Groupe de Recherche en Économie et Développement International

Cahier de recherche / Working Paper
05-13

A Poverty and Inequality Assesment of Liberalization of Water Utility in Senegal : A Macro-Micro Analysis

Dorothée Boccanfuso

Antonio Estache

Luc Savard

UNIVERSITÉ DE SHERBROOKE

A POVERTY AND INEQUALITY ASSESMENT OF LIBERALIZATION OF WATER UTILITY IN SENEGAL: A MACRO-MICRO ANALYSIS

Dorothée Boccanfuso[1], Antonio Estache[2] and Luc Savard[3]

December 2005

Abstract

Many argued that water accessibility to the poor has been improved with the privatization of water utilities and that privatization on the whole has been beneficial to the poor households. In this paper, we used a multi-household integrated CGE model to analyze the impact of the privatization of the water utilities in Senegal on poverty and inequality and we also present a distributional analysis of water distribution before and after privatization to verify is the privatization process has been pro-poor. We simulate OPEX and CAPEX strategies and analyze how they affect government finances and other key macro and sectoral variables and attempt to measure the impact on poverty and inequality of different groups of households. The simulated price increases for the utility sector, have marginal effects on government finances and positive effects on most groups and negative effects on others agents.

Keyword: computable general equilibrium model, micro-simulation, poverty analysis, income distribution, privatization.

JEL: D58, D31, I32, L33

([1]) Professor, GREDI, Université de Sherbrooke : dorothee.boccanfuso@usherbrooke.ca

([2]) Senior Economic Advisor, World Bank.: Aestache@worldbank.org

([3]) Professor, GREDI, Université de Sherbrooke : luc.savard@usherbrooke.ca

Introduction

In this paper we attempt to investigate on the one hand the distributional impact the privatization of the water utility has created in terms of supply of potable water between 1995 and 2000 and on the other hand, we attempt to isolate winners and losers of Senegal's' water utility company following privatization. There is much debate in the policy arena on the pros and cons of privatization of utilities. In Latin America, privatization of utilities have resulted in large price increases and created enormous social and political tensions. In Africa, the privatization process has been more sluggish for numerous reasons that we will not attempt to highlight but the process could certainly be help by *ex ante* analysis of the impact of price increase on different agents and groups in the country in order to help design policies to compensate the losers. If the reform is positive at the macroeconomic level, understanding the impact on specific groups and compensating losers can be a key element in succeeding in this process.

The *compagnie des eaux* was the private water utility company after independence and was nationalized in 1972. Important investment followed but poor maintenance strategy leads to a quick depreciation of the infrastructure. *Société Nationale d'Exploitation des Eaux du Sénégal* (SONEES) a public company was responsible for maintenance and improvement of water supply in cities and the government was responsible to determine tariff changes twice a year. The financial situation of SONEES continually deteriorated due to poor revenues their low tariffs, public companies and government not paying their water bills and regular interference in the company management. This situation prevented SONEES from expending its water supply outside of urban centers. Three main reasons justified privatization: (1) improves the financial situation with increase productivity; (2) improves efficiency to increase tariffs; and (3) isolates from government intervention. *Senegalaise des eaux* (SDE) was created with the participation of

Société d'Aménagement Urbaine et Rurale (SAUR) as the main shareholder. SDE is responsible for the production and the distribution of water in urban and peri-urban zones, the maintenance of the water network, commercial publicity and tariffs collection. SONEES continued to exist as a state holding and its role is essentially to manage the investment on potable infrastructures and also delegates renting and granting permits (Bayliss (2001)).

The investments planned in by the government as part of its investment program is aimed to increasing assess to potable water in the urban and rural areas and it represents 11% of the total public investments for primary sectors and 25% of tertiary sectors (MEF (2000), MEF (2001)). Improvements in the provision of potable water for rural population and mobilizing water for agricultural purpose are a priority for primary sector investments. More specifically, the aim is to consolidate and increase the existing network of water supply, and strengthen the production capacity, transportation, stocking and distribution of water in urban centers as well as the implement an institutional framework that would guarantee a quality water service at minimal costs all while implementing necessary reforms and improve exploration for new water sources for rural populations. It is worth noting that there is an increasing level of private sector participation since 2000 (MEF (2002)). We can highlight that the investment plan (MEF-2003) mentions that by 2010, the level of access to water should be raised to 35 liters per person per day to comply with the World Health Organization recommendations.

Water pricing has increase on average by 3.1% annually when using the price per cubic meter. The water sector can use flexible pricing adjusted to the type of consumer. A new tax grid was adopted in early 2003 based on the following principles; Reduction to three types of consumers: crop agriculture, households and other consumers; Other consumers face a fixed single tariff; Maintain the three level tariff system for households with a reduction of the volume of the lower

tier from 100 to 40 m^3/bimester; Value added tax (VAT) exemption of the "social segment", fire hydrant and crop agriculture. The price of water is decomposed in the following elements: The VAT of 18%; A specific tax distributed to *Fonds National de l'Hydraulique* (FNH); The asset price (*prix Patrimoine*) which is destined to cover operating cost (OPEX) and investment cost (CAPEX) of SONEES, debt servicing used to finance infrastructure and the investment fund to maintain and expend the network; The operator price which is designed to cover the operating cost of the private supplier SDE (OPEX), debt reimbursement and investments, operating material, contractual obligations in terms of renewal of network. Infrastructure work performed by SDE on demand from SONEES will be financed by SONEES or with external funds (MAH (2004)).

The 1996 reforms aimed to secure the financial situation and the renewal of investments in the hydraulic sector. This reform was named ''Water sectorial project''**.** The main element of this reform was the partial privatization of the sector. The reform goal was to supply all households in Dakar with potable water by 2010. The government also aims to increase the private participation to improve potable water supply and irrigation in rural areas and this was highlighted in the government investment plan of 2002\2004 (MAH (2004)).

This paper is structured as follows: first we make a brief presentation of water utilities, we will then follow with a brief description of distribution impact of the privatisation of the water utilities by with a simple comparative analysis of two survey periods by using the ESAM-I (94-95) and ESAM-II (00-01), we will then make a brief literature review of macro-micro modeling for poverty analysis and describe the model used for the analysis. We follow with a presentation of the macroeconomic and sectoral results before moving to the poverty and inequality analysis and completing presenting a short conclusion.

PRSP approved by the board of the IMF and WB in 2002 included numerous items among which the privatization of utilities was included. Some actors within government, NGO and other development partners question the impact of some of these reforms on the most vulnerable groups in the Senegalese society. Liberalization of the utilities in Senegal is very complex and many facets should be subjected to impact analysis. In this study we focus mainly on the analysis of some potential changes in prices of utilities on poverty and inequality indices. We will attempt to highlight the main transmission mechanisms between the reforms and the household welfare changes.

Distributional analysis of water supply for 94-95 and 00-01

We have used the two ESAM surveys (i.e. 1994-95 and 2000-01) to analyze the evolution of water supply of for households in Senegal based on income quintiles. In Table 1, we present a decomposition based on three characteristics, we first decompose the households based on regions (Dakar, Other urban and rural), then a quintile decomposition and finally the source of water supply used by households. We then compare by quintile and region the distribution of source of supply (i.e. in Quintile 1 for 1995 in the rural area 1.4% of these households had a potable water supply in the house, 19.1% used a public or a neighbour tap and 79.5% other sources[4]). It is quit interesting to note that significant increases in the supply coming from private tap supply (newly connected client to the system) are observed in only five groups out of fifteen possible. We also observe slight changes in six more groups. We note slight decreases in two groups and strong decreases in two other groups. It is quit surprising to note that if the goal of government was to increase the supply to poor household this was certainly not achieved during

[4] In private tap we included house tap, and concession tap in public tap we included neighbour, public tap and other sources; water vendor, cittern truck, concession well, village well surface water, other source.

this period as the group that benefited the most is by fare the fourth and third quintile. In the fourth quintile all regions had important increases for private taps installation.

