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WATER PRICE REFORMS IN SENEGAL: DISTRIBUTIONAL IMPACT ANALYSIS

By Dorothée Boccanfuso, Antonio Estache and Luc Savard

ABSTRACT

This paper focuses on the distribution impact from Senegal’s water reforms with emphasis on rates reforms. We first analyze the evolution of consumption patterns before and after the reforms. We found that most of the gains accrue to the highest income classes while the poor have seen little changes. We then use a multi-household integrated Computable General Equilibrium model (CGE) to analyze the impact of water pricing reforms on poverty in Senegal. We conclude that the simulated price increases for the sector have marginal effects on government finances but positive effects on most actors except households unless specific transfer programs are introduced to protect the poor.

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

JEL: D58, D31, I32, L33

1 We are grateful to Francois Joseph Cabral, Ana Goicoechea, Racine Kane, Jacques Morisset and Eustache Ouayoro and Mamar Sylla for useful discussions.
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WATER PRICE REFORMS IN SENEGAL: DISTRIBUTIONAL IMPACT ANALYSIS

By DOROTHÉE BOCCANFUSO, ANTONIO ESTACHE AND LUC SAVARD

I. Introduction

THERE is currently an emotional debate in the policy arena on the pros and cons of the privatization of utilities. Since the 1990s development agencies and international institutions have been promoters of these reforms (Hall et al (2005). In many parts of the developing world, these privatizations designed to improve efficiency and cost recovery have often been associated with large price increases that have created enormous social and political tensions (Birdsall and Nellis (2003), Estache (2005a), Hall et al (2005), Parker and Kirkpatrick (2005)). Many African policymakers are looking into the highly publicised Latin American policy reversals and are starting to question their own privatization efforts. The supporters of privatization affirm that without them, inefficient management, recurring deficits, underinvestment and rent-seeking behaviour will persist. On the other hand, opponents claim that privatization has led to increase in prices and loss of utility assets which cause significant hardship for the poor households in these countries (Birdsall and Nellis 2003). Africa’s experience is however still recent and up to now there has been little robust evidence of its impact on users. Senegal is one of the few African countries with a track record long enough to allow a fair impact assessment because some of its reforms started in the mid 1990s. Moreover, numerous agencies have been promoting Senegal water privatization as a positive experience.

Most of this literature on African utility reform experiences is however not analytical. It has so far focused on reform processes rather than outcomes or on partial impact assessments rather than full impact assessments, in particular with respect to poverty related issues. Senegal is an interesting case study because its utilities reforms are generally viewed as a success story by the international community. The policy changes discussed

1 For an overview of the issues in Latin America, see Estache (2005b)

2 A look at the DFID, GTZ and AFD web site illustrates the popularity of Senegal experience. It is covered by the three agencies as part of its efforts to disseminate best practice in Africa.

3 For a survey of what is known about reforms and their impact in Africa, see Estache (2005a).

4 It was clearly so in water and telecoms, less so in energy because of the exit of the private operator of the sector. This exit has however not resulted in a major failure in the sector and the public Senegalese management has continued to run the sector without major problems.
for the utilities sector since the mid 1990s were relatively consistent with what was then considered best practice among experts. While the changes included many sectors and institutional dimensions, this paper focuses only on pre and post reform distributional effect based on two household survey data and price reforms with a series of policy fine-tuning. This paper is, to our knowledge, the first attempt to investigate the distributional impact of utility price reform associated with privatization analytically for a specific African case study.

Let us briefly review the main elements of water privatization in Senegal. The 1996 reforms aimed to secure the financial situation and the renewal of investments in the sector. One of its main elements was the partial privatization of the sector. The overall goal was to supply all households in Dakar with potable water by 2010. The commitment to these reforms was quite strong and they were included in the poverty reduction strategy paper (PRSP) approved by the board of the International Monetary Fund (IMF) and the World Bank (WB) in 2002 (MAH 2004).

 Société Nationale d’Exploitation des Eaux du Sénégal (SONEES), a public company, was responsible for maintenance and improvement of the water supply in cities and the government was responsible for determining tariff changes twice a year. The financial situation of SONEES continually deteriorated in the seventies through the early nineties. Three main reasons were used to justify privatization: (1) it would improve the financial situation with increased productivity; (2) it would improve efficiency in cost recovery; and (3) it would isolate the utility from government interventions. Sénégalaise 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 (Bayliss (2001)).

The investments planned in that context aimed to increase access to potable water in the urban and rural areas. The production capacity, transportation, water pricing, stocking and distribution of water in urban centers have in fact all increased since the reforms. The price per cubic meter has increased on average by 3.1 percent annually. The previous three-level tariff system was maintained for households with a reduction of the volume considered for the lower tier from 100 to 40 m³/bimester (MEF 2000 and 2003).

The price of water is now comprised of the following elements: the 18% VAT; a specific tax distributed to Fonds National de l’Hydraulique (FNH); the asset price (prix Patrimoine) designed to cover operating costs (OPEX) and investment costs (CAPEX); debt servicing used to finance infrastructure and the investment fund to maintain and expand the network; the

5 SONEES continues to exist as a state holding and its role is essentially to manage the investment on potable infrastructures and also to delegate the renting and granting of permits.
operator price designed to cover the operating costs of the private supplier SDE (OPEX); debt reimbursement and investments; operating material and contractual obligations for renewing the network (MEF 2000 and 2003). The OPEX and CAPEX are thus essential dimensions of the pricing structure as they are in most other countries; hence, they will be central to the simulations to be reported later in the paper.6

Our main objectives is to analyze the distributional and poverty impact of water pricing reforms often associated with privatization of water utilities and perform an ex ante analysis of a targeted transfer program to compensate poor households directly affected by water price increases. In a privatization process other distributional effects could be analyzed. Birdsall and Nellis (2003) provide a relatively complete list of distributional effects of privatization of utilities in developing countries. Among the effects we will capture in our analysis are the price changes of the reform, factor payments and fiscal effects. Two important issues associated with privatization are not dealt with in the paper. These are the investment effects and consequences of reducing consumption of potable water in favour of informal sources of water.7

To analyze the impact of pricing reforms in the water sector in Senegal, we rely on a computable general equilibrium integrated multi-household (CGE-IMH) model.8 As suggested by Parker and Kirkpatrick (2005), privatization of utilities is ideally assessed using CGE models when one’s goal is to verify the impact of relative price changes affecting different markets and socio-economic groups. Macroeconomic assessment is important because utility reforms typically affect other economic markets (for labour, investment, and savings, for example) that can have a significant effect on poverty and on the welfare of the poor.9 Although CGE models have been around for at least 25 years, few scholars have used them to analyze the effects of reforms of public infrastructure services. Chisari et al (1999), Benitez et al (2003) and Boccanfuso et al (2009) are among the few applications. The data have improved since the late 1990s, enabling a growing number of researchers to develop and apply macro–micro type CGE modelling

6 They will be central to the discussion later in the paper because they constitute the parts of the pricing structure most relevant to equivalent water reforms in other countries.

7 For the first issue, we analyze this question along with other utility and public services sectors in another forthcoming paper. The second issue related to loss of welfare associated with moving from potable water to informal water presenting health risk is a complex one to analyze, albeit very interesting. Analyzing this question, would require measuring the monetary value of welfare loss between the two types of water. This would include the intrinsic value households attribute to the water but it would also include loss of welfare associated with increase in disease associated with the consumption of informal water. A field survey would be required to obtain credible and accurate figures for such a study.

