

Impact of Tariff and Non-tariff measures removals on structural transformation and poverty in Senegal: the case of AfCFTA

Leysa Maty Sall, Imfall@akademiya2063.org

Associate Scientist, AKADEMIYA2063

Version of April 15th, 2022

Please do not use or quote*

Abstract

The African Continental Free Trade Agreement (AfCFTA) has recently entered into force and it appears as a possibility of economic growth and structural transformation for most African countries. Senegal is among the 54 countries that had signed and the 42 countries that had ratified the agreements. The objective of this study is to i) evaluate the impact of the abolition of imports duties on the transformation of the Senegalese economy ; ii) assess the impact of NTMs removal on Senegal industrial transformation through trade and labor market impact ; iii) estimate the socio-economic impact of AfCFTA on different groups of households.

Four scenarios of the AfCFTA have been simulated, from full to partial liberalization, with a Senegal multi-sector static CGE model based on the STAGE CGE model. . In addition, to have more accurate results, Ad valorem equivalent (AVE) for NTBs estimated by Bao et.al (2020) at disaggregated level are used as an additional shock.

Results suggest some trade diversion effects. Assuming the elimination of Senegal tariffs on all African products, main increase on imports come from sectors such as forestry, tobacco, grain milling, leather and footwear, and food crops. In addition, production increases mainly for manufacturing sectors including manufactured food , chemicals, cash crops , processed tobacco, hotels, fertilizers and machines . In contrast, production decreases for mining products, glass and pottery , food crops and forestry whose production is substituted by imports. Members can experience changes in production and consumption structures, by improving value chains integration through trade. Finally, macroeconomic impacts show that the elimination of trade barriers has the potential to boost trade and transform the production structure of Senegalese economy. However, the choice of sensitive products to be excluded is critical and have several implications.

Results on the socio-economic impact are yet to be included.

Keywords: Senegal, AfCFTA, Structural transformation, CGE modelling, tariffs, non-tariff-measures

Preprint submitted to UNECA-IFPRI CGE modelling course

June 9, 2021

1. Introduction

Senegal is among the 54 countries that had signed and the 28 countries that had ratified the agreements on the African Continental Free Trade Agreement (AfCFTA). The AfCFTA is aligned with the African Union Agenda 2063 and the Sustainable Development Goals and aims to establish a single continent-wide market for goods and services, including the free movement of people and capital. In the agreement, member states of the African Union agreed to eliminate at least 90% of tariff barriers on goods imported from other states. Estimates from the Economic Commission for Africa (UNECA) suggest that the AfCFTA has the potential to boost intra-African trade by 52.3 per cent by eliminating import duties and reducing non-tariff barriers (UNECA, 2019). Besides, as part of the implementation of its strategic development plan, Senegal, like other African countries, implemented a plan called Plan Senegal Emergent (PSE) in 2014 to achieve economic emergence by 2035. The main axis of the PSE, which mobilizes 66.3% of Priority Action Plan (PAP) funding, relies on the structural transformation of the economy and growth. The strategic axes pass through the development of infrastructures and services of transport and energy; of agriculture, breeding, fishing and the agro-food industry; and on mining resources and fertilizers.

The process of structural transformation involves reallocating employment from low-productivity sectors, such as agriculture, to high-productivity sectors, such as manufacturing and marketable services. This reallocation increases average labor productivity and therefore average incomes. This is an essential condition for ensuring sustainable growth in order to reduce poverty. International trade plays a key role in this process, as it allows countries to transform their production structures by moving towards more sophisticated products. Several authors have shown the link between trade and the level of industrialization of the economy (Teignier, 2018). Literature on structural transformation has shown export structure to be a good predictor of economic growth and therefore, can help to understand the underlying knowledge or institutional advantages that make a country competitive (Hausmann et al., 2007; Hausmann & Hidalgo, 2011; Hidalgo et al., 2007).

The objective of this study is to quantify the impact of the abolition of imports duties on the transformation of the Senegalese economy by looking at the effects on the various sub-sectors of the economy. The economic transformation is assessed in terms of both international trade

composition (intra-African potential trade) and domestic output (macroeconomic aggregates, sectoral production, employment by skills, etc.).

For that purpose, the chosen model is a single country static Computable General Equilibrium (CGE) model. Based on the STAGE model (McDonald, 2009), the treatment of a continental agreement for Senegal requires the distinction of intra-Africa trade from the trade relations with the non-Africa rest of the worlds, thus some improvements and adaptations were implemented in the base model. The Senegal CGE model was calibrated for 2014 based on the Social Accounting Matrix (SAM) of Boulanger et al. (2017) with a sector, factor and agents' disaggregation that allow focusing on socio-economic impacts of the AfCFTA. The calibration data is completed with the BACI database (Gaulier & Zignago, 2010) for Senegal bilateral trade and MACMapHS6 (Guimbard et al., 2012) for tariffs between this country and its African and non-African partners.

To assess the socio-economic impact, the latest nationally representative survey "Enquête Harmonisée sur les Conditions de Vie des Ménages" (EHCVM-2018-2019) will be used to calibrate the microsimulation model.

The remaining paper is organized as follows. Section 2 discusses potential impacts of the AfCFTA in Senegal according to the current literature. Section 3 describes the ex-ante situation for trade and tariffs in Senegal by sector and partners and Ad Valorem Equivalent (AVE) of sanitary and Phyto-Sanitary (SPS) measures and Technical barriers to trade (TBT). Section 4 presents the CGE model for Senegal, its improvements compared to the base STAGE model, data calibration and aggregation chosen and presents the scenarios to be simulated. Section 5 presents and discusses the AfCFTA socio-economic impacts in Senegal at the different levels of details. Finally, section 6 provides final conclusions of this exercise of simulations, highlights its technical limitations and potential extensions to overcome them.

2. The potential AfCFTA impacts: the state of the art

2.1. Toward the AfCFTA

Regional integration is an essential pillar of the development programs of African countries. The overall development strategy of the African continent is based on regional integration, as adopted and pursued by the African Union Summit. The basement of boosting African integration are related to the known links between growth and trade in the literature. Increasing regional trade would enrich intra-Africa value chains (e.g., minerals and metals) to then, favour the participation of Africa's products in global value chains. This is an important issue since relative share of manufactured products trade intra-Africa is low compared to worldwide trade in manufactures (Bouet et al., 2020). It is estimated that manufactures exports account for 68% of merchandise exports worldwide while the share is 24% for Senegalese

exports (WorldBank). In this sense, regional integration in Africa can help in diversifying economies away from dependence on the export of just a few raw minerals by adding value; in delivering food and energy security; in generating jobs for the increasing number of young people; and in alleviating poverty and delivering shared prosperity in general terms.

The roadmap of African integration started in 1991 when the African heads of state and government signed the Treaty Establishing the African Economic Community (Abuja Treaty). It set out the guiding principles and objectives, as well as the regional framework aimed at strengthening the integration agenda. The integration strategy adopted by the Abuja Treaty is based on the use of Regional Economic Communities (RECs) as "milestones" for the final continental trade block. AU Member States thus have a dual obligation to comply with the provisions of the Abuja Treaty as well as those of the RECs of which they belong. The continental vision is to create an African Economic Community at the end of six successive stages: .

Under this framework and for the 25th Summit of the African Union, the negotiations for the AfCFTA started in June 2015. The first 44 countries signed the agreement in March 2018, which is structured in six protocols covering:

1. Trade in goods,
2. Trade in services,
3. Dispute settlement system (rules and procedures),
4. Investments,
5. Competition provisions, and
6. Intellectual property rights.

Up to date, only the three first protocols have been adopted. Trade in goods is based on the progressive elimination of import duties of and on African members' products, in accordance with their schedules of tariff concessions. In general terms, this tariff eliminations concerns:

- 90% of tariff lines liberalized within 5 years (10 years for Least Developed Countries LDCs) following the entry into force of the agreement (January 2021);
- 7% of tariff lines designated as "sensitive products" subject to longer phase-out periods of tariff elimination;
- 3% of tariff lines "excluded", for which no tariff concession is offered.

