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The AfCFTA impact on agricultural and food trade: a value added perspective

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Abstract

The African Continental Free Trade Area agreement will create the largest single market in the world in terms of the number of countries and people. We analyse the effects of regional trade liberalisation on production fragmentation and networks using a global computable general equilibrium model adapted to take into account the value-added structure of international trade. This permits the analysis of the impact of trade policies in the presence of global upstream and downstream linkages through a counterfactual analysis. The analysis goes beyond previous studies by focusing on member countries' agricultural and food integration in regional and global value chains through backward and forward linkages. Our simulation results suggest that the agreement could have a significant impact on trade patterns in terms of value-added structure and extra- or intra-regional destinations. The reduction in trade costs within the region has a higher incidence on agriculture and food backward intra-regional integration than on forward participation, but this pattern varies substantially across countries. We find that the continental agreement translates in more widely spread benefits across sectors if we consider the income generated within each sector (value added) rather than simply accounting for gross exports.

Keywords: African continental free trade area, global and regional value chains, regional integration, computable general equilibrium

JEL classification: F14, C68

1. Introduction

International trade integration has deepened over the past decades, not only in the world but also in Sub-Saharan Africa. This trend is partly attributed to countries' efforts to liberalise trade unilaterally and engage in free trade and regional integration agreements. In March 2018, 44 heads of state from

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44 African countries met in an Extraordinary Summit in Kigali, Rwanda, to sign the framework agreement forming a new African Continental Free Trade Area (AfCFTA), the largest free trade area in the world, covering over 1.2 billion people and generating US$2.5 trillion in GDP. To date, 54 of the 55 member states of the African Union (AU) have signed the agreement,[1] which entered into force on 30 May 2019 for the 27 countries that had deposited their instruments of ratification. Trading under the AfCFTA commenced on 1 January 2021 after postponements due to the COVID-19 pandemic.

As of today, the African share of world exports only represents 2 per cent, and trade between African countries barely exceeds 10 per cent of the total trade of Africa, which is much lower than the intra-regional trade share of other continents (Jung, 2018).[2] The structural causes of Africa's 'under-trading' are profound: the small economic size of African economies, the vast distances that separate them and the specialisation in natural resources that they can buy from each other in only limited quantities.

Intra-continental agricultural exports have steadily grown over the past two decades. Intra-regional trade in Africa is attributable to regional factors such as geographic proximity, cultural similarities, historical trading relationships and preferential trade agreements, while current policy and non-policy barriers to trade likely deter exchanges among African countries. However, trade occurs predominantly within regional economic communities (RECs)[3] without developing a strategic web of regional supply chains within the continent. Moreover, intra-continental agricultural trade, although relatively less diversified in Africa compared to Europe, is significantly more diversified in Africa than in South Asia. Intra-continental trade expansion can leverage regional differences in the competitiveness of African countries in key food value chains (Bouët, Odjo and Zaki, 2020).

Nonetheless, the current pace of trade growth within Africa remains slow, prompting a recent commitment by African heads of state to triple intra-continental agricultural trade by 2025 and raising questions about the feasibility for Africa of enhancing its food security through its regional supply chains and greater intra-African trade. Among the steps taken to facilitate expanded African trade, countries launched the AfCFTA. The AfCFTA aims to create a single continental market for goods and services, harmonising different trade liberalisation processes currently occurring in the continent and boosting regional integration. There are about 30 bilateral or regional trade agreements

1 Eritrea is the only country of the 55 AU member states that has not yet signed the agreement.

2 It is worth mentioning that indeed intra-African trade and its share in total trade are systematically underestimated, as only official statistics are used. For agricultural products in particular, informal trade through unofficial channels distant from official border posts plays a major role (Bouët and Odjo, 2019). Recent estimates suggest that informal cross-border trading contributes about 30–40 per cent of the overall intra-regional trade in the Southern Africa Development Community and 40 per cent in the Common Market for Eastern and Southern Africa (Nshimbi and Moyo, 2017).

3 The RECs are regional groupings of African states. The AU recognises eight RECs: Arab Maghreb Union; Common Market for Eastern and Southern Africa; CEN–SAD; East African Community; Economic Community of Central African States; ECOWAS; Intergovernmental Authority on Development and Southern African Development Community.

within the continent, and each African country is a member of at least one of them. Despite the marginalisation of Africa in the world trade system, Candau, Guepie and Schlick (2018) show that African Regional Trade Agreements ushered in an era of economic integration with strong trade creation effects. Nonetheless, African countries continue to impose high duties on trade with each other—overall intra-continental import tariffs on both agricultural and non-agricultural goods average 8.6 per cent, the highest intra-continental trade tariff in the world. More specifically, on average, tariffs on agricultural goods reach 19.58 per cent, while tariffs on non-agricultural goods average 8.3 per cent (Bouët, Cosnard and Laborde, 2017). As a consequence, the route towards free trade raises some serious challenges and issues that need to be addressed by African countries, especially for the agricultural sector, which remains a key sector to employment and overall economic development.

The agricultural sector is characterised by small-scale farming, which is an important part of the livelihood of about three-quarters of the rural population (Lowder, Skoet and Singh, 2014). Due to the importance of the agricultural sector and the multiplier effects of increased agricultural income in downstream sectors, agricultural growth is two to three times more effective in reducing poverty in developing countries than growth in other sectors (Christiaensen, Demery and Khul, 2010). Much of world trade now occurs in differentiated products within value chains. Participation in global value chains (GVCs) is frequently highlighted as a promising route to industrialisation and it features prominently in recent reports by international organisations (e.g. World Bank, 2019). Concomitantly, there is great interest in new empirical measures that describe the performance of countries carrying out activities in GVCs and a scramble for new data, in particular input–output (IO) tables, that are needed to apply the new measures.

We refer to GVCs when the activities take place in at least two different countries. Put otherwise, a GVC arises when a production process is fragmented across borders. Value-added trade describes the country in which the various components of final goods are produced. Value-added trade flows differ from gross trade flows due to trade in intermediate goods. This is because an intermediate good, such as an agricultural input, might cross several international borders multiple times until the final good—for instance, a food product—is purchased by a client abroad. Gross exports do not consider the imports needed to be able to export. As such, gross export does not provide information about the type of activities that a country is undertaking when exporting. Besides, gross exports do not inform about the final destination of a country's value-added exports, although this is a crucial measure to capture when analysing the impact of a tariff reduction when countries export not only final goods but also intermediates, including raw materials.

Production fragmentation multiplies the potential gains from specialisation. However, it also makes it harder to understand the consequences of policy changes for production and trade. The sectoral and bilateral heterogeneity of tariff changes suggests that input suppliers are differentially affected and the sectoral and global interlinkages make it hard to predict ex ante how value-added flows change as a consequence of trade cost changes. Cost and

demand changes spill over across production stages to sectors and countries further up or down the value chain. Moreover, with upstream value added in vertically sliced production processes crossing borders multiple times, the importance of fundamental determinants of trade relationships such as relative productivity differences and natural or political barriers to trade are magnified. We use measures of network integration to shed light on the question of which African countries and agri-food sectors intensified their production linkages.

This paper jointly examines different dimensions of the impact of the AfCFTA on African trade integration; that is, the extent of trade openness (i.e. how much African countries trade among them and with the rest of the world), the diversification of African countries' export basket (i.e. what they export) and the diversification of the country's export destinations (i.e. to whom they export). We focus on the agri-food sector and address the AfCFTA potential contribution to the straightening of regional value chains and thus help insert African economies into global supply networks.

In a world characterised by GVCs, even if a study focuses on the agri-food sector, it is not sufficient to limit the analysis to the trade of agricultural and food products to provide a full picture of the effect of a multi-sector and continent-wide policy change: tariff elimination encourages imports of final goods embarking previously exported domestic agri-food value added, as well as imports of intermediate goods entering into the domestic agri-food production process. Beyond the direct effects of trade liberalisation, the lower cost of primary imports typically decreases the final consumer price of final goods in which they are embodied. Moreover, the lower cost of imported intermediate consumption increases the competitiveness of the country's exports that incorporate these intermediates. In particular, the free trade area will allow exporting the agricultural value added embodied in domestically produced components contained in non-food exports.

In Section 2, we review some recent studies on the potential impact of the AfCFTA. However, we are unaware of any studies that provide a quantitative assessment of the ability of member countries to integrate regional and GVCs due to the AfCFTA with a particular focus on food and agriculture. Such an analysis is made possible by assessing the size of the changes in value-added trade flows and their main sources. It allows shedding light on the potential benefits of the AfCFTA for economic development.

More specifically, we provide a picture of the impact of the AfCFTA on a set of indicators that summarise the engagement of each country in GVC (Section 3). One of the indicators that we calculate is the percentage of domestic value added (DVA; e.g. domestic income) that is contained in the exports of each African country. The other GVC indicators measure the importance of sourcing foreign inputs and exporting either intermediate inputs or final products.

Since the AfCFTA is yet to be fully implemented, an ex-ante analysis is in order. General equilibrium models make it possible to simulate the expected impact of such an agreement. Moreover, the AfCFTA involves the whole economy of many countries. Accordingly, we perform the analysis using a global Computable General Equilibrium (CGE) model. Global CGE models

are based on IO tables that, combined with trade data, make it possible to compute the value-added content of trade, a metric that has been intensively studied in the literature (e.g. Daudin, Rifflart and Schweisguth, 2011; Johnson and Noguera, 2012; Koopman, Wang and Wei, 2014; Wang, Wei and Zhu, 2013; Borin and Mancini, 2017; Johnson, 2017).

Our analysis is based on a model featuring intermediate input trade and international intersectoral linkages, and thus can be interpreted to capture the fact that global production takes place in a series of stages with each stage adding value. We introduce several improvements with respect to the standard version of the Global Trade Analysis Project (GTAP) model (Hertel and Tsigas, 1997). First, we implement a novel decomposition of bilateral gross trade balances as it accounts for the differences between gross and value-added flows that can be quite intricate. Second, we allow the elasticities of substitution to differ depending on whether goods are imported as final goods for consumers or inputs for industries. This extension proves fruitful when studying how different trade policy shocks shape the average positioning (upstream or downstream) of countries in GVCs. Finally, the model provides evidence of two value-adding pathways related to trade and GVC engagement (Greenville, Kawasaki and Jouanjean, 2019). The first is the primary pathway where domestic value is added to the primary (or raw) product, and the engagement in trade and GVCs is direct via the exports of these primary products for either foreign processing or foreign final demand. The second is the processing pathway where domestic value addition and links to trade and GVCs occur through downstream processing sectors of the exporting country.

At the time of writing, the outcome of the AfCFTA negotiation process is still uncertain in terms of sensitive and excluded products. As a consequence, we simulate an AfCFTA scenario that is not meant to be realistic but rather representative of the possible consequences of the integration process. More specifically, we consider the impact of tariff cuts on the structure of production networks involving the African countries as well as on the global degree of production fragmentation. Admittedly, we do not consider very important issues such as institutional change, failing markets or unemployment. Nonetheless, we do believe that our results represent a relevant policy contribution by providing model-based expressions for value-added trade flows and production networks and by providing a quantification of the local and global effects of one of the major instances of trade liberalisation.

To this end, we calibrate the model and perform a counterfactual analysis using the latest release of the GTAP Data Base, including the 26 individual AfCFTA signatory countries and using the highest possible disaggregation for the primary products with 11 agricultural sectors and 7 food sectors (Section 4). Multi-region or world IO tables—that extend domestic tables to incorporate multiple geographic units—are a tool of necessity for economists interested in decomposing the ultimate sources of value added embodied in a good (either a finished good or a semi-finished good-in-process) whose production has traversed multiple country borders (i.e. a GVC). This is precisely the nature of the information provided by global CGE models that make them

a key object of analysis for the 'macro' measurement of GVCs. In what Antràs and Chor (2021) refer to as 'macro' approach, the unit of analysis is a country or a country-industry, and we put the emphasis on understanding the quantitative importance of GVCs both in determining international trade flows and in shaping the implications of trade policy shocks for aggregate and sectoral income. It is worth emphasising that the ultimate goal of this 'macro' approach is to construct more reliable tools for counterfactual analysis than those that ignore the relevance of GVCs in world trade.

Our results indicate that the implementation of the regional free trade area would deepen agri-food value chain integration, especially at the regional level (Section 5). Overall, the AfCFTA would increase the trade connections of Africa with the rest of the world and, at the same time, intensify backward linkages within the continent, as African countries would source more intermediates from within Africa. An important result from our simulations is the increasing importance of AfCFTA countries as intermediate links exporting regional agricultural and food value added, as well as destinations of re-exports, suggesting a reduced dependence on extra-regional final demand due to the continental agreement. If its potential is realised due to the removal of intra-African trade tariffs, the agreement will improve the capacity of African countries to better benefit from the re-organisation of GVCs and strengthen regional value chains facilitating the creation of an African export 'platform'. This may help to counter-balance rising trade cost and mitigate the economic and social impact of the decreasing world demand since it will be partially compensated by new export possibilities across African economies.