8 We will discuss this approach to CGE modeling in a following section.

9 It is important to note that in certain context (depending on objectives of privatization or the objective of the analysis) these models are not necessarily the most appropriate tools. See Parker and Kirkpatrick (2005) for a discussion on this issue. For a more critical review of CGE models see Gunter et al (2005) and Sadoulet and de Janvry (1995) for strengths and weaknesses of CGE models.
in developed and developing economies alike for poverty analysis in this context.10

As we will see later in our tables, public water consumption is relatively small at the aggregate level and water is a minor intermediate input in the production process of most other sectors of the economy. This could lead one to use partial equilibrium analysis for the distributional impact analysis. However, as is shown in Boccanfuso et al (2009), general equilibrium effects can dominate the direct price effect captured by a partial equilibrium analysis and in turn generate misleading results. In order to provide a complete and rigorous answer to the pros and cons of water pricing reforms and compensating policies on income distribution and poverty, a CGE approach is well justified as stated by Parker and Kirkpatrick (2005) and this even if the result are relatively small.11 The final point we can make is that the simulated prices increases are not insignificant. Hence, even with water being a minor consumption and intermediate consumption good, the price effect will likely produce general equilibrium effects and interesting distributional effects.

In this paper, we focus on two types of decomposition of the distributional impact analysis.12 The first is the effect across households consuming water supplied by the water utility company and the ones consuming water from informal suppliers. The second decomposition is a regional decomposition: Dakar, other urban centers and rural areas.

The paper is organized as follows. Section 2 provides a basic analysis comparing the evolution of water supply before and after the reforms to draw some initial intuitive conclusions on the impact on households of the reforms in the water sector. To do so, we rely on a simple comparative analysis of two survey periods using the Senegalese household survey (Enquête Sénégalaise Auprès de Ménages-ESAM-I (94-95) and ESAM-II (00-01)). Section 3 presents the specific CGE-IMH model used for the distributional impact analysis. Section 4 provides a description of simulations performed and a brief analysis of the macro and sectoral results of the CGE model. Section 5 studies the income distribution effects of the most likely financing options. Section 6 concludes.

10 For a review of CGE models for poverty analysis, the reader can consult Hertel and Reimer (2005) and Bourguignon and Spadaro (2006).

11 It is important to note that to provide a complete picture of the privatization of the water sector; other elements would need to be analyzed to present a complete poverty impact analysis of the water sector privatization process but this goes beyond the scope of the paper.

12 We actually started this research by also trying to compare the effects of reforms across economic agents (households vs. firms vs. government) and across sectors but the water specific reforms have a very modest impact at that level. The fact that sector specific reforms have such a modest macroeconomic effect is clearly an interesting result in itself but does not raise many interesting policy issues which is why we do not report the detailed results here. They are however available from the authors.
II. Basic Statistical Analysis of the Reform Effects

Before discussing the findings of the CGE-IMH model, it seems useful to get an intuitive reading of the distributional effects of the privatization process from a very basic data analysis.

The three types of provider are formal private vs. public and neighborhood taps vs. other sources—informal. To provide a sense of these dimensions, the table decomposes the households based on regional groupings (Dakar, Other urban and Rural) and by income quintiles. The most obvious observation emerging from the table may be the regional differences in the changes associated with the reforms.

Table 1 presents the characteristics of the water sector market structure at the household level. It shows the evolution of the source of water supply between the two ESAM surveys.

The three types of provider are formal private vs. public and neighborhood taps vs. other sources—informal. To provide a sense of these dimensions, the table decomposes the households based on regional groupings (Dakar, Other urban and Rural) and by income quintiles. The most obvious observation emerging from the table may be the regional differences in the changes associated with the reforms.

The story is indeed very different between rural and urban areas and between the quintile of urban areas. The evolution is also different between Dakar and other urban centers. In rural areas, the share of the two sources of supply originating from SDE has increased for all income groups except the fourth quintile for private provision (-0.2%). Overall, the other sources of supply continue to prevail across rural income groups.

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13 In the first two categories, the water is supplied by SDE. In the case of private taps, it concerns households with a link to the SDE water network. In the case of communal or public taps, it is linked to the SDE network and a person is designated to sell the water from this tap at a price higher than the one charged by SDE. The margin charged for the public and communal taps can be quit high. For a more detailed description of the water market and prices see Diagne, Briand and Cabral (2004). In private taps, we aggregate households which have specified being supplied by house taps and concession taps in the ESAM surveys. In public tap, we included neighbour and public taps. In “other sources”; we include water vendor, cistern truck, concession well, village well, surface water, and other sources.
Table 1

Decomposition of the Type of Water Supply for the Two ESAM

<table>
<thead>
<tr>
<th>Quintile 1</th>
<th>Quintile 2</th>
<th>Quintile 3</th>
<th>Quintile 4</th>
<th>Quintile 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>0.8%</td>
<td>4.6%</td>
<td>1.9%</td>
<td>4.5%</td>
</tr>
<tr>
<td>Public &amp; neighbor</td>
<td>16.8%</td>
<td>18.6%</td>
<td>21.9%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Other sources</td>
<td>82.4%</td>
<td>76.8%</td>
<td>77.1%</td>
<td>70.8%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Other urban</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>26.6%</td>
<td>26.5%</td>
<td>30.6%</td>
<td>42.3%</td>
</tr>
<tr>
<td>Public &amp; neighbor</td>
<td>42.8%</td>
<td>38.4%</td>
<td>47.4%</td>
<td>25.9%</td>
</tr>
<tr>
<td>Other sources</td>
<td>30.6%</td>
<td>29.8%</td>
<td>22.0%</td>
<td>31.8%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Dakar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>41.0%</td>
<td>53.1%</td>
<td>50.7%</td>
<td>66.9%</td>
</tr>
<tr>
<td>Public &amp; neighbor</td>
<td>47.9%</td>
<td>35.6%</td>
<td>40.2%</td>
<td>29.1%</td>
</tr>
<tr>
<td>Other sources</td>
<td>10.0%</td>
<td>11.3%</td>
<td>9.1%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Sources: ESAM I and II

In Dakar, the main observation may be the increase in the share of informal provision (other sources) for the poorest and the declining trend of the informal across all other income groups. The share of private tap provision has increased for all groups with the strongest increase for the second quintile. The two richest groups have relatively small increase but this outcome was expected given the high coverage rate in 1995. In other urban centers, the story is somewhat similar except on the relative importance of the increase of informal supply for the poorest group and that the second quintile also experiences an important increase in informal supply. Hence, the informal sources have increased significantly for the bottom 40% of the population while private and public provision has dropped significantly for the 20% poorest. Moreover, the poorest quintile does not experience an increase in private provision while the fourth quintile in the region is the biggest gainer followed by the second quintile. More then half of the other urban households from the richest 60% of households are now supply by private taps.

Overall, private providers have now essentially become the main source for Dakar and other urban centers but informal providers continue to the main ones in rural areas. Considering that informal providers tend to be more expensive and less reliable than private and often public providers, the
bottom 20% of the population, in other urban areas appears to be worse off with the evolution of the market structure. Considering the full set of information provided by Table 1, it is quite surprising to note that the formal supply (private and public supply) to poor households does not seem to be one of the outcomes of the reforms so far. We only observe a slight increase in the rural poor (from 17.6% to 23.2%). The second, third and fourth quintile enjoyed the most important increases in the share of private tap installation in all regions. At the other extreme, the worst case is found for the poorest quintile in Other Urban Centers. The general equilibrium analysis presented next offers a more complete picture by allowing a wide range of simulations on the impact of changes in water pricing and transfer program with different financing options.

