

Agricultural subsidies removal in North countries: what about the effects in Senegal?

François Joseph CABRAL¹

Abstract

In this paper, experiments of the impact north countries subsidies removal on Senegal is performed based on a general equilibrium framework. The model that we suggest includes 19 sectors and four factors: capital, labour, land and water. In agriculture, we distinguish two sub-sectors: the set of the irrigated sectors and that of the non-irrigated sectors. An export demand function unable us take into account constraints facing local producers on international markets. A simulation is performed based on ICAC, IFPRI, IADB and Iowa state university predictions on the impact of subsidies removal on world prices. It appears from the experiments carried out that the elimination of agricultural subsidies in developed countries will result in a shift of agricultural supply toward external markets. However, this will induce an increase in the cost of imported cereals, in particular rice and will have an adverse effect on households, worsening their well-being, except those of Delta rural households.

¹ Lecturer-researcher, FASEG/University Cheikh Anta Diop / Dakar, joecabral2001@yahoo.fr

Introduction

The agricultural Agreement discussed within the framework of the World Trade Organization (WTO) aims at fixing the rules agricultural products trade. It was the subject of several negotiations which were characterized by repeated failures of which the most outstanding is that of Cancun in Mexico in 2003. For developing countries, the suppression of the subsidies granted to the farmers of North appears in good place in the points defended by the negotiators. It is among all the more crucial as the producers lose million dollars each year because of these practices which are against fair trade. In Senegal, agricultural liberalization is one of the components of the reforms engaged in the agricultural sector since 1984 with the application of the New agricultural policy (NPA). The agricultural Agreement will make effective the deregulation of the agricultural sector which will therefore operate within WTO rules. The Senegalese producers, like their counterparts African, see in the grants accorded to the north farmers, a measurement which distorts the rules of the market. During the recent conference held in Geneva in August 2004, discussions of WTO on the agricultural seem to finally move to an Outline agreement likely to advance them. The suppression of the subsidies granted to the producers of north constitutes one of the elements of this Outline agreement. It will have, for various reasons, important effects on the agricultural sector, the whole economy and the Senegalese households, in particular those of the rural area.

Agricultural sector occupies 54% of the active population despite its relatively weak contribution to GDP in Senegal (10%²). Agricultural exports are about 6.38% of total foreign sales and agricultural imports represents 15.75% of total agricultural imports. The effects of a removal of subsidies granted to north agricultural is to increase world prices. If this rise is transmitted to small producer, their wellbeing might improve. However what will be the net effect of world price increase on households, those rural in particular, if the country is a net importer of cereals for which world price will also increase. The main aim of this study is to assess the effects of north subsidies removal on foreign trade, resources reallocation and household wellbeing in Senegal.

These last years, the macroeconomic impacts of shocks and the external shocks on the economies are in the core of intense debates. It explains its useful to try to quantify their effects at a sector level and on the households. In one of its work, Subramanian (1993) address this issue of agricultural trade liberalization impact on India. The author tries to assess its effects on agriculture and the other sectors. The model used by the author is a standard CGE but includes some specificity. In particular, it combines the multi-markets model of Binswanger-Quinzon type (1986) concerning factor supply and demand, a standard CGE to describe the technology of the other sectors. The scenarios of liberalization tested by the author confirms the assumption of Krueger et al.. (1991) according to which the customs duties restrictions and agricultural trade taxation represent are relatively weak compared to the principal source of agriculture tax which comes from non-agricultural sectors protection. In the developing countries, agriculture is dominated by non-exchangeable goods or goods with very weak exchanged volumes. For the major part of the exchanged agricultural product, elasticity of price transmission of price is close to 1 in the developed countries while they are significantly weak in the developing countries (Mundlak & Larson, 1992). Ardeni (1989) shows that the modifications in the world prices generally are only partially transmitted to the prices of the domestic goods substitutes. In partial equilibrium, bias against agriculture is analyzed in the absence of product differentiation. On the other hand, CGE framework incorporates a greater assumption of imperfect substitutability and offers a framework of analysis making it possible to capture the various repercussions of policies interventionists' policies and to measure their impact on agriculture. While trying to assess liberalization

² without fishery, forestry and livestock and 19% including those sectors

impact in Zimbabwe, Bautista Romeo, Tarp Finn and Wobst Peter (1998) use CGE of the neo-classic type. One of specificities of the model is that it makes it possible to determine the direct effects of the official interventions on the farm prices, just as the indirect interventions through inter-sector bonds and the induced variations of the rate of exchange. In order to make the results derived from agricultural CGE analysis as comparable as possible with those done on partial equilibrium, the authors adapt the theoretical framework of the model that enable them evaluate explicitly policy bias and use this structure to carry out simulations by which they isolate these specific effects. Bias against agriculture is captured through the terms of trade between the agricultural sector and the not-agricultural sector. They are defined like the ratio of the indices of price of these respective sectors. The markets of factors are segmented between agricultural and non-agricultural sectors. Labour and capital are mobile inside the two sectors but there is no possible flow between agriculture and the non-agricultural sector. Induced measures of bias against agricultural sector reflect only the price changes and inter-sector flows of resources. Despite the fact that lot of CGE surveys deals with agricultural sector, few of them focus explicitly on the question of the allowance of land and water allowance in agricultural sector. However agricultural performances are often linked to those factor endowments and to their marked functioning. Some studies tried to focus on the specific treatment of water and land while modelling agricultural sector. The impact of distortions in the market of these specific factors to the agricultural sector covers, in particular, a great importance. In their study, Robinson Sherman and Gehlar Clemen (1995) have tried to capture the impact of a package of political measures intended to mitigate the dysfunction of the market of water in Egypt. In the Egyptian model, agricultural sector is disaggregated, land and water is treated in a specific way. This land-water CGE model follows the traditional models dealing with liberalization applied to many developing countries in order to analyze the issues related to SAP. CGE land-water combines an analysis of the agricultural activity, technology programming of the sector and standard neo-classical representation of the technology of non-agricultural sectors. It is also inspired by former CGE models applied to Egypt. The vale added is a elasticity of constant substitution function combining capital and composite factor land-water in the agricultural sector. This composite factor is a linear function combining of water and land. Except this composite factor, the model has a standard specification of neo-classic type. The objective of this research is to evaluate the impact of the subsidies removal granted to North countries farmers on foreign trade, sector reallocation of the resources, the cost of the inputs and households wellbeing in Senegal. The next sections of this paper include a first section which treats structure of the foreign trade in Senegal. Section 2 gives the contents of the internal support measures and the outcomes of their suppression. In section 3, we expose the model and give the results of simulations (section 4).

I- Structure of the foreign trade

Excepted the post-devaluation period, the growth rate was moderate growth for Senegalese economy. The commercial balance is structurally a deficit one. Exports represent on average less than 1/3 of the GDP whereas the imports reach, per moment, about half of the GDP (48% in 1980-1984). At the benchmark year (1996), the imports represent nearly 41% of the GDP and exports nearly 31%. The imports are dominated by the “other industrial products” (56%) followed by services (19%) and agro-pastoral products (16%). Exports of other industries products occupy a relatively important weight in total exports (41%). They are followed by those of services (27%) and food industry (19%). Exports of primary products occupy a relatively weak weight (6%) (SAM, 1996). On the domestic market, the origin of products is by an amount of 21% from the external markets. According to markets, the origin of the composite product differs. The supplies of other industrial goods, oil and agro-pastoral

products are strongly linked to the world market. Their foreign purchases reach respectively proportions of 44%, 35% and 21% of availabilities on domestic market.

