The impact of trade liberalization on Senegal:

An assessment of the potential impacts of an Economic Partnership Agreement (EPA) on Senegalese Households using a Single country CGE analysis

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Abstract

This study developed a single country computable general equilibrium (CGE) model including a Household disaggregation in order to measure the potential impacts of two scenarios, the first on full liberalization and the second on the potential implementation of Economic partnership agreement (EPA) between European Union and Ecowas. The classical indicators of poverty and inequality were also computed in addition to the equivalent variation measure in order to capture the effects of the implementation of these policies on Senegalese households. The results show that the EPA scenario seems to be more beneficial in term of welfare variation than the full liberalization scenario. However, the urban households seem to benefit more. The analysis of the inequality indicators shows whatever the scenario considered a decrease of the income inequality. However the EPA scenario again seems to be more beneficial. Lastly, concerning the poverty indicators, the two scenarios envisaged did not seem to reduce poverty.

1- Introduction[3]

This work addresses the need to update the studies on the relationship between trade liberalization and poverty in developing countries. Indeed, next to the multilateral negotiations in the WTO, developing countries are involved in a regional agreement as evidenced by negotiations between the EU and its ACP partners for the implementation of a free trade area. In addition, this study will contribute to address also the need for the EU negotiators to assess the consequences of the agreements negotiated by EU on poor countries. Because European Union is the main contributor to many African poor countries, so a key concern of the European trade policy has always been development and poverty alleviation in poor countries, particularly in Africa. Thus, the issue of the coherence between the CAP, the EU trade policy and the EU assistance policy raised by the EU Parliament and several member states is relevant and timely.

The general objective of this study is to evaluate the impact of trade liberalization on poverty in Senegal, but the focus is made on the assessment of EPAs on Senegalese households for several reasons. First of all, the EU and its ACP partners were unable to conclude the EPA negotiations as planned on January 1st 2008 and they are still ongoing. Second, most recent assessments of the potential impact of EPAs on Senegal have used Multicountry CGEMs (Berisha-Krasniqi and al, 2008; Fall and al., 2007). However, as underlined by Bouët (2008), Multicountry CGEMs are only one analytical instrument, one particularly appropriate for assessing the impact of multilateral or regional agreements on trade flows and macroeconomic variables. But a complete evaluation of the benefits of trade reform for developing countries requires the addition of other instruments, such as single country trade models that allow for microsimulations aimed at evaluating the precise impact of trade liberalization one income distribution, partial equilibrium global trade models, the gravity equation, and so forth. These are complementary tools, not substitutes. For all these reasons, the Senegal Case study also uses a single country CGE with household disaggregation to evaluate the potential impact of Trade reforms (full liberalization and Economic partnership agreement) on Senegalese households. The study focuses on the poverty and income distribution impact of various potential trade reforms.

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Thereafter, section 2 presents a brief review of some studies that address the EPA studies on Senegal. Section 3 describes the general structure of the model. Lastly, section 4 deals with the description of scenario, the data used and the results of simulations.

2- Review of the literature on EPA studies on Senegal.

Many tools (mainly partial Equilibrium models and Multicountry Computable General Equilibrium models) were used to assess the potential impacts of EPA on African countries. But as underlined by Bouët (2008), these tools are rather complementary than substitutes. So in this part we will do a quick presentation of the results of some recent studies attempting to assess EPA for some African countries notably for Senegal.

Fall and al. (2007) tried to assess the potential impact of the implementation of EPA on Senegal using MIRAGE[4] model. Their study generally showed very low earnings prospects for Senegal. Indeed, in addition to the expected loss of tax revenue, the study also showed a decline in real income combined with worsening of terms of trade. Furthermore, the rise in exports displayed by the results cannot cover the deficit in the trade balance. In addition, they also inform about the necessity for Senegal to include sensitive products since the selection process of sensitive products is done by negotiation group and Senegal can be in a situation where the main sensitive products proposed its list are excluded from the Ecowas final list. This last finding is also confirmed by Ndir and al. (2007) still using Mirage model. These latter explained that whatever the degree of flexibility on sensitive products, the EPAs will result in loss of real income for Senegal. And these losses are even more important that flexibility is reduced because the EPA increases the distorting effect of different levels of protection. Berisha-Krasniqi and al. (2008), still using Mirage model point out that the EPA reform for Senegal will not improve its access to foreign markets because this economy already has very good access to the EU with Cotonou Agreement and the initiative “Everything but Arms”. They also reported that EPA will not create much trade for Senegal and cause significant trade diversion. While recognizing that these agreements can be beneficial for some ACP areas as SADC, COMESA and the Caribbean and the Pacific, they note that this reform is not easy for a country like Senegal in terms of trade and is even more meaningful in fiscal terms. Indeed, they estimated that a 46%loss of customs revenue for Senegal and 37% for the rest of ECOWAS. This result is a key policy element given the importance of customs revenue in the total public receipts. In addition, they note that the implementation of EPA would require financial compensation that EU could pay. Calculated on the

[4] MIRAGE (Modeling international relations under applied general equilibrium) is a multisector, multiregion CGEM devoted to trade policy analysis developed at Centre d’études prospectives et d’informations internationales (Cepii).

basis of changes in real income, the annual compensation may be in the order of $ 20 million for Senegal. They also underlined that this type of reform may not have the sole purpose of making European trade policy vis-à-vis the ACP countries compatible with WTO rules and development objectives are necessary. Still about the financial compensation Fontagné and al (2010) used a partial equilibrium approach to provide an extensive assessment of the market access component of EPA between the EU and the six ACP regions, with a focus on trade and budgetary aspects. They also argue that the final impact depends on the importance of tariffs in government revenue, and on potential compensatory effects. The absolute values of customs revenue losses computed in their paper provide a starting point for defining the financial needs of ACP governments. However, long-term solutions will depend on the capacity of each ACP country to reorganize its fiscal base. Finally on the issue of financial compensation, Calipel and al (2004) using a Single country general equilibrium model for Senegal come to the conclusion of the validity of a commitment of Senegal for the conclusion of an EPA subject among others measures to the provision of sufficient external financing directed in part at the beginning of the implementation of the agreement.

For this study, we will also use a single country CGE model for which the methodological description is presented in the next section. However in order to better contribute to the debate about the validity or not of the EPA for Senegal and to complete these previous analyses, we will focus on the impact on EPA on households, that is, compute poverty, inequality and welfare indicators after simulating EPA scenario.