While most of the literature emphasises that the expected benefits of the AfCFTA are largely dominated by industrial products and manufactured goods, our results highlight that patterns vary substantially across countries and sectors. Indeed, the potential impact of the AfCFTA goes far beyond the manufacturing sector once we consider the income generated within each sector (value added) rather than simply accounting for gross exports. The benefits of the continental agreement are spread more widely across sectors if we consider that gross exports embed value added originated from several sectors and each sector value added can be exported both directly and indirectly (i.e. embedded in other sectors exports).

This result has many implications in terms of policies in the context of strong demographic pressure in Africa. While African countries register periodic trade deficits in food items, a large share of this food demand could be met by greater intra-regional and intra-African trade. It is expected that the AfCFTA will help remove the remaining trade barriers, leading to greater food security and accelerating the growth of a crucial agri-food sector upon which the livelihoods of the majority of the region's population still depends.

2. Review of the literature

The ability of different countries around the world to integrate into international production networks has become an important policy topic. De Melo

and Twum (2020b) analyse how GVC participation has evolved across the different RECs of Sub-Saharan Africa. Despite its low world trade share, most African countries are deeply involved in GVCs; their participation in agro-food GVCs mirrors that of other countries, such as India and China. Upstream suppliers of primary products have higher forward participation, while downstream sectors have higher backward participation, as more of their output goes straight to the final consumer (Del Prete, Giovannetti and Marvasi, 2018; Balié *et al.*, 2019). The region's major export products—such as palm oil, gold, oil, timber, or cotton for some Western African countries—generally have higher forward participation (selling inputs into GVCs that cross multiple borders) but lower backward participation (buying foreign inputs from GVCs) compared with world averages. Overall, current export patterns are dissimilar enough within the different African regions to suggest there is room to expand intra-regional trade within the continent (Bouët, Odjo and Zaki, 2020). However, export dissimilarity is not a sufficient condition for bilateral trade expansion. Indeed, the large increase in international trade and the disintegration of production chains that the world economy has witnessed over the last 15–20 years have only lightly impacted most sub-Saharan countries (Van Biesebroeck and Mensah, 2019). More generally, Antràs and Chor (2021) argue that, relative to the work on the measurement and modelling of GVCs, our profession's understanding of the policy implications of the rise of GVCs is not sufficiently developed.

Africa is a vast and diverse continent where discussions of trade integration, as a driver of sustained growth and poverty reduction, have been long standing. Africa stands out in at least four areas: heterogeneity in country size, income levels/development and trade openness; diversity of trade regimes and trade policies; patterns of intra-regional trade; and the lack of a major continent-wide trading hub. Apart from South Africa, which operates somewhat as a trading hub for Southern Africa, Africa lacks a systemic global exporter that imports value added from within Africa. During 2000–2017, intra-African trade was dominated by manufactured goods and food. In contrast, exports to the rest of the world were dominated by primary products. These accounted for about 60 per cent of total exports (Abrego *et al.*, 2019).

2.1. African regional integration

Three broad elements characterise the trade regimes on the continent. First, there are preferential trade agreements between individual African countries and countries outside the continent.[4] Second, there are regional trade agreements between African countries and countries outside Africa. This grouping includes the various economic partnership agreements that the EU has negotiated with different countries and regional groupings on the continent, which also call for the partial and gradual opening of African markets to EU imports.

4 These include agreements under the general system of preferences and duty-free treatment for least-developed countries and preferential access to the US market under the African Growth and Opportunity Act.

Due to tariff preferences and historically developed trade relations, the EU is the most important trading partner for the African continent and the main buyer of African agricultural exports. While trade with Africa accounts for only a small proportion of agricultural extra-EU trade (most of it takes place with Asia and other industrialised countries), around one-third of Africa's agricultural exports are destined for the European Union (EU). Third, there is a web of intra-African trade agreements (Abrego *et al.*, 2019).

The call for trade and market integration is well rooted in African history. Since the early 2000s, multiple projects have been designed to accelerate regional integration in agriculture and trade under a variety of forms—from ambitious common agricultural policies or customs unions to more flexible free trade areas or specific trade agreements (Fouilleux and Balié, 2009). The diverse regional groups concerned include the Economic Community of West African States (ECOWAS), the Economic Community of Central African States, the Community of Sahel–Saharan States (CEN–SAD), the Common Market for Eastern and Southern Africa, the East African Community and the West African Economic and Monetary Union (UEMOA) to cite just the main ones.

In this context, Ben Barka (2012) shows that, in 2009, the share of Africa in global trade was just under 3 per cent, compared to close to 6 per cent for Latin America and a significant 28 per cent for Asia. Intra-African trade accounted for less than 10 per cent of total trade, far below the levels of intra-regional trade in Latin America and Asia at 22 per cent and 50 per cent, respectively. Allard *et al*. (2016) estimated that the share of intra-regional trade almost doubled between 1995 and 2013 to reach 3.5% of the region's GDP, although from a very low baseline. During the same period, the Africa region's export-to-GDP ratio rose from 20.5 per cent to 27.5 per cent, while the import-to-GDP ratio reached 23 per cent in 2013 compared to 19 per cent in 1995. These figures suggest a gradual increase in trade openness in Africa. However, trade patterns are extremely heterogeneous across the region, especially between natural resource-rich oil (Angola, Chad, Nigeria, etc.) and non-oil (Botswana, DRC, Niger, South Africa, etc.) exporting countries and the very low-income agriculture-dependent landlocked (Burundi, Ethiopia, Lesotho, Malawi, etc.) and coastal (Benin, Mozambique, Togo, Cote d'Ivoire, Senegal, etc.) countries.

African exports are expanding into emerging and fast-growing countries. African agricultural exports showed an upward trend between 2003 and 2018, as well as a diversification of export destinations, with exports increasing to Brazil, Russia, India, China and other Asian countries, including Saudi Arabia, Vietnam, United Arab Emirates, Turkey, Malaysia and Pakistan. This diversification has resulted in a progressive decrease in the share of the EU as a destination for African exports, from 45 per cent in 2005–2007 to 36 per cent in 2016–2018. However, in current US dollar value terms, EU imports of Africa's agricultural products have experienced a sustained increasing trend, despite the decrease in share, and the EU has remained the primary destination for African agricultural exports. Similarly, exports to the United States and

intra-African destinations have continually grown in value terms, but the corresponding shares (5 and 20 per cent, respectively) have remained unchanged (Bouët, Odjo and Zaki, 2020).

As in other regions, these regional integration processes in Africa are often politically promoted to achieve peace and stability. Still, the initial aim is typically to gain greater political clout and voice in the international arena. In most cases, the real engine for regional cooperation remains the integration of trade and markets. Countless studies are available in the economic, political science or international relations literature on the benefits of regional trade integration and liberalisation within Africa. African markets are still extremely fragmented. Tariff and non-tariff barriers, compounded by substantial transaction costs, still prevent large-scale trade across the continent. While African trade with the rest of the world has increased in the last decades, African trade integration or intra-trade still offers huge untapped opportunities for goods as well as services (Brenton and Isik, 2012; Ben Barka, 2012; Bouët, Cosnard and Laborde, 2017; Hoekman, Senbet and Simbanegavi, 2017).

The African regional integration processes, and the AfCFTA in particular, are mostly seen as vehicles to reap the benefits of economies of scale and access to extremely large markets, to increase competitiveness *vis-a-vis* other mega-regions and to augment Africa's presence and negotiation power on foreign markets (Melo, Panagariya and Rodrik, 1993; Rodrik, 1995). Allard *et al*. (2016) demonstrate that increased trade in sub-Saharan Africa between 1995 and 2013 has significantly impacted growth in GDP per capita (+1.4 per cent). The two main boosting factors were trade openness (+0.6 per cent) and improved terms of trade (+0.2 per cent), accounting for more than half of the registered GDP per capita growth.

In the literature, substantial evidence has been produced on the main technical reasons why continental integration has been so slow. These include inadequate infrastructure, low production capacity, limited capital markets, insufficient human and institutional capacities, policy failures, lengthy and non-transparent customs transactions, administrative hurdles that increase trade costs, etc. (Ben Barka, 2012; United Nations Conference on Trade and Development, 2015; United Nations Economic Commission for Africa, 2018; Allard *et al.*, 2016). The slow progress of trade integration in Africa is also partly explained by the debate about the benefits of global and regional trade liberalisation (Alesina and Rodrik, 1994; Rodrik, 1995; Copeland and Taylor, 2004).

Several scholars argue that general trade openness, trade in agri-food products and foreign direct investments have positive impacts on the key challenges of food insecurity, malnutrition and massive poverty that have characterised Africa for decades (Dithmer and Abdulai, 2017; Kamau, 2010). In recent years, increasing political uncertainties have emerged about the role of trade in economic growth and development amid stagnation in the traditional markets of Europe and North America (Brenton and Isik, 2012). Scholars and policymakers alike have pointed out the unrealised welfare benefits of the waves of trade liberalisation. Most have argued that liberalisation has been unsuccessful

because it was promoted on theoretical grounds, while real-world economics deviate from the assumptions of perfect market competition. This criticism resonated strongly in Africa, where missing institutions and failing markets, together with policy incoherence and poor governance, are more the norm than the exception (Boussard *et al.*, 2006). Moreover, being integrated into the regional and global economy also means that each country of the region is more vulnerable to external shocks (Allard *et al.*, 2016). In several instances, regional trade liberalisation has been portrayed as a cause of higher unemployment, especially in the short term, primarily affecting the poorest and least-educated population groups. Challenging the conventional wisdom on the benefits of trade openness, Mary (2019) finds that increasing food trade openness by 10 per cent would increase the prevalence of hunger by about 6 per cent.

Other authors emphasise that trade patterns are rapidly changing. Increasingly, trade is happening within GVCs and at the intra-firm level, making it more difficult and less accurate to calculate the benefits and costs of trade at the national level (Balié *et al.*, 2019; Allard *et al.*, 2016). Van Biesebroeck and Mensah (2019) provide a systematic overview of the extent to which firms in sub-Saharan Africa engage in GVCs, concluding that the participation of most sub-Saharan economies is low. In the same vein, Pahl *et al.* (2019) track the number of jobs associated with GVC production of goods, assessing the potential for job growth in Africa under participation in GVCs in Ethiopia, Kenya, Senegal and South Africa.

Sufficient levels of capacity, quality, technology and efficiency are needed for developing countries to successfully participate in international production. Sexton *et al.* (2007) emphasise that in analysing the impact of trade liberalisation on developing countries, it is necessary to understand the vertical linkages that characterise food markets in many developed countries. Sub-Saharan Africa is already more represented in agriculture and food GVCs than what is generally assumed, although it is still confined to relatively upstream sectors or characterised by forward integration, with limited capacity to capture a higher share of the value added (Balié *et al.*, 2019).

Bouët, Odjo and Zaki (2020) point out that the limited complementarity or overlap between the commodity composition of African imports and exports suggests limited scope for intra-African trade expansion through trade diversion. In other words, African countries will not be able to sensibly increase intra-continental trade by simply substituting products supplied by other African countries for those currently sourced from their extra-continental partners. Indeed, Africa's world agricultural imports largely and persistently consist of food products, while exports are predominantly unprocessed non-food products.

Despite its comparative advantage in several agricultural products, Africa's share in total exports at the world level is relatively low when compared to other regions with a similar level of development. This can be explained by several factors, including large domestic demand, lack of competitiveness,

high tariffs and numerous non-tariff measures (NTMs) in different destinations. In other research, the blocking factors identified relate to structural and political barriers. Overall, tariff barriers to trade and overlapping memberships tend to confuse regional integration goals (Balié and Fouilleux, 2008) and lead to counterproductive competition between countries and regional economic groupings (World Bank, 2007).

The proliferation of trade agreements in Africa makes the continent a 'spaghetti bowl' of both reciprocal and non-reciprocal trade agreements. Many countries belong simultaneously to several regional groupings, which correspond to different realities and sometimes have different or even contradictory objectives. For example, Burkina Faso, Mali and Niger belong to UEMOA, ECOWAS, CEN–SAD, CILSS[5] and the AU. Besides, because of the superposition or multiplication of regional structures, competition can arise between organisations. Despite the proliferation of reciprocal and non-reciprocal trade agreements, Africa's share in world export is very small and stagnating. Moreover, only a few resources (including oil, ores, base metals and gold) account for three-quarters of the continent's total exports. All these factors have prevented African countries from capitalising on the returns that higher levels of regional trade could generate. This deceptive scenario has pushed trade advocates to call for renewed efforts to ensure policy harmonisation and accelerate trade integration by reducing tariff and non-tariff barriers, such as border formalities, tackle corruption and address the problems of currency transfers (Geda and Seid, 2015; Hallam, 2009; World Bank, 2007).

2.2. AfCFTA

AfCFTA is the culmination of an ambitious project announced in the 1980 Lagos Plan of Action to enhance Africa's economic self-reliance and reduce its dependence on trade and aid from overseas. The AU (https://au.int/en) sets out a strategy to utilise regional integration experiences as an interim step in creating an African Economic Community by 2028 (Jaldi, 2021).

