Dynamic Effects of an Economic Partnership Agreement: Implications for Senegal

Cissokho Lassana
Suffolk University
cis11@suffolk.edu
ciskolass@yahoo.fr

Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Corpus Christi, TX, February 5-8, 2011

Dynamic Effects of an Economic Partnership Agreement: Implications for Senegal

Cissokho Lassana
Suffolk University

December 4, 2010

Abstract

In this paper, I use a dynamic recursive computable general equilibrium to evaluate, for the economy of Senegal, the dynamic effects of an economic Partnership Agreement between West African countries and the European Union. In the simulation, the liberalization scheme is designed in a way similar to the interim agreement signed by Cote d'Ivoire and Ghana. The effects described are the shifts from the baseline numbers. I found that the production of agricultural goods will decrease, affecting employment negatively, particularly in unskilled labor, since this sector is very labor intensive. In fact, employment drops at around 0.2 percent a year, during the simulation period (2012-2030). GDP grows on average by 1.9 percent a year. The effects of the economic partnership agreement closely mirror the results of a free trade agreement between Senegal and the European Union, implying that a customs union between West African countries is not necessary to reap of the benefit of the former.

1 Introduction

West African countries and the European Union (EU) are a step closer to establishing of a new framework for their trade relationship: an economic partnership agreement (EPA), consistent with the rules of the World Trade Organization (WTO). Senegal, like all least developed countries, exports duty-free to the EU under the everything-but-arms initiative (EBA). In the new framework, the relationship will be reciprocal, that is, the EU will benefit from the same preferences in all West African countries. In addition, the EU has made the creation of a customs union between West African countries a condition for the establishment of the EPA. The effects of these policy changes on the domestic economies of the West African countries will be important and are, in fact, the primary concerns in the EPA negotiations.

The objective of this paper is to evaluate, for the economy of Senegal, the dynamic effects of an EPA between West African countries (WA), composed of ECOWAS plus Mauritania, and the EU.

Two types of models are used for this type of analysis: partial equilibrium (PE) and computable general equilibrium models (CGE).

Partial equilibrium models are used when the analysis is not extended to the entire economy, but focuses on changes in specific markets after a policy change, or a shock. These models, however, by ignoring the interdependence that exists between different markets, are missing the spillover effects of shocks affecting a specific market. General equilibrium models fill this gap by describing the entire economic system, capturing not only the direct impact of a shock in a particular sector, but also the impact on other areas of the economy and the feedback effects from these to the entire economy. Two types of CGE models are commonly used : Static CGE (SCGE) and dynamic CGE (DCGE).

SCGE are used to compare the equilibrium state of an economy before and after a perturbation, when all adjustments have taken place. This type of model is widely used, and similar questions on Senegal have been studied using it. For instance, Dumont et al. (2000) studied the impact of public infrastructure on competitiveness and growth in Senegal. They found that when public infrastructure is financed using aid, the production of non-tradables increases, but GDP decreases compared to baseline scenario; and if financed using foreign savings, it has a positive impact on GDP. Diagne et al. (2007), in another study on Senegal, found that trade liberalization worsens poverty and inequality in the short run and decreases production both in protected agriculture and industrial sectors. In the long run, however, it brings substantial decreases in poverty even though income distribution worsens. SCGE have been also used for multi-countries analysis. Decaluwe et al. (2001) evaluated the effects of a customs union between country members of the West African Economic and Monetary Union (UEMOA) using a multi-country CGE model; the reform is shown to be welfare-improving, and has a positive impact on regional and non-regional trade flows; however, it induces negative effects on government finances. For the Common Market of Eastern and Southern Africa, Karingi et al. (2005) found that an EPA with the EU leads to a steady increase in imports into country members, and if reciprocity is not applied there is a net improvement in welfare, though the trade balance continues to fall. Under free trade however, GDP grows at 3.4% and the trade balance improves.

The second type of model, the DCGE, is receiving a growing attention from researchers. In trying to capture the evolution of an economy from one equilibrium to a new one after a shock, DCGE models push the analysis further. The simulated counterfactual paths of the economy, with and without shocks, give an idea of the time paths of the likely impacts of the policy changes, and thus could serve as guidance for a better policy choice. In this line of research, Löfgren et al. (1999) analyzed the impact of the Association Agreements with the European Union on households in Morocco. The authors used a dynamic CGE model and found that removing tariffs and non-tariff barriers result in a growth slowdown in agricultural sectors, and growth in non-agricultural sectors. There are also few studies on Senegal using these models. Dissou (2002) analyzed the dynamic effects of a customs union between countries member of the West African Economic and Monetary Union on Senegal, using an intertemporal DCGE. He found that, if adopted with an outward-looking strategy, the customs union is welfare-improving for Senegal. Annabi et al (2005) analyzed the effects of trade liberalization on welfare and poverty in Senegal. Their results indicate small negative impacts in terms of welfare and poverty, in the short run . In the long run however, they find positive impacts on production in the industrial and services sectors, and a substantial decrease in poverty.

In this paper, I use a recursive DCGE to analyze the effects of an EPA between the EU and ECOWAS on Senegal's economy. I find that, in the period covered by the simulation (2012-2030), the EPA increases employment by 0.3 percent, much of which is composed of skilled workers; however, in the first decade after the EPA is implemented, total employment decreases by 0.2 percent, mainly due to reduced demand for unskilled labor. This result comes from the adverse effects on sectors that are big providers of unskilled employment, such as agriculture, commerce, and public services.

The rest of the paper is organized as follow: section 2 discusses the context of the EPA and gives some background information on Senegal's economy; in section 3, I present the model; the data and calibration issues are dealt with in the section 4; and finally, the different simulations are explained, and the results presented and discussed in section 5.

2 Context and Economic Background

2.1 Context of the EPA

The Most Favored Nation (MFN) clause of the World Trade Organization (WTO) was established to prevent countries from giving preferential treatment a few countries while excluding the rest of the world. However, developed countries have thought of using trade as a development tool in their relationship with developing countries. This issue brought the idea of the Generalized System of Preferences (GSP), first discussed in 1968 by UNCTAD, before being adopted by the GATT in 1971 for a 10-year period, and extended permanently in 1979 with the enabling clause. A waiver to the MFN rule, the GSP gives developed countries legal grounds to treat their trading partners differently, depending on their level of development. However, this waiver is constrained to be non-discriminatory among developing countries, and non-reciprocal. With respect to this last aspect it differs from the trade relation defined by the article XXIV of the GATT on free trade agreements (FTA). It is clear, therefore, that this European Union (EU) - African Caribbean and Pacific (ACP) relationship violates not only the reciprocity clause on FTA, but also goes against the underlining principle of the GSP, that is the non-discrimination clause. Because, first, ACP's imports from the EU are subject to trade barriers, while they export to the EU under the GSP; and second, only the developing ACP countries are beneficiaries. With the complaints of the excluded developing countries and pressure from the WTO, the EU is engaged in the process of bringing its trade relations with the ACP countries into conformity with the rules the WTO; this process formally started with the Cotonou agreements in 2000. In September 2002, the EU and different groups of ACP countries, among which the Economic Community of West African Countries[1] (ECOWAS) plus Mauritania, established a new framework for their trade relationship, the economic partnership agreements (EPA), to conform to the rules of the WTO. In this new framework, trade between ECOWAS and the EU will be free; the latter will ease up all trade barriers, while the former will drop all tariffs on at least 80 percent of its imports from the EU. The negotiations were expected to be completed by January 2008; however, the deadline was reached without a final agreement,

[1] ECOWAS countries: Benin, Burkina Faso, Cap Verde, Cote d'Ivoire, Gambia, Ghana, Guinnea, Bissau Guinnea, Liberia, Mali, Niger, Nigeria, Senegal, Sierre Leone, Togo.

except between the EU and the Cariforum[2]. Many countries have, individually or as subgroups, signed interim agreements, but still remain within their groups for the final EPA negotiations.

ECOWAS represents the biggest trading partner of the EU within the ACP group, with around 40 percent of imports and 32 percent of exports, and as of yet has not reached a final agreement on the EPA with the EU. However, two members, Côte d'Ivoire and Ghana, have signed interim agreements with the EU, in March 2009 and November 2008 respectively. Nigeria is trading under the GSP standard, and Cape Verde (until 2011) and the LDC countries of the group are trading with the EU under the Everything But Arms (EBA) initiative.

Benefiting from the EBA initiative Senegal has duty-free access to the EU market; therefore, it has no apparent reason for joining an agreement to have an access it already has. However, it is widely agreed that the benefits from trade go beyond access to a wider market for domestic producers; in fact, if most domestic firms can access a larger market by exporting duty free to the EU, the domestic economy will miss most of the benefits attributed to trade openness such as lower prices for intermediate inputs and consumer goods, technology transfer, and efficiency gains through competitive exposure of domestic firms. However, the costs in terms of unemployment, factor incomes, and loss of revenue for the government, during the transition period play a major role in the negotiations. Economists in general agree on the long term benefits, but the path that the economy takes during the transition period is unclear and remains the main concern of developing countries when negotiating RTAs with more-developed countries.

2.2 Economic Background

The Senegalese economy grew at 4.2 percent on average during the 2000-2007 period, but was affected by the slowdown of the global economy in 2008 and 2009, with 2.3 and 1.2 percent growth rates respectively (Table 1). The primary sector, 13.5 percent of GDP and main provider of employment, grew at 1.4 percent in the 2000-2009 span; services, representing around two thirds of GDP, grew at 4.5 percent; and finally manufacturing, accounting for 20 percent of GDP, grew at 3.4

[2] CARIFORUM countries: Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, the Dominican Republic, Grenada, Guyana, Haiti, Jamaica, Saint Lucia, Saint Vincent and the Grenadines, Saint Christopher and Nevis, Surinam, and Trinidad and Tobago.

percent. Available resources come from domestic production (77.6 percent), imports (16.6 percent) and taxes (5.8 percent). Consumption, intermediate and final, represent respectively 36 and 41 percent of total expenditures; investment and exports account for 11 and 12 percent respectively. Investment grew at the average rate of 6 percent during the same time-period; both final and intermediate consumption recorded a 4 percent growth rate (Table 2).

The import-GDP and export-GDP ratios remained very stable, with a average of 36.4 and 27.2 percent respectively. Consumption goods occupy the highest portion in total imports, 39 percent in 2008 and 44 percent in 2009. However, capital goods, intermediate inputs and raw materials, together, represented more than half of total imports in 2008 and around 61 percent in 2009. The EU is the main import partner of Senegal, with more than 40 percent of total imports; on the exports side, more than 50 percent of Senegal's production go to WA countries. However, at the disaggregated level, Senegal gets a little more than half of its raw material imports from the WA countries, and exports 60 percent to the EU. The imports and exports of intermediate goods with the rest of the world are half of total imports and total exports.

