How Important is the Relationship between Trade Policies and Backward and Forward Participation of the Sub-Saharan Countries in Agriculture and Food Global Value Chains?

By

Jean Balié
FAO

Ilaria Fusacchia
Roma Tre University

Luca Salvatici
Roma Tre University and Rossi-Doria Centre for Economic and Social Research

The most recent literature on international trade highlights the key role of Global Value Chains (GVCs) in structural transformation, development and growth. The connection to global networks may represent an opportunity for supporting the on-going transformations of Sub-Saharan Africa (SSA), especially in agriculture and food markets. In this paper, we give a description of GVC-related trade for Burkina Faso in order to assess the geographical and sectoral trade diversification in terms of value-added content along international chains. A new modelling Trade in Value Added module is introduced to the Global Trade Analysis Project model and used to empirically assess the impact of a regional trade agreement on Burkina Faso's backward and forward connections of agriculture and food sectors. Our findings support the view that a more liberalized regional market would strengthen regional integration and boost the participation in international production networks, both through backward and forward linkages.

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1. Introduction

The most recent literature on international trade highlights the key role of Global Value Chain (GVCs) in structural transformation, development and growth. The connection to global networks may represent an opportunity for supporting the on-going transformations of Sub-Saharan Africa (SSA), especially in agriculture and food markets, which could move from a subsistence oriented and farm-centered agri-food system to a more commercialized, productive and off-farm centered activity (IMF, 2015; Greenville et al., 2017). A growing number of analyses highlight that GVC participation may stimulate public and private investments in infrastructure that would otherwise not be profitable, and spur local production in the agriculture sector through minimum scale achievements. This can translate into more competitive market restructuring effects potentially benefitting not only GVC suppliers, but also non-GVC participants (Del Prete et al., 2016). By generating higher and more stable incomes, higher GVC participation can also have important spillovers on the food security of small-holder farmers since it is associated with increasing employment, better remunerated jobs, use of resources, governance, and political stability (Minten et al., 2009; Bellemare, 2012; Cattaneo et al., 2013; Swinnen, 2014; Swinnen and Vandeplas, 2014; Bellemare et al., 2016; Montalbano et al., 2017; Balié et al., 2017).

The common perception is that Africa, unlike most Latin American and Asian countries, has neither been able to intercept the main changes in trade patterns nor to enter massively into global production networks. However, new evidence has been found on a significative and increasing involvement of Sub-Saharan Africa (SSA) in internationally fragmented productive processes (see, e.g., Foster-McGregor et al., 2015; IMF, 2016; Del Prete et al., 2016; Balié et al., 2017).

Trade policy plays a crucial role in shaping the opportunity to participate in global production networks. GVC-related trade is particularly sensitive to border protection, due to amplification effects (i.e., tariffs are incurred several times along the chain and are applied on the full value of exports, including on imported inputs and tariffs previously paid). Moreover, chain effects arise and impact all the backwardly or forwardly linked production activities, which are spanned across different countries. A deeper understanding of these effects would allow to inform better competitiveness strategies. These should, for example, recognize a different role for imports in giving access to the most efficient inputs (Cattaneo et al., 2013; Taglioni and Winkler, 2014). This in turn would free resources to focus on core competences and would increase export competitiveness. The overall high level of trade barriers applied by SSA countries suggests that there is an ample margin for intervention (Bown and Crowley, 2016; Caliendo et al., 2016). It has been outlined that many of the measures that would enhance SSA countries' participation in GVCs would also remove barriers to regional integration (Draper and Lawrence, 2013).

The signature of the Agreement Establishing the African Continental Free Trade Area (AfCFTA Agreement), which would liberalize 90% of tariff lines, could provide an enabling environment where build efficient regional supply chains and encourage intra-industry trade, thereby promoting investment, growth and the creation of jobs. The resulting increase of intra-regional trade would have great potential for building sustainable economic development and counter risk from uncertainty of the global trade system (AfDB, OECD and UNDP, 2017).

Thanks to the recent availability of data reporting on inter-country, inter-sector transactions and the development of new techniques decomposing trade flows and identifying the contribution to trade flows in terms of value added from each country, a broader and deeper analysis of international trade can be performed. Accordingly, it allows to assess the participation in the international production networks and identify the trade partners which are linked both directly and indirectly to production system of a given country. Finally, retrieving a country's value added absorbed in the final destination market provides an assessment of how foreign countries activate (both directly and indirectly) national production.

In this paper, we give a description of GVC-related trade for Burkina Faso, a low-income, landlocked Sub-Saharan country, in order to identify whether the value-added embedded in agricultural products is finally consumed in high income countries, emerging economies or regional partners. Since the growth in agri-food exports may be vitally important for expanding returns from African agriculture and for increasing its overall exports, we focus on the agriculture and food products.

Compared with manufacturing sectors, less is known about trade within agro-food GVCs, especially for Africa, mainly due to a lack of data. For example, the OECD-WTO's (2013) Trade in Value Added (TiVA) database and the World Input Output Database (WIOD) provide data for agriculture and food processing as broad sectors. In terms of geographical coverage, neither TiVA nor WIOD include Africa. The UNCTAD-Eora data currently provide the most inclusive data on value-added trade and GVCs for developing countries, including over 90% of countries in Sub-Saharan Africa (Lenzen et al., 2012), but still at aggregate for agriculture and food. Using Eora database, Foster-McGregor et al. (2015) provide evidence on a substantial involvement of Africa in GVCs, which results to be more engaged in GVCs than many developing country regions as well as developed countries such as the USA. The contribution of primary sector in GVC participation for Africa tend to be well above the average for all regions. Del Prete et al. (2016) and Balié et al. (2017) confirm these findings and show that the relevance of their international linkages is increasing over time, although still limited to upstream (likely unprocessed) production stages of the chain. However, few is known about the characteristics ofindividualagriculture and food sectors

involved in GVC-related trade for SSA. We make use of a new data set of trade in value added derived from the Global Trade and Analysis Project (GTAP) database, which has a good coverage of SSA[1] and a relatively high disaggregation for agriculture and food.

In this study, we recognize that the level of integration in GVCs depends on the import content of exports (*foreign value added in exports*) and on the domestic production which is used by the receiving country to produce its exports (*domestic value added in other countries' exports*).[2] These metrics were first introduced by Hummels, Ishii, and Yi (2001) and have been subsequently extended and redefined by an active strand of literature focused on the correct measurement of production and trade flows in terms of value added (e.g., Daudin et al., 2011; Johnson and Noguera, 2012; Koopman et al., 2014; Wang et al., 2013; Borin and Mancini, 2015). GVC analyses at the macro level use different approaches in measuring trade on a value-added basis. According to the categorization proposed in a recent paper by Johnson (2017), TVA can be assessed by decomposing the value-added content either of final goods or of gross exports. In this work, we focus on the decomposition of gross trade flows which represent a crucial outcome of trade policy simulation carried out with global model.

The value-added decomposition allows to assess the geographical and sectoral trade diversification in terms of value-added content along the GVCs. We implement these trade metrics in a computable general equilibrium (CGE) framework to analyze the systemic, global effects of trade policy on production networks. Specifically, we integrate the decomposition of bilateral trade at the sector level in the GTAP model. Incorporating trade on a value-added base into CGE models can improve the ability of these models to trace out trade and allocative implications of trade policies which were previously unexplored in traditional models. Having an accurate, evidence-based measure of the true value of trade is necessary if policy makers are to make informed decisions regarding trade and economic policy.

The main contribution of this analysis is the empirical assessment of the impact of trade policy on the GVC-related trade for SSA countries. In this regard, our work is related to Balié et al. (2017), which give empirical evidence of "chains" effects for the agri-food GVCs based on a gravity approach. They find that bilateral trade protection is a key determinant of the heterogeneity in GVC participation across SSA, and their estimates indicate that, whenever multiple border crossing occurs, domestic trade policy can negatively affect domestic value added, due to a chain effects on upstream and downstream producing countries. By contrast, we use a counterfactual approach

[1] It includes 26 individual countries and 5 sub-regions in Africa.

[2] A different measure of international fragmentation of production has been developed by Antràs et al. (2012). They measure the relative production-line position to assess specialization patterns of countries in relatively upstream or downstream stages of global production processes.

which allows us to assess the impact on the output which is activated through the production chain for a traded commodity, taking into account substitution and reallocation effects due to changes in prices following a policy shock. For instance, in our tariff removal scenario, we are able to quantify, at the bilateral and sector level, the variations in the value-added exports of the liberalizing economies (net of foreign inputs), which occur both directly and indirectly.

The analysis of Burkina Faso's backward connection of agriculture and food sectors finds out that Burkina Faso's tariff structure highly protects key sectors (e.g., light manufacturing, chemicals, textiles) providing intermediate inputs necessary to produce exports in agri-food. Regional trade liberalization seems to bring some positive effects on the export performance. Our findings support the view that a more liberalized regional market would strengthen regional integration and boost the participation in international production networks, both through backward and forward linkages.

The paper is structured as follows. In the following section, we provide some preliminary insights into value-added trade and develop the GTAP module for GVC analysis which introduces the value-added decomposition of gross bilateral flows. Section 3 deals with data issue arising when using the GTAP Data Base for GVC analysis. In section 4, we provide a comprehensive map of Burkina Faso's agro-food GVC participation and relative trade partners, and analyze the effects of shifts in trade regimes associated with regional trade agreements on the backward participation and forward participation. Section 5 concludes.