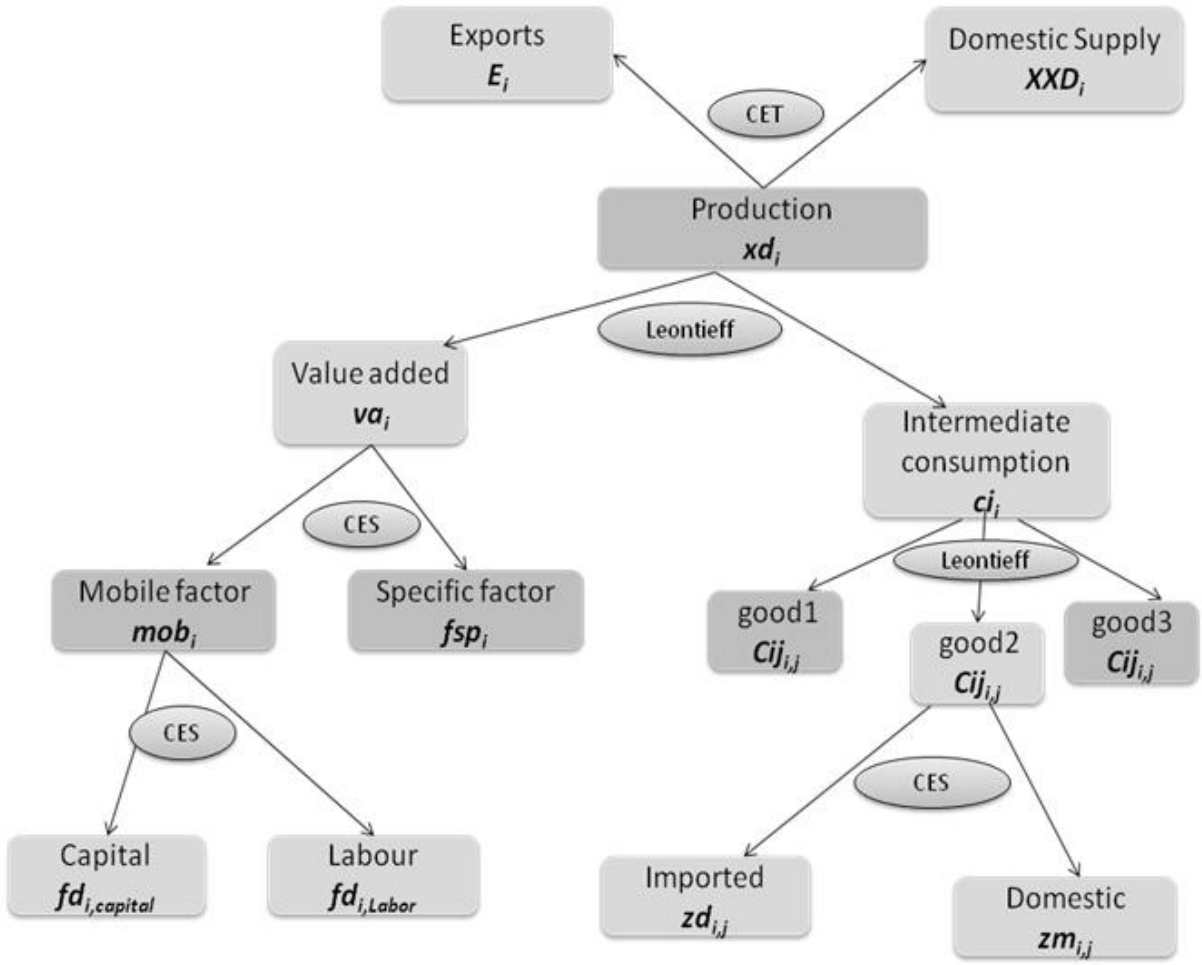
3- Methodology

The CGE used is a modified version of the model constructed by Bouët and al (2001). It is a static, perfect competition and non monetary which describes a small open economy. The main modifications are the introduction of a public agent, the disaggregation of the households and the implementation of a compensatory tax through income tax. A proportional tax is applied to income, the level of tax (in %) being selected to compensate for variations in tax revenue and keep the same level of public deficit and public good production.

Production Side

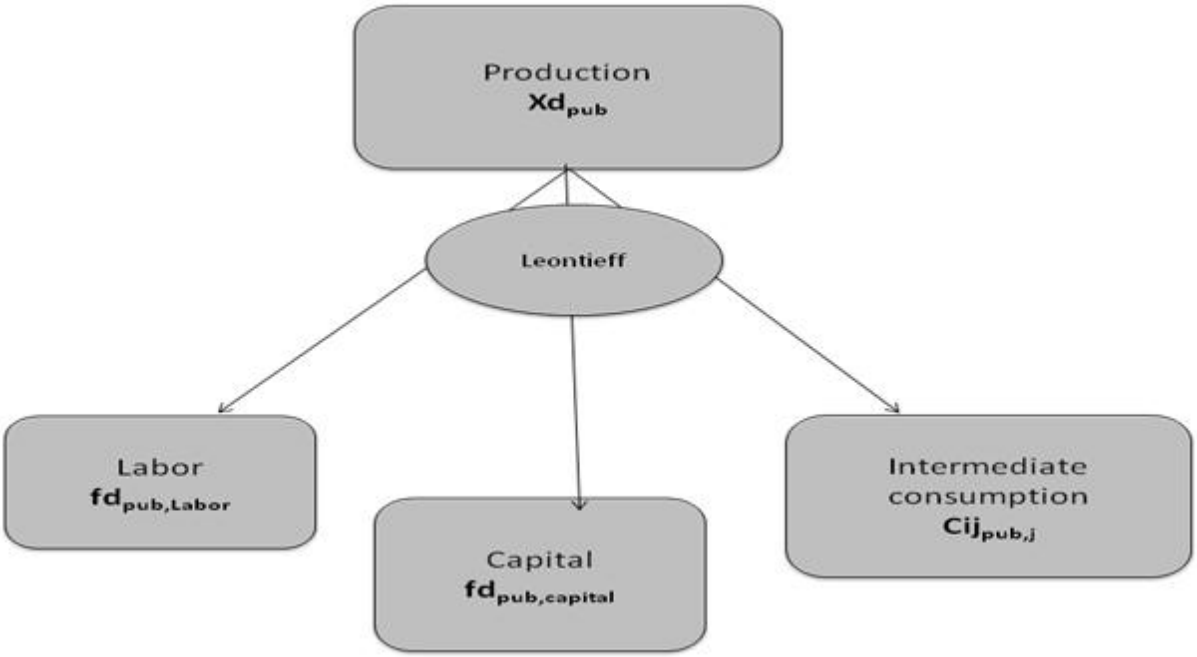
The newness is the distinction in the production of private and public goods. For the private goods, the same structure than Bouët and al (2001) is maintained (figure1).

Figure 1: Private production tree



For public good, the government is involved in the production of this latter. We suppose that the government use a Leontief technology, which means that the structure of its inputs (Labor, Capital and intermediate consumption) does not change (figure 2). This public good is defined a non exclusive and non depletable, thus households consume the same quantity of public goods, whatever are their preferences.

Figure 2: Public Production tree



Demand Side

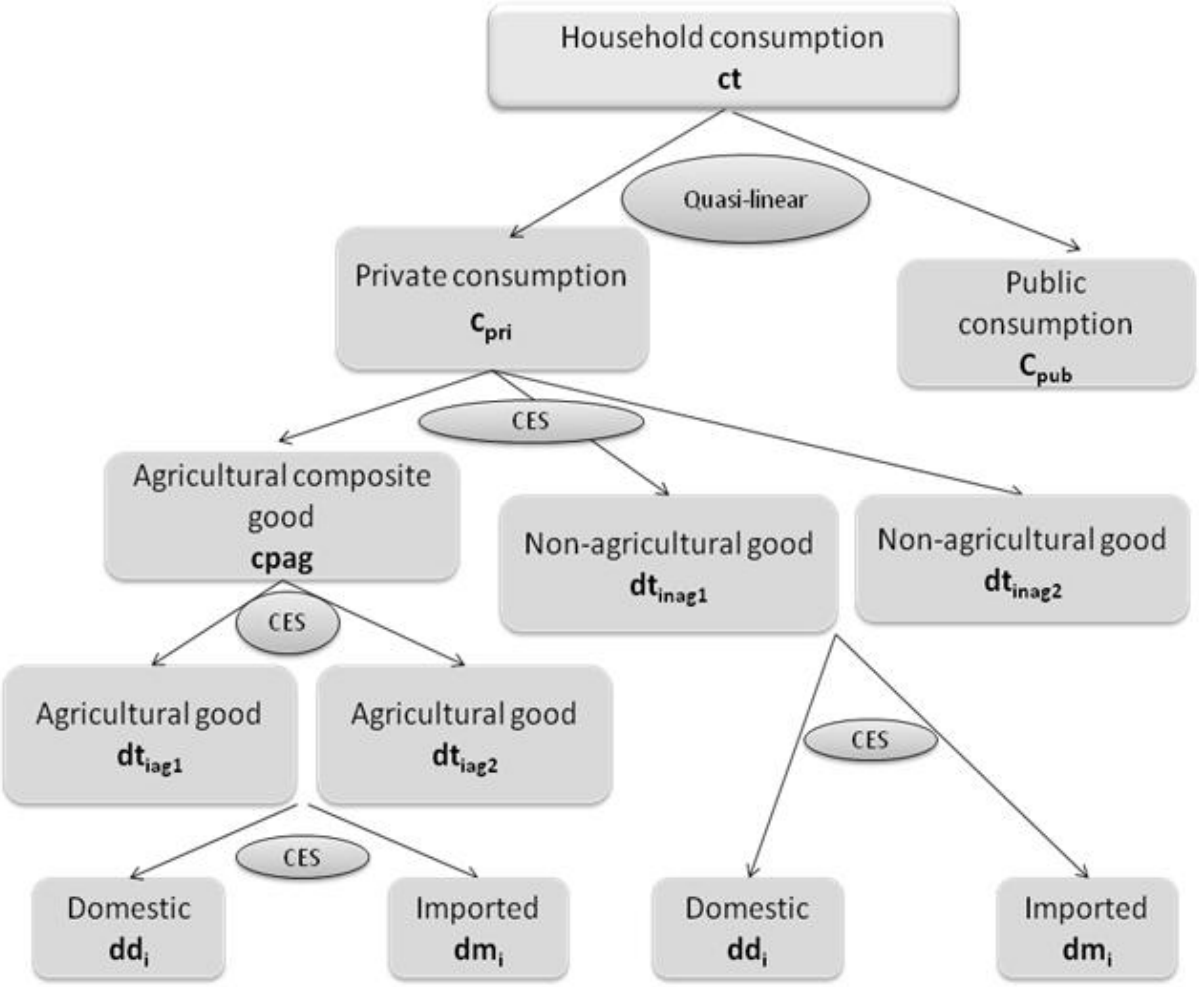
Each household ***h*** maximizes a utility function over public and private goods.

$$U_h(C_{pub}, C_{pri}) = \log(C_{pub}) + C_{pri}$$

Where C_{pub} is a composite good of public services, produced by the government, C_{pri} the total consumption of private goods (produced or imported).