Table 2 contains the tariff rates on imports to and from Senegal. Tariff rates on imports from West African countries (10.3 percent) are on average lower than the rates on imports from the EU and the rest of the world (12.4 percent).

Table 1: Structure of GDP (constant CFAF 1999) per Sector

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
GDP growth(%)	3.2	4.6	0.7	6.7	5.9	5.6	2.5	4.9	2.3	1.2
					Percentage shares of GDP					
Agriculture	14.7	14.3	10.8	12.2	11.8	12.4	11.1	9.8	11.0	11.2
Fishing	1.9	1.8	1.6	1.5	1.4	1.5	1.3	1.3	1.3	1.3
Industries	20.9	21.0	22.0	21.5	21.5	20.9	20.5	21.0	19.9	20.0
Services	62.5	63.0	65.6	64.8	65.2	65.2	67.1	67.9	67.8	67.5

Source: Author's computation using data from Agence National de la Statistique et de la Demographie (ANSD), Senegal.

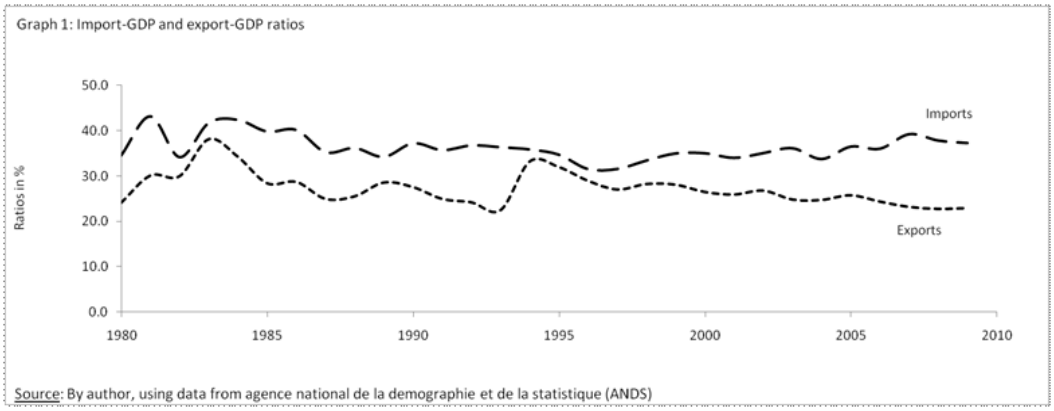


Table2: Import tariffs (simple average)

	On imports from regions			On imports from Senegal		
	WA	EU	ROW	WA	EU	ROW
Agriculture	5.7	10.7	10.8	10.2	0.1	10.8
Mining	7.6	7.7	7.9	7.2	0.0	1.5
Wood	13.6	14.1	14.3	10.7	0.0	2.7
Rubber	10.1	10.7	10.7	11.3	0.0	5.2
Fishing Products	5.0	10.1	10.1	9.1	0.0	5.1
Processed food	8.6	16.0	16.0	14.8	0.8	11.8
Leather	14.7	14.7	14.8	11.6	0.0	5.3
Textile	17.4	18.4	18.2	15.2	0.0	6.9
Tobacco	4.9	9.7	9.7	21.3	0.0	29.5
Beverage	10.2	19.4	19.4	16.8	0.0	12.9
Chemicals	9.0	9.5	9.5	9.5	0.0	4.6
Petroleum and Coal	4.3	4.4	4.4	8.2	0.0	1.5
Transport Equipment	9.4	9.0	9.0	7.1	0.0	4.8
Glass and Pottery	15.7	16.2	16.2	16.4	0.0	5.2
Iron and Steel	13.1	13.6	13.4	11.2	0.0	3.0
Machinery	12.5	12.7	12.7	11.3	0.0	4.8
Paper	6.4	6.8	6.9	7.3	0.0	2.4
Other products	18.0	19.0	19.0	18.0	0.0	6.3

Source: International Trade Center (ITC)

2.3 Senegal's Trade Policies and Trade Agreements

Senegal is a founding member of the Economic Community of West Africa (ECOWAS). This body, established in 1975, is aimed at unifying the markets of the member countries and harmonizing their trade policies and ultimately at creating an economically-integrated entity. A revision was undertaken in 1993 to revive the economic integration project. The trade liberalization scheme

adopted categorizes trade into 3 groups. The first 2 groups, made up of unprocessed goods, and traditional handicraft products, was granted an immediate and full liberalization status. The third group, made of industrial goods, would be liberalized gradually over the 1990 to 2000 period. Tariffs are still high within ECOWAS and most of the datelines were not met. However, efforts to bring the rates down and transforming ECOWAS in a unified market are real, especially in the wake of an EPA between ECOWAS and the EU. In 1994 a subgroup of countries within the ECOWAS, the UEMOA, signed the UEMOA treaty, and in 1996 a preferential tariff regime was enforced among member states.

Senegal's trade policies are tailored to fit the UEMOA's common external tariff adopted in 1997. UEMOA's CET defines four major bands for customs duties. Products admitted in the first band are admitted duty free. The approved products are mainly pharmaceuticals (drugs and other medicines for infectious diseases, HIV/AIDS), agricultural inputs, capital goods, computer and data processing equipment not available through local production, and social, cultural, and scientific goods. Raw materials, crude oil, and cereals for industries are subject to a 5 percent tariff rate, which corresponds to the second band. The third band, corresponding to a 10 percent tariff, is applied on semi-finished products, diesel and fuel oil, intermediate goods, and other cereals. The last band of 20 percent is imposed on final consumption goods, capital goods, and computer and data processing equipment already available through local production, as well as new and used vehicles. In addition to the CET however, Senegal applies supplementary levies in conformity with UEMOA policies, and taking into account all levies, the average applied duties are higher than if the CET alone was applied.

For products of UEMOA origin, a preferential regime is applied. Since 2000, duty free access is granted to all agricultural products and handicraft goods and for approved industrial products. Eligible manufactured goods must have at least 60 percent of the raw materials or 40 percent of the added value of UEMOA origin. For products not approved, a 5 percent reduction is granted. And effective of January 1st , 2000, approved industrial and agricultural products within UEMOA may be imported free of customs duty.

Beyond the ECOWAS and the UEMOA agreements, Senegal is also a member of the GATT

since September 1963, and later of the WTO. The country has a long history of trade relationship with the EU, its greatest trade partner, under the EU-ACP relations. Admitted to the group of LDCs in April 2001, Senegal has the opportunity to export duty free to the EU.

The new challenge now goes beyond the UEMOA and ECOWAS treaties, because an RTA between WA countries is put as a condition for the EPA with the EU; but the custom union status is yet to be achieved. However, since January 2006, a CET was adopted and scheduled for application on January 2008, the negotiations are still going on. The WA countries CET is an extension of the UEMOA CET, organizing trade in 4 bands as set out above. Under the proposition of Nigeria, a fifth band of a 35 percent tariff rate was adopted on Jun. 2009 to protect new industries.

When the EU-WA negotiations end, the EPA will be the framework that defines the trade relationship between Senegal, the rest of WA countries, and the EU. The EU will abolish all trade restrictions (tariffs and non tariffs) on its imports from the ACP countries, while the latter liberalizes up to 80 percent of imports from the EU, with the possibility of a gradual phasing out of tariffs. By the end of 2007, when it became clear that the EU-WA EPA would not be completed, Côte d'Ivoire and Ghana concluded interim agreements with the EU "to prevent trade interruption". Côte d'Ivoire signed the initialled agreement in November 2008; Ghana is yet to sign its agreements, however, the first phase has been in effect since January 2009. From that period up to now, the negotiations are ongoing, with a cycle of propositions and rejections turning around two main things: the extent of liberalization on the WA countries side, and the level of aid attached to the development dimension of the EPA on the EU side. The WA countries last offer was a 67 percent liberalization over 25 years, on October 2009, and they are yet to respond to a 70 percent liberalization at a higher speed proposed by the EU. The EU on its side has committed to spend €6.5 billion over a 5 year period, on May 2010.

3 Description of the Model

The settings of the model are presented in this section. It is a recursive dynamic CGE model of a small open economy, based on that of Thurlow (2004), which also is an extension of the model in Lofgren et al.(2002). It differs from these models in that each activity produces only one commodity,

and in other settings that are discussed below. The model has two main components. The first one is the static module, which consists of the core equations of the model; the calibration of this part defines the values of the different parameters, offers the starting values for the endogenous variables, and solves for the values of the endogenous variables within each period. The dynamic module defines the equations linking the different periods. The equations of the model consist of the first order conditions of the different optimization programs of institutions, along with the constraints, and the different accounting equations. They are presented in the appendix.

3.1 Static Part of the Model

It identifies 28 activities, each producing one commodity, and counts four institutions: households, enterprises, and the government; plus the rest of world. The model separates activities from commodities, the former are the domestic production units, while the latter, similar to the domestic markets, buy goods from domestic and foreign producers, and allocate it between the domestic sales and exports. Households consume home and imported goods to maximize their inter-temporal utility; firms maximize their profit in a constant return to scale (CRS) framework; the government collects taxes to consume and make transfers; and they all have access to the international capital market where they can lend and borrow at the world interest rate.

3.1.1 Activities

Activities correspond to domestic producers; they use three factors of production, unskilled and skilled labor, and capital to produce goods and services. Primary factors of production (capital and labor) are combined in a CES function to get value added (VA); aggregate intermediate input is a Leontief function of disaggregated intermediate inputs. Activity output is a Leontief function of intermediate inputs and VA, the intuition being that the optimal combination between VA and intermediate inputs is defined by technology rather than by the decision of a manager (Thurlow, 2004). Firms produce the quantities that maximizes their profits, subject to a production technology constraint:

$$PROFIT = (1 - t_a)\, P_a Q_a - \sum_c Pq_c.Qint_{ac} - \sum_f Wf_f.d_{fa}.Qf_f \tag{1}$$

is maximized subject to

$$\begin{aligned}
Qv_a &= \alpha v_a \left(\sum \delta_{fa}.Qf_{fa}^{-\rho v_a} \right)^{-\frac{1}{\rho v_a}} && (2)\\
Qint_{a,c} &= ic_{a,c}.Qt_a && (3)\\
Q_a &= Min \left[\frac{Qv_a}{iv_a}, \frac{Qt_a}{it_a} \right] && (4)\\
Pint_c &= \sum_c Pq_c.ic_{ca}. && (5)
\end{aligned}$$

P_a: activity price of the commodity produced by activity a; Q_a: quantity of commodity produced by activity a; Pq_c: price of composite commodity c, which is a mixture of home produced and imported goods; $Qint_{a,c}$: quantity of commodity c as intermediate to activity a; Wf_f : average price of factor f; $d_{f,a}$: wage distortion factor for factor f in activity a; Qf_f: quantity of factor f; Qv_a: quantity of value added; $ic_{a,c}$: quantity of commodity c per unit of aggregate intermediate input; Qt_a: quantity of aggregate intermediate input; iv_a: quantity of value added per unit of activity; it_a: quantity of aggregate intermediate input per unit of activity.