The objectives of the AfCFTA are consistent with these ambitions and aim to: (i) eliminate tariffs and non-tariff barriers to trade in goods progressively; (ii) liberalise trade in services progressively; (iii) cooperate on investment, intellectual property rights and competition policy; (iv) cooperate on all trade-related areas; (v) cooperate on customs matters and the implementation of trade facilitation measures; (vi) establish a mechanism for the settlement of disputes concerning members' rights and obligations and (vii) establish and maintain an institutional framework for the implementation and administration of the AfCFTA. Phase 1 of the negotiations focused on trade in goods, trade in services and dispute settlement. The Protocol on Trade in Goods aims to boost intra-African trade in goods through progressive elimination of tariffs and non-tariff barriers, enhanced efficiency of customs procedures, trade facilitation and transit. More specifically, member states have undertaken to

5 CILSS: Inter-State Standing Committee for Combating Drought in the Sahel.

liberalise 90 per cent of tariff lines on goods within 5–15 years through successive rounds of trade negotiations. The remaining 10 per cent of tariff lines comprise sensitive products for which member states are afforded more time to liberalise, as well as products that are completely exempt from liberalisation. The first step to operationalise the AfCFTA will be to finalise tariff concessions in goods, rules of origin (RoO) and schedules of specific commitments for trade in services. Phase 2 negotiations focus on the protocols on competition; intellectual property rights and investment are still expected to be concluded by December 2021.

As such, the AfCFTA is undoubtedly the most ambitious attempt to structurally transform the trade patterns of the region in decades. Thirty-one member states deposited their instruments of ratification of the AfCFTA agreement to the AU, exceeding the threshold for the agreement to come into effect. Because of the COVID-19 pandemic, the AfCFTA became operational on 1 January 2021, instead of the originally scheduled date of 1 July 2020 (https://au.int/en/cfta).

While there are several sub-regional integration agreements in Africa, the impact of the AfCFTA is likely to stem from two main features. First, in the policy areas that are already covered by sub-regional agreements, the AfCFTA will provide a non-discriminatory reduction in tariffs and a common regulatory framework, thereby reducing fragmentation of the continental market. Second, sub-regional agreements in Africa tend to be relatively shallow covering few of the NTMs that affect trade integration.

Given comprehensive characteristics of a continental market aggregation, a majority of the studies employ CGE models as they account for the most significant interactions among all sectors through domestic, regional and global linkages. Jensen and Sandrey (2015) was a pioneering study on the economic effects of trade liberalisation in Africa with an emphasis on food and agriculture. Using the GTAP model, under a complete intra-African tariff elimination, African countries seem to have positive welfare gains except for Zimbabwe (−US$1,486 million), which would face a huge welfare decrease mostly due to a decline in the terms of trade. All results are referred to the year 2025. Mureverwi (2016) also used the GTAP model to simulate the welfare effect of the AfCFTA. His analysis is based on 31 sectors and 21 countries or regions and assumes a complete liberalisation of all tariffs; it confirms the results of Jensen and Sandrey. Saygili, Peters and Knebel (2018) propose the last available study assessing the impact of a continental FTA in Africa using the GTAP model. They indicate that gains remain unevenly distributed among participating countries, while intra-African trade is expected to increase by 33 per cent with full tariff removal and by 24 per cent with some tariff exemptions. Also using the GTAP model, the United Nations Conference on Trade and Development (UNCTAD, 2018) has estimated the quantitative effects of the AfCFTA according to two long-term scenarios: a full Free Trade Agreement (FTA) and a Special Product Categorization (SPC). Under the full FTA, intra-African trade would be expected to grow at 33 per cent and the continent's trade deficit would drop by 50.9 per cent. Under the SPC scenario, products with the

highest current tariff revenue would be exempted from liberalisation. In this case, intra-African trade would only grow by 24 per cent, while Africa's trade deficit would only shrink by 3.8 per cent. The distribution of these changes varies by sector.

Other studies use dynamic models. In particular, Mevel and Karingi (2013); Depetris Chauvin, Ramos and Porto (2017) and UNECA (2018) use the MIRAGE-e CGE model to assess the effects of the continental trade liberalisation with a focus on agricultural and food sectors. Mevel and Karingi present results for 16 African countries and 12 agricultural and food products, sugar and dairy products being the most affected. Depetris Chauvin *et al*. report an asymmetric increase of trade across African countries and also provide a comprehensive analysis of the likely effects on welfare computed at the household level. The report of the UNECA has estimated that the agreement will boost intra-African trade by 52 per cent by 2022 compared to trade levels of 2010. The share of intra-African trade, estimated at 13 per cent of Africa's exports in 2019, is expected to double by the start of the next decade. In the same vein, World Bank (2020) assesses the economic and distributional effects of the agreement by using a global CGE model (ENVISAGE) and a microsimulation model (GIDD) finding that the agreement would increase income in African countries by $450 billion (7 per cent) by the year 2035: the effects in individual countries range from 2 per cent in Malawi to 14 per cent in Côte d'Ivoire.

Some studies also use a CGE framework to quantify how the establishment of the AfCFTA can counterbalance negative impacts for Africa of external initiatives or trade development such as the potential establishments of 'mega' FTAs (Guimbard and Le Goff, 2014) or the collateral effects on Africa of a trade war between China and the United States (Bouët, Traoré and Laborde, 2019), while Abrego *et al*. (2019) use a 'new quantitative trade model' to estimate the welfare effects of the AfCFTA for 45 countries in Africa. As intra-regional import tariffs in the continent are already low, the bulk of the gains come from lowering non-tariff barriers, with considerable variation of potential welfare gains across countries in all model structures.

More recently, a series of studies use another dynamic CGE model, MAGNET (Modular Applied GeNeral Equilibrium Tool), to assess the AfCFTA impact. Simola *et al*. (2021) show that further integration of intra-African markets is likely to have largely beneficial effects not only on economic growth but also on the food security of the African people. Levin-Koopman, Carrico and Falsetti (2021) explore the changing demands of the agricultural system on the natural environment resulting from the liberalised inter-regional trade assessing the impact on the land and water systems, as well as the greenhouse gas emissions resulting from agricultural activity. Finally,

Carrico, Cui and Tabeau (2021) focus on the fruit and vegetables sector implementing an extension of the MAGNET model, which has theoretical adaptions to model trade flows at the disaggregate Harmonized System (HS) level.

We add to this literature by relying on information at the most detailed level on multiregional IO tables and by encapsulating this information in a General Equilibrium framework featuring GVCs. Beyond traditional gross trade impacts, we analyse to what extent trade liberalisation has contributed to global and regional production fragmentation and the formation of production networks. To that end, we implement a revised version of a multi-sector, multi-country, general equilibrium trade model. The model-based measures of production at the bilateral and sectoral levels provide an assessment of the effects of changes in trade costs on the degree of production fragmentation, the structure of the GVC and the intensity of production networks.

3. Trade in value added decomposition

The methodology adopted to conduct the quantitative evaluation of the impacts of the AfCFTA is based on a counterfactual approach using a perfectly competitive CGE model built on general equilibrium theory and designed to assess the inter-regional, economy-wide incidence of economic policies. The main advantages of the CGE approach are its solid micro-theoretical underpinning and its economy-wide scope, as well as its complete and consistent coverage of all bilateral trade flows. Our simulation is comparatively static with a short-run closure: fixed (exogenous) factor endowments (labour and capital), while wage rates and rates of return are endogenous (Antimiani, Fusacchia and Salvatici, 2018).

The utility function is nested, with a first aggregation made over distinct goods or sectors, and, in the second, a choice is made between domestic and imported quantities. As for the production side, separable, constant returns-to-scale technologies are assumed to model the production side through a sequence of nested Constant Elasticity of Substitution (CES) functions that aim to reproduce the substitution possibilities across the full set of inputs. The firms' conditional demand for components of value added depends on the relative prices of factors of production, whereas composite value added and intermediates are used in fixed proportions (a fixed coefficient function of the Leontief type). On the intermediate input side, imported intermediates are assumed to be separable from domestically produced intermediate inputs.

The import demand is modelled following the Armington aggregation structure, with an exogenous differentiation scheme given by the geographical origin of nationally homogeneous products. That is, under Armington trade, the output of each sector is assumed to be a region-specific variety. Indeed, since each GTAP product from different origins does include different (HS6) products with different weights, the composition of the underlying products within each GTAP aggregate commodity can vary significantly according to the origin. Consumer and intermediate goods are CES composites of domestic and trade partner varieties.

With respect to the standard GTAP model, GTAP-VA ('Value Added') provides complete and consistent coverage of all bilateral trade flows in both gross and value-added metrics. It is designed to assess the inter-regional,

economy-wide incidence of economic policies, including the configuration of global networks. Because it incorporates the deconstruction of the sources of value added, this framework allows assessing the effects of the regional agreement on the global structure of value chains, taking into account the interdependence between sectors, allowing relative prices to adjust and factors to be reallocated across sectors, as well as admitting substitution effects in production and consumption both within and across countries (Walmsley, Hertel and Hummels, 2014; Ferrarini and Hummels, 2014).

The international value chain aspect of international trade is included in the extended model via a modification of the Armington specification as follows. In the standard GTAP model, the sourcing of imported goods is placed at the border of an economy. In other words, producers and consumers choose between the domestic and the foreign origin of products without consideration for the country providing the foreign (final or intermediate) goods. To be consistent with and take full advantage of the refinements of GVC data (see Section 4), we adopt this assumption and introduce differentiation in the demand for imports at the agent level. This implies that firms form their sourcing decision for intermediate inputs along with deciding how much to import of a particular good, allowing to establish tighter linkages between sectors located in different economies (see also Koopman *et al.*, 2013; Walmsley, Hertel and Hummels, 2014; Aguiar *et al.*, 2016). Accordingly, we compute Armington elasticities of substitution of imports at the agent level. Starting from the ProTEE (PROduct level Trade Estimated Elasticity) dataset by the CEPII (Fontagné, Guimbard and Orefice, 2020), which provides trade elasticities at the 6-digit of the HS product level, we use the Broad Economic Categories (BEC) attribution to allocate them into two sets: one for intermediate products and one for final goods. Each set of elasticities has been consequently aggregated at the GTAP sector level using a CES weighting scheme.[6] Next, the ratio between the two elasticities at the sector level has been applied to the original value in GTAP to compute new parameters for elasticities of substitution among imported intermediates while keeping those for final goods at the original GTAP level.[7] Based on this framework, the gross trade flows are deconstructed to reallocate the value added generated in the production of goods back to the countries in which that income is generated.[8] This information makes it possible to deconstruct export values at the sector level into the DVA generated in their production—both directly (from the producing/exporting sector) and indirectly (embedded in other domestic sectors' exports or other countries' exports)—and the foreign value added (FVA) generated in other countries producing the imported inputs used in exports.

6 The weighted values are obtained as: $P(p) = (\sum_j p_j^{1-\sigma})^{\frac{1}{1-\sigma}}$, where p_j are elasticities at the HS6 level, and σ are original parameters in the GTAP model.

7 The new estimated elasticities are reported in Table A1 in Appendix A. A sensitivity analysis is also provided in Appendix A (Figure A1).

8 The value added is defined as the difference between the value of output and the total value of purchased intermediate inputs and includes compensation for labour, capital and taxes.

Specifically, the main indicators related to the value added to an exported good or service used in this analysis[9] are the following:

i) Bilateral DVA

This corresponds to the value added originating in domestic sectors and embedded in all exports of the exporting country. The DVA gives a measure of the real contribution a given export makes to an economy's income.

The aggregate DVA component can be split into direct and indirect value added by distinguishing between: (i) the value originating in the domestic exporting sector (direct); and (ii) the value that originated in other domestic sectors providing intermediate inputs to the domestic exporting sector (indirect)

ii) Multilateral DVA

This is defined as the DVA contained in intermediate goods and services exported to a partner country, which then re-exports it to the final market, embedded in other goods or services. It is also referred to as a 'triangular' production chain (Johnson and Noguera, 2012) and provides a measure of the forward linkages a country has in selling in GVCs.

At the sector level, we distinguish between the value added originated within a given domestic sector, which is exported by all other sectors of the economy and then re-exported by the importing country (sector of origin) and the DVA exported through the sector under consideration to the re-exporting country (sector of export).

Both the bilateral and multilateral DVA and indicators are adjusted for double-counting, meaning that the DVA, which is embedded in an export that has previously crossed the international border, and hence has already been counted as DVA, is netted out (Antimiani, Fusacchia and Salvatici, 2018).

iii) FVA

This is the value of imported intermediate inputs embedded in a country's exports and represents the import content of exports. It is sometimes referred to as the backward linkage in global production networks.

These indicators above allow us to measure value chain participation and integration at the regional and global levels. Specifically, we assume that the level of integration in international value chains depends on the import content of exports (FVA on gross exports) and on the domestic production, which is used by the receiving country to produce its exports. These metrics were first introduced by Hummels, Ishii and Yi (2001) and have been subsequently extended and redefined in an active strand of literature focused on the correct measurement of production and trade flows in terms of value added (e.g. Daudin, Rifflart and Schweisguth, 2011; Johnson and Noguera, 2012; Koopman, Wang and Wei, 2014; Wang, Wei and Zhu, 2013; Borin and Mancini, 2017; Antimiani, Fusacchia and Salvatici, 2018).