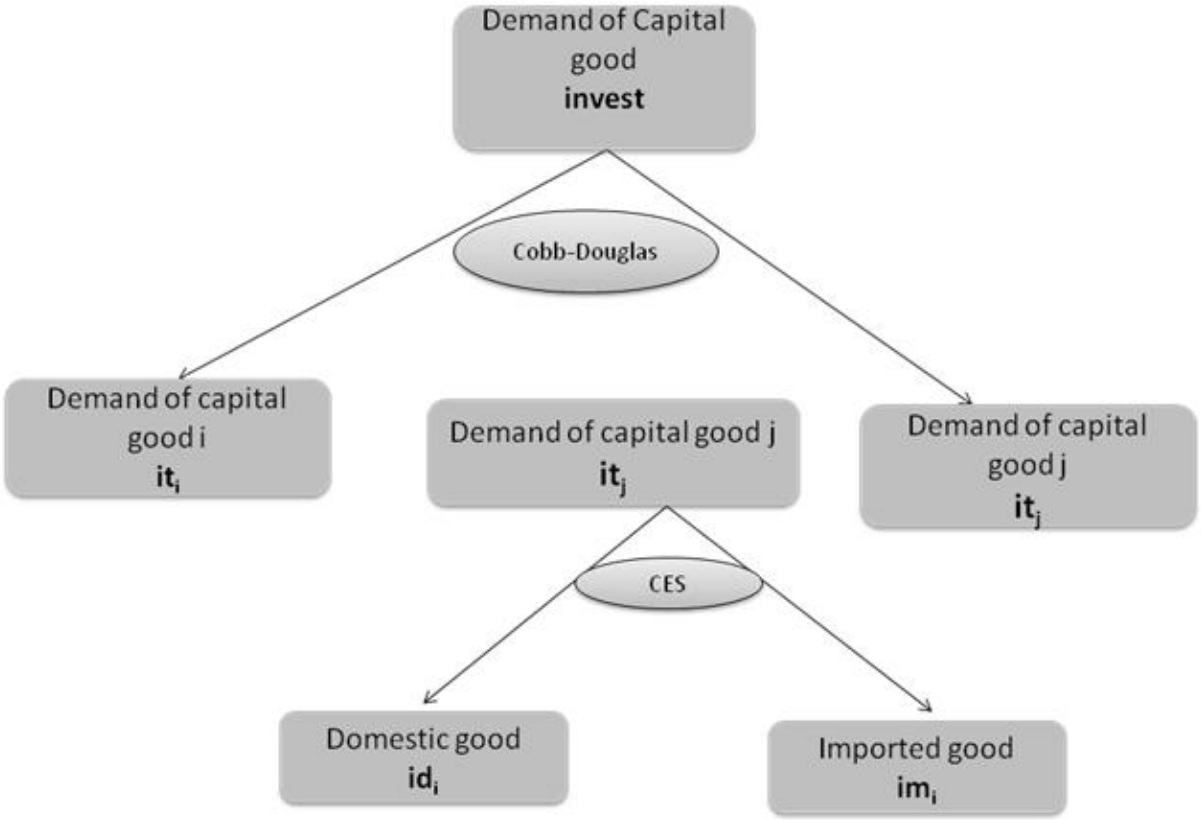
It can be noted that by definition, the consumption of public good is exogenous and the consumer cannot choose the quantity consumed. Each household consumes the same quantity of public good. The private consumption is a CES function of agricultural (composite good) and non agricultural products. The budget constraint is expressed in function of private prices indexes. So the public good is free for the consumer.

Figure 3: Household demand tree



For the capital good demand, we kept the same formulation than in Bouët and al (2001) as depicted in figure 4. However, for further information about all the equations, parameters and variables used in the model see Appendix 2.

Figure 4: Capital good demand tree



4- Liberalization scenarios and results

4-1 Description of scenarios

Two evaluations were made for this study. The first is a scenario of full liberalization that is the complete removal of tariffs in all sectors. The advantage of this scenario, although unlikely, is that it allows to measure the impact of full trade openness for a small economy and to measure the potential impact on households. The second evaluation is the Economic Partnership Agreement (EPA) scenario which is to cancel customs duties on almost all sectors except those considered as sensitive. In this regard, and if we refer to Article XXIV:8 of the GATT dealing with customs unions and free trade areas, it is stated that the customs duties and other restrictive rules of trade must be eliminated for the most part of trade between the constituent territories of the Union or free trade area. However, it is important to note that the interpretation of this article and the choice of level of trade openness including the selection of sensitive products is not the subject of consensus between the parties and constitutes the stumbling block of negotiation between European Commission and Ecowas. So, for the selection of sensitive products in this study, we mainly relied on a provisional list of Senegal proposed to ECOWAS because negotiations are still ongoing and are done by negotiation

group as planned by this agreement. In addition, the list of sensitive products of Ecowas group has not yet been validated by the member countries.

4-2 Benchmark data

The first step of this work was the construction of a Social Accounting Matrix (SAM) based on the Senegal 2006 Input-Output table built by Senegal statistics agency[5]. This 2006 SAM built for Senegal and documented in Fall (2011) comprises 31 accounts of production activities of goods and services, 31 accounts of commodities, 2 production factors capital and Labor, 1 representative household, 1 firm, the government, a capital accumulation account and lastly the Rest of the world (Appendix 3). However for our microsimulation purposes, this SAM has been disaggregated into 34 accounts of production activities of goods and services, 34 accounts of commodities (Table 1 and Appendix 4). The capital composite factor is also split into capital and Land. Lastly, the representative household is disaggregated into eight representative households using the most recent Senegalese household survey ESPS (2005) which comprises about 13,500 households. The household disaggregation criteria (Table 2) are the area (rural or urban), gender (male or female) and the level of literacy (literate or not literate).

Table 1 : Sectoral decomposition

Code	Label	Sectors	Sensitive
A1	Subsistance Agriculture	Primary	Yes
A2	Industrial or export agriculture	Primary	No
A3	Livestock and hunting	Primary	Yes
A4	Forestry	Primary	No
A5	Fishing	Primary	No
A6	Extractive activities (mining)	Primary	No
A7	Meat fish food processing	Secondary	No
A8	Edible oils	Secondary	Yes
A9	Grains processing	Secondary	Yes
A10	Cereals processing	Secondary	Yes
A11	Sugar and sugar processing	Secondary	Yes
A12	Other Foods products	Secondary	No
A13	Beverages	Secondary	No
A14	Tobacco products	Secondary	No
A15	Cotton and textile processing	Secondary	Yes
A16	Leather products	Secondary	Yes
A17	Wood products	Secondary	No
A18	Paperboard industry	Secondary	Yes
A19	Oil refinery and coke	Secondary	No
A20	Chemical products	Secondary	No

[5] Agence Nationale de la Statistique et de la Démographie-ANSD. www.ansd.sn

A21	Rubber products	Secondary	No
A22	Glass and pottery industry	Secondary	No
A23	Metals	Secondary	No
A24	Machinery processing	Secondary	No
A25	Equipments and devices	Secondary	No
A26	Transport equipment industry	Secondary	Yes
A27	Other manufactured products	Secondary	No
A28	Electricity gas water	Secondary	No
A29	Construction	Secondary	No
A30	Public Administration	Tertiary	
A31	education and formation	Tertiary	No
A32	health and social activities	Tertiary	No
A33	collective activities	Tertiary	No
A34	market services	Tertiary	No

Source: Author compilation

Table 2 : Households disaggregation details

Households	Zone	Gender	Literacy
Household1	Rural	Male	Illiterate
Household2	Rural	Male	Literate
Household3	Rural	Female	Illiterate
Household4	Rural	Female	Literate
Household5	Urban	Male	Illiterate
Household6	Urban	Male	Literate
Household7	Urban	Female	Illiterate
Household8	Urban	Female	Literate

Source: Author compilation

4-3 Simulation results

Price and Volume Impacts

Import prices decline as expected regardless of the scenario except for sectors considered as sensitive under the EPA scenario where the import prices remained stable compared to the baseline (Table 3). These decreases in the prices of imported products are very significant in the secondary sector for the two scenarios and the effect on the one hand is an increase in import volumes in practically all sectors of the secondary (about 50% for the scenario of full liberalization and about 35% for EPA scenario vs increases of around 1% and 5% respectively for primary and tertiary sectors, cf. Table 5).