Table 1 : Decomposition of the distribution of supply source for water

	Quintile 1		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	1995	**2000**	**1995**	**2000**	**1995**	**2000**	**1995**	**2000**	**1995**	**2000**
Rural										
Private	1.4%	4.8%	5.4%	7.2%	8.8%	9.7%	7.3%	12.7%	11.4%	8.9%
Public & neighbour	19.1%	20.9%	29.0%	29.6%	28.5%	34.5%	46.3%	26.9%	31.8%	24.1%
Other sources	79.5%	74.4%	65.6%	63.2%	62.7%	55.8%	46.3%	60.3%	56.8%	67.0%
Other urban										
Private	27.1%	19.2%	12.3%	35.4%	42.7%	48.9%	42.5%	62.7%	72.8%	71.9%
Public & neighbour	44.3%	35.4%	58.1%	29.9%	33.5%	26.1%	33.3%	23.0%	16.2%	16.4%
Other sources	28.6%	45.4%	29.7%	34.6%	23.8%	25.0%	24.1%	14.2%	11.0%	11.8%
Dakar										
Private	44.0%	37.4%	41.0%	48.2%	43.6%	62.6%	45.4%	70.6%	82.0%	85.7%
Public & neighbour	56.0%	36.9%	46.2%	40.4%	46.4%	29.7%	45.9%	24.6%	14.8%	12.3%
Other sources	0.0%	25.7%	12.8%	11.3%	10.1%	7.7%	8.8%	4.8%	3.2%	2.0%

Sources: ESAM I and II.

The other specific groups benefiting from increase private tap supply are the second quintile-other urban going from 12.3% to 35.4% and the third quintile from Dakar going from 43.6% to 62.6%. On the other hand, we observe the strongest decreases in private tap supply in two groups of the first quintile namely the other urban with a decrease of 29.7% to 19.2% and Dakar with a drop from 44% to 37.4%. The decreases in households supplied by potable water tap come from the fact that the household survey was performed on a different sample of households. It is also interesting to look at the public and neighbour supply as this source of supply is potable comes in large part from an extension of the network water supply network. In this category we only find an increase in the third quintile for rural areas. All other groups see a decrease in supply from this source or no significant change. This can be explained by the fact that the switches to the private tap comes in part from this type of supply as the network was likely in the vicinity of the houses concerned.

In Table 2, we present the evolution in water expenditure share for the same household decomposition as in the previous table. Given that the ESAM provide the expenditure on goods, we cannot distinguish between the price and the volume of consumption. Therefore this evolution in the share of water consumption can be attributed to either a price change or a change in volume of water consumed. It is quit interesting to note that for households in the rural and other urban areas supplied by private taps, generally decreased their water share expenditure and for Dakar, the households with private taps increased their expenditure share on water.

For all households in the four lowest quintiles being supplied by public or neighbour taps, their share of water consumption decreased and for the highest quintile (quintile 5) this share increased. On the other hand, households being supplied by other sources tend to increase their share by quit large proportion with the exception of 4 out of 15 groups. For eight groups in this category, the water expenditure share more then doubled between the two periods.

Table 2 : Evolution of share of water expenditure in total expenditure from 1995-2000

	Quintile 1	**Quintile 2**	**Quintile 3**	**Quintile 4**	**Quintile 5**
Rural					
Private	1.0%	-28.5%	12.8%	-4.1%	-76.5%
Public& neighbour	-20.6%	-17.6%	-39.0%	-28.2%	84.6%
Other sources	52.9%	249.3%	-62.5%	-57.6%	531.2%
Other urban					
Private	-19.0%	5.3%	-3.7%	-18.5%	-8.1%
Public& neighbour	-43.3%	-12.1%	-24.2%	-30.5%	23.9%
Other sources	152.2%	2427.8%	290.8%	229.3%	133.0%
Dakar					
Private	12.6%	10.2%	6.6%	3.6%	10.9%
Public& neighbour	-15.9%	-17.0%	-36.0%	-31.0%	31.5%
Other sources	n-a	-10.3%	45.4%	103.3%	-34.9%

Sources : ESAM I and II.

It seem like the households supplied by private, public and neighbour taps seem to have decreases the budget share for water whereas the ones not supplied by these sources seem to have increased quit significantly their share of budget for water consumption. As we have

mentioned we cannot distinguish if it is a price effect or volume effect but given the size of changes, we are incline to think that prices increases explain a large portion of these increases.

Literature review of macro-micro modeling for poverty analysis

Since the late 90's an increasing number of researchers have been developing and applying macro-micro modeling with the use of CGE base modeling in developed and developing economies One of the first contribution linking a CGE model and micro data in a developing country is Adelman and Robinson (1977) for South Korea. This application was followed by that of Taylor and Lysy (1979) for Brazil, Dervis et *al.* (1982), and Bourguignon et *al.* (1983) for Venezuela. These papers were pioneer for income distribution analysis with CGE models. Later in the early nineties OCDE sponsored work by Thorbecke (1991), de Janvry et *al.* (1991), Bourguignon, et *al.* (1991) and Morrisson (1991) which analysed the impact of structural adjustment programs on income distribution. The first article survey using poverty indices is de Janvry et *al.* (1991) with an application to Ecuador. They used the Foster, Greer and Thorbecke (FGT) (1984) to measure poverty changes. Chia et *al.* (1994) also used the same indices in a CGE application to Ivory Coast.

More recently, a new wave of researchers tried to go further by making poverty analysis a central objective of research. As a result, it was possible, in particular, to highlight the relation existing between economic policies, poverty levels and income distribution. These researchers include Decaluwé et *al.* (1999a), Decaluwé et *al.* (1999b) and Cogneau and Robilliard (2000). These papers have been followed by a large number of applications[5].

[5] For an interesting review, the reader can consult Hertel and Reimer (2004).

Three main approaches have been used to link macro reforms to changes in income distribution and poverty. The first one being is the most commonly used is the representative household approach (RH), the second one is usually referred to as CGE integrated multi-household (IMH) approach and the third is generally referred to as the Top-down or micro-simulation sequential approach (MMS). The RH approach consists of using representative household subgroups in a CGE model and inferring changes in the income of all household within each groups based on the change of income of the representative household of the CGE model. In this group, we can mention the applications by de Janvry et *al.* (1991), Chia et *al.* (1994), Decaluwé et *al.* (1999a) and Montaud (2003). With this approach, the within-group redistribution of income is not taken into account and can lead to misleading conclusions as demonstrated in Savard (2005). The second approach, CGE - IMH, was first proposed by Decaluwé et *al.* (1999b)[6]. This approach is theoretically sound since the macro and micro components are coherent and fully respect the standard CGE framework. CGE-IMH consists of including a large number or all of households from household survey into a CGE model. However, it can raise some difficulties at implementations and resolution stage. First, according to Rutherford et *al.* (2005) data reconciliation can be very problematic; the numerical resolution can also be challenging (Chen and Ravallion (2004)).