2. Methodology

2.1. How to measure trade with GVCs

As production processes have become more fragmented across the borders, and intermediate goods (e.g., parts and components or any other item used as an input for further processing) cross more than one border, traditional trade statistics do not provide information on the production patterns underlying global trade, do not allow an adequate measurement for understanding domestic value added and national income, and often hiding the extent of GVCs.

Trade economists, official international statistics agencies and policymakers have reached a near consensus on this point and a wide recognition that GVCs require a new approach to measure trade has emerged. In particular, it has been outlined the need to measure Trade in Value Added (TVA), taking into account the fact that portions of value are added at each successive stage of the productive process, where the value added equals the value of payments to the primary factors of production in the country-sector in which the particular stage of production takes place. TVA decomposition allows the segments of value created in different countries to be disentangled in gross trade flows.

To deal with the increased complexity in global trade, a number of indicators within the TVA analytical framework have been developed based on ICIO data. Some of them refer to the decomposition of final goods as in Johnson and Noguera (2012) who measure inter-country production sharing as the ratio of value added to gross exports (VAX), where value-added exports are defined as the value added produced in one country but absorbed in final demand by another. A complementary perspective in decomposing final goods looks at the production side and consists in allocating the value added generated in the production of final goods back to the countries in which that income is generated. This "GVC Income" approach traces the value added by all labor and capital that is directly and indirectly needed for the production of final manufacturing goods (Timmer et al., 2013; Timmer et al., 2014; Los et al., 2016).

The literature aimed at decomposing gross trade flows is more relevant in our case. This line of research starts from the pioneering work of Hummels, Ishii, and Yi (2001) who provide the first metric of vertical trade considering the foreign inputs used in a country's exports. Accordingly, the vertical specialization (VS) measures the value of imported inputs embodied in goods that are exported. As a share of total exports, it provides an index of backward participation in GVCs.

A second indicator refers to a different channel through which a country is involved in GVC, i.e., by producing intermediate exports which are used by the receiving country to produce its exports. In the literature, this indicator is labeled as VS1 (Hummels et al., 2001) and provides a measure of the forward linkages a country has in selling in GVCs. Although the degree to which exports are used by other countries for further export generation may appear less relevant for policymakers because it does not change the domestic value-added contribution of trade, the participation rate is a useful indicator for the extent to which a country's exports are integrated in international production networks (UNCTAD, 2013).

A third measure (VS1*) captures reflected, or circular, trade; it accounts for a subset of VS1 and refers to the portion of trade that is imported back in the country of origin of value (Daudin et al., 2011). This indicator provides interesting insights for policy makers since one implication of the reflected trade is that the restrictive measures a country imposes on its imports have an impact on domestic firms exporting intermediate inputs processed abroad and then imported back. This may alter that country's incentive to impose import protection (Blanchard et al., 2016) as long as restrictive measures assume a 'beggar thyself' connotation (IMF, 2013; Miroudot and Yamano, 2013; Antimiani et al., 2016; Balié et al., 2017).

A complete decomposition of gross trade is found in Koopman, Wang and Wei (2014). They provide a unified mathematical framework for the decomposition of total gross exports into three main components: the domestic value-added, the foreign value-added, and the 'reflected' value-

added., i.e. the domestic content in intermediate exports that finally returns home. Each of these components can be further split taking into account the intermediate or final use of the exported goods. Furthermore, they quantify double counted items from standard trade statistics.

Wang, Wei and Zhu (2013) and Borin and Mancini (2015) extend Koopman et al.'s (2014) framework to provide a breakdown of bilateral exports at sector level. The analysis of TVA on a specific bilateral flow can be performed from two different perspectives: looking at the country where the value added originates (source-based), or considering the country that lastly absorbs that value (sink-based). This distinction is relevant whenever a certain portion of value added crosses the same border more than once (Nagengast and Stehrer, 2014; Borin and Mancini, 2015). Since our interest in this work is on the value-added creation related to trade, we adopt here a source-based approach and we assign the value-added exports to the gross trade flow in which it leaves the producing country for the very first time, whereas it is labeled as double counted in case it has crossed international borders previously.

2.2. The GTAP-VA module for GVC analysis

The current standard for GVC analysis relies on input-output (IO) economics, where the linkages across industries and countries are used to quantify the gross output in all stages of production that is needed to one unit of production. A unitary increase in the demand for a final good has an initial output effect on the production and value added of the sector that supplies that good. This in turn implies changes in the production and value added of sectors supplying intermediate inputs to the sector concerned (direct, or first round effect) and indirect effects on the outputs of all the other sectors producing in all the stages of the production chain (Gretton, 2013). In IO analysis, these effects are traditionally assessed using simplifying assumptions, e.g., fixed technological coefficients and an infinitely elastic supply of factors available to the economy so that output can instantaneously and costlessly adjust to any variation in the level of final demand. On the other hand, GVCs are better analyzed as a complex set of general equilibrium interdependencies between countries that reflect a combination of preferences, technology, endowments, and policy (Walmsley et al., 2014, p.17).

Consequently, CGE modeling appears to be a more refined method of analyzing GVC linkages since it takes 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 (Ferrarini and Hummels, 2014). However, traditional CGE models assess changes of trade flows in gross terms. The GTAP-VA (Value Added) module for the GTAP model allows the value-added content of gross flows to be computed from a source-based perspective, i.e., according to the country/sector of origin. On the one hand,

this allows to retrieve the domestic value-added content of exports across borders computing the backward/forward trade linkages. On the other hand, it allows to follow the value added from the sector of origin to the sector of trade highlighting the upstream/downstream position of different industries (Antimiani et al., 2018).

The main advantage of the GTAP-VA module is that it introduces GVCs analysis into a CGE, allowing to assess the changes in countries' GVC-related trade in response to changes in trade policy. In other words, GTAP-VA allows an evaluation of the impact on the entire output which is activated through the production chain for a traded commodity, taking into account substitution and reallocation effects due to changes in prices (e.g., following a tariff removal).

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). The GTAP Model is based on a complete IO accounting framework which takes into account all sources and uses of each economic good and all inputs into production. However, it requires some manipulations in order to perform GVC analysis. The approach followed in this study to track the movement of intermediate inputs across each border is based on work by Peters et al. (2011) which converts the GTAP Data Base into an ICIO Table. We use their procedure to attribute the sourcing of imports for intermediate use. In the standard GTAP Model, the sourcing of imports occurs at the border, providing information on total purchases of intermediate inputs by firms (domestic and imported), and total purchases of final goods by households, government and for investment (domestic and imported), but not attributing bilateral trade to the consuming agent (e.g., firms or final consumption). We link the import demand for each specific agent to the sourcing country/sector by applying proportionality, e.g., using the shares of imports used by firms on the total country's imports and applying them to bilateral trade. In recovering the bilateral delivery of intermediates used by firms, market prices are considered, the closest approximation in GTAP to the *basic* prices used in the standard IO analysis (European Communities, 2008). However, it should be noticed that GTAP market prices are net of taxes but include domestic transport margins (as inputs into the production process) whereas basic prices are defined as net of taxes *and* transport margins (see also, Peters et al., 2011, and Greenville et al., 2017).

In the GTAP Model, regional transport services exports are not associated with particular commodities and routes and it is assumed that all demand is met from the same pool of services (Hertel and Tsigas, 1997). This implies that there is a disconnection between the sector output and the sector users of margins as an intermediate product. In order to include international transportation margins in the value-added multipliers, transportation margins related to the shipment of intermediate goods need to be allocated to the providing countries. Thus, we proportionally

distribute the transport margins over users (firms versus final consumers) and we also need to assume that the use of international transportation services by each route is in proportion to the transport services supply source structures. This allows us to reallocate the supply of international transport margins within the intermediate demand matrices and to include the value created by those sectors in the value-added multipliers. The value-added multipliers applied to trade allow to retrieve the entire value structure underlying gross trade, thus disentangling each country's contribution, in terms of income, in the production of traded goods.

Let i and $j = 1, \ldots, N$ index sectors, and $s, r = 1, \ldots, C$ index countries. Define $\hat{V}$ 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 labor) and the income derived from output and trade-related taxes. Further define A as the technical coefficient matrix with dimension NCxNC, and $L = (I - A)^{-1}$ as the global Leontief inverse (or multiplier) matrix, giving total requirement of output directly and indirectly required worldwide to produce one unit of consumption. Then, the value-added in trade (TVA) can be defined as:

$$TVA_{ij}^{tsr} = \hat{V}_i^t L_{ij}^{ts} * VXE_j^{sr} \qquad (1)$$

where $\hat{V}_i^t L_{ij}^{ts}$ is the value-added multiplier matrix giving the value-added contributions for the entire output directly or indirectly required to produce one 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 domestic and foreign value-added 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.

Equation (1) allows the value added embedded in each input sourced locally or imported to be unpacked within the value of a traded good. Exploiting the information on the origin of value added embedded in trade, we can decompose export values at the sector level into the domestic value added generated in their production, both directly (from the producing/exporting sector) and indirectly (embedded in other domestic sectors' exports, or in other countries' exports), and the foreign value added generated in other countries producing the imported inputs used in exports.