Table3: Price Effects (% change from base)

	Imports			Domestic goods			Production			Value Added		
	Benchmark	**Full lib**	**EPA**	**Benchmark**	**Full lib**	**EPA**	**Benchmark**	**Full lib**	**EPA**	**Benchmark**	**Full lib**	**EPA**
A1	1	-5%	0%	1	2%	4%	0.993	2%	4%	1	3%	4%
A2	1	-1%	-1%	1	2%	4%	0.817	2%	3%	1	3%	4%
A3	1	0%	0%	1	4%	5%	0.959	4%	5%	1	5%	5%
A4	1	-4%	-4%	1	4%	5%	1.017	4%	5%	1	5%	5%
A5	1	0%	0%	1	-4%	-4%	1.094	-2%	-1%	1	6%	6%
A6	1	0%	0%	1	-3%	-3%	1.428	-3%	-3%	1	6%	6%
A7	1	-7%	-7%	1	6%	5%	1.046	4%	4%	1	6%	6%
A8	1	-19%	0%	1	-7%	1%	1.187	-4%	1%	1	6%	6%
A9	1	-12%	0%	1	-1%	2%	1.348	-1%	2%	1	6%	6%
A10	1	-6%	0%	1	0%	1%	1.063	0%	1%	1	6%	6%
A11	1	-23%	0%	1	-1%	0%	1.433	-1%	0%	1	5%	6%
A12	1	-19%	-19%	1	-4%	-1%	1.356	-3%	-1%	1	6%	6%
A13	1	-24%	-24%	1	0%	1%	1.464	0%	1%	1	5%	5%
A14	1	-19%	-19%	1	3%	3%	1.236	2%	3%	1	6%	6%
A15	1	-10%	0%	1	3%	4%	1.144	3%	3%	1	6%	6%
A16	1	-19%	0%	1	3%	3%	1.302	3%	3%	1	6%	6%
A17	1	-5%	-5%	1	3%	2%	1.157	3%	2%	1	6%	6%
A18	1	-11%	0%	1	0%	1%	1.323	0%	1%	1	6%	6%
A19	1	-50%	-50%	1	0%	0%	2.614	0%	0%	1	6%	6%
A20	1	-16%	-16%	1	0%	0%	1.406	0%	0%	1	6%	6%
A21	1	-20%	-20%	1	-1%	0%	1.366	-1%	0%	1	6%	6%
A22	1	-45%	-45%	1	-3%	-3%	1.390	-3%	-3%	1	6%	6%
A23	1	-22%	-22%	1	-5%	-5%	2.186	-4%	-4%	1	6%	6%
A24	1	-14%	-14%	1	-10%	-8%	5.071	-9%	-7%	1	6%	6%
A25	1	-22%	-22%	1	6%	7%	2.263	4%	5%	1	5%	5%
A26	1	-20%	0%	1	-8%	-7%	2.554	-8%	-7%	1	5%	6%
A27	1	-7%	-7%	1	5%	4%	1.072	5%	4%	1	6%	6%
A28	1	0%	0%	1	3%	3%	1.117	3%	3%	1	6%	6%
A29	1	0%	0%	1	2%	2%	1.000	2%	2%	1	6%	6%
A30				1	0%	0%				1	0%	0%
A31	1	0%	0%	1	4%	5%	1.000	4%	5%	1	5%	5%
A32	1	0%	0%	1	4%	4%	1.000	4%	4%	1	5%	5%
A33	1	0%	0%	1	7%	7%	1.000	5%	5%	1	6%	6%
A34	1	0%	0%	1	6%	6%	0.975	5%	5%	1	6%	6%

Source: Author calculation using simulation results

On the other hand, the decline in import prices following the trade liberalization has contributed to the decrease of certain consumer and producer prices including those of the secondary sector

(Table 4). This can be explained by the fact that the majority of the secondary sector products consumed in Senegal (final and intermediate) are imported.

Table 4: Consumer prices

Sectors	Benchmark	Scenario 1 : full liberalization	Scenario 2 : EPA
A1	1	0%	3%
A2	1	2%	3%
A3	1	4%	4%
A4	1	2%	3%
A5	1	-2%	-2%
A6	1	-2%	-2%
A7	1	3%	3%
A8	1	-14%	1%
A9	1	-6%	1%
A10	1	-1%	1%
A11	1	-14%	0%
A12	1	-12%	-11%
A13	1	-9%	-8%
A14	1	-2%	-1%
A15	1	-1%	3%
A16	1	-11%	2%
A17	1	-1%	-1%
A18	1	-5%	1%
A19	1	-45%	-45%
A20	1	-10%	-10%
A21	1	-11%	-11%
A22	1	-29%	-29%
A23	1	-18%	-18%
A24	1	-14%	-14%
A25	1	-21%	-21%
A26	1	-19%	-1%
A27	1	3%	3%
A28	1	3%	3%
A29	1	2%	2%
A30	1	0%	0%
A31	1	4%	4%
A32	1	4%	4%
A33	1	7%	7%
A34	1	6%	6%

Source: Author calculation using simulation results

For primary sectors that employ more than 50% of the population, the results showed an increase in imports for food crops in the EPA scenario where it is considered as sensitive. However, consumer

prices have not fallen despite this increase in imports. On the other hand, it is found that the export in volume of the primary sector rose by nearly 10% regardless of the scenario considered. However, the overall export growth in the primary is due to the growth of the fisheries and mining sectors. In contrast, purely agricultural sectors (food crops and industrial agriculture and export) are experiencing declines of more than 10% of their exports coupled with lower production in volume and value added in both scenarios. This trend is also noted for the tertiary sector (Table 5)

Table 5: Volume effects aggregated (% Change from base which is expressed in million of FCFA)

	imports			exports			production			Value added		
	Benchmark	**full liberalization**	**EPA**	**Benchmark**	**full liberalization**	**EPA**	**Benchmark**	**full liberalization**	**EPA**	**Benchmark**	**full liberalization**	**EPA**
A1	139944	10%	5%	766	-14%	-12%	311295	-10%	-5%	276226	-10%	-5%
A2	43949	-17%	-1%	2389	-16%	-12%	125340	-13%	-5%	99003	-13%	-5%
A3	27172	0%	1%				237027	-5%	-5%	195114	-5%	-5%
A4	16103	25%	27%				59401	-6%	-6%	38729	-6%	-6%
A5	32815	-4%	-1%	97661	7%	8%	143676	4%	5%	78931	4%	5%
A6	59267	-11%	-11%	21147	23%	17%	99054	15%	10%	52148	15%	10%
PRIMARY	**319250**	**1.04%**	**1.15%**	**121964**	**9.42%**	**9.30%**	**975793**	**-4.42%**	**-1.92%**	**740152**	**-5.71%**	**-2.74%**
A7	33216	25%	26%	89473	-16%	-16%	251909	-11%	-10%	115583	-11%	-10%
A8	79111	22%	0%	54249	-14%	-5%	121738	-20%	-4%	6695	-20%	-4%
A9	127204	19%	1%	623	-10%	-6%	184626	-11%	-3%	29073	-11%	-3%
A10	7715	16%	3%				178735	-1%	0%	28695	-1%	0%
A11	53396	61%	-2%	3136	-36%	0%	53852	-37%	0%	23912	-37%	0%
A12	121993	29%	34%	16893	-13%	-19%	141883	-18%	-21%	27373	-18%	-21%
A13	31604	43%	47%				50578	-15%	-15%	20908	-15%	-15%
A14	6448	45%	47%	7855	-15%	-15%	31587	-10%	-10%	10265	-10%	-10%
A15	47265	39%	8%	9228	-21%	-12%	142073	-14%	-4%	58602	-14%	-4%
A16	14214	79%	10%	1060	-58%	-15%	14353	-55%	-9%	7815	-55%	-9%
A17	26460	28%	25%	1713	3%	0%	55730	10%	6%	25762	10%	6%
A18	28173	15%	2%	9289	-2%	-1%	90178	-1%	2%	30758	-1%	2%
A19	83098	136%	137%				132877	-18%	-19%	40398	-18%	-19%
A20	133960	26%	27%	79338	-10%	-10%	240921	-9%	-10%	153058	-9%	-10%
A21	27708	40%	43%	14634	-8%	-10%	65889	-10%	-11%	26506	-10%	-11%

A22	7960	100%	90%	34317	55%	43%	159807	45%	33%	58083	45%	33%
A23	51681	30%	25%	27909	40%	33%	93697	27%	20%	42136	27%	20%
A24	165305	65%	53%	11847	41%	32%	22556	13%	10%	5116	13%	10%
A25	66338	81%	67%	17921	14%	4%	27959	27%	18%	27796	27%	18%
A26	148160	73%	31%				11437	23%	19%	3745	23%	19%
A27	14786	18%	19%	597	-9%	-9%	99888	2%	1%	60171	2%	1%
A28	19834	3%	5%				254033	0%	1%	115749	0%	1%
A29	117	-3%	0%				885734	46%	34%	242014	46%	34%
SECONDARY	**1295748**	**48.84%**	**34.35%**	**380082**	**-0.30%**	**-0.97%**	**3312042**	**9.46%**	**7.67%**	**1160213**	**7.72%**	**6.01%**
A30							431569	0%	0%	296794	0%	0%
A31	8219	10%	13%	336	-13%	-13%	210578	-2%	-1%	175380	-2%	-1%
A32	12	10%	12%	93	-11%	-11%	91926	-1%	-1%	59175	-1%	-1%
A33	570	21%	20%	38900	-20%	-18%	140356	-7%	-6%	93771	-7%	-6%
A34	101143	4%	5%	716791	-14%	-14%	3296824	-2%	-2%	2011841	-2%	-2%
TERTIARY	**109943**	**4.59%**	**5.65%**	**756120**	**-14.70%**	**-14.34%**	**4171253**	**-1.82%**	**-1.91%**	**2636962**	**-1.81%**	**-1.88%**

Source: Author calculation using simulation results

The exports in the secondary sector decline, but they are relatively small less than 1% in both scenarios (Table 5). However, these declines are accompanied by an increase in production and value added. This could be explained by the fact that this sector of the economy derives its strength from access to intermediate goods more accessible to increase production.