The third approach is referred to as the CGE micro-simulation sequential method (MSS) which could be subdivided in different variants. The first variant is the macro-accounting formally presented by in Chen and Ravallion (2004) and extensively applied in recent years. The second variant proposed by Bourguignon, et *al.* (2005) consists of integrating rich micro behavior at the household level such as labor supply at the individual level, consumption behavior etc. The

[6] Some authors refer to this approach as a CGE micro-simulation application.

general idea of the MSS approach is that a CGE module feeds market price changes into a micro-simulation household model. The main drawback of this approach is that the micro-feedback effect is not fully taken into account. This critique of the MMS approach has been raised in two literature review of macro-micro modeling for poverty analysis (Hertel and Reimer (2004) as well as Bourguignon and Spadaro (2005)).

In this paper, we have selected the CGE-IMH as we were able to resolve the problems raised by Rutherford et *al.* (2005) and Chen and Ravallion (2004). We used the database and model constructed by Boccanfuso et *al.* (2005) and modified to allow integration of stylized facts necessary for the impact analysis of the water utilities. Before describing the model in detail, it is important to highlight the key transmission mechanisms between economic policy and household welfare. Economic policies or external shocks are transmitted onto household incomes through such transmission mechanisms as variations in the prices of goods and services affecting the cost of consumer baskets and more significantly changes in factor payments[7]. In order to capture the impact of policies on the individual households welfare, it is important on the one hand to integrate specificities of the question at hand, i.e. the water utility sector and on the other hand to introduce as much as possible specificities of the Senegalese economy. We will describe some of the adaptations made to the model used in Boccanfuso et *al.* (2005) model in which they modeled reforms of the groundnut sector in Senegal. The first change necessary was to isolate water production and disaggregate into water produced by the utility company and the water produced by informal suppliers.

The Boccanfuso et *al.* (2005) model is an extension of the Decaluwé et *al.* (2001) EXTER model. Here are the main hypotheses of our model. Production is determined in the first place

[7] McCullouch, et *al.* (2002) provide an interesting discussion on transmission mechanism between liberalization and poverty.

through a 3-level system: total production of the branch (*XS*) is made up of fixed share between value-added (*VA*) and intermediate consumptions (*CI*). *VA* is a combination of composite labor (*LD*) and capital (*KD*) related with a Cobb-Douglas function. Producers minimize their cost of producing VA subject to the Cobb-Douglas function. Optimal labor demand equations are derived from this process. Labor is then decomposed in qualified labor and unqualified labor, and the choice of combinations of these two factors is determined by a constant elasticity of substitution (CES) function. This assumption allows for sector specific elasticity of substitution. We have assumed that capital is not mobile between sectors as it is quit difficult in the short to medium term to convert capital to be used in another production sector. Intermediate consumptions with the Leontief (fixed share) assumption as is commonly done in CGE modeling.

In terms of specificities of the two water sectors, we have assumed that the water utility is subject to price control (exogenous to the model) and therefore they will produce their goods based on the constraint of a production function and the quantity of water supplied will respond to the demand[8]. The output of the sector is therefore demand driven given the price fixed on the market. Since capital is fixed these sectors will need to hire out labor and increase intermediate consumptions to respond to an increase in demand or lay off workers and reduce intermediate consumptions when faced with decreases in demand. We have assumed that production sectors will consume utility water and household will consume one or the other based on information found in the household survey. We have assumed that all water consumed with the categories private tap and public & neighbor tap are supplied by the utility company. Water purchased from the third group (of our Table 1 and Table 2) are supplied by private informal water producers.

[8] We make the implicit assumption that the water network will not be expanded endogenously and therefore the increase in demand originates for the consumers and industries already supplied by SDE"

The private water producers are an important consumer of water produced by the utility company but they have the possibility to substitute the two sources of water as their input into producing water.

We assume that Senegal is a small open economy which implies that world prices of imports and exports are exogenous with infinite demand for exports by the rest of the world. We posit the Armington (1969) hypothesis for import demand where domestic consumers can substitute domestically produced goods with imports (imperfectly) with a sector specific elasticity of substitution. The relative price of the two goods is the other determinant of the ratio of imported goods versus local goods demand. On the export side, the producers can sell the goods on the local market or export their production and are influenced by relative prices on each market and by their elasticity of transformation of the good for one or the other market.

On the household side, we include in the model all 3,278 households of the Senegalese Households Survey (ESAM-I, 94-95) to capture intra group changes in the distribution of income. We do not need to specify any household groups in the model as we use a large number of households. With this approach, we circumvent one of the criticisms formulated by de Maio et *al.* (1999) on household disaggregation in CGE modeling. Our household income equations are consistent with the structure observed in the ESAM. Initial factor endowments (labor and capital) as well as the endogenous transfers between agents are also very important determinants on welfare changes at the household level following policy simulations. In this model, factor allocations are exogenous and factor payments are endogenous. As capital is fixed by sector, we have eighteen capital payments and two wages (qualified and unqualified). Dividends paid to households are also endogenous and depend of firm's income after taxes. Inter-agent transfers are considered endogenous. The households that are heavily dependent on these transfers turn

out to be very vulnerable to variations of this variable. The other sources of income are exogenous transfers from the other agents (Government, and the rest of the world). The private firm's income is the residual of capital income not paid to households to which must be added government subsidies and transfers from the rest of the world. We have also isolated the water and other utilities from the aggregate firm. Government revenue is made up of production taxes, import duties, household and private firm income taxes as well as transfers from the rest of the world (foreign aid). The Government spends its budget on producing public services, transfers to households, subsidies to private firms and transfers to the rest of the world.

The demand function for each household is derived from a utility maximization process (Cobb-Douglas utility function) which leads to demand functions with fixed value share for each goods. Households have specific marginal share parameters based on observed data in the household survey. Investment demand is also specified with a fixed value share function. We use the GDP deflator as a price index, and as we have stated earlier herein, world prices (for imports and exports) are exogenous; accordingly the country has no control over world prices. The only specific item in terms of prices as was previously mentioned is that fact that prices of utilities are exogenous to reflect the observed stylized facts.

Model equilibrium conditions are also standard for non utility markets. The commodity market is balanced by an adjustment of the market price of each commodity. The labor market is perfectly segmented into qualified and unqualified and each market balances out with an adjustment of its specific nominal wage. It is therefore possible for workers to go from one branch to the other but not from one market to another. One should also note that labor supply on each market is exogenous and that there is no endogenous unemployment[9]. The current account balance is fixed

(9) This does not mean that we assume that there is zero unemployment in the Senegalese economy but simply that unemployment is exogenous to the model.

as well as the nominal exchange rate and hence the price index varies to allow the real exchange rate to clear the current account balance. The nominal exchange rate plays the role of the numéraire. For savings/investment equilibrium, total investment is determined by to the sum of the agents' saving[10].

We selected two commonly used indices in the context of macro-micro modeling to analyze poverty and inequality changes. The Foster, Greer and Thorbecke (F-G-T, 1984) and Gini indices are applied. We use the change in households' welfare measure by the equivalent variation to measure the impact of the policy on each household. The approach has the advantage of taking into account the price and income effect simultaneously. For purpose of poverty and inequality analysis, we aggregate households into sub-groups with two decomposition criteria. The first one based on regional and educational criteria and the second based on the source of water supply of the households.