Nevertheless, non-tariff measures that constraint trade in goods should be also considered in this intra-African market access improvement.

For boosting trade in services there are four priority sectors (i.e., tourism,...). Trade in services is complementary to trade in goods. It has been growing fast in the last 10 years and

increasing their shares in global value chain (OMC, 2019). Concerning how to improve trade in services there is two possibilities: same as goods or by common disciplines.

2.2. Potential impacts of the AfCFTA

The recent empirical literature has analysed the potential impacts of the AfCFTA for African economies. Since the purpose of this paper is to evaluate this trade agreement in terms of boosting Senegal industrialization through its integration with the rest of Africa, this state of the art will focus particular on the channel in trade, production, employment and of course on welfare.

In general terms, regional integration helps countries overcoming restrictions that impede free flows of goods, services, capital, people and ideas. The existence of policy barriers limits the possibilities of economic growth and socioeconomic development; thus, regional integration can lead to substantial economic gains. In the context of a free trade agreement, such as the AfCFTA, regional integration allows countries to improve market efficiency and share the cost of public good, they can generate. However, several risks are also known.

Most of papers that particularly address the impact evaluation of the AfCFTA uses Computable General Equilibrium (CGE) models, either static or dynamic. Depetris Chauvin et al. (2017) and Maliszewska & Ruta (2020) use different multi-sector multi-country dynamic CGE models (the former the Mirage-E CGE model and the latter the Envisage CGE model) using the GTAP dataset to evaluate different scenarios of the AfCFTA. As main AfCFTA scenario they reduce/eliminate intra-Africa tariffs in different sectors (some of them with a differentiated treatment due to their sensitivity) but also the add the reduction of some non-tariff measures (NTMs) and the reduction of trade costs as a consequence of the economic integration and infrastructure potential investments. Nevertheless, simulated scenarios in both papers are not identical. While Depetris Chauvin et al. (2017) differentiate tariff elimination scenarios between agricultural and non-agricultural intra-Africa trade, (Maliszewska & Ruta, 2020) follows a tariff cut scheme quite similar to the market access in goods provision in the real agreement. Moreover, the latter identifies sensitive products according to their importance in tariff revenue for each country. Another methodological coincidence between these two works is that they couple their CGE models with microsimulations modules in order to capture distributional impacts of the AfCFTA, between and within some of African countries, such as a poverty analysis. Even when magnitudes differ, findings of both papers are in line, particular for Senegal, which would benefit from this agreement (trade and welfare) particularly due to the reduction of non-trade barriers and trade facilitation of this integration. This is due because, Senegal already benefit from low tariffs in the African markets due to current agreements (e.g. the custom union it belongs).

Abrego et al. (2019, 2020), with a static CGE model, find similar conclusions as (Maliszewska & Ruta, 2020) and (Depetris Chauvin et al., 2017), even under different market structure assumptions (perfect competition, monopolistic competition and heterogeneous firms). Gains from eliminating intra-Africa tariffs are positive but small, specially compared to that could provide lower NTMs and lower transactions costs.

(Mevel & Karingi, 2012) in terms of scenarios compare gains from the AfCFTA with an additional African custom unions. Conclusions highlighted by the authors are that there is not additional intra-Africa trade gains from a continental custom union.

Since all these papers analyse the AfCFTA focusing on international aggregates and macroeconomic indicators for each African country, the purpose of this work is to focus on the AfCFTA impact on the Senegal's economy and to evaluate a potential economic transformation, assessed in terms of both domestic output and international export composition. That is why in section 4 we improved a single-country multi-sector CGE model for Senegal to measure:

- the impact on production and the various economic aggregates,
- the impact on trade potential (intra-African trade), and
- the effect on employment for each qualification.

3. Senegal's trade and tariffs concessions under the AfCFTA

3.1. Senegal trade structure

In 2018, according to the Observatory of Economic Complexity (OEC), Senegal exported a total of 3.89B dollars, making it the number 120 exporter in the world and imported 11.1B dollars, making it the number 97 trade destination in the world. Senegal like many African countries has demonstrated a high degree of dependence on a few agricultural or mineral exports. The structure of Senegalese trade shows that the country mostly exports raw materials and imports finished products. In 2019, exports are driven by primary products like animal related products, fruits and vegetables, food, minerals and fuels which account for more than 70% of total exports (Table 9). Intra-African trade is characterized by a greater proportion of manufactured products than African exports to the rest of the world, which are concentrated in low value-added products like animals, vegetables and chemicals. In contrast, imports are higher for manufacturing products like machinery and equipment (16%), fuels especially petroleum product (26%), transportation (9 %) and metals (9 %) (Table 2). According to UN COMTRADE database (Table 9), 43% of Senegal's total exports are sold in the African market. Main exported product in this market are fuels (34%), food products (16 %), fish products (11%), chemicals (10%) and minerals (9%).

Table 1: Senegal exports by sector - total and intra-Africa - 2019

	Export	Intra-Africa exports	Row exports	Intra-Africa exports
	(% of total exports)	(% of total Intra-Africa Exports)	(% of total row exports)	(% of total exports)
<i>Animal</i>	12.07	11.37	12.60	40.56
<i>Vegetable</i>	12.16	3.96	18.36	14.03
<i>Food product</i>	8.75	16.01	3.25	78.84
<i>Minerals</i>	9.36	9.38	9.34	43.16
<i>Fuels</i>	19.91	34.29	9.03	74.17
<i>Chemicals</i>	12.44	9.59	14.59	33.22
<i>Plastic or Rubber</i>	0.93	1.94	0.17	89.40
<i>Hides and skin</i>	0.16	0.02	0.27	6.61
<i>Wood</i>	0.62	1.00	0.33	69.42
<i>Textile and Clothing</i>	1.14	0.75	1.44	28.27
<i>Footwear</i>	1.00	0.73	1.20	31.55
<i>Stone and Glass</i>	15.43	0.14	27.81	0.38
<i>Metal</i>	3.23	6.70	0.60	89.33
<i>Mach and Electricity</i>	1.39	2.37	0.66	73.07
<i>transportation</i>	1.18	1.43	0.99	52.23
<i>Miscellaneous</i>	0.23	0.33	0.15	62.35
<i>Total</i>	100.00	100.00	100.00	43.07

Source: own elaboration based on UN COMTRADE database

Senegal imports from the rest of Africa is quite limited to the 13% of its total imports in 2019 (Table 2). Senegalese imports from Africa are driven by fuels (50%), vegetables (11%), chemicals (7%) and wood (6%). Fuels include mainly crude oil and coal while palm oil is the main component of vegetables. Goods imported with non African partners are mainly fuels (22%), machinery and equipment(17%) and vegetables (12%).

Table 2: Senegal imports by sector - total and intra-Africa - 2019

	Import	Intra-Africa imports	Row imports	Intra-Africa imports
	(% of total imports)	(% of total Intra-Africa imports)	(% of total row imports)	(% of total imports)
<i>Animal</i>	1.90	1.05	2.0	7.10
<i>Vegetable</i>	11.60	11.56	11.6	12.77
<i>Food product</i>	6.45	5.98	6.5	11.88
<i>Minerals</i>	1.19	0.93	1.2	10.06
<i>Fuels</i>	26.01	50.27	22.4	24.76
<i>Chemicals</i>	7.88	7.20	8.0	11.71
<i>Plastic or Rubber</i>	3.50	2.98	3.6	10.91
<i>Hides and skin</i>	0.11	0.03	0.1	3.80
<i>Wood</i>	2.19	6.36	1.6	37.17
<i>Textile and Clothing</i>	2.32	0.75	2.5	4.14
<i>Footwear</i>	0.24	0.04	0.3	2.14
<i>Stone and Glass</i>	0.77	0.24	0.9	3.95
<i>Metal</i>	8.72	3.77	9.5	5.54
<i>Mach and Electricity</i>	15.76	3.78	17.5	3.07
<i>transportation</i>	9.21	3.15	10.1	4.39

Miscellaneous	2.15	1.90	2.2	11.33
Total	100.00	100.00	100	12.81

Import duties applied for African countries are generally lower than those applied for the rest of the world for all commodity groups of activity except chemicals where tariff rates are 6 percent lower. Energy products like fuels benefit from the lowest tariff rate of 0.63 percent for African while 2 percent is applied in average with other partners. Agri-food products including livestock products, fishery, cereals, fruits and vegetables, and footwear imported from Africa are the most challenging group with tariffs rates from 8 to 13 percent.

