AFRICA INFRASTRUCTURE COUNTRY DIAGNOSTIC

WORKING PAPER 16

Water Reforms in Senegal: A Regional and Interpersonal Distributional Impact Analysis

Dorothée Boccanfuso, Antonio Estache, and Luc Savard

FEBRUARY 2006

Africa's Infrastructure | A Time for Transformation

1818 H Street, NW
Washington, DC 20433 USA
Telephone: 202-473-1000
Internet: www.worldbank.org
E-mail: feedback@worldbank.org

A publication of the World Bank.

The World Bank
1818 H Sreet, NW
Washington, DC 20433 USA

About AICD

This study is a product of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. AICD will provide a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It should also provide a better empirical foundation for prioritizing investments and designing policy reforms in Africa's infrastructure sectors.

AICD is based on an unprecedented effort to collect detailed economic and technical data on African infrastructure. The project has produced a series of reports (such as this one) on public expenditure, spending needs, and sector performance in each of the main infrastructure sectors—energy, information and communication technologies, irrigation, transport, and water and sanitation. *Africa's Infrastructure—A Time for Transformation*, published by the World Bank in November 2009, synthesizes the most significant findings of those reports.

AICD was commissioned by the Infrastructure Consortium for Africa after the 2005 G-8 summit at Gleneagles, which recognized the importance of scaling up donor finance for infrastructure in support of Africa's development.

The first phase of AICD focused on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage is expanding to include as many other African countries as possible.

Consistent with the genesis of the project, the main focus is on the 48 countries south of the Sahara that face the most severe infrastructure challenges. Some components of the study also cover North African countries so as to provide a broader point of reference. Unless otherwise stated,

therefore, the term “Africa” will be used throughout this report as a shorthand for “Sub-Saharan Africa.”

The World Bank is implementing AICD with the guidance of a steering committee that represents the African Union, the New Partnership for Africa’s Development (NEPAD), Africa’s regional economic communities, the African Development Bank, the Development Bank of Southern Africa, and major infrastructure donors.

Financing for AICD is provided by a multidonor trust fund to which the main contributors are the U.K.’s Department for International Development, the Public Private Infrastructure Advisory Facility, Agence Française de Développement, the European Commission, and Germany’s KfW Entwicklungsbank. The Sub-Saharan Africa Transport Policy Program and the Water and Sanitation Program provided technical support on data collection and analysis pertaining to their respective sectors. A group of distinguished peer reviewers from policy-making and academic circles in Africa and beyond reviewed all of the major outputs of the study to ensure the technical quality of the work.

The data underlying AICD’s reports, as well as the reports themselves, are available to the public through an interactive Web site, www.infrastructureafrica.org, that allows users to download customized data reports and perform various simulations. Inquiries concerning the availability of data sets should be directed to the editors at the World Bank in Washington, DC.

Contents

About the authors

Professors Dorothée Boccanfuso and Luc Savard are members of the faculty of the Economics and International Development Research Group at the University of Sherbrooke in Montreal. Antonio Estache is a member of the faculty of the European Centre for Advanced Research in Economics and Statistics at the Université Libre de Bruxelles.

Abstract

This paper focuses on the distribution of gains and losses from Senegal's water utility reforms across regions and across households according to income class. We show that most of the gains accrued to the highest income classes, while the poor saw no changes or suffered losses with the extension of the water network. We then use a multihousehold integrated computable general equilibrium (CGE) model to analyze the impact of possible water pricing reforms on poverty in Senegal. We conclude that although the simulated price increases for the sector have marginal effects on government finances, they benefit most actors except for households, unless specific transfer programs are in place to protect the poor.

The international community has identified distributional effects as a primary concern when assessing any reform that ties the private sector to the delivery of public services. Our main objective is to analyze the distributional effects of water pricing reforms and poverty often associated with the privatization of water utilities and perform an ex ante analysis of a targeted transfer program to compensate poor households affected by water price increases. We focus on two main distributional dimensions: (1) the effect across households, and (2) the impact across regions, separating Senegal into three areas: Dakar, other urban centers, and rural areas. We modify the database developed by Boccanfuso and others (2005) and undertake an explicit modeling of the sector's market structure. We simulate the impact of efforts to increase the price for recurrent and capital costs and of different transfer policies designed to mitigate undesirable social outcomes across income groups.

We analyze water supply distribution in a sector now dominated by a privatized water utility, comparing performance indicators before and after reforms to draw conclusions about household impact. We conduct a comparative analysis of two survey periods using the Senegalese household surveys Enquête Sénégalaise Auprès des Ménages (ESAM) I (1994–95) and II (2000–01). Although average access rates have increased, we found that the network's expansion caused by reforms did not help the two lowest quintiles of the population across regions. The biggest gainers were in the fourth quintile in secondary cities, the third quintile in rural areas, and the second quintile in Dakar.

The analysis of the CGE model confirmed that when the general equilibrium effects are accounted for, all groups are negatively affected by efforts to improve cost recovery unless poor households are compensated after the associated price increase. The analysis also showed that, through transfer programs, all groups in the regions appeared to benefit from the reform regardless of funding source. The gains were not, however, evenly distributed. The group winning the least were rural households in all scenarios with the transfer program. But when disaggregating by source, the transfer program benefitted only those households supplied by the utility. This conclusion is valid regardless of the source of funding for the reform. The drivers of these results were price effects and income effects.

The pricing and financing simulations conducted in this paper show that even if the impact of the network extension 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 would be relatively easy to implement given the low efficiency cost of implementing a compensation program for poor households affected by the water price increase.

A rollicking policy debate is currently underway regarding the pros and cons of utility privatization. Many African policy makers have seen the controversy surrounding Latin American policy reversals and are now questioning their own privatization efforts.[1] Except for Senegal,[2] whose reforms date to the mid-1990s, most African countries have only recently implemented utility reforms. As a consequence, analysts have seen little robust evidence of its impact on users.

Most of the literature on African utility reform experiences is not analytical; it has focused on reform processes rather than on outcomes, or on partial rather than full impact assessments, in particular with respect to poverty.[3] To our knowledge, this paper is the first attempt at an impact analysis for one African country; it consists of a case study on Senegal's water utility reform experience.