III. A CGE-IMH to Assess of the Impact of Water Utilities Reforms

In this paper, we rely on a CGE integrated multi-household model (CGE-IMH) first proposed by Decaluwé et al. (1999). It is theoretically sound since the macro and micro components are coherent and fully respect the standard CGE framework (Bourguignon and Savard 2008). It can include all households from the household survey into a CGE model.

We rely on the database and model developed by Boccanfuso et al. (2005) used to assess the groundnut sector reforms in Senegal. We then modify their model to allow the integration of stylized facts of the water market in Senegal. The data on Senegal’s water sector is relatively exhaustive and allows for an explicit modeling of this sector, and is one of the few detailed modeling for the distributional impact analysis of a utility sector. We focus our impact analysis on price reforms associated with privatization process of utilities as this is the most appropriate policy to analyze in the context of the CGE model (Parker and Kirkpatrick (2005). The most common changes

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15 Some authors refer to this approach as a CGE micro-simulation application. This is one of the three main approaches used to link macro reforms to changes in income distribution and poverty. The other two are the representative household approach (RH) and the top-down or micro-simulation sequential approach (MSS). Because the RH approach consists of using representative household subgroups, it is problematic for our concern here because it does not account for the within-group redistribution of income and hence can lead to misleading conclusions as demonstrated in Savard (2005). The MSS approach has different variants: macro-accounting (Chen and Ravallion (2004)) or micro-behavioral (Bourguignon, et al. (2005)). This approach does not explicitly capture the feedback effects of the micro household behavior as stated in Hertel and Reimer (2005) as well as in Bourguignon and Spadaro (2006). The CGE-IMH approach is theoretically sound and allows capturing feedback effects.

16 While there are about 25 years of CGE modeling experience, the published CGE literature on the distributional effects of public infrastructure service reform is indeed rather modest to begin with: Chisari et al (1999), Benitez et al. (2003) and Navajas (2000) for Argentina, Andersen and Faris (2002) for natural gas in Bolivia, Lofgren et al (1997) for rural Morocco and Boccanfuso et al (2009) for the electricity sector in Senegal are the only published papers on the topic to our knowledge. They all address the distributional issues at a very aggregate level simply because household data quality was quite limited.
are price increases to improve cost recovery. We also simulate the impact of several types of transfer policies aimed at mitigating the undesirable social outcomes of these cost recovery efforts on poor households.

Before describing the hypothesis of water production it is important to highlight some stylized facts. We note that the SDE water is available to a majority of households in the urban areas and most of Dakar. There is a significant capacity to increase supply of water without further investment in the network by the water utility. Moreover, the main barrier to increasing the number of clients is not on SDE side but on the client side. In fact, it is the fixed cost the clients must pay to get connected to the network that creates problems to increase connections. The simulations we will be performing will involve water price increases. In light of this, our simulations will make it more costly for households to connect to the network. Hence, it is irrelevant to attempt to capture an increase in the number of clients as this is not likely to occur in any significant fashion with important price increases. In fact, we will aim to capture the reduction in consumption of SDE water by households and production sector. To increase or decrease its production, SDE will require more of less intermediate inputs. It is these stylized facts of the water production that we capture with our hypothesis.

Our first change in the Boccanfuso et al (2005) model and SAM was to isolate water production from the electricity-gas-water sector in the original SAM. We followed by a disaggregation of the water production into water produced by the utility company and water produced by informal suppliers. The water market structure is modeled explicitly in terms of these two suppliers. We assume that the water utility is subject to price controls (i.e. exogenous to the model which is consistent with the ways the average tariff and the tariff structure are set in Senegal). This implies that the company will produce water based on the quantity of water demanded on the market. Both capital and labor are fixed in this sector. Increase/decrease in output is generated by increasing/decreasing the consumption of intermediate input.

The price of the informal producer is flexible but strongly dependent

17 The investment goals of SDE are mainly focused in the expansion of the network in small urban communities and in rural communities. The other element that required investment is the actual distribution network that requires repair and the leaks encountered in the network contributes to a lower efficiency of the system with more water being treated than what is eventually sold to clients. This is standard in all municipal water distribution system. A high loss rate implies higher production cost per unit of water sold. Hence, investment in this element does not involve increase the number of households being connected but improving efficiency by reducing production cost. One cannot conclude that investments are needed to increase the demand for water.

18 The minimal fixed cost for a new connection is around 100$ but can be up to 500$. For most poor families, this is a significant barrier to get access SDE water.

19 If the objective of the paper would be to measure subsidies require increasing the number of clients, one would have to use another methodology to achieve this goal.

20 We can also capture marginal increases in water consumption with our hypothesis but we will not be exploiting this in the rest of the paper.
on the SDE water price since it uses SDE water in its production process. In fact, the informal water production can use both formal and informal water as an intermediate consumption to produce its water. It can substitute between the two sources by minimizing the cost of the two inputs subject to a technological constraint specified by and Cobb-Douglas function. The value added of this sector is determined by a Cobb-Douglas function between capital and labour.

On the demand side of water, in addition to the informal water producer we have two other types of demand. First, the other production sectors (outside informal water) consume utility water as intermediate input with a fix share (Leontief function). Table 14 in appendix provides information on sectors using water most intensively and the share of water in their total intermediate consumption as well as households. Second, we have households that can substitute both types of water and other goods based on a demand system derived from a utility maximizing process based on a Cobb-Douglas utility function. The information found in the household survey to calibrate the value share of goods and services consumed by households among which we have SDE water and informal water. All water consumed within the categories of private tap and public and neighbor tap are considered SDE water. Water purchased from the other sources is supplied in the model by private informal water producers.

In the other production sectors output is determined through a 3-level system. Total production of a sector \(X_S\) is made up of fixed shares (Leontief) between value-added \((VA)\) and intermediate consumptions \((CI)\).

\[ VA = LD + KD \]

\(VA\) 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 into skilled labor and unskilled labor, and the choice of combining these two factors is determined by the constant elasticity of the 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 difficult in the short to medium term to convert capital for use in another sector.

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

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21 Other industries, other services and public services are the biggest water consumers. Total water consumption including informal water by households is 3.5% of their total expenditure.