9 The formal derivation is provided in Appendix B.

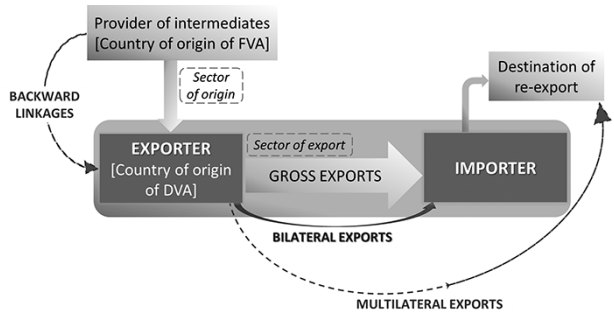

Fig. 1. Standard and GVC-related trade.

iv) Backward participation index

It measures the share of FVA in a country's (or sector's) exports. The aggregate index is composed of the 'intra-regional backward integration', measuring the regional import content of exports from a member of the region, and the 'extra-regional backward integration', including the value of FVA from non-regional providers.

v) Forward participation index

It provides the share of a country's exports that are re-exported to other markets by regional partners (intra-regional) or non-regional partners (extra-regional).

Figure 1 gives a graphical representation of standard gross trade and GVC-related linkages. Standard trade involves an exporter and an importer and assumes that the entire production process occurs in the exporting country, which ships the final good to the importing country, which finally consumes it. GVC-related trade describes goods and services that cross more than one border, involving at least two production stages located in different countries before the final product reaches the destination market (Borin and Mancini, 2017). Thus, it implies a third country (country of origin of the FVA), providing intermediate inputs to the exporter that is backwardly linked to the international value chain. Moreover, the importer may not consume the imported good or service but perform a further processing phase before re-exporting it to the destination country.

George Box said 'All models are wrong', then added 'but some are useful'. The model we use here is in many respects a standard CGE model. It focuses on trade flows, including the value added embodied in them, and estimates the effects of trade policy shocks by sector and region consistently taking into account the full set of markets from factors of production through to international trade and final purchase by consumers or users.

Several extensions have been proposed to CGE models to take into account market imperfections, but we do not implement them in this exercise. This is not because they are implausible but because to explore the trade effects of the

AfCFTA we have chosen, rather conservatively, a model structure that is well understood and for which there is a robust basis for its parameterisation. Thus, we did not incorporate institutional and structural details because it would have added to the complexity and may have led to problems in identifying the main causal mechanisms at work.[10] We intend to provide results that are useful for policy analysis and decisions. In doing that, we were guided by the modellers' version of Occam's Razor: use the simplest model adequate to the task at hand (Devarajan and Robinson, 2002).

4. The GTAP Data Base and the global Inter-Country Input–Output data

Measuring the GVC-related linkages presented in the previous section requires a huge amount of data, gathering national accounts and bilateral trade data on goods and services into a consistent statistical framework to trace transactions in final and intermediate goods both within and between countries. The current standard for GVC analysis relies on a global Inter-Country Input–Output (ICIO) table, which harmonises national IO tables for multiple regions and links trade flows directly from producers in each region to importing firms and consumers in all other regions. Various research initiatives have undertaken the development of different versions of an ICIO table. Among the most well known are the World Input Output Database, Trade in Value Added and the GTAP Data Base.

In this study, data are drawn from Version 10 of the GTAP Data Base for a baseline of consistent data on consumption, production and trade (Aguiar *et al.*, 2019). The GTAP Data Base is a fully documented global database that provides comprehensive and balanced data on production, bilateral trade, transport and trade policies, covering 121 countries (representing 98 per cent of world GDP and 92 per cent of the world population) and 20 aggregate regions for 65 commodities. It has been extensively used to perform CGE economic analysis, mainly due to its consistency, full global coverage and the large country and sectoral details it provides. The advantage of using the GTAP Data Base for trade in value added analyses is that it reconciles data from different sources and puts them into one consistent database with a broad sectoral and regional coverage. However, the database itself does not account for how imported intermediate products are used. Within the GTAP framework, imports of intermediates from all countries are aggregated at the product level at the border into a composite imported good. This composite good is then allocated across sectors and uses based on relative demands and shares. Using this approach, we cannot trace exports of intermediates from one country into the production processes of another, and following on from that, into their contributions to other countries' exports. In other terms, we cannot directly identify the industry-to-industry trade required to implement the above GVC indicators.

10 It is the 'black box syndrome' that critics argue is a common problem with simulation models.

Different methods exist by which supplementary information is used to distinguish between countries of origin on an industry-use basis. A commonly used approach is to apply proportionality, for example, using the shares of imports used by firms on the total imports of a country and applying them to bilateral trade (e.g. Daudin, Rifflart and Schweisguth, 2011; Johnson and Noguera, 2012; Lejour, Rojas-Romagosa and Veenendaal, 2014; Greenville, Kawasaki and Beaujeu, 2017). The key problem with this method is that it ignores differences in the types and quality of imports from different regions. For a given product, some country exports may target final demand, while others may target intermediate demand.

To provide a concrete example, the proportionality assumption imposes that when buying finished products in the food industry (e.g. vegetable oils), African consumers spend their income across foreign sources of these finished goods in the same proportion in which African food producers buy agricultural inputs across foreign suppliers. Since there are good reasons to believe (see Antràs and Chor, 2021) that trade shares do vary significantly in the real world depending on what and where the input is used for, we relax this feature of the proportionality assumption and we rely on an end-use classification such as BEC to attribute bilateral trade at the agent level (i.e. firms and final consumers). This allows us to take into account differences in the types of imports from different regions (e.g. for a given product, some countries' exports may target final demand, while others may target intermediate demand). Specifically, we start with UN COMTRADE import data at the six-digit level of the Harmonized Commodity and Coding System (HS) and apply the first concordance between HS and the BEC Rev.5. Each economic category is completely decomposable by end use. Accordingly, the mapping between BEC and the System of National Accounts end-use dimension makes it possible to identify three different end-use classes, namely intermediate consumption, gross fixed capital formation and final consumption.[11] Consequently, we apply the HS-GTAP concordance to map each HS line to a GTAP commodity, deriving country-specific trade values at the GTAP level for the three end-use categories. Finally, we apply the BEC-informed shares for the different usages to the GTAP original coefficient for bilateral trade, thus assuring consistency in the entire database. Aguiar *et al*. (2016); Walmsley, Hertel and Hummels (2014); Bellora and Fontagné (2019) and Carrico, Corong and van der Mensbrugghe (2020) applied a similar procedure.[12]

We sourced the protection data in the GTAP Data Base from the Market Access Maps (MAcMap) at the six-digit level of the HS and then aggregated using trade weighted averages (Guimbard *et al.*, 2012). MAcMap accounts for

11 Correspondence tables are retrieved from: https://unstats.un.org/unsd/classifications/econ/.

12 While it is clearly a useful step in the right direction, we note that a common set of weights continues to be applied to imports of inputs across all purchasing industries in each country. In other words, the source-country shares of agricultural inputs imported by say the 'Processed rice' industry would be identical to that imported by the 'Sugar' industry. Moreover, the same technology is used regardless of the destination country to which that output is being sold.

bilateral applied tariffs, ad valorem equivalents for products with specific and mixed duty rates, anti-dumping charges and agricultural tariff rate quotas, but it does not include any information on NTMs. We note that the database provides the tariffs aggregated along the value chain distinguishing imports of commodities purchased by sectors (intermediate), households (final), government and investment (final),

We aggregate the GTAP Data Base in 26 individual AfCFTA signatory countries and one composite region. Due to the focus on intra-regional trade, we split the rest of the world into seven countries/regions, identified in terms of their relevance in trade relationships with AfCFTA countries. The EU is by far Africa's largest export market for agriculture and food products (30 per cent of Africa's exports), followed by Africa itself (22 per cent), South and Southeast Asia (14 per cent), China (8 per cent) and North America (6 per cent). About one quarter of foreign inputs used by AfCFTA's firms exporting agricultural and food products are sourced from the EU and 30 per cent of the forwarded AfCFTA's DVA is re-exported by the European region. The EU is also the most relevant market absorbing about 20 per cent of the DVA originated in AfCFTA countries' agricultural and food sectors and processed by other regions (e.g. multilateral DVA). Other relevant markets for AfCFTA agricultural and food multilateral DVA are North America (17 per cent), South and Southeast Asia (16 per cent) and China (11 per cent). Our sectoral aggregation consists of 29 sectors: 11 agricultural sectors, 7 food sectors, 1 extractive sector, 9 manufacturing sectors and services (see Table 1).

The simulated AfCFTA scenario is based on the dismantlement of all intra-African tariffs on goods. This is more optimistic than the 90 per cent mentioned in the agreement's modalities. We do not consider the non-tariff barrier reduction and trading cost reduction due to trade facilitation measures.

Relatively high tariffs are a legacy of Africa's (including North Africa and Sub-Saharan Africa) pursuit of an inward-looking industrialisation strategy behind high trade barriers. This strategy was ultimately abandoned, but Africa still lags in the reduction of tariff protection relative to other regions, notably for intermediate inputs. The average tariff on intermediates across African countries is still around 10 per cent and has fallen slowly over the last 15 years (De Melo and Twum, 2020b).

However, lower tariffs implemented after the creation of the regional trade agreements increased significantly trade flows within sub-regions in the continent—although the effects were uneven across agreements (Calderon, Cantù and Zeufack, 2020). Accordingly, the tariffs reported above are imposed by countries from different agreements.

5. Simulation results

This section discusses the outcomes of full import-tariff elimination among the AfCFTA countries and regions of our aggregation (see Section 4). We focus on trade patterns and consider both gross and value-added trade flows.[13] This

13 The most traditional results of the simulation (e.g. welfare and production for domestic market) are available upon request.

Table 1. GTAP data base aggregation

Country/region[a]	Sector
AfCFTA	Agriculture
Benin (BEN)	Paddy rice
Botswana (BWA)	Wheat
Burkina Faso (BFA)	Other grains
Cameroon (CMR)	Vegetables and fruit
Cote d'Ivoire (CIV)	Oil seeds
Egypt (EGY)	Sugar cane and beet
Ethiopia (ETH)	Plant fibres
Ghana (GHA)	Other crops
Guinea (GIN)	Cattle
Kenya (KEN)	Other animal products
Madagascar (MDG)	Wool
Malawi (MWI)	Forestry and fishing
Mauritius (MUS)	Food
Morocco (MAR)	Meat
Mozambique (MOZ)	Vegetable oils
Namibia (NAM)	Dairy products
Nigeria (NGA)	Processed rice
Rwanda (RWA)	Sugar
Senegal (SEN)	Food products nec
South Africa (ZAF)	Beverages and tobacco products
Tanzania (TZA)	Other goods
Togo (TGO)	Extraction and petroleum
Tunisia (TUN)	Textiles
Uganda (UGA)	Wood and paper products
Zambia (ZMB)	Chemical rubber products
Zimbabwe (ZWE)	Metals and non-metallic minerals
Rest of AfCFTA	Pharmaceutical products
European Union (EU27)	Motor vehicles and transportation
China	Electronic equipment
South and Southeast Asia (S-SE Asia)	Other machinery and equipment
North America (N America)	Other manufacturing
Latin America (L America)	Services
Rest of the World (RoW)	

[a]Rest of AfCFTA: Rest of North Africa, Rest of Western Africa, Central Africa, South Central Africa, Rest of Eastern Africa and Rest of South African Customs. European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden. South and Southeast Asia: Hong Kong, Japan, Korea, Mongolia, Taiwan, Rest of East Asia, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of Southeast Asia, Bangladesh, India, Nepal, Pakistan, Sri Lanka and Rest of South Asia. North America: Canada, United States of America and Rest of North America. Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago and Caribbean.

allows us, on the one hand, to analyse the impact of the AfCFTA on the contribution of exports to countries' GDP at the sector level and, on the other hand, to assess whether the continental agreement represents a push toward

the integration of sub-Saharan African countries in regional value chains and GVCs. We then analyse the impact on intra-regional and extra-regional trade integration for agricultural and food products, considering both backward and forward linkages in international networks.

5.1. Gross and value-added exports

The elimination of tariff barriers within the African continent would lead to an increase of 3.7 per cent (US$2,412 million) in AfCFTA gross agri-food exports (Table 2). In contrast with other studies (World Bank, 2020), such an increase is larger than the overall export change, and this suggests that non-tariff barriers and trade facilitation measures will mostly affect the manufacturing sectors. It is also worth mentioning that third countries and, in particular, the EU, would register marginal changes in their agri-food exports.

Even if the overall level of export growth is not changing dramatically, some countries experience a significant expansion of trade, while a few countries, such as Togo, Guinea and Côte d'Ivoire, would 'de-specialize' in agricultural and food exports. Tanzania and Zambia are at the high end with increases of over 10 per cent, followed by Nigeria, South Africa and Morocco at above 5 per cent (column [1]).