In this paper we emphasize the distributional effects of reforms. The international community has identified distributional effects as a primary concern when assessing any reform that ties the private sector to the delivery of public services. We focus on two main distributional dimensions[4]: (1) the effect across households, and (2) the impact across regions, separating Senegal into three areas: Dakar, other urban centers, and rural areas. Our main objective is to analyze the distributional effects of water pricing reforms and the poverty often associated with the privatization of water utilities, and to perform an *ex ante* analysis of a targeted transfer program to compensate poor households affected by water price increases.

We rely on a macroeconomic framework to conduct our diagnostic because water utility reforms can affect the poor through labor, capital, and products markets. An economy-wide analysis is needed to capture secondary effects. Because the feedback is multidimensional, the analysis calls for a multiagent, multicommodity model, which a CGE model delivers.[5] The latest generations of CGE models are useful in simulating the social impacts of reforms. This is accomplished through detailed modeling of the socioeconomic structure of any economy with a social accounting matrix (SAM). How deep the analysis goes depends on data availability.[6] The data on Senegal's water sector is relatively complete and allows an explicit modeling of this infrastructure, possibly the most detailed modeling available of the distributional implication of an infrastructure sector so far.[7]

---

[1] For an overview of the issues in Latin America, see Estache (2005a).

[2] A look at the Web sites of the U.K. Department for International Development, German Agency for Technical Cooperation, and Agence Française de Développement illustrates the popularity of Senegal experience. It is covered by the three agencies as part of its efforts to disseminate best practices in Africa.

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

[4] We actually started this research by also trying to compare the effects of reforms across economic agents (households versus firms versus 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, hence we do not report the detailed results here. However, they are available from the authors upon request.

[5] For a review of the history of CGE, see Hertel and Reimer (2004).

[6] The potential of these models was quite clearly identified early on in Dervis, de Melo, and Robinson (1982).

[7] Although 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 and others (1999), Benitez and others (2003), and Navajas (2000) for Argentina; Andersen and Faris (2002) for natural gas in Bolivia;

In this paper, we rely on an integrated multihousehold CGE model, or CGE-IMH.[8] This approach was first proposed by Decaluwé and others (1999b)[9] and is considered theoretically sound because the macro and micro components are coherent and respect the standard CGE framework. It includes most or all households from the household survey. The version used here explicitly addresses criticisms of this method raised by Rutherford and others (2005) and Chen and Ravallion (2004). They observe, for example, that the reconciliation of household data and the SAM data is fraught with difficulty and that the approach requires balancing all accounts, reconciling data at the household level. Given the good information available in Senegal, both issues were addressed easily here. Our first assumption for data reconciliation was to adjust the aggregation of the family-level data on consumption and expenditure to the level reported by national accounts in the SAM. Next, we used the structure of income and expenditures observed in the micro surveys and applied these structures to the SAM, replacing the national account–based structure with the micro-based structure.[10]

We relied on the database developed by Boccanfuso and others (2005) and then modified it in order to undertake an impact analysis of the water utility reforms. This implied an explicit modeling of the market structure of the sector. We also needed to identify a specific set of simulations reflecting the changes typically associated with water sector reforms; a price increase to improve cost recovery is the most common change. We simulated the impact of efforts to increase the price for recurrent and capital costs as well as of different transfer policies designed to mitigate undesirable social outcomes across income groups.

The next section of this paper summarizes the main water sector reforms in Senegal. In section 2, a basic analysis compares performance indicators before and after the reforms and draws some commonsense conclusions on the household impact brought by reforms in the water sector. We relied on a simple comparative analysis of two survey periods using the Senegalese household surveys Enquête Sénégalaise Auprès de Ménages, or ESAM, I (1994–95) and II (2000–01). Section 3 presents the specific general equilibrium model used to account for all interactions between water and the rest of the economy. In section 4, we analyze in detail poverty and regional consequences of cost-recovery improvements and of the various methods of financing these improvements to minimize the impact on the poorest. Section 5 discusses the income distribution effects of the most likely financing options. Section 6 presents our conclusions.

---

and Löfgren and others (1997) for rural Morocco are about the only published papers on the topic. They all address the distributional issues at a very aggregate level simply because quality household data is quite limited.

[8] 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 microsimulation sequential, approach (MSS). Because the RH approach consists of using representative household subgroups, it is problematic for use 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: macroaccounting (Chen and Ravallion, 2004) or microbehavioral (Bourguignon and others, 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.

[9] Some authors refer to this approach as a CGE microsimulation application.

[10] After this procedure, minor adjustments were required on the initial SAM household account value to balance the SAM.

1 Senegal's experience with water reform

Senegal is an interesting case study because the international community generally regards its utility reforms as a success.[11] The policy changes instituted in the mid-1990s were relatively consistent with what was then considered best practice. Although the reforms included many sectors and institutional dimensions, this paper focuses only on the long-term effects of the reforms implemented in the operation and management of water utilities in 1996 and a series of policy modifications implemented since, including a new price structure adopted in 2003.

The 1996 reforms aimed to secure the financial situation and the renewal of sector investments. Partial privatization was a principal goal. The overall objective was to supply all households in Dakar with potable water by 2010. The government also aimed to increase private participation in rural irrigation. The commitment to these reforms was strong; in fact, they were included in the poverty-reduction strategy paper approved in 2002 by the boards of the International Monetary Fund and the World Bank.

Compagnie des Eaux, Senegal's private water utility company after independence, was nationalized in 1972. Large investments followed, but a poor maintenance strategy led to rapid deterioration of the infrastructure. Société Nationale d'Exploitation des Eaux du Sénégal (SONEES), a public company, was responsible for maintaining and improving the water supply in cities, while the government set tariffs twice a year. Its financial situation deteriorated, however, because low tariffs translated into poor revenues, while public companies and the government did not pay their water bills. In addition, there was regular government interference in company management. SONEES was therefore hard-pressed to expand water supply outside of urban centers.

Privatization was justified because it would improve productivity and cost recovery and also protect the utility from government intervention. Sénégalaise des Eaux (SDE) was created, with Société d'Aménagement Urbaine et Rurale as the main shareholder. SDE produces and distributes water in urban and peri-urban zones, maintains water networks, publicizes commercial products, and collects tariffs. SONEES continues to exist as a state holding; its role is essentially to manage the investment on potable infrastructures and also to delegate the renting and granting of permits (Bayliss, 2001).