22 It is important to note that agriculture used marginal quantities of water produced by our two water produces. In fact, figures from national account indicate that the agricultural sectors consume less then 1% of water produced by formal and informal water producers. This is another non potable water market. In countries such as Morocco, the same supplier produces potable water for production and households simultaneously with irrigated water for agriculture. For Roe et al (2005) and Decaluwé et al (1998) provide CGE modeling of water in this context.
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 demand for local goods. On the export side, the producers can sell the goods on the local market or export their production and are influenced by relative prices in each market and by their elasticity of transformation of the goods 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. Our household income equations are consistent with the structure observed in the ESAM. The initial factor endowments (labor and capital) and the endogenous transfers between agents are very important determinants for household welfare changes following policy simulations. In this model, factor allocations are exogenous and factor payments are endogenous. Household welfare changes are captured through changes in the cost of their consumption basket, changes in factor payments and changes in inter-households transfers. As capital is fixed by sector, we have eighteen capital payments and two wages (skilled and unskilled). Dividends paid to households are also endogenous and are dependent on the representative firm’s income after taxes. The households that are heavily dependent on transfers turn out to be very vulnerable to changes in this variable. The other sources of income are exogenous such as transfers from 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 good. Households have specific marginal share parameters based on observed data in the household survey. Investment demand is also specified with a fixed value share

23The assumption for water consumption implies that households will react to an increase in price of formal water by decreasing their consumption and substitute for other goods among which informal water. However, since the formal water is an important input into the production of informal water, hence an increase in the price of the formal water will lead to an increase in price of informal water. This simultaneous increase in price of both water sources will limit the substitution between the two sources of water. More sophisticated demand system could have been used such as a linear expenditure system but given the fact that we did not have information on household specific Frisch parameter and income elasticity parameter required for calibration process we selected the more tractable Cobb-
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 skilled workers and unskilled workers 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. The current account balance and the nominal exchange rate are fixed and hence the price index (GDP deflator) varies to allow the real exchange rate to clear the current account balance. The nominal exchange rate plays the role of the numéraire. For the savings and investment equilibrium, total nominal investment is determined by the sum of the agents’ saving. Total government expenditure is maintained constant but given the fact that we perform simulations on government transfers to households our total government expenditure includes these transfers. Hence, the consumption of public services will adjust to maintain the total government expenditure constant.

The diagnostic of poverty and inequality changes is based on two commonly used indices in the context of macro-micro modeling. The poverty index chosen is the additively decomposable Foster, Greer and Thorbecke (FGT, 1984) and for inequality analysis we selected the Gini index. We use the change in households’ welfare measured by the equivalent variation to measure the impact of the policy on each household. This approach has the advantage of taking into account the price and income effect simultaneously. This approach is quite standard in the context of macro-micro CGE analysis. The CGE-MSS model generates post simulation changes in welfare

Douglas utility function. Moreover Savard (2005) found that differences in distributional impact between the demand system derived from the two utility function are relatively small.

24 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.

25 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. Some modellers argue that total real investment should remain constant. We have not closed our model in this fashion because for two reasons. The balancing option in a disaggregated model can create more distortion in results than our selected closure. Moreover, our variations in real investment never exceed 0.2% in absolute value. Hence, this closure does not bias our results.

26 FGT poverty indices are interesting within the framework of this analysis and make it possible to measure the proportion of the poor among the population but also of this poverty depth and severity. For detailed information on the FGT index family, see Ravallion (1994).
which are used for poverty and inequality analysis. Target groups are defined independently of the CGE modeling exercise and poverty and inequality analysis can be performed for the base period and after simulations.  

IV. Simulations and Analysis of Macro and Sectoral Results

Since specific information on the pricing policies of the operators, including the private operators, is not available, we present here illustrative simulations of the possible impact of various pricing strategies. We focus on strategies typically considered by private operators in their efforts to improve cost recovery. We analyze two broad types of policies. First, we focus on cost recovery only and compare the impact of an increase in the recovery of operating expenditures (OPEX) with the impact of an increase in the recovery of capital expenditures (CAPEX). For illustrative purposes, for OPEX we simulate an increase of 25% of the SDE water price at the reference period and for CAPEX an increase of 35% of the SDE water price at the reference period. The common wisdom is that the resulting increases in water tariff will have a negative consequence on the welfare of poor households consuming SDE water but the specific average and distributional impact is unclear, although many of the critics of these policies argue that the poor are likely to suffer relatively more since their relative share of water in total consumption is higher.

The second type of policy simulation we conduct is the introduction of a transfer program for poor households directly affected by the cost recovery programs. The objective of this set of simulations is twofold. First, to verify if a compensation program for poor households directly affected by the price increase can eliminate or attenuate its negative effects. Second, which is the best funding option for this type of transfer program. Households that are compensated in these scenarios are the ones below the poverty line and consuming SDE water. The amount of the transfer corresponds to the budget required to pay for the price increase of the water. For example, a poor household connected to the SDE water supply and experiencing a 2500CFA franc increase in water bill following the price increase will receive a 2500CFA franc transfer. The level of the transfer implies that the operator is allowed to rely on cross subsidies to meet the needs of the poor given the budget balance constraint. In these scenarios, the transfer program is funded by the government through a reduction of public services. We also

27 No groups are found in the CGE model but all households of the survey.

28 As we are mainly interested in the impact of relative changes on various variables in the model, the exact level of the price changes is not key in our exercise. Simulating larger nominal levels would not have modified our comparative analysis but the amplitude of the effects. We have made some sensitivity analysis for this and our results are quite robust to this. The levels of the simulations are based on rough estimates of Niang (2004).
run a set of simulations comparing cross-subsidies to various types of tax instruments and to foreign grants as sources of financing for the transfer programs needed to mitigate the consequences of a policy aiming at improving cost recovery. Funding the program through these instruments allows the government to maintain its public services constant. More specifically, we test: (i) an increase in household income tax level, (ii) an increase in value added tax, (iii) a program were the transfers would be funded by an external donor and finally, (iv) we look at an increase in import duties. Even though the differences in impact of the various financing instruments proved to be relatively minor, we report all the results. For reference, the eight simulations decomposed in two sets are summarized in Table 2. The second set of simulation comprises the financing options.

### Table 2
**Summary Statistics**

<table>
<thead>
<tr>
<th>Set</th>
<th>Simulation</th>
<th>Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sim A</td>
<td>1A</td>
<td>OPEX 25% Increase in the price of SDE Water</td>
</tr>
<tr>
<td>1</td>
<td>Sim B</td>
<td>1B</td>
<td>Sim 1A + transfers program to poor households supplied by SDE</td>
</tr>
<tr>
<td>1</td>
<td>Sim C</td>
<td>1C</td>
<td>CAPEX 35% Increase in the price of SDE Water</td>
</tr>
<tr>
<td>1</td>
<td>Sim D</td>
<td>1D</td>
<td>Sim 1C + transfers program to poor households supplied by SDE</td>
</tr>
<tr>
<td>2</td>
<td>Sim A</td>
<td>2A</td>
<td>Sim 1D + Household Income tax to fund the transfers program</td>
</tr>
<tr>
<td>2</td>
<td>Sim B</td>
<td>2B</td>
<td>Sim 1D + VAT increase to fund transfers program</td>
</tr>
<tr>
<td>2</td>
<td>Sim C</td>
<td>2C</td>
<td>Sim 1D + Foreign Aid to fund the transfers program</td>
</tr>
<tr>
<td>2</td>
<td>Sim D</td>
<td>2D</td>
<td>Sim 1D + Increase in import duties to fund the transfers program</td>
</tr>
</tbody>
</table>

Before moving into the simulation analysis let us review the main mechanism at play in our price increase scenarios. We will not go into a detailed analysis of the model’s results as our focus of the paper is on the poverty and distributional impact analysis. The direct effects of the water rate increases are on the increase in the consumption cost of water for households which will reduce their water consumption for other goods. It will have the same effect on production sectors using water in their production process. The sectors using water more intensively will be more negatively affected. The simulation also improves public finance. As the total government expenditure is fixed, it increases the government savings since it reduces its subsidy to SDE.29 Other effects we observe are the results of general equilibrium effects.