To facilitate GVC analysis in the GTAP Model, GTAP-VA includes several indicators with a straightforward economic interpretation. The new sets and coefficients introduced for TVA analysis within GTAP are reported in Table 1. In the remainder of this section, a detailed explanation of each indicator used in this analysis is provided.

i) Domestic and foreign content of bilateral exports by sector

The original GTAP value for bilateral trade can be split into two main components: the domestic value added, giving the value originated in all sectors of the exporting country s which is embedded in sector j's exports and the foreign value added, which gives the value of imported intermediate inputs embodied in country s's exports in sectorj. The domestic content of gross trade flow refers to the origin country of the first export flow. Thus, we compute a double-counted component which accounts for the portion of domestic value that has previously crossed international borders, and hence is already counted as domestic value added in other bilateral links. Mathematically, this is implemented by introducing the local (or domestic) Leontief inverse, $\mathrm{loc}_{\mathrm{ij}}^{\mathrm{ss}} = (\mathrm{I} - \mathrm{A}_{\mathrm{ij}}^{\mathrm{ss}})^{-1}$, which is computed on the domestic block of the technical coefficients matrix, thus representing intra-country processing only. The difference between the local and the global Leontief inverse ($\mathrm{l}_{ij}^{ss} - \mathrm{loc}_{ij}^{ss}$) gives the portion of the domestic value added that has crossed international borders at least twice. Thus, we can express bilateral exports in terms of three components: the domestic value added (DVA_ex), the double-counted term related to the domestic content (DDC_ex), and the foreign content (FVA_ex):

$$
\begin{aligned}
VXE_j^{sr} &= \sum_i \sum_t TVA_{ij}^{tsr} \\
&= \underbrace{\textstyle\sum_i vsh_i^s loc_{ij}^{ss} * VXE_j^{sr}}_{DVA\_ex_j^{sr}} + \underbrace{\textstyle\sum_i vsh_i^s (l_{ij}^{ss} - loc_{ij}^{s}) * VXE_j^{sr}}_{DDC\_ex_j^{sr}} \\
&+ \textstyle\sum_i \sum_{t \neq s} vsh_i^t l_{ij}^{ts} * \underbrace{VXE_j^{sr}}_{FVA\_ex_j^{sr}}
\end{aligned}
\tag{2}
$$

The domestic VA content of exports gives a measure of the real contribution a given export makes to an economy's income, the remainder being the value of imported inputs representing the import content of exports (i.e., the vertical specialization component).

ii) Bilateral direct/indirect domestic value added by originating sector

Within the domestic value-added component, we compute the sector of origin of value added, assuming that the country of origin coincides with the exporting country. Accordingly, the aggregate domestic value added component can be split by distinguishing between the value

originated in the domestic exporting sector (DVA_dir) and the value originated in other domestic sectors providing intermediate inputs to the domestic exporting sector (DVA_indir):

$$\sum_j DVA\_ex_j^{sr} = \underbrace{\hat{V}_i^s loc_{ii}^{ss} * VXE_i^{sr}}_{DVA\_dir_i^{sr}} + \underbrace{\sum_{j \neq i} \hat{V}_i^s loc_{ij}^{ss} * VXE_j^{sr}}_{DVA\_indir_i^{sr}} \quad (3)$$

iii) Bilateral and multilateral value added by sector, exporter and importer

In order to assess the trade relevance of partner countries, gross bilateral exports are both too much and too little: too much because they include foreign value added (see i)) and too little because they do not take into account the whole international trade network. As a matter of fact, domestic value added reaches every importer through bilateral exports as well as through the value embedded in the exports of third countries to that market.

The total value added of country s which is absorbed by country r is given by the sum of the bilateral ($DVA\_ex_j^{sr}$) and multilateral ($DVA\_mlt_j^{sr}$) components:

$$DVAEXP_j^{sr} = \underbrace{\sum_i vsh_i^s loc_{ij}^{ss} * VXE_j^{sr}}_{DVA\_ex_i^{sr}} + \underbrace{\sum_i \sum_{t \neq s,r} vsh_j^s l_{ji}^{st} * VXE_i^{tr}}_{DVA\_mlt_j^{sr}} \quad (4)$$

The first term in the RHS corresponds to the domestic value in bilateral exports defined in Equation (2). The second term gives the value added of intermediate good j exported by country s and embedded in the third countries' exports to country r.[3] The total exported value added to a given destination may be bigger or smaller than gross trade values, depending on the magnitude of backward and forward linkages. Specifically, gross exports exceed total value-added exports (DVAEXP) when the foreign content of bilateral exports (FVA_ex) is larger than the multilateral value added component (DVA_mlt).

The decomposition used in this analysis allows to retrieve the main components proposed by the literature on TVA, and allows to replicate the main indicators provided by the main databases used in macro analysis of GVCs, such as TiVA or WIOD. However, differently from all the existing trade in value-added decompositions, these indicators are embedded in a simulation model that allows to perform policy analysis. As a matter of fact, it is possible to assess the effect of a policy

[3] In the DVA_mlt component in Equation (4) the order of indexes is reversed in order to express the bilateral and multilateral domestic value-added indicators for the same reference country and sector. Specifically, in DVA_{mlt}, the source country of value is indexed by s (instead of t as in all other equations) and j is the sector of origin of value (instead of i). This allows us to compute the value added originated in the reference country for a given sector which is embedded in goods and reaches the importer both bilaterally and multilaterally.

change on the global structure of GVCs, by comparing the baseline values and the updated values deriving from the shock that has been simulated. We exploit this tool in order to analyze GVC-related trade for Burkina Faso, exploring both the backward involvement (e.g., as user of foreign inputs to produce exports) and the forward participation (e.g., as provider of intermediate in other countries' exports) participation of agriculture and food sectors in GVCs.

3. Data

The GTAP Data Base has been extensively used to perform economic analysis of GVCs (Koopman et al., 2010 and 2014; Daudin et al., 2011; Johnson and Noguera, 2012; Lejour, et al., 2014), mainly due to its consistency, full global coverage, and the large country and sectoral details. The GTAP Data Base reconciles data from different sources into one consistent database with a broad sectoral and regional coverage. However, the database itself does not allow for an accounting of how imported intermediate products are used in exports. 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. In this way, we cannot trace exports of intermediates from one country into the production processes of another, and following on from that, into their contributions to the other countries' exports. That is, it is not possible to directly identify the industry to industry trade required for the construction of an ICIO.

One common approach to overcoming this limitation is to assume that all uses of a good are sourced in the same way (proportionality assumption). Daudin, Rifflart and Schweisguth (2011), Jonson and Noguera (2012) and Lejour, Rojas-Romagosa and Veenendaal (2014) use the GTAP Data Base and the proportionality assumption in order to estimate value-added trade flows and define indicators for GVCs. A more informed procedure is obtained when applying the UN Broad Economic Categories (BEC) classification scheme to the 6 digit harmonized system (HS) level bilateral trade data in COMTRADE. The BEC-influenced sourcing shares for intermediate and final demand are then applied to the original GTAP Data Base (Koopman et al., 2010; Walmsley et al., 2014; Aguiar et al., 2016). However, the BEC classification is far from perfect and has been criticized for its subjective allocation of products which is based on expert judgment concerning descriptive characteristics, particularly with regard to the fact that some goods may be used both as intermediates and final products and which may not align with the equivalent allocations used in national data. The ability of merchandise trade data to differentiate between products on the basis of their likely end-use (for example, whether the goods are intermediate, consumption or capital in nature) and better information on the tariff rates applied on intermediate goods, would improve the

ability to analyze the impact of trade policies. Moreover, it would be important to obtain information at the firm level to relax the assumption that all firms in a given industry have the same import content relative to their output and the same export propensity relative to their output. In this work we apply the proportionality assumption to attribute the sourcing of imports to the specific agent.[4]

The aggregation for this study is reported in Table 2. The aggregation has been informed by a preliminary recognition of Burkina Faso's patterns trade for agriculture and food sectors, in order to identify the main countries and regions involved in trade with those countries and the most important sectors for non-agriculture and food. As for the agriculture and food, we keep all the GTAP sectors disaggregated (twelve sectors for agriculture and eight sectors for food, beverages, and tobacco). In Table A2 in the Appendix, the detailed sectoral aggregation is provided.

[4] The BEC concordance method is used in other databases suitable for GVC analysis, e.g., TiVA, WIOD, and EORA.

Table 2. GTAP Data Base aggregation.

Country/region *	**Sector**
CFTA	*Agriculture*
Burkina Faso	Paddy rice
Senegal	Wheat
Ghana	Cereal grains nec
Other CFTA	Vegetables, fruit, nuts
Rest of SSA	Oil seeds
Rest of MENA	Sugar cane, sugar beet
China	Plant-based fibers
South and South East Asia	Crops nec
India	Cattle,sheep,goats,horses
GCC	Animal products nec
EU_28	Raw milk
North America	Wool, silk-worm cocoons
Latin America	Forestry
Rest of the World	Fishing
	Food
Endowment commodities	Meat: cattle,sheep,goats,horse
(mobile)	Meat products nec
Unskilled Labor	Vegetable oils and fats
Skilled Labor	Dairy products
Capital	Processed rice
	Sugar
	Food products nec
	Beverages and tobacco products
	Other
	Extraction
	Minerals nec
	Petroleum, coal products
	Textiles and Wearing apparel
	Chemical,rubber,plastic prods
	Minerals and Metals
	Light Manufacture
	Heavy Manufacture
	Services

* CFTA: Egypt, Morocco, Tunisia, Rest of North Africa, Benin, Cameroon, Cote d'Ivoire, Guinea, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Uganda, Zimbabwe, Rest of Eastern Africa, Rest of South African Customs. Rest of SSA: Nigeria, Tanzania, Zambia, Botswana, Namibia, South Africa. South and South East Asia: Hong Kong, Japan, Korea, Mongolia, Taiwan, Rest of East Asia, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia, Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia. GCC: Brunei Darussalam, Kuwait, Oman, Qatar, Saudi Arabia, UnitedArab Emirates. EU_28: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia,, Slovenia, Spain, Sweden, United Kingdom, Bulgaria, Croatia, Romania.North America: Canada, United States of America, Mexico, Rest of North America. Latin America: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, 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, Caribbean.