Once produced, firms allocate their output between domestic and foreign markets by maximizing their total revenue in both markets. The quantities of domestically produced commodities are a constant elasticity of transformation function of domestic sales and exports. As the relative price of the goods changes, the producer increases slightly the quantity sold in one market relative to the other.

3.1.2 Consumers

The model considers one category of households, deriving their income from factors of production, and transfers from the government and the rest of the world; and use it to pay taxes, to consume, and to make transfers to the rest of the world; the residual income is saved. They consume composite commodities which are also used for investment and for intermediate inputs. Households' demand

for a commodity is derived by maximizing their total utility. The consumers' preferences are represented by a Stone-Geary utility function:

$$U = \prod_c (Q_c - \gamma_c)^{\beta_c} . \tag{6}$$

Households maximize their utilities under the constraint that total expenditures equal total incomes. The solutions give the demand and expenditure functions in equations 7 and 8 respectively.

$$\begin{aligned} Q_c &= \gamma_c + \frac{\beta_c^m}{Pq_c}\left(EH - \sum Pq_c.\gamma_c^m\right) && (7) \\ Pq_c.Q_c &= Pq_c.\gamma_c + \beta_c^m\left(EH - \sum Pq_c.\gamma_c^m\right). && (8) \end{aligned}$$

With Q_c: quantity of commodity c consumed by household; γ_c: subsistence consumption of marketed commodity c for household; β_c^m: marginal share of consumption spending on marketed commodity c for household; and EH: consumption spending of households.

Composite commodities are CES aggregations of domestic goods and aggregate imports, allowing for imperfect substitution between home goods and imports (Armington assumption). Households allocate their consumption expenditures between domestic and imported commodities by minimizing total costs subject to imperfect substitutability of goods from the 2 origins.

3.1.3 Trade

Imports are differentiated with respect to their region of origin; for each commodity, aggregate imports is a CES aggregation of imports from different regions. This specification assumes imperfect substitutability between the goods imported from different regions, depending on their relative price. A similar treatment is applied to exports; the aggregate exports being a CES function of exports to different regions. The regional disaggregation allows for different tariff rates for different regions making the analysis of preferential tariffs between regions more practical.

Transaction costs are incurred on domestic sales, imports, and exports, as fixed shares per unit of commodity. Exports and imports prices include transaction costs and are adjusted for any applied tax (import tariffs or export taxes). The current account balance, corresponding to foreign saving, equals the difference between exports plus income received from the rest of the world and imports plus income paid to the rest of the world.

3.1.4 Government

Government, in this model, is an entity separated from the public service activity; it is, however, the primary buyer of the service produced by the latter. In one hand, it collects taxes and receives transfers from enterprises and from the rest of the world. On the other hand, it spends on final consumption and makes transfers to other institutions. The difference between government revenues and expenditures is the budget deficit, financed through borrowing from domestic institutions and the rest of the world.

3.1.5 Equilibrium Conditions and Macro-closures

The solution of the model depends on how the equilibrium is reached in each market and on a set of macro closures. Senegal is a small open economy; therefore, it faces an infinitely elastic world demands and supplies for its imports and exports at world prices. Import prices paid by demanders include import tariffs, and the transaction costs per unit of commodity. As for domestically supplied goods, buyers pay the producer prices plus the transaction costs. The supply prices of exports is equal to world prices adjusted for any transaction costs and export taxes. The supply prices of domestically sold outputs are equal to the prices paid by domestic demanders net of transaction costs. In domestic markets, flexible prices ensure the equilibrium between demand and supply for disaggregated commodities as well as for composite commodities.

Labor markets' closures depend on the type of labor and on the characteristics of the market. Globally, unemployment rate is around 13 percent and prevails in both markets. More than 100,000 new comers enter the labor market each year with 75,000 more jobs created between 1995 and 2004, most of which went to the informal sector, the main provider of employment in the country.

Employment, in both the skilled labor and unskilled labor markets, is driven by the demand from the private and public enterprises (World Bank, 2007). In the unskilled labor market, labor supply is fixed at the observed level, the importance of unemployment dictates a fixed wage; the supply, therefore, adjusts passively to match demand. Unemployment in the skilled labor market, may be explained by the fact that, both workers and firms are responsive to the real wage. In this case, the latter adjusts to ensure equilibrium (Lofgran et al. 2002). To be more realistic, an exogenous wage-distortion factor is introduced to make them different across sectors. Capital is sector specific and fully employed; the equilibrium between demand and supply is ensured by a sector specific flexible wage.

The government budget deficit equals its total revenues net of its total expenditures, which is kept fixed in real terms. Therefore, the closure of the government account depends on how the government's saving and its total revenues, or more precisely, the tax rates are treated. In this model, the tax rates on domestic institutions are fixed; therefore, to ensure equilibrium, uniform point change in sales taxes is applied.

Foreign savings remain fixed, which leaves the exchange rate as the adjusting variable. The opposite closure is considered in the sensitivity analysis.

Investment is financed by savings from domestic institutions and the rest of the world. With the government's persistent budget deficit, and low level of domestic savings, an investment driven closure would be more realistic. However, instead of maintaining the investment fixed, nominal share of investment in total absorption is set fixed, this option allows investment to vary. The adjustment variables are the saving rates of households and enterprises, which receive a uniform point change to equal total Investment. This closure, known as the balanced closure, is a variant of investment-driven closures; it spreads the adjustments to all components of absorption, for the shares of households and government consumptions in total absorption are also fixed. This closure is very useful in analyzing the role of complementary policies to external shocks or policy changes (Lofgran et al. 2002).

3.2 The Dynamic of the Model

The dynamic part of the model helps draw a counterfactual path of the economy in reaction to external shocks or policy changes. The dynamics is carried by a certain number of factors, which are adjusted between periods to account for some non-policy related changes in some variables or parameters in the model. Those changes concern the population growth, changes in the labor force, capital accumulation and government expenditure.

Population growth enters the model through the demand for goods and services of households, by increasing private consumption spending on each commodity (equation 7 and 8) for households. Equation 7 represents a LES specification of the demand; it allows for an income-independent level of consumption (γ_c) and a linear relationship between consumption and disposable income. Population growth affects households' spending by increasing the income-independent parts of households' demands for commodities (γ_c) the same rate as the population growth. This change, however, does not affect consumption at the margin but on the average, which means new consumers have the same preferences as the existing ones.

For two types of labor are distinguished in the model, skilled and unskilled, the way the dynamic is modeled depends on the closure adopted in each market. In the unskilled labor market, the closure adopted assumes an infinitely elastic labor supply, therefore, no adjustment is necessary in this factor market. In the skilled labor market, the supply is endogenous, making any exogenous adjustment unnecessary.

Capital accumulation is endogenous in the model. Each period's capital stock is a function of the previous period's capital stock and investment spending. In the model, capital renewal motion starts by allocating the new capital across sectors. This process starts by defining first the share of each sector in the new capital. Equation 9 defines the average rental rate of capital.

$$Awf_{ft} = \sum_{a} \left[\left(\frac{Qf_{fat}}{\sum_{a} Qf_{fat}} \right) .Wf_{ft}.Wfdist_{fat} \right], \tag{9}$$

with Qf_{fat} the quantity demanded of factor f from activity a in time period t; Awf_{ft}, Average capital rental rate in time period t; Wf_{ft}, the average price of factor f; and $Wfdist_{fat}$, a wage distortion factor for factor f in activity a. The share of new capital for each sector ($\eta^{a}_{f,a,t}$) is

estimated using equation 10. For $\frac{Wf_{f,t}.Wfdist_{f,a,t}}{Awf^a_{f,t}} > 1$, the second term in the right hand side is greater than 1 and the converse is true if $\frac{Wf_{f,t}.Wfdist_{f,a,t}}{Awf^a_{f,t}} \leq 1$. β^a is the intersectoral mobility of investment parameter; if its value is zero, therefore the new capital share of the activity is the same as its share in the existing capital. Sectors with a rental rate of capital higher than the average receive a share of new capital higher than their share of existing capital.

$$\eta^a_{f,a,t} = \left(\frac{Qf_{a,f,t}}{\sum_a Qf_{a,t}}\right)\left[\beta^a\left(\frac{Wf_{ft}.Wfdist_{fat}}{Awf_{ft}} - 1\right) + 1\right] \tag{10}$$

To get the new capital for activity a ($\nabla K^a_{f,a,t}$), the gross fixed capital formation is first deflated by the price of capital ($Pk_{f,t}$) and multiplied by the sectoral share of new capital, as displayed in equation 11. From there, the perpetual inventory method is used to determine the capital stock of each sector in period t.

$$\nabla K^a_{f,a,t} = \eta^a_{f,a,t}.\frac{\sum_c Pq_{c,t}Qinv_{c,t}}{Pk_{f,t}} \tag{11}$$

$$\text{where, } Pk_{f,t} = \sum Pq_{c,t}.\frac{Qinv_{c,t}}{\sum_c Qinv_{c,t}} \tag{12}$$

4 Data and Calibration

The model is calibrated using the 2004 social accounting matrix for Senegal (Cissokho, 2010). Besides the SAM, data on some other parameters, necessary to the dynamics of the model, have been collected from similar work on Senegal. Those parameters include the elasticities of substitution between primary factors of production, between domestic and imported commodities, and between different commodities by households ; further, data are provided on shares of regional imports, and exports and tariff revenues from the different regions considered in the model.

Elasticities of substitution are selected from various studies on Senegal (Dumont and Mesplé-

Somps, 2000; Diagne et al., 2003). The Armington elasticities (Table 3) assume imperfect substitutability between domestically produced and imported goods; lower elasticities indicate greater differences between domestic and imported goods; therefore, changes in relative prices of imports and home goods bring slight changes in the allocation of expenditures between domestic and imported goods. The elasticities of substitution between primary factors serve in the CES aggregation of capital and labor. The elasticities of substitution between commodities by households are from the GTAP African database.

Imports, exports, and tariff revenues are regrouped by region; the shares of each region, by commodity, are computed using data from the world integrated trade solution (WITS). Employment numbers are given in the input-output table from the statistical agency of Senegal; the disaggregation into skilled and unskilled labor is realized using information from the ESAM II (households survey in Senegal, 2003). The initial capital in the model is generated using the capital-output ratio; these numbers at the sectoral level, are collected in Estache and Muñoz (World Bank, 2007). The depreciation rate used in this model for manufactures is of the same magnitude as in most studies on Senegal, 5 percent (Diagne et al, 2003,2007 and Dissou, 2003); however, for services I use a rate of 3 percent. With respect to these last two characteristics, this paper differs from the previous papers (Thurlow, 2004, Diagne et al, 2003,2007 and Dissou, 2003).