The investments aimed to increase access to potable water in the urban and rural areas.[12] Improvements in the provision of potable water for the rural population and mobilizing water for agricultural purposes were and still are priorities for primary sector investments. More specifically, existing water supply networks are expected to consolidate the existing network with renovations and repairs and to expand beyond its current network. The production capacity, transportation, stocking, and distribution of water in urban centers have in fact all increased since the reforms. Investments are also expected to deliver an institutional framework that guarantees quality water service at minimal cost while

[11] It was clearly so in water and telecoms, less so in energy because of the exit of the private operator from the sector. This exit has not, however, resulted in a major failure in the sector; Senegalese management has continued to run the sector without any significant problems.

[12] The government investments represent 11 percent of the total public investments for primary sectors and 25 percent of tertiary sectors (MEF, 2000 and 2001).

implementing needed reforms and improving exploration for new water sources for rural populations. For instance, the 2003 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.

As part of the implementation strategy, Senegal has seen a steady increase in private sector participation since 2000 (MEF, 2002). Water pricing has also improved. The price per cubic meter has risen on average by 3.1 percent annually. The water sector now makes the most of a flexible pricing system adjusted to the type of consumer. The new price structure, adopted in early 2003, is based on several principles. First, the structure reduces the types of users to three categories: crop agriculture, households, and other consumers. Second, those in the "other consumers" category face a fixed single tariff, whereas 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 m^3/bimester. Finally, a value-added tax (VAT) exemption exists for the social segment, including fire hydrant and agricultural use.

The price of water now includes the following elements: the 18 percent VAT; a tax distributed to Fond National de l'Hydraulique; the asset price (*prix patrimoine*) designed to cover SONEES' operating costs (OPEX) and investment costs (CAPEX); debt servicing used to finance infrastructure and the investment fund to maintain and expand the network; the operating costs of the private supplier, SDE (OPEX); debt reimbursement and investments; and operating material and contractual obligations for renewing the network. The OPEX and CAPEX are thus essential dimensions of the pricing structure—as they are in most other countries. This is why they are central to the simulations reported later in the paper.[13]

2 Basic statistical analysis of the reform effects

Before discussing the insights produced by the CGE modeling, it might be useful to provide an intuitive take on the distributional effects of reform from a basic statistical analysis. We first look at poverty in Senegal to provide a sense of how water-specific market characteristics have evolved.

According to Cissé (2003), the poverty head count ratio in Senegal grew significantly from the early 1980s to the mid-1990s. However, poverty has dropped since the first household survey was conducted in 1994–95 (ESAM I). The head count ratio had dropped from 58 percent to around 51 percent for households and from 65 percent to 59 percent for individuals when the second survey was conducted in 2000–01 (ESAM II).[14] One of the major characteristics of poverty in Senegal is that it is heavily biased toward rural communities, where more than 80 percent of the poor households are located. Historically, investment favored cities and a few rural areas, where we find a lower poverty head count ratio today (Cissé, 2003). In the 1970s, policies favored wage earners over agricultural workers. The exchange rate

[13] They will be central to our discussion here because they constitute the parts of the pricing structure most relevant to equivalent water reforms in other countries.

[14] Conveniently for this paper, the first survey was conducted just before the 1996 water reforms and provides a snapshot of the situation in 1994–95. The second provides an equivalent picture for 2000–01, four to five years after the initial policy change.

policies and protection of industries in the 1980s produced an overvalued CFA franc favoring, again, urban dwellers. Devaluation of the CFA franc in early January 1994 corrected part of this bias and allowed the economy some breathing room and reductions in the poverty level.

Table 1 presents an alternative snapshot of poverty in terms of the water sector market structure. It shows the changes that occurred between the two ESAM surveys with a breakdown of provider types (formal private versus public and neighborhood taps versus other—mostly informal) according to two characteristics that address the main distributional dimensions, regional access rates versus household access rates.[15] To provide a visual sense of these dimensions, the table disaggregates the households based on three main regional groupings (Dakar, other urban centers, and rural areas) and of income quintiles.[16]

The most obvious observation emerging from the data may be the regional differences. The picture is very different between rural and urban areas and within the two urban areas (other urban and Dakar). The picture is also different between Dakar and the other urban centers.

Table 1. Breakdown of the distribution of supply source for water (in percentages)

	Quintile 1		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	1995	Feb. 01	1995	Feb. 01	1995	Feb. 01	1995	Feb. 01	1995	Feb. 01
Rural										
Private	0.8	4.6	1.9	4.5	3.8	7.8	9.2	9.0	8.8	10.5
Public/neighborhood	16.8	18.6	21.0	24.7	26.7	30.7	29.0	31.6	27.1	28.4
Other sources	82.4	76.8	77.1	70.8	69.5	61.5	61.8	59.4	64.1	61.0
Other urban										
Private	26.6	26.5	30.6	42.3	45.7	54.3	53.2	66.8	72.8	71.8
Public/neighborhood	42.8	35.4	47.4	25.9	30.6	26.0	27.7	20.6	15.0	16.9
Other sources	30.6	38.0	22.0	31.8	23.7	19.7	19.1	12.6	12.1	11.4
Dakar										
Private	42.0	53.1	50.7	65.8	67.1	76.9	76.3	81.0	87.7	91.9
Public/neighborhood	47.9	35.6	40.2	29.1	23.7	17.6	18.3	17.2	10.5	7.0
Other sources	10.0	11.3	9.1	5.1	9.1	5.5	5.5	1.8	1.8	1.2

Sources: ESAM I and II.

[15] In the first two categories,water is supplied by SDE. In the case of private taps, households are linked to the SDE water network. In the case of communal or public taps, supply is linked to the SDE network, and a person is designated to sell water from the tap at a price different than the one charged by SDE. The margin charged for the public and communal taps can be quite high. For a more detailed description of the water market and prices, see Diagne, Briand, and Cabral (2004). In the private category, we aggregated households that have specified being supplied by house taps and concession taps in the ESAM surveys. In the public category, we included neighbor taps. In other sources, we included water vendors, cistern trucks, concession wells, village well surface water, and other sources.

[16] When aggregating the figures from this table, we found that 83 percent of the total urban households (Dakar plus other urban areas) are supplied by SDE water; the official government figure is 81 percent for 2002. Moreover, it is important to note that the quintiles are based on the three regions analyzed and that the breakdown was based on family expenditure per capita. Quintile 1 represents the poorest quintile, and quintile 5, the richest.

In rural areas, the share of the two sources of SDE-supplied water increased for all income groups, except in the fourth quintile for private provision (–0.1 percent). Overall, the other supply sources continued to prevail across rural income groups.