II- Contents and outcomes of internal support measures

The objective of WTO Agricultural agreement is "to start a process of liberalization of agricultural trade, on the one hand, by limiting measures of agricultural policy which interfere with free market, namely the instruments of support and protection, on the other hand, by setting rules and disciplines for the definition of the agricultural policies". It came into effect on July 1, 1995. Its setting is planned over a period of six years, which is completed on December 31, 2000 for the developed countries. This period runs for 10 years for the developing countries (table A1³). The Agreement is structured in three points: the market access, the internal support and export subsidies. The internal support is the annual monetary support granted by a country to its farmers, either for the production of specific agricultural goods, or for the infrastructures, or for research. These support policies create strong distortions on the exchanges. That's why the internal support measures internal in favour of the agricultural producers are subjected to a regulation. One distinguishes two types from them: exempted of reduction measures of support and the support provided within the framework of not exempted measures. These last are classified in several "boxes" according to the nature of the support measure.

II.1 Support measures exempted reduction engagements

They are classified in several categories: green box, special and differentiated treatment in favour of the developing country, blue box and exemptions of minimis.

The green box includes many measures of very different nature like instruments of policy used by the developing countries and notified to WTO. It is the case of agricultural services (infrastructures, vulgarization, research, stocks of food security, food aid, programs of nets of safety, etc). They must form part of programs of the State financed by public funds not implying transfers on behalf of the consumers, and must not have support effects on producer prices. The fundamental condition for their exclusion of reduction engagements is that their distorted effects on trade or production are null or, at most, tiny.

Measures related to the development or special and differentiated treatment in favour of the developing country (TSD): they are support measures which are part of the "development" category such as assistance measures, direct or indirect, intended to encourage the agricultural and rural development and forming integral part of the programmes of development of the developing countries are excluded from engagements of reduction. Those are investment subsidies, agricultural input subsidies and the internal support for the producers of the developing countries.

The blue Box: the direct payments under programmes of production limitation (often called measures of the "blue Box") are exempted from engagements of reduction if they are based on a fixed area and outputs or if these payments are carried out for 85%, or less of the basic level of the production, or then for the livestock, if the payments are carried out for a fixed number of heads. The blue box was created primarily to allow the United States and Europe to preserve instruments to manage their supply derogating from the principles of GATT. They are in particular the "compensatory aids" of the Common agricultural policy (CAP) and the American system of "deficiency payments". These categories of supports benefits from the Blair house clause between the USA and the European Union. They are exempted of reduction until 2006.

Exemptions "of minimis": they allow the developing countries to support the prices, insofar as

³ annexe

the value of this support does not exceed 10% of the value of the production while this ratio is 5% for the developed countries.

II.2 Support provided within the framework of not exempted measurements

It is subjected to reduction engagements. These measures are those contained in the orange box which makes it possible to directly support the prices or the production thus creating distortions on the market. The agricultural Agreement do not allow the installation of new measures and stipulates the reduction of those existing. Engagements of reduction are calculated according to a total support measure or "total MGS", which is equal to the sum of the expenditure in internal support, all products and all measures confused. The methods indicate a reduction of 20% (13,3% for the any reduction and developing countries for the least advanced countries) of the basic total MGS, to operate by equal annual amount, over its period of setting. Annual reduction engagements of reduction envisaged are registered in the Lists of the countries, which are juridically constraining documents. For each year of the period of setting, the members calculate the current total MGS, which should not exceed the level of engagements indicated in the lists (Table A1).

Senegalese engagements as regards to internal support has to be added to those already taken within the framework of the policies of adjustment and the process WAEMU integration which must carry out, in the long term, an elimination of the support measures internal. Compared to the shutter "access to the market" in the framework of the ASA, specifics engagements of Senegal are given by table A2. Senegal has adopted a consolidated uniform rate (30%), plus the additional duties and various impositions which can go up to 150% on the agricultural produce. These tariffs enable him theoretically to set up levels being able to go up to 180% (table A3). The preliminary imports authorizations in particular for the dairy products and certain categories of agricultural machinery as well as the quotas of importation were removed and replaced by a temporary surtax. To the customs duties applied, is added an additional surtax on the sensitive products. Under the effect adjustment policies of adjustment and its engagements compared to its partners of the WAEMU and the ACP states, Senegal is already engaged in a dynamics of tariff dismantling which leads it to set up relatively low tariffs. This explains why the rates applied (surtax included) are generally lower than the consolidated rates. The agricultural Agreement has also for objective to reduce the export subsidies i.e. the possibility for a country of exporting its agricultural produce at prices lower than those of the world market.

II.3 Export subsidies

This type of instrument is not used by the developing countries, but the subsidies "war" between Europe and the USA is at the origin of this agreement. The subsidies concerned are those of direct type (restitutions), the export sales of stocks at prices lower than the prices of the domestic market and the subsidies intended for the reduction of the costs of marketing and internal and external transport. A reduction of 36% over one six years period of the export subsidies and 21% of the volumes exported with subsidy (respectively of 24% and 14% over one ten years period for the developing countries) is expected from agricultural agreement. The reduction of the marketing assistance, with interior and international transport does not relate to the developing countries, generally confronted to higher cost in this field. It is envisaged a limitation of the skirting of these rules, in particular, via the use of the food aid like substitute with the export subsidies. On the other hand, the guarantees of export credit and the programmes of promotion to export are not taken into account. In its list of measures transmitted to WTO, Senegal states not to use export subsidies. Consequently, it cannot introduce news of them. In fact, the programme of export subsidies was removed with devaluation CFA currency in 1994. Nevertheless, sustaining measures were set out in the

form of administrative procedures simplification, support in market prospecting. In the same way, a project of improving freight capacities financed by the European Union was completed in 1999. In the setting these objectives, each Member State of WTO is constrained to pledge quantitative reduction per product in the three fields of the Agreement. These engagements are included in a legal document, called list of the countries. For each field, engagements of reduction are calculated starting from the period basic (1986-1988) and over a setting period at the time of the negotiations and reflected in the methods. The agricultural Agreement comprises important outcomes thus, in particular for the countries of the South such Senegal.

II- 4 Outcomes of the support measures

FAO estimates that agricultural exports of sub-Saharan Africa could pass from 9,4 billion between 1987 and 1989 to 13,5 billion dollars US in 2000. This increase of which 17% would relate to primarily the fat products and the oilseeds would be induced by the setting of agricultural Agreement (Jadot, 1999). In addition, one can note that the food goods represent a strong percentage of the household expenditures (close of the 2/3 in many developing countries and 17% in the European Union). However, the ACP countries often expressed scepticism with regard to the agricultural Agreement. This scepticism is related, in particular, to the internal support measures used by the north countries to help their farmers but also with the anticipated rise of the world cereal prices for net cereal importing countries Nets of food products. For the developing countries, the special and differentiated treatment constitutes a measure necessary to mitigate the asymmetry of the rules applied in WTO more especially as the supports granted to the farmers of north constitute a heavy burden for those of the south. However, the net cereals importers should expect a rise in their price following the suppression of these subsidies.