29 As our national account figures did not show this information, we applied the change in subsidy directly to the savings account and it did not transit through government revenues but in its expenditure which is expressed with the savings equations. This explains why our government revenues do not increase following the elimination of the subsidy of the government to SDE.
For the first simulation (1A), we begin by looking at government revenues \((Y_g)\). In this case, we note a very slight decrease of -0.28%. When looking at the two other agents in the economy (i.e. the firm \((Y_e)\) and the aggregate household \((Y_m)\)) we observe a decrease of 0.40% for firms and 0.41% for households.

**Table 3**

**Key Macro Results from Simulation (Percentage Variation)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Y_m</strong></td>
<td>177.62</td>
<td>-0.41</td>
<td>-0.32</td>
</tr>
<tr>
<td><strong>w</strong></td>
<td>1.00</td>
<td>-0.72</td>
<td>-1.14</td>
</tr>
<tr>
<td><strong>wnq</strong></td>
<td>0.50</td>
<td>-0.51</td>
<td>-0.60</td>
</tr>
<tr>
<td><strong>Y_g</strong></td>
<td>59.41</td>
<td>-0.28</td>
<td>-0.21</td>
</tr>
<tr>
<td><strong>Y_e</strong></td>
<td>106.03</td>
<td>-0.40</td>
<td>-0.32</td>
</tr>
<tr>
<td><strong>PIB</strong></td>
<td>210.56</td>
<td>-0.01</td>
<td>-0.02</td>
</tr>
<tr>
<td><strong>Pindex</strong></td>
<td>1.00</td>
<td>0.15</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>Y-Telecom</strong></td>
<td>5.34</td>
<td>0.49</td>
<td>0.64</td>
</tr>
<tr>
<td><strong>Y-Water</strong></td>
<td>0.92</td>
<td>103.08</td>
<td>103.40</td>
</tr>
<tr>
<td><strong>Y-Senelec</strong></td>
<td>2.54</td>
<td>-1.61</td>
<td>-1.59</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

The drop in income for the aggregate household is mainly caused by the decrease in the two wage rates (qualified wage \((w)\) and non qualified wage \((wnq)\)). 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 of the rental rates of capital for non utility sectors (nine out of sixteen non utility sectors\(^{30}\)). 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 at -1.12%.

\(^{30}\) Cf. Table 4.
Table 4

Variation of Rental Rate of Capital

<table>
<thead>
<tr>
<th>Variables</th>
<th>Branches</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td>1</td>
<td>-0.29</td>
<td>-0.25</td>
</tr>
<tr>
<td>Forestry</td>
<td></td>
<td>1</td>
<td>-0.15</td>
<td>0.19</td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td>1</td>
<td>0.01</td>
<td>0.17</td>
</tr>
<tr>
<td>Fish industries</td>
<td></td>
<td>1</td>
<td>-0.11</td>
<td>-0.24</td>
</tr>
<tr>
<td>Edible oil industries</td>
<td></td>
<td>1</td>
<td>0.59</td>
<td>0.58</td>
</tr>
<tr>
<td>Other food industries</td>
<td></td>
<td>1</td>
<td>-0.25</td>
<td>-0.23</td>
</tr>
<tr>
<td>Mining</td>
<td></td>
<td>1</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>Other industries</td>
<td></td>
<td>1</td>
<td>-1.12</td>
<td>-1.18</td>
</tr>
<tr>
<td>Refineries and energy</td>
<td></td>
<td>1</td>
<td>-0.95</td>
<td>-0.92</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>1</td>
<td>0.34</td>
<td>0.50</td>
</tr>
<tr>
<td>Tourism</td>
<td></td>
<td>1</td>
<td>-0.7</td>
<td>-0.75</td>
</tr>
<tr>
<td>Telecom</td>
<td></td>
<td>1</td>
<td>0.49</td>
<td>0.64</td>
</tr>
<tr>
<td>Water-Utilities</td>
<td></td>
<td>1</td>
<td>103.08</td>
<td>103.4</td>
</tr>
<tr>
<td>Water-Informal</td>
<td></td>
<td>1</td>
<td>0.00</td>
<td>-3.24</td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td>1</td>
<td>-0.27</td>
<td>-0.23</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td>1</td>
<td>-1.61</td>
<td>-1.59</td>
</tr>
<tr>
<td>Commercial services</td>
<td></td>
<td>1</td>
<td>-0.13</td>
<td>0.14</td>
</tr>
<tr>
<td>Other services</td>
<td></td>
<td>1</td>
<td>-0.96</td>
<td>-0.92</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

On the other hand, the increase in the price of water produces a strong decrease in the demand for that good when there is some flexibility in the demand. When the demand is determined by a Leontief function (production sectors outside informal water) 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 that use water relatively intensively in their production process and creates a relative disadvantage for these goods versus other branches in the economy.

It is now interesting to highlight how this policy impacts 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 the relative price of the two goods. This generates a reduction of 10.81% in the supply of the SDE water.31 The informal water output increases by 0.26%. It is interesting to note here that if the quality of the informal water is not well controlled, it is quite probable that this would lead to an increase in disease in the population and hence a

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31 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.
decrease in welfare. As mentioned previously, we do not model and measure this probable outcome. The other sectors benefiting the most are the edible oil industries (+0.70%), fish industries (+0.34%) and forestry (+0.22%). Refineries & energy sectors faces the greatest decrease of 0.20%.

Table 5
Variation for Value Added or Output by Sector

<table>
<thead>
<tr>
<th>Variables</th>
<th>Branches</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1A</td>
<td>1B</td>
<td>1C</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td>23.66</td>
<td>0.08</td>
<td>0.15</td>
</tr>
<tr>
<td>Forestry</td>
<td></td>
<td>1.71</td>
<td>0.22</td>
<td>0.28</td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td>17.5</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Fish industries</td>
<td></td>
<td>4.98</td>
<td>0.34</td>
<td>0.41</td>
</tr>
<tr>
<td>Edible oil industries</td>
<td></td>
<td>0.95</td>
<td>0.70</td>
<td>0.80</td>
</tr>
<tr>
<td>Other food industries</td>
<td></td>
<td>14.29</td>
<td>0.09</td>
<td>0.15</td>
</tr>
<tr>
<td>Mining</td>
<td></td>
<td>3.19</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Other industries</td>
<td></td>
<td>14.94</td>
<td>-0.13</td>
<td>-0.09</td>
</tr>
<tr>
<td>Refineries and energy</td>
<td></td>
<td>0.83</td>
<td>-0.20</td>
<td>-0.08</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>9.12</td>
<td>0.15</td>
<td>0.21</td>
</tr>
<tr>
<td>Tourism</td>
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<td>2.07</td>
<td>-0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Telecom</td>
<td></td>
<td>7.99</td>
<td>-0.17</td>
<td>-0.18</td>
</tr>
<tr>
<td>Water-Utilities</td>
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<td>1.47</td>
<td>-1.08</td>
<td>-1.07</td>
</tr>
<tr>
<td>Water-Informal</td>
<td></td>
<td>0.08</td>
<td>0.26</td>
<td>-0.82</td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td>10.65</td>
<td>0.08</td>
<td>0.13</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td>2.74</td>
<td>-0.34</td>
<td>-0.28</td>
</tr>
<tr>
<td>Commercial services</td>
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<td>30.24</td>
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<td>0.11</td>
</tr>
<tr>
<td>Other services</td>
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<td>46.2</td>
<td>-0.05</td>
<td>-0.02</td>
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<tr>
<td>Public services</td>
<td></td>
<td>22.08</td>
<td>0.00</td>
<td>-0.75</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

Finally, let us look at market price changes \((Pq)\) in Table 6. As we have already mentioned, the price of water increases exogenously by 25%. This will have a direct, negative impact on the household consumption basket cost. The only other sectors that experience an endogenous increase in market prices are the construction sector with a slight increase of 0.05% and the tourism sector (+0.01%). The strongest decreases are found in the other services sector (-0.69%) and the refineries & energy with a decrease of 0.34%.