In Dakar, informal provision (“other sources,” above) increased among the poorest and decreased across all other income groups. The share of private tap provision rose for all groups, with the strongest increase for the second quintile. The two richest groups showed relatively small increases, but this outcome was expected given the already high coverage rate in 1995.

In the other urban centers, the picture is similar, except for the relative importance of more informal supply among the poorest group and the second quintile. Informal sources rose significantly for the bottom 40 percent of the population, while private and public provision dropped significantly for the poorest. Moreover, the poorest quintile did not see an increase in private provision, while the fourth quintile in the region was the biggest gainer, followed by the second quintile. More than half of the other urban households from the richest 60 percent of households are now supplied by private taps.

Overall, private providers have now essentially become the main source for Dakar and other urban centers, but informal providers continue to be the main suppliers in rural areas. Considering that informal providers tend to be more expensive and less reliable than private and even public providers, the bottom 20 percent of the population (in the other urban centers) appears to be worse off with the evolution of the market structure. Observing the data (see table 1), it is surprising to note that formal supply (private and public) to poor households does not seem to be one of the outcomes of the reforms so far. We observed only a slight increase for the rural poor (from 17.6 percent to 23.2 percent). The middle class may have benefited the most from the reforms. The second, third, and fourth quintiles enjoyed the most important increases in shares of private tap installation in all regions. At the other extreme, the poorest quintile in the other urban centers presented the worst case, with the percentage of formal supply decreasing and the percentage of informal supply increasing.

In table 2, we present the change in water expenditure as a share of total expenditure for the same household disaggregation as in table 1 to get a sense of any significant shift between formal private operators and others. From a regional distributional perspective, the most obvious observation stemming from a superficial look at table 2 may be that households in rural and other urban areas supplied by private taps generally saw their water expenditure drop, and for Dakar, households with private taps saw it increase. Unfortunately, given that the ESAMs provide the expenditure on goods, this evolution in the share of water consumption can be attributed to either a price change or a change in volume of water consumed or a combination of both. It is, however, interesting to note the difference in outcome between Dakar and the other regions.

In the comparison across income groups, the principal observation may be that for all households in the four lowest quintiles supplied by public or neighborhood taps, the share of water consumption decreased. For the richest quintile (quintile 5), the share increased. Once more, however, the welfare effect of this change is unclear since it reflects a combination of price and quantity effects. For households being supplied by other sources in rural and secondary cities, the share increased by quite a large proportion. In fact, considering Senegal as a whole, only 4 quintiles out of 15 supplied by other sources saw a drop in the share of their expenditures on water. For eight groups, the water expenditure share more than doubled between the two periods.

Table 2. Evolution of share of water expenditure in total expenditure from 1995 to 2000

	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Rural					
Private	1.0	–28.5	12.8	–4.1	–76.5
Public / neighborhood	–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 / neighborhood	–43.3	–12.1	–24.2	–30.5	23.9
Other sources	152.2	242.8	290.8	229.3	133.0
Dakar					
Private	12.6	10.2	6.6	3.6	10.9
Public / neighborhood	–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.

Overall, the prevalent drop in the share of households supplied by private, public, and neighborhood taps—combined with the frequent increase for households relying on other sources—hints at a possible problem with the overall strategy of addressing the needs of the poorest with the reforms, since the poor tend to rely on alternative sources. The only positive interpretation would be that most of the increase reflects a quantity effect rather than a price effect. However, given the size of the changes, price increases are most likely responsible for most of the changes in the expenditure share. The data, however, do not allow a clearer diagnostic.

Although this somewhat naive preliminary diagnostic provides useful information, it needs to be informed by the survey's technical dimensions. For one thing, the household survey was performed on a different sample of households. This could explain at least some of the changes observed. For another, we need to remember that the public and neighborhood supplies come in large part from an extension of the water supply network, which is one of the outcomes of the overall reform, including the increased participation of the private sector.

The general equilibrium analysis presented next offers a more robust story by allowing a wide range of simulations on the impact of changes in water pricing and financing options.

3 A computable general equilibrium model to assess the impact of water utility reforms

The model used here to document the impact of water sector reforms in Senegal is an adaptation of the Boccanfuso and others (2005) model used to assess the reforms of the groundnut sector in Senegal. In order to capture the impact of policies on individual household welfare, we integrated the elements of the water utility sector with the characteristics of the Senegalese economy. To do so, we isolated water production and then disaggregated the data into water produced by the utility company and water produced by informal suppliers.

Production is determined through a three-level system. Total production of a sector (XS) is made up of fixed shares (Leontief) 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 the VA subject to the Cobb-Douglas function. Optimal labor-demand equations are derived from this process. Labor is then broken down into qualified and unqualified labor, while 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.

The water market structure is modeled explicitly in terms of the types of suppliers and of their pricing models. Consistent with the reality faced by the utilities, we assumed that water utilities are subject to price controls (that is, exogenous to the model, which is roughly consistent with how the average tariff and the tariff structures are set in Senegal). This implies that the network will produce goods based on the constraint of a production function, and that the quantity of water supplied will respond to the demand.[17] The output of the sector is therefore demand driven given the fixed price on the market. Because capital is fixed, these sectors will need to hire out labor and to increase intermediate consumption to respond to an increase in demand; alternatively, the sectors will need to lay off workers and to reduce intermediate consumption when faced with decreases in demand. In the model, according to the information found in the household survey, the production sectors consume utility water and households can consume water from any of the sources. The utility company supplies all water consumed in the categories of private taps and public/neighborhood taps. Water purchased from the third group (see tables 1 and 2) is supplied by private, informal water producers. The private water producers are an important consumer of water produced by the utility company, but they have the option to substitute the two sources of water as their input for producing water.

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 demand for local goods. On the export side, 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 goods for one market or the other .

On the household side, we included in the model all 3,278 households of the first Senegalese survey (ESAM I, 94–95) to capture intragroup changes in the distribution of income. We did not need to specify any household groups in the model as we used a large number of households. With this approach, we

[17] 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.

circumvented one of the criticisms formulated by de Maio and others (1999) on household disaggregation in CGE modeling. 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 while factor payments are endogenous.

As capital is fixed by sector, we have 18 capital payments and 2 wages (qualified and unqualified). Dividends paid to households are also endogenous and are dependent on a firm's income after taxes. Inter-agent transfers are considered endogenous. The households that were heavily dependent on these transfers turned out to be vulnerable to differences in this variable. The other sources of income are exogenous transfers from other agents (government and the rest of the world).