Impact analysis of price reform and compensation programs

In this paper, we focus on the poverty and social impact analysis of the cost recovery strategy of the privatized water utility company in Senegal (i.e. SDE). We will analyze two sets of scenarios where the company will increase tariffs at two levels and analyze sub-scenarios where poor households are compensated for price increases. In the first set of scenarios, we increase revenues with an aim to recover operating cost (OPEX) of SDE and in the second set of simulations, the objective is to recuperate the operating cost and the capital cost with the new tariff rates. These increases in tariff will in all likelihood have a negative consequence on the welfare of poor households consuming SDE water. To soften this negative impact on the poor,

[10] We have simulated the policies with other macroeconomic closures and the general trends of results are maintained even if we observe some slight changes in results. Complete set of equations, variables and parameters can be supplied upon request to authors.

we will simulate a targeted transfer program to the poor households being affected by the price increase of water. Hence, we have performed seven policy simulations two in the first set (OPEX) and five in the second set (CAPEX). Given the type of modeling exercise our objective is not to find the appropriate price level to cover OPEX and CAPEX costs. Our objective is to look at the impact of two levels of price increases on poverty, inequality changes and on other economic variables. In this context we posit the assumption that an increase of 20% in the price of water will be sufficient for SDE to cover its OPEX cost and SDE would be required to increase its prices by 35% to cover OPEX plus CAPEX cost. We then simulate these two price changes. The second step is to compensate the poor households following these price increases. In the case of the CAPEX plus OPEX funding, we analyze the effects of different modes of funding the compensating transfer program. We investigate four modes of funding of the targeted program; first is an increase in household income tax level, the second an increase in private firms income tax, the third is an increase in import duties and finally, we look at a program were the transfers would be funded by an external donor[11]. We will make a brief description of the macro and sectoral effects before moving to poverty and inequality changes of these policy scenarios.

For the first simulation, we begin by looking at the government revenues. In this case, we note a very slight decrease of -0.23%. When looking at the two other agents in the economy (i.e. firms and aggregate household) we also observe a decrease of 0.33% for both agents.

Table 3: Key macro results from simulation (percentage variation)

Variables	Reference (Level)	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7

[11] We present a summary of the simulations definition in the annexe at Table 13.

Ym	177.62	-0.33	-0.28	-0.42	-0.32	-0.35	-0.32	-0.28
s	1.00	-0.59	-0.79	-1.25	-0.51	-0.52	-0.52	-0.40
sn	0.50	-0.42	-0.46	-0.79	-0.58	-0.59	-0.60	-0.63
yg	59.41	-0.23	-0.20	-0.32	0.41	0.41	0.41	0.41
g	29.54	-0.47	-0.81	-1.48	0.00	0.00	0.00	0.00
ye	106.03	-0.33	-0.29	-0.45	-0.63	-0.62	-0.62	-0.59
it	97.99	0.18	0.24	0.35	0.22	-0.20	-0.24	0.02
GDP	210.56	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00
Y-Sénélec	5.34	-1.28	-1.27	-2.24	-2.27	-2.31	-2.31	-2.50
Y-Water	0.92	84.19	84.31	135.58	138.68	138.73	138.73	134.21
Y-Télécom	2.54	0.40	0.48	0.78	0.49	0.45	0.45	0.11

Source: from authors' computation

The drop in income for household is mainly caused by the decrease in the two wage rates. Moreover, income from dividends also decreases as they are proportional to the firms' income. This firms' income decrease is essentially caused by the reduction in most rental rate of capital for non utility sectors (nine out of sixteen non utility sectors[12]). This component of the household income also produces a downward pressure on its income at the aggregate level. At the micro level the impact on households will depend on their endowment of capital but we note that agriculture, fishing and services decrease and they are the most important source of capital income for households.

At the sectoral level, as expected we observe strong capital return increases in the water producing sector. Outside utilities, we note the strongest increases for the rental rate of capital in the edible oil sector and the construction sector. The strongest decrease is found in the *other industries* sector -0.94%. On the other hand, the increase in price of water produces a strong decrease in the demand for that good when there is some flexibility in the demand.

Table 4: Variation of rental rate of capital

Variables	**Branches**	**Base**	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**	**Sim 5**	**Sim 6**	**Sim 7**
***r* (rental rate of**	**Agriculture**	1	-0.24	-0.22	-0.31	-0.43	-0.22	-0.20	-0.16
	Forestry	1	0.12	0.14	0.21	0.19	-0.21	-0.25	0.06

[12] Cf. Table 4.

Variables	Branches	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
capital)	Livestock	1	0.00	0.08	0.13	-0.16	-0.28	-0.30	-0.12
	Fish industries	1	-0.09	-0.15	-0.25	0.00	-0.23	-0.26	-0.16
	Edible oil industries	1	0.49	0.49	0.80	0.78	0.75	0.75	0.29
	Other food industries	1	-0.20	-0.19	-0.31	-0.37	-0.37	-0.37	-0.47
	Mining	1	0.03	0.04	0.05	0.00	-0.09	-0.10	-0.28
	Other industries	1	-0.90	-0.94	-1.66	-1.46	-1.48	-1.48	-1.58
	Refineries and energy	1	-0.78	-0.76	-1.19	-1.32	-0.90	-0.86	-1.24
	Construction	1	0.27	0.35	0.50	0.31	-0.45	-0.53	-0.44
	Tourism	1	-0.56	-0.59	-1.04	-0.91	-1.11	-1.13	-1.13
	Telecom	1	0.40	0.48	0.78	0.49	0.45	0.45	0.11
	Water-Utilities	1	84.19	84.31	135.58	138.68	138.73	138.73	134.21
	Water-Informal	1	0.00	0.00	0.00	0.00	-0.02	0.00	0.00
	Transport	1	-0.22	-0.20	-0.34	-0.42	-0.34	-0.33	-0.42
	Electricity	1	-1.28	-1.27	-2.24	-2.27	-2.31	-2.31	-2.50
	Commercial services	1	-0.10	0.03	-0.02	-0.46	-0.64	-0.66	-0.65
	Other services	1	-0.78	-0.77	-1.29	-1.31	-1.04	-1.01	-1.12

Source: from authors' computation

When the demand is determined by a Leontief function (production sectors) the increase in price will produce an increase in production cost. This in turn will lead to an increase in the market price of goods using water relatively intensively in their production process and creating a relative disadvantage versus other branches in the economy.

Table 5: Variation for value added or output by sector

Variables	Branches	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
Va **(value added)**	Agriculture	23.06	0.06	0.10	0.17	0.03	0.07	0.08	0.07
	Forestry	1.71	0.18	0.21	0.34	0.24	0.12	0.10	0.20
	Livestock	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Fish industries	4.98	0.28	0.31	0.51	0.38	0.23	0.21	0.25
	Edible oil industries	0.95	0.58	0.63	1.04	0.82	0.81	0.80	0.52
	Other food industries	14.29	0.08	0.11	0.17	0.05	0.06	0.06	0.02
	Mining	3.19	0.04	0.04	0.07	0.04	0.04	0.03	0.02
	Other industries	14.94	-0.11	-0.08	-0.17	-0.23	-0.23	-0.23	-0.27
	Refineries and energy	0.83	-0.17	-0.10	-0.14	-0.41	-0.18	-0.16	-0.37
	Construction	9.12	0.12	0.15	0.24	0.15	0.02	0.01	0.02
	Tourism	2.07	-0.04	0.00	-0.03	-0.17	-0.26	-0.27	-0.28
	Telecom	7.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water-Utilities	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water-Informal	0.08	0.21	0.28	0.35	0.19	0.19	0.20	0.28
	Transport	10.65	0.06	0.09	0.14	0.04	0.07	0.07	0.05
	Electricity	2.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Variables	Branches	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
	Commercial services	30.24	0.04	0.07	0.11	0.01	-0.01	-0.01	-0.02
	Other services	46.20	-0.05	-0.03	-0.05	-0.11	-0.07	-0.06	-0.08
	Public services	22.08	-0.23	-0.47	-0.96	0.13	0.11	0.10	-0.03