Table 3: Arming elasticities

Commodities	SIGMA	Commodities	SIGMA
agriculture	2.62	Telecommunication	0.30
Mining and extracting	1.60	Restaurants and Hotels	0.30
Wood	1.50	Glass and Pottery	1.50
Rubber	1.50	Iron and steel	1.30
fishing	1.20	Machineries Equipment	1.30
Food processing	2.00	Construction	0.30
Leather	1.50	Paper products	1.50
Textile	1.50	Other Products	1.50
Tobacco products	1.50	Commerce	0.30
beverages	2.00	Transportation	0.30
Chemicals	1.30	Real estate	0.30
Electricity, Gas and water	0.30	Public Services	0.30
petroleum and coal	0.30	Financial services	0.30
Transport equipment	1.30	Other Services	0.30

Source: Dumont and Mesplé-Somps, 2000; Diagne et al., 2003

5 Simulations and results

5.1 Simulations

The interim agreements between the EU and Côte d'Ivoire set the liberalization process and scope as follows: up to 2012, 58.5 percent of imports from the EU will be liberalized; between 2013 and 2017, 10.6 percent; and finally between 2018 and 2022, 9.9 percent. On the Ghanian side, the import liberalization agenda is set as 28.8, 42.6 and 8.3 percent, corresponding respectively to the time periods defined for Côte d'Ivoire. Values are with respect to the 2004-06 imports for each country. Trade, under the interim agreements, is regrouped in 4 main bands, A, B, C, and D. The first 3 bands are liberalized progressively and successively as follows: band A, up to 2012; band B, between 2013 and 2017; and band C, between 2018 and 2022. The last band is excluded from liberalization; the selected products or sectors are the sensitive ones, based on their fragility or on their importance in fiscal revenue collection for the government. Even if the EPA contents are likely to be different from the agreement signed by Côte d'Ivoire and Ghana, the progressive and successive liberalization scheme will be maintained. The simulations, in the different scenarios considered in this paper, are designed in a similar way.

I have considered five simulation cases: The baseline, corresponding to the scenario without any shock; FTAEU, corresponding to the case where Senegal forms a free trade area with the European Union; FTAWA, in which the West African countries form a custom union; FTAEPA, where the West African countries and the European Union form an economic partnership agreement; and at last FTAWORD, in which Senegal engages in free trade with the rest of the world.

The baseline is the scenario without any change in trade regime; it traces a counterfactual path for the economy that serves as a benchmark for comparison for all remaining scenarios. Shifts from the results in this simulation represent the effects of the shock introduced in each of the remaining cases. The second scenario assumes an FTA between Senegal and the EU. Senegal, being a least-developed country, exports to the EU duty free under the EBA; therefore, any trade liberalization between the two countries affects only the tariffs on Senegalese imports from the EU. Following the example in the interim agreements, I have regrouped the different commodities in 4 bands. The first

band, A, regroups machineries and appliances, iron and steel, transport equipment, wood, tobacco, leather, and fishing. The second band, B, is made up of glass and pottery, textiles, beverages and mining. The third band, C, comprises rubber, petroleum, chemicals and other products; and the last band, D, includes agricultural goods, paper, and processed food. Band D is excluded from liberalization, and represents 28 percent of Senegal's imports from the EU in 2004, leaving 72 percent of imports to be liberalized; the negotiations are planning a 70 percent cut in tariffs on WA countries' imports from the EU. A gradual and successive liberalization of the different bands is set up in the simulation; each band is liberalized within a 6 year period, and for each band the liberalization starts with a drop of 50 percent in tariff rates; a gradual decrease of 10 percent is then applied until trade is completely free at the end of the corresponding period . In this paper, the liberalization of the different bands is implemented during the following time period: 2012-2017 for band A; 2017-2022 for band B; and 2022-2027 for band C. The tariff removal starts with less-sensitive sectors and then moves to the more-sensitive ones, in terms of fiscal revenues and employment. The third simulation corresponds to the case of a customs union between the WA countries. In this case, the liberalization schemes for products in bands A, B and C are the same as those in FTAEU. Within band D, tariffs on agricultural products are completely removed in the first year of implementation; processed food and paper products are liberalized following the plan for band C in FTAEU. The fourth scenario, FTAEPA, the most important one in this paper, corresponds to the case of an EPA between the WA countries and the EU. The liberalization scheme here is the sum of the schemes in the FTAEU and the FTAWA. Within this scenario, trade between Senegal and the EU is set as in the FTAEU; similarly trade between Senegal and the rest of WA countries is set as in the FTAWA. The fifth and last scenario, FTAWORLD,corresponds to a free trade between Senegal and all its trading partners; tariffs are completely removed on all trade in this case.

5.2 Results

The effects of the different scenarios are presented as shifts from the baseline numbers. Graphs 1-12 show the impacts on production, GDP, absorption, consumption, investment, employment,

imports, and exports, of the different policy changes. Tables 1-4 present the average effects of the different simulations on production, imports and exports.

Total production, in Senegal, increases under all FTAs, with the West African Customs Union (FTAWA) yielding the weakest impact, with 1.1 percent on average over the simulation period (2011-2030); under a free trade agreement with the EU and with the economic partnership agreement, total product increases by 2.1 and 2.2 percent respectively; free trade, however, has the largest impact on total product, with a 10.4 percent increase on average. The increases in total production are mostly accounted for by manufacturing, except under the West African Customs Union scenario, in which increased production mainly comes from the increase in the production of primary goods. Manufacturing rises by 3.2 and 3.3 percent under free trade with the EU and under the EPA. These increases are concentrated in by sectors such as transport equipment, (up 7.1 percent under FTAEU and 6.7 percent under FTAEPA); iron and steel, (up 7.8 percent under FTAEU and 8 percent under FTAEPA); and machinery (up 27.2 percent under FTAEU and 26.4 percent under FTAEPA).

The changes in the production of machinery and appliances are quite high in percentage terms, however, production of machinery and appliances in Senegal, currently, is very low, accounting for only 7 percent of total quantity of machines and appliances available, the rest being imported. The high shifts in machinery production, thus are explained by the fact the production was at a very basic basic level before the shock. Further, "machinery" includes both machinery and other equipment and appliances; while it is possible that Senegal may produce more appliances under the new environment, an increase of production in machinery at this pace would be less realistic. Therefore, another way to rationalize this increase is to consider the increase in production as mainly coming from the production of appliances; the increase in imports, therefore, are mainly made up of machines.

With the West African Custom Union, the increase in total product is carried mainly by primary goods, with a 0.5 percent increase; manufacturing increases by 0.2 percent on average, while services drop slightly (-0.02 percent). The positive effect in the production of primary goods under this scenario is dominated by fishing, which rises by 3 percent on average, against -0.08 and 0.02 percent

shifts for the production of agricultural goods and mining respectively.

Graphs 10-12 describe the evolution of the effects of the simulations on skilled and unskilled labor, and total employment. The primary sector (with agriculture and fishing) and services (commerce and public services) are among the main providers of employment in Senegal, therefore the impact on these sectors is of particular importance, at least in the short term. That may explain why employment is negatively affected under the West African Customs Union scenario (-0.1 percent on average), with a decrease of production in agriculture and commerce. In the production of primary goods, the comparative advantage of Senegal within West Africa resides in fishing. A customs union in the region will increase the exports of fish products (4.8 percent) and the imports of agricultural goods (0.3 percent on average) for Senegal. However, the increase in fishing, in this scenario, is not enough to compensate for the loss of employment mainly due to the decrease of the production of agricultural goods, and commerce. Unskilled labor, the largest share of employment in the economy, shows adverse effect twice as much as what is seen skilled labor. Unskilled labor faces negative effects during the first 15 years after the policy change; it starts recovering thereafter,but, the overall effect is negative throughout the simulation period. Skilled labor, on the other hand, shows the same pattern, except that the recovery starts 17 years after the shock, but is not enough to induce an increase in employment overall. Under the West African customs union scenario, the negative effects on employment are smaller compared to those in the others. Under the FTA with the EU, and under the EPA , total employment have overall increased by 0.3 and 0.2 percent on average, respectively; again free trade has the biggest impact, with 4.2 percent increase on total employment. In these three scenarios skilled labor employment has increased more than unskilled labor, due to the increase in manufacturing and in services (Table 4).

Unskilled labor receives a highly adverse effect in the early period of liberalization under free trade, the positive impacts start showing up only more than a decade after implementation. Skilled labor, however, experiences positive effects for all years. Total employment shows a pattern very similar to that of unskilled labor; it experiences negative effects for more than a decade and afterwards, it starts increasing. Therefore, in the early stages of liberalization under free trade, the negative effects on unskilled labor employment outweigh the positive effects on that of skilled labor,

leading to an overall decrease in employment. These negative impacts are due to the adverse effects on the commerce, public services and telecommunication activities, which under free trade have decreased in the early years after liberalization.

With the FTAEU, the unskilled labor recovers from the negative shocks 14 years after the shock. Skilled labor, though, is positively affected during the entire period, but these effects are not enough to compensate the loss in unskilled labor employment in the first decade, explaining the low effects on employment overall.

The effects of the EPA are shaped by the influences of the West African customs union and the FTA with the EU. In this scenario, skilled labor employment is positively affected throughout the entire period of simulation. Unskilled labor, on the other hand, decreases in the first decade, but recovers in the second decade after the shock. The negative effects in this scenario come from the decrease, in the first years of the policy changes, of the production in sectors such as agriculture, commerce, and public services.

The effects of FTAWA on real GDP are small, with an increase of 0.1 percent on average compared to those under FTA EU and FTA EPA, under which the effects are of a higher magnitude, with an increase of 1.8 and 1.9 percent on average, respectively. Private consumption and investment also increase, with again the FTAWA causing the smallest impact and the free trade scenario, the largest.

Imports and exports increase in all scenarios, therefore, trade overall has increased. As a results, discussing the issue of trade diversion becomes less relevant; for, the acceptance of an FTA by the WTO relies on the condition that it increases trade overall. In general, the effects of FTAWA on the Senegal's economy are small compared to those of FTAEU and FTAEPA; consequently, the effects of the EPA closely mirror those of FTAEU.

Four major points stand out among the results analyzed above. First, the condition of EU that the WA countries set up a customs union before the EPA is of less relevance in the case of Senegal, and by extension for WA countries in general. Second, employment, of unskilled labor in particularly, will be negatively affected in a period extending for more than a decade. Employment during the first decade of the EPA has decreased by -0.2 percent on average due to the loss of

employment of unskilled labor. The positive effects in the second decade, however, outweigh the negative effects in the first, leading to a positive impact overall. Therefore, in facilitating the transition, programs should focus on educating and training unskilled workers, bearing in mind that the transition will take at least a decade. Third, agriculture is the most affected sector, with negative impacts in the entire period covered. It would therefore, be necessary to help farmers focus their efforts in the production of a few crops in which Senegal could be efficient given the new environment, and help the inefficient farmers convert to alternative activities such as livestock, fishing, among others. Finally, for the fourth point, it appears that free trade represents the best option, even though, the short term cost, in terms of unemployment, is larger compared to other scenarios, during the first decade after the shock.

