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Abstract

This paper uses a computable general equilibrium (CGE) microsimulation model to explore the distributional and poverty effects of price reform in the electricity sector of Senegal. In the first part of the paper we analyze the distribution of electricity in Senegal by income quintiles, charting changes between 1995 and 2001. The analysis demonstrates that poor and rural households are not the main beneficiaries of the expanded network. The results of the CGE application show that direct price increases have a minimal effect on poverty and inequality, whereas the general equilibrium effects are strong and negative. Moreover, compensatory policies tested can help attenuate these negative effects on some poor households.

Keyword: computable general equilibrium model, microsimulation, poverty analysis, income distribution, privatization.

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1 Introduction

Privatization of public utilities is a hot topic in the policy arena. In Latin America, privatization efforts designed to improve efficiency and cost recovery have been associated with large price increases that have created enormous social and political tensions (Estache 2005a). In Africa, the privatization process has been more sluggish (Estache 2005b). Only recently has evidence begun to emerge on the effects of reforms in the few African countries that have followed Latin America's lead. By exploring the evidence from Senegal, this paper provides an early assessment of the impact of utility reforms in Africa.

An inadequate and unreliable supply of electricity is one of the most serious constraints to economic growth in Senegal (AFDB/OECD 2004). Demand is growing at 7–10 percent per year, while coverage in the rural parts of the country was less then 8 percent in 2001. The country's poverty reduction strategy calls for rural coverage to rise to 30 percent by 2015. Reaching that goal and meeting demand will require investments of at least $200 million and a thorough reform of the sector (Government of Senegal 2002).

Drawing hope from the country's positive experience with water sector privatization, the government of Senegal has made two attempts to privatize its public power company since the mid-1990s. At that time, the country's electricity sector was already perceived to be in poor shape, with poor billing practices, faulty meters, and fraud foremost among its many problems (Gökgür and Jones 2006). Only 30 percent of the population was connected to the grid, and most of the utility's generating equipment was nearing the end of its useful life.

The World Bank provided financial and technical assistance for the first attempt at reform of the electric utility. The tender process attracted four bidders, from which the HydroQuébec/Elyo was selected; the consortium assumed full management of the utility in January 1999. In September 2000, the new government of Abdoulaye Wade bought back the consortium's share of the utility—just 18 months after the privatization.[1] The second attempt was carried out independently by the government of Senegal. The consortium that won the tender refused to complete the deal, after which the government turned to the other bidder, which had problems raising funds—another failure. As of mid-2006, no new privatization plan was on the table, although external and internal pressure may oblige the government to initiate a new process in the next few years.

Whether and when the utility is privatized, raising the price of electricity may be necessary to generate the funds needed to reach the coverage target set in the poverty reduction strategy and to cover

[1] For an analysis of the reasons for the failure of early privatization attempts, see Gökgür and Jones (2006).

operating expenses. Raising prices has implications for economic activity in many sectors of the economy and for the distribution of income, subjects of great interest to the government. For the past ten years, the government has been the utility's deficits and hence cross-subsidizing consumers of electricity.

We use on a computable general equilibrium (CGE) model to analyze the impact of pricing reforms in the electricity sector in Senegal. 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. An economy-wide analysis can capture these feedback effects, particularly if it uses a multi-agent, multi-commodity approach. CGE models are very useful for simulating the economic and social impact of reforms when based on a detailed modelling of the socioeconomic structure of an economy in the form of a social accounting matrix (SAM), with its multisectoral disaggregation. How deep the analysis can go depends on data availability.[2]

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 Navajas (2000) did so for Argentina. Andersen and Faris (2002) did so for natural gas in Bolivia. And Löfgren *et al* (1997) did so for rural Morocco. But those are among the very few published papers on the topic. Boccanfuso *et al* (2005), on the water utility in Senegal, and Boccanfuso *et al* (2007) on the electricity utility in Mali, are more recent examples. Most of these contributions addressed the distributional issues of reform at a highly aggregated level, because good household data were scarce. The data have improved since the late 1990s, enabling a growing number of researchers to develop and apply macro–micro CGE modelling in developed and developing economies alike. Poverty analysis has been a central objective of this research.