Table 3: Senegal import taxes by sector (%)

Sectors	Rest of the world	Africa
<i>Animal</i>	18.58	8.20
<i>Vegetable</i>	15.00	8.68
<i>Food product</i>	17.36	11.91
<i>Minerals</i>	6.86	5.19
<i>Fuels</i>	2.07	0.63
<i>Chemicals</i>	5.34	5.70
<i>Plastic or Rubber</i>	8.79	5.62
<i>Hides and skin</i>	12.43	6.62
<i>Wood</i>	7.82	6.31
<i>Textile and Clothing</i>	16.62	5.26
<i>Footwear</i>	17.28	13.30
<i>Stone and Glass</i>	7.26	5.71
<i>Metal</i>	8.97	5.89
<i>Mach and Electricity</i>	7.21	6.33
<i>transportation</i>	6.79	5.13
<i>Miscellaneous</i>	10.69	10.48

Source: own elaboration based on MacMaps-HS6 database Guimbard et al. (2012)

Senegal's import taxes paid are mainly intended for the rest of the world. Africa only benefits from 3 percent on average (Table 4). Africa's share is relatively larger than average for agricultural and mineral products (9%). African tax revenues from Senegal are driven by primary products like Stone and glass group (17%), vegetable (14%), chemicals (11%) and fuels (10%). In contrast tariff revenue for the rest of the world is more manufacturing oriented with a higher share for machinery and equipment (19 %) and textile and clothing (11 %)

Table 4: Senegal tariff revenue by sector and market of origin

	Rest of the world	Africa
--	-------------------	--------

	(% of total tariff revenue RoW)	(% of total tariff revenue Africa)	(% of total tariff revenue)
<i>Animal</i>	2.94	2.87	2.77
<i>Vegetable</i>	9.30	14.26	4.29
<i>Food product</i>	5.68	8.54	4.21
<i>Minerals</i>	1.30	4.15	8.55
<i>Fuels</i>	6.08	10.40	4.76
<i>Chemicals</i>	6.32	10.68	4.71
<i>Plastic or Rubber</i>	4.73	2.88	1.75
<i>Hides and skin</i>	0.67	0.57	2.42
<i>Wood</i>	2.25	3.50	4.34
<i>Textile and Clothing</i>	11.15	3.05	0.79
<i>Footwear</i>	0.74	0.39	1.54
<i>Stone and Glass</i>	10.20	16.73	4.57
<i>Metal</i>	9.15	9.24	2.86
<i>Mach and Electricity</i>	18.83	5.82	0.89
<i>Transportation</i>	6.45	5.18	2.29
<i>Miscellaneous</i>	4.23	1.74	1.18
Total	100.00	100.00	2.84

Source: own elaboration based on UN COMTRADE and MAcMaps-HS6 Gumbard et al. (2012).

• **Ad Valorem Equivalent of Sanitary and Phyto-Sanitary (SPS) measures and Technical Barriers to Trade (TBT)**

Table 5 below presents the AVEs of SPS and TBT barriers for 24 groups of agricultural products for 3 western African countries sharing borders with Senegal. The latter has trade barriers related to SPS on animals or vegetable fats and oil with an average AVE of 60 percent.

Table 5: Ad Valorem Equivalent of Sanitary and Phyto-Sanitary measures and Technical Barriers to Trade

HS2	HS2 name	AVE for SPS			AVE for TBTs		
		Senegal	Gambia	Mali	Gambia	Mali	Guinea
01	Live animals			-0,13			
02	Meat and edible meat offal		0,49	-0,03	0,65		0,18
04	Dairy produce		0,68	0,18	0,94		
05	Products of animal origin		0,47	0,02	0,81		0,56
06	Live trees and other plants			0,053			
07	Edible vegetables and certain roots and tubers		0,46	0,10	0,67		0,44
08	Edible fruit and nuts		0,49	0,77	0,58		-0,43
09	Coffee, tea, mate and spices		0,55	0,58	0,81		0,52
10	Cereals		0,37		0,51		
11	Products of the milling industry		0,56	-0,43	0,73		1,04
12	Oil seeds and oleaginous fruits		-0,25				1,51
13	Lac; gums, resins and other vegetable saps and extracts						
14	Vegetable plaiting materials; vegetable products nesi						
15	Animal or vegetable fats, oils and waxes and their cleavage products	0,60	0,42	0,68	0,80		0,11

16	Preparations of meat	0,26				
17	Sugars and sugar confectionery	-0,30	1,05			
18	Cocoa and cocoa preparations	0,44	0,27	0,59		-0,13
19	Preparations of cereals, flour, starch or milk; pastrycook products	0,46	0,41	0,66		0,44
20	Prep. of vegetables, fruit, nuts or other parts of plants	0,41	0,18	0,61	0,18	0,23
21	Miscellaneous edible preparations		-0,14		0,63	0,90
22	Beverages, spirits and vinegar	0,83		1,46		0,88
23	Residues and waste from the food industries; prepared animal fodder	0,52	0,21	0,79		-0,32
24	Tobacco and manufactured tobacco substitutes					-0,84

Source: Nguyen, Bouet, and Traore 2020.

Note: These are import-weighted averages at the HS2 level of AVEs calculated at the HS6 level.

4. Modelling issues

The simulation model chosen for the Senegal economy is a single-country multi-sector multiagent static CGE model based on the STAGE CGE model in its free available version (STAGE 1) (McDonald, 2009). This model is commonly used for representing African economies (Kenya, Ethiopia, Senegal, Mozambique, Botswana, etc.) and provides a basis on which adding bilateral trade behaviours to simulate the AfCFTA.

Main characteristics of the STAGE model are:

- a generalised treatment of trade relationships by incorporating provisions for non-traded exports and imports;
- relaxation of the small country assumption for exported commodities that do not face perfectly elastic demand on the world market;
- multiple product activities (fixed proportions of commodity outputs);
- production technologies specified as nested Constant Elasticity of Substitution (CES);
- household consumption expenditure represented by Stone-Geary utility functions.

Trade is modelled using nested CES (imports) and CET (exports) functions with an adaptation to mitigate the impacts of small trade shares.

There also are multiple tax instruments on commodities, activities, factors and institutions, and multiple sources of savings. The model is designed to include many factor and household accounts.

4.1. STAGE CGE model with bilateral trade modelling

In the basic STAGE CGE model trade is modelled using the Armington insight Armington (1969) under the assumption that imperfect substitution between domestically produced and imported goods is represented by a one-level CES function. In addition, exports are assumed to be imperfect substitutes for domestically produced goods and this is represented by a one-level CET function.

Small country assumption can be relaxed with Export Demand functions. This model allows for non-traded and non-produced and non-consumed domestic goods (*ARMALT* and *CETALT*).

Nevertheless, this basic model does not distinguish between different origin of imports and export markets, which is required for a proper modeling and simulation of the AfCFTA.

For that paper, the trade block has been improved by extending imports and exports trees (Figures 1 and 2).

4.1.1. Modeling of Imports block

Imports are modeled using a two-way trade. To explain two way trade, paul Armington (1969) : internationally traded products are differentiated by country of origin Competition is not only due to price. To model model differentiation, we use Constant Elasticity of Substitution (CES) where the elasticity varies depending of the characteristics of the product.

In figure 1 shows a CES demand function where: QQ is the quantity of a composite commodity, QM is the total quantity of that commodity imported, QM_{afr} is the total quantity of that commodity imported from Africa, QM_{row} is the total quantity of that commodity imported from other regions outside Africa, QD is the quantity of that commodity that is produced and consumed domestically.