The second simulation (1B) 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 and the aggregate household income decreases less. The same is true for other agents who seem to lose less in this scenario. The main change comes from the government expenditure. In this scenario, it is a reduction
in government expenditure that finances the transfer to poor SDE water consuming households. Hence, it decreases by 0.75%. The reduction in public services is also responsible for the stronger decrease in wages as laid off public service workers 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 will not analyze in detail these effects.

The three types of provider are formal private vs. public and neighborhood taps vs. other sources—informal. To provide a sense of these dimensions, the table decomposes the households based on regional groupings (Dakar, Other urban and Rural) and by income quintiles. The most obvious observation emerging from the table may be the regional differences in the changes associated with the reforms.

Table 1 We now move on to the CAPEX simulations. Simulation 1C is a 35% price increase for SDE water. This simulation produces stronger effects compared to simulation 1A as expected. We observe the same qualitative effects for sectoral and macro variables. In terms of quantitative effects the range is larger in simulation 1C compared to 1A. As these are the only changes, we are likely to observe some increases in the size of the effects of the poverty and income distribution analysis, which will be analyzed in the next section. For the next simulation (1D), we add the transfer to poor households consuming SDE water to simulation 1C. First, we do not observe qualitative differences on macro variables and most sectoral variables. The only exception is for the tourism sector which goes from a slight increase of 0.03% in simulation 1C to a decrease of 0.03% in simulation 1D. We cannot isolate a specific trend in the quantitative differences between the two simulations. Given this, we do not go into more a detailed analysis of these two simulations.

For the final four simulations, which concern the funding options for the transfer program, we will analyze their impact simultaneously. The simulations seek to explore the best option to generate the income necessary to finance the transfers to poor households, while maintaining the total government expenditure constant. We note that few differences are observed at the macro between these simulations. At the sectoral level, we observe some differences in market prices and rental rate of capital.

If we make a general comparison of the four simulations versus 1D, where the program is funded with a reduction in the government expenditure in public services, we note that household aggregate income decreases less in the four cases compared to simulation 1D. This come from the fact that wages decrease less, and for qualified wage it decreases by less than half compared to simulation 1D less (between -0.40% and -0.57%) compared to -1.25% for simulation 1D. 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 1D. We also note that the government income increased by 0.41% in the four simulations. The firms’ income decreases more in all the four simulations compared to simulation 1D and hence the simulations are negatively biased toward firms compared to households and government.

**Table 6**

Variation for Market Prices

<table>
<thead>
<tr>
<th>Variables</th>
<th>Branches</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td>1.03</td>
<td>-0.19</td>
<td>-0.17</td>
</tr>
<tr>
<td>Forestry</td>
<td></td>
<td>1.07</td>
<td>-0.14</td>
<td>-0.10</td>
</tr>
<tr>
<td>Livestock</td>
<td></td>
<td>1.00</td>
<td>0.00</td>
<td>0.14</td>
</tr>
<tr>
<td>Fish industries</td>
<td></td>
<td>1.00</td>
<td>-0.26</td>
<td>-0.25</td>
</tr>
<tr>
<td>Edible oil industries</td>
<td></td>
<td>1.18</td>
<td>-0.29</td>
<td>-0.29</td>
</tr>
<tr>
<td>Other food industries</td>
<td></td>
<td>1.10</td>
<td>-0.15</td>
<td>-0.12</td>
</tr>
<tr>
<td>Mining</td>
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<td>1.01</td>
<td>-0.03</td>
<td>-0.01</td>
</tr>
<tr>
<td>Other industries</td>
<td></td>
<td>1.17</td>
<td>-0.08</td>
<td>-0.07</td>
</tr>
<tr>
<td>Refineries and energy</td>
<td></td>
<td>1.04</td>
<td>-0.34</td>
<td>-0.36</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>1.01</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Tourism</td>
<td></td>
<td>1.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Telecom</td>
<td></td>
<td>1.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water-Utilities</td>
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<td>1.02</td>
<td>25.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Water-Informal</td>
<td></td>
<td>1.00</td>
<td>-0.51</td>
<td>0.68</td>
</tr>
<tr>
<td>Transport</td>
<td></td>
<td>1.02</td>
<td>-0.27</td>
<td>-0.26</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td>1.02</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Commercial services</td>
<td></td>
<td>1.02</td>
<td>-0.13</td>
<td>0.00</td>
</tr>
<tr>
<td>Other services</td>
<td></td>
<td>1.01</td>
<td>-0.69</td>
<td>-0.69</td>
</tr>
<tr>
<td>Public services</td>
<td></td>
<td>1.00</td>
<td>-0.28</td>
<td>-0.49</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

At the sectoral level, we concentrate on prices and the rental rate of capital, as these are the key transmission variables between the policies and household welfare changes. For market prices, we observe both quantitative changes in most sectors and qualitative changes for five sectors. In some instances the differences between simulations can be greater than 0.5%. This is the case for the other industries prices between simulation 2C (-0.11%) and 2D (0.44%). In general, the negative price effects are stronger for simulation 2A.

In the case of rental rate of capital, we have stronger differences and we have qualitative changes in four sectors namely the forestry, livestock, edible oil industries and construction sectors with differences greater than 1%. For example the rental rate of capital for the edible oil industries increases by 0.78% in simulation 2A (income tax on households) and decreases by 0.48% in simulation 2B (VAT increase).
In conclusion, these four funding scenarios generate similar effects at the macro level, and some differences at the sectoral level. It will be interesting to see how the differences will affect the poverty and distributional analysis.

V. Distributional Impact of Water Pricing Reform

Section 3 showed how difficult it is to separate the quantity and the price effects of reforms from a simple comparison of basic statistical information. This section allows a refinement of the basic analysis by a documentation of the general equilibrium effect of water pricing and financing options. Indeed, one of the main concerns associated with water reform in Senegal as in most other developing countries is the poverty and distributional impact of pricing and financing reforms aimed at improving cost recovery.

We are now ready to move to the poverty and inequality analysis under the different policy scenarios. We first separate the households on a regional basis, namely Dakar, Other Urban and Rural. Next we decompose households based on their source of supply (SDE versus other). The definition and relative importance of the groups are presented in Table 7.

Table 7

<table>
<thead>
<tr>
<th>Decomposition Code</th>
<th>Definition</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGIONAL</td>
<td>DKR Dakar</td>
<td>33.39</td>
</tr>
<tr>
<td></td>
<td>OURB Other urban</td>
<td>26.44</td>
</tr>
<tr>
<td></td>
<td>RURAL Rural</td>
<td>40.17</td>
</tr>
<tr>
<td>WATER SUPPLY</td>
<td>NSW NOT SUPPLIED BY SDE</td>
<td>47,23</td>
</tr>
<tr>
<td></td>
<td>SW SUPPLIED BY SDE</td>
<td>52,77</td>
</tr>
</tbody>
</table>

Sources: ESAM I and II.