4. Application: the case of Burkina Faso

4.1. Patterns of trade

The assessment of trade patterns is performed considering both gross statistics and value-added flows. This allows to retrieve the contribution of exports to each country's GDP at the sector level and to assess whether the value added embedded in agricultural products is finally consumed in high income countries, emerging countries or regional partners.

Burkina Faso's economy is largely built on services, which account for more than 40% of total output (Figure 1); the share of the agricultural and food sectors is around 30% (18.2% and 9.1%, respectively), and is characterized by the production of cereals, cotton and tobacco products. The production in agriculture and food sectors is mostly for domestic consumption ($4,202 million over a total output of $4,819 million), whereas, following the gold mining boom, exports are dominated by Minerals and Metals, and Extraction (see table A1 in the Appendix for the sectoral details on the disposition of output).

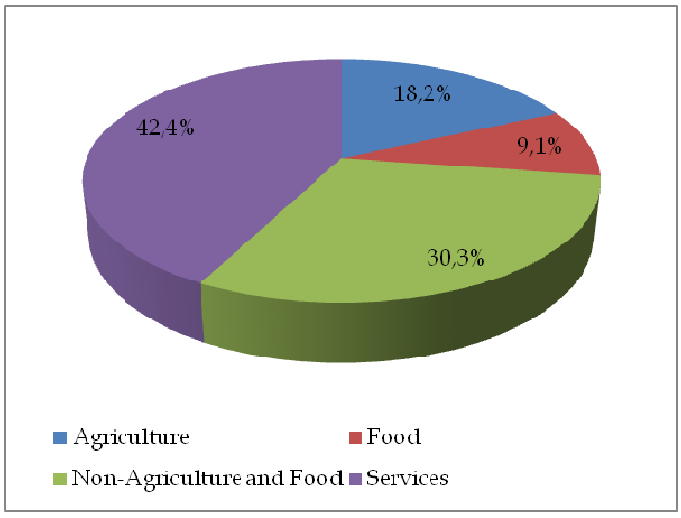

Figure **1**. Composition of Burkina Faso's output, 2014.

In terms of sectors, agriculture and food exports from Burkina Faso are highly concentrated (Table 3). As reported in Table 3, agriculture and food sectors are relatively more intensive of foreign inputs used to produce exports than other sectors. 18.2% of the gross exported value is foreign (18.4% and 14.8 % for agriculture and for food, respectively, and 7.7% for non-agriculture and food sectors). Plant fibers, the "white gold", is the main exporting sector, accounting for more than 60% of total exports in agriculture and food. It is a relatively foreign-input intensive sector, explaining more than 80% of the value of imported inputs used in the production of exports in agriculture and food. Other relevant sectors are Oil seeds, Vegetables and Fruit, Vegetable oils and Cereals, which

are relatively most important in terms of domestic value added, showing a lower share of foreign intermediates used in the production.

Table 3). Agriculture and Food exports from Burkina Faso, main trading sectors (million USD).

	Gross exports	DVA in exports	FVA in exports
Plant-based fibers	393.7	302.0	91.7
Oil seeds	116.2	107.3	8.9
Vegetables, fruit, nuts	54.7	49.6	5.1
Vegetable oils and fats	26.4	22.3	4.1
Cereal grains nec	9.8	9.1	0.7
Other Agriculture and Food	14.7	13.1	1.6
Agriculture	579.7	472.9	106.8
Food	35.8	30.5	5.3
Non-Agriculture and Food	2,829.9	2,610.8	219.1

Source: Authors' computations based on the GTAP-VA model. Baseline 2014.

Out of $615.5 million of exports in agriculture and food, $503.4 million represent Burkina Faso's value added exported in agriculture and food sectors, the rest being the value of imported inputs representing the import content of exports (i.e., the vertical specialization component).

The analysis of the upstream and downstream linkages of the agriculture and food with other domestic sectors reveals that $439 million are exported directly in agriculture and food, whereas $64 million represent the value in intermediate inputs produced in other sectors of the economy and used by agriculture and food to produce exports (Table 4). Agriculture is a relatively direct exporting sector: the 90.7% of the exported domestic value ($473 million) originates within agriculture ($429 million). An opposite pattern is observed in food: 67% of the exported value in food products is originated in other sectors providing inputs to food production.

Agriculture contributes to the export performancealso through the inputs provided to other domestic exporting sectors. $82 million of agriculture and food are embedded in other sectors' exports. There are significant differences at the sector level: Plant-based fibers, Vegetables and Fruit, and Vegetable oils are relatively downstream sectors, whereas Oil seeds and Cereals are more upstream since they are mostly used as inputs by other domestic exporting sectors.

Table 4). Burkina Faso's exports in Agriculture and Food, direct and indirect value added (million USD).

	DVA_dir	DVA_indir	
		Exp. sector: requirement of domestic intermediates	Origin sector: used by other exporting sectors
Plant-based fibers	268.4	33.6	6.9
Oil seeds	101.4	5.9	7.6
Vegetables, fruit, nuts	45.5	4.1	1.3
Vegetable oils and fats	5.2	17.1	0.7
Cereal grains nec	8.7	0.4	1.8
Other Agriculture and Food	10	3.1	63.3
Agriculture	429.1	43.8	74.4
Food	10.1	20.4	7.2
Non-Agriculture and Food	1,733.7	877.1	861.1

Source: Authors' computations based on the GTAP-VA model. Baseline 2014.

In Figure 2 the geographical origin of foreign inputs used in Burkina Faso's exports is represented. High-income countries are main the providers of inputs (42.6%), specifically of Services and Chemicals sectors mainly from the European Union. CFTA countries are also key trade partners, accounting for 25.7% of the total imported inputs, with relatively higher share for the agriculture and food sectors (26.6% and 28.6%, respectively). Other non-regional developing countries (e.g., South-East Asia and China) are also important trade partners providing inputs to Burkina Faso's exports.

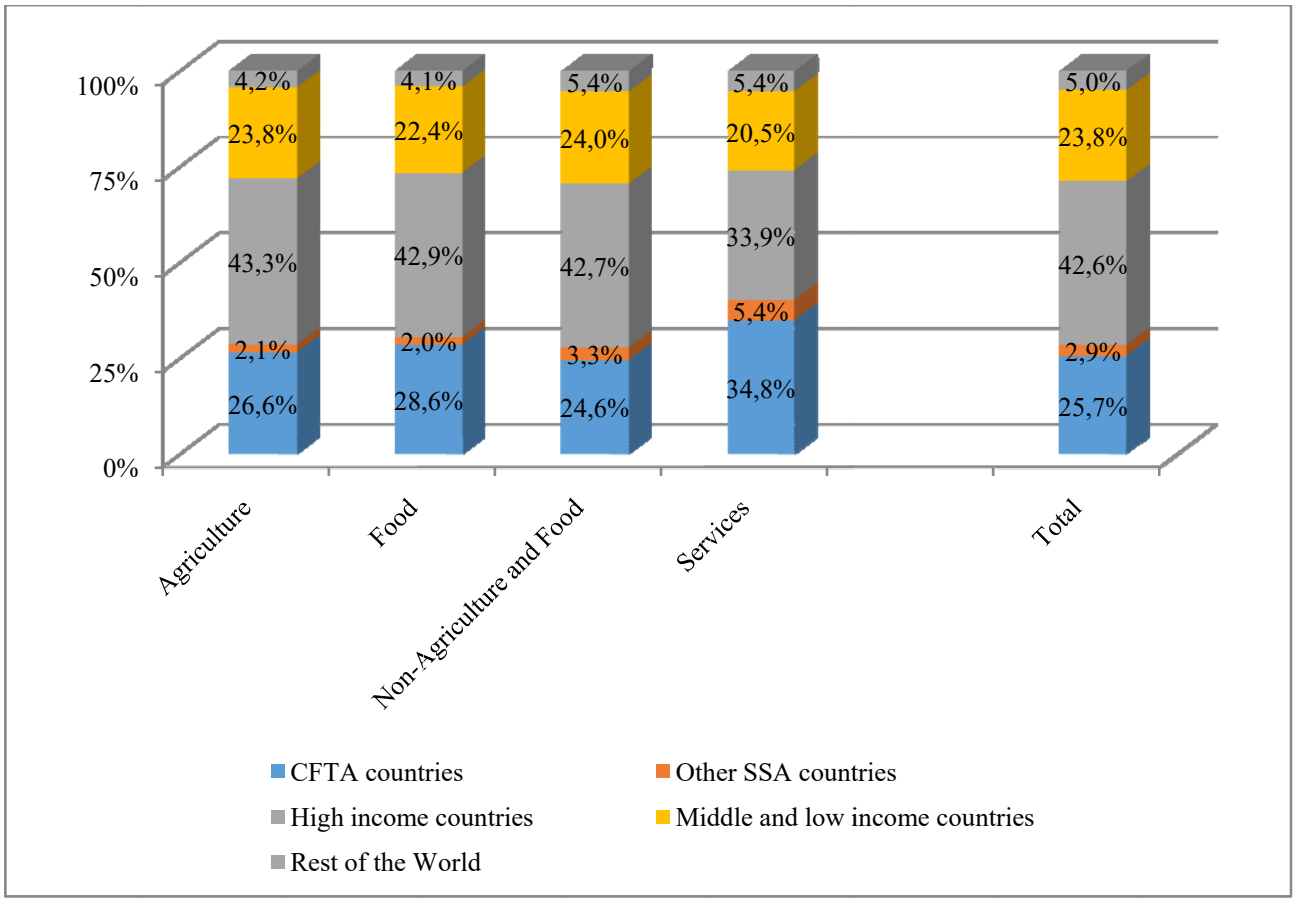

Figure 2. Sourcing of foreign intermediates used in Burkina Faso's exports.