Private firm 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 also isolated 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 was derived from a utility maximization process (Cobb-Douglas utility function), which leads to demand functions with a fixed-value share for each good. Households had specific marginal share parameters based on observed data in the household survey. Investment demand was also specified with a fixed-value share function. We used the GDP deflator as a price index, and as we stated earlier, world prices (for imports and exports) are exogenous. Accordingly, the country has no control over world prices.

Model equilibrium conditions are also standard for nonutility 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 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 in each market is exogenous and that there is no endogenous unemployment.[18] The current account balance and the nominal exchange rate are fixed, 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 the savings investment equilibrium, we have the total investment being determined by the sum of the agents' saving.[19]

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 (1984) P_{α}, and for inequality analysis we selected the Gini index. We used the

[18] This does not mean that we assumed that there is zero unemployment in the Senegalese economy but simply that unemployment is exogenous to the model.

[19] We simulated the policies with other macroeconomic closures and the general trends of the results remained even though we observed some slight changes in results. The complete set of equations, variables and parameters can be supplied by the authors upon request.

change in household 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-IMH model generates postsimulation changes in welfare, which are used for the poverty and inequality analysis. Target groups are defined independently of the CGE modeling exercise, and the poverty and inequality analysis can be performed for the base period and after the simulations.

4 Who should care about pricing and transfer reforms?

Section 3 showed how difficult it is to separate the quantity and the price effects of reforms in a simple comparison with basic statistical information. This section allows a refinement of the basic analysis by documenting 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 social impact of pricing and financing reforms that seek to improve cost recovery.

Because specific information on the pricing policies of operators, including the private operators, is not available, we present here simulations of the impacts created by various pricing strategies. We focus on strategies typically used by private operators in their efforts to improve cost recovery. We analyzed two broad types of policies. First, we focus on cost recovery only and compar 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 percent, and for CAPEX an increase of 35 percent.[20] The common wisdom is that the resulting increases in water tariffs will have a negative consequence on the welfare of poor households consuming SDE water; but the distributional impact is unclear, although many 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.

We conduct a second type of policy simulation by introducing a transfer program for poor households directly affected by the cost-recovery programs. The level of the transfer was household specific and implied that the operator was allowed to rely on cross-subsidies to meet the needs of the poor. In these scenarios, the transfer program was funded by the government through a reduction of public services. We also ran 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 aimed at improving cost recovery. Funding the program through these instruments allows the government to consistently maintain its public services. More specifically, we tested: (1) an increase in household income tax level, (2) an increase in value-added tax, (3) a program where the transfers would be funded

[20] As we are mainly interested in the impact of relative changes on multiple variables in the model, the precise price changes are not key in our exercise. Simulating larger nominal levels would not have modified our comparative analysis but would have affected the amplitude of the effects. We have undertaken some sensitivity analysis for this, and our results are quite robust. The difference in the simulation of the OPEX and CAPEX reflects the cost structure of the sector, which is presented in the appendix. This CAPEX represents approximately 23 percent of the total cost structure. We simulated the CAPEX as being just over 25 percent to have a round figure; we used 25 percent for OPEX and an additional 10 percent for the CAPEX.

by an external donor, and (4) 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 broken down into two sets are summarized in table 3. The second set of simulations includes the various financing options.

Table 3. Key to simulations

Set	Simulation	Code	Definition
1	Sim A	1A	OPEX 20 percent increase in the price of SDE water
1	Sim B	1B	Sim 1A + transfers program to poor households supplied by SDE
1	Sim C	1C	CAPEX 35 percent increase in the price of SDE water
1	Sim D	1D	Sim 1C + transfers program to poor households supplied by SDE
2	Sim A	2A	Sim 1C + household income tax to fund the transfers program
2	Sim B	2B	Sim 1C + VAT increase to fund transfers program
2	Sim C	2C	Sim 1C + foreign aid to fund the transfers program
2	Sim D	2D	Sim 1C + increase in import duties to fund the transfers program

Before we address the poverty and inequality analysis, let us first say that we do not analyze the general equilibrium effects of the reform, as this is not the focus of the paper. It is important to note, however, that the various simulated policies affected market prices and factor payments. Both formal and informal wages decreased in all scenarios; the strongest decrease was found for simulation 3, in which we found a reduction for the formal wage of 1.25 percent. The rental rates of capital, excluding the water sector, varied from a 0.8 percent increase for edible oil industries (in simulation 3) to a 2.5 percent decrease for the electricity sector (in simulation 7). All other variations fell between these values. The market prices were the least sensitive to the simulated policies when excluding the two water sectors. Price changes were in the range of –0.94 percent for private services (see simulation 3) to +0.44 percent for other industries (see simulation 7). It is therefore through these variations that the households will be affected; the CGE model used here allowed us to capture the price effects on water and other goods as well as the income effects through changes in factor payments. A partial equilibrium analysis would have excluded these effects.[21]

We now move to the poverty and inequality analysis under the different policy scenarios. Because we were interested in isolating the impact of the introduction of private operations to the network, we first separated the households on a regional basis, namely Dakar, other urban centers, and rural areas. Next we disaggregate households based on their source of supply (SDE versus other). The definition and relative importance of the groups are presented in table 4.

Table 4. Breakdown of groups and some statistics

Breakdown	Code	Definition	Percent
Regional	DKR	Dakar	33.39
	OURB	Other urban	26.44
	RURAL	Rural	40.17
Water supply	NSW	Not supplied by SDE	47.23
	SW	Supplied by SDE	52.77

Sources: ESAM I and II.

[21] A complete table of key variables of the CGE model can be provided by the authors upon request.

To obtain the benchmark case, we first looked at the changes in poverty indices at the national level before moving to the disaggregated regional analysis. We reported three measures of poverty: incidence, depth, and severity. *Incidence*—the share of poor in the total population—is the most common definition. For the base case, the poverty incidence (FGT 0) indicates that 57.86 percent of the population is poor, a figure that corresponds to the official statistic reported by Senegal for the base year. Poverty *depth*, FGT 1, reflects the difference between the poor's income and the poverty floor. Depth is a more refined measure of poverty than the simple proportion of poor in the total population measured by FGT 0. Poverty *severity*, FGT 2, is the square of the poverty depth figure. This measure boils down to a stronger weight for the very poor. (See table 5 for a summary of the results.)