To get an average benchmark, we first look at the changes in poverty indices at the national level before moving to the decomposition analysis. We report three measures of poverty, incidence, depth and severity. Incidence is the most common definition used. It reports the share of poor in the total population. For the base case, the poverty incidence (FGT0) indicates that 57.86% of the population is poor. This corresponds to the official statistic reported by Senegal for the base year. Poverty depth, FGT1, captures the difference between the poor’s income and the poverty threshold. Poverty severity, FGT2, is the square of the poverty depth giving more weight to poorest households in the index. Table 8 summarizes the results.
As expected, a policy aimed at increasing cost recovery in the water sector without any adjustment in transfers to protect the poor will result in deteriorating the three poverty measures. The first simulation 1A (an increase in OPEX cost recovery without transfers) shows indeed an increase of 0.31% in the poverty rate, of 0.21% in poverty depths and of 0.30% in poverty severity. The other simulated price increase is simulation 1C (an increase in CAPEX cost recovery without transfers) produce similar but stronger effects. The effect on poverty is quite small considering the importance of the price increase. This is explained in large part by the relatively small number of poor households relying on SDE water.

The second (1B) consisted of giving a cash transfer to poor households consuming SDE water. Even if the number of households concerned is relatively small, the transfer produces a positive effect at the national level with a reduction of the headcount index of 0.19% and a half percentage point improvement compared to simulation 1A. This positive effect is accentuated for the depth and severity indices as they decrease respectively by 0.54% and 0.64%. The total improvement for the severity index between 1A and 1B is 0.94%. The improvement of the three indices is a signal that transfer program is useful in attenuating the negative effect of the price increase.

Simulation 1D, which is the same simulation 1B illustrates the importance of using the depth and severity indices. The poverty depth and severity indices decrease around two times more then for the poverty headcount. When the transfer program is funded from other sources (taxes or external grants), it produces a 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 as simulation 1D. In Senegal, transfer from import duties (2D) or foreign aid (2C) would however have a somewhat stronger impact on poverty depth and severity than the government financed programs (1D) or financed by income taxes (2A) and value added tax (2B).

It is interesting to see if our findings will be modified when performing

---

32 It is important to highlight that the poverty changes at the national level were computed with the entire set of households included in the model.
a decomposition poverty analysis. Tables 9 to 11 summarize the results of poverty indices variations. It is important to note that when using empirical distribution to compute poverty a headcount index we often obtain weak or no effects. This comes from the fact that few households can be observed around the poverty line.\textsuperscript{33} For example, in Table 9, the Dakar group is unaffected in simulation 1A when using the poverty headcount index. In this context the poverty depth and severity indices are much more informative.

**Table 9**

**Variation of Poverty Incidence by Regional/Educational Decomposition**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td>Dakar</td>
<td>33.76%</td>
<td>0.00</td>
<td>-0.62</td>
</tr>
<tr>
<td>Other Urban</td>
<td>43.01%</td>
<td>1.32</td>
<td>-0.72</td>
</tr>
<tr>
<td>Rural</td>
<td>71.28%</td>
<td>0.21</td>
<td>-0.03</td>
</tr>
<tr>
<td>Informal-Supply</td>
<td>72.59%</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td>SDE-Supplied</td>
<td>41.66%</td>
<td>0.28</td>
<td>-1.19</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

The upper part of Table 9 does, however, suggest that the two cost recovery scenarios and transfer programs would impact regional users differently. Although the signs are the same, intensity of the effects are different. The simulations 1A and 1C show that the improved cost recovery leads to an increase in poverty for three groups but with Other Urban supporting the strongest effect and Rural households the weakest effect. When adding the transfer program, we observe the opposite where Other Urban being the biggest gainers and Rural the weakest gainers. The lower part of the table tracking the difference in the impact for water users supplied by SDE and the others shows a surprising result. Indeed, the poverty level increases more for households not supplied by the SDE (informal supply) 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 of this policy on households than on the increase in the price of water. Such a result could not be captured by a partial equilibrium analysis. It also reflects the fact that some of the informal providers are SDE clients and pass on the increase of water onto their own users. This result is reversed for the CAPEX cost recovery (1C) but with negative effects being almost as strong for the two groups. However, when looking at the depth

\textsuperscript{33}See Boccanfuso et al (2008) for a detailed discussion on this issue.
and severity changes in Tables 10 and 11, we see that households supplied by SDE experience stronger poverty increases (i.e. 0.41% vs. 0.16% for depth and 0.50% and 0.22% for severity). It is also quite interesting to note that the conclusion from the poverty depth and severity analysis changes the ranking of the effects in the regional decomposition. We now have the Dakar household most negatively affected in the cost recovery strategy (1A and 1C) and the biggest winners with the transfer program (1B and 1C).

Table 10

<table>
<thead>
<tr>
<th>Variation of Poverty Depth by Regional/Educational Decomposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dakar</td>
</tr>
<tr>
<td>Urban</td>
</tr>
<tr>
<td>Rural</td>
</tr>
<tr>
<td>Informal-Supply</td>
</tr>
<tr>
<td>SDE-Supplied</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

For the second set of simulations (with the transfer program funded by taxes and grants), we obtain an interesting reduction in poverty for the Dakar and Other Urban groups for the poverty depth and severity from -2.45% to -4.00% (Table 10 and 11). The transfer program has a positive effect on the SDE water consumers but a negative effect on the non SDE consumers whatever funding option is used. The tendency is similar for all three indices but the positive effect is stronger for the SDE consumers for poverty depth and severity.

Overall, one of the most interesting conclusions of these simulations may be that impact of the different funding programs for transfers should leave in general the informally supplied households and Rural households relatively indifferent but they should be of interest Other Urban, Dakar and households supplied by SDE. It is interesting to note that the poverty headcount is almost unchanged for the Dakar households when the poverty depth and severity produce relatively strong positive effect. However for the Rural households the effect is almost the same for the three indices for the second set of simulations. Finally, there is an increase in poverty for the four cases for the users unable to rely on SDE (informal supply group), confirming that the reforms are likely to have an impact even on the users not supplied by the utility operator. Note that many of these simulations clearly show that allowing cross-subsidies (simulation 1D) may have desir-
able poverty payoffs as compared to alternative funding sources. Indeed, the poverty rate does not decrease as much when using the household income tax (2A) for the households supplied by SDE (SW).

Table 11

<table>
<thead>
<tr>
<th>Groups</th>
<th>Reference</th>
<th>Set 1</th>
<th>Set 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td>Dakar</td>
<td>6.37%</td>
<td>0.67</td>
<td>-2.27</td>
</tr>
<tr>
<td>Urban</td>
<td>8.74%</td>
<td>0.54</td>
<td>-1.73</td>
</tr>
<tr>
<td>Rural</td>
<td>18.03%</td>
<td>0.21</td>
<td>-0.27</td>
</tr>
<tr>
<td>Informal-Supply</td>
<td>19.11%</td>
<td>0.22</td>
<td>0.20</td>
</tr>
<tr>
<td>SDE-Supplied</td>
<td>7.92%</td>
<td>0.50</td>
<td>-2.86</td>
</tr>
</tbody>
</table>

Source: from authors’ computation

There is also a regional incidence story that emerges from the analysis of the funding schemes. In general, the funding schemes most favorable to most groups are the foreign aid option (2C) followed by the increase in import duties (2D).34

To analyze more formally the changes in income distribution we use the S-Gini index. Results of variation from 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 1.18% are observed for all groups in any simulation. The second general observation is that all policies simulated reduce inequalities at the national level and for the sub-groups analyzed. This is somewhat surprising since both the reforms and the various funding schemes simulated in section 5 tended to leave the users in Dakar relatively better off on average.