In terms of geographic diversification (Table 5), exports of agricultural products from Burkina Faso are largely bound to non-regional middle- and low-income countries (especially South-East Asia and China). Those countries absorb more than 70% of exports in agriculture. Intra-regional trade with other SSA countries is more limited. However, intra-regional exports are more relevant in terms of domestic value embedded in exports (21.1%), due to a relatively low degree of imported inputs used in the production of those exports (if compared to the exports to other non-regional developing trade partners).

CFTA countries are much more relevant markets for food products from Burkina Faso, absorbing more than half of those exports. High-income countries account for one-fourth of food exports. The production for high-income countries' markets requires less foreign value added than what is embedded in Burkina Faso's exports of food to middle- and low-income countries.

***Table* 5.** Agriculture and Food exports from Burkina Faso, main trade partners.

	Gross exports	DVA in exports	FVA in exports
Agriculture			
Exports (million USD)	579.7	472.9	106.8
Percentage to:			
CFTA countries	*19.6*	*21.1*	*12.9*
Other SSA countries	*0.3*	*0.3*	*0.1*
High-income countries	*7.6*	*8.0*	*5.7*
Middle- and low-income countries	*72.4*	*70.4*	*81.3*
Rest of the World	*0.2*	*0.2*	*0.0*
Food			
Exports (million USD)	35.8	30.5	5.3
Percentage to:			
CFTA countries	*51.4*	*51.5*	*50.9*
Other SSA countries	*0.0*	*0.0*	*0.0*
High-income countries	*24.0*	*24.3*	*22.6*
Middle- and low-income countries	*22.9*	*22.6*	*24.5*
Rest of the World	*1.7*	*1.6*	*1.9*

Source: Authors' computations based on the GTAP-VA model. Baseline 2014.

Next, we use the multilateral value-added export, i.e., domestic value added which is embedded in the exports of third countries to the market of destination, to investigate the trade relevance of partners countries and the channels through which Burkina Faso's value added reaches the markets of final destination (Table 6). The analysis of Burkina Faso's forward linkages for the agriculture and food sectors shows an overall higher degree of this kind of GVC-related trade ($134.3 million) as compared to the backward linkages ($112.1 million, see last column in Table 3). However, we observe different patterns of involvement in GVC between agriculture and foodsectors. While agricultural production seems to be more specialized in providing primary inputs to firms in countries further down the value chain (forward participation), food sectors are mostly buyers of foreign inputs and barely involved in multilateral trade (backward participation).

High-income countries are the main final destination for exports, accounting for more than half of the total agriculture and food value added of exported multilaterally ($72.9 million out of $134.3 million). Middle- and low-income countries absorb 33.7% of multilateral exports, whereas the relevance of regional partner countries is very low (3.8% for CFTA countries, and 1.6% for other SSA). South-East Asia, and China to a lower extent, are the key intermediate importers: irrespective of the final importer, around 60% of Burkina Faso's value added passes through those countries before reaching the final destination. Regional partners also have some relevance, mainly in re-

exports of Burkina Faso's value added to high-income countries and other SSA countries ($7.4 million and $600 thousand, respectively).

Table 6. Burkina Faso's forward connections, agriculture and food only.

Final importer (million USD):	
CFTA countries	5.1
Share of intermediate importer:	
South and South East Asia	*39.2*
China	*21.6*
European Union	*11.8*
Other SSA countries	2.2
Share of intermediate importer:	
South and South East Asia	*31.8*
CFTA countries	*27.3*
China	*22.7*
High-income countries	72.9
Share of intermediate importer:	
South and South East Asia	*44.2*
China	*18.2*
CFTA countries	*10.2*
Middle- and low-income countries	45.2
Share of intermediate importer:	
South and South East Asia	*37.8*
China	*26.8*
European Union	*6.0*

Source: Authors' computations based on the GTAP-VA model. Baseline 2014.

4.2. Trade policy

VA trade flows crucially depend on both the level of protection faced by its exports in the destination countries and the protection applied on imports. Protection data in the GTAP Data Base are sourced from the Market Access Maps (MAcMap) at the six-digit level of the Harmonized System (HS6) and then aggregated using trade weighted averages (Guimbard et al., 2012). MAcMap accounts for 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 non-tariff measures.

Figure 3 records the applied tariff rates included in the GTAP Data Base by the main trade partners on exports from Burkina Faso. Because of its least developed country status, Burkina Faso enjoys preferential access in high-income markets such as the European Union. However, a number of exports from Burkina Faso face relatively high tariffs to get into other developing countries markets (e.g., South and South-East Asia), mainly in agricultural sectors, with the highest level of tariffs on Oil seeds. Trade with other CFTA countries is also affected by significant levels of protection, where industrial sectors are most affected by tariffs. Key exporting agriculture and food sectors, e.g., Oil seeds and Vegetable oils, face a quite high level of protection.

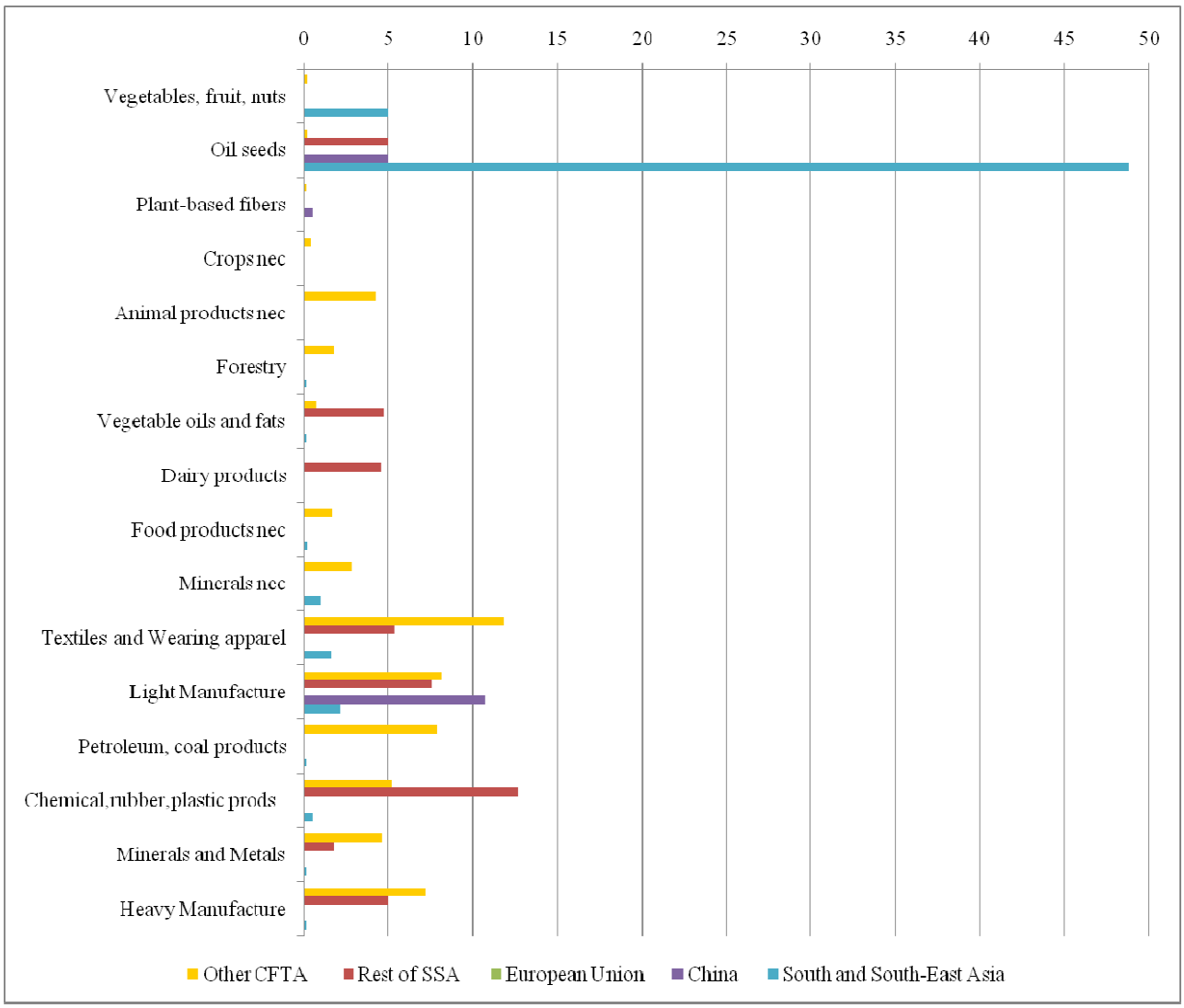

Figure 3. Tariffs applied on imports from Burkina Faso, main trade partners.