The paper is organised as follows. The next section summarises electricity sector reforms in Senegal. Section 3 provides a very basic distributive analysis, comparing electricity supply before and after the first privatization attempt. We rely on a simple comparative analysis of two iterations of the Senegalese household survey—Enquête Sénégalaise Auprès des Ménages, or ESAM. ESAM-I was conducted in 1994–95; ESAM-II in 2000–01. The general equilibrium model we used to account for interactions between electricity and the rest of the economy is described in section 4. Section 5 provides a brief description of the macroeconomic and sectoral results of the CGE model, followed, in section 6, by a detailed poverty analysis based on hypothetical cost-recovery policies and equally hypothetical schemes

[2] For alternative reviews of CGEs for poverty analysis see Hertel and Reimer (2005) and Bourguignon and Spadaro (2007). The potential of CGE models was clearly identified early on, as seen in Dervis, de Melo, and Robinson (1982).

to finance those policies and minimise their impact on the poorest. Section 7 studies the income-distribution effects of the simulated scenarios simulated.

2 Electricity reforms in Senegal

2.1 Pricing issues

The pricing practices of Senegal's electricity utility, Senelec, resembles those used elsewhere. Senelec's customers are billed based on the amount of electricity they consume, measured in kilowatt hours. Prices are differentiated by voltage: users of higher voltages are billed the highest price, and the price drops with the voltage. Since March 2002 various pricing schemes have been implemented for specific clients. This practice allows some flexibility for real-time pricing, reflecting the fact that peak consumption is more costly than off-peak. Tariffs are relatively high by West African standards. In the subregion, only Burkina Faso has higher tariffs than Senegal. The high prices are a consequence of obsolete and inefficient equipment, poor management of transport and distribution, and strong reliance on petroleum products in the generation of electricity. Proposed changes in Senelec's prices must be authorised by an administrative process before taking effect. The regulator fixes a ceiling price, allowing Senelec to adjust its prices under this ceiling. The ceiling price is derived from a formula established by the Commission de Régulation du Secteur de l'Électricité (CRSE 2002).

2.2 Planned investments

The three-year public investment program for 2000/02 foresaw investments of 85,834 million CFA francs for the period—8 percent of the country's total productive investment. The plan confirmed the intent of the government to privatize Senelec and to increase the supply of electricity in Senegal. Other goals of the investment were to increase efficiency in production, improve the institutional framework for production and distribution, protect the environment, promote regional cooperation, and raise the rate of electrification in rural areas. The investment plan for 2001/03 painted a similar picture. The plan for 2002/04 reaffirms the importance of electrification but reintroduces the idea of privatization by signalling the government's intent to partially disengage itself from the sector. The plan for 2003/05 proposed an investment of 44,676 million CFA to achieve goals similar to those of earlier plans, except for environment protection, which was not mentioned.

2.3 Reforms and anticipated changes in the sector

Notwithstanding two failed attempts to privatize, the government reiterated its will to privatize Senelec in 2003. The reform would likely follow the terms of a 1998 council order to reform the electricity sector in Senegal. The main items of that reform were as follows:

- An independent regulatory body—the Commission de Régulation du Secteur de l'Électricité (CRSE)—was to be created. That has been done.
- For a period of 10 years, Senelec was to be restricted to buying and transmitting electricity produced by private independent producers. That part of the reform has been only partially applied.
- A concession system for licensing distribution and transmission was to be implemented, and the ban on licenses for production and sale of electricity abolished. Applications for licenses were to be filed with the CRSE and approved by the minister. That part of the reform has yet to be implemented.
- The last piece of the proposed reform was the privatization of the remainder of Senelec's activities. That was to consist of selling the monopoly's distribution network and production capacity.

To date, progress toward the chief goal of the proposed reform—to increase the supply of electricity and the share of the population with access to it—has been slight. The rural electrification rate remains very low: only 9.4 percent of rural households have access to electricity, despite the creation in 1999 of a rural electrification agency (*Agence sénégalaise d'électrification rurale*).

3 The distribution of electricity in Senegal

Before discussing the insights generated by our CGE modelling, it may be useful to get an intuitive reading of the distributional aspects of electricity supply reform. To do so, we first present some basic facts about poverty in Senegal before moving on to consider changes in the electricity network, by region, between 1995 and 2001.