Table 6: Volume effects per sector (% Change from base which is expressed in million of FCFA)

	hh1			hh2			hh3			hh4		
Secteurs	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**
A1	106786	-1%	-2%	50782	-3%	-2%	14689	-4%	0%	2439	-2%	-2%
A2	14780	-10%	-2%	7203	-12%	-2%	2250	-13%	0%	456	-12%	-2%
A3	20505	2%	-4%	13355	0%	-4%	3239	-1%	-2%	778	0%	-4%
A4	13337	1%	-2%	7465	-1%	-2%	1851	-2%	0%	585	0%	-2%
A5	10707	7%	3%	5928	5%	3%	1760	5%	5%	320	6%	3%
A6	4165	-2%	-1%	4165	-4%	-1%	4165	-5%	1%	4165	-3%	-1%
A7	55087	0%	-2%	25114	-1%	-2%	8358	-3%	0%	1151	-1%	-2%
A8	39620	0%	-1%	19952	-2%	-1%	6163	-3%	0%	1127	-1%	-2%
A9	51618	-1%	-2%	28790	-3%	-1%	8485	-4%	0%	1603		
A10	40510	-1%	-2%	22594	-3%	-1%	6659	-4%	0%	1258	-2%	-2%
A11	45067	-1%	-1%	21167	-2%	-1%	6307	-4%	1%	995	-2%	-1%
A12	61207	-1%	1%	31698	-3%	1%	9989	-4%	3%	1822	-2%	1%
A13	12043	-1%	0%	8290	-3%	1%	1687	-4%	2%	692	-2%	0%
A14	8945	-1%	-1%	5698	-3%	-1%	1051	-4%	1%	290	-2%	-1%
A15	22214	-1%	-2%	14493	-3%	-2%	3502	-4%	0%	809	-2%	-2%
A16	6791	4%	-2%	3957	2%	-1%	1098	1%	0%	313	3%	-2%
A18				4114	-3%	-1%				4114	-3%	-2%
A19												
A20												
A21												
A22	511	-2%	6%	511	-4%	6%	511	-5%	8%	511	-3%	6%
A23	486	-2%	3%	486	-4%	3%	486	-5%	5%	486	-3%	3%
A24	740	-2%	2%	443	-4%	2%	137	-5%	4%	49	-3%	2%

A25	1386	-2%	3%	830	-4%	3%	257	-5%	5%	91	-3%	3%
A26	2626	-2%	-1%	2245	-4%	-1%	334	-5%	1%	65	-3%	-1%
A27	7052	-1%	-2%	3996	-3%	-2%	1200	-4%	0%	213	-2%	-2%
A28	21807	-1%	-2%	13806	-3%	-2%	3565	-4%	0%	1034	-2%	-2%
A29	5	-2%	-2%	4	-4%	-1%	1	-5%	0%	0	-3%	-2%
A30	76	0%	0%	44	0%	0%	12	0%	0%	1	0%	0%
A31	8296	0%	-2%	6656	-2%	-2%	1311	-3%	0%	415	-1%	-2%
A32	16792	0%	-2%	9616	-2%	-2%	2536	-3%	0%	299	-2%	-2%
A33	18634	0%	-3%	10671	-2%	-2%	2814	-3%	-1%	332	-1%	-3%
A34	204258	0%	-3%	139266	-2%	-2%	30227	-3%	-1%	8253	-1%	-3%

Table 6 (cont.): Volume effects per sector (% Change from base which is expressed in million of FCFA)

	hh5			hh6			hh7			hh8		
Secteurs	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**	**Benchmark**	**Full liberalization**	**APE**
A1	34498	-3%	1%	56754	-3%	-1%	22194	-3%	3%	14075	-2%	1%
A2	4144	-13%	1%	6017	-12%	-2%	2774	-13%	3%	1537	-11%	1%
A3	15463	-1%	-1%	43313	0%	-3%	11792	-1%	1%	12314	1%	-1%
A4	12329	-1%	1%	17521	-1%	-2%	7850	-1%	3%	4436	0%	1%
A5	8547	5%	7%	16464	5%	4%	5829	5%	9%	4282	7%	7%
A6	4165	-4%	2%	4165	-3%	-1%	4165	-4%	4%	4165	-2%	2%
A7	22382	-1%	1%	39370	0%	-2%	16551	-1%	3%	10782	1%	1%
A8	20086	-1%	2%	31865	-1%	-1%	12778	-1%	4%	8111	1%	2%
A9	42774			76251			28939	-3%	4%	18408	-1%	2%
A10	33569	-2%	2%	59842	-2%	-1%	22711	-2%	4%	14446	0%	2%

A11	15642	-2%	2%	24973	-1%	-1%	9613	-2%	4%	6186	0%	2%
A12	38964	-2%	4%	71328	-2%	1%	26782	-2%	6%	19103	0%	4%
A13	18798	-2%	4%	49795	-2%	1%	15033	-2%	6%	14659	0%	4%
A14	4966	-2%	2%	15271	-2%	-1%	4721	-2%	4%	4147	0%	2%
A15	16648	-2%	1%	30771	-2%	-1%	11105	-2%	3%	8955	0%	1%
A16	5726	3%	2%	9537	3%	-1%	3604	3%	4%	3157	5%	1%
A18				9599	-2%	-1%				9599	-1%	2%
A19	38536	-3%	15%	38536	-3%	12%	38536	-3%	17%	38536	-1%	15%
A20	38057	-2%	4%	38057	-2%	1%	38057	-2%	6%	38057	0%	4%
A21	10517	-2%	4%	10517	-2%	1%	10517	-2%	6%	10517	0%	4%
A22	511	-3%	9%	511	-3%	6%	511	-4%	11%	511	-2%	9%
A23	486	-4%	6%	486	-3%	3%	486	-4%	8%	486	-2%	6%
A24	457	-3%	5%	1282	-3%	2%	288	-3%	7%	319	-1%	5%
A25	855	-4%	7%	2401	-3%	4%	539	-4%	9%	598	-2%	7%
A26	2344	-3%	2%	13803	-3%	-1%	627	-3%	4%	2353	-1%	2%
A27	4710	-2%	1%	11119	-2%	-1%	3506	-2%	3%	3064	0%	1%
A28	32489	-2%	1%	78453	-2%	-1%	25198	-2%	3%	20942	-1%	1%
A29	2	-3%	2%	7	-3%	-1%	1	-3%	4%	1	-2%	1%
A30	72	0%	0%	129	0%	0%	44	0%	0%	40	0%	0%
A31	20654	-1%	1%	129432	-1%	-2%	19802	-1%	3%	31894	0%	1%
A32	15729	-2%	1%	28268	-1%	-2%	9587	-2%	3%	8833	0%	1%
A33	17455	-2%	1%	31370	-1%	-2%	10639	-2%	3%	9803	0%	0%
A34	177861	-2%	1%	434331	-1%	-2%	130984	-2%	3%	117022	0%	1%

Source: Author calculation using simulation results

The analysis of final consumption by sector of different households (Table 6) shows generally that urban households benefit more from trade liberalization particularly in the EPA scenario. In fact we notice that an increase in final consumption for almost all the products consumed. This result, crossed with the table of the evolution of final consumption prices (Table 4) revealed at some point that rises in consumer prices could be accompanied by an increase in final consumption of this product for urban, while rural households, in general noticed decreases in their final consumption even in situations of lower consumer prices. In addition, the analysis of the table of changes in the remuneration of factors of production (Table7) revealed in both simulations significant falls in the return of land factor which is a significant source of income for rural households. Thus, it appears that this drop in income from land is more important than the decline in some consumer prices, which does not benefit the rural areas. In contrast, urban households who depend more on wage income, are experiencing increases in income from factors. That is probably why they can enable to increase their consumption in some cases where the consumer prices increase.

Factor Price Effects

Table 7: Factor price (% change from base)

variable	Benchmark	Scenario 1 : full liberalization	Scenario 2 : EPA
wage rate	1	5%	5%
return to capital	1	6%	6%
return to land			
Subsistance Agriculture	1.00016	-17%	-5%
Industrial or export agriculture	1.00021	-21%	-6%
Livestock and hunting	1.00041	-5%	-4%
Forestry	1.00868	-8%	-7%

Source: Author calculation using simulation results

The welfare Change Effects

Some studies have used one or more indicators to measure the distributional impact while others rely on a discussion of the benefits and gains to each group. Commonly used summary measures (Gini coefficient, Theil index, Atkinson measure…) indicate whether the policy affects distribution favorably or adversely (Khan, 1997). However, studies that are more walrasian in flavor use the equivalent variation as an indicator of household welfare. In our studies we investigate the both ways and the results of welfare analysis using the equivalent variation undertaken in this study and displayed in Table 8 represent the percentage deviation from the benchmark.