5.3 Sensitivity Analysis

The results of CGE models are often said to depend greatly on the magnitudes of some parameters (elasticities) and on the closure of the model. I conducted a sensitivity analysis using different elasticities and a different closure.

The Armington elasticities are at the center of most of the criticisms against CGE models. larger elasticities imply a high degree of substitutability between domestic and foreign varieties of a good. Ruhl (2008) argues that economic actors have different reactions when they experience temporary or permanent changes. Permanent changes often induce bigger adjustments compared to temporary ones. Tariff removal or decrease, being permanent, thus, tends to be related to an increase in the size of elasticities. He found that a tariff change increases the elasticity to 6.4 compared to 1.2 with temporary changes. On this basis, I inflated the elasticities in Table 3 by 5, taking them from an average of 1.1 to 6.1.

The second issue for the robustness check addresses the closure of the model. The main results are based a flexible exchange rate, and sales tax rates, which allows for fixed foreign saving and government expenditure. I relax this two assumption, by adopting a fixed exchange rate and tax rates, which allows for flexible foreign and government savings.

The effects of the EPA, on real GDP, employment, and on total imports, in these two alternatives

are presented in graphs 15-18, along the effects of the EPA in the main results. This analysis shows that, while the magnitude of some impact changes with different elasticities and closure, the direction of the impact remains the same. The effects on real GDP are robust to the change in elasticities. The closure, however, gives lower effects compared to the original closure. Employment receives higher adverse effects when different elasticities and closure are used, with the recovery starting later compared to the main results. Finally, the effects on imports are higher when different elasticities are used and lower with the alternative closure.

As mentioned above, the directions of the effects, under the different alternatives, follow the same patterns than those in the main results. Thus, the analysis, in terms of policy implications, stay the same.

6 Conclusion

This paper analyzed the consequences, on Senegal's economy, of an economic partnership agreement (EPA) between the EU and West African countries (WA), using a recursive dynamic general equilibrium. The results found in this paper point that sectors such as agriculture, very intensive in unskilled labor, receive some adverse effects for more than a decade; consequently, unskilled labor employment is negatively affected in the transition period. The results also show that, in the case of Senegal, integrating a WA customs union to the EPA does not make much difference. That is probably what explains the difficulties in reaching an agreement on the customs union currently. The EPA affects real GDP positively, which probably comes from Senegal developing it manufacturing. The results found are check for robustness, and the patterns are not affected much, which leaves the recommendations based on the main results still relevant.

Further, on May 2010, the EU responded favorably to the WA countries request of a fund "to reap the benefit and mitigate the negative effects of the EPA" (Trade Negotiation Insight, June 2010). The EPA development program (EPADP) funds will be aimed at issues such as the diversification and production capacities, the development of intra-regional trade and facilitation of access to international markets, and improvement and reinforcement of trade-related facilities. These funds therefore, could be used to help workers adjust to the new environment, by helping

them reconvert to new jobs; and improve the capacity of exporters, by building trade related infrastructure, which will make the regional market in WA more accessible for the development of the manufacturing sectors.

References

Bayar, A., X. Diao, and E. Yeldan. 2000. "An International, Multi-region General Equilibrium Model of Agricultural Trade Liberalization in the South Mediterranean NIC's, Turkey, and the European Union." Trade and Macroeconomics Division. International Food Policy Research Institute. http://www.ifpri.org/sites/default/files/publications/tmdp56.pdf.

Annabi, N., F. Cissé, J. Cockburn, and B. Decaluwé. 2005. "Trade Liberalisation, Growth and Poverty in Senegal: a Dynamic Microsimulation CGE Model Analysis." Centre Interuniversitaire sur le Risque, les Politiques Economiques et l'Emploi. Cahier de recherche/Working Paper 05-12.

Boccanfuso, D. and S. Kaboré. 2003. "Croissance, Inégalité et Pauvreté dans les années 1990 au Burkina Faso et au Sénégal." Paper presented at Journées scientifiques du Réseau "Analyse économique et développement" Marrakech, Maroc.

Cissokho, L. 2010. "A Social Accounting Matrix for Senegal for 2004." Suffolk University.

Diagne, A., F. J. Cabral, F. Cissé, M. Dansokho, and S.Ba. 2007. "Trade Policies, Regional Integration, Poverty and Income Distribution in Senegal." Cahier de recherche MPIA 15, PEP. URL: http://ssrn.com/abstract=984532.

Dissou, Yazid. 2000. "Dynamic Effects in Senegal of a Regional Trade Agreements among UEMOA Aountries." *Review of international economics.*

Dumont, J.C. and S. Mesple-Somps. 2001. "Des retombées généralement bien appréciées: infrastructure publique, croissance et compétitivité au Sénégal." *La politique économique du développement et les modèles d'équilibre général calculable.* Montréal : Presse de l'Université de Montréal, AUPELF/UREF.

Estache, A. and R. Munoz. 2007. "Building Sector Concerns into Macroeconomic Financial Programming: Lessons from Senegal and Uganda." Africa Region Working Paper Series No. 108, The World Bank. URL: http://go.worldbank.org/MXLVMNC9I0h.

European Center for Development and Policy Management. . 2008 "EPA negotiations: Where do we stand?" URL: www.ecdpm.org/epa.

Gasiorek M. and A. L. Winters. 2004. "What Role for the EPAs in the Caribbean?" *The World Economy* pp: 1335–62.

Löfgren, H., M. El-Said, and S. Robinson. 1999. "Trade Liberalization and Complementary Domestic Policies: A Rural-Urban General Equilibrium Analysis of Morocco." Discussion Paper no. 41, Trade and Macroeconomics Division, International Food Policy Research Institute, Washington, D.C.

Karingi, S. N., R. Lang, N. Oulmane, R. Perez, M. Sadni-Jallab and H. Ben Hammouda. 2005. "Economic and Welfare Impacts of the EU-Africa Economic Partnership Agreements." African Trade Policy Centre Work in Progress No. 10, Economic Commission for Africa, Addis Ababa.

Lofgren, H., G. Harris, and S. Robinson. 2001: "A Standard computable general equilibrium (CGE) model in GAMS." International Food Policy Research Institute, Trade and Macroeconomic Division, Discussion Paper no 75. Washington, D.C.

Lofgren, H., Harris, R. and Robinson, S. (2001) "A Standard Computable General Equilibrium (CGE) Model in GAMS." Trade and Macroeconomics Discussion Paper No. 75, International Food Policy Research Ins titute, Washington, D.C.

Milner, C., O. Morrissey, and A. McKay (2005) "Some Simple Analytics of the Trade and Welfare Effects of Economic Partnership Agreements." *Journal of African Economies*, 14 (3):327–58.

Sadoulet, E., and A., de Janvry. 1995. "Quantitative Development Policy Analysis." The Johns Hopkins University Press.

Agence nationale de la statitique et de la demographie, Sénégal. 2003. "Enquête sénégalaise auprès des ménages (ESAM II)." Ministère de l'économie et des finances, Dakar.

Agence nationale de la statitique et de la demographie, Sénégal. 2006. "Notes d'Analyse du Commerce Exterieur." Ministère de l'Economie et des Finances, Dakar, 2006.

Agence nationale de la statitique et de la demographie, Sénégal. 2006. "Banque des Données Economiques et Financieres." Ministère de l'économie et des finances, Dakar, 2006.

Agence nationale de la statitique et de la demographie, Sénégal. 2006. "Analyse des Comptes Nationaux", Ministère de l'économie et des finances, Dakar, 2006.

te Velde, D. W., and D. Bezemer. 2004. "Regional Integration and Foreign Direct Investment in Developing Countries." Forthcoming in Transnational Corporations. URL: http://www.odi.org.uk/resources/download/1301.pdf.

Thurlow J. and, D. E. N. van Seventer 2002. "A Standard Computable General Equilibrium (CGE) Model of South Africa." Trade and Industrial Policy Strategies, Johannesburg.

Thurlow, J. 2005. "A Standard Recursive Dynamic Computable General Equilibrium (CGE) Model of South Africa: Extending the Static IFPRI Model." Trade and Industrial Policy Strategies, Johannesburg.

Thurlow, J. 2006. "The Impact of Trade Liberalisation on Pro-Poor Growth in South Africa." South African Labour Research Unit, University of Cape Town, South Africa.

Thurlow, J. 2004. "A Dynamic Computable General Equilibrium (CGE) Model for SouthAfrica: Extending the Static IFPRI Model." Working Paper 1-2004. Trade and Industrial Policy Strategies (TIPS).

World Bank. 2007. "Sénégal A la Recherche de l'Emploi – Le Chemin vers la Prospérité: Mémorandum Economique sur le Pays. Rapport No. 40344-SN

World Bank .2005. "Senegal: une Evaluation du climat des investissements."

.

A Tables and Graphs of Results

Table 1: Average shifts in production from baseline values (%)

	FTAWA	FTAEU	FTAEPA	FTAWORLD
Agriculture	-0.1	-0.5	-0.6	7.3
Mining	0.0	0.9	0.9	3.9
Wood	0.4	0.6	1.0	4.5
Rubber	0.1	3.5	3.6	19.6
Fishing	2.9	7.2	10.5	18.1
Processed food	0.3	0.3	0.5	13.7
Leather	-0.1	3.7	3.5	11.5
Textile	0.2	1.0	1.2	6.4
Tobacco	-0.1	1.5	1.4	10.1
Beverages	0.0	2.2	2.1	9.2
Chemicals	0.1	2.7	2.8	27.5
Electricity gaz and water	0.1	1.8	1.8	7.6
Petroleum and Coal	0.1	3.3	3.4	15.7
Transport equipment	-0.4	7.1	6.7	17.0
Telecommunication	-0.1	0.6	0.5	2.9
Restaurant and Hotels	0.1	-1.0	-0.9	9.9
Glass and pottery	-0.1	2.4	2.2	5.4
Iron and Steel	0.2	7.8	8.0	9.4
Macheneries	-0.5	27.2	26.4	40.3
Construction	0.0	2.6	2.6	7.9
Paper	-0.1	1.8	1.7	5.9
Other Products	0.1	2.0	2.0	9.3
Commerce	-0.1	0.7	0.7	3.6
Transport	0.0	0.9	0.8	3.8
Real Estate	0.0	1.0	1.0	4.5
Public Services	0.0	0.0	0.0	0.2
Financial Services	0.0	1.2	1.2	6.2
Other Services	0.0	1.7	1.7	5.8
Total Product	0.1	2.1	2.2	10.4

Source: computed by author from CGE simulations results

Table 2: Average shifts from baseline values (%)

		FTAWA	FTAEU	FTAEPA	FTAWORLD
Production	Primary goods	0.5	1.1	1.7	9.4
	Manufactured goods	0.2	3.2	3.3	17.0
	Services	0.0	1.3	1.3	5.4
Imports	Primary goods	0.3	3.1	3.4	22.4
	Manufactured goods	0.3	3.7	4	16.4
	Services	0.1	2	2.1	7.3
	Total	0.3	3.4	3.7	17.7
Exports	Primary goods	3.3	7.6	11.3	17.5
	Manufactured goods	4.5	4.5	4.7	20.9
	Services	-0.1	-1.1	-1.2	2.6
	Total	0.3	3.7	4	19.8
Absorption		0.1	1.7	1.8	8.5
Private Consumption		0.1	1.6	1.7	9.4
Private Investment		0.0	2.5	2.5	7.7
RGDP		0.1	1.8	1.9	8.9
Employment	Skilled	0.0	1.1	1.0	8.1
	Unskilled	-0.1	0.2	0.1	3.2
	Total	-0.1	0.3	0.2	4.2

Source: Computed by author from CGE simulations results.