Source: from authors' computation

It is now interesting to highlight how this policy impacts on other productive sectors of the economy. The first sectoral effect expected is the increase in informal sector water production which is the result of the substitution in the demand based on the change in relative price of the two goods. This generates a reduction of 9% in supply of the SDE water[13]. The informal water output increases by 0.21%. It is interesting to note here that if the quality if the informal water is not well controlled. It is quit probable that this would lead to an increase in disease in the population although we do not model this, it is a probable outcome. The other sectors benefiting the most are the *edible oil industries* (+0.58%), *fish industries* (+0.28%) and *forestry* (+0.18%). The *public services*, and *refineries & energy* sectors are the ones decreasing the most their output with decreases of 0.23% and 0.17% respectively.

Finally, let us look at market price changes (Table 6). As we have already mentioned, price of water increases exogenously by 20%. This will have a direct negative impact on households consumption basket cost. The only other sectors that experience an endogenous increase in price are the *construction* sector with a slight increase of 0.03% and the *tourism* sector (+0.001%). The strongest decreases are found in the *other services* sector (-0.57%) and the *refineries & energy* with a decrease of 0.28%.

[13] This reduction in supply is not found in Table 5 as the factors are fixed for this sector the adjustment is made through a reduction in intermediate inputs and the reduction in supply is taken directly from the total output of the SDE water sector. Since other sectors have the Leontief assumption between value added and intermediate consumption, the change in the value added is equivalent to the change in output of the sectors. Hence we present the value added changes and not the total output changes.

The second simulation consists of providing a transfer to poor households consuming SDE water equivalent to the exogenous price increase times their water consumption. The differences with the previous simulation are relatively small but we note that the decreases of wages are stronger, but the aggregate household income decreases less. The same is true for other agents who seem to loose less in this scenario. The main change comes from the government expenditure which decreases almost twice as much compared with the previous simulation. This comes from the fact that the transfers to households are funded with a decrease in government expenditure. The reduction in public services is also responsible for the stronger decrease in wages as laid off civil servants need to be absorbed by the other sectors. These decreases in wages are likely to cause a negative effect on the households' welfare which will be analyzed in the next section. The effect on market prices and production by sector are not much different from the previous simulation and therefore we won't analyze in detail these effects but results are found in Table 1 to 4.

We now move on to the next set of simulations (i.e. the CAPEX and OPEX recuperation). We analyze the first simulation of this set (i.e. simulation 3) in which a 35% price increase for SDE water is applied. This price increase in combined with the targeted transfers to poor households as in the previous simulation. First, we don't observe changes in the signs of variations but as expected, the amplitude of the effects are stronger. These observations are true for macro and sectoral variables. As these are the only changes, we are likely to observe some increases in the amplitude of the effects of the poverty and income distribution analysis which will be analyzed in the next section. Given this, we do not go into more a detailed analysis of this simulation.

Table 6: Variation for market prices

Variables	branches	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
pq **(Market prices)**	**Agriculture**	1.031	-0.16	-0.15	-0.23	-0.28	-0.23	-0.23	-0.18
	Forestry	1.068	-0.11	-0.10	-0.18	-0.22	-0.33	-0.34	-0.07
	Livestock	1.001	-0.01	0.06	0.10	-0.15	-0.25	-0.26	-0.12

Variables	branches	Base	Sim 1	Sim 2	Sim 3	Sim 4	Sim 5	Sim 6	Sim 7
	Fish industries	1.004	-0.22	-0.21	-0.36	-0.37	-0.44	-0.45	-0.33
	Edible oil industries	1.179	-0.24	-0.24	-0.39	-0.38	-0.32	-0.32	-0.23
	Other food industries	1.096	-0.12	-0.11	-0.17	-0.22	-0.24	-0.24	-0.14
	Mining	1.010	-0.02	-0.02	-0.03	-0.05	-0.07	-0.07	-0.04
	Other industries	1.171	-0.07	-0.07	-0.12	-0.10	-0.11	-0.11	0.44
	Refineries and energy	1.041	-0.28	-0.29	-0.47	-0.42	-0.34	-0.33	-0.08
	Construction	1.014	0.03	0.06	0.07	0.02	-0.26	-0.29	-0.02
	Tourism	1.014	0.001	0.00	0.02	0.03	0.00	0.00	0.17
	Telecom	1.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Water-Utilities	1.023	20.00	20.00	35.00	35.00	35.00	35.00	35.00
	Water-Informal	1.000	-0.42	-0.43	-28.67	-0.65	-0.51	-0.51	-29.24
	Transport	1.024	-0.22	-0.21	-0.36	-0.37	-0.32	-0.32	-0.18
	Electricity	1.022	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Commercial services	1.020	-0.11	-0.05	-0.11	-0.31	-0.39	-0.39	-0.35
	Other services	1.006	-0.57	-0.57	-0.94	-0.91	-0.69	-0.67	-0.70
	Public services	1.000	-0.24	-0.34	-0.52	-0.13	-0.11	-0.10	0.03

Source: from authors' computation

For the final four simulations we will analyze their impact simultaneously as they all seek to explore the best option to generate the income necessary to finance the transfers to poor households while maintaining the government expenditure constant. The first comment we can make is with respect to the fact that very little differences are observed at the macro and even at the sectoral level between these simulations. This comes from the fact that the size of the transfers to poor households consuming water from SDE is relatively small. Hence, the increase in different taxes and transfers necessary to fund the program generate limited general equilibrium effects. The funding through the foreign aid is the one presenting the strongest differences with other simulations.

If we make a general comparison of the four simulations versus the third one where the program is funded with a reduction in the government expenditure, we note that household aggregate income decreases more in three case compared to simulation 3, the informal wage decreases by less then half and the formal wage decreases less (between 0.16% and 0.21%). The gap between the two wages is smaller for the last four simulations (from 0.07% to 0.23%) compared to a gap

of 0.46% for simulation 3. We also note that the government income increase by 0.41% in the four simulations. This is the implicit cost of the transfers program which is indeed quit small. The firms' income decreases more in all the four simulations compared to simulation 3 and hence the simulations are negatively biased toward firms compared to households and government.

At the sectoral level, we concentrate on prices and rental rate of capital as these are the key transmission variables between the policies and household welfare changes. For market prices, we note that the quantitative changes are quit limited; however we observe some qualitative changes for three sectors. The sectors concerned are *livestock* (positive for simulation 3 becoming negative for the four funding simulations and *public services* price is positive for the last simulation. In general, the price effects are weaker for the last simulation (simulation 7) and almost the same for the others three simulations (4, 5 and 6). In the case of rental rate of capital, we have stronger differences and we have qualitative changes in four sectors namely the *forestry*, *livestock*, *mining* and *construction* sectors. On average the quantitative effects are weaker for the four funding scenarios then the third simulation.