The poverty headcount in Senegal grew significantly from the early 1980s to the mid-1990s (Cissé 2003) but now seems to be declining. Poverty dropped from 58 percent for households and 65 for individuals in ESAM-I (1994–95) to around 51 percent and 59 percent in ESAM-II (2000–01).[3] Poverty in Senegal is more prevalent in rural areas, where more the 80 percent of poor households are located.

[3] 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, 4–5 years after the initial policy change.

The households supplied by Senelec in the three broad regions of Senegal—Dakar, other urban areas, and rural areas—are broken down by income quintiles in table 1. In the six years between the two ESAM surveys, as the government began to reform the sector, the three areas progressed at different rates and from very different baselines.

Table 1 Households connected to Senelec by location and income quintile, 1995 and 2001

Percent

	Quintile 1		Quintile 2		Quintile 3		Quintile 4		Quintile 5	
	1995	2001	1995	2001	1995	2001	1995	2001	1995	2001
Dakar	48.72	61.15	58.41	79.96	79.64	85.78	86.83	91.69	93.52	97.30
Other urban areas	21.52	28.92	34.28	46.62	42.52	57.18	63.74	68.39	85.77	81.55
Rural areas	0.00	4.63	1.78	5.95	2.00	7.86	2.60	9.33	5.16	10.61

Sources: Computation by authors from data in ESAM-I and ESAM-II.

The share of rural households connected to the electricity grid in 1995 and 2001 was small, both absolutely and with regard to urban areas. Connection rates tripled among some rural income groups, but from very low baselines. In urban areas other than Dakar, connection rates were much higher than for rural areas, but only in 2001 did connection rates of the median income quintile exceed one-half. Much smaller shares of poorer households were connected in 1995 and 2001. In Dakar connection rates are higher, but here one notices relatively large differences between the poorest and richest quintiles in both years sampled.

After the failed attempt to privatize Senelec the overall coverage rate increased from 28.1 percent to 36.8 percent—a substantial increase (not shown in table 1). That increase was reported in the government's poverty reduction strategy paper, as approved by the International Monetary Fund and World Bank (Government of Senegal 2002).[4] Table 1 shows us which geographic and income groups benefited most from the increase. The largest nominal increase in the percentage of households supplied by Senelec was the second income quintile in Dakar (+21.6 percent), followed by the third quintile in other urban areas (+14.7 percent) and the poorest quintile in Dakar (+12.4 percent).[5] The only loser was the richest quintile in other urban areas, whose connection rate decreased by 4.2 percent. We also observe relatively small increases in the two poorest rural groups (quintile 1: +4.6 percent and quintile 2: +4.2 percent). The richest group in Dakar had a smaller increase, but considering that it started from a 93.5 percent coverage rate, its room for improvement was relatively limited.

[4] The exact figures presented in the PRSP are 28 percent for 1995 and 36 percent for 2001 (Government of Senegal 2002). As we did not round our figures, they are slightly different.

[5] These figures are obtained from the difference of the coverage rate for the two periods.

Overall, the rural–urban divide has widened since 1995, especially among the three poorest income quintiles. Although the coverage rate grew in rural areas, it did so at a slower pace than in the other two regions, accentuating the inequality between rural and urban households.

Increasing rural electrification to 30 percent by 2015 remains a major challenge. The overall rural connection rate increased from just 2.3 percent in 1995 to 7.6 percent in 2001. To reach the goal, the share of connected households would have to grow by 22.4 percent between 2002 and 2015.

4 A CGE microsimulation applied to Senegal

Since the late 1990s researchers have been using CGE principles to develop and apply macro–micro models in developed and developing economies. The impetus for this growing body of research was recognition of the unsuitability of the CGE representative agents approach (CGERA) for analysis of poverty and income distribution. CGERA does not allow researchers to taken into account within-group changes in income distribution, even though studies (Huppi and Ravallion 1991 and Savard 2005, for example) have shown that such changes can be greater than between-group inequality changes. This is true both for the static measure and for variations following policy simulations. Savard (2005), comparing the CGERA approach to a CGE microsimulation approach (a top–down/bottom–up approach to be discussed later), demonstrated that the results of poverty and income distribution analysis can be completely reversed by taking into account within-group distributional effects.