The DVA embedded in AfCFTA's agricultural and food exports (i.e. gross exports less the value of foreign inputs and net of double counting) grows overall relatively less than gross exports (3.4 per cent corresponding to +US$1,784 million, column [2]). This result indicates that the implementation of the regional free trade area will deepen value chain integration: the decreased costs of regional trade will cause most of the exporters to use more imported intermediate goods and less DVA. Two different effects may explain this trend. On the one side, there may be a change in the intermediate import intensity within sectors—that is, a given product may increase its dependence on foreign inputs while reducing the demand for domestic inputs. On the other side, the reduction of tariffs implies a redistribution of factors of production among products. Products whose exports are expanding due to a decrease in trade costs can be those embedding relatively more foreign inputs. This composition effect seems to explain our findings. As we will discuss later, the agreement would boost exports from AfCFTA countries in sectors relatively more dependent on foreign intermediates (e.g. food rather than agriculture). There are exceptions to this pattern with countries such as Namibia, Malawi and Mozambique, for which the proportionate increase in the DVA embedded in agricultural and food exported products is larger than that in gross exports.

Finally, column [3] in Table 2 records the DVA (remuneration of primary factors of production) originated in agricultural and food sectors, which are embedded in exports from all other sectors of the economy (i.e. indirect exports). Forgetting about the agri-food value added indirectly exported implies underestimating the benefits for the factors of production used in the primary sectors for every country except Togo, Guinea and Côte d'Ivoire. Indeed, for countries such as Nigeria, Namibia and Malawi, the growth in

Table 2. AfCFTA scenario: gross and value-added exports in agricultural and food products (% change)

		DVA	
	Gross exports [1]	Exporting sector [2]	Origin sector [3]
Tanzania	13.2	10.0	9.0
Zambia	11.4	11.0	9.7
Nigeria	9.9	9.9	14.9
South Africa	7.5	7.6	7.1
Morocco	6.6	6.3	4.6
Tunisia	4.7	3.7	2.1
Rest of AfCFTA	4.7	4.3	3.0
Ghana	4.1	4.1	3.7
Rwanda	3.1	2.5	1.0
Egypt	2.9	2.1	1.5
Mozambique	2.8	3.3	2.8
Zimbabwe	2.4	2.5	2.6
Namibia	2.1	2.8	3.8
Cameroon	1.8	1.7	2.0
Senegal	1.7	1.3	0.0
Malawi	1.4	2.0	2.5
Botswana	1.4	1.7	0.9
Benin	1.1	1.1	1.3
Uganda	0.6	0.5	0.1
Burkina Faso	0.5	0.3	0.6
Madagascar	0.5	0.4	0.4
Kenya	0.2	0.2	0.6
Ethiopia	0.0	−0.1	0.0
Mauritius	−0.1	−0.2	0.0
Côte d'Ivoire	−3.3	−3.7	−4.4
Guinea	−12.5	−12.2	−11.2
Togo	−13.6	−13.1	−12.4
Tot. AfCFTA	3.7	3.4	2.8
EU27	−0.2	−0.9	−1.1
China	0.0	0.0	0.0
Rest of Asia	−0.2	0.1	0.3
North America	0.0	−0.2	−0.2
Latin America	0.0	−0.3	−0.3
Rest of the World	−0.1	−0.1	−0.2
WORLD	0.2	−0.1	−0.1

Source: simulation using the GTAP-VA model.

the intermediate inputs sold to other exporting sectors is even larger than the agri-food exports growth itself.

The increase in exports from AfCFTA countries is driven by intra-agreement exports, while extra-regional exports would decrease, especially with some traditional trade partners such as the EU and Asian countries.

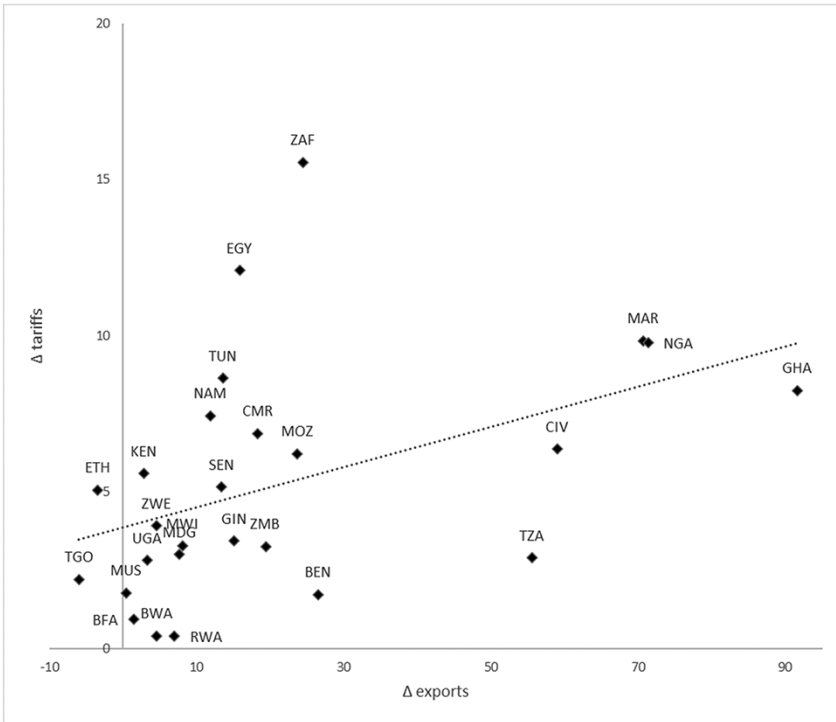

Fig. 2. Correlation between the level of tariff reduction and percentage change in intra-agreement DVA exports for agriculture and food.
Note: tariff reductions are equal to the rates in the baseline. For each country, we compute the weighted average of the tariff rates faced in the other AfCFTA countries.
Source: simulation using the GTAP-VA model.

The establishment of the AfCFTA area would increase intra-agreement exchanges of agricultural and food products by 24.6 per cent, corresponding to +US$3,555 million. Netting out the value of foreign production embedded in exports, we find that the growth in the income of AfCFTA countries generated by agricultural and food intra-regional exports amounts to US$2 778 million (aggregate DVA).

There is a wide variation in the impact of the tariff reduction at the country level (Figure 2). The heterogeneity in countries' responses is related to the degree of reduction in tariffs due to current disparities in duties across African countries. We find the biggest trade gains for Ghana where intra-agreement DVA exports would increase by 91.7 per cent and 71 per cent for Morocco and Nigeria. For these countries, intra-agreement exports are characterised by a high sectoral concentration and the DVA increase is mostly explained by a few sectors exporting to a few trade partners.[14] Côte d'Ivoire

14 For Ghana, vegetable oils and fats exported to Nigeria and other AfCFTA countries (+161 per cent and +126 per cent, respectively) and mainly cocoa exported to Nigeria (+79.2 per cent) account for half of the total increase in DVA. As for Morocco, other foods are exported to the

and Tanzania would also significatively increase their DVA exports by 59 per cent and 56 per cent, respectively. If we compare these results with those presented in Table 2, it appears that these increases take place at the expense of extra-agreement exports. This suggests that relatively higher regional duties presently divert agri-food exports towards third markets. Indeed, the RECs have helped to establish preferential tariff agreements, free trade zones or customs unions among some neighbouring member states but tariffs are notably higher for extra-regional imports (Bouët, Odjo and Zaki, 2020). At the other extreme, countries facing positive tariffs in the baseline, but set at sufficiently low levels not to discourage trade, are not impacted by the liberalisation in their exports. This is the case of Botswana and Rwanda, for example, which seem unable to increase their access to the regional markets as a consequence of the increased competition from other exporters benefitting from larger tariff reductions.

5.2. Sector analysis of direct and indirect DVA export

In general, we observe an increase in exports for the relatively more downstream sectors (e.g. food and manufacturing), while the opposite is true for agriculture and services. However, each sector-exported DVA includes some domestic value originated in upstream sectors, as well as some FVA (e.g. the value of imported intermediate inputs used by the exporting sector). In the same vein, each sector provides input downstream to other exporting sectors: this is DVA originated in one sector and indirectly exported through other sectors.

In Table 3, we look at how the change of gross exports is explained by different value-added sources: foreign and domestic originated in the exporting sector itself or upstream. The gross change could be misleading from two points of view. On the one hand, it may overstate the benefits for the sector income since most of the increase could accrue to foreign or other sectors' factors of production. On the other hand, indirect exports could increase or reduce direct changes and even change the overall sign of the AfCFTA impact.

The AfCFTA would increase member countries' food exports by +US$2,511 million (column [1]). However, this growth is only partially due to an increase in food value added for exports, accounting for +US$833 million (column [4]). The rest is explained by the value of foreign (+US$598 million, column [2]) and other sectors' (+US$1,186 million, column [5]) intermediate inputs. This means that most of the value added embedded in food exports is sourced from other domestic sectors. Within the food sector, the products that would be most impacted would be vegetable oils and fats, a sector facing high tariff levels in African markets (see Figure A2 in Appendix C) and explaining more than one-third of the export growth in food with an increase in gross exports of +US$817 million (+36.2 per cent) and +US$309 million (+66.3 per cent) in export income (column [7]).

Rest of AfCFTA (+71 per cent), while Nigeria would mostly increase its VA exports in other food and dairy products to Ghana (+183 per cent and 84 per cent, respectively).

Table 3. AfCFTA scenario: change in exports from AfCFTA countries, gross and value added (absolute values, US$ million)

			DVA by exporting sector				
	Gross exports [1]	FVA[a] [2]	Total [3] = [4] + [5]	Own sector [4]	Other sectors [5]	Indirect exports of DVA [6]	DVA by origin sector [7] = [4] + [6]
Agriculture	−249	−31	−218	−170	−48	436	266
Paddy rice	−1	0	−1	−1	0	1	0
Wheat	−3	0	−3	−2	−2	35	33
Cereal grains nec	4	1	3	4	−1	38	42
Vegetables, fruit and nuts	2	18	−17	−40	23	66	26
Oil seeds	−34	−8	−26	−18	−8	99	81
Sugar cane and sugar beet	0	0	0	0	0	66	66
Plant-based fibres	−107	−25	−82	−53	−29	58	5
Crops nec	−108	−14	−95	−68	−27	54	−14
Bovine cattle, sheep and goats and horses	12	1	10	8	2	14	23
Animal products nec	5	0	5	3	1	7	10
Wool and silk-worm cocoons	−18	−6	−12	−3	−9	−2	−5
Forestry and fishing	−19	−7	−12	−7	−5	74	66

(continued)

Table 3. (Continued)

			DVA by exporting sector				
	Gross exports [1]	FVA[a] [2]	Total [3] = [4] + [5]	Own sector [4]	Other sectors [5]	Indirect exports of DVA [6]	DVA by origin sector [7] = [4] + [6]
Food	2,511	598	1,913	833	1,080	78	911
Meat products	53	9	44	7	38	20	26
Vegetable oils and fats	817	231	586	308	277	1	309
Dairy products and raw milk	175	19	156	98	59	23	121
Processed rice	−4	2	−6	0	−6	1	1
Sugar	240	64	176	46	130	12	59
Food products nec	693	181	513	176	336	18	195
Beverages and tobacco products	536	93	444	197	246	3	200
Other manufacturing goods	6,565	2,396	4,169	2,074	2,094	221	2,296
Services	−1,224	−222	−1,002	−858	−144	2,180	1,322
Total	7,585	2,735	4,850	1,873	2,977	2,988	4,861

[a]Includes double-counted value added of US$54 million in total.
Source: simulation using the GTAP-VA model.

Indeed, the largest supplier to the food sector is agriculture, and this radically changes the impact assessment of the agreement for agriculture. In gross terms, we register a reduction of US$249 million, mostly explained by the DVA component (−US$218 million, column [3]). However, taking into account the DVA indirect exports—that is, the income produced in the domestic agriculture sector but exported via other sectors (column [6])—the net impact is positive (+US$266 million). The largest contribution is from the growth in indirect exports of domestic value in the oilseeds sector (+US$99 million).

In absolute terms, the AfCFTA would provide the largest export boost in manufacturing goods, which would increase overall by more than US$6.5 billion. Due to their downstream location, the largest part of the increase in the DVA component is explained by the increased demand for domestic inputs from other sectors. Inputs from the Services sector account for 90 per cent of the increased demand from manufacturing production to other domestic sectors, while the agricultural and food sectors represent slightly less than 10 per cent. It is worth observing that our results also confirm the increased importance of regional partners as destinations for African manufacturing exports. Their share as export-market destinations of manufacturing products would increase from 12 per cent to 14.4 per cent (+US$12,322 million) for gross exports, while the share of direct DVA would increase from 9 per cent to 10.4 per cent (+US$4,102 million).

Since the service sector is not included in our liberalisation scenario, its exports are negatively affected (−US$1,224 million) by the increased trade specialisation in goods exports. However, factors of production in the service sector will benefit from the AfCFTA given that the increase in sales to other sectors (+US$2,180 million) more than compensate the VA reduction due to the export contraction (−US$858 million).

Overall, the changes in terms of gross exports are far more dispersed than those in value-added terms. That is, once we move from considering gross exports to considering the sectors and income contributing to their value, the benefits of the continental agreement are more widely spread and more equally distributed among sectors.