Special and differentiated treatment: a panacea for the developing countries vis-a-vis the economy openness

The developing countries are often dealing with inequality of treatment as regards internal support or recourse to the safeguard clause. That's because the promised measures were not held that they claim an improvement of the "special and differentiated treatment" which is undervalued. This question raises the problem of the box of development which was supposed to be in the core of Doha round for development. However, the focus of the negotiations is not made on this aspect (P. Chalmin, 2004). The role and the contents of the "differentiated special treatment" remain an important point for the developing countries. They wish that the "differentiated special treatment" go beyond a simple additional time of adjustment to the commercial rules and the discipline on the support for supply. In the future agreement, it should include significant improvements in the access to the market and a greater flexibility in the possibility of supporting and of protecting agriculture as well as the developed countries. Partly, the "development box" seeks to cover the actions in favour of the safety of the sources of provision of the developing countries. However, the request of some developing countries aiming at increasing the customs duty protection of their domestic production raises some claims from developed countries but also agro-exporters developing countries (A. Matthews, 2002). This request is justified by the fact that there is an asymmetry in the application of the rules set by WTO. Several developing countries consider that the promises formulated within the framework of the Agricultural agreement were not held. For these countries, the most crucial issues are those relating to agricultural subsidies and the questions of development.

Supports granted to the north farmers: a costly weight for the African farmers

In spite of the agricultural Agreement, the flow of exchanges continues to concentrate in the developed countries without being liberalized. The market access of the developed countries remains very limited for certain products. Export subsidies more or less disguised are always used by north countries. The developing countries do not have, as for them, the possibility of

subsidizing some of their agricultural exports products to make them more competitive. This type of measures is difficult to set up because of its high cost. Agriculture occupies, indeed, on average 2/3 of labour force in sub-Saharan Africa countries and less than 5% in the developed countries (Jadot, 1999). The subsidies granted by the United States and the European Union to their farmers have a high cost for the countries of the South. For instance, these last caused losses estimated at 300 million US dollars to the producing African cotton countries. In particular, between 1999 and 2002, Mali estimates its losses of receipts at an amount ranging between 75 and 199 million US dollars. This question constitutes a war-horse for the least advanced countries (LDC). In the same way, the agro-exporters countries, in particular the group of Cairns attributes to the export subsidies of north countries the disturbance of their domestic markets. Several predictions are done on the effect of subsidies removal on world prices of which those of ICAC⁴, IFPRI⁵, IADB⁶ and Iowa state university predictions (table A4 & A5). A study done by ICAC and IFPRI have found on the base of price prediction that the percentage of variation of the world price resulting from the impact of subsidies removal is estimated will vary between 11,4% and 12,6% for cotton. For other studies, the effects of subsidies removal on world price is more lower. While looking other predictions like those of IABD, Iowa state university predictions, it appears that price increase between 2% and 4,3% (Fok, 2005) .

The increase in the cost of the imports: one of the effects of the subsidies removal

The reduction of the aids to producers and agricultural exporters in developed countries will involve a rise of the prices on the world markets. This one will induce an increase in the cost of the food imports for the countries with food deficit. The conditions of access to food have, consequently, a very important impact on the poorest categories of the population. For more half of the ACP countries, the purchases outside foodstuffs account for at least 15% of the total imports. The external cereals supplies account for, as for them, on average 40% of the cereal imports. Exports profiting from subsidies bound for the LDCA dropped. They represented in 1994-1995, 26% of the cereal imports of the latter (46% of those of the developing countries) and became practically null since 1995-1996 (Y. Jadot, 1999). According to FAO, the cost of cereal imports has increased by 83% for the LDCA and 61% for the countries with cereal deficit of the category of the developing countries between 1993-1994 and 1995-1996. This increase comes primarily from the sharp rise in cereal prices. The contribution of the food aid to the provisioning also constantly dropped. Its share in the imports passed from 22% in the middle of the Eighties, to 7,6% in 1993-1994, then fell to 2% in 1997-1998 (Jadot, 1999).

Senegalese peasants are supposed to be affected though products like local or imported cereals (maize, millet/sorghum, irrigated rice, other agricultural products⁷), vegetables and tubers, cotton and product concurrent of groundnut like soja. The effect of subsidies removal on households will depend on the magnitude of its price effect compared to its income effect. Income effect depends on the transmission of world price increase to producers while price effect will depend on the consumption basket of Senegalese households.

III- Methodology

The section which follows provides a description of the model which takes as a starting point

⁴ International cotton advisory committee

⁵ International food policy research institute

⁶ Inter-american development bank

⁷ Ce sont le blé, le niébé, etc.

the Exter-plus model performed by Decaluwe, Cockburn and Robichaud (2002) and of Senrur (Cabral, 2005). It applies to a small economy for which the world prices are given.

The model includes 19 sectors: corn, mil/sorgho, irrigated rice of Delta river, irrigated rice out of Delta river, rainfall rice, groundnut, tubers, cotton, vegetables, fruits, forest, livestock, fishery, another agriculture, oil mills, food industries and other industries, marketed services and non-marketed services. One distinguishes four types of factors: labour, capital, land and water. The model also includes nine categories of households: seven in rural zone (basin arachidier, Niayes, Casamance, Senegal Eastern, zone sylvo-pastoral, Delta of the river and river except Delta) and two in urban zone (Dakar and other urban centres). The majority of the assumptions of the model are those of a standard MEGC. In the following description, the stress will be laid on its adaptation compared to the modelling of the agricultural sector. The technology of production is described by the equations of the production and the added value. The production of the sector is expressed by a function of the Leontief type combining shares of the value added and the intermediate consumptions (equation 1). However, the value added is formulated in a different way according to sectors. In the non-agricultural sectors, it is a CES function combining labour and capital (equation 2). In agriculture, one distinguishes non-irrigated sectors from those irrigated. In the non-irrigated sectors, the value added is a CES function combining land with a composite factor labour/capital (equation 3). This last is determined by a CES function combining capital and labour (equation 5). In the irrigated sectors, the value added is a CES function combining composite factors labour/capital and land-water. This last is determined by a function of the Leontief type which combines fixed shares of the factors land and water (equation 6). In the income block of households, the saving of the households is, a priori, a linear function of the income (equation 17). However, it is defined only for the urban households whose saving is positive. The consumption function of each product is of LES type (equation 28). The specificity of this function is that it comprises a minimal basket of consumption and makes it possible to better ensure the continuity of the aggregate demand function. In the non-agricultural sector, the difference between the value added and wages are equal to the return on the capital. The price of a unit of capital in the non-agricultural sector is thus equal to the ratio between this difference and the volume of capital used (equation 34). In the non-irrigated agricultural sectors, the unit price of the capital is equal to the difference between the value of the composite factor (labour/capital) and that of labour reported to the amount of agricultural capital employed (equation 35). The value of the composite factor in the non-irrigated sectors is equal to the difference between the value added of the agricultural sector and the return to land factor (equation 36). In the irrigated sectors, the difference between the value added and the composite factor land-water is equal to the value of composite factor labour/capital (equation 37). The unit price of land is equal to the difference between the value of the composite factor land-water and the amount of the return to water factor reported to the quantity of land (equation 38). The import price is a function of the world prices, rate of exchange, rate of customs duties and of indirect imposition (equation 40). The price the export received by the producers is a function of fob price, the rate of exchange and the taxes and/or subsidies (equation 41). In order to take into account the constraints of the Senegalese economy, we introduce a function of export demand into the model. This one is with finished elasticity and is a function of the relative price of exports evaluated in world price and fob price (equation 48). The local producers, indeed, are constrained to reduce their price to increase their market shares abroad. The market equilibrium of export for a product is determined by the equality between the supply and demand of export (equation 49). The current balance which is the equivalent of the external saving is equal to the difference between the imports and the factor incomes received from the rest of the world and exports and received transfers of the rest of the world (equation 52). The price of investment is a geometric mean of the price index of the

composite goods; the weighting coefficient being defined like the share of each good in the total investment (equation 44). The general index of the prices is represented by the GDP deflator (equation 45). As defined by the standard model of Armington, the composite good Q (or national consumption Q) is a CES function between local sales and imports (equation 50). The national production is an aggregate CET function combining local sales and exports (equation 46).