Poverty analysis and income distribution

According to Cissé (2003), poverty has expended significantly from the early eighties to the mid-nineties. But poverty seems to be declining since then. Based on ESAM-I (94-95) data where the headcount ratio of 58% for households and 65% for individuals it dropped to around 51% for households and 59% for households from ESAM-II (2000-01). One of the major characteristic of this poverty is that it is heavily biased toward rural household where more the 80% of the poor households are located. Historically, investment favoured cities and in a few rural cities that exhibit a lower poverty headcount ratio today (Cissé, 2003). In later years, policies favoured

wage earners over agricultural workers (in the seventies). Finally, the exchange rate policies and protection of industries in the eighties produced an overvalued CFA franc favouring again the urban dwellers. Devaluation of the CFA franc in early January 1994 have corrected part of this bias and has allowed the economy some breathing room to grow, and generated the significant decreases in poverty level since then.

We now move to the poverty and inequality analysis performed after implementing the different policy scenario. We perform this analysis at the national level and with two types of household classification. For the first decomposition, we used two criteria. First, we decompose the households based on the level of education of the head of the household (educated and non-educated) and a second, we decompose based on regional criteria (three regions: Dakar, other urban and rural). In the second classification, we group households based on being supplied or not by SDE water. The definition and relative importance of the groups are presented in Table 7

Table 7: Decomposition of groups and some statistics

Decomposition	Code	Definition	%
Regional /educational	DKRE	Dakar-educated	16,12
	DKRNE	Dakar-non-educated	17,27
	AUE	other urban educated	9,11
	AUNE	other urban non educated	17,33
	RE	Rural educated	3,61
	RNE	Rural non educated	36,56
Water supply	NSW	Not supplied by SDE	47,23
	SW	Supplied by SDE	52,77

Sources: ESAM I and II.

We first look at the changes in poverty indices at the national level before moving to the decomposition analysis. For the first simulation, we have an increase in the aggregate household income and we observe an increase in poverty rate by 0.31% as seen in Table 8[14]. The trend is

[14] It is important to highlight that the poverty changes at the national level was computed with the entire set of households included in the model.

confirmed when looking at poverty depth and severity although the effect is smaller in these two indices.

The second simulation consist a giving a cash transfer to poor households consuming SDE water. Even if this number is relatively small the transfer produces a positive effect at the national level with a reduction of the headcount index of 0.19% but this is even more positive for the depth and severity index as they decrease respectively by 0.54% and 0.64%. This shows that the households negatively affected in the first simulation were the poor households consuming SDE water.

Table 8: Variation of poverty indices at the national level

National								
	Base	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**	**Sim 5**	**Sim 6**	**Sim 7**
FGT 0	0.58	0.31	-0.19	-0.51	-0.35	-0.43	-0.43	-0.43
FGT 1	0.27	0.21	-0.54	-0.92	-0.90	-0.93	-0.95	-0.95
FGT 2	0.15	0.30	-0.64	-1.09	-0.98	-1.06	-1.10	-1.10

Source: from authors' computation

In the case of simulation 3 (same simulation 2 with a stronger price increase), it produces similar but stronger positive effect. It is quit surprising that the four other simulations produce very similar effect at the national level for the depth and severity poverty indices. For the headcount ratio, the four simulations are not as positive of the simulation 3. It is interesting to see if our findings will be modified when performing decomposition poverty analysis. Before presenting the decomposition results, we can highlight that most groups are relatively small. When using empirical distribution to compute poverty headcount index for small groups we often obtain weak or no effects. This comes from the fact that few households can be observed around the poverty line. For example, the smallest group (rural educated) is unaffected in all simulations when using the poverty headcount index. As seen in Table 7, this group represents less then 4% of the sample. In this context the poverty depth and severity indices are much more informative.

The first simulation shows an increase in poverty for three groups namely the other urban non educated (AUNE), the other urban educated (AUE) and the rural non educated (RNE). It is quit surprising that the poverty level increases more for households not supplied by the SDE (NSW) albeit not much stronger (0.33% versus 0.28%). This tells us that the general equilibrium effects on prices and wages play a more important role in determining the final effects on households of this policy then the increase in price of water.

Table 9: Variation of poverty incidence by regional/educational decomposition

FGT $_0$: Poverty incidence								
Code Group	**Base**	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**	**Sim 5**	**Sim 6**	**Sim 7**
DKE	23.18	0.00	-0.85	-1.44	-1.44	-1.44	-1.44	-1.44
DKNE	43.34	0.00	-0.51	-0.19	0.63	0.63	0.63	0.63
AUE	28.38	0.88	-3.01	-3.01	-3.01	-3.01	-3.01	-3.01
AUNE	51.02	1.46	-0.02	-0.70	-0.70	-0.70	-0.70	-0.70
RE	54.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RNE	73.25	0.22	-0.03	-0.40	-0.29	-0.40	-0.40	-0.40
NSW	72.59	0.33	0.33	0.44	0.56	0.56	0.56	0.56
SW	41.66	0.28	-1.19	-2.33	-2.10	-2.33	-2.33	-2.33

Source: from authors' computation

However, when looking at the depth and severity changes in Table 10 and Table 11, we have effects more conform to our expectations where households supplied by SDE experience stronger poverty increases (i.e. 0.31% versus 0.16% for depth and 0.50% and 0.22% for severity).

Table 10: Variation of poverty depth by regional/educational decomposition

FGT $_1$: Poverty depth								
Code Group	**Base**	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**	**Sim 5**	**Sim 6**	**Sim 7**
DKE	0.22	0.17	-0.77	-1.37	-1.68	-1.73	-1.75	-1.74
DKNE	0.21	0.40	-1.28	-2.20	-2.58	-2.22	-2.26	-2.24
AUE	0.11	0.49	-1.47	-2.50	-2.35	-2.48	-2.55	-2.54
AUNE	0.20	0.46	-1.52	-2.62	-2.44	-2.51	-2.57	-2.56
RE	0.26	0.18	-0.17	-0.31	-0.19	-0.30	-0.32	-0.33
RNE	0.33	0.16	-0.27	-0.47	-0.38	-0.44	-0.46	-0.46
NSW	0.34	0.16	0.15	0.24	0.33	0.26	0.24	0.23
SW	0.20	0.31	-1.78	-3.05	-3.16	-3.09	-3.14	-3.13

Source: from authors' computation

Similar conclusions can be drawn from FGT_2 with the regional decomposition where the Dakar educated (DKE), Dakar non educated (DKNE), other urban educated (AUE) suffer the most as they are the biggest consumers of water supplied by SDE.

For the second simulation, we obtain an interesting reduction in poverty for the Dakar educated (DKE) and non educated (DKNE) and the other urban educated (AUE) where improvements go from -0.51% to -3.01% (Table 9). It is quit interesting but not surprising to note that the transfer program has a positive effect on the SDE water consumers and a negative effect on the non SDE consumers. In fact the transfer program has no impact on the non water consumers versus the first simulation. The tendency is similar for the two other indices where urban households benefit the most and rural households are only very slightly affected by a positive effect. As for simulation 3, it produces the same trends as the second simulation with effects generally stronger.