Table 8: Welfare impact of import liberalization on households' category (percentage change in utility from benchmark expressed in million of FCFA)

Households Group	Benchmark	Full liberalization scenario	EPA scenario
Household1	800707	-1.79%	-1.73%
Household2	467995	-1.60%	-1.56%
Household3	129299	0.57%	0.32%
Household4	39322	-1.90%	-1.51%
Household5	664094	1.88%	2.26%
Household6	1386195	-1.90%	-1.00%
Household7	500422	4.29%	4.50%
Household8	445993	1.21%	2.48%
Total variation	**4434027**	**-0.20%**	**0.30%**

Source: Author calculation

The results show that the EPA scenario seems to be more beneficial in term of welfare variation than the full liberalization scenario (+0.3 % vs. -0.2% with respect to the benchmark). However, the urban households seem to benefit more. Looking at the gender aspect, it would seem that females seem to take advantage more than males.

Poverty Effects

Poverty is measured using the classical Foster–Greer–Thorbecke (FGT) $P\alpha$ class of additively decomposable measures (Foster et al., 1984). Poverty indices are calculated using the Stata DASP[6] module developed by Araar and Duclos (2009). This module helps to estimate the most popular statistics (indices, curves) used for the analysis of poverty, inequality, social welfare, and equity. The poverty line used is 365,000 FCFA per year (approx. 1000 F CFA/day, the equivalent of 1.5 Euros/day).

Table 9: National FGT Indices (% Change from Base)

	Benchmark	Full liberalization	EPA
Poverty Headcount	38%	0.00%	0.00%
Poverty Gap	29%	0.77%	0.03%
Poverty Severity	23%	1.13%	-0.04%

Source: Author calculation using simulation results

Now looking at the national FGT indices shown in Table 9, we note that the number of poor people represented by the Poverty headcount does not change regardless of the scenario. It appears that the gains from trade liberalization are not significant enough to reduce the number of poor. By

[6] http://dasp.ecn.ulaval.ca/

investigating other poverty indicators, we find that the EPA scenario seems slightly more beneficial than the Full Liberalization scenario even if it must be recognized that variations are very small.
Table 10 shows that poverty is more prevalent in rural areas. Indeed, one person in two is living in a situation of poverty in rural areas while one in four is part of the poor in urban areas.

Table 10: Poverty Headcount by Area (% Change from Base)

	Benchmark	Full liberalization	EPA
Urban	25%	0.00%	0.00%
Rural	50%	0.00%	0.00%

Source: Author calculation using simulation results

Table 11, representing the poverty gap which corresponds to the average distance separating the poor from the poverty line, shows a narrowing of the poverty gap for the rural (-0.21%) in the EPA Scenario. This result is probably due to the fact that in this scenario the main activities of these people are generally food crops and livestock, which are protected from liberalization. At the same time, they will also take advantage of price decreases induced by trade openness.

Table 11: Poverty GAP by Area (% Change from Base)

	Benchmark	Full liberalization	EPA
Urban	14%	2.86%	0.79%
Rural	44%	0.11%	-0.21%

Source: Author calculation using simulation results

Regarding the severity of poverty that takes into account the inequality among the poor, Table 12 shows that inequality among the poorest decreased slightly for the rural still in the EPA scenario while it increases in the case of full Liberalization scenario. For the urban, it is noted a slight worsening of inequality in the two scenarios simulated.

Table 12: Poverty severity By Area (% Change from Base)

	Benchmark	Full liberalization	EPA
Urban	8%	5.81%	1.59%
Rural	39%	0.22%	-0.36%

Source: Author calculation using simulation results

Table 13 provides information that for the poverty line of 1000 FCFA/ day chosen for this study, three women out of four are in situation of poverty. However, the simulated scenarios have not shown a decrease of the number of poor women. For the poverty gap indicator (Table 14), we find that the situation of women has hardly changed after trade openness.

Table 13: Poverty Headcount by gender (% Change from Base)

	Benchmark	Full liberalization	EPA
Female	75%	0.00%	0.00%
Male	0%	0	0

Source: Author calculation using simulation results

Table 14: Poverty Gap by gender (% Change from Base)

	Benchmark	Full liberalization	EPA
Female	58%	0.77%	0.03%
Male	0%	0.00%	0.00%

Source: Author calculation using simulation results

Table 15 shows a slight improvement in the poverty severity indicator for women in the EPA scenario. This could mean that women are involved in sensitive sectors and protected under the EPA scenario. Moreover, it is interesting to note that the poverty line chosen in our study seems too low for men. This seems to mean that women are more affected by poverty than men. However, additional calculations were made for men by raising the poverty line at about 2 Euros/day and about 3 Euros / day in order to obtain non-zero results for men. The results presented in Appendix 1 show generally better indicators of poverty gap and severity in the EPA scenario.

Table 15: Poverty Severity by gender (% Change from Base)

	Benchmark	Full liberalization	EPA
Female	47%	1.13%	-0.04%
Male	0%	0.00%	0.00%

Source: Author calculation using simulation results

Table 16 exhibits that one literate person in two is poor. As for the subpopulation of non-literate, we note that one person in four is below the poverty line. However it should be noted that the literate subpopulation is very heterogeneous because grouping those who have, for example, high levels of education (university, business schools or engineering schools ...) and those who have very low levels of education (knowing at least read), reason why we cannot know according to our breakdown details the exact composition of the poor educated.

Tableau 16: Poverty Headcount By education (% Change from Base)

	Benchmark	Full liberalization	EPA
Educated	50%	0.00%	0.00%
Not Educated	25%	0.00%	0.00%

Source: Author calculation using simulation results

In analyzing other indicators of poverty we see in general a very slight improvement in the poverty severity and poverty gap in the EPA scenario and for the population of uneducated (Tables 17 & 18). One explanation could be that the main activities of the majority of uneducated population are agriculture and livestock and this population benefits in this scenario of protection of their activities and the benefits brought about by liberalization.

Tableau 17: Poverty GAP By education (% Change from Base)

	Benchmark	Full liberalization	EPA
Educated	38%	1.07%	0.30%
Not Educated	19%	0.18%	-0.50%

Source: Author calculation using simulation results

Tableau 18: Poverty severity by education (% Change from Base)

	Benchmark	Full liberalization	EPA
Educated	32%	1.50%	0.41%
Not Educated	15%	0.35%	-0.99%

Source: Author calculation using simulation results

Inequality Effects

Inequality is a broader concept than poverty in that it is defined over the entire population, and does not only focus on the poor (Haughton and al, 2009). The most used indicators are the Gini coefficient, the Theil index, the Atkinson index… and are reported for our study in the Table 19 below. However it is relevant to wonder which indicators capture more this concept of inequality. Some authors like Dervis, de Melo and Robinson (1982) underlined that Gini coefficient and log variance are especially sensitive to the lower tail of income distribution. While the Theil index and the coefficient of variation are more influenced by extreme relative wealth. So we compute all these indicators to capture all these characteristics for our study.

Table 19: inequality and dispersion indicators

VARIABLES	Benchmark	Full liberalization	EPA
Gini index	0.480598	-0.03%	-0.09%
Theil index	0.405915	-0.07%	-0.15%
Atkinson index	0.233190	0.05%	-0.04%
Coefficient of variation	0.873390	-0.22%	-0.23%
Quantile ratio index of inequality	0.004346	-0.58%	-0.64%
Share ratio index of inequality	0.053031	2.36%	2.11%

Source: Author calculation using simulation results

The analysis of the Table 19 shows whatever the scenario considered a decrease of the income inequality. Indeed, the Gini, Theil and Atkinson indices decrease with respect to the benchmark values. However the EPA scenario seems to be more beneficial. Examining, the coefficient of variation which is the income dispersion indicator, we still note a diminishing but not enough to have a homogeneous distribution because benchmark value is quite high.

5 Conclusion

This case study on Senegal provides an assessment of potential impacts of trade liberalization in general, but especially the Economic Partnership Agreements (EPAs) which should be the new pattern of trade partnership between the EU and ACP countries. These agreements which were supposed to come into force on January 1st 2008 are still in negotiations and raise many questions about its validity and its impact on the economy in general. Thus, several studies on the impacts of EPAs simulation using different methodologies (Multicountry CGEM, Single Country CGE, partial equilibrium model) were carried out for Senegal and are dwelled on the consequences on market access, changes in tax revenues and the main macroeconomic aggregates.