While looping of the model and calibrating of the parameters, we assume that:

- (i) the current balance is supposed to be fixed; what in the transmission mechanism of the model isolates the situation where a flow of capital would make it possible to finance the domestic policies. Consequently, the increased imports of a group of goods and services will require a stepping up of exports of other goods and services or then a fall of the imports of other categories in order to maintain fixed the current balance;
- (ii) in order to isolate the specific effect of the policies simulated on the wellbeing of households, the expenditure in goods and services of the State are supposed to be fixed in real term;
- (iii) in order to confine the dynamic effects likely to come from the modification of the level of the investment, this last is maintained fixed in real term;
- (iv) the saving of the households is defined only for the urban ones for which it is positive. One observes negative savings for rural households. To avoid an increase in their consumption at the price of an aggravation of their level of their debt, the saving level of rural households is supposed to be fixed in the model closure. Since the investment is equal to the saving, household average propensity to save will be, consequently, a useful variable of adjustment. The equation of the equivalent variation (equation 59) gives the modification of the wellbeing of the various categories of households following a measurement of policy or with an external shock. Equation 53 represents the equilibrium condition of the goods market. The supply of composite product is the sum of the intermediate demands, final consumption of the households and the private investments. The total demand of labour by the whole sectors is equal to the total supply (equation 54). The land supply is equal at the demand of agricultural sectors (equation 55) while that of water is adjusted to the demand of the irrigated sectors (equation 56). The total investment equals the sum of the households saving, the firms, the government and rest of the world (equation 57). This assumption is known under the name of neo-classic looping. The model comprises 993 equations for 1068 variables. 75 restrictions were introduced so that the number of equations (993) is equal to that of the endogenous variables (993). These restrictions are based, on the one hand, on the exogenous nature of certain variables and, on the other hand, determine the looping of the model. In the calibration process, elasticities of substitution of the foreign trade block of equations come from the GTAP data base. The income elasticity is drawn from Dorosh (1996) surveys on Madagascar and Dorosh and Lundberg (1993) study on Gambia. Elasticity of transformation as those of substitution between the factors are those used in the construction of CGE model of Senegal within the framework of Mimap surveys. Elasticity of export demand function used is drawn from Decaluwé & Al. (2001) surveys. All the others parameters are calibrated from the SAM data. This SAM was built for Senegal is based on 1996 data and the 1995 households surveys (EsamI, 1995). The agricultural sector is disaggregated in 14 sub-sectors. The imports and exports world prices as well as the rate of exchange are fixed at 1 at the benchmark year. It is also the same for the wages, price of capital, land and water. The other values

related to the variables of the model are drawn from the social accounting matrix. Simulations which we will carry out starting from this accounts framework defined by the SAM will allow us evaluate in the case of Senegal the effect of the suppression of the subsidies granted to the farmers of north on the foreign trade, factor reallocation, cost of inputs and wellbeing of the households.

IV- Experiments

The scenario experimented is related to the removal of supports granted to the farmers of North countries. The export subsidies are considered by WTO as one of measures which distort world market and do not contribute to a fair trade between the various stakeholders in the international market of the agricultural products. We suppose that under the effect of the subsidies removal granted by the countries of North to their producers, the prices received by the local producers on their external sales of agricultural products increases. These products are represented by the set including maize, millet/sorghum, irrigated rice out of Delta, groundnuts, tubers, vegetables, cotton, fruits, other agricultural products⁸. Groundnuts, cotton, vegetables, fruits, tubers and rice are agricultural product exported while rice, maize, millet/sorghum, vegetables, fruits, tubers and other agricultural products are imported.

But the removal of the supports granted to the producers in north countries is likely to involve an increase in the cost of imports for net cereals developing countries importers. The cereals occupy a significant weight in the consumption basket of poor household. Rice represents, in particular, nearly 18% of the consumption of foodstuffs by the poor households in Senegal behind the "other foodstuffs" (30,76%). Its weight in the cereal imports is about 69% on average between 1994 and 1998. Thus, in a simultaneous way, we suppose that under the effect of removing the export subsidies granted to the farmers in the north countries, the world price of the agricultural imports products also increases. Simulations are performed going from high rates of increase in world prices to low rates on the basis of predictions made by some institutions.

The first experiment (experiment 1) is based on the predictions of ICAC⁹ and IFPRI¹⁰ who assess that world prices will increase by 12,6% for cotton and 11,4% for the other agricultural products if the agricultural subsidies are removed. The second experiment (experiment 2) is to assess like IABD¹¹ and Iowa state university predictions, an increase in world price which turn around 3.7% for all products. We assume that world import prices increase simultaneously to world export prices.

Foreign exchanges, supply and resource reallocation

The rise of agricultural import prices induces a decrease of their imports. It is formerly the agricultural sectors in which rate of tariffs are highest and where the share of imports on domestic consumption that experiment more increase in their foreign purchases. The rate of tariff of vegetables, corn, the forest products is respectively 53,54%, 14,42%, 18,71%. In addition, the part of imports of vegetables, fishery products, maize, forest products in local consumption is respectively 23,98%, 20,69%, 15,22%, 11,30%. Consequently, in experiment 1a, the imports of fishery products, maize, forest products undergo heavy falls respectively by 11.66%, 8.86%, and 1.39% in experiment 1 (respectively by 3.90%,

⁸ that's corn, niébé, etc.

⁹ International cotton advisory committee

¹⁰ International food policy research institute

¹¹ Inter-american development bank

3.07%, 0.46%% in experiment 2). Fruits imports decrease is about 15.98% in experiment 1 and 5.68% in experiment 2. However because of the slight elasticity between local and imported products as given by the value of its CES elasticity, vegetables experiment an increase in their imports by 9.75% in experiment 1 and 3.52% in experiment 2. On average, the imports decrease (-1.05% in experiment 1 and -0.35% in experiment 2). One should therefore expect a substitution of the imports by local sales. But the local sales decrease also by 0.18% in experiment 1 and 0.06% in experiment 2. This is explained by the fact that the effects induced by the rise in import prices are counterbalanced by those induced by the rise of the exports prices. The export prices increases induce a depreciation of the rate of real exchange. Thus sales in foreign market are therefore more advantageous for producers than sales in domestic markets. Exports increase for the majority of the agricultural sectors, except tubers. The exports rise mainly for sectors which export an important part of their production. Cotton, groundnuts, fruits and vegetables oil record the strongest progressions of respectively 12.82%, 11.89%, 11.76%, 10.68% in experiment 1 (respectively 3.79%, 3.86%, 3.81%, 3.63% in experiment 2). Non-food industries and services export increase also by respectively by 0.54% and 0.67% in experiment 1 and 0.18% and 0.22% in experiment 2. Their shares in total exports are respectively 40,18% and 27,30%. So, on average, exports increases by 0.77% in experiment 1 and 0.25% in experiment 2. As imports decrease by 1.05% in experiment 1 (by 0.35% in experiment 2), the trade balance increase by 1.82% in experiment 1a (0.6% in experiment 2) compared to the benchmark year. This is mainly induced by the improvement of the balance fruits, cotton, groundnut and fishery by respectively 27.74%, 12.82%, 11.89% and 10.89% in experiment 1 (respectively 9.49%, 3.79%, 3.86% and 3.65% in experiment 2).

