Electrical machinery and apparatus	.74	Radio.television and communication equipment	76.22
High technology manufactures	1.47	High technology manufactures	
Recycling	.04	Basic metals	4.50
Basic metals	2.77	Recycling	20.63
Printing and publishing	3.27	Printing and publishing	32.74
Unclassified products	6.08	Unclassified products	

Data source: United Nations Industrial Development Organization.
*The fact that the total employment share of sectoral activity is greater than 100% (103.52%) could be due to some data processing errors.



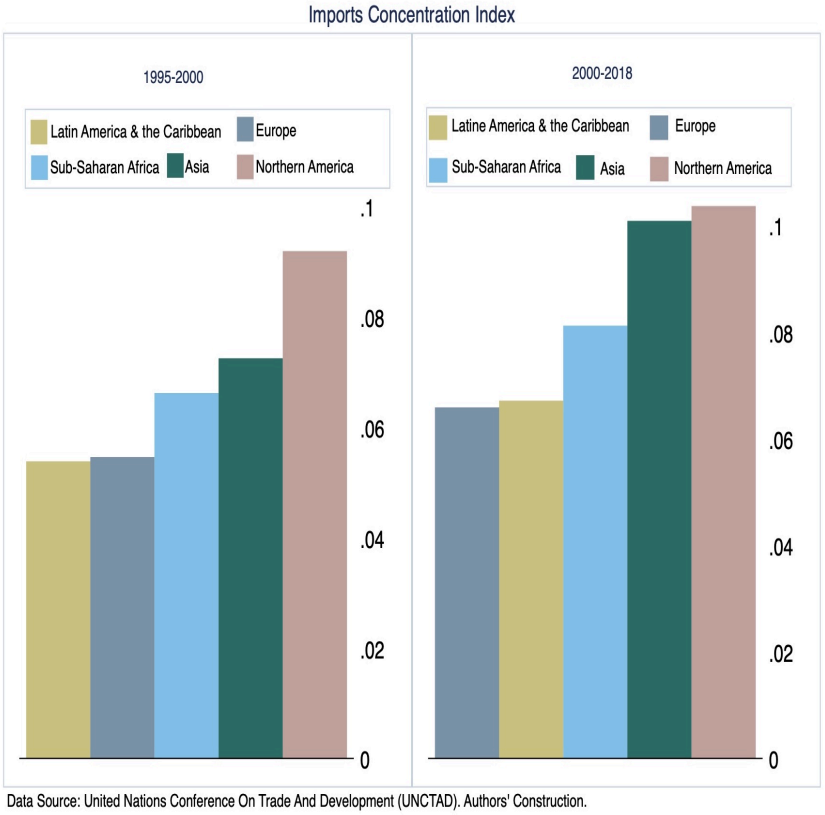


Figure 2: Trade Concentration in the world regions

Table 10: List of Country

Country	Country
Benin	Guinea-Bissau
Botswana	Kenya
Burkina Faso	Lesotho
Burundi	Malawi
Cabo Verde	Mali
Cameroon	Mauritania
Central African Republic	Mozambique
Chad	Niger
Congo. Rep.	Nigeria
Cote d'Ivoire	Rwanda
Equatorial Guinea	Senegal
Eswatini	Sierra Leone
Ethiopia	South Africa
Gabon	Tanzania
Gambia. The	Togo
Ghana	Zambia
Guinea	Zimbabwe