For each zone (rest of Africa and Regions outside Africa), The domestic price of competitive imports ($M1$) is the product of the world price of imports (PWM), the exchange rate (ER) and one plus the import tariff rate (TMc) . These equations are only implemented for members of the set c that are imported, i.e., for members of the subset cm .. The domestic supply equations are modeled using Constant Elasticity of Substitution (CES) functions and associated first order conditions to determine the optimum combination of supplies from domestic and foreign

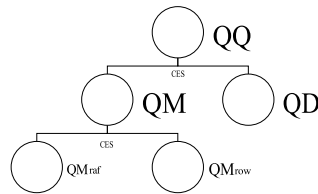


Figure 1: Import demand tree - CES structure

(import) producers. The domestic supplies of the composite commodities (QQ) are defined as CES aggregates (M2) of domestic production supplied to the domestic market (QD) and imports (QM), where aggregation is controlled by the share parameters (δ_c), the elasticity of substitution parameters (ρ_{hoc}) and the shift/efficiency parameters (a_c).

The first order conditions (M3) define the optimum ratios of imports to domestic demand in relation to the relative prices of imported (PM) and domestically supplied (PDD) commodities. But (M2) is only defined for commodities that are both produced domestically (cx) and imported (cm). Although this condition might be satisfied for the majority of commodities, it is also necessary to cover those cases where commodities are produced but not imported, and those cases where commodities are not produced domestically and are imported.

$$PM_c = PWM_c * (1 + TM_c) * ER \quad \forall cm. \quad (M1)$$

$$QQ_c = a_c (\delta_c^{QM} c^{-\rho_{hoc}} + (1 - \delta_c) QD_c^{-\rho_{hoc}})^{-\frac{1}{\rho_{hoc}}} \quad \forall cm \text{ AND } cx. \quad (M2)$$

$$\frac{QD_c}{PM_c} = \frac{(1 - \delta_c) QM_c}{\delta_c QM_c} \quad \forall cm \text{ AND } cx. \quad (M3)$$

$$QQ_c = QD_c + QM_c \quad \forall (cmn \text{ AND } cx) \text{ OR } (cm \text{ AND } cxn) \quad (M4)$$

$$\frac{QD_c}{QM_c} = \left[\frac{PDD_c}{PM_c} * \frac{\delta_c}{1 - \delta_c} \right]^{-\frac{1}{(1 + \rho_{hoc})}}$$

- Disaggregation of imports demand

To disaggregate imports on the demand side, we assume that imports from Africa and outside Africa are imperfect substitutes. The disaggregation follows the following equation:

$$PM_c * QM_c = PMrow_c * QMrow_c + PMrafr_c * QMrafr_c \quad \forall cm. \quad (M5)$$

$$QMrow_c = am.row_c * QM_c * \left(\frac{PM}{PMrow_c} \right)^{\sigma.arm_c} \quad \forall cm. \quad (M6)$$

$$QMrafr_c = am.rafr_c * QM_c * \left(\frac{PM}{PMrafr_c} \right)^{\sigma.arm_c} \quad \forall cm. \quad (M7)$$

$$PMrow_c = PWMrow_c * (1 + TMrow_c) * ER \quad \forall cm. \quad (M8)$$

$$PMrafr_c = PWMrafr_c * (1 + TMrafr_c) * ER \quad \forall cm. \quad (M9)$$

- Modeling Rest of the world Africa and ROW outside Africa imports

Imports Supply by the rest of the world and the rest of Africa in Senegal in good c

$$QMrafr_c = fm.rafr_c * (PWMrafr_c / (1 + te.star.rafr_c))^{\sigma_{m,armc}} \quad \forall cm. \quad (M10)$$

$$QMrow_c = fm.row_c * (PWMrow_c / (1 + te.star.row_c))^{\sigma_{m,armc}} \quad \forall cm. \quad (M11)$$

where:

- $pwm,row(c)$ is the foreign price of imports of good c - units of foreign currency
- $pwm,afr(c)$ foreign price of imports of good c - units of foreign currency

4.1.2. Modeling of Exports block

To model exports, we assume that assumed that production directed to one market is different from production directed to another market. This imperfect substitutability is represented by means of a constant elasticity of transformation (CET) aggregator function that describes how readily production can be redirected from one market to another.

A CET supply function is presented in Figure 2, where: QXC is the quantity of a commodity produced domestically, QE is the total quantity of that commodity exported, QE_{afr} is the total quantity of that commodity exported to Africa, QE_{row} is the total quantity of that commodity exported outside Africa, QD is the quantity of that commodity that is consumed domestically.

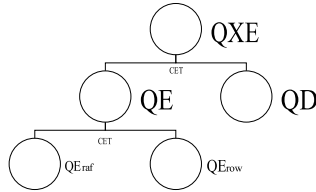


Figure 2: Export supply tree - CET structure

The domestic price of exports (E1) is defined as the product of the world price of exports (PWE), the exchange rate (ER) and one minus the export tax rate and are only implemented for members of the set c that are exported, i.e., for members of the subset ce . The world price of imports and exports are declared as variables to allow relaxation of the small country assumption and are then fixed as appropriate in the model closure block.

$$\frac{PE_c}{PE_c} = \left[\frac{PE_c}{PE_c} * \frac{(1 - \gamma_c)}{(1 - \gamma_c)} \right] \frac{1}{(1 - \gamma_c)} \quad \forall ce. \quad (E1)$$

$$QXC_c = at_c (\gamma_c QE_{crhot_c} + (1 - \gamma_c) QD_{-crhot_c}) \quad \forall ce \text{ AND } cd. \quad (E2)$$

$$QE_c = \frac{QD_c}{\gamma_c} \quad \forall ce \text{ AND } cd. \quad (E3)$$

$$QXC_c = QD_c + QE_c \quad \forall (ce \text{ AND } cd) \text{ OR } (ce \text{ AND } cdn) \quad (E4)$$

$$QE_c = \frac{PE_c^{-\eta_{ac}}}{PWE_c} \quad \forall ced \quad (E5)$$

• Disaggregation of imports demand

To disaggregate exports on the supply side, we assume that exports to Africa and outside Africa are imperfect substitutes. The disaggregation follows the following equation:

$$QE_{rafr_c} = ax.rafr_c * QE_c * \left(\frac{PE_{rafr_c}}{PE_c} \right)^{\sigma.cet_c} \quad \forall ce \text{ and } cd. \quad (E6)$$

$$QE_{row_c} = ax.row_c * QE_c * \left(\frac{PE_{row_c}}{PE_c} \right)^{\sigma.cet_c} \quad \forall ce \text{ and } cd. \quad (E7)$$

$$PE_c * QE_c = PE_{row_c} * QE_{row_c} + PE_{rafr_c} * QE_{rafr_c} \quad \forall ce \text{ and } cd. \quad (E8)$$

$$PE_{rafr_c} = PWE_{rafr_c} * (1 - TE_{rafr_c}) * ER \quad \forall cm. \quad (E9)$$

$$PE_{row_c} = PWE_{row_c} * (1 - TE_{row_c}) * ER \quad \forall cm. \quad (E10)$$

- Modeling foreign demand

Export demand of Senegal by the rest of the world and the rest of Africa in Senegal in good c

$$QE_{rafr_c} = econ.rafr_c * (PWE_{rafr_c} / (1 + tm.star.rafr_c))^{\sigma_{xc}} \quad (E11)$$

$$QE_{row_c} = econ.row_c * (PWE_{row_c} / (1 + tm.star.row_c))^{\sigma_{xc}} \quad (E12)$$

where:

- $PWE_{row}(c)$ is the foreign price of exports of good c - units of foreign currency
- $PWE_{rafr}(c)$ foreign price of exports of good c - units of foreign currency
- $tm.star.rafr(c)$ tarif a l'importation du reste de l'afrique sur le bien i en provenance du Senegal
- $tm.star.row(c)$ tarif a l'importation du reste du monde sur le bien i en provenance du Senegal

4.2. The SCIndex

A commonly used method of measuring structural change in output (and employment) is the rate or coefficient of (composition) structural change, often referred to as a SCI. The SCI for output may be defined as half the sum of the absolute value of the differences in value-added shares over time. The calculation is given by the formula:

$$\frac{1}{2} \sum_i |x_{i,t} - x_{i,t-1}| \quad (1)$$

where $x_{i,t}$ and $x_{i,t-1}$ represent each industry's share of total value-added at time (t) and (t-1), respectively. The use of absolute values ensures that positive and negative changes in industry shares do not cancel each other out when the values are summed across industries.