Table1: Evolution of imports, exports and trade balance (%)

	Expriment 1	Expriment 2	Expriment 1	Expriment 2	Expriment 1	Expriment 2
Sectors	Imports	Imports	Exports	Exports	BC	BC
Maize	-8.86	-3.07	0.00	0.00	3,07	8,86
Millet/sorghum	-9.97	-3.47	0.00	0.00	3,47	9,97
Delta rice	0.00	0.00	0.00	0.00	0	0
Rice out of Delta	-3.33	-1.15	3.39	1.20	2,35	6,72
Rainfall rice	0.00	0.00	0.00	0.00	0	0
Groundnuts	0.00	0.00	11.89	3.86	3,86	11,89
tubers	-1.11	-0.34	-0.51	-0.15	0,19	0,6
Vegetables	9.75	3.52	10.68	3.63	0,11	0,93
Fruits	-15.98	-5.68	11.76	3.81	9,49	27,74
Cotton	0.00	0.00	12.82	3.79	3,79	12,82
Forest	-1.39	-0.46	0.76	0.25	0,71	2,15
Livestock	-0.54	-0.17	0.57	0.19	0,36	1,11
Fishery	-11.66	-3.90	-0.77	-0.25	3,65	10,89
Other agriculture	2.89	1.02	0.00	0.00	-1,02	-2,89
Vegetables oil	-3.25	-1.07	0.38	0.13	1,2	3,63

Foods industries	-0.97	-0.32	0.82	0.27	0,59	1,79
Non-food industries	-0.58	-0.19	0.54	0.18	0,37	1,12
Tradables services	-1.31	-0.43	0.67	0.22	0,65	1,98
Total	-1.05	-0.35	0.77	0.25	0,6	1,82

BC : trade balance

Source : simulations

In agricultural sector, millet/sorghum, irrigated rice out of Delta, rain fall rice, forest, livestock, fishery, vegetable oil, food industry and services experiment a contraction of their activity in experiments 1 and 2. One observes resources reallocation on the profit of vegetables, cotton, groundnut, fruits, tubers and other agricultural activities. This reallocation is mainly explained by the expansion of exports in these sectors. The total supply is stagnant (-0.03% in experiment 1 and -0.01% experiment 2). But for vegetables, other agriculture, tubers, cotton and groundnuts, production increases respectively by 13.06%, 9.92%, 5.20%, 1.57%, and 1.40% in experiment 1 (respectively 4.50%, 3.26%, 1.76%, 0.45% and 0.45% in experiment 2). It also increases in the other industries by 0.13% in experiment 1 and 0.04% in experiment 2.

Table2: Evolution of production

	Expriment 1	Expriment 2
Sectors	dXSi	dXSi
Mais	0.45	0.15
Milsorgo	-0.33	-0.10
rizDelta	0.47	0.17
rizhorsDelta	-0.70	-0.24
riz pluviale	-0.29	-0.09
Arachide	1.40	0.45
tubercules	5.20	1.76
Legumes	13.06	4.50
Fruits	0.14	0.05
Coton	1.57	0.45
Foret	-0.07	-0.02
Elevage	-0.15	-0.05
Peche	-4.09	-1.35
autre agriculture	9.92	3.26
Huilerie	-0.47	-0.15
Industry	-0.01	0.00

Autind	0.13	0.04
Services	-0.12	-0.04
Non tradable services	0.00	0.00
Total*	-0.03	-0.01

Source : simulations

Cost of the inputs

Whereas the value added price decreases by 0.78% in experiment 1, the producer prices also decrease by 0.63% in experiment 1. So the rise combined of the import prices and those with export has induced a slight increase in the cost of the intermediate consumptions of about 0.15% in experiment 1. Cost of inputs more increase for irrigated rice. Vegetables sector is the one which experiment a significant fall in the cost of his inputs.

In experiment 2, value added price decrease by 0.26% while producer prices decrease by 0.21%. This induces an increase in inputs costs by 0.47%. Only vegetables experience a decrease in its cost of inputs.

Factor incomes

Services and livestock distribute relatively more wages in the economy with respective proportions of 41,45% and 10,62%. In experiment 1, the supply of these sectors having decreases, their labour demand also decreases. Consequently, the wage rate falls by 0.82%. The capital is specific to each sector. It increases, in average in the sectors which experiment an increase in their supply a decrease in the others. The most important progressions are those of vegetables (+40.31%), tubers (+14.33%) and other agriculture (+10.46%). The return of capital records a strong fall in irrigated rice out of Delta (-11.06%). In average, the return in capital decreases in the economy by 0.75%. The shares of groundnut and fruits in the land factor remuneration paid are significant (respectively 30,5% and 11,37%). So because of the increase in their supply, the rate of return of land factor increases by 1.40%. On the other hand, the decrease in the supply of irrigated sectors induces less demand for irrigated water. This rate of return to water decreases sharply by about 13.82%.

In experiment 2, the decrease observed in the main employers sectors leads to a decrease in labour demand increase and, then wage rate by 0.27%. The rate of return to capital decreases in average by 0.25%. Because of the supply increase in agricultural sectors which occupy large shares in the amount of land, the rate of return to this factor increase by 0.44%. The supply of irrigated rice out of Delta decrease, so the rate of return to water decreases by 4.89%.

Table 3: Evolution of the rate of capital return

	Exprimment 1	Exprimment 2
Sectors	dri	dri
Mais	1.20	0.40
Milsorgo	-0.63	-0.21
rizDelta	-8.67	-3.06
rizhorsDelta	-11.06	-3.94

riz pluviale	-0.53	-0.18
Arachide	3.88	1.21
tubercules	14.33	4.68
Legumes	40.31	12.75
Fruits	0.34	0.12
Coton	4.41	1.25
Foret	-0.90	-0.30
Elevage	-1.05	-0.34
Peché	-5.54	-1.84
autre		
agriculture	10.46	3.47
Huilerie	-1.29	-0.42
Industry	-0.83	-0.27
Autind	-0.46	-0.15
Services	-1.06	-0.35
Non tradable services	-	-
Total*	-0.75	-0.25

Sources: simulations

Income, consumer price and household wellbeing

The evolution of the return paid to factors has a negative effect on household income. This one decreases by 0.49% in experiment 1. The most important decreases is experimented by urban households. The consumer prices decrease in average but increase several households. Consequently, the wellbeing of the households drops on average by 0.68%. The households are differently affected. Those of Niaye, Basin arachidier and Casamance are the largest losers. Their wellbeing drops respectively by 1.43%, 1.40% and 1.08%. Only the households of Delta river experiment an improvement in their wellbeing (+0,10%).

In experiment 2, income has decrease by 0.16%. Consumer prices also decrease (+0.08%). The wellbeing of households decreases by 0.22%. Except Delta river households, all the other households experiment a decrease in their wellbeing. The most affected are those from Niaye, Basin arachidier and Casamance. In average, households whose wellbeing worsens are those for who prices more increase for the products which share is significant in their consumption basket.