Table 3: Average shifts on imports from baseline values (%)

	FTAWA	FTAEU	FTAEPA	FTAWORLD
Agriculture	0.3	2.9	3.2	24.6
Mining	0.1	3.3	3.4	19.8
Wood	1.2	2.9	4.1	11.3
Rubber	0.1	5.4	5.5	20.1
Fishing	1.9	6.3	8.0	23.1
Processed food	0.7	2.5	3.2	20.0
Leather	0.1	9.9	10.1	30.2
Textile	0.9	5.9	6.8	30.7
Tobacco	0.1	7.0	7.2	22.6
Beverages	0.3	13.2	13.5	30.6
Chemicals	0.2	3.5	3.6	18.5
Petroleum and Coal	0.3	2.1	2.4	9.3
Transport equipment	0.0	4.0	4.0	11.1
Telecommunication	0.0	1.4	1.3	5.5
Glass and pottery	0.1	6.4	6.4	20.4
Iron and Steel	0.2	5.6	5.8	13.1
Machineries	0.0	2.7	2.7	10.2
Paper	0.2	4.3	4.5	21.5
Other Products	0.2	6.5	6.8	28.0
Transport	0.1	1.7	1.7	6.6
Financial Services	0.0	1.8	1.8	8.0
Other Services	0.1	2.4	2.4	8.0
Total	0.3	3.4	3.7	17.7

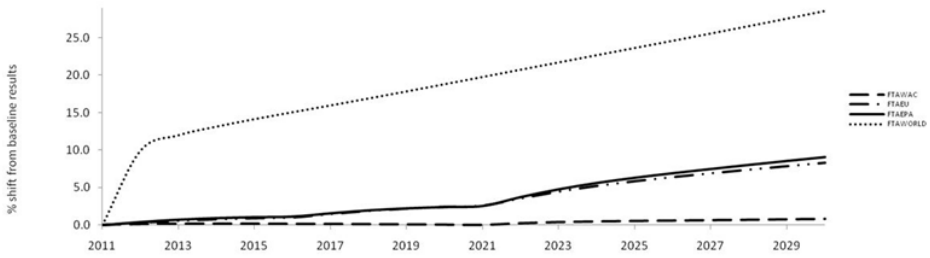
Source: Source: Computed by author from CGE simulations results.

Table 4: Average shifts on exports from baseline values (%)

	FTAWA	FTAEU	FTAEPA	FTAWORLD
Agriculture	-0.3	-2.1	-0.3	18.6
Mining	0.0	0.6	0.0	1.2
Wood	2.0	-2.7	2.0	2.4
Rubber	0.1	3.9	0.0	19.1
Fishing	4.8	6.0	4.9	5.8
Processed food	0.6	-1.2	0.5	19.2
Leather	0.0	5.6	-0.9	13.6
Textile	0.3	0.0	0.3	6.7
Tobacco	-0.2	1.0	-0.2	11.3
Beverages	4.0	0.0	10.0	0.0
Chemicals	0.1	3.1	0.1	13.6
Petroleum and coal	0.2	3.7	0.2	14.8
Transport equipment	-0.5	9.6	-0.5	11.3
Telecommunication	0.0	-1.1	-0.5	-1.9
Restaurant and hotels	0.1	-2.3	0.1	12.4
Glass and pottery	-0.2	4.7	-0.2	4.3
Iron and Steel	0.3	8.8	0.3	1.6
Machineries	-0.5	28.7	-0.7	11.5
Construction	-0.2	0.3	-0.2	5.9
Paper	-0.2	0.3	-0.2	5.9
Other Products	0.1	3.3	0.1	11.4
Transport	0.0	-1.3	-0.2	-0.9
Financial Services	-0.1	-0.4	-0.1	-1.1
Other Services	-0.1	0.2	-0.2	0.5
Total	0.3	3.7	4.0	19.8

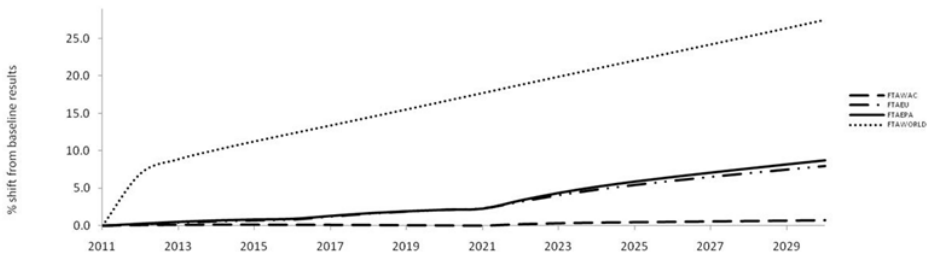
Source: Source: Computed by author from CGE simulations results.