Overall, the distributional effects are not very dramatic although they show that redistribution intra- and inter-groups has very different impacts. The inter-group redistribution contributes to reducing overall inequalities but the intra-group redistribution contributes to an increase in the overall inequalities for the two cost recovery scenarios (1A and 1C). The Urban households benefit the most for reduction in inequality for all cases in which we apply the transfer program. In the cost recovery scenarios it is the Rural households that experience the strongest reduction in inequality.

34 If we had assumed that public services generate production externalities or provide utility to households we would have had different results since the simulation 1D generates a 1.48% decrease in public services. This reduction in public services produces little impact on the economy other than the downward pressure on wages. See Savard and Adjovi (1998) for an explicit modeling of public expenditure externalities namely in the primary education and primary health sectors.
The funding scenarios, as expected, systematically affect less the Rural households for the regional decomposition and the informally supplied households. The household income tax approach (simulation 2A) is the one that reduces the inequalities for all groups whatever decomposition used. This is not surprising as most households paying income tax in Senegal are relatively rich and households receiving the transfers are the poor. The last three simulations have identical distributional effect on all groups. The analysis based on the water supply source produced expected results. We observe very little impact on the households not supplied by SDE (from -0.03% to -0.14%). As for the households supplied by SDE, we have reductions ranging from 0.03% for simulation 1A to 1.18% for simulation 2A (funding of the transfer program through the income tax).

VI. Conclusions

In this paper, we first analysed the evolution (before and after reform) of the water supply distribution in a sector now dominated by a privatized water utility. We analyze first the raw data extracted from household surveys. Although the average access rates have increased, we find that the expansion of the network associated with the reforms did not benefit the two lowest quintiles of the population in all regions. The biggest gainers are the fourth quintile in Other Urban region, third in Rural and second in Dakar.
We then use a CGE integrated multi-household model approach to analyze the relevance of the interactions of the effects of possible pricing and financing changes consistent with the committed reforms with all other social and economic dimensions of interest to policymakers. The analysis confirms that, as expected, when the general equilibrium effects are accounted for, all groups are negatively affected with the efforts to improve cost recovery unless the poor households are compensated after the associated price increase.

The analysis also shows that, through transfer programs, all groups in the regional decomposition appear to benefit from the reform whatever funding source is used to fund the program. The gains are however not evenly distributed. The group winning the least seems to be the rural households in all the scenarios with the transfer program. However, when using decomposition based on source of water supply, the transfer program is favourable to the households supplied by SDE water and unfavourable to the other households. This conclusion is valid for all the different funding options. The drivers of these results are price effects and income effects which are both captured in this analysis.

An additional interesting finding in looking poverty incidence at the regional decomposition is that in general, the other urban dwellers are the most strongly affected, followed by the Dakar households and then the rural households. This conclusion is not surprising for the rural as they are mainly affected by the general equilibrium effects. However, we expected stronger effects on the Dakar households.

Because the actual pricing and financing data necessary to conduct a full incidence analysis is not available, we cannot make a definitive assessment of the impact of reforms on the poor based on facts. However, the pricing and financing simulations conducted in this paper show that even if the impact on the network extension analyzed in the first part was not as kind to the poor as expected, it would be easy to design pricing and financing to ensure a progressive reform outcome. This outcome is actually relatively easy to implement given the low efficiency cost of implementing a compensation program for poor households affected by the water price increase. This result is robust to different funding scheme to the transfer program.

Beyond Senegal’s experience, the main interest of this paper may have been to show that that the IMH-CGE approach could be used quite effectively to study the incidence of pricing and financing policies often associated with privatization of utilities. It adds to results achieved from the earlier CGE generations the evidence that detailed knowledge of household level data can be extremely valuable in designing compensatory programs. Overall, it provides fairly precise information regarding winners and losers at the macro, sectoral and micro levels.


Hall, D., E. Lobina, and R. de la Motte, (2005), Public resistance to privatisation in water and energy, *Development in Practice*, 15(3 & 4); 286-301.


**Appendix 1**

**Table 13**

Cost Structure of the Formal Water Production Sector

<table>
<thead>
<tr>
<th><strong>CAPEX</strong></th>
<th>Capital payments and investment</th>
<th>9227</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OPEX</strong></td>
<td>Labor Cost</td>
<td>5441</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -other industries</td>
<td>15543</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Construction</td>
<td>331</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Hotel and restaurant</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Energy</td>
<td>197</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Telecom</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Water</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Electricity</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Transport</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Commercial services</td>
<td>398</td>
</tr>
<tr>
<td></td>
<td>Intermediate input -Other services</td>
<td>10009</td>
</tr>
<tr>
<td><strong>Value of sales</strong></td>
<td>Total output at factor price</td>
<td>41534</td>
</tr>
<tr>
<td><strong>Losses 1996</strong></td>
<td></td>
<td>463</td>
</tr>
</tbody>
</table>
### Cost Structure of the Formal Water Production Sector

<table>
<thead>
<tr>
<th>Consumption (IC) of Water</th>
<th>SDE Water</th>
<th>Water Consumption</th>
<th>% of Water in Total IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>150.9</td>
<td>0.36%</td>
<td>0.07%</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.0</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Livestock</td>
<td>291.0</td>
<td>0.68%</td>
<td>0.36%</td>
</tr>
<tr>
<td>Fish industries</td>
<td>2.7</td>
<td>0.01%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Edible oil industries</td>
<td>33.9</td>
<td>0.08%</td>
<td>0.04%</td>
</tr>
<tr>
<td>Other food industries</td>
<td>1668.7</td>
<td>3.93%</td>
<td>0.40%</td>
</tr>
<tr>
<td>Mining</td>
<td>189.6</td>
<td>0.45%</td>
<td>0.53%</td>
</tr>
<tr>
<td>Other industries</td>
<td>5988.9</td>
<td>14.09%</td>
<td>1.05%</td>
</tr>
<tr>
<td>Construction</td>
<td>404.6</td>
<td>0.95%</td>
<td>0.41%</td>
</tr>
<tr>
<td>Tourism</td>
<td>1393.3</td>
<td>3.28%</td>
<td>1.19%</td>
</tr>
<tr>
<td>Refineries and energy</td>
<td>27.3</td>
<td>0.06%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Telecom</td>
<td>11.4</td>
<td>0.03%</td>
<td>0.03%</td>
</tr>
<tr>
<td>Water-Utilities</td>
<td>36.8</td>
<td>0.09%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Water-Informal</td>
<td>1602.1</td>
<td>3.77%</td>
<td>63.42%</td>
</tr>
<tr>
<td>Electricity</td>
<td>1831.3</td>
<td>4.31%</td>
<td>10.73%</td>
</tr>
<tr>
<td>Transport</td>
<td>36.0</td>
<td>0.08%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Commercial services</td>
<td>1819.0</td>
<td>4.28%</td>
<td>0.99%</td>
</tr>
<tr>
<td>Other services</td>
<td>3221.3</td>
<td>7.58%</td>
<td>3.12%</td>
</tr>
<tr>
<td>Public services</td>
<td>3015.7</td>
<td>7.10%</td>
<td>2.62%</td>
</tr>
<tr>
<td>Household consumption</td>
<td>20770.4</td>
<td>48.94%</td>
<td>1.55%</td>
</tr>
</tbody>
</table>