In table 7 we give a more detailed information regarding the tariff structure faced by Burkina Faso in trading with regional trade partners. North African countries (e.g., Egypt, Morocco and Tunisia) protect agricultural products from Burkina Faso most heavily than other regional partners. Burkina

Faso also faces quite high barriers for exports of food sectors to an important market such as Ghana, mainly for Vegetable oils and Food products.

Table 7. Tariffs applied on imports from Burkina Faso, regional trade partners.

	Egypt	Morocco	Tunisia	Benin	Cameroon	Cote d'Ivoire	Ghana	Guinea	Senegal	Togo	Ethiopia	Kenya	Mauritius	Mozambique	Rwanda	Uganda	Zimbabwe	Nigeria	South Africa	Tanzania	Zambia
Cereal grains nec	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetables, fruit, nuts	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil seeds	0	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Plant-based fibers	0	1	0	7	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Crops nec	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Animal products nec	0	0	0	0	0	5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Forestry	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Vegetable oils and fats	0	11	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Dairy products	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Food products nec	0	0	0	0	15	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beverages and tobacco products	0	25	0	0	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minerals nec	0	0	0	0	0	5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles	0	0	0	20	0	12	4	0	0	4	0	0	15	0	35	0	0	15	0	0	0
Wearing apparel	0	0	0	20	30	20	20	12	0	20	35	25	0	0	0	0	0	0	0	0	0
Leather products	0	0	0	20	0	19	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wood products	0	0	0	10	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0
Paper products, publishing	0	0	0	3	0	13	20	0	0	20	5	0	0	0	0	0	0	0	0	0	0
Petroleum, coal products	0	0	0	8	0	9	7	0	6	8	0	3	0	0	0	0	0	0	0	0	0
Chemical,rubber,plastic prods	0	0	0	6	0	8	14	0	2	5	0	0	0	0	5	0	6	20	0	0	0
Mineral products nec	0	0	0	0	0	5	10	0	20	5	0	0	0	0	0	0	0	0	0	0	0
Ferrous metals	0	0	0	0	0	10	11	0	0	10	0	0	0	0	0	0	0	0	0	0	3
Metals nec	0	7	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Metal products	0	10	0	20	0	13	11	18	0	0	0	0	0	0	0	0	0	0	0	0	0
Motor vehicles and parts	0	0	0	11	0	8	3	10	14	9	0	0	0	0	9	0	0	0	9	9	0
Transport equipment nec	7	0	0	9	0	7	5	20	0	10	0	0	0	0	5	0	0	0	0	0	0
Electronic equipment	0	0	0	8	10	15	8	0	0	12	0	0	0	0	0	0	0	10	0	0	0
Machinery and equipment nec	0	0	0	0	0	7	0	0	0	6	0	0	0	0	0	0	0	0	2	0	0
Manufactures nec	0	25	0	4	0	16	20	5	20	20	0	0	0	3	0	25	0	0	5	13	0

Note:In Table 8, we exclude sectors and African countries with zero tariffs in Burkina Faso's market (e.g., Madagascar, Malawi, Botswana, and Namibia).
Source: GTAP Data Base Version 10 (pre-release).

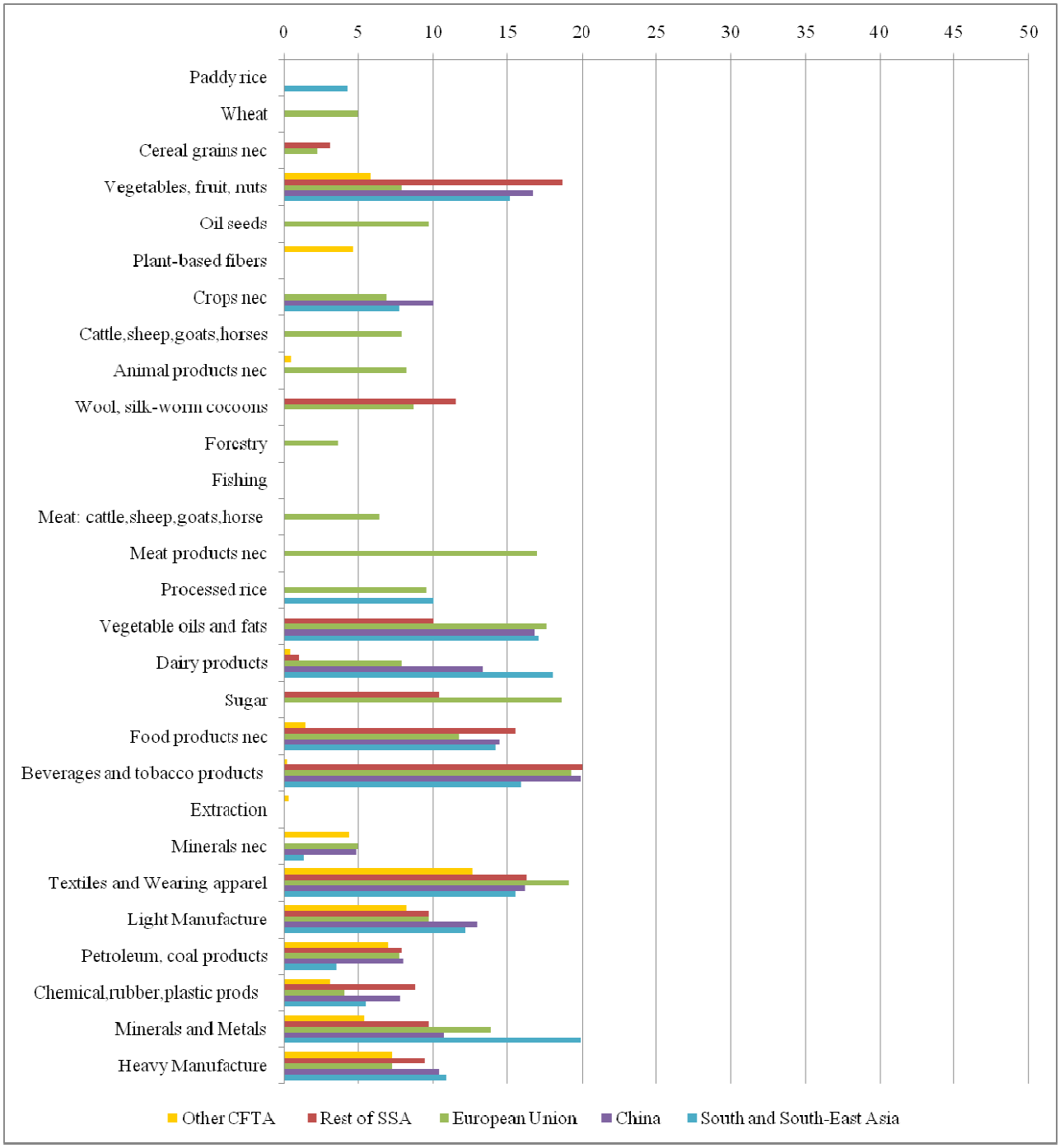

Figure 4. Burkina Faso's tariffs on imports, main trade partners.

Burkina Faso's tariff regime is characterized by high tariffs in almost all sectors from all countries (Figure 4). Table 8 reports Burkina Faso tariffs applied on imports from regional countries. With international fragmentation of production processes and with the increased relevance of foreign intermediate inputs required to export, high levels of trade restrictions may represent an important obstacle to foster exports and increase the trade integration.

Table 8. Burkina Faso's tariffs on imports, regional trade partners.