The CGERA approach divides households into groups, choosing a representative household for each group and using that representative household in the CGE model. Changes in the income of all households in each group are then inferred from the change of income of the representative household. But, as noted, ignoring within-group income redistribution can lead to misleading conclusions. A second approach, proposed by Decaluwé *et al* (1999) and applied by Cogneau and Robilliard (2000), Gørtz *et al* (2000), and Cockburn (2001), is the CGE integrated multi-household approach (CGEIMH). This method incorporates a large number of households from a household survey (and sometimes all of them) into the CGE model. The approach takes into account within-group distributional effects and has the further advantage of providing coherence between the micro and macro parts of the model, but at a cost. First, data reconciliation can be very problematic (Rutherford *et al* 2005); second, numerical resolution can be challenging (Chen and Ravallion, 2004).

The third approach is referred to as the CGE micro-simulation sequential method (MSS) and could be subdivided into two variants. The first one, micro-accounting, is formally presented by Chen and

Ravallion (2004) and extensively applied in recent years[6]. The second one, proposed by Bourguignon, Robilliard and Robinson (2005), consists in integrating at an individual level rich micro behavior observed at a household level such as consumption or labour supply. The general idea of the MSS approach is that a CGE module feeds market and factor price changes into a micro-simulation household module. The main criticism levelled at this approach is that the micro-feedback effect is not fully taken into account : the question has been raised in two literature reviews of macro-micro modeling for poverty analysis (Hertel and Reimer (2005) as well as Bourguignon and Spadaro (2007). However, Bourguignon and Savard (2007) found that the loss of information associated to using the MSS approach can be relatively small and policy conclusions were robust between the two approaches[7].

Here we applied the CGEMSS approach. The main reason for our choice is that we simulate conditional transfers to poor households in some scenarios, and such conditional transfers are difficult to handle using a standard CGEIMH model.[8]

Before describing the model in detail it is important to highlight the links between economic policy and household welfare. Economic policies and external shocks are transmitted to household incomes through mechanisms such as variations in prices of consumer goods and services and, more significantly, in the return on factors of production. Between the policy reform and the appearance of price changes, many interactions take place between production sectors as factors relocate. The structure of the economy, the behaviours of economic actors, and rules of macroeconomic closure also play important roles. To capture the impact of policies on the welfare of individual households, it is important to incorporate details of the question at hand, in this case Senegal's utilities and the structure and functioning of the nation's overall economy.

The model we used to analyze the impact of potential changes in the price of electricity and of policies to compensate the poor for those changes is an adaptation of the model used by Boccanfuso, Cabral, and Savard (2005) to assess the reforms of the groundnut sector in Senegal. In order to capture the impact of policies on individual household welfare, we integrated a detailed view of the electricity sector with an equally detailed view of the Senegalese economy. To start, we isolated electricity production from the electricity, gas, and water sector found in the original input/output table in the ESAM data.

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[6] Among early applications of this approach are Vos and De Jong (2003) and King and Henda (2003).

[7] Bourguignon and Savard (2007) comparative analysis between the IMH and MSS approaches was applied on the Filipino economy. In there study, the labour supply was endogenous and the largest portion of the gap in the results obtained from the two approaches came from the labour supply. The labour supply will be held constant in our application.

[8] Solving these models using the GAMS software with the standard algorithm, one cannot introduce conditional transfers within the model. The CGEMSS approach offers more flexibility without great loss of information, because our macro and micro database are fully coherent, and all household accounts have been balanced.

Access to Senelec's financial accounts allowed us to do this. The rest of this section provides a detailed presentation of the model we used.