Table 11: Variation of poverty severity by regional/educational decomposition

FGT $_2$: Poverty severity								
Code Group	**Base**	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**	**Sim 5**	**Sim 6**	**Sim 7**
DKE	**0.06**	**0.78**	**-2.10**	**-3.58**	**-3.53**	**-3.81**	**-3.85**	**-3.81**
DKNE	**0.11**	**0.62**	**-2.34**	**-3.99**	**-3.88**	**-4.00**	**-4.07**	**-4.04**
AUE	**0.06**	**0.68**	**-1.30**	**-2.17**	**-1.97**	**-2.15**	**-2.25**	**-2.23**
AUNE	**0.13**	**0.50**	**-1.84**	**-3.10**	**-2.96**	**-3.01**	**-3.08**	**-3.07**
RE	**0.19**	**0.25**	**-0.02**	**-0.03**	**0.10**	**0.00**	**-0.03**	**-0.04**
RNE	**0.22**	**0.21**	**-0.30**	**-0.51**	**-0.41**	**-0.48**	**-0.51**	**-0.51**
NSW	**0.22**	**0.22**	**0.20**	**0.32**	**0.43**	**0.35**	**0.32**	**0.31**
SW	**0.09**	**0.50**	**-2.86**	**-4.84**	**-4.73**	**-4.81**	**-4.87**	**-4.86**

Source: from authors' computation

We can now investigate the impact of the different funding programs. The poverty headcount remains unchanged for four of the six groups. The only ones affected when using this index are the Dakar non educated (DKNE) and the rural non educated (RNE). For the DKNE group, we

have an increase in poverty rate instead of the decrease observed for simulation 3 and for the RNE group, the decrease in poverty is smaller when using the income tax to fund the transfer program (simulation 4). For the decomposition based on source of water supply, we have a stronger increase in poverty for the four cases for the NSW group and the poverty rate does not decrease as much when using the household income tax for the households supplied by SDE (SW).

When comparing the funding schemes with the third simulation, we note that the depth and severity indices are more sensitive since we have changes in indices for all sub-groups. The funding schemes most favorable to most groups are the increase in import duties and the foreign aid. Only two groups do not benefit from an improvement of the FGT_1 (i.e. the AUNE and RNE). On the other hand only one group does not gain for the FGT_2 namely the AUNE. Funding the transfers program through the household income tax only improves the situation for the two groups in Dakar (DKE and DKNE) and all groups have a weaker poverty decrease when using the poverty severity index. If we would have assumed that *public services* generate production externalities or provide utility to households we would have had different results since the third simulation generate a 1.48% decrease in public services. This reduction in public services produces little impact in the economy other then the downward pressure on wages[15].

When looking at the water supply source decomposition, we have an improvement for the households supplied by SDE for all four funding alternatives (albeit small improvements) for the poverty severity index. For the poverty depth index, it improves only for the import duties and foreign aid scenarios. With the poverty severity index the NSW group faces the weakest increase

[15] See Savard and Adjovi (1998) for an explicit modeling of public expenditure externalities namely in the primary education and primary health sectors.

in poverty with the foreign aid case (simulation 7) and the household income tax (simulation 4) is the most damaging for this group when using the depth and severity indices.

To analyze changes in income distribution we use the Gini index. Results of variation of the index for Senegal and for subgroups of the population are presented in Table 12. The first observation concerning the inequality changes is that the effects are relatively small. No changes above 1.5% are observed for all groups and in any simulation. The second general observation is that all policies simulated reduce inequalities at the national level and for the sub-groups analyzed with the exception of the first simulation which slightly increase inequalities for two groups (Dakar educated and non educated).

Table 12: Variation of Gini index

S-Gini indice									
Group #	**Définition**	**Base**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	National	**0.51**	**-0.04**	**-0.33**	**-0.54**	**-0.64**	**-0.49**	**-0.49**	**-0.48**
Region	**Inter-group**	**0.40**	**-0.07**	**-0.38**	**-0.63**	**-0.72**	**-0.54**	**-0.54**	**-0.53**
	Intra-group	**0.10**	**0.06**	**-0.13**	**-0.22**	**-0.31**	**-0.27**	**-0.28**	**-0.29**
Région	**DKE**	**0.54**	**0.03**	**-0.26**	**-0.45**	**-0.59**	**-0.49**	**-0.50**	**-0.50**
	DKNE	**0.47**	**0.04**	**-0.57**	**-0.97**	**-1.26**	**-0.96**	**-0.96**	**-0.95**
	AUE	**0.42**	**0.00**	**-0.41**	**-0.69**	**-0.74**	**-0.59**	**-0.61**	**-0.59**
	AUNE	**0.40**	**-0.02**	**-0.71**	**-1.21**	**-1.39**	**-1.19**	**-1.21**	**-1.21**
	RE	**0.52**	**-0.07**	**-0.20**	**-0.33**	**-0.27**	**-0.19**	**-0.19**	**-0.17**
	RNE	**0.38**	**-0.01**	**-0.12**	**-0.20**	**-0.28**	**-0.20**	**-0.20**	**-0.21**
Water	**Inter-group**	**0.27**	**-0.06**	**-0.22**	**-0.37**	**-0.46**	**-0.31**	**-0.31**	**-0.30**
	Intra-group	**0.23**	**-0.02**	**-0.44**	**-0.75**	**-0.85**	**-0.70**	**-0.70**	**-0.69**
Water	**SE**	**0.41**	**-0.03**	**-0.03**	**-0.06**	**-0.14**	**-0.03**	**-0.03**	**-0.03**
	E	**0.51**	**-0.01**	**-0.65**	**-1.09**	**-1.20**	**-1.03**	**-1.04**	**-1.02**

Source: from authors' computation

The first simulation produces very small distribution effects. It is interesting that the inter-group redistribution contributes to reducing overall inequalities but the intra-group redistribution contribute to increase the overall inequalities. The second simulation generates stronger distributional effects with the strongest effects found for the other AUNE group (-0.71%) and the DKNE group (-0.57%). The weakest effects are with the RNE as they are not much affected

either by price increases and transfers program. This group is consistently the least affected group whatever simulation applied.

Finally, let us compare the third simulation with the four scenarios to fund the transfers program. First we note a reduction of inequalities for the RE in all funding approaches, the household income tax approach (simulation 4) is the one that reduces the inequalities for most groups (5 out of 6). The last three simulations have little effect on the other groups excluding the Dakar educated (DKE). The analysis based on the water supply source produce expected results. We observe very little impact on the household not supplied by SDE (from -0.03% to -0.14%). As for households supplied by SDE we have reductions raging from 0.01% for the first simulation to 1.2% for the fourth simulation (funding of the transfer program through the income tax).

Conclusion

In this paper, first analyse the evolution of the water supply distribution by the privatized water utility and show that the expansion of the network has not benefited to the two lowest quintiles of the population and the biggest gainers are the upper middle class (i.e. the fourth quintile). Then, we have used an integrated multi-household CGE model approach to analyze possible effects of price increase of water associated with the privatisation of water utility in Senegal. This model is an extension of the Boccanfuso et *al.* (2005) model in which we isolated the utilities and introduced stylized facts of the production behaviour of the water sector. When privatizations are analyzed, one often looks at the consumption side of the equation to say that the strong consumers of utilities will be the most negatively affected. However, privatization process does not only involve change in prices of goods but also has some general equilibrium effects on other prices in the economy including factor payments. Water is an important input in the production process of many sectors and price changes can have general equilibrium effects

on this front also. The external trade through competitiveness is also affected by the changes in water prices. The CGE-IMH approach allows capturing all these effects simultaneously. Therefore, the analysis provides very rich information of winners and losers of the privatization process. The main winner of the process is the private sector firms who see their income level increase in all cases analyzed. For the government the situation is mitigated with gains in some cases and slight loses in others. On the other hand the aggregate household is the biggest loser in all cases. We cannot say that tradable or non tradable goods were the winners and losers as we observe winners and losers in the two groups of sectors.