Table 5. Variation of poverty indices at the national level

Percent

National									
		Set 1				Set 2			
	Reference	Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
FGT 0 (Incidence)	57.86	0.31	–0.19	0.57	–0.51	–0.35	–0.43	–0.43	–0.43
FGT 1 (Depth)	25.05	0.24	–0.57	0.40	–0.97	–0.87	–0.96	–0.98	–0.98
FGT 2 (Severity)	13.79	0.30	–0.64	0.49	–1.09	–0.98	–1.07	–1.10	–1.10

Source: From the authors' computations.

As expected, a policy aimed at increasing cost recovery in the water sector without adjusting transfers to protect the poor will produce a deterioration in all three poverty measures. The first simulation, 1A (an increase in OPEX cost recovery without transfers) indeed shows an increase of .31 percent in the poverty rate, of 0.24 percent in depth, and of 0.30 percent for severity.[22] The second simulated price increase is 1C (an increase in CAPEX cost recovery without transfers), which produces similar but stronger deterioration. Considering the size of the price increase, the effect on poverty is quite small, mostly because few poor households rely on SDE water. The second (1B) was a cash transfer to poor, SDE-supplied households. Even if this number is relatively small, the transfer produces a positive effect at the national level with a reduction of the head count index of 0.19 percent—this is even better for the depth and severity indices as they decrease respectively by 0.57 percent and 0.64 percent. So, the households adversely affected in the first simulation were the poor, SDE-consuming households.

Simulation 1D—which is the same as simulation 1B but with a stronger price increase (CAPEX)—suggests that the government-financed transfer policy has an even stronger poverty-reduction effect than the head count would suggest. Indeed, it reduces poverty depth and severity significantly more than incidence. 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 head count 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 or those financed by income taxes (2A) and value-added tax (2B).

[22] 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.

It was interesting to see whether our findings were modified when performing a disaggregated poverty analysis. (See Tables 6 to 8 for the results of poverty indices variations.) It is notable that, when using empirical distribution to compute poverty into a head count index, we often obtained weak or no effects because few households can be observed near the poverty line. For example, in table 6, the Dakar group is unaffected in simulation 1A. In this context, the poverty depth and severity indices are much more informative.

Table 6. Poverty incidence by regional/educational disaggregation

Percent

FGT 0: Poverty incidence									
Groups		Set 1				Set 2			
	Reference	Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	33.76	0.00	–0.62	1.29	–0.60	–0.05	–0.05	–0.05	–0.05
Other urban	43.01	1.32	–0.72	1.32	–1.24	–1.24	–1.24	–1.24	–1.24
Rural	71.28	0.21	–0.03	0.32	–0.37	–0.26	–0.37	–0.37	–0.37
Informal supply	72.59	0.33	0.33	0.56	0.44	0.56	0.56	0.56	0.56
SDE-supplied	41.66	0.28	–1.19	0.60	–2.33	–2.10	–2.33	–2.33	–2.33

Source: From the authors' computations.

We can see from the data shown in the upper part of table 6 that the two cost-recovery scenarios and transfer programs would affect regional users differently. Although the signs are the same, the intensities are quite different. The simulations 1A and 1C show that improved cost recovery increases poverty for three groups, with the other urban centers exhibiting the strongest effect and rural households the weakest. When adding the transfer program, we observed the opposite, with other urban centers being the biggest gainers and rural areas 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. The poverty level increases more for households not supplied by the SDE (informal supply), albeit not by much (0.33 percent versus 0.28 percent). This tells us that the general equilibrium effects on prices and wages plays a more important role in determining the final effects of this policy on households than on the increase in the price of water. It also reflects the fact that some of the informal providers are SDE clients and pass on the increase in water prices to their own users. This result is reversed for the CAPEX cost recovery (1C).

Given the depth and severity changes (evident in tables 7 and 8), however, we see that households supplied by SDE experience a rise in poverty (that is, 0.41 percent versus 0.16 percent for depth and 0.50 percent and 0.22 percent for severity). It is also interesting to note that the conclusion from the poverty depth and severity analysis changes the ranking of the effects in the regional breakdown. We now have the Dakar households most negatively affected in the cost-recovery strategy (1A and 1C) and the as biggest winners with the transfer program (1B and 1C).

Table 7. Variation of poverty depth by regional/educational disaggregation

Percent

FGT 1: Poverty depth

Groups	Reference	Set 1				Set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	12.64	0.55	–1.67	0.91	–2.89	–2.80	–2.93	–3.00	–2.98
Other urban	16.60	0.48	–1.53	0.80	–2.62	–2.45	–2.54	–2.59	–2.58
Rural	32.15	0.16	–0.27	0.26	–0.45	–0.36	–0.44	–0.45	–0.45
Informal supply	33.54	0.16	0.15	0.27	0.24	0.33	0.25	0.24	0.24
SDE-supplied	15.69	0.41	–2.25	0.68	–3.84	–3.72	–3.81	–3.86	–3.85

Source: From the authors' computations.

For the second set of simulations (with the transfer program funded by taxes and grants), we obtained an interesting reduction in poverty for Dakar and the other urban centers for the poverty depth and severity, from –2.45 to –4.00 (tables 7 and 8). The transfer program had a positive effect on the SDE water consumers but a negative effect on the non-SDE consumers regardless of the funding option. The tendency was similar for all three indices, but the positive effect was stronger for SDE consumers for poverty depth and severity.

Table 8. Variation of poverty severity by regional/educational disaggregation

Percent

FGT 2: Poverty severity

Groups	Reference	Set_1				Set_2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	6.37	0.67	–2.27	1.11	–3.87	–3.77	–3.91	–4.00	–3.97
Other urban	8.74	0.54	–1.73	0.89	–2.91	–2.77	–2.86	–2.91	–2.90
Rural	18.03	0.21	–0.27	0.36	–0.47	–0.36	–0.45	–0.46	–0.47
Informal supply	19.11	0.22	0.20	0.37	0.32	0.43	0.33	0.32	0.31
SDE-supplied	7.92	0.50	–2.86	0.83	–4.84	–4.73	–4.82	–4.87	–4.86

Source: From the authors' computations.