The SCI is bounded between zero and 100, with zero representing no structural change while 100 indicates a complete reversal of structure (OECD 1994).

In order to compute this indicator for sectors' production and labours' value-added we will consider the initial situation of 2014 and the results under each AfCFTA scenario.

4.3. Calibration data

Senegal's CGE model requires three main data sources for calibration:

- Social Accounting Matrix (SAM) for Senegal: we have chosen the most recent (2014) and free available SAM Boulanger et al. (2017) ;
- Bilateral trade (imports and exports) between Senegal and its African and non-African partners at a compatible sector level with the SAM: we have used the BACI database Gaulier & Zignago (2010) to reflect trade structure of Senegal in 2014;
- Trade protection in Senegal over imports coming from African and non-African partners in a compatible sector breakdown with the SAM: we have been working with MAcMap-HS6 database Guimbard et al. (2012) for 2013/2017 duties.

The Senegal SAM 2014 from (Boulanger et al., 2017) considers 218 accounts, from which 55 are the economic activities (including 14 household accounts as producers), 66 commodities (including 3 agricultural commodities and 9 accounts of self-consumed products), 3 categories of labours differentiated by qualification (skilled, semi-skilled and unskilled) in 14 Senegalese regions and the rest of the world, 5 capital accounts (agricultural, non-agricultural, non-irrigated land, irrigated land and livestock), 5 taxes and tax accounts (direct, indirect, sales, labour factor and imports), 33 categories of representative households (regionalized),¹ on account for margins, an investment savings account, 4 accounts allocating investments (roads, irrigation, other infrastructure, rest of investments) and 3 accounts for enterprises, government, and the rest of the world (Table 5).

Table 5: Senegal SAM 2014 - Accounts details - Boulanger et al. (2017)

Categories	Description
Activities	55 activities including 14 representative household groups producers
Commodities	66 commodities with 57 marketed commodities and 9 self-consumed commodities
Regions	14 regions including Dakar.
Labor	3 labours by qualification (skilled, semi-skilled and unskilled) in 14 Senegalese regions and the rest of the world

¹ The regions considered are : Dakar, Ziguinchor, Diourbel, Saint-Louis, Tambacounda, Kaolack, Thies, Louga, Fatick, Kolda, Matam, Kaffrine, Kedougou, S'edhiou. Households from Dakar are splitted by quintile of income and in the rest of regions they differentiate by rural and urban households.

Capital and Land	5 capital accounts (agricultural, non-agricultural, nonirrigated land, irrigated land and livestock),
Households	33 categories of representative households (regionalized): 5 quintiles of income in Dakar and 2 (rural and urban) in other regions.
Other institutions	3 accounts for enterprises, government, and the rest of the world.
Investment and savings	An investment savings account, 4 accounts allocating investments (roads, irrigation, other infrastructure, rest of investments)
Taxes	5 tax accounts (direct taxes, indirect taxes, sales taxes, Factor taxes and imports taxes)

In order to calibrate the Senegal CGE model and to properly address the objective of this paper we have chosen a particular aggregation of the original SAM's accounts (Table 6). So, we will have a SAM of 112 accounts: 44 activities and commodities (one of each represents a good of self-production/consumption by households), 10 production factors (Senegal and rest of the world's labour by 3 skills; 1 land and 3 capital - agricultural, non-agricultural and livestock); 2 representative households in Senegal (rural and urban), 1 household of the rest of the world, enterprises aggregated at national level with one single representative group. Other institutions include the government (with its taxes) and the rest of the world.

Table 6: Senegal SAM Aggregation and CGE model accounts

Activities	Commodities	Factors	Agents	Taxes	Others
Self-cons. HH activity	Self-cons. good HH	High skilled labour SEN	Urban HH SEN	Value added taxes	Inv-Savings
Food crops	Food crops	Medium skilled labour SEN	Rural HH SEN	Import duties	Stock Changes
Cash crops	Cash crops	Unskilled labour SEN	HH ROW	Export taxes	Transport margins
Livestock	Livestock	High skilled labour ROW	Government	Excise duty	Trade margins
Forestry	Forestry	Medium skilled labour ROW	Enterprises	Sales taxes	
Fish	Fish	Unskilled labour ROW	Rest of World	Production taxes	
Mining products	Mining products	Land		Factor taxes	
Meat - Fish processed	Meat - Fish processed	Livestock		Direct income taxes	
Grain milling	Grain milling	Capital agri			
Cereal based food	Cereal based food	Capital non-agri			
Sugar	Sugar				
Other manufactured food	Other manufactured food				

Beverages	Beverages
Tobacco (processed)	Tobacco (processed)
Textile & clothing	Textile & clothing
Leather & footwear	Leather & footwear
Wood & paper	Wood & paper
Printing and publishing	Printing and publishing
Petroleum	Petroleum
Chemicals	Chemicals
Fertilizers	Fertilizers
Rubber	Rubber
Glass, pottery	Glass, pottery
Metals	Metals
Machines	Machines
Equipment	Equipment
Transport material	Transport material
Other manufactures	Other manufactures
Electricity	Electricity
Construction	Construction
Trade	Trade
Maintenance / Repair	Maintenance / Repair
Hotels	Hotels
Transport	Transport
Communication	Communication
Finance	Finance
Real estate	Real estate
Other business services	Other business services
Administration	Administration
Education	Education

Health	Health
Other personal services	Other personal services

Trade (Gaulier & Zignago, 2010) and protection data (Guimbard et al., 2012) have been used to calibrate bilateral trade imports and export functions of the model. Ad-valorem equivalent tariff from Senegal have been aggregated at the sector level (Table 6) and for African and nonAfrican partners using the weight of the reference group from MACMaps-HS6. Sectoral imports and exports have been splitted between Africa and the rest of the world by applying trade shares calculated on the based of UNCOMTRADE data for each SAM sector.

4.4. AfCFTA experimental scenarios

- **Removal of Tariffs**

According to the criteria of the share in the Senegal tariff revenue for Africa imports (Table 3), we classify tariff lines (at HS4 level) a sensitive capping to 10% of tariff lines and the for those lines that compromise 30% of Senegal's tariff revenue. Tariff revenue for each country generated from imports is ranked by descending order to identify the two categories, sensitive and non-sensitive goods.

For ranking the lines from the most sensitive to the least sensitive and ultimately determining the lists of products under each of the two categories for the two scenarios.

Full Trade Liberalisation: elimination of all tariffs on Senegal's imported goods from the rest of Africa.

Partial Trade Liberalisation with 10% of HS lines as sensitive: elimination of all tariffs between Senegal and the rest of Africa except for sensitive products. An alternative to thus scenarios assumes a tariff cut of a 50% for these sensitive products.

Partial Trade Liberalisation with sensitive of 30% of tariff revenue: elimination of all tariffs between Senegal and the rest of Africa except for sensitive products that concentrate 30% of tariff revenue.