For all sectors except electricity, total production of a sector (*XS*) is made up of fixed shares (Leontief shares) of value added (*VA*) and intermediate consumptions (*CI*). *VA* is a combination of composite labour (*LD*) and capital (*KD*) related using a Cobb-Douglas function. Producers minimise their cost of producing *VA* subject to the Cobb-Douglas function. Optimal labour demand equations are derived from this process. Labour is then decomposed into skilled and unskilled labour, with combinations of the two factors determined by the constant elasticity of the substitution function (CES). 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 structure of the electricity market is modelled with rigidities of factors (capital and labour are exogenous for this sector) and market price. Consistent with the reality faced by utilities in Senegal, we assume that the electrical utility is subject to price controls, so that the average tariff and tariff structure are givens. This implies that Senelec will produce electricity based on the constraint of a production function and that the quantity of electricity supplied will respond to demand. Since the factors are fixed, Senelec increases its output by increasing its purchases of the intermediate inputs (such as diesel fuel) that it uses to produce electricity. The output of the sector is therefore demand driven, given a fixed price on the market. In the model, production sectors consume electricity as an intermediate input, and households consume it as final consumption; these quantities are drawn from the household surveys.

Ours is a model of a small open economy to which world prices of imports and exports are exogenous. We posed the Armington hypothesis (1969) for import demand, whereby domestic consumers can substitute domestically produced goods with imports (imperfectly) according to an elasticity of substitution that is sector specific. Where local consumers have no preference between imported and local goods, we will have a high elasticity of substitution; inversely, the elasticity of substitution is low where consumers prefer one good over the other. The relative price of the two goods is the other determinant of the ratio of demand for 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 on each market and by their elasticity of transformation of the good for one or the other market.

We include in the model all 3,278 households covered in ESAM-I in order to capture intra-group changes in the distribution of income. Because we use all households of the survey, there is no need to specify household groups within the CGE model.[9] Our household income equations are consistent with the structure observed in ESAM-I.

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[9] Household decomposition can be done independently of the modeling exercise after policy simulations.

The initial factor endowments for labour and capital, as well as the endogenous transfers between agents, are important determinants of how household welfare changes under various policy simulations. In this model, factor allocations are exogenous; factor payments, endogenous. The other important element is the consumption structure of households, which will be affected by the price changes in the policy simulations. As capital is fixed by sector, we generate 18 endogenous capital payments and 2 wages (skilled and unskilled). 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 are heavily dependent on those transfers turn out to be very vulnerable to fluctuations in this variable. The other sources of income are exogenous transfers from government and the rest of the world, which are the last two agents in the model.

The income of private firms is computed as income less dividends plus government subsidies and transfers from the rest of the world. We consider Senelec as an agent in the model, separate from the government and private firms. In the baseline period, we used information from before the first privatization to reflect the situation at Senelec. In 1998, one year before the privatization and for 1 year after the first privatization, the government provided annual subsidies to Senelec around 4 billion CFA francs (CRSE 2003)[10]. This is the financial situation we used for the reference period. An increase in the price of electricity would help reduce the subsidy, which is endogenous in the model and determined by the difference between the revenues generated from sales of electricity and the cost of producing it.

Government revenue is made up of taxes on producers, customs duties, individual and business income and sales taxes, and transfers from the rest of the world (budgetary assistance and other foreign grants). The government spends its budget on public goods, transfers to households, subsidies to private firms, transfers to the rest of the world, and subsidies to public utilities, such as Senelec.

The household demand function is derived from a utility maximization process (Cobb-Douglas utility function), which produces demand functions in which each good has a fixed value share. Households have specific marginal share parameters based on observed data in the household survey. Investment demand is also specified with a fixed value share function. Our price equations are standard. We used the GDP deflator as a price index, and, as stated earlier, international prices (imports and exports) are exogenous. Accordingly the country has no control over the prices applied on the world market. The only specific item in terms of prices, as mentioned earlier, is that prices for utility services are exogenous to reflect the observed facts.

Our model equilibrium conditions for non-utility markets are also standard. The commodity market is balanced by an adjustment of the market price of each commodity. The labour market is

[10] In fact it varied from 4 to 6 billion CFA francs during the period. We used the 4 billion figure in our model.

segmented and balances out with an adjustment of the nominal wage on each of the respective markets (skilled and unskilled). It is therefore possible for workers to move from one sector to the other, but not from one market to another. Labour supply in each of the markets is fixed, and there is no unemployment.[11] The price index and the nominal exchange rate are fixed, and hence the current-account balance is left endogenous. With regard to the equilibrium of savings and investment, total investment adjusts to the sum of the savings of all agents in the model.[12]

The diagnostic of poverty and inequality changes is based on two indexes commonly used in macro–micro modelling. The poverty index we chose is the P_α index of Foster, Greer, and Thorbecke (1984).[13] For inequality, we chose the Gini index. The CGEMSS model generates post-simulation changes in welfare that are then used for poverty and inequality analysis. Target groups are defined independently of the CGE modelling exercise, and poverty and inequality analysis can be performed for the reference period and after simulations. This approach, standard in macro–micro CGE analysis, has the advantage of taking into account price and income effects simultaneously.