Overall, one of the most interesting conclusions of these simulations may be the indifferent impact of the funding programs for transfers on the informally supplied and rural households. But the impacts were perceptible for Dakar, other urban centers, and SDE-supplied households. It is notable that the poverty head count was almost unchanged for Dakar households when the poverty depth and severity produced relatively strong positive effects. But for rural households, the effect was almost the same for the three indices used in the second set of simulations. Finally, for the users unable to rely on SDE (the informal supply group), poverty rose in all four cases. This confirms that the reforms are likely to affect even the users not supplied by the utility operator. Note that many of these simulations clearly show that allowing cross-subsidies (simulation 1D) may have desirable poverty payoffs as compared with 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).

A picture of regional effects also emerged 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).[23]

5 The impact of funding schemes on income distribution

We used the S-Gini index to more formally analyze the changes in income distribution. (Results of variations from the index for Senegal and for population subgroups are presented in table 9.) First, the effects on inequality were relatively small. No changes above 1.18 percent were observed for all groups in any simulation. Second, all simulated policies reduced inequalities at the national level and for the subgroups analyzed. This is surprising because both the reforms and the various funding schemes simulated in section 5 generally left the users in Dakar better off on average.

Overall, the distributional effects are not dramatic, although they show that intra- and intergroup redistribution has different impacts. The intergroup redistribution contributes to reducing overall inequalities, but the intragroup redistribution contributes to rises in overall inequalities for the two cost-recovery scenarios (1A and 1C). The urban households benefit the most from decreased inequality for all cases in which the transfer program is applied. In the cost-recovery scenarios, rural households experience the greatest decreases in inequality.

Table 9. Variation of Gini index

S-Gini indices									
Groups		Set 1				Set 2			
	Reference	Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
National	0.485	–0.05	–0.33	–0.08	–0.55	–0.61	–0.47	–0.47	–0.46
Intergroup	0.322	–0.08	–0.37	–0.13	–0.62	–0.69	–0.53	–0.52	–0.50
Intragroup	0.163	0.01	–0.25	0.02	–0.41	–0.45	–0.37	–0.38	–0.37
Dakar	0.482	–0.001	–0.42	–0.002	–0.71	–0.78	–0.63	–0.63	–0.62
Other urban	0.440	–0.003	–0.58	–0.004	–0.98	–1.09	–0.90	–0.90	–0.89
Rural	0.417	–0.04	–0.18	–0.06	–0.29	–0.33	–0.24	–0.24	–0.23
Intergroup	0.262	–0.07	–0.22	–0.11	–0.36	–0.42	–0.29	–0.28	–0.27
Intragroup	0.223	–0.03	–0.45	–0.05	–0.76	–0.83	–0.69	–0.69	–0.68
Informal supply	0.407	–0.03	–0.03	–0.04	–0.05	–0.14	–0.03	–0.03	–0.03
SDE-supplied	0.478	–0.03	–0.67	–0.05	–1.12	–1.18	–1.03	–1.03	–1.01

Source: From the authors' computations.

[23] 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 percent 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, had less effect on rural households in the regional **breakdown** and on the informally supplied households. The household income tax (simulation 2A) reduced inequalities for all groups regardless of the disaggregation. This is not surprising as most households paying income tax in Senegal are relatively rich and households receiving the transfers are poor. The last three simulations have identical distributional effects on all groups. The analysis based on the water supply source produced expected results. We observed very little impact on the households not supplied by SDE (from –0.03 percent to –0.14 percent). As for the households supplied by SDE, we had reductions ranging from 0.03 percent for simulation 1A to 1.18 percent for simulation 2A (funding of the transfer program through the income tax).

6 Conclusion

In this paper, we first analyzed the evolution (before and after reform) of the water supply distribution in a sector now dominated by a privatized water utility. We analyzed raw data from household surveys. Although average access rates increased, we found that the network's expansion brought by the reforms did not help the two lowest quintiles of the population across regions. The biggest gainers were in the fourth quintile in other urban centers, the third quintile in rural areas, and the second quintile in Dakar.

We then used an integrated multihousehold CGE model to analyze the effects of possible pricing and financing changes from the reforms on social and economic dimensions of interest to policy makers. The analysis confirmed that, as expected, when the general equilibrium effects are accounted for, all groups are negatively affected by efforts to improve cost recovery unless the poor households are compensated after the associated price increase.

The analysis also showed that, through transfer programs, all groups in the regional breakdown appeared to benefit from the reform regardless of funding source. The gains were not, however, evenly distributed. The group winning the least was that of rural households in all scenarios with the transfer program. But when disaggregated based on source, the transfer program benefitted households supplied by SDE water and was unfavorable to other households. This conclusion is valid for all of the different funding options. The drivers of these results were price effects and income effects, both of which were captured in this analysis.

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

Because the 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. 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 for the different funding schemes of the transfer program.

Beyond the case of Senegal, the main interest of this paper may be to show that that the CGE-IMH, or integrated multihousehold, approach could be used quite effectively to study the effects of pricing and financing policies often associated with the privatization of utilities. It adds to results achieved from earlier CGE models 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.

References

Anderson, Lykke E., and Robert. Faris. 2002. “Natural Gas and Income Distribution in Bolivia.” Working Paper, Andean Competitiveness Project, February.

Armington, Paul S. 1969. “A Theory of Demand for Products Distinguished by Place of Production.” International Monetary Fund Staff Paper 16:159–176.

Bayliss, Keith. 2001. “Water Privatization in Africa: Lessons from Three Case Studies.” PSIRU Report no. 2001–05. London: University of Greenwich.

Benitez , Daniel, Omar Chisari, and Antonio Estache. 2003. “Can the Gains from Argentina’s Utilities Reform Offset Credit Shocks?” In C. Ugaz and C. Waddams Price, eds., *Utility Privatization and Regulation: A Fair Deal for Consumers?*, 175–202. Northampton, Mass.: Edward Elgar.

Boccanfuso, Dorothée, F. Cabral, and Luc Savard, 2005. “Une Analyse d’Impacts de la Libéralisation de la Filière Arachide au Sénégal: Une Application EGC Multi-ménages.” *Perspective Afrique* 1:1, 32–58.

Bourguignon François, Anne-Sophie Robilliard, and Sherman 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 (Eng.): Cambridge University Press.

———, and A. Spadaro. 2006. “Micro-Simulation as a Tool for Evaluating Redistribution Policies.” *The Journal of Economic Inequality*, 4(1): 77–106.

Chen, S., and M. Ravallion. 2004. Welfare Impacts of China’s Accession to the World Trade Organization. *World Bank Economic Review* 18(1): 29–57.