	Egypt	Morocco	Tunisia	Benin	Cameroon	Cote d'Ivoire	Ghana	Guinea	Senegal	Togo	Ethiopia	Kenya	Madagascar	Mauritius	Mozambique	Rwanda	Zimbabwe	Botswana	Namibia	Nigeria	South Africa	Tanzania	Zambia
Paddy rice	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheat	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cereal grains nec	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
Vegetables, fruit, nuts	20	20	17	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	19	0	19	0	0
Oil seeds	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant-based fibers	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Crops nec	0	0	0	0	0	0	9	0	12	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Animal products nec	0	0	0	0	0	0	8	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wool	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
Fishing	0	0	0	0	0	0	11	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meat: cattle,sheep,goats,horse	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Meat products nec	0	0	0	0	0	0	20	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vegetable oils and fats	0	20	0	0	0	0	13	0	12	0	0	0	0	0	0	0	0	0	0	0	10	0	0
Dairy products	0	20	0	0	0	0	5	0	17	0	0	0	0	0	0	0	0	0	0	6	0	0	0
Processed rice	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sugar	0	0	10	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0
Food products nec	13	13	18	0	0	0	18	0	17	0	0	0	0	0	0	0	0	0	0	20	16	0	0
Beverages and tobacco products	0	0	20	0	20	0	20	0	18	0	0	0	0	0	0	0	0	0	0	20	20	0	0
Coal	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minerals nec	0	5	5	5	0	4	5	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Textiles	0	14	20	16	0	3	19	0	17	20	17	0	0	0	0	0	0	0	0	17	17	0	0
Wearing apparel	20	20	20	20	20	17	20	0	20	16	0	20	0	0	0	20	0	0	0	20	17	0	0
Leather products	0	20	20	20	20	1	20	0	15	19	15	0	0	0	0	0	0	0	0	20	20	0	0
Wood products	13	6	0	11	0	7	10	0	13	20	13	0	13	0	0	0	0	0	0	0	0	0	0
Paper products, publishing	0	12	18	2	2	1	13	0	0	6	0	20	0	0	0	0	0	0	0	13	13	0	0
Petroleum, coal products	0	8	8	7	0	7	6	0	6	8	0	0	0	0	0	0	0	0	0	0	8	0	0
Chemical,rubber,plastic prods	10	2	7	5	0	2	9	0	8	5	0	16	0	4	0	0	0	2	0	15	7	0	0
Mineral products nec	20	11	20	7	10	2	20	0	17	6	0	0	0	0	0	0	0	0	0	10	18	0	0
Ferrous metals	0	6	0	7	0	2	14	0	9	3	0	0	0	0	0	0	0	0	0	17	8	0	15
Metals nec	9	20	11	15	13	8	14	0	11	15	0	0	0	0	0	0	0	0	0	0	20	0	0
Metal products	16	11	14	19	0	3	14	0	20	14	0	20	0	0	0	0	0	0	0	20	15	0	15
Motor vehicles and parts	0	8	11	16	14	8	11	0	11	11	10	0	0	0	0	0	0	0	0	11	19	11	5
Transport equipment nec	5	7	8	10	8	3	10	0	8	14	8	8	8	8	8	0	0	0	0	11	6	8	0
Electronic equipment	14	11	10	11	10	7	3	0	12	4	5	0	0	0	0	0	12	0	0	16	8	0	0
Machinery and equipment nec	16	13	0	8	0	4	8	0	8	9	0	0	0	0	0	0	0	0	0	6	6	0	0
Manufactures nec	7	14	12	18	20	3	20	20	16	14	7	20	20	0	0	0	0	0	0	20	11	0	20

Note:In Table 7, we exclude sectors and African countries with zero tariffs in Burkina Faso's market (e.g., Malawi and Uganda).
Source: GTAP Data Base Version 10 (pre-release).

4.3. Simulation

In our simulation, we fully remove tariffs among countries within the CFTA countries included in the GTAP Data Base (21 countries: Benin, Burkina Faso, Cameroon, Central Africa, Cote d'Ivoire, Egypt, Ethiopia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mauritius, Morocco, Mozambique, Rwanda, Senegal, Togo, Tunisia, Uganda, Zimbabwe; and 5 aggregated regions: South Central Africa, Rest of Eastern Africa, Rest of North Africa, Rest of South African Customs, Rest of Western Africa). It is worth mentioning that, up to date, Botswana, Namibia, Nigeria, South Africa, Tanzania and Zambia have not signed the Agreement.

Table 9. CFTA scenario: sectoral output changes in Burkina Faso.

	Output		Domestic consumption	
	(USD million)	*(% change)*	(USD million)	*(% change)*
Paddy rice	18.7	*0.54*	18.7	*0.54*
Cereal grains nec	977.8	*0.36*	968.0	*0.36*
Vegetables, fruit, nuts	179.9	*-0.22*	125.3	*-0.24*
Oil seeds	162.3	*1.00*	46.8	*5.17*
Sugar cane. sugar beet	61.1	*0.49*	61.0	*0.49*
Plant-based fibers	508.0	*0.53*	113.7	*1.88*
Crops nec	47.4	*0.42*	46.7	*0.43*
Cattle.sheep.goats.horses	503.2	*0.80*	502.7	*0.80*
Animal products nec	169.7	*0.77*	169.2	*0.77*
Raw milk	153.0	*0.46*	152.5	*0.46*
Forestry	406.6	*-0.02*	403.7	*-0.02*
Meat: cattle,sheep,goats,horse	330.0	*0.52*	329.0	*0.55*
Meat products nec	93.7	*0.32*	93.6	*0.32*
Vegetable oils and fats	131.3	*5.89*	97.2	*-0.41*
Dairy products	35.2	*-1.12*	35.0	*-1.13*
Sugar	42.4	*0.00*	42.4	*0.00*
Food products nec	405.4	*-1.72*	400.4	*-1.77*
Beverages and tobacco products	557.3	*0.13*	554.2	*0.13*
Extraction	1,159.2	*-0.10*	28.1	*-2.43*
Minerals nec	648.3	*-0.12*	571.9	*-0.12*
Textiles and Wearing apparel	210.2	*-3.67*	194.4	*-6.72*
Light Manufacture	543.6	*-0.78*	497.5	*-3.79*
Petroleum. coal products	7.0	*-4.11*	5.9	*-9.23*
Chemical,rubber,plastic prods	285.7	*-2.02*	270.3	*-3.67*
Minerals and Metals	2,022.6	*-0.22*	576.9	*-5.24*
Heavy Manufacture	458.8	*0.72*	396.3	*-1.39*
Services	7,501.6	*0.22*	7,404.0	*0.23*

Source: Simulation using the GTAP-VA model.

The sectoral output changes appear in Table 9. Many agriculture and food sectors respond positively to the regional trade liberalization. Overall, the output in agriculture sectors would increase by $13.8 million and the domestic consumption would increase even more (+$14 million), implying a relative decrease in the share of exports on total output from those sectors. Vegetables and Fruits would be less produced (-$400 thousand), and a slight negative impact is found for Forestry.

For food, the increased production (+$2.4 million) is mainly pushed by exports, whereas less would be consumed in the domestic market. Vegetable oils, a quite export oriented sector, experiences +$7.5 million output gain, whereas its domestic consumption would slightly decrease (-0.4%) under the CFTA scenario. Conversely, the output for Food products which are mainly absorbed by the domestic market, would lose $7.1 million.

The industrial production, still accounting for around 30% of the total output, would be reduced in almost all sectors, with the only exception of Heavy manufacture. This is mostly explained by a strong reduction in the domestic consumption side (-$83.4 million). However, we find an increase in exports from industrial sectors (see Table 10). Finally, Services would gain from the CFTA (+$16.8 million), which mostly depends on the increased demand from other domestic downstream exporting sectors.

Table 10 shows Burkina Faso's gross exports and the decomposition by domestic and foreign value added for the CFTA scenario. Gross exports from Burkina Faso would overall increase by 2% (+$69.3 million). In absolute terms this increase is mostly due to the non-agriculture and food sectors (+$61.8 million), consistently with the country's export structure. However, in relative terms the major increase is in the food sectors that would increase their exports by around 20%, both in gross and in value-added terms ($7.7 million and $6.4 million, respectively). We observe almost no changes in gross agricultural exports, and a slight decrease in the domestic content (-0.2%), which is explained by the fact that tariff faced in regional markets in the baseline are at very low levels. It also reflects the lower importance of CFTA countries as destination market for agricultural products (see Table 5). The total domestic value added content increases less than the foreign content (+1.7% against 5.1%).

Table 10. CFTA scenario: Exports from Burkina Faso.

	Gross exports		DVA in exports		FVA in exports	
	(USD million)	*(% change)*	(USD million)	*(% change)*	(USD million)	*(% change)*
Agriculture	579.5	*-0.0*	471,9	*-0.2*	107,6	*0.7*
Food	43.5	*21.5*	36,9	*21.0*	6,6	*24.5*
Non-Agriculture and Food	2891.7	*2.2*	2657,9	*1.8*	233,8	*6.7*
Total	3514.7	*2.0*	3166,7	*1.7*	348,0	*5.1*

Source: Simulation using the GTAP-VA model.

Next, we assess the impacts of the CFTA on the agriculture and food sectors' value added, exported both directly and indirectly; then we investigate the changes in the sourcing of imported intermediates due to the CFTA.

Looking at upstream and downstream linkages among domestic sectors (Table 11), we find a substantial stability in Burkina Faso's direct exports of agricultural products, with a slight decrease in the value of domestic intermediates used by agriculture (-2.9%).However, under the CFTA scenario, we find that the overall contribution of the agriculture in Burkina Faso's exports would increase by $5.2 million, against the slight drop of the gross exports in those sectors. This is mostly explained by the increase in the value of agriculture embedded in other exporting sectors (+6.7%), mainly for Plant-based fibers and Oil seeds, whose demand as input in the production of food

sectors would increase as a consequence of the increased exports of Vegetable oils. This last sector alone accounts for all the observed impact of the CFTA on the food sectors (+$6.5 million against the total +$6.4 million). It is a relatively intensive user of domestic intermediate (see Table 3) and would increase its demand for intermediates from domestic upstream sectors. Moreover, since it faces a significant level of protection in intra-regional exports, it would increase its direct exports by 29.4% after the CFTA.

Table 11. CFTA scenario: exports from Burkina Faso, direct and indirect value added.