Graph 1: Effects of different FTA on total exports



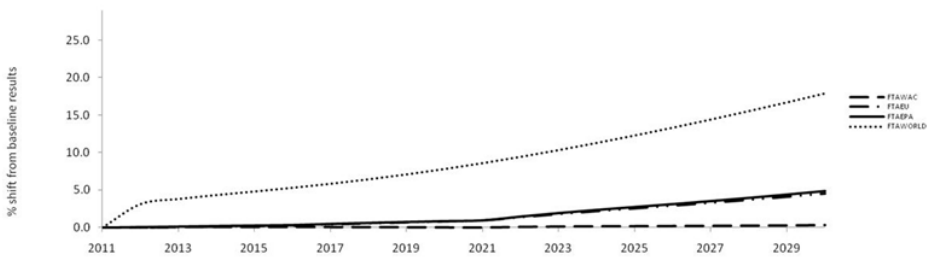
Source: From Simulations by author

Graph 2 Effects of different FTA on total imports



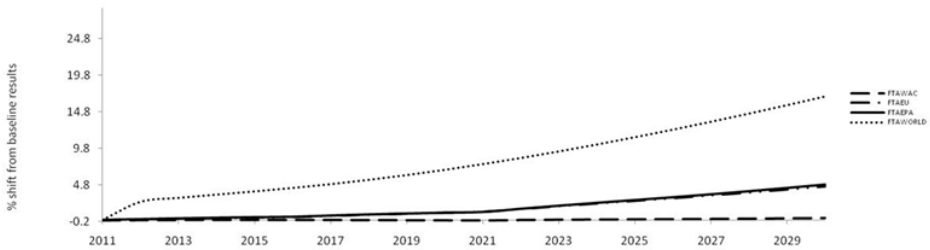
Source: From Simulations by author

Graph 3: Effects of different FTA on private consumption



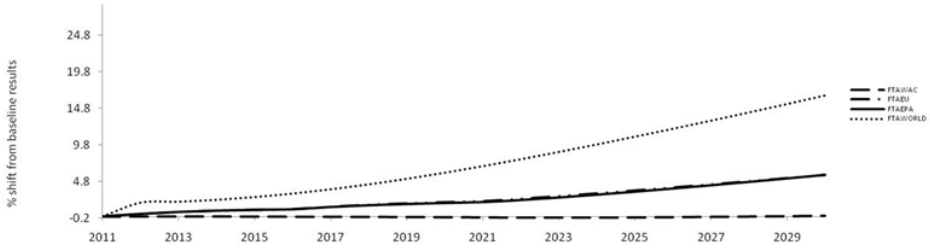
Source: From Simulations by author

Graph 4: Effects of different FTA on Absorption



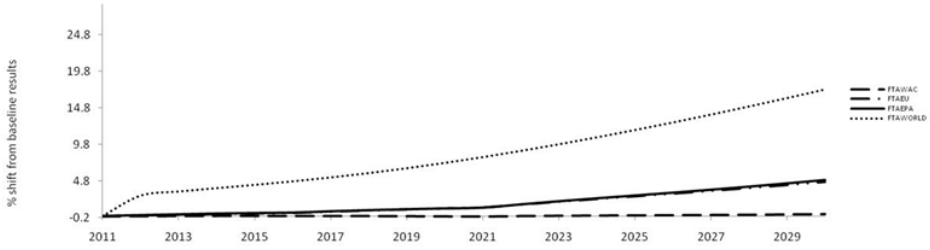
Source: From Simulations by author

Graph 5: Effects of different FTA on private investment



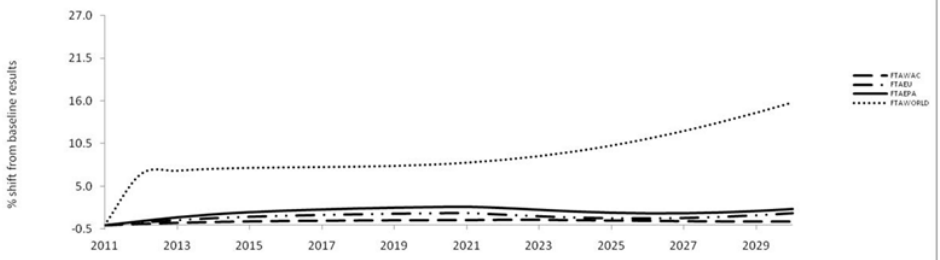
Source: From Simulations by author

Graph 6: Effects of different FTA on real GDP



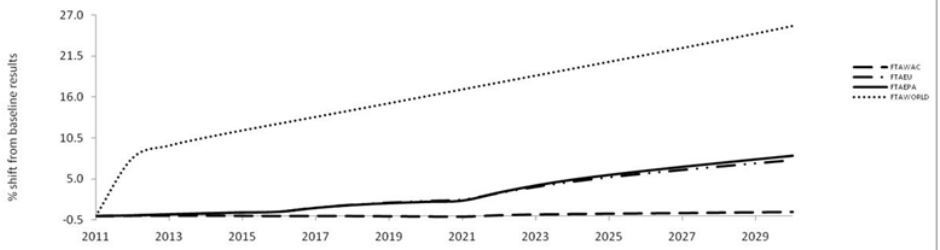
Source: From Simulations by author

Graph 7: Effects of different FTA on the production of primary goods



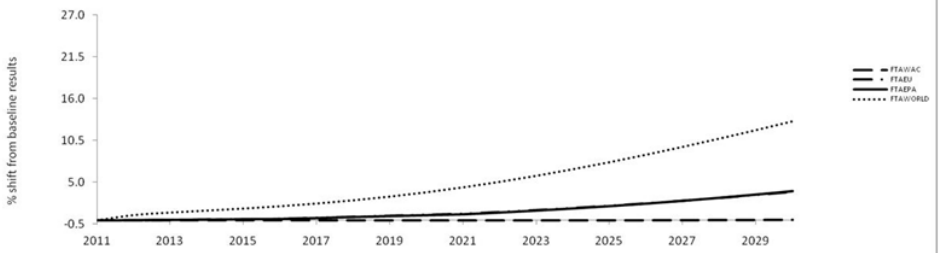
Source: From Simulations by author

Graph 8: Effects of different FTA on the production of manufactured goods



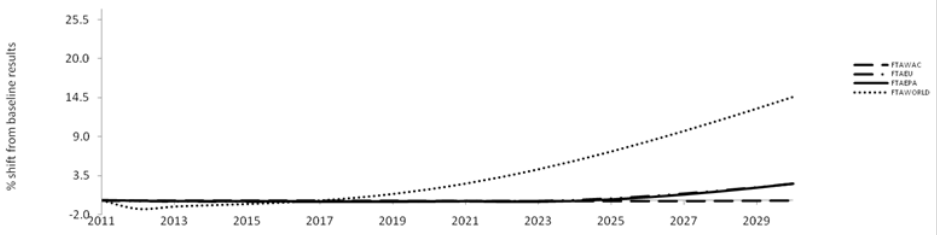
Source: From Simulations by author

Graph 9: Effects of different FTA on the production of services



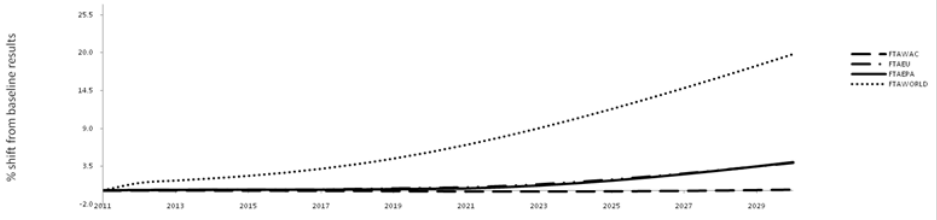
Source: From Simulations by author

Graph 10: Effects of different FTA on total employment



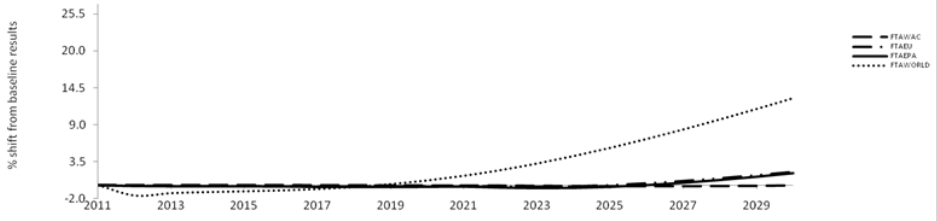
Source: From Simulations by author

Graph 11: Effects of different FTA on total the employment of skilled labor



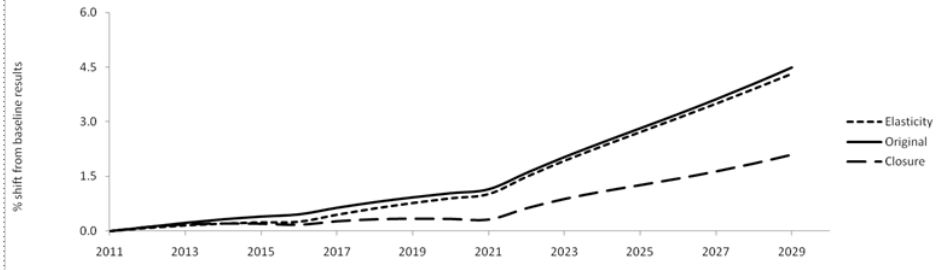
Source: From Simulations by author

Graph 12: Effects of different FTA on total the employment of unskilled labor



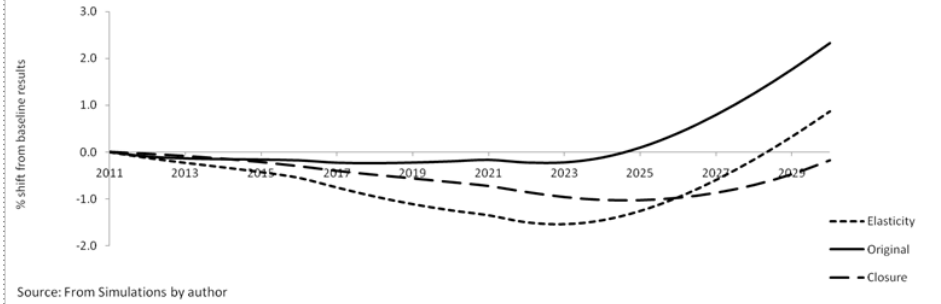
Source: From Simulations by author

Graph 13: Effects of the EPA on real GDP, using different elasticities and diffent closure



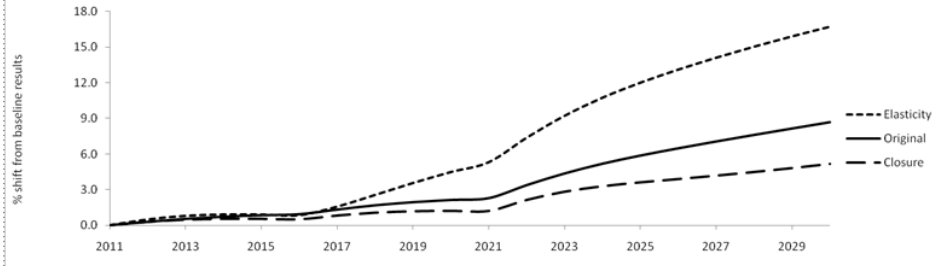
Source: From Simulations by author

Graph 14: Effects of the EPA on employment, using different elasticities and diffent closure



Source: From Simulations by author

Graph 15: Effects of the EPA on imports, using different elasticities and diffent closure



Source: From Simulations by author

B The equations of the model

B.1 Static Model

B.1.1 Price Bloc

$$
\begin{aligned}
Pm_c &= Pwm_c.\left(1+tm_c\right).EXR + \sum_{c'} Pq_c.icm_{c'c} && (1)\\
Pe_c &= Pwe_c.EXR + \sum_{c'} Pq_c.ice_{c'c} && (2)\\
Pmr_c &= Pwmr_{cr}.\left(1+tmr_c\right).EXR + \sum_{c'} Pq_c.icm_{c'c} && (3)\\
Per_c &= Pwer_{cr}.EXR + \sum_{c'} Pq_c.ice_{c'c} && (4)\\
Pdd_c &= Pds_c + \sum_{c'} Pq_c.icd_{c'c} && (5)\\
Pq_c\left(1-tq_c\right)Qc_c &= Pdd_c.Qd_c + Pm_c.Qm_c && (6)\\
Px_c.Qx_c &= Pds_c.Qd_c + Pe_c.Qe_c && (7)\\
\left(1-t_a\right)P_aQ_a &= Pint.Qint + Pv_a.Qv_a && (8)\\
Pint_a &= \sum_{c} Pq_c.ica_{ca} && (9)\\
CPI &= \sum_{c'} Pq_c.cwts_c && (10)\\
DPI &= \sum_{c'} Pds_c.dwts_c && (11)
\end{aligned}
$$

B.1.2 Households

Households maximize their utilities under their the constrain that total expenditure equals total income. The solutions gives the demand and expenditure functions for each commodity in equations 7 and 8 respectively.

$$
\begin{aligned}
Q_c &= \gamma_c + \frac{\beta_c^m}{Pq_c}\left(EH - \sum Pq_c.\gamma_c^m\right) && (12)\\
Pq_c.Q_c &= Pq_c.\gamma_c + \beta_c^m\left(EH - \sum Pq_c.\gamma_c^m\right) && (13)\\
EH &= \left(1-\sum shi_{ih}\right)\left(1-mps_h\right)\left(1-tins_h\right).Y_h && (14)
\end{aligned}
$$

B.1.3 Production Bloc

Goods and services are produced by firms that maximize profit in a perfect competion framework. Each activitie produces one good and combines VA and intermediates in a fixed proportion for a given quantity of production.

$$
\begin{aligned}
Qv_a &= iv_a.Q_a \\
Qinta_a &= int_a.Q_a && (15)\\
Qint_{ac} &= ica_{ac}.Qinta_a && (16)\\
(1-t_a)\,P_aQ_a &= Pv_aQv_a - Pinta_a.Qinta_a && (17)\\
Qv_a &= \alpha v_a\left(\sum \delta v_{fa}\left(\alpha v_{fa}.Qf_{fa}^{-\rho v_a}\right)\right)^{-\frac{1}{\rho v_a}} && (18)\\
Wf_f.d_{f\ a} &= (1-tv_a)\,Pv_a.Qv_a\left(\sum_f \delta v_{fa}\left(\alpha v_{fa}.Qf_{fa}^{-\rho v_a}\right)\right)^{-1}\delta v_{fa}\left(\alpha v_{fa}.Qf_{fa}\right)^{-\rho v_a-1} && (19)
\end{aligned}
$$

B.1.4 Output Transformtion

Domestically produced outputs are either sold domestically or exported. Producers maximize their revenues (TR) on both markets subject to a constant elasticity of transformation and prices. imperfect substituability

$$
\begin{aligned}
TR &= Px_c.Qx_c && (20)\\
Qx_c &= \alpha t_c\left(\delta t_c.Qe_c^{\rho t_c} + (1-\delta t_c)\,Qd_c^{\rho t_c}\right)^{\frac{1}{\rho t_c}} && (21)\\
Px_c.Qx_c &= Pe_c.Qe_c + Pd_c.Qd_c && (22)\\
\frac{Qd_c}{Qe_c} &= \frac{1-\delta t_c}{\delta t_c}\left(\frac{Pe_c}{Pd_c}\right)^{\frac{1}{\rho t_c-1}} && (23)\\
\rho t_c &\geq 1 \implies \text{isoquant concave to the origin} && (24)\\
Qx_c &= Qe_c + Qd_c && (25)
\end{aligned}
$$

imperfect substituability between output sold on domestic markets and exported. A change in $\frac{Pd_c}{Pe_c}$ shift supply toward the destination offering a higher price. When one the markets is not supplied then