In experiment 1, the combined rise of the world export and import prices has worsened the government revenue by 0.44%. This drop induces a fall in the government consumption of about 0.62%. The government investments decrease in value by 0.69%. In experiment 2, government revenue decreases by 0.15% and induce a cut on public consumption by 0.20%. Public investment has also decrease in value by 0.22%.

Conclusion

The suppression of the subsidies granted to the farmers of north will result in an increase in the prices the export of the agricultural produce but also of the import prices of cereals. This shock implies important general equilibrium effects within the economy. It will thus have an impact on factor reallocation in the agriculture and the rest of the economy as well as significant effects on the commercial balance, the cost of the inputs and the wellbeing of the households. In order to better address those issues, a CGE model based on 1996 SAM of Senegal with disaggregated rural sector is used. From simulations carried out, it arises that:

- (i) in agriculture, vegetables, cotton, groundnut, fruits, tubers and other agricultural activities are the principal beneficiaries of this shock. Their production increases. The agricultural supply offer shifts towards the external markets. Adversely, millet/sorghum, irrigated rice out of Delta, fishery, forest, livestock, vegetable oil and services are negatively affected by this shock since their activity contracts;
- (ii) the cost of the inputs increases. It affect mainly irrigated rice sector out of Delta, but some sectors like vegetables experiment a decrease in the cost of their inputs;
- (iii) the suppression of the supports granted by the countries of North for their farmers induces a fall of the households wellbeing. Except the Delta river households, all the others experiment a decrease in their well-being.

Simulating the effects of subsidies removal with high or low predictions seems to lead to the same trend of results. The removal of the grants of North countries to their farmers will induce a reorientation of agricultural product supply towards the external market and on the other hand, except the households of Delta river households, the wellbeing worsens.

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ANNEXES

Table A1 : Principal measures of the agricultural Agreement under GATT

Mesures	Pays développés	Pays en développement
Accès au marché		
- réduction des droits de douanes	36%	24%
- (minimum par ligne tarifaire)		
- période (base 1986-1988)		
- taux minimum d'importation		
- date limite	(15%)	(10%)
Soutien interne	6 ans	10 ans
- réduction de la MGS		
- période (base 1986-1988)	5%	4%
- clause de minimis	2000	2005
(en % valeur la production)		
- exceptions		
- clause spéciale de sauvegarde	20%	13,3%
- clause de modération	6 ans	10 ans
Exportation		
- réduction des subventions à l'exportation (par produit)	5%	10%
- réduction du volume des exportations subventionnées		
- période (base 1986-1988) ou 1991-1992)	boîtes bleue & verte	boîtes bleue & verte et S+D
- exceptions	oui	oui
	2003	2003
	36%	24%
	21%	14%
	6 ans	10 ans
-		aides à la commercialisation et au transport interne et externe

S+D : traitement spécial et différencié

Source : Y. Jadot (1999).

Tableau A2 : Support measures excluded from reduction, period 1986-1988, Senegal

Désignation de la mesure	Description	Valeur de la mesure en millions de F CFA
Programme de soutien à la production	Aménagements hydro-agricoles	31500
Programme d'appui en amont et aval de la production	Encadrement dans les aménagements agricoles du fleuve Sénégal	1867
Programme de soutien d'intensification des spéculations	Opération de développement rural intégré Aménagement agro-sylvo- Pastoral	3100

Source: Cabinet d'études et de conseil (1989).

Tableau A3 : Engagements of Senegal as regards access to the market and rights and taxes applied to the groups of imported agricultural product

Catégories	Produits	Taux consolidé		Taux appliqué		
		Taux consolidé	Autres droits et impositions	Taxes	Surtaxes	Cumul
Céréales	Riz intermédiaire et entier	30%	150%	15%	20%	35%
	Mil, sorgho, maïs, blé			27%		37%
				20,5%	10%	20,5%
Huiles & graisses*		30%	150%			27%
Sucres*		30%	150%			44%
Produits animaux*		30%	150%			31%
Coton et fibres textiles*		30%	150%			48%
Produits halieutiques*		30%	150%			45%
Fruits et	Banane	30%	150%	44,5%	20%	64,5%

légumes	Oignon, pomme de terre			35%	20%	55%
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Source : Cabinet d'études et de conseil (1989).

* Il s'agit des taux moyens de prélèvements sur la période 1995 - 1997

Tableau A4a : Price predicted from models of subsidies removal evaluating

Authors	Model	Sectors/products	Data origins	Campaign	Price effect (%)
ICAC	ICAC/FAO	Cotton	ICAC	2000/01	21
ICAC	ICAC/FAO	Cotton	ICAC	2001/02	72,4
Summer	IFPRI	Cotton	ICAC	2000/01	12,6
IFPRI	IFPRI	All Agri. prod.	ICAC&IFPRI	2000/01	11,4
Tokarick	Tokarick	All agri. Prod.	ICAC&autres	2000/01	2,8
FAO	CNUCED/FAO	Cotton	OMC	2000/01	2,3-5,0
Reeves & al.	Reeves & al.	Cotton/textile/hab.	ICAC	2000/01	10,7
Gillson & al.	ODI	Cotton	ICAC	2000/01	18,0-28,0
Goreux	Variante ICAC/FAO	Cotton	ICAC	2000/01	2,9-13,4

Sources: FOK (2005) *from* FAO, 2004.

Tableau A4b: Price predicted from models of subsidies removal evaluating

Model	Products	Level of subsidies removal	Price variation (%)
IFPRI	Maize	All north countries subsidies	2.90
IADB	Cereals	All subsidies	1.80
ERS-USDA	All products	All north countries subsidies	3.70
Iowa State University	all cereals except rice&corn	Different type of north subsidies	3.30-4.30
APAC-Zero subsidy	maize	All US subsidies	-3.00

Sources: FOK (2005) *from* T. Wise, 2004.

Tableau A5 : Evolution of the wage rate

	Expriment 1	Expriment 2
Sectors	dwi	dwi
travail	-0.82	-0.27

Tableau A6 : Evolution of the rate of return to land

	Expriment 1	Expriment 2
Sectors	drll	drll
Land	1.40	0.44

Tableau A7 : Evolution of the rate of return to water

	Expriment 1	Expriment 2
Sectors	drwl	drwl
Wat	-13.82	-4.89

Tableau A8 : Evolution of Government income, consumption and investment

	Expriment 1	Expriment 2
government income	-0.44	-0.15
gouvernement consumtion	-0.62	-0.20
total investissement	-0.69	-0.22

Tableau A9 : Expriment 1 : Households well-being (%)

	Dakar	ACU	BA	NIAY	CASA	ZSP	SO	FLEUVHD	Deltaf	All
Change in nominal income	2.88	2.90	2.47	3.14	2.79	2.12	3.47	2.67	2.75	2.84
Change in household consumer price	3.94	4.26	4.88	4.91	4.82	4.69	4.78	4.80	4.38	3.51
Equivalent variation	-0.13	-0.16	-3.95	-2.12	-2.44	-3.62	0.45	-3.01	-4.75	-0.73

Tableau A10 : Expriment 1 : Households well-being (%)