Table 7: African Continental Free Trade Agreement - Senegal's Scenarios of tariff cuts (ratios)

Senegal's Scenarios in the African Continental Free Trade Agreement		
Full Liberalisation	Sensitive Products - 10% HS6 lines	Sensitive Products - 30% in tariff revenue

		No tariff change	50% tariff cut	No tariff change
Food crops	-1.00	-0.07	-0.53	-0.78
Cash crops	-1.00	-0.06	-0.53	-0.42
Livestock	-1.00	-0.56	-0.78	-1.00
Forestry	-1.00	-0.27	-0.64	-1.00
Fish	-1.00	-0.14	-0.57	-1.00
Minning products	-1.00	-0.02	-0.51	-0.28
Meat - Fish processed	-1.00	-0.21	-0.61	-1.00
Grain milling	-1.00	-0.09	-0.55	-1.00
Cereal based food	-1.00	-0.10	-0.55	-1.00
Sugar	-1.00	-0.01	-0.51	-1.00
Other manufactured food	-1.00	-0.11	-0.55	-1.00
Beverages	-1.00	-0.06	-0.53	-1.00
Tobacco (processed)	-1.00	-0.02	-0.51	-1.00
Textile & clothing	-1.00	-0.48	-0.74	-1.00
Leather & footwear	-1.00	-0.48	-0.74	-1.00
Wood & paper	-1.00	-0.19	-0.59	-1.00
Printing and publishing	-1.00	-0.22	-0.61	-1.00
Petroleum	-1.00	-0.01	-0.51	-0.29
Chemicals	-1.00	-0.13	-0.57	-0.70
Fertilizers	-1.00	-0.05	-0.52	-1.00
Rubber	-1.00	-0.24	-0.62	-1.00
Glass, pottery	-1.00	-0.33	-0.67	-1.00
Metals	-1.00	-0.25	-0.62	-1.00
Machines	-1.00	-0.54	-0.77	-1.00
Equipment	-1.00	-0.37	-0.68	-1.00
Transport material	-1.00	-0.08	-0.54	-0.69
Other manufactures	-1.00	-0.51	-0.75	-1.00
Transport	0.00	0.00	0.00	0.00
Communication	0.00	0.00	0.00	0.00
Finance	0.00	0.00	0.00	0.00
Other business services	0.00	0.00	0.00	0.00
Education	0.00	0.00	0.00	0.00
Health	0.00	0.00	0.00	0.00
Other personal services	0.00	0.00	0.00	0.00

To simulate the impact of the full liberalization, the same criteria were applied by the rest of Africa for each scenario. Tariff cuts for Africa are presented in Table 4.4.

Africa's Scenarios in the African Continental Free Trade Agreement				
Full Liberalisation	Sensitive Products - 10% HS6 lines		Sensitive Products - 30% in tariff revenue	
	No tariff change	50% tariff cut	No tariff change	
Food crops	-1.00	-0.01	-0.51	-1.00

Cash crops	-1.00	-0.37	-0.69	-1.00
Livestock	-1.00	-0.18	-0.59	-1.00
Forestry	-1.00	-1.00	-1.00	-1.00
Fish	-1.00	-0.01	-0.51	-1.00
Minning products	-1.00	0.00	-0.50	-0.08
Meat - Fish processed	-1.00	-0.29	-0.65	-1.00
Grain milling	-1.00	-0.02	-0.51	-1.00
Cereal based food	-1.00	-0.01	-0.50	-1.00
Sugar	-1.00	-0.04	-0.52	-1.00
Other manufactured food	-1.00	-0.01	-0.50	-1.00
Beverages	-1.00	-0.07	-0.54	-1.00
Tobacco (processed)	-1.00	0.00	-0.50	-1.00
Textile & clothing	-1.00	-0.11	-0.56	-1.00
Leather & footwear	-1.00	-0.10	-0.55	-1.00
Wood & paper	-1.00	-0.09	-0.54	-1.00
Printing and publishing	-1.00	-0.58	-0.79	-1.00
Petroleum	-1.00	0.00	-0.50	-1.00
Chemicals	-1.00	-0.04	-0.52	-1.00
Fertilizers	-1.00	-0.10	-0.55	-1.00
Rubber	-1.00	-0.05	-0.53	-1.00
Glass, pottery	-1.00	-0.22	-0.61	-1.00
Metas	-1.00	-0.04	-0.52	-1.00
Machines	-1.00	-0.28	-0.64	-1.00
Equipment	-1.00	-0.10	-0.55	-1.00
Transport material	-1.00	-0.05	-0.51	-1.00
Other manufactures	-1.00	-0.12	0.00	-1.00
Transport	0.00	0.00	0.00	0.00
Communication	0.00	0.00	0.00	0.00
Finance	0.00	0.00	0.00	0.00
Other business services	0.00	0.00	0.00	0.00
Education	0.00	0.00	0.00	0.00
Health	0.00	0.00	0.00	0.00
Other personal services	0.00	0.00	0.00	0.00

- **Removal of Non-Tariff barriers**

For each scenario a total removal on non-tariff barriers using AVEs estimated by Nguyen et. Al 2020 is applied in addition to tariff liberalization.

5. Socio-economic impact of AfCFTA agreement: the results (To be updated)

5.1. Trade impact

Table 8: Impact on bilateral Senegal's imports by product (% change compared to the baseline)

Senegal's Imports - African Continental Free Trade Agreement									
	Full Liberalisation		Sensitive Products - 10% HS6 lines				Sensitive Products - 30% in tariff revenue		
			No tariff change		50% tariff cut		No tariff change		
	<i>Africa</i>	<i>RoW</i>	<i>Africa</i>	<i>RoW</i>	<i>Africa</i>	<i>RoW</i>	<i>Africa</i>	<i>RoW</i>	
Food crops	38.94	-1.27	2.18	-0.07	18.69	-0.63	28.69	-1.02	
Livestock	0.70	0.19	0.29	0.01	0.47	0.07	0.62	-0.11	
Fish	0.37	0.18	0.03	0.01	0.20	0.09	0.30	0.11	
Cash crops	25.81	-1.67	1.40	-0.07	12.68	-0.89	10.29	-0.40	
Forestry	30612.02	-45.70	124.38	-1.21	993.27	-6.34	30593.13	-45.73	
Minning products	0.48	-0.03	0.03	0.02	0.25	-0.01	0.18	0.04	
Meat - Fish processed	7.08	-0.17	1.41	-0.08	4.19	-0.13	6.94	-0.30	
Other manufactured food	2.44	-0.61	0.25	-0.07	1.33	-0.35	2.41	-0.64	
Grain milling	109.06	-1.48	6.20	-0.09	46.23	-0.68	108.88	-1.57	
Cereal based food	27.08	-0.70	2.35	-0.06	13.84	-0.36	27.08	-0.70	
Sugar	20.84	-1.05	0.25	-0.01	9.89	-0.52	20.84	-1.05	
Beverages	12.38	-0.95	0.64	-0.05	6.36	-0.49	12.39	-0.94	
Tobacco (processed)	139.76	-1.82	1.63	-0.08	51.44	-0.81	140.69	-1.44	
Textile & clothing	8.61	-0.21	3.99	-0.08	8.34	-0.08	8.55	-0.26	
Leather & footwear	68.52	-0.83	26.97	-0.36	45.86	-0.53	68.41	-0.89	
Wood & paper	1.21	-0.45	0.24	-0.07	0.76	-0.22	1.18	-0.48	
Printing and publishing	9.82	-0.21	2.00	-0.07	5.80	-0.15	9.74	-0.28	
Petroleum	0.93	-0.23	0.01	0.00	0.47	-0.11	0.25	-0.09	
Chemicals	9.97	-0.55	1.23	-0.07	5.45	-0.33	6.89	-0.37	
Fertilizers	0.57	0.37	0.06	0.06	0.27	0.27	0.43	0.43	
Rubber	5.29	-0.22	1.23	-0.08	3.22	-0.16	5.24	-0.28	
Glass, pottery	39.76	-1.23	11.49	-0.31	24.62	-0.73	39.83	-1.23	
Metas	9.17	-0.47	2.16	-0.10	5.59	-0.29	9.19	-0.46	
Machines	6.37	0.15	3.21	-0.06	4.75	0.03	6.27	0.05	
Equipment	12.03	-0.37	4.25	-0.11	8.06	-0.23	12.04	-0.36	
Transport material	22.42	-0.82	1.50	-0.04	11.35	-0.38	14.72	-0.57	
Other manufactures	8.00	-0.06	3.85	-0.12	7.91	-0.15	7.89	-0.17	
Transport	0.18	0.18	0.02	0.02	0.10	0.10	0.13	0.13	
Communication	0.27	0.27	0.03	0.03	0.14	0.14	0.18	0.18	
Finance	0.34	0.34	0.03	0.03	0.17	0.17	0.22	0.22	
Other business services	0.17	0.17	0.03	0.03	0.11	0.11	0.10	0.10	
Education	-0.02	-0.02	-0.01	-0.01	0.00	0.00	-0.04	-0.04	
Health	0.14	0.14	0.01	0.01	0.07	0.07	0.09	0.09	
Other personal services	0.32	0.32	0.03	0.03	0.17	0.17	0.21	0.21	