5.3. Backward and forward integration in global and regional value chains

Next, we assess how the AfCFTA would affect the member countries' integration in agricultural and food regional and global production networks. The level of participation in international value chains depends on: (i) the import content of exports (FVA in exports, so-called backward participation) and (ii) the domestic production, which is used by the receiving country to produce its exports (DVA in other countries' exports, so-called forward participation). In what follows, we consider both these backward and forward linkages, focusing on regional and extra-regional linkages for AfCFTA agricultural and food production.

Intra-regional trade in Sub-Saharan Africa typically takes place within each of the RECs existing in the region. Regional hubs emerged as trade in each community intensified; namely, Côte d'Ivoire, Kenya, Senegal and South Africa. For instance, South Africa is the source of approximately 35 per cent of intra-regional imports in Africa and about 40 per cent of intra-regional manufacturing imports (Calderon, Cantù and Zeufack, 2020).

In our baseline, foreign intermediate inputs used by AfCFTA member countries to produce agricultural and food exports come mainly from the EU (producing, on average, 22 per cent of foreign value embedded in AfCFTA countries' exports of agricultural and food products), South and Southeast Asia (16 per cent) and China (13 per cent). Regional partners provide, on average, only 14 per cent of total foreign inputs. Within the continent, different countries show different degrees of regional backward integration, ranging from 15.1 per cent for Namibia to 0.2 per cent for Ethiopia and Nigeria.[15]

Most of the African countries exhibit a higher level of agriculture and food value chains forward integration outside the region. The EU is the main platform that vehiculates AfCFTA's DVA to other regions (30 per cent), followed by South and Southeast Asia (20 per cent) and China (16 per cent). Regional partners re-export, on average, 10 per cent of the AfCFTA's agriculture and food DVA. Intra-regional forward integration varies substantially among countries, with Zimbabwe showing the highest value (4.2 per cent) and Ghana the lowest (0.3 per cent).[16]

5.3.1. Backward integration

The AfCFTA will make the foreign content of agri-food exports grow more than gross exports due to tariff liberalisation, suggesting an increase in the backward participation in international value chains. This is the result of the change in relative prices due to the tariff elimination; inputs from AfCFTA countries become cheaper than inputs from both domestic and other foreign producers.

In Figure 3, the changes in the intra-regional participation index are reported along the horizontal axis, while the corresponding changes in the extra-regional component are reported along the vertical axis. Overall, regional backward integration increases without affecting extra-regional providers. However, several countries, such as Tunisia, Togo, Ghana and Senegal, would source more intermediate inputs from continental partners while decreasing their backward linkages outside the continent (IV quadrant). Other countries, for example, Tanzania and Rwanda (I quadrant) increase both intra- and

15 Regional backward integration is computed as the share of AfCFTA providers on the total FVA component in each AfCFTA country's agricultural and food exports.

16 Figure A3 in Appendix C shows the integration in agricultural and food regional and extra-regional value chains for different countries in the baseline.

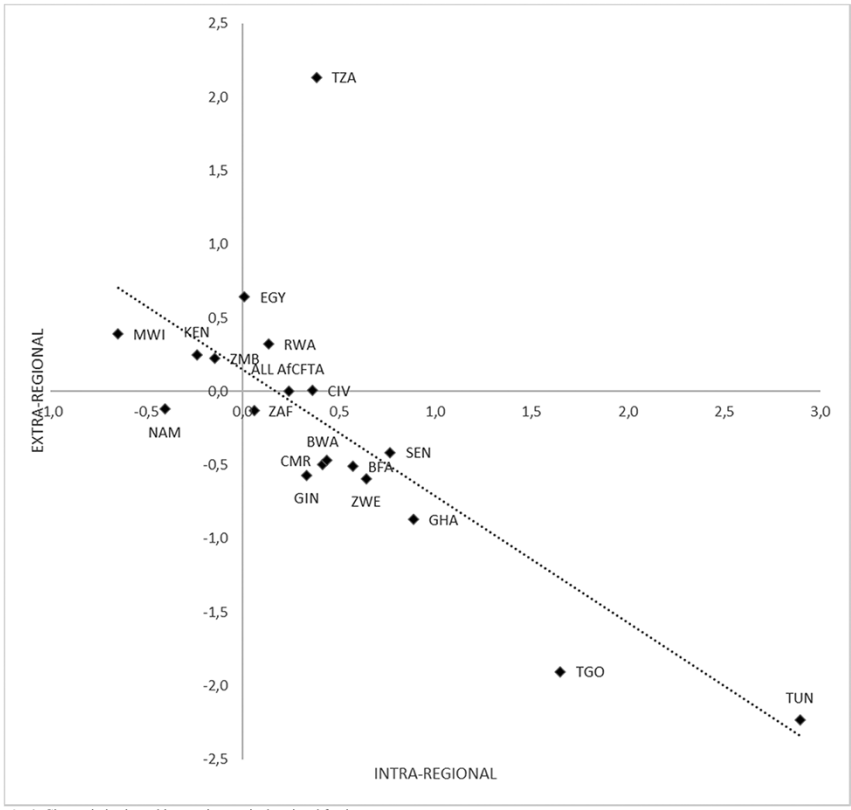

Fig. 3. Change in backward integration, agricultural and food sectors.
Source: simulation using the GTAP-VA model.

extra-regional backward integration.[17] The lack of regional backward integration in the case of Egypt, Kenya or Malawi is explained by trade specialisation in sectors characterised by low reliance on foreign intermediate inputs.

Table 4 shows the change in the AfCFTA countries' demand for regional foreign inputs to export agricultural and food products and indicates the providers that are primarily impacted. Our results support the view that continental liberalisation would push regional trade integration. In most cases, the demand from agricultural and food production for regional providers of intermediate inputs increase, although the overall restructuring also generates some reductions. This is the case, for example, of Malawi, which would decrease its demand for Zambian inputs. In absolute terms, South Africa is the country that would benefit the most in terms of the demand for

17 The model aggregation and the properties of the CES demand system prevent us from establishing whether the increase takes place at the extensive (i.e. new import flows) and/or at the intensive margin (i.e. larger import flows).

Table 4. AfCFTA scenario: regional sourcing of FVA in AfCFTA countries' agricultural and food exports by provider

	% change
South Africa	12.1
Nigeria	18.2
Côte d'Ivoire	40.8
Morocco	38.9
Egypt	24.4
Ghana	34.2
Tunisia	38.8
Burkina Faso	12.1
Botswana	5.7
Guinea	22.1
Kenya	4.5
Cameroon	36.0
Togo	33.1
Zimbabwe	4.6
Mauritius	9.7
Benin	19.1
Madagascar	−6.1
Senegal	−6.4
Malawi	−10.2
Tanzania	−11.9
Namibia	−22.3
Ethiopia	−14.2
Mozambique	−8.9
Rwanda	−51.5
Uganda	−27.3
Zambia	−33.0

Source: simulation using the GTAP-VA model.

inputs by regional partners (US$78 million). This country would intensify pre-existing trade relationships both within the Southern African Development Community (e.g. with Zimbabwe, Malawi and Tanzania) and with other regional partners (e.g. with Kenya and Ghana). However, in relative terms, the countries that would benefit the most would be Côte d'Ivoire and Tunisia (46 per cent).

5.3.2. Forward integration

The other aspect of participation in international production networks is related to forward connections in which a country's exports are embodied in the importing country's exports to third countries. Overall the AfCFTA leads to the strengthening of an African export 'platform' since the changes in the intra-regional and extra-regional forward participation indexes show opposite signs (Figure 4). However, we find that forward participation indices increase less than backward participation indicators, which is coherent with the findings

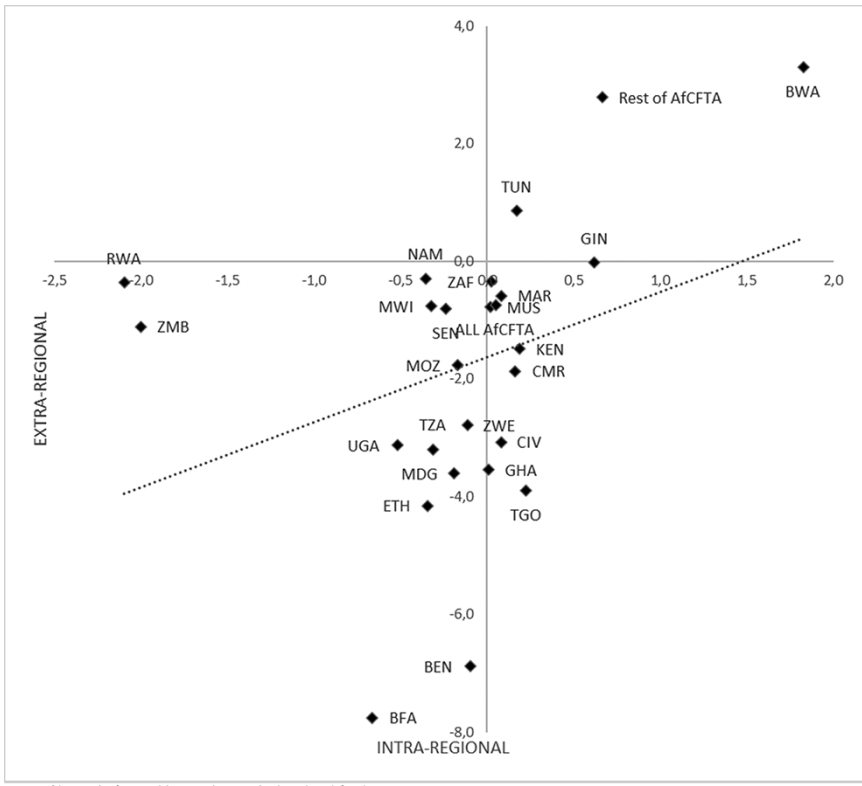

Fig. 4. Change in forward integration, agricultural and food sectors.
Source: simulation using the GTAP-VA model.

suggesting that forward participation, associated with upstream stages of production, is less sensitive to trade costs than backward integration (Antràs and de Gortari, 2020).

We observe important variations between countries. At the low end of the intra-regional participation, we find Rwanda and Zimbabwe, although changes in absolute values are negligible. Nigeria is an example of higher integration with the extra-regional partners, featuring a large increase (+20.8 per cent) mostly using the EU and the Asian countries as platforms. The largest reduction (−7.8 per cent) is registered by Burkina Faso. This is due to a strong reduction in the agricultural forward participation that is less than compensated by an increase of the index for food products. Such a change may suggest a shift downstream in the production processes. Most of the countries are in the IV quadrant confirming that AfCFTA countries will replace non-African countries as export platforms.

In Table 5, we present changes in the structure of multilateral exports (i.e. those reaching the final destination through other countries' re-exports) of

Table 5. AfCFTA scenario: AfCFTA countries' forward connections of agriculture and food sectors' DVA (% change)

		Destination							
		AfCFTA	EU28	China	S-SE Asia	N America	L America	RoW	Total
Platform	AfCFTA	29.7	6.6	5.4	1.9	5.0	3.8	−0.5	8.6
	EU28	−5.5	n.a.	3.0	0.4	−2.0	2.4	−1.3	−0.8
	China	−23.6	−17.6	n.a.	−15.4	−16.7	−13.6	−19.4	−17.1
	S-SE Asia	−13.9	−13.1	−4.4	n.a.	−10.8	−7.1	−9.4	−9.2
	N America	−2.8	1.1	1.4	1.5	n.a.	2.3	2.1	1.3
	L America	64.3	65.4	40.2	75.1	37.7	n.a.	50.9	50.3
	RoW	−13.1	−6.7	−6.8	−8.2	−8.3	−4.0	n.a.	−7.6
	Total	1.1	−5.5	−1.6	−4.9	−5.4	−2.7	−3.5	−3.8

Source: simulation using the GTAP-VA model.

DVA originated in the agricultural and food sectors to assess the impact on the factors' income stimulated by the consumption in different destinations. The rows represent regional platforms through which the AfCFTA countries' agricultural and food DVA reaches the final destinations, represented by the columns.

There is an increase in the relevance of AfCFTA countries as intermediate links exporting regional agricultural and food value added.[18] Overall, AfCFTA countries would re-export US$52 million more agricultural and food African value added in total (+8.6 per cent). Most of the increase will be due to final demand within the AfCFTA itself (+US$34 million, corresponding to +29.7 per cent) that can be expected as a consequence of tariff reductions. This intensification of intra-agreement exchange comes at the expense of other platforms; the major impact is found for China (−17.1 per cent) and other Asian countries (−9.2 per cent), which would overall re-export US$239 million less of African agricultural and food value added. This result can be interpreted as a movement towards more downstream production activities performed within Africa before reaching the final destination.

There is not a significant impact looking at the platform role played by EU countries (−0.8 per cent). On the contrary, the absorption capacity of the EU shrinks by 5.5 per cent given that the increase of African exports (+6.6 per cent) does not compensate for the reduction of Asian exports (−17.6 per cent in the case of China). Overall, forward connections for AfCFTA agriculture and food sectors' value added are reduced outside Africa, a result which is mainly explained by the contraction in agriculture, whereas re-exported food value added increased. This downstream movement caused by the establishment of the regional free trade area suggests that the role of African countries as providers of low-processed inputs to the world system would be reduced as far as agriculture and food are concerned.