Chisari, Omar., Antonio Estache, and Carlos Romero. 1999. “Winners and Losers from Privatization and Regulation of Utilities: Lessons from a General Equilibrium Model of Argentina,” *The World Bank Economic Review* 13:2, 357–78.

———, Antonio Estache, and Catherine Waddams-Price. 2003. “Access by the Poor in Latin America’s Utility Reform: Subsidies and Service Obligations.” In Cecelia Ugaz and Catherine Waddams-Price, eds., *Utility Privatization and Regulation: A Fair Deal for Consumers?* Northampton, Mass.: Edward Elgar.

Cissé, Fatou. 2003. “Profil de Pauvreté au Sénégal: Une Approche Monétaire.” Rapport MIMAP-Sénégal, Centre de Recherche en Économie Appliquée (CREA), Université Cheik Anta Diop (UCAD), Dakar: Sénégal.

Cogneau, Denis, and Anne-Sophie Robillard. 2000. “Income Distribution, Poverty, and Growth in Madagascar: Micro Simulations in a General Equilibrium Framework.” IFPRI TMD Discussion Paper No. 61, Washington, DC: International Food Policy Research Institution.

Decaluwé Bernard., André. Patry, Luc Savard, and Erik. Thorbecke. 1999a. "Poverty Analysis within a General Equilibrium Framework." Working Paper 99-09, African Economic Research Consortium, Nairobi.

———, Jean-Christophe Dumont, and Luc Savard. 1999b. "How to Measure Poverty and Inequality in General Equilibrium Framework." Working Paper 9920. Québec: Université Laval, CREFA.

———, André. Martens, and Luc Savard. 2001. *La Politique Economique du Développement et les Modèles d'Equilibre Général Calculable*. Montréal: Presse de l'Université de Montréal.

de Maio, Lorenzo., Frances. Stewart, and Rolph. van der Hoeven. 1999. "Computable General Equilibrium Models, Adjustment and the Poor in Africa," *World Development* 27(3):453–470.

Dervis Kermal., Jaimie de Melo, and Sherman Robinson. 1982. *General Equilibrium Models for Development Policy*. London: Cambridge University Press.

Diagne, Abdoulaye, Anne Briand, and François Joshep Cabral. 2004. "Sector Reforms and Universal Access to Water in Senegal." UNRISD Project on Commercialization, Privatization, and Universal Access to Water. Mimeo.

Estache, Antonio. 2005a. "How Much Do We Know about Sub-Saharan Africa's Infrastructure and the Impacts of Its 1990 Reforms?" Paper presented at the Cape Town Conference on Private Participation in Infrastructure, Economic Growth, and the Poor in Africa, June.

———. 2005b. "On Latin America's Infrastructure Experience: Policy Gaps and the Poor." In J. Nellis and N. Birdsall, *Reality Check: The Distributional Impact of Privatization in Developing Countries*, 281–96. Washington, DC: Center for Global Development.

Foster, James, Joel Greer, and Erik. Thorbecke. 1984. "A Class of Decomposable Poverty Measures," *Econometrica* 52:3 761–66.

Hertel, Thomas, and Jeffrey Reimer. 2005. "Predicting the Poverty Impacts of Trade Reform." *Journal of International **Trade** and Economic Development* 14(4): 377–405.

Löfgren, Hans., Rachid Doukkali, Hassan Serghini, and Sherman. Robinson. 1997. "Rural Development in Morocco: Alternative Scenarios to the Year 2000." IFPRI TMD Discussion Paper 17, Washington, DC: IFPRI.

McCulloch, Neil, Alan Winters, and Xavier Cirera. 2002. *Trade Liberalization and Poverty: A Handbook*. London: Centre for Economic Policy Research and Department for International Development.

Montaud Jean-Marc, 2003. "Dotations en Capital et Pauvreté des Ménages au Burkina Faso: Une Analyse en Equilibre Général Calculable," *Revue d'Economie du Développement* 1: 42–72.

Morrison Christian. 1991. "Adjustment Incomes and Poverty in Morocco." *World Development* 19:11, 1633–1651.

MAH (Ministère de l'Agriculture et de l'Hydraulique). 2004. "Rapport Diagnostic ICEA Réforme, Mars 2004." Ministère de l'Agriculture et de l'Hydraulique, Dakar.

MEF (Ministère de l'Economie et des Finances). 2000. "Programme Triennal d'Investissements Publics (PTIP), 2000/02." Ministère de l'Economie et des Finances, Dakar.

———. 2001. Programme Triennal d'Investissements Publics (PTIP), 2001/03." Ministère de l'Economie et des Finances, Dakar.

———. 2002. "Programme Triennal d'Investissements Publics (PTIP), 2002/04." Ministère de l'Economie et des Finances, Dakar.

———. 2003. "Programme Triennal d'Investissements Publics (PTIP), 2003/05." Ministère de l'Economie et des Finances, Dakar.

Navajas, Fernando. 2000. "El Impacto Distributive de los Cambios en los Precios Relativos en la Argentina entre 1988–1998 y los Efectos de las Privatizaciones y la Desregulacion Economica." In Fundacion de Investigaciones Economicas Latinoamericanas (FIEL), ed., *La Distribucion del Ingreso en la Argentina*. Buenos Aires, Argentina: FIEL.

Rutherford, Thomas, David Tarr, and Oleksandr Shepotylo. 2005. "Poverty Effects of Russia's WTO Accession: Modeling 'Real' Household and Endogenous Productivity Effects," World Bank Policy Research Working Paper no. 3473. Washington, DC: World Bank.

Savard, Luc. 2005. "Poverty and Inequality Analysis within a CGE Framework: A Comparative Analysis of the Representative Agent and Microsimulation Approaches," *Development Policy Review* 23:3, 313–32.

Savard, Luc, and Epiphane Adjovi. 1998. "Externalités de la santé et de l'éducation et bien-être: Un MEGC appliqué au Bénin." *Actualité Économique* 74(3): 523–560.

Appendix

Cost structure of the formal water-production sector

CAPEX	Capital payments and investment	9,227
OPEX	Labor cost	5,441
	Intermediate input—other industries	15,543
	Intermediate input—Construction	331
	Intermediate input—Hotel and restaurant	72
	Intermediate input—Energy	197
	Intermediate input—Telecom	134
	Intermediate input—Water	37
	Intermediate input—Electricity	86
	Intermediate input—Transport	59
	Intermediate input—Commercial services	398
	Intermediate input—Other services	10,009
Value of sales	Total output at factor price	41,534
Losses 1996		463