Table 9: Impact on Senegal's bilateral exports by product (% change compared to the baseline)

Senegal's Exports - African Continental Free Trade Agreement				
	Full Liberalisation	Sensitive Products 10% HS6 lines		Sensitive Products - 30% in tariff revenue
		No tariff change	50% tariff cut	No tariff change
Food crops	-0.30	0.01	-0.15	-0.25
Livestock	-0.21	0.01	-0.11	-0.17
Fish	0.01	0.17	0.02	-0.01
Cash crops	-1.90	-0.04	-0.92	-1.27
Forestry	2.81	0.02	0.28	2.76
Mining products	0.23	0.00	0.27	-0.00
Meat - Fish processed	-0.10	0.22	-0.01	-0.10
Other manufactured food	-3.25	0.04	-1.50	-2.12
Grain milling	-0.52	0.04	-0.26	-0.26
Cereal based food	-0.53	0.07	-0.25	-0.48
Sugar	-0.46	0.03	-0.22	-0.04
Beverages	-0.26	0.11	-0.12	-0.16
Tobacco (processed)	-1.21	-0.01	-0.60	-0.62
Textile & clothing	0.05	-0.15	0.00	0.06
Leather & footwear	0.42	-0.01	0.29	0.37
Wood & paper	-0.52	0.02	0.05	-0.59
Printing and publishing	-0.21	0.02	-0.08	-0.15
Petroleum	-0.03	0.20	-0.02	-0.08
Chemicals	-1.32	0.05	-0.58	-1.19
Fertilizers	-0.44	-0.05	-0.19	-0.33
Rubber	0.26	0.05	0.17	0.19
Glass, pottery	-0.16	0.05	-0.04	-0.28
Metals	-0.59	0.01	-0.26	-0.53
Machines	-0.35	0.00	0.16	-0.56
Equipment	-0.24	0.07	-0.03	-0.23
Transport material	-0.83	0.03	-0.40	-0.69
Other manufactures	-0.19	0.01	-0.09	-0.17
Transport	-0.12	0.02	-0.04	-0.12
Communication	-0.23	0.00	-0.09	-0.20
Finance	0.01	0.00	0.03	-0.04
Other business services	0.08	0.02	0.02	0.05
Education	-0.13	0.01	-0.06	-0.12
Health	-0.19	0.00	-0.03	-0.20
Other personal services	0.00	0.00	0.00	0.00

5.2. Production and Consumption Impacts

Table 10: Impact on Senegal's production by product (% change compared to the baseline)

Senegal's production - African Continental Free Trade Agreement			
	Full Liberalisation	Sensitive Products 10% HS6 lines	Sensitive Products - 30% in tariff revenue

		No tariff change	50% tariff cut	No tariff change
Autocons good HH	0.00	0.00	0.00	-0.01
Food crops	-0.83	-0.04	-0.39	-0.67
Cash crops	1.15	0.12	0.54	0.90
Livestock	0.42	0.02	0.19	0.30
Forestry	-2.74	-0.04	-0.23	-2.75
Fish	0.23	0.01	0.09	0.20
Minning products	-0.22	0.02	-0.26	0.28
Meat - Fish processed	0.15	0.00	0.05	-0.11
Grain milling	0.08	0.01	0.04	-0.00
Cereal based food	0.13	0.01	0.06	0.11
Sugar	0.13	0.04	0.05	-0.13
Other manufactured food	2.71	0.18	1.25	1.75
Beverages	-0.02	0.01	-0.02	-0.07
Tobacco (processed)	0.81	0.07	0.41	0.41
Textile & clothing	-0.07	-0.02	0.00	-0.10
Leather & footwear	-0.37	-0.15	-0.24	-0.37
Wood & paper	0.19	-0.02	-0.07	0.22
Printing and publishing	0.13	0.00	0.04	0.06
Petroleum	-0.04	0.01	0.02	0.02
Chemicals	1.20	0.18	0.53	1.09
Fertilizers	0.55	0.06	0.24	0.44
Rubber	0.28	0.02	0.11	0.19
Glass, pottery	-0.37	-0.06	-0.23	-0.31
Metas	0.07	0.03	0.00	0.16
Machines	0.48	0.03	0.20	0.41
Equipment	-0.16	-0.04	-0.11	-0.17
Transport material	0.06	0.00	-0.18	0.24
Other manufactures	0.21	0.00	0.06	0.16
Electricity	0.16	0.01	0.08	0.12
Construction	-0.31	-0.02	-0.13	-0.24
Trade	0.23	0.03	0.11	0.16
Maintenance / Repair	0.24	0.03	0.12	0.18
Hotels	0.57	0.05	0.27	0.46
Transport	0.18	0.03	0.10	0.15
Communication	0.19	0.02	0.09	0.15
Finance	0.28	0.03	0.13	0.21
Real estate	0.22	0.02	0.10	0.17
Other business services	0.06	0.01	0.02	0.06
Adminsitration	-0.07	0.00	-0.03	-0.06
Education	-0.05	0.00	-0.01	-0.04
Health	0.14	0.01	0.06	0.10
Other services	0.23	0.02	0.08	0.21

Table 11: Impact con Senegal's urban and rural consumption patterns (% change compared to the baseline)

Senegal's Consumption - African Continental Free Trade Agreement									
	Full Liberalisation		Sensitive Products - 10% HS6 lines				Sensitive Products - 30% in tariff revenue		
	Urban	Rural	No tariff change		50% tariff cut		No tariff change		
			Urban	Rural	Urban	Rural	Urban	Rural	
Autocons good HH	-0.04	0.00	0.00	0.00	0.00	-0.01	-0.04		0.00
Food crops	0.09	0.12	0.01	0.01	0.00	0.04	0.07		0.10
Livestock	0.04	0.07	0.00	0.01	0.00	0.02	0.03		0.06
Fish	0.03	0.07	0.00	0.01	0.00	0.01	0.02		0.05
Cash crops	0.16	0.19	0.01	0.01	0.01	0.08	0.08		0.11
Forestry	0.23	0.26	0.01	0.01	0.00	0.03	0.22		0.25
Mining products	0.06	0.13	0.01	0.01	-0.01	0.03	0.05		0.11
Meat - Fish processed	0.17	0.23	0.02	0.02	0.00	0.09	0.13		0.18
Other manufactured food	0.17	0.23	0.01	0.02	0.29	0.08	0.14		0.19
Grain milling	0.11	0.17	0.01	0.01	0.00	0.05	0.09		0.14
Cereal based food	0.16	0.22	0.01	0.01	0.00	0.08	0.12		0.18
Sugar	0.12	0.19	0.01	0.01	0.00	0.06	0.10		0.15
Beverages	0.19	0.25	0.02	0.02	0.00	0.09	0.12		0.17
Tobacco (processed)	0.13	0.24	0.02	0.02	0.04	0.07	0.10		0.19
Textile & clothing	0.19	0.30	0.05	0.05	0.00	0.11	0.17		0.26
Leather & footwear	0.18	0.29	0.02	0.02	0.00	0.07	0.16		0.25
Wood & paper	0.15	0.26	0.02	0.02	0.00	0.08	0.12		0.21
Printing and publishing	0.15	0.29	0.01	0.02	0.00	0.08	0.10		0.21
Petroleum	0.28	0.40	0.03	0.04	0.00	0.15	0.20		0.30
Chemicals	0.19	0.32	0.03	0.03	0.03	0.10	0.16		0.26
Fertilizers	0.25	0.35	0.05	0.05	0.00	0.14	0.22		0.32
Rubber	0.22	0.39	0.04	0.04	-0.03	0.12	0.18		0.32
Glass, pottery	0.20	0.39	0.03	0.03	0.00	0.10	0.17		0.32
Metals	0.11	0.23	0.01	0.02	0.00	0.06	0.08		0.18
Machines	0.24	0.45	0.03	0.04	0.00	0.12	0.18		0.36
Equipment	0.37	0.57	0.03	0.04	0.00	0.18	0.29		0.45
Transport material	0.19	0.40	0.02	0.03	0.00	0.10	0.14		0.32
Other manufactures	0.17	0.38	0.02	0.03	0.00	0.08	0.13		0.30
Transport	0.18	0.39	0.02	0.03	0.00	0.09	0.13		0.31
Communication	0.15	0.36	0.01	0.02	0.00	0.06	0.12		0.30
Finance	0.17	0.38	0.02	0.03	0.00	0.08	0.13		0.31
Other business services	0.18	0.39	0.02	0.03	0.00	0.09	0.14		0.31
Education	0.18	0.39	0.02	0.03	0.00	0.09	0.14		0.31
Health	0.19	0.40	0.02	0.03	0.00	0.10	0.14		0.32
Other personal services	0.17	0.38	0.01	0.02	0.00	0.07	0.14		0.31