	Dakar	ACU	BA	NIAY	CASA	ZSP	SO	FLEUVHD	Deltaf	All
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Change in nominal income	-0.17	-0.17	-0.11	-0.16	-0.13	-0.11	-0.18	-0.13	-0.12	-0.16
Change in household consumer price	0.06	0.12	0.27	0.29	0.21	0.15	0.18	0.12	-0.09	-0.08
Equivalent variation	-0.17	-0.21	-0.46	-0.47	-0.35	-0.29	-0.29	-0.27	0.04	-0.22

Modèle

I-1 Module de l'offre

1.
$$XS_j = \min \left[\frac{CI_j}{io_j}, \frac{VA_j}{v_j} \right]$$
2.
$$VA_{nag} = A_{nag}^{KL} \left[\alpha_{nag}^{KL} LD_{nag}^{-\rho_{nag}^{KL}} + (1 - \alpha_{nag}^{KL}) KD_{nag}^{-\rho_{nag}^{KL}} \right]^{-1/\rho_{nag}^{KL}}$$
3.
$$VA_{nirg} = A_{nirg}^{CL} \left[\alpha_{nirg}^{CL} CF_{nirg}^{-\rho_{nirg}^{CL}} + (1 - \alpha_{nirg}^{CL}) LAND_{nirg}^{-\rho_{nirg}^{CL}} \right]^{1/\rho_{nirg}^{CL}}$$
4.
$$CF_{AGR} = A_{AGR}^{KL} \left[\alpha_{AGR}^{KL} LD_{AGR}^{-\rho_{AGR}^{KL}} + (1 - \alpha_{AGR}^{KL}) KD_{AGR}^{-\rho_{AGR}^{KL}} \right]^{1/\rho_{AGR}^{KL}}$$
5.
$$VA_{irg} = A_{irg}^{CW} \left[\alpha_{irg}^{CW} CF_{irg}^{-\rho_{irg}^{CW}} + (1 - \alpha_{irg}^{CW}) FLW_{irg}^{-\rho_{irg}^{CW}} \right]^{1/\rho_{irg}^{CL}}$$
6.
$$FLW_{irg} = \min \left[\frac{LAND_{irg}}{n_{irg}}, \frac{WAT_{irg}}{u_{irg}} \right]$$
7.
$$VA_{ntr} = LD_{ntr}$$
8.
$$CI_j = io_j XS_j$$
9.
$$DI_{tr,j} = a_{ij} DI_{tr,j} CI_j$$
10.
$$LAND_{nirg} = \left(\frac{1 - \alpha_{nirg}^{CL}}{\alpha_{nirg}^{CL}} \right)^{\sigma_{nirg}^{CL}} \left(\frac{rc}{rl} \right)^{\rho_{nirg}^{CL}} CF_{nirg}$$
11.
$$LAND_{irg} = n_{irg} FLW_{irg}$$
12.
$$LD_{agr} = \left(\frac{\alpha_{agr}^{KL}}{1 - \alpha_{agr}^{KL}} \right)^{\sigma_{agr}^{KL}} \left(\frac{nr}{w} \right)^{\rho_{agr}^{KL}} KD_{agr}$$
13.
$$WAT_{irg} = u_{irg} FLW_{irg}$$
14.
$$LD_{NTR} = \frac{P_{NTR} XS_{NTR} - \sum_{tr} PD_{tr} DI_{tr,NTR}}{w}$$

I-2 Revenu et épargne

- $$15. \quad \begin{aligned} &= YH_h^W \sum_j LD_j + \lambda_h^R \sum_{tr} r_{tr} KD_{tr} + \lambda_h^L \cdot rl \cdot LAND + PINDEX \cdot TG_h \\ &+ DIV_h^+ + T_{wh} + \sum_{fij} R_{fij}^T \end{aligned}$$
- $$16. \quad YDH_h = YH_h - DTH_h - \sum_{fij} R_{fij} - TH_{wh}$$
- $$17. \quad SH_h = v \cdot \psi_h \cdot YDH_h$$
- $$18. \quad YF = \lambda^{RF} \sum_{tr} r_{tr} KD_{tr} + \lambda^{LF} \cdot rl \cdot LAND + \lambda^{WF} \cdot rw \cdot WAT$$
- $$19. \quad SF = YF - \sum_h DIV_h - e \cdot DIV^{ROW} - DTF - \sum_h DIV_h$$
- $$20. \quad YG = \sum_{tr} TI_{tr} + \sum_{tr} TIE_{tr} + \sum_{tr} TIM_{tr} + \sum_h DTH_h + DTF + TWG$$
- $$21. \quad SG = YG - G - PINDEX \sum_h TG_h - TGW$$
- $$22. \quad TI_{tr} = (ttv + tx_{tr})(PrXS_{tr} - PE_{tr}EX_{tr}) + (ttv + tx_{tr})(1 + tm_{tr}) e PWM_{tr}M_{tr}$$
- $$23. \quad TIM_{tr} = tm_{tr} e PWM_{tr}M_{tr}$$
- $$24. \quad TIE_{tr} = te_{tr} PE_{tr}EX_{tr}$$
- $$25. \quad DTH_h = ty_h YH_h$$
- $$26. \quad DTF = tyf \cdot YF$$

I-3 Demande

- $$27. \quad CTH_h = YDH_h - SH_h$$
- $$28. \quad PC_{tr}C_{tr,h} = PC_{tr}C_{tr,h}^{MIN} + \gamma_{tr,h} \left(CTH_h - \sum_{trj} PC_{trj}C_{trj,h}^{MIN} \right)$$
- $$29. \quad G = XS_{ntr}P_{ntr}$$
- $$30. \quad INV_{tr} = \frac{\mu_{tr}IT}{PC_{tr}}$$
- $$31. \quad ITVOL \cdot PINV = IT$$
- $$32. \quad DIT_{tr} = \sum_j DI_j$$

I-4 Prix

- $$33. \quad PV_j = \frac{P_j XS_j - \sum_{tr} PC_{tr} DI_{tr,j}}{VA_j}$$
- $$34. \quad r_{nag} = \frac{PV_{nag} VA_{nag} - w LD_{nag}}{KD_{nag}}$$
- $$35. \quad r_{AGR} = \frac{r_{CAGR} CF_{AGR} - w LD_{AGR}}{KD_{AGR}}$$

$$36. \quad rC_{nirg} = \frac{PV_{nirg}VA_{nirg} - rI_{nirg}LAND_{nirg}}{CF_{nirg}}$$

$$37. \quad rC_{irg} = \frac{PV_{irg}VA_{irg} - rI_{irg}FLW_{irg}}{CF_{irg}}$$

$$38. \quad rI_{irg} = \frac{rI_{irg}LW_{irg} - rW_{irg}WAT_{irg}}{LAND_{irg}}$$

$$39. \quad PD_{tr} = (1 + (ttv + tx_{tr})) PL_{tr}$$

$$40. \quad PM_{tr} = (1 + (ttv + tx_{tr})) (1 + tm_{tr}) e \cdot PWM_{tr}$$

$$41. \quad PE_{tr} = \frac{e \cdot PEfob_{tr}}{1 + te_{tr}}$$

$$42. \quad PC_{tr}Q_{tr} = PD_{tr}D_{tr} + PM_{tr}M_{tr}$$

$$43. \quad P_{tr}XS_{tr} = PL_{tr}D_{tr} + PE_{tr}EX_{tr}$$

$$44. \quad PINV = \prod_{tr} \left(\frac{PC_{tr}}{\mu_{tr}} \right)^{\mu_{tr}}$$