6. Conclusions

Currently, the world is facing an unprecedented period characterised by protectionist measures and multiple shocks. As the coronavirus pandemic unfolds, policy reactions among the world's leading food and agricultural producers have led to disruptions in world supply chains, threatening food security systems in food import-dependent countries. Africa differs from other regions in that natural resources and agriculture dominate exports, and the share of total trade that is intra-regional is relatively small. While the experience of East Asian countries indicates the potential benefits of intra-regional trade, the African experience tells a different story. This is one reason why regional integration is at the core of the stated priorities of African leaders. Efforts to promote regional integration have reduced tariff protections in Africa but, despite significant progress, intra-regional traders still face high tariffs.

18 Also, in this case, we cannot distinguish between extensive and intensive margin changes.

While the picture is gloomy, the AfCFTA provides the opportunity to eliminate tariff measures and NTMs on goods, improve continental integration and speed up customs procedures that remain a serious barrier to trade performance in Africa.

Over the past few decades, production processes have become increasingly more complex in the world economy. Any finished good now typically embodies value added from multiple countries of origin, with this value added often crossing multiple borders en route to its point of consumption, in production arrangements that have come to be referred to as 'global value chains'. As a consequence, traditional export statistics become less informative about the global pattern of production and income. Also, vertically sliced production processes imply that goods cross borders multiple times at different production stages, driving a wedge between the value of exports observed at customs and the income generated in its production at home and abroad.

We base our analysis on CGE modelling, as it is a method uniquely well suited for assessing multiple interconnections between trade policies, agri-food supply and intersectoral connection with sufficient regional details. More specifically, we employ a state-of-the-art multi-sector, multi-region version of the GTAP CGE model that includes some of the most important factors determining the patterns of trade: a detailed representation of agricultural and food sectors with respect to other multi-region IO tables, limitations of relevant production factors, such as land, and use of imported intermediate inputs in various regions. The advantage of this approach is the possibility to measure policies' ultimate impact in a theoretically consistent way by quantifying the changes that result from the interactions and feedbacks by all of the markets in the economy. The model we use links policy changes in a country to its participation in regional value chains and GVCs. It provides a measure of the depth of a production relationship that simultaneously takes into account all possible linkages between countries, thus rendering feasible the computation of value-added indicators for multiple countries and sectors. Accordingly, our analysis contributes to the literature by analysing the effects of the AfCFTA through a counterfactual experiment in a general equilibrium model, where countries' production chains are integrated through sectoral IO linkages. In contrast to a firm-level study, this approach allows us to capture general equilibrium feedback effects on African countries through adjustments in the global pattern of goods and factor prices, and it permits an analysis of the effects on third countries and the global degree of production fragmentation.

Yet models should not be treated as a sort of 'crystal ball': their usefulness in policy analysis owes less to their predictive accuracy and more to shed light on the economic mechanisms through which price and quantity adjustments are transmitted among world markets. Accordingly, the results presented here are not unconditional predictions of the future but rather attempts to quantify the impacts of trade policy changes in a 'what-if' manner. They make no allowance for future changes in economic conditions or policies and are also subject to other uncertainties. The latter stems from several sources, not least the fact that the AfCFTA implementation is subject to various well-known

uncertainties, the most significant of which is the huge uncertainty about the height of existing non-tariff barriers to trade, let alone exactly how the Agreement will decrease them. In comparison with the existing CGE literature, we simulate a less optimistic liberalisation scenario, since we do not include trade facilitation and/or elimination of NTMs. Nonetheless, our results are in line with the previous analysis of the overall economic effects of the AfCFTA: both economic activity and intra-African trade are positively affected due to the agreement. More importantly, the results show that the AfCFTA has an overall positive effect on agri-food value chain integration, especially at the regional level. An important result from our simulations is the increasing importance of AfCFTA countries as intermediate links exporting regional agricultural and food value added.

We have created a comprehensive dataset using a series of concordances from the United Nations Statistics Division to obtain BEC-informed shares that allow attributing bilateral imports in the GTAP Data Base at the agent level (i.e. firms, government and private households). The simulation is carried out using an improved version of the GTAP-VA model (Antimiani, Fusacchia and Salvatici, 2018). This model accounts for the value-added composition of trade flows, thus providing evidence of the backward and forward domestic and international linkages of each sector. We differentiate the demand of goods according to their use for final or intermediate consumption, thus explicitly representing GVCs. Our main specification uses the elasticities of import substitution estimates of Fontagné, Guimbard and Orefice (2020), which are identified at the tariff line level to derive sector-specific intermediate inputs elasticities. Next, we analyse the robustness of our findings using the standard elasticities provided by the GTAP Data Base.

The present level of global and regional value chain engagement of most countries in Africa is rather low. Given the shift in international trade from goods to tasks, for the AfCFTA to have a transformative effect on member countries, it would need to spur the development of the nascent supply chain on the continent: to what extent may the AfCFTA contribute to global and regional production fragmentation and the formation of production networks? Our results show that the answer to this question depends not only on the composition of trade volumes by product (primary goods vs. manufacturing goods) and the composition of trade volumes by destination (inter- vs. intra-regional trade) but also on the structure of trade in terms of the different value added components (DVA, FVA, backward and forward). Accordingly, we compute value-added trade flows as well as model-based measures for production networks, and we find that the associated trade cost changes spur global production fragmentation so that the AfCFTA is likely to be a driving force behind the strengthening of production networks with its neighbours.

Our results show that the regional agreement is expected to not only increase the intra-regional trade flows but also to deepen the agricultural and food value chains at the regional level. We also show that the AfCFTA would contribute to strengthening trade linkages between African countries overall. In this respect, the AfCFTA would remove one of the obstacles impeding progress to greater

participation in supply chain trade, namely high tariffs on intermediate inputs (De Melo and Twum, 2020a). As a consequence, we register a rising share of trade in value added (relative to gross trade), which indicates growing participation in GVCs. At the same, this trade expansion and integration within Africa and the emergence of an African export 'platform' is expected to occur at the expense of trade with partners outside Africa, especially with Asia, mostly China. Interestingly, we also find that the trade flows between Africa and the EU would largely remain unaffected.

The AfCFTA will facilitate more participation of agricultural and food sectors in complex GVC trade (defined as trade in intermediates crossing at least two borders) through an increase in forward as well as backward participation. Due to the AfCFTA, countries are going to be less reliant on the export of agricultural intermediates for the production of final goods with higher value added. However, we find that the reduction in trade costs within the region has a higher incidence on backward intra-regional integration than on forward participation, on average, but this pattern varies substantially across countries.

In addition, the AfCFTA would result in a net overall increase of food exports attributed in part to a rise in value added for food exports and also to an increase of the value of foreign and other sectors' intermediate inputs. This means that most of the value added embedded in food exports would be sourced from other domestic sectors, further demonstrating the integration effect of the AfCFTA. In other words, we find that the continental agreement translates into more widely spread benefits across sectors if we consider the income generated within each sector (value added) rather than simply accounting for gross exports.

Moreover, foreign sourcing of intermediates rises more quickly than exporting as highlighted by the decline in the DVA to gross exports ratio. This is good news because African exporters may access lower-cost suppliers of intermediate products. We find that the aggregate increase in DVA ratio was driven both by a higher domestic content share of processing exports and a relative shift towards ordinary exports, which contain significantly more DVA to begin with. These are sizeable effects if one takes into account that the only difference between the baseline and the counterfactual is the tariff structure since we do not include NTMs on top of tariff cuts. However, the pattern is by no means universal in terms of either countries or sectors. The size of the potential changes in the structure of trade depends critically on the initial level of trade barriers and the strength of initial intra-African trade ties.

A few comments are in order regarding the effects of our counterfactual experiment. First, by summarising all indirect production relationships, Leontief-inverse based decompositions do not allow for a step-by-step analysis of all sequential production stages. Nor can it capture differences in the structure of the value chain, as discussed by Baldwin and Venables (2013): the model essentially assumes that goods are produced via an endless sequence of steps, with each stage using inputs from prior stages in an infinite loop. Second, our analysis rests on the assumption that labour is perfectly mobile

across sectors within each country. Since sectors are affected very differently, owing both to heterogeneous tariff cuts and different sourcing structures, labour mobility matters for whether countries can realise the restructuring predicted by the model and over what time horizon. Third, the consequences of AfCFTA are going to be much broader than those we discuss here: (i) the level of sector aggregation is a major limitation. Producers and consumers do benefit from lower prices but also an increase in product varieties. This so-called love-of-variety effect can have important impacts on consumer welfare. Likewise, for producers, imports of key intermediate and capital goods can be embedded with technology that could lead to an increase in productivity, all else equal. (ii) Rising exports can be associated with two additional impacts. First, exports can themselves lead to rising productivity as exporters need to meet the quality and regulatory requirements of global markets. Besides, evidence suggests that rising exports tend to benefit higher productivity firms. This structural shift could lead to a growing share of higher productivity firms relative to lower productivity firms that would be left to produce for the domestic market. (iii) The model assumes constant returns to scale and perfect competition; thus, there are no pro-competitive impacts of lowering trade barriers, nor potentially pro-productivity impacts as more productive export-oriented firms gain market share. Furthermore, all producers in a given sector use the same bundle of inputs in production and operate the same technology regardless of the stage of production in which that production takes place. (iv) Improving market conditions, competitiveness and business sentiment would induce foreign direct investment in Africa. This would thus lead to more imports of higher technology intermediate and capital goods and improved management practices. However, our study ignores the potential costs of lowering the non-tariff barriers and the trade facilitation measures, as well as the transaction costs associated with a change in trade structure, such as employment shifts, and potentially stranded assets, such as capital.

Our results are also limited by data availability and quality. Complementary evidence would be welcomed on two fronts: first, more data on informal and small-scale enterprises alongside the formal sector firms;[19] second, data on imports and exports at the firm level since it is likely that production by exporting firms is more intensive in the use of imports than production by firms serving the domestic market.

Given the importance of the EU–Africa economic relationship, it is worth noting that the current EU common agricultural policy hampers the development of African agriculture much less than it did before with export subsidies and coupled subsidy payments. Although African raw agricultural material exports to the EU are largely free of duties under various agreements, processed products are only free of duties if they can be ruled out under the ‘country of origin’ principle that components of the final good were

19 Recent estimates of informal cross-border trade can be found in the 2020 Africa Agriculture Trade Monitor (Bouët, Odjo and Zaki, 2020).

imported from a third country.[20] The proof of origin requires a list of the production stages and ingredients, as well as their origin. This condition often makes it difficult for African exporters to export processed agricultural products to the EU, hindering the creation of regional value chains. A simplification of and more flexibility on the rules on origin (supported through consultation with trading partners) should be sought provided the majority of the ingredients originate in the partner country or regional economic areas, such as the AfCFTA. In this respect, it is worth recalling that the AfCFTA annex on RoO has not yet been finalised. RoO that are too restrictive can negate the preferential market access intended by the FTA and prevent regional supply chains from functioning independently from the EU choices.

The AfCFTA is going to be a major trade shock. Our results show that it has the potential to significantly change global sourcing structures and the formation of production networks within Africa. However, achieving the AU's continental trade goals will require strategic development of regional food processing and supply chains that capitalise on the existing production and local processing potential and access to markets. Indeed, for the AfCFTA to realise its economic and trade transformation potential, member countries are likely to need to adopt a mix of policies and investments to spur the development of the nascent supply chain on the continent. Yet policymakers must proceed cautiously—trade policy changes can have unintended consequences for informal, local supply chains and dietary habits, sometimes excluding producers or elevating less-nutritious processed foods over traditional dietary staples. Moreover, realising the ambitious AfCFTA agenda requires dealing with the political economy of execution. The success of the AfCFTA may require complementing trade policies with national policies that make the gains from trade more inclusive—for instance, policies that may range from re-training workers for new tasks/jobs as a result of technological changes, to adequate regulatory frameworks to promote investment and competition, to social protection of the most vulnerable. We have also shown that the AfCFTA would displace trade flow to some extent. These effects are not likely to be neutral from a geopolitical perspective and the implications on international relations would need to be watched. This study contributes by bringing quantitative elements that will further document the debate on the necessary framework, reforms and investments for a pooled African market.

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20 A closer look at the agricultural products traded shows that African agricultural exports to Europe are largely raw agricultural commodities, such as cocoa, coffee, tea and tobacco, which find their way to the EU for further processing (Bouët and Odjo, 2019).

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Appendix A

Heterogeneous Armington elasticities are derived from the ProTEE (PROduct level Trade Estimated Elasticity) dataset by the CEPII. This database provides trade elasticities at the six-digit HS level and is built based on a structural gravity approach and regressing bilateral import values on bilateral applied tariffs for each HS6 product. The estimated tariff coefficients represent the trade elasticity at the product level (Fontagné, Guimbard and Orefice, 2020).

In this work, we apply the BEC attribution to allocate them into two sets: one for intermediate products (used by firms) and one for final goods (used by government, household and investment). CES weights are then used to aggregate the HS6 level to the GTAP sector level. These are defined as:

$$P(p) = \left(\sum\nolimits_j p_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}},$$

where p_j are elasticities at the HS6 level, and σ are original parameters in the GTAP model.