5.3. Macroeconomic impact

Table 12: Macro-economic impact (% change compared to the baseline)

Macroeconomic impact-African Continental Free Trade Agreement					
	Value (millions CFA)	Full Liberalisation	Sensitive Products 10% HS6 lines		Sensitive Products 30% in tariff revenue
			No tariff change	50% tariff cut	No tariff change
Household consumption	588	0.17	0.01	0.08	0.13
Government consumption	131	-0.07	0.00	-0.03	-0.06
Investment consumption	212	-0.31	-0.02	-0.13	-0.24
Domestic final demand	930	0.03	0.00	0.02	0.02
Import demand	379	0.44	0.04	0.17	0.36
Export supply	212	0.69	0.06	0.28	0.56
GDP from Income side	762	-0.09	-0.01	-0.04	-0.07
GDP from Expenditure	764	0.01	0.00	0.01	0.00
Total domestic production	1480	0.15	0.02	0.07	0.11
Total intermediate inputs	819	0.26	0.03	0.13	0.19

5.4. Impact on poverty

5.5. Impact on employment

6. Concluding remarks

In the framework of the African Continental Free Trade Agreement, members can experience changes in production and consumption structures, by improving value chains integration through trade. The aim of this paper was quantifying the impact of the abolition of Senegal's imports duties on the transformation this economy by looking at the effects on the various subsectors of the economy. The economic transformation is assessed in terms of both international trade composition (intra-African *versus* trade with the rest of the world), domestic output, consumption pattern in rural and urban regions of the country and main macroeconomic indicators.

To address this objective, we have improved bilateral trade block of the single-country static STAGE CGE model (McDonald, 2009), which was calibrated for Senegal in 2014 as base year Boulanger et al. (2017). New block of equations was calibrated using trade and protection data according to BACI database (Gaulier & Zignago, 2010) and MAcMap-HS6 (Guimbard et al., 2012) respectively. Simulated scenarios have considered four options of Senegal tariff cuts *visa-vis* its African trade partners: full trade liberalisation in goods and partial trade liberalisation in goods assuming two different criteria of sensitiveness (10% of tariff lines according to protection and products that concentrate 30% of tariff revenue) and lower tariff cuts for them.

Sectoral and macroeconomic results across scenarios show that improving market access in Senegal for African partners based on a sensitivity criteria of tariff revenue losses is close to a

full trade liberalisation scenario. Full liberalization has a positive impact on household consumption globally and affects the production structure with a higher impact on manufacturing sector. Other sensitivity criteria limit trade liberalisation and thus, the magnitude of changes in the current production and consumption patterns. At the macroeconomic level, this scenarios' relation remain true by highlighting that trade, consumption and production gains are greater when Senegalese market is full open for an African integration. In addition, the choice of sensitive products is critical and have several implications. Our results suggest that the criteria based on tariff revenue may be closer to the optimum full liberalization scenario.

Acknowledgement and Financial Supports

This research project was undertaken thanks to the joint initiative between the United Nations Economic Commission for Africa (ECA) and the International Food Policy Research Institute (IFPRI) on economic modeling with a focus on the AfCFTA, under the mentoring of Dr. Maria Priscila Ramos (UBA-CONICET, IIEP & CEPII) and with financial support from the European Union.

References

- Abrego, M. L., Amado, M. A., Gurusoy, T., Nicholls, G. P., & Perez-Saiz, H. (2019). *The African Continental Free Trade Agreement: welfare gains estimates from a general equilibrium model*. International Monetary Fund.
- Abrego, M. L., de Zamaroczy, M. M., Rosas, J.-N., Perez-Saiz, H., Nicholls, G. P., & Gurusoy, T. (2020). *The African Continental Free Trade Area: Potential Economic Impact and Challenges*. Technical Report International Monetary Fund.
- Armington, P. S. (1969). A theory of demand for products distinguished by place of production. *Staff Papers*, 16, 159–178.
- Bouet, A., Odjo, S. P., & Zaki, C. (2020). *Africa agriculture trade monitor 2020*. Intl Food Policy Res Inst.
- Boulanger, P., Dudu, H., Ferrari, E., & Mainar-Causape, A. (2017). 'Matrice de comptabilite sociale d'esagr'ee de l'economie senegalaise en 2014. doi:10.2760/563430 (online), 10.2760/138165 (print).
- Depetris-Chauvin, N., Ramos, M. P., & Porto, G. (2017). Trade, growth, and welfare impacts of the cfta in africa. In *CSAE Conference 2017: Economic Development in Africa CONFERENCE*.
- Gaulier, G., & Zignago, S. (2010). *BACI: International Trade Database at the Product-Level. The 1994-2007 Version*. Working Papers 2010-23 CEPII. URL: <http://www.cepii.fr/CEPII/fr/publications/wp/abstract.asp?NoDoc=2726>.
- Guimbard, H., Jean, S., Mimouni, M., & Pichot, X. (2012). Macmap-hs6 2007, an exhaustive and consistent measure of applied protection in 2007. *International Economics*, 130, 99–121.
- Hausmann, R., & Hidalgo, C. A. (2011). The network structure of economic output. *Journal of Economic Growth*, 16, 309–342.
- Hausmann, R., Hwang, J., & Rodrik, D. (2007). What you export matters. *Journal of economic growth*, 12, 1–25.

- Hidalgo, C., Klinger, B., Barabasi, A.-L., & Hausmann, R. (2007). The product space and its consequences for economic growth. In *APS March Meeting Abstracts* (pp. A22–006).
- Maliszewska, M., & Ruta, M. (2020). *The African Continental Free Trade Area: Economic and Distributional Effects*. World Bank Group.
- McDonald, S. (2009). A static applied general equilibrium model (stage). version 1: July 2007. department of economics & strategy.
- Mevel, S., & Karingi, S. (2012). Deepening regional integration in africa: A computable general equilibrium assessment of the establishment of a continental free trade area followed by a continental customs union. In *7th African Economic Conference, Kigali, Rwanda*. volume 30.
- Teignier, M. (2018). The role of trade in structural transformation. *Journal of Development Economics*, 130, 45–65.
- UNECA (2019). *African Continental Free Trade Area: Questions & Answers*. Addis Ababa. Technical Report UNECA.
- WorldBank (). *World Development Indicators*. Technical Report World Bank.

DRAFT NOT FOR PUBLICATION