B.1.5 Composite Supply

Composite supply is made of goods produced domestically and imported, combined in a CES function, which captures the imperfect substituability between goods from the 2 origins. Armington function

$$
\begin{aligned}
Qc_c &= \alpha c_c\left(\delta c_c.Qm_c^{-\rho c_c} + (1-\delta c_c)\,.Qd_c^{-\rho c_c}\right)^{-\frac{1}{\rho c_c}} && (26)\\
\frac{Qm_c}{Qd_c} &= \frac{1-\delta c_c}{\delta c_c}\left(\frac{Pd_c}{Pm_c}\right)^{\frac{1}{\rho c_c+1}} && (27)\\
\rho c_c &\geq -1 && (28)\\
Qc_c &= Qd_c + Qm_c && (29)
\end{aligned}
$$

An increase in $\frac{Pd_c}{Pm_c}$, shifts supply toward foreign goods. For goods not produced domestically or not imported, the Armington function is replaced by

B.1.6 International Trade

Regional Exports to different regions are aggregated in a CES function, allowing imperfect substitution between different destinations.

$$Qe_c = \alpha e_c \left(\sum_r \delta e_{rc}.Qer_{rc}^{-\rho_c} \right)^{-\frac{1}{\rho e_c}} \tag{30}$$

$$\frac{Per_{rc}}{Pe_c} = Qe_c. \left(\sum_r \delta e_{rc}.Qer_{rc}^{-\rho_c} \right)^{-1} \delta e_{r,c}.Qer_{rc}^{-\rho e_c - 1} \tag{31}$$

Regional Imports from different regions are aggregated in a CES function, allowing imperfect substitution between different origins.

$$Qm_c = \alpha m_c \left(\sum_r \delta m_{rc}.Qmr_{rc}^{-\rho_c} \right)^{-\frac{1}{\rho m_c}} \tag{32}$$

$$\frac{Pmr_{rc}}{Pm_c} = Qm_c. \left(\sum_r \delta m_{rc}.Qmr_{rc}^{-\rho_c} \right)^{-1} \delta m_{rc}.Qmr_{rc}^{-\rho m_c - 1} \tag{33}$$

Factor Income

$$Yf_f = \sum_a Wf_f.d_{fa}Qf_{fa} \tag{34}$$

$$Yif_{if} = shf_{if}.\left(Yf_f - trsf_{wf}.EXR\ \right) \tag{35}$$

$$Yi_i = \sum_f Yif_{if} + \sum_i Tri_{ig} + trsf_{ig}.CPI + trsf_{iw}.EXR \tag{36}$$

$$Tri_{i'i} = shi_{if}.\left(1 - mps_i\right).\left(1 - \overline{tins_i}\right).Yi_h \tag{37}$$

B.1.7 Government

$$\begin{aligned} Yg = & \sum_i tins_i.Yi_i + \sum_a t_a.P_a.Q_a + \sum_c tm_c.pwm_c.Qm_c.EXR + \sum_c tm_c.pwm_c.Qm_c.EXR \\ & + \sum_r \sum_c tmr_{cr}.pwmr_{cr}.Qmr_{cr}.EXR + \sum_c tq_c.Pq_cQc_c + \sum_a Yf_{gf} + trsf_{gw}.EXR \end{aligned} \tag{38}$$

$$EG = \sum_c Pq_c.Qg_c + \sum_i trsf_{igov}.\overline{CPI} \tag{39}$$

$$Qg_c = \overline{gadj}.\overline{Qg_c} \tag{40}$$

$$Qinv_c = \overline{iadj}.\overline{Qinv_c} \tag{41}$$

B.1.8 Constraints and Macro-closures

$$Qc_c = \sum_a Qint_{ca} + \sum_h Qh_{ch} + Qg_c + Qinv_c + qdst_c + Qt_c \tag{42}$$

$$\sum_a Qf_{fa} = Qfs_f \tag{43}$$

$$Yg = Eg + Gsav \tag{44}$$

$$\sum_c pwm_c.Qm_c + \sum_r \sum_c pwmr_{cr}.Qmr_{cr} + \sum_f trsf_{wf} = \sum_c pwe_c.Qe_c + \sum_r \sum_c pwer_{cr}.Qer_{cr} + \sum_i trsf_{iw} + Fsav \tag{45}$$

$$\sum_i mps_i.\left(1 - \overline{tins_i}\right).Yi_i + Gsav + Fsav.EXR = \sum_c Pq_c.Qinv + \sum_c Pq_c.qdist_c \tag{46}$$

$$mps_i = \overline{mps_i}.(1 + \overline{mpsadj}) \tag{47}$$

B.1.9 Capital Accumulation

$$Awf^a_{ft} = \sum_a \left[\left(\frac{Qf_{a\ f\ t}}{\sum_a Qf_{at}} \right) .Wf_{ft}.Wfdist_{aft} \right] \tag{48}$$

$$\eta^a_{fat} = \left(\frac{Qf_{aft}}{\sum_a Qf_{at}} \right) \left[\beta^a \left(\frac{Wf_{ft}.Wfdist_{fat}}{Awf^a_{ft}} - 1 \right) + 1 \right] \tag{49}$$

$$\nabla K^a_{fat} = \eta^a_{fat}.\frac{\sum_c Pq_{ct}Qinv_{ct}}{Pk_{ft}} \tag{50}$$

$$Pk_{ft} = \sum Pq_{ct}.\frac{Qinv_{ct}}{\sum_c Qinv_{ct}} \tag{51}$$

$$Qf_{aft+1} = Qf_{aft}\left(1 + \frac{\nabla K^a_{fat}}{Qf_{aft}} - v_f\right) \tag{52}$$

$$Qfs_{ft+1} = Qfs_{ft}\left(1 + \frac{\nabla K^a_{fat}}{Qfs_{ft}} - v_f\right) \tag{53}$$

Endogenous Variables

Pq_c	Price of Composite commodity c
P_a	The activity price, that is the gross revenue per unit of activity.
$Pint_a$	Aggregate intermediate input price for activity a
Px_c	Aggregate producer price for commodity
Wf_f	Average price of factor f
Pv_a	Value-added price (factor income per unit of activity)
Pm_c	Import price (domestic currency)
Pe_c	Export price (domestic currency)
Pmr_c	Import price by region (domestic currency)
EXR	Exchange rate (LCU per unit of FCU)
Pq_c	Composite commodity price
Per_c	Export price by region (domestic currency)
Pdd_c	Demand price for commodity produced and sold domestically
Pds_c	Supply price for commodity produced and sold domestically
DPI	Prodeucer price index
Awf_{ft}	Average capital rental rate in time period t
Wf_{ft}	Average price of factor
$Pk_{f\ t}$	Unit price of capital in time period t
Q_c	Quantity of commodity c consumed by households
Qf_{fat}	Quantity demanded of factor f from activity a in time period t
EH	Consumption spending of households
Q_a	The level of output by activity A, it corresponds to the domestic production
$Qint_{a\ c}$	Quantity of commodity c as intermediate to activity a
Qf_f	Quantity of factor f
$Qinta_a$	Quantity of aggregate intermediate input
Qx_c	Aggregated quantity of domestic output of commodity
Qc_c	Quantity of goods supplied to domestic market (composite supply)
Qm_c	Quantity of imports of commodity c
Qd_c	Quantity sold domestically of domestic output
Qe_c	Quantity of exports
Qv_a	Quantity of (aggregate) valueadded
$Qf_{a\ f\ t}$	Quantity demanded of factor f from activity a
Qg_c	Government consumption demand for commodity
$Qinv_c$	Quantity of investment demand for commodity
$Qh_{c\ h}$	Quantity consumed of commodity c by household h
$qdst_c$	Quantity of stock change
Yf_f	Income of factor f
$Yif_{i\ f}$	Income to domestic institution i from factor f
$Tri_{i\ i}$	Transfers from institution i' to i
$trsf_{f\ i'}$	Transfer from factor f to institution i
$shi_{i\ f}$	Share for domestic institution i in income of factor f
Yi_i	Income of domestic nongovernment institution
mps_i	Marginal propensity to save for domestic non-government institution (exogenous variable)
Yg	Government revenue
EG	Government expenditures

Parameters

t_a	Tax rate for activity a
tmr_c	Import price by region (foreign currency)
tq_c	Rate of sales tax
tm_c	Import price (foreign currency)
$d_{f\ a}$	Wage distortion factor for factor f in activity a;
$ica_{a\ c}$	Quantity of commodity c per unit of aggergate intermediate input;
iv_a	Quantity of value added per unit of activity;
it_a	Quantity of aggergate intermediate input per unit of activity.
$icm_{c'c}$	Quantity of commodity c as trade input per imported unit of c'
$ice_{c'c}$	Quantity of commodity c as trade input per exported unit of c'
$icd_{c'c}$	Quantity of commodity c as trade input per unit of c' produced and sold domestically
$ic_{c\ a}$	Quantity of c as intermediate input per unit of activity a
$cwts_c$	Weight of commodity c in the CPI
$dwts_c$	Weight of commodity c in the DPI
γ_c	Subsistence consumption of marketed commodity c for household;
β_c^m	Marginal share of consumption spending on marketed commodity c for household;
$\eta_{f,a,t}^a$	The share of new capital for each sector
αv_a	Efficiency parameter in the CES value added function
$\delta v_{f\ a}$	CES value-added function share parameter for factor f in activity a
ρv_a	CES value-added function exponent
αt_c	CET function shift parameter
δt_c	CET function share parameter
ρt_c	CET function exponent
αc_c	Armington function shift parameter
ρc_c	Armington function exponent
δc_c	Armington function share parameter
αe_c	Shift parameter in the CES regional export function
$\delta e_{r,c}$	Share parameter in the CES regional export function
ρe_c	Regional exports aggregation function exponent
αm_c	Shift parameter in the CES regional import function
$\delta m_{r\ c}$	Share parameter in the CES regional import function
ρm_c	Regional imports aggregation function exponent
v_f	Capital depreciation rate
$\overline{mps_i}$	Base savings rate for domestic institution i
Rwf_f	Real average factor price
Pwm_c	Import price (foreign currency)
$Pwmr_{cr}$	Import price by region (foreign currency)
$Pwer_{c\ r}$	Export price by region (foreign currency)
Pwe_c	Export price (foreign currency)
$\overline{Qg_c}$	Base-year quantity of government demand
$\overline{Qinv_c}$	Base-year quantity of private investment demand
$\overline{tins_i}$	Exogenous direct tax rate for domestic institution i

Exogenous variables

$\overline{mpsadj}$	Savings rate scaling factor
$\overline{Wfdist_{fat}}$	Wage distortion factor for factor f in activity a
$\overline{Qfs_f}$	Quantity Supplied of factor
$\overline{CPI}$	Consumer price index
$\overline{gadj}$	Government consumption adjustment factor
$\overline{iadj}$	Investment adjustment factor
$Fsav$	Foreign savings (FCU)
$Gsav$	Government savings