$$45. \quad PINDEX = \sum_i \delta_i PV_i$$

I-5 Commerce international

$$46. \quad XS_{tr} = B_{tr}^E \left[\beta_{tr}^E EX_{tr}^{\kappa_{tr}^E} + (1 - \beta_{tr}^E) D_{tr}^{\kappa_{tr}^E} \right]^{\frac{1}{\kappa_{tr}^E}}$$

$$47. \quad EX_{tr} = \left[\left(\frac{PE_{tr}}{PL_{tr}} \right) \left(\frac{1 - \beta_{tr}^E}{\beta_{tr}^E} \right) \right]^{\tau_{tr}^E} D_{tr}$$

$$48. \quad EXD_{tr} = Eref_o \left[\left(\frac{PWE_{tr}}{PEfob_{tr}} \right) \right]^{-\theta_{tr}}$$

$$49. \quad EXD_{tr} = EX_{tr}$$

$$50. \quad Q_{tr} = A_{tr}^M \left[\alpha_{tr}^M M_{tr}^{-\rho_{tr}^M} + (1 - \alpha_{tr}^M) D_{tr}^{-\rho_{tr}^M} \right]^{\frac{-1}{\rho_{tr}^M}}$$

$$51. \quad M_{tr} = \left[\left(\frac{PD_{tr}}{PM_{tr}} \right) \left(\frac{\alpha_{tr}^M}{1 - \alpha_{tr}^M} \right) \right]^{\sigma_{tr}^M} D_{tr}$$

$$52. \quad CAB = \sum_{tr} PWM_{tr}M_{tr} + \lambda^{ROW} \sum_{tr} r_{tr}KD_{tr} / e + \lambda^{ROW} rI \cdot LAND / e - \sum_{tr} DIV_{tr} - e \sum_{tr} PWE_{tr}EX_{tr} + TGW + \sum_h TH_{wh} - TWG - \sum_h TW_h$$

I-6 Équilibre

$$53. Q_{tr} = DIT_{tr} + \sum_h C_{tr,h} + INV_{tr}$$

$$54. LS = \sum_j LD_j$$

$$55. TOTLAND = \sum_j LAND_j$$

$$56. TOTWAT = \sum_j WAT_j$$

$$57. IT = \sum_h SH_h + SF + SG + e \cdot CAB$$

$$58. LEON = Q_{ser} - \sum_h C_{ser,h} - DIT_{ser} - INV_{ser}$$

$$59. EV_h = \left(CTH_h - \sum_{trj} PC_{trj} C_{trj,tj}^{MIN} \right) \prod_{tr} \left[\frac{PCO_{tr}}{PC_{tr}} \right]^{y_{tr,h}} - \left(CTHO_h - \sum_{trj} PCO_{trj} C_{trj,tj}^{MIN} \right)$$

III/ Définition des paramètres et ensembles du modèle

III-1 Paramètres

Fonctions de production

A_j :	Coefficient d'échelle (fonction Cobb-Douglas)
$a_{ij_{tr,j}}$	Coefficients entrées-sorties
α_j :	Élasticité (fonction Cobb-Douglas)
io_j :	Coefficient technique (fonction Leontief)
v_j :	Coefficient technique (fonction Leontief)

Fonctions à élasticité de substitution constante (CES) entre le capital et le travail

A_{tr}^{KL} :	Coefficient d'échelle
α_{tr}^{KL} :	Paramètre distributif
ρ_{tr}^{KL} :	Paramètre de substitution
σ_{tr}^{KL} :	Elasticité de substitution

Fonctions à élasticité de substitution constante (CES) entre le facteur composite (capital – travail) et la terre

A_{nirg}^{CL} :	Coefficient d'échelle
α_{nirg}^{CL} :	Paramètre distributif
ρ_{nirg}^{CL} :	Paramètre de substitution

σ_{nirg}^{CL} : Elasticité de substitution

Fonctions à élasticité de substitution constante (CES) entre le facteur composite (capital – travail) et le facteur composite (eau-terre)

A_{irg}^{CW} : Coefficient d'échelle

α_{irg}^{CW} : Paramètre distributif

ρ_{irg}^{CW} : Paramètre de substitution

σ_{irg}^{CW} : Elasticité de substitution

Fonctions à élasticité de substitution constante (CES) entre les importations

et la production domestique

A_{tr}^M : Coefficient d'échelle

α_{tr}^M : Paramètre distributif

ρ_{tr}^M : Paramètre de substitution

σ_{tr}^M : Elasticité de substitution

Fonctions à élasticité de transformation constante (CET) entre la production

domestique et les exportations

B_{tr}^E : Coefficient d'échelle

β_{tr}^E : Paramètre distributif

K_{tr}^E : Paramètre de transformation

τ_{tr}^R : Élasticité de transformation

Fonction de consommation linéaire des dépenses (LES)

$\gamma_{tr,h}$: Part en (valeur) du produit tr dans la consommation totale du ménage h

$C_{tr,h}^{MIN}$: Consommation Minimale du ménage h en bien tr

Taux de taxe

te_{tr} : Taux de taxe à l'exportation du bien tr

tm_{tr} : Taux de tarif à l'importation du bien tr

tx_{tr} : Taux de taxe indirecte du bien tr

ty_h : Taux d'imposition sur le revenu du ménage h

ty_f : Taux d'imposition sur le revenu des entreprises

III- 2 Autres paramètres

δ_j : Part de la branche j dans la valeur ajoutée totale

ε_{tr}^E : Élasticité prix de la demande pour le produit exporté tr

λ_h^L	Part de la rémunération du facteur terre versée au ménage h
λ_h^R :	Part de la rémunération du capital versée au ménage h
λ^{RF}	Part de la rémunération du capital versée aux entreprises
λ^{ROW} :	Part de la rémunération du capital versée au reste du monde
λ_h^W	Part de la rémunération du travail versée au ménage h
ψ_h :	Propension à épargner du ménage h
μ_{tr} :	Part (en valeur) du produit tr dans l'investissement total

III- 3 Ensembles

$i, j \in I = \{ \text{branches et produits mil/sorgho, riz Delta, riz hors-Delta, arachide, tubercules, coton, légumes, fruits, forêt, élevage, pêche, autre agriculture, IND, AUTIND, SER, NTR} \}$

$tr \in TR = \{ \text{branches et produits mil/sorgho, riz Delta, riz hors-Delta, arachide, tubercules, coton, légumes, fruits, forêt, élevage, pêche, autre agriculture, IND, AUTIND, SER} \}$

$agrs \in \text{à AGRS} = \{ \text{branches mil/sorgo, rizDelta, riz hors-Delta, arachide, tubercules, légumes, fruits, coton, foret, élevage, autre agriculture} \}$

$exps \in EXPS = \{ \text{branches arachide, tubercules, légumes, fruits, coton, foret, élevage, pêche, industrie alimentaire, autres industries, services} \}$

$imps \in IMPS = \{ \text{branches mil/sorgho, riz hors-Delta, tubercules, légumes, fruits, élevage, foret, pêche, autre agriculture, industrie alimentaire, autres industries, services} \}$

$h \in H = \{ \text{Dakar, ACU, Bassin arachidier, Niayes, Casamance, Sénégal Oriental, Zone sylvo-pastorale, Zone Fleuve hors Delta, Delta du fleuve} \}$