5 Analysis of the impact of electricity reform

One of the main concerns associated with electricity pricing reform in Senegal, as in most other developing countries, is the social impact of pricing and financing reforms aimed at improving cost recovery. This section refines the basic distributional analysis of section 3 by capturing the income and price effects created by various simulated electricity pricing and targeting policies, acting on general equilibrium.

We modelled two cost-recovery objectives. The first was to pay for operating costs (OPEX) only; the second was to increase recovery to fulfil the country's investment objectives for the electricity sector. We dubbed this second assumption CAPEX, for capital expenses. To obtain the price increase necessary for OPEX recovery, we simulated price increases in the model until we eliminated Senelec's subsidy from the government. The result of that procedure led us to a 10.6 percent increase in price of electricity. To arrive at the CAPEX recovery price, we used the ratios in Modi (2006), in which he presents the total cost structure for electricity production in Senegal, including capital investment needs. Capital expenses

[11] This does not mean that we assume that zero unemployment in the economy but rather that unemployment is exogenous to the model.

[12] We simulated the policies with other macroeconomic closures. The general trends of the results were maintained, although we observed some slight changes in results. A complete set of equations, variables, and parameters can be obtained from the authors.

[13] The poverty indexes of de Foster, Greer, and Thorbecke (1984) are additively decomposable; as such they are useful for this analysis because they allow us to measure not only the proportion of the poor among the population but also the depth and severity of poverty. For detailed information on this index family, see Ravallion (1994).

represent 74 percent of total cost; operating expenses, 26 percent. Applying that ratio to the 10.6 percent increase needed to meet the OPEX recovery goal, we obtained a price increase of 40.6 percent to achieve CAPEX recovery.

The common wisdom is that increases in electricity tariffs to achieve cost-recovery objectives will negatively affect the welfare of poor households that consume electricity. Critics of cost-recovery policies argue that the poor are likely to suffer relatively more than better-off households because the share of electricity in their total consumption is greater. But such reasoning is based only on the direct (partial equilibrium) effect induced by the price hikes. As we will see below, increases in the price of electricity have general equilibrium effects that may be greater than the direct effects.

In a second type of policy simulation we introduce a transfer program for poor households directly affected by the cost-recovery programs. The transfers are household specific, implying that the operator is allowed to rely on cross-subsidies to meet the needs of the poor. In a first set of scenarios, the transfer program is funded directly by the Senelec but indirectly by the government through its subsidy. We also run a second set of simulations comparing cross-subsidies to various types of tax instruments and to foreign grants as sources of financing for the transfer programs. Funding the program through these instruments allows the government to maintain its public services constant. More specifically, we test: (i) an increase in the value-added tax, (ii) an increase in import duties, and (iii) an increase in household income tax rates. We also explore a program in which the transfers are funded through foreign grants. Although the differences in impact of the various financing instruments proved to be relatively minor, we report all the results. For reference, the eight simulations are summarised in table 3. The second set of simulation comprises the financing options.

Table 2 Definition of simulations

Simulation	Costs to be recovered	Definition
1A	OPEX	10.6 percent increase in the price of Senelec power
1B	OPEX	Sim 1A + transfers program to poor households supplied by Senelec
1C	CAPEX	40.6 percent Increase in the price of Senelec power
1D	CAPEX	Sim 1C + transfers program to poor households supplied by Senelec
2A	CAPEX	Sim 1D + VAT increase to fund transfer program
2B	CAPEX	Sim 1D + increase in import duties to fund transfer program
2C	CAPEX	Sim 1D + increase household income tax to fund transfer program
2D	CAPEX	Sim 1D + foreign aid to fund transfer program

We focus first on the two simulations involving recovery of operating expenses (OPEX simulations 1A and 1B) before moving on to those designed to simulate the recovery of both operating and capital expenses (CAPEX simulations 1C–D and 2A–D).