The objective of the present study was to contribute to the debate by proposing to supplement the existing studies Senegal, based on recent data and focusing on the potential impacts of EPAs on poverty, welfare and inequality analysis on the Senegalese household's level.

On the methodological point of view, this study developed a single country computable general equilibrium (CGE) model including a household disaggregation in order to measure the potential impacts of two scenarios, the first on full liberalization and the second on the potential implementation of Economic partnership agreement (EPA) between European Union and Ecowas. The classical indicators of poverty and inequality were also computed in addition to the equivalent variation measure in order to capture the effects of the implementation of these policies on Senegalese households.

The results show that the EPA scenario seems to be more beneficial in term of welfare variation than the full liberalization scenario. However, the urban households seem to benefit more. The analysis of the inequality indicators shows whatever the scenario considered a decrease of the income inequality. However the EPA scenario again seems to be more beneficial. Lastly, concerning the poverty indicators, the two scenarios envisaged did not seem to reduce poverty.

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Appendices

Appendix 1: Poverty indicators by Gender

Appendix 2: Equations of the model

Appendix 1: Poverty indicators by Gender

Note: Male1 = poverty line at1.5 Euros/day; Male2 = poverty line at 2 Euros/day; Male3 = poverty line at 3 Euros/day; Female = poverty line at1.5 Euros/day

Table A-1: Poverty Headcount by gender (% change from Base)

	Benchmark	Full liberalization	EPA
Female	75%	0.00%	0.00%
Male1	0%	0.00%	0.00%
Male2	25%	0.00%	0.00%
Male3	75%	0.00%	0.00%

Source: Author calculation using simulation results

Table A-2: Poverty Gap by gender (% change from Base)

	Benchmark	Full liberalization	EPA
Female	58%	0.77%	0.03%
Male1	0%	0.00%	0.00%
Male2	5%	9.06%	-1.94%
Male3	17%	7.15%	-1.12%

Source: Author calculation using simulation results

Table A-3: Poverty severity by gender (% change from Base)

	Benchmark	Full liberalization	EPA
Female	47%	1,13%	-0,04%
Male1	0%	0,00%	0,00%
Male2	1%	18,94%	-3,85%
Male3	6%	8,87%	-1,17%

Source: Author calculation using simulation results

Appendix 2: Equations of the model

Sets, Subsets and alias

$\boldsymbol{i}$ *sectors* $\{A_1, A_2, \cdots, A_{34}\}$

$\boldsymbol{f}$ *mobile factors of production* $\{Labor, capital\}$

$\boldsymbol{h}$ *Households* $\{h_1, h_2, \cdots, h_8\}$

$\boldsymbol{iag(i)}$ *agricultural sectors* $\{A_1, A_2, A_3, A_4, A_5\}$

$\boldsymbol{inag(i)}$ *non agricultural sectors*

$\boldsymbol{pub(i)}$ *non market sectors* $\{A_{30}\}$

$\boldsymbol{priv(i)}$ *market sectors* $\{A_1, A_2, \cdots, A_{29}, A_{31}, \cdots A_{34}\}$

$\boldsymbol{ifs(i)}$ *sectors with a specific factor* $\{A_1 A_2, A_3, A_4\}$

$\boldsymbol{infs(i)}$ *sectors without a specific factor* $\{A_5, A_6, \cdots, A_{34}\}$

alias $(\boldsymbol{i}, \boldsymbol{j})$

alias $(\boldsymbol{pri}, \boldsymbol{jpri})$

alias $(\boldsymbol{h}, \boldsymbol{r}, \boldsymbol{k})$

Parameters

$\boldsymbol{tm_i}$	*rate of import duty*
$\boldsymbol{se_i}$	*rate of export subsidy*
$\boldsymbol{sx_i}$	*rate of production subsidy*
$\boldsymbol{io_i}$	*share of intermediate consumption in production of i*
$\boldsymbol{v_i}$	*share of added value in production of i*
$\boldsymbol{aij_{i,j}}$	*share of intermediate consumption of good in total intermediate consumption of j*
$\boldsymbol{\sigma f_i}$	*CES elasticity of mobile factor labor capital*
$\boldsymbol{\sigma v_i}$	*CES elasticity of mobile factor specific factor*
$\boldsymbol{\sigma i_{i,j}}$	*CES elasticity intermediate consumption domestic good imported good*
$\boldsymbol{\sigma t_i}$	*CET elasticity*
$\boldsymbol{pmep_h}$	*saving rate*
$\boldsymbol{kip_i}$	*share of capital good i in total investment*

σk_i	*CES elasticity of demand for capital good domestic good imported good*
σd_i	*elasticity of final Armington final demand domestic imported*
σg	*CES elasticity agricultural consumption*
σc	*CES elasticity aggregate consumption*
xwf_i	*CES coefficient VA K L*
xrf_i	*second CES coefficient VA K L*
xmv_i	*CES coefficient VA MOBILE SPECIFIC FACTOR*
xsv_i	*second CES coefficient VA MOBILE SPECIFIC FACTOR*
$xdi_{i,j}$	*CES coefficient intermediate consumption domestic imported*
$xmi_{i,j}$	*second CES coefficient intermediate consumption domestic imported*
xex_i	*CET coefficient*
xxx_i	*second CET coefficient*
xdk_i	*CES coefficient investment good*
xmk_i	*second CES coefficient investment good*
$xagn_h$	*CES coefficient agricultural consumption*
$xnagn_{i,h}$	*CES coefficient non agricultural consumption*
$xig_{i,h}$	*CES coefficient consumption of agricultural goods*
$xdd_{i,h}$	*CES coefficient consumption domestic imported products*
$xmd_{i,h}$	*second CES coefficient consumption domestic imported products*
al_{pub}	*share of labor in public production*
ak_{pub}	*share of capital in public production*
aci_{pub}	*share of intermediate consumption in public production*
nh	*total number of households*
$q0$	*exchange rate*
δkg	*government capital income share*
δkf	*firm capital income share*
δlh_h	*labor income share per household*
δkh_h	*Capital income share per household*

δsh_h	*Specific factor income share per household*

Variables

PM_i	*domestic price of imports*
PE_i	*domestic price of exports*
PP_i	*production price of domestic products*
$PCF_{i,h}$	*price of final consumption*
PCK_i	*price of capital good*
$PCI_{i,j}$	*price of intermediate consumption*
PVA_i	*price of value added*
$PINDEXAG_h$	*price of agricultural consumption*
$PINDEX_h$	*Consumption price index*
PD_i	*consumption price of domestic products*
$PCNTER_i$	*price of intermediate consumption*
$PINDEX\_PRI_h$	*index price of private consumption*
MOB_i	*demand of mobile factor*
VA_i	*sector demand of domestic intermediate consumption*
$ZM_{i,j}$	*sector demand of imported intermediate consumption*
$CIJ_{i,j}$	*total intermediate consumption of good i by sector j*
CI_i	*total intermediate consumption*
XD_i	*domestic production*
XXD_i	*domestic supply*
E_i	*exports in volume*
M_i	*imports in volume*
WM_i	*remuneration of composite good in sector i*
WS_i	*remuneration of specific factor*

W_f	*remuneration of mobile factors*
$FD_{i,f}$	*sector demand of mobile factors*
$YFSP_i$	*income of specific factors*
IT_i	*total sector investment*
ID_i	*sector demand of domestic product for capital good*
IM_i	*sector demand of imported product for capital good*
$DT_{i,h}$	*sector final consumption in volume*
$DD_{i,h}$	*sector final consumption of domestic good*
$DM_{i,h}$	*sector final consumption of imported good*
$CPAG_h$	*final consumption of agricultural goods*
CT_h	*total household consumption private and public goods*
$CPRI_h$	*private consumption*
$CPUB_h$	*public consumption*
$INVEST$	*investment*
YBH_h	*household gross income*
YNH_h	*household net income*
$SAVH_h$	*household savings*
YBF	*firm gross income*
YNF	*firm net income*
$SAVF$	*firm savings*
$RGOV$	*government receipts*
G	*government spending*
$SUBEX$	*total exports subventions*
$SUBPRO$	*total production subventions*
$SOLD$	*public balance*
$TAXIM$	*custom receipts*
IDH_h	*household income taxes*
IDF	*firm income taxes*

comptax	*compensation tax*
TI_i	*indirect taxes*
TRROWF	*transfers row to firms*
$TRGH_h$	*transfers government to households*
TRGF	*transfers government to firms*
TRGROW	*transfers government to row*
$TRFH_h$	*transfers firms to households*
$TRROWH_h$	*transfers row to households*
TRROWG	*transfers row to government*
TRFROW	*transfers firms to row*
$TRHH_{h,r}$	*Domestic Intra-household transfers*