	DVA direct		DVA indirect			
			Exp. sector: requirement of domestic intermediates		Origin sector: used by other exporting sectors	
	(USD million)	*(% change)*	(USD million)	*(% change)*	(USD million)	*(% change)*
Plant-based fibers	269.0	*0.3*	32.6	*-3.3*	8.3	*22.1*
Oil seeds	101.1	*-0.1*	5.7	*-6.6*	9.6	*28.0*
Vegetables, fruit, nuts	45.3	*-0.4*	4.2	*2.4*	1.0	*0.0*
Vegetable oils and fats	6.6	*29.4*	22.2	*29.1*	0.6	*0.0*
Other Agriculture and Food	17.0	*-0.6*	5.1	*0.0*	65.2	*2.0*
Agriculture	428.2	*0.1*	43.7	*-2.9*	78.4	*6.7*
Food	10.8	*16.1*	26.1	*23.1*	6.3	*0.0*
Non-Agriculture and Food	1,767.1	*1.9*	890.8	*1.5*	872.4	*1.3*
Total	2,206.1	*1.6*	960.6	*1.8*	957.1	*1.7*

Source: CFTA simulation using the GTAP-VA model.

Turning to the foreign component of gross exports, we already noticed that the foreign content of Burkina Faso's exports would grow more than gross exports due to tariff liberalization (see Table 10), suggesting an increase in the backward participation in GVCs. Table 12 shows the relevance of each region as provider of foreign inputs. Under the CFTA scenario, we find an increase in the regional integration. Regional trade partners would increase their shares as providers of intermediate inputs from 26.6% (see Figure 1) to 30.8%. While the stronger increase is found for non-agriculture and food sectors, agricultural production would also require more intermediate inputs from CFTA countries (+$4.9 million). The backwardly-linked sectors most beneficially affected in CFTA countries would be Chemicals and Services, providing intermediate inputs to Plant fibers' production in Burkina Faso. All other regions would decrease their relative share on total FVA in Burkina Faso's exports.

Table 12. CFTA scenario: sourcing of foreign intermediates used in Burkina Faso's exports.

Agriculture		
FVA in exports (million USD)	107.6	
Percentage from (Absolute change):		
CFTA countries	*30.8*	(4.9)
Other SSA countries	*2.0*	(-)
High-income countries	*40.5*	(-2.4)
Middle- and low-income countries	*22.6*	(-0.9)
Rest of the World	*4.1*	
Food		
FVA in exports (million USD)	6.6	
Percentage from (Absolute change):		
CFTA countries	*33.9*	(0.6)
Other SSA countries	*1.7*	(-)
High income countries	*40.7*	(0.3)
Middle and low income countries	*20.3*	(0.1)
Rest of the World	*3.4*	
Non-Agriculture and Food		
FVA in exports (million USD)	233.8	
Percentage from (Absolute change):		
CFTA countries	*30.4*	(16.0)
Other SSA countries	*3.3*	(0.3)
High income countries	*39.1*	(-1.3)
Middle and low income countries	*22.2*	(-0.3)
Rest of the World	*5.0*	

Source: CFTA simulation using the GTAP-VA model.

As the impact of the tariff liberalization on agricultural exports is very low, we find only modest changes in the exporting patterns for agriculture sectors (Table 13). Burkina Faso would export only slightly more to CFTA partners (+$800 thousand), while the exported value in agricultural goods to non-regional middle- and low-income countries would decrease (-$1.6 million). For food, trade diversion effects would be more pronounced: intra-regional trade would increase by 44% (+$8 million) due to tariff reform, whereas exports to other groups of partner countries would decrease.

Table 13. Agriculture and Food exports from Burkina Faso, main trade partners.

	Gross exports		DVA in exports		FVA in exports	
Agriculture		Absolute change		Absolute change		Absolute change
Exports (million USD)	579,5		471,9		107,6	
Percentage to:						
CFTA countries	*19.7*	0.8	*21.3*	0.7	*12.9*	0.1
Other SSA countries	*0.3*	0.0	*0.3*	0.0	*0.1*	0.0
High-income countries	*7.6*	-0.1	*8.0*	-0.1	*5.7*	0.0
Middle- and low-income countries	*72.2*	-0.9	*70.2*	-1.6	*81.3*	0.7
Rest of the World	*0.2*	0.0	*0.2*	0.0	*0.0*	0.0
Food						
Exports (million USD)	43,5		36,9		6,6	
Percentage to:						
CFTA countries	*60.7*	8.0	*60.4*	6.6	*62.1*	1.4
Other SSA countries	*0.0*	0.0	*0.0*	0.0	*0.0*	0.0
High-income countries	*19.5*	-0.1	*19.8*	-0.1	*18.2*	0.0
Middle- and low-income countries	*18.4*	-0.2	*18.4*	-0.1	*18.2*	-0.1
Rest of the World	*1.4*	0.0	*1.4*	0.0	*1.5*	0.0

Source: CFTA simulation using the GTAP-VA model.

The structure of multilateral exports, those reaching the final destination through other countries' re-exports, gives interesting insights on intra-regional integration (Table 14). Specifically, within the overall increase in the forward connections of agriculture and food exports (+$1.5 million), we observe an increase in the relevance of CFTA countries as final destination markets (4.6% instead of 3.8% in the baseline) which is almost completely explained by the increase in Burkina Faso's value added re-exported regionally(+$1.2 million). We also find a slightly increased importance of the CFTA countries as intermediate links re-exporting to high-income countries (+$300 thousand), whereas tariff reform seems to not impact all other forward links.

Table 14. CFTA scenario: Burkina Faso's forward connections, agriculture and food only.

Final importer (million USD):		
CFTA countries	6.3	(1.2)
Share of intermediate importer (Absolute change):		
South and South East Asia	*31.7*	(-)
CFTA countries	*25.4*	(1.2)
China	*17.5*	(-)
Other SSA countries	2.2	(-)
Share of intermediate importer (Absolute change):		
South and South East Asia	*31.8*	(-)
CFTA countries	*27.2*	(-)
China	*22.7*	(-)
High-income countries	73.2	(0.3)
Share of intermediate importer (Absolute change):		
South and South East Asia	*44.1*	(-)
China	*18.2*	(-)
CFTA countries	*10.5*	(0.3)
Middle- and low-income countries	45.2	(-)
Share of intermediate importer (Absolute change):		
South and South East Asia	*38.1*	(0.1)
China	*26.5*	(-0.1)
European Union	*6.0*	(-)

Source: CFTA simulation using the GTAP-VA model.

5. Concluding remarks

African leaders have long recognized the importance of regional integration as a way of supporting economic development. The debate on the link between trade liberalization and growth is still open among academicians and the capacity of Sub Saharan African economies to realize the potential of intra-Africa trader lies on a complex mix of factors that go beyond the narrow focus on intraregional tariff reductions. The provision of regional and domestic infrastructures, the harmonization of macroeconomic policies, the enhancing of trade enabling institutions, the development of trade facilitation, and a regionally focused diversification plan, have been pointed out as crucial policy areas to exploit the potential for intra-Africa trade (see, for example, Geda and Seid, 2015). Integration could still remove most of the supply-side constraints on regional and international trade and potentially facilitate the region's participation in the global trading system (Mbekeani, 2013).

In this study, we consider the effects of a full tariff removal among CFTA countries on Burkina Faso's GVC-related trade, by exploiting a new developed module for the GTAP model. GTAP-VA implements a decomposition of bilateral gross trade flows in different value added components regarding exporter, importer and third countries. This provides a comprehensive picture of each country/sector level of integration in GVC activities from multiple dimensions, and a useful tool to assess the global, systemic effects caused by a change in trade policies.

Our findings support the view that a more liberalized regional market would strengthen regional integration and boost the participation in international production networks. By tracing value added embedded in trade flows back to its origin or forward to its destination, we give an accurate, evidence-based measure of the true value of trade which is necessary if policy makers are to make informed decisions on trade and economic policy.

First, we find that Burkina Faso does participate in GVC-related trade, even if with just a few sectors. We find different patterns of involvement in GVC for the agriculture and the food sectors. Agricultural sectors participate in value chains mainly as the supplier of raw materials to other countries' exports, whereas the food sectors participate more in terms of sourcing inputs from other trade partners.

Second, agri-food production would be overall positively affected by the regional trade liberalization. Indeed, agricultural exports would decrease in gross and even more when domestic value added is considered. Against this drop, we find that the overall contribution of agriculture in Burkina Faso's exports would still increase, mainly due to its downstream linkages with other domestic exporting sectors. For example, the production of key sectors like Plant-based fibers and Oil seeds would increase as a consequence of the increased demand for inputs in food sectors (mainly, Vegetable oils). Both the increase in direct exports in food sectors and the increase in the production for upstream domestic sectors would imply an increased demand for foreign inputs. Indeed, we find that the foreign content of Burkina Faso's exports would grow more than gross exports due to tariff liberalization, suggesting a more backwardly integrated trading system for the agri-food.

These effects, along with pushing both the backward and the forward participation in agri-food GVCs, would also reinforce regional integration, given the increased relative relevance of regional trade partners within the CFTA. The backwardly-linked sectors most beneficially affected in CFTA countries would be Chemicals and Services, providing intermediate inputs to Plant fibers' production in Burkina Faso.

We finally find an overall increase in the forward connections, mostly explained by re-exports of Burkina Faso's value added by other regional countries (particularly, Ghana). Even if high-income countries and non-regional emerging economies remain main destinations for multilateral exports from Burkina Faso, we observe a slightly increase in the relevance of CFTA countries as destination markets.