Once this has been said, we have look further into the winners and losers at the household level. At this level we have all groups being negatively affected with the first scenario were poor households are not compensated for price increases. The groups that seems win the least are the rural households. On the other hand, the transfers programs seem favourable for all subgroups in the regional decomposition and the SDE water consumers are favoured versus non SDE supplied households. The items explaining these effects are price effects and income effects which are both captured in this analysis. This paper demonstrates that using IMH-CGE approach can inform on winners and losers at the macro, sectoral and micro level. This type of information is very valuable in designing compensatory programs and improves one's understanding of the impact of a reform.

References

Adelman I and S. Robinson (1977) « Income Distribution Policy in Developing Countries: A Case Study of Korea », Stanford, Stanford University Press.

Armington P. S. (1969) « A Theory of Demand for Products Distinguished by Place of Production », IMF *Staff Paper*, nº 16, p. 159-176.

Bayliss, K. (2001) « Water Privatization in Africa: Lessons from Three Case Studies », University of Greenwich, PSIRU Report nº 2001-05, London.

Boccanfuso, D., F. Cabral and L. Savard (2005) « Une Analyse d'Impacts de la Libéralisation de la Filière Arachide au Sénégal : une Application EGC Multi-ménages », *Perspective Afrique*, Vol. 1, nº 1 p. 32-58.

Bourguignon F, G. Michel and D. Miqueu (1983) « Short-Run Rigidities and Long Run Adjustments in a Computable General Equilibrium Model of Income Distribution and Development », *Journal of Development Economics*, Vol. 13, n° 1-2, p. 21-43.

Bourguignon F., J. de Melo, and A. Suwa, (1991) « Modelling the Effects of Adjustment Programs on Income Distribution », *World Development*, Vol. 19, nº 11, p. 1527-1544.

Bourguignon F., A.S. Robilliard and S. Robinson (2005) « Representative Versus Real Households in the Macroeconomic Modelling of Inequality », in T. J. Kehoe, T.N. Srinivasan and J. Whalley (eds.) « *Frontiers in applied general equilibrium modelling* », Cambridge, Cambridge University Press.

Bourguignon F., and A. Spadaro (2005) « Microsimulation as a Tool for Evaluating Redistribution Policies », Working paper n° 2005-02, Paris-Jourdain sciences économiques, Paris.

Chen S. and M. Ravallion (2004) « Welfare Impacts of China's Accession to the World Trade Organization », *The World Bank Economic Review*, Vol 18, n° 1, p. 29-57.

Chia N.-C., S. Wahba and J. Whalley (1994) « Poverty-Reduction Targeting Programs: A General Equilibrium Approach », *Journal of African Economies*, Vol 3, n° 2, p. 309-338.

Cogneau D. and A.-S. Robillard (2000) « *Income Distribution, Poverty and Growth in Madagascar: Micro Simulations in a General Equilibrium Framework* », IFPRI TMD Discussion Paper No.61, Washington.

Decaluwé B., A. Patry, L. Savard and E. Thorbecke (1999a) « *Poverty Analysis within a General Equilibrium Framework* », Working Paper 99-09, African Economic Research Consortium, Nairobi.

Decaluwé B., J.-C. Dumont and L. Savard (1999b) « *How to Measure Poverty and Inequality in General Equilibrium Framework* », Université Laval CREFA Working Paper #9920 Québec.

Decaluwé B., A. Martens and L. Savard (2001) « *La Politique Economique du Développement et les Modèles d'Equilibre Général Calculable* », Montréal. Presse de l'Université de Montréal.

de Janvry A., E. Sadoulet and A. Fargeix (1991) « *Adjustment and Equity in Ecuador* », OECD Development Center, Paris.

de Maio L., F. Stewart and R. van der Hoeven (1999) « Computable General Equilibrium Models, Adjustment and the Poor in Africa », *World Development*, Vol. 27, n° 3, p. 453-470.

Dervis K., J. de Melo and S. Robinson (1982) « *General Equilibrium Models for Development Policy* », London, Cambridge University Press.

Foster J., J. Greer and E. Thorbecke (1984) « A Class of Decomposable Poverty Measures », *Econometrica*, Vol. 52, n° 3, p. 761-766.

Hertel T. and J. Reimer (2004) « Predicting the Poverty Impacts of Trade Reform », *World Bank Policy Research Working Paper* n° 3444, World Bank, Washington.

Montaud J.M. (2003) « Dotations en Capital et Pauvreté des Ménages au Burkina Faso : une Analyse en Equilibre Général Calculable », *Revue d'Economie du Développement*, n° 1, p. 42-72.

Morrisson C. (1991) « Adjustment Incomes and Poverty in Morocco », *World Development*, Vol. 19, n° 11, p. 1633-1651.

McCulloch, N., A. Winters and X. Cirera (2002) « Trade Liberalization and Poverty: A Handbook », London: Centre for Economic Policy Research and Department for International Development.

Ministère de l'Agriculture et de l'Hydraulique-MAH (2004) « Rapport diagnostic ICEA réforme mars 2004», Ministère de l'Agriculture et de l'Hydraulique, Dakar.

Ministère de l'Economie et des Finances-MEF (2000) « Programme Triennal d'Investissements Publics – PTIP, 2000/02 », Ministère de l'Economie et des Finances, Dakar Sénégal.

Ministère de l'Economie et des Finances-MEF (2001) « Programme Triennal d'Investissements Publics – PTIP, 2001/03 », Ministère de l'Economie et des Finances, Dakar Sénégal.

Ministère de l'Economie et des Finances-MEF (2002) « Programme Triennal d'Investissements Publics – PTIP, 2002/04 », Ministère de l'Economie et des Finances, Dakar Sénégal.

Ministère de l'Economie et des Finances-MEF (2003) « Programme Triennal d'Investissements Publics – PTIP, 2003/05 », Ministère de l'Economie et des Finances, Dakar Sénégal.

Rutherford T., D. Tarr and O. Shepotylo (2005) « Poverty Effects of Russia's WTO Accession: Modeling "Real" Household and Endogenous Productivity Effects », *World Bank Policy Research Working Paper* n° 3473, World Bank, Washington.

Savard, L. (2005), « Poverty and Inequality Analysis within a CGE Framework: a Comparative Analysis of the Representative Agent and Microsimulation Approaches », *Development Policy Review*, Vol. 23, n° 3, p 313-332.

Taylor, L. and F. Lysy (1979) « Vanishing Income Redistributions: Keynesian Clues about Model Surprises in the Short-Run », *Journal of Development Economics*, Vol 6, n° 1, p. 11-29.

Thorbecke, E. (1991) « Adjustment Growth and Income Distribution in Indonesia and Equity in Indonesia », *World Development*, Vol. 19. n° 11. p. 1595-1614.

Appendix

Table 13: Definition of simulations

Set	Simulation code	Definition
First-OPEX	Sim 1	20% Increase in the price of SDE Water
First-OPEX	Sim 2	Sim 1 + transfers program to poor households supplied by SDE
Second-OPEX+CAPEX	Sim 3	35% Increase in the price of SDE Water + transfers program to poor households supplied by SDE
Second-OPEX+CAPEX	Sim 4	Sim 3 + Household Income tax to fund the transfers program
Second-OPEX+CAPEX	Sim 5	Sim 3 + Firms' Income tax to fund the transfers program
Second-OPEX+CAPEX	Sim 6	Sim 3 + Increase in import duties to fund the transfers program
Second-OPEX+CAPEX	Sim 7	Sim 3 + Foreign Aid to fund the transfers program