Equations

Exports and imports Prices

$$PM_i = pwm0_i . q0 . (1 + tm_i) \quad (1)$$

$$PE_i = pwe0_i . q0 . (1 + se_i) \quad (2)$$

Production Double Leontief

$$XD_i . io_i = CI_i \quad (3)$$

$$PP_{pri} . XD_{pri} . (1 + sx_{pri}) = (PVA_{pri} . VA_{pri}) + (PCNTER_{pri} . CI_{pri}) \quad (4)$$

$$CIJ_{i,j} = aij_{i,j} . CI_j \quad (5)$$

$$PCNTER_i . CI_i = \sum_j PCI_{j,i} . CIJ_{j,i} \quad (6)$$

Public production block (Leontief)

$$XD_{pub} . al_{pub} = FD_{pub,f} \quad (7)$$

$$XD_{pub} . ak_{pub} = FD_{pub,f} \quad (8)$$

Production added value mobile factor specific factor

$$MOB_{ifs} = VA_{ifs}.\left(xmv_{ifs}.\frac{PVA_{ifs}}{WM_{ifs}}\right)^{\sigma v_{ifs}} \quad (9)$$

$$fsp0_{ifs} = VA_{ifs}.\left(xsv_{ifs}.\frac{PVA_{ifs}}{WS_{ifs}}\right)^{\sigma v_{ifs}} \quad (10)$$

$$PVA_{ifs}.VA_{ifs} = WM_{ifs}.MOB_{ifs} + WS_{ifs}.fsp0_{ifs} \quad (11)$$

$$MOB_i = VA_i \quad \boldsymbol{if\ i\ \epsilon\ infs} \quad (12)$$

$$PVA_i = WM_i \quad \boldsymbol{if\ i\ \epsilon\ infs} \quad (13)$$

Production composite factor

$$WM_{pri}.MOB_{pri} = \sum_f W_f.FD_{pri,f} \quad (14)$$

$$FD_{pri,f} = MOB_{pri}.\left(xwf_{pri}.\frac{WM_{pri}}{W_f}\right)^{\sigma f_{pri}} \quad (15)$$

$$FD_{pri,f} = MOB_{pri}.\left(xrf_{pri}.\frac{WM_{pri}}{W_f}\right)^{\sigma f_{pri}} \quad (16)$$

Production CES intermediate consumption domestic imported

$$ZD_{i,j} = CIJ_{i,j}.\left(xdi_{i,j}.\frac{PCI_{i,j}}{PD_i.(1+itr0_i)}\right)^{\sigma i_{i,j}} \quad (17)$$

$$ZM_{i,j} = CIJ_{i,j}.\left(xmi_{i,j}.\frac{PCI_{i,j}}{PM_i * (1+itr0_i)}\right)^{\sigma_{i,j}} \quad (18)$$

$$PCI_{i,j}.CIJ_{i,j} = \left(PD_i.(1+itr0_i).ZD_{i,j}\right) + \left(PM_i.(1+itr0_i).ZM_{i,j}\right) \quad (19)$$

CET domestic sales _ exports

$$E_{pri} = XD_{pri}.\left(xex_{pri}.\frac{PP_{pri}}{PE_{pri}}\right)^{-\sigma t_{pri}} \quad (20)$$

$$XXD_{pri} = XD_{pri}.\left(xxx_{pri}.\frac{PP_{pri}}{PD_{pri}}\right)^{-\sigma t_{pri}} \quad (21)$$

$$PP_{pri}.XD_{pri} = PD_{pri}.XXD_{pri} + \left(PE_{pri}.E_{pri}\right) \quad (22)$$

Definition of imports

$$M_i = \sum_j ZM_{i,j} + IM_i + \sum_h DM_{i,h} \quad (23)$$

Demand of capital good

$$PCK_i.IT_i = kip_i.INVEST \quad (24)$$

$$ID_i = IT_i.\left(xdk_i.\frac{PCK_i}{PD_i.(1+itr0_i)}\right)^{\sigma k_i} \quad (25)$$

$$IM_i = IT_i.\left(xmk_i.\frac{PCK_i}{PM_i.(1+itr0_i)}\right)^{\sigma k_i} \quad (26)$$

$$PCK_i.IT_i = PD_i.(1+itr0_i).ID_i + PM_i.(1+itr0_i).IM_i \quad (27)$$

Final demand first level

Utility Function

$$CT_h = CPRI_h + CPUB_h \quad (28)$$

$$PINDEX_h.CT_h = PINDEX\_PRI_h.CPRI_h \quad (29)$$

Final demand second level

$$CPAG_h = CPRI_h.\left(xagn_h.\frac{PINDEX\_PRI_h}{PINDEXAG_h}\right)^{\sigma c} \quad (30)$$

$$DT_{inag,h} = CPRI_h.\left(xnagn_{inag,h}.\frac{PINDEX\_PRI_h}{PCF_{inag,h}}\right)^{\sigma c} \quad (31)$$

$$PINDEXPRI_h.CPRI_h = \sum_i PCF_{i,h}.DT_{i,h} + PINDEXAG_h.CPAG_h \quad (32)$$

Final demand third level agricultural goods

$$DT_{iag,h} = CPAG_h.\left(xig_{iag,h}.\frac{PINDEXAG_h}{PCF_{iag,h}}\right)^{\sigma g} \quad (33)$$

$$PINDEXAG_h.CPAG_h = \sum_{iag} PCF_{iag,h}.DT_{iag,h} \quad (34)$$

Final demand third level all goods

$$DD_{i,h} = DT_{i,h}.\left(xdd_{i,h}.\frac{PCF_{i,h}}{PD_i.(1+itr0_i)}\right)^{\sigma d_i} \quad (35)$$

$$DM_{i,h} = DT_{i,h}.\left(xmd_{i,h}.\frac{PCF_{i,h}}{PM_i.(1+itr0_i)}\right)^{\sigma d_i} \quad (36)$$

$$PCF_{i,h}.DT_{i,h} = (PD_i.(1+itr0_i).DD_{i,h} + (PM_i.(1+itr0_i).DM_{i,h} \quad (37)$$

$$\sum_i PCF_{i,h}.DT_{i,h} = (1 - pmep_h).YNH_h \quad (38)$$

Income and savings

Private income and savings

Households

$$ybh_h = \delta lh_h.\left(\sum_i w_{\text{labor}}.fd_{i,\text{labor}}\right) + \delta kh_h.\left(\sum_i w_{\text{capital}}.fd_{i,\text{capital}}\right) + \delta sh_h.\left(\sum_{ifs} ws_{ifs}.fsp0_{ifs}\right) + trfh0_h + trgh0_h + trrowh0_h - \sum_r trhh0_{h,r} + \sum_r trhh0_{r,h} \quad (39)$$

$$ynh_h = (1 - tyh_h).ybh_h - comptax.ybh_h \quad (40)$$

$$idh_h = tyh_h.ybh_h \quad (41)$$

$$savh_h = pmep_h.ynh_h \quad (42)$$

Firms

$$ybf = \delta kf.\left(\sum_i w_{\text{capital}}.fd_{i,\text{capital}}\right) + trgf0 - \sum_h trfh0_h - trfrow0 + trrowf0 \quad (43)$$

$$Idf = tyf.yb \quad (44)$$

$$savf = (1 - tyf).ybf \quad (45)$$

$$ynf = savf - idf \quad (46)$$

Public income

$$taxim = \sum_i (tm_i.m_i.pwm0_i).q0 \quad (47)$$

$$rgov = taxim + \sum_i ti_i + \sum_h idh_h + idf + trrowg0 + \delta kg.\left(\sum_i w_{\text{capital}}.fd_{i,\text{capital}}\right) \quad (48)$$

$$g = \sum_h trgh0_h + trgf0 + trgrow0 + subpro + subex \quad (49)$$

$$Subex = \sum_i (se_i.e_i.pwe0_i).q0 \quad (50)$$

$$subpro = \sum_i sx_i . xd_i . pp_i \tag{51}$$

$$sold = rgov + \sum_h comptax . ybh_h - g - \sum_{pub} PCNTER_{pub} . CI_{pub} + \sum_f W_f . FD_{pub,f} \tag{52}$$

$$cpub_h = \sum_{pub} xd(pub) \tag{53}$$

$$ti_i = itr0_i . \left(pd_i . \sum_h dd_{i,h} + pm_i . \sum_h dm_{i,h} + pd_i . id_i + pm_i . im_i + \sum_j pd_i . zd_{i,j} + \sum_j pm_i . zm_{i,j} \right) \tag{54}$$

Specific factor

$$yfsp_{ifs} = ws_{ifs} . fsp0_{ifs} \tag{55}$$

Equilibrium of markets

$$xxd_{pri} = \sum_j zd_{pri,j} + id_{pri} + \sum_h dd_{pri,h} \tag{56}$$

$$\sum_i fd_{i,f} = fs0_f \tag{57}$$

Closure

$$q0 . \sum_i pwe0_i . e_i - q0 . \sum_i pwm0_i . m_i + trrowg0 + \sum_h trrowh0_h - trgrow0 - trfrow0 = \sum_h savh_h + savf + sold - invest \tag{58}$$