We keep elasticities of substitution for final goods ($ESUBM_{FIN}$) at the original GTAP level. Elasticities for intermediates ($ESUBM_{INT}$) are obtained by applying the ratio between the CES weighted elasticity for intermediates and finals (e-ratio).

Table A1. Heterogeneous Armington elasticities for intermediate and final use

Sector	$ESUBM_{FIN}$	e_ratio	$ESUBM_{INT}$
Paddy rice	10.10	0.73	7.37
Wheat	8.90	0.37	3.26
Other grains	2.60	2.03	5.29
Vegetables and fruit	3.70	1.49	5.53
Oil seeds	4.90	3.44	16.87
Sugar cane and beet	5.40	0.24	1.31
Plant fibres	5.00	2.69	13.44
Other crops	6.50	0.61	3.95
Cattle	4.00	0.38	1.52
Other animal products	2.60	0.45	1.17
Wool	12.90	0.50	6.43
Forestry and fishing	3.62	0.87	3.16
Meat	8.36	1.35	11.29
Vegetable oils	6.60	0.07	0.48
Dairy products	7.30	0.99	7.25
Processed rice	5.20	1.78	9.25
Sugar	5.40	0.21	1.16
Food products nec	4.00	1.11	4.43
Beverages and tobacco products	2.30	2.56	5.90
Textiles	7.59	1.11	8.44
Wood and paper products	6.18	0.96	5.95
Extraction and petroleum	10.30	1.28	13.20
Pharmaceutical products	6.60	0.56	3.72
Chemical rubber products	6.60	0.13	0.83
Metals and non-metallic minerals	7.23	0.82	5.91
Motor vehicles and transportation	6.35	0.91	5.79
Electronic equipment	8.80	0.95	8.39

(continued)

Table A1. (Continued)

Sector	$ESUBM_{FIN}$	e_ratio	$ESUBM_{INT}$
Other machinery and equipment	8.10	0.98	7.97
Other manufacturing	7.50	2.34	17.57

Source: Authors' computations based on the GTAP Data Base, Version 10, and the ProTEE dataset.

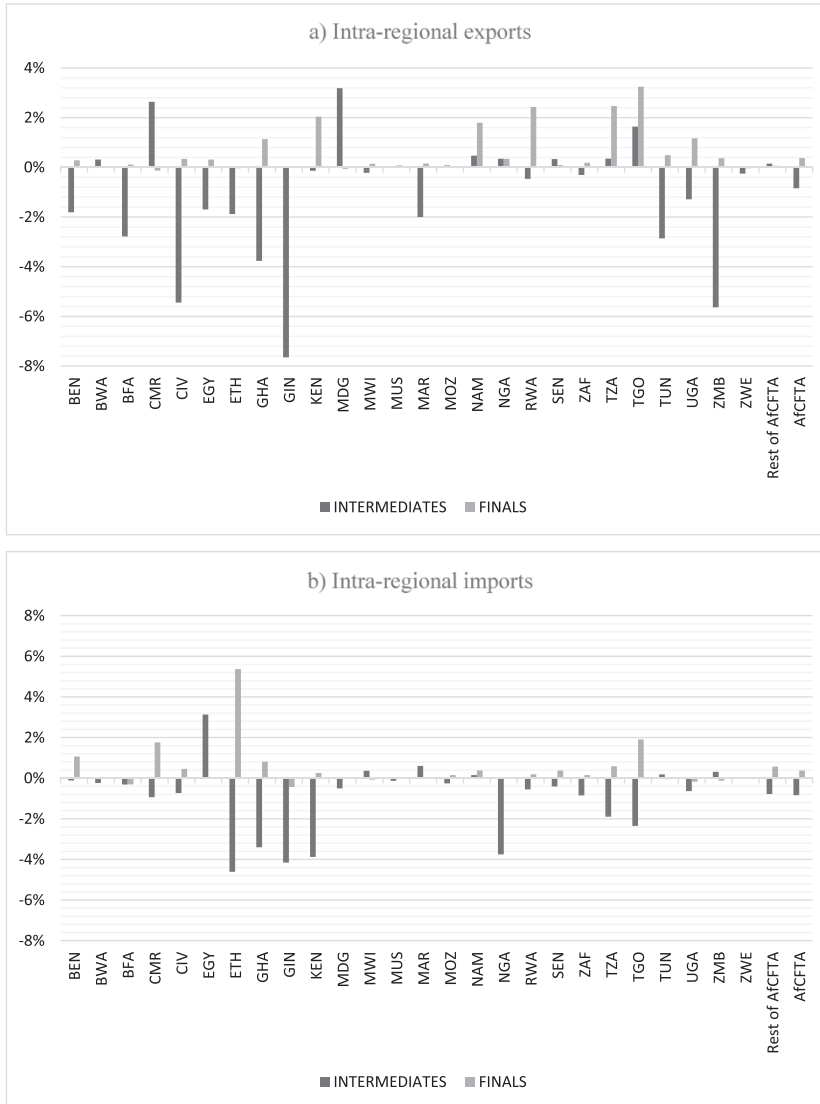

Fig. A1. Intra-regional trade, homogeneous vs. heterogeneous elasticities (% changes).
Note: percentage changes in the AfCFTA scenario under Armington elasticities differentiated by agents with respect to the AfCFTA scenario under standard, homogeneous Armington elasticities.

Appendix B

As a complement to the description given in the main text, in this Appendix, we provide the formal derivation of the main indicators related to the value added in exports used in the paper. The complete documentation can be found in Antimiani, Fusacchia and Salvatici (2018).

The value-added decomposition of trade is applied to the standard static GTAP model with perfect competition and constant returns to scale technology (Hertel and Tsigas, 1997).

Let i and $j = 1,\ldots,N$ index sectors, and s, $r = 1,\ldots,C$ index countries. Define $\widehat{\mathrm{VSH}}$ as the diagonal matrix containing the sectoral value-added shares (value added on total output) in the main diagonal. The value added includes the remuneration of primary factors of production (e.g. capital and labour) and the income derived from the output and trade-related taxes. Furthermore, define A as the technical coefficient matrix with dimension NCxNC and $\mathrm{L} = (\mathrm{I} - \mathrm{A})^{-1}$ as the global Leontief inverse (or multiplier) matrix, giving total requirement of output, directly and indirectly, required worldwide to produce 1 unit of consumption. Then, the value added in trade (TVA) can be defined as:

$$\mathrm{TVA}_{ij}^{tsr} = \widehat{\mathrm{VSH}}_i^t \mathrm{L}_{ij}^{ts} * \mathrm{VXE}_j^{sr} \tag{1}$$

where $\widehat{\mathrm{VSH}}_i^t \mathrm{L}_{ij}^{ts}$ is the value-added multiplier matrix giving the value-added contributions for the entire output directly or indirectly required to produce 1 unit of output. The coefficient VXE_j^{sr} represents bilateral exports evaluated at market prices excluding possible intra-regional trade flows (for which the distinction between DVA and FVA is not applicable). Thus, TVA_{ij}^{tsr} expresses the value added, which originates (in sector i) of country t and is embedded in country s' exports (in sector j) to country r.

i) Bilateral DVA

$$\mathrm{DVA}_j^{sr} = \sum_i \widehat{\mathrm{VSH}}_i^s \mathrm{LOC}_{ij}^{ss} * \mathrm{VXE}_j^{sr} \tag{2}$$

where $\mathrm{LOC}_{ij}^{ss} = \left(\mathrm{I} - \mathrm{A}_{ij}^{ss}\right)^{-1}$ represents the local (or domestic) Leontief inverse, which is computed on the domestic block of the technical coefficients matrix, thus representing intra-country processing only.

The aggregate DVA can be split according to the sector of origin/export:

$$\sum_j \mathrm{DVA}_j^{sr} = \underbrace{\sum_i \widehat{\mathrm{VSH}}_i^s \mathrm{LOC}_{ii}^{ss} * \mathrm{VXE}_i^{sr}}_{DVA\_dir_i^{sr}} + \underbrace{\sum_i \sum_{j \neq i} \widehat{\mathrm{VSH}}_i^s \mathrm{LOC}_{ij}^{ss} * \mathrm{VXE}_j^{sr}}_{DVA\_indir_i^{sr}} \tag{3}$$

ii) Multilateral DVA (DVAM)

$$\mathrm{DVA\_mlt}_j^{sr} = \sum_i \sum_{t \neq s,r} \widehat{\mathrm{VSH}}_j^s \mathrm{L}_{ji}^{st} * \mathrm{VXE}_i^{tr} - \mathrm{DCM}_j^{sr} \tag{4}$$

where DCM represents the double counting. This term accounts for *s*' value added previously exported to country *r* as embedded in intermediates, which are used by country *r* to re-export to *s*; once again in country *s*, it is exported to country *t*, which processes it again before exporting to country *r*.

iii) FVA

$$FVA_j^{sr} = \sum_i \sum_{t \neq s} \widehat{VSH_i^t} L_{ij}^{ts} * VXE_j^{sr} \quad (5)$$

Appendix C Additional figures

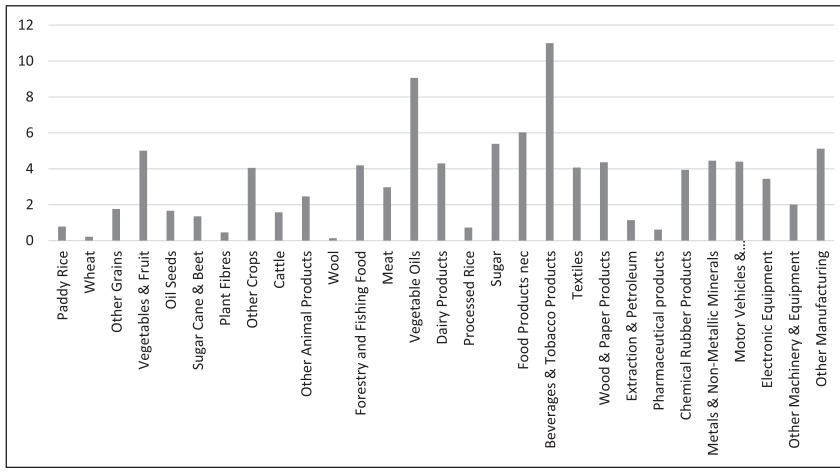

Fig. A2. Import taxes faced by AfCFTA countries (ad valorem rates in the baseline, 2014).
Source: GTAP Data Base, Version 10.

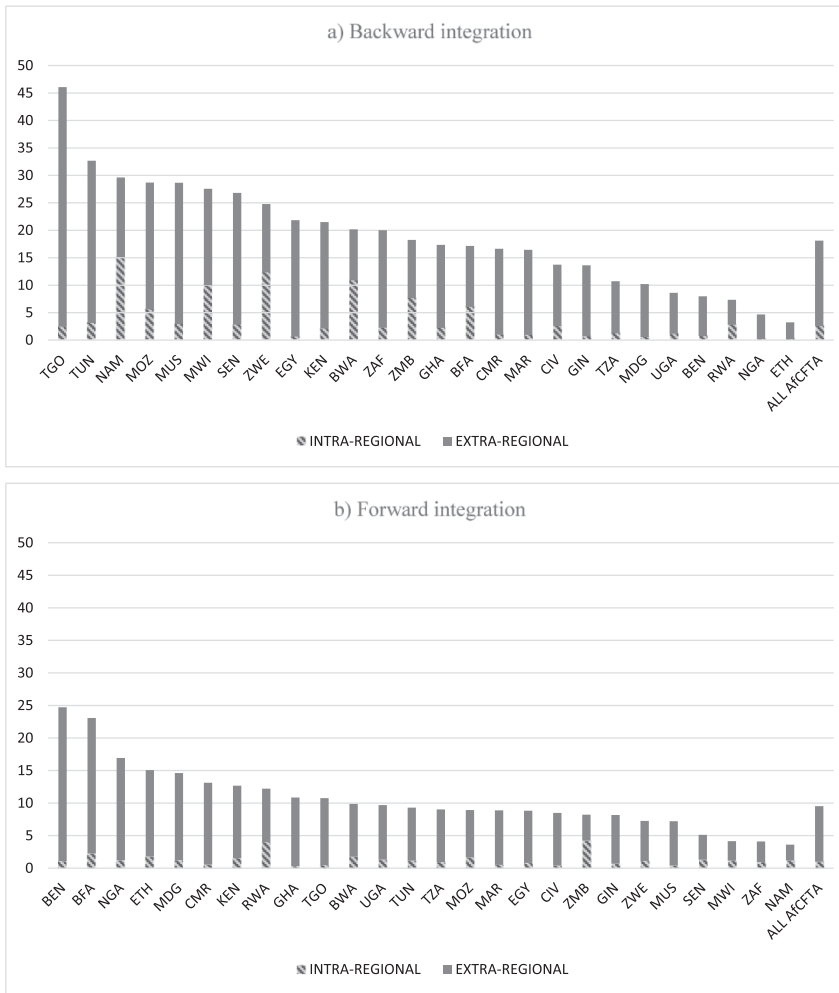

Fig. A3. Integration in agricultural and food regional and extra-regional value chains (baseline, 2014).
Source: Authors' computations using the GTAP-VA model.