5.1 *First set of simulations: OPEX funding and CAPEX funding*

We first examine the impact of raising electricity tariffs by 10.6 percent to fully recover operating expenses (simulation 1A). The change produces a very slight decrease (–0.23 percent) in government revenue (table 3). The two other agents in the economy also show a decrease in income: aggregate households experience a drop of 0.16 percent; firms, 0.26 percent.

Table 3 Key macro results of simulations

Variable	Baseline	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Aggregate household income	1776.2	–0.16	–0.11	–0.60	–0.51	–0.41	–0.41	–0.41	–0.41
Skilled wage	1.00	–0.01	–0.03	–0.62	–0.13	–0.66	–0.65	–0.62	–0.63
Unskilled wage	0.50	–0.23	–0.23	–0.72	–0.56	–0.75	–0.75	–0.72	–0.73
Government revenue	614.9	–0.23	–0.21	–0.58	–0.55	–0.10	–0.11	–0.11	–0.11
Government savings	94.9	3.31	2.64	12.22	9.34	12.22	12.22	12.22	12.22
Business income	967.3	–0.26	–0.26	–0.79	–0.87	–0.78	–0.78	–0.79	–0.79
Total investment	939.6	–0.24	–0.30	–0.21	–0.51	–0.12	–0.30	–0.21	–0.47
GDP	2105.6	0.00	0.00	–0.01	0.01	–0.01	–0.01	–0.01	–0.01
Senelec subsidy	4.60	–100.0	–83.6	–331.2	–268.1	–267.9	–268.2	–268.1	–268.4

Baseline or reference period variables are in billion CFA francs with the exception of wages. Simulation results are percentage change from reference period.

The downward pressure in income for households at the micro level is mainly caused by the decrease in the unskilled wage rate (–0.23) percent. The capital income component of household income again at the micro level also produces downward pressure on household income as we observe a reduction in most rental rates of capital for non-utility sectors (13 out of 14 sectors, table 4). The decrease firm income is essentially caused by the same factor.

Table 4 Variation in rental rate of capital

Sector	Baseline	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Agriculture	1.00	–0.04	–0.01	–0.30	–0.21	–0.19	–0.18	–0.30	–0.17
Forestry	1.00	–0.17	–0.22	–0.14	–0.34	–0.11	–0.20	–0.14	–0.38
Livestock	1.00	–0.20	–0.22	–0.34	–0.54	–0.18	–0.31	–0.34	–0.41
Fish industries	1.00	–0.04	–0.08	–0.15	–0.11	–0.15	–0.26	–0.15	–0.29
Edible oil industries	1.00	0.45	0.44	1.15	1.03	0.42	0.61	1.15	1.13
Other food industries	1.00	–0.10	–0.10	–0.43	–0.45	–0.53	–0.45	–0.43	–0.43
Mining	1.00	–0.04	–0.06	–0.20	–0.29	–0.29	–0.31	–0.20	–0.25
Other industries	1.00	–0.58	–0.57	–1.71	–1.52	–1.94	–1.73	–1.71	–1.72
Refineries and energy	1.00	–0.43	–0.37	–1.60	–1.37	–1.56	–1.54	–1.60	–1.35
Construction	1.00	–0.49	–0.59	–0.66	–1.18	–0.65	–0.97	–0.66	–1.13
Tourism	1.00	–0.55	–0.58	–1.77	–1.79	–1.88	–2.09	–1.77	–1.90
Telecom	1.00	0.24	0.24	0.80	0.57	0.69	0.68	0.80	0.79
Water Utilities	1.00	1.08	1.00	1.67	0.70	1.18	1.18	1.67	1.53
Transport	1.00	–0.17	–0.16	–0.56	–0.53	–0.60	–0.55	–0.56	–0.51
Electricity	1.00	17.97	17.97	59.52	59.53	59.49	59.54	59.52	59.58
Commercial services	1.00	–0.54	–0.55	–1.17	–1.51	–1.23	–1.21	–1.17	–1.28
Other services	1.00	–0.40	–0.35	–1.11	–0.94	–1.00	–0.98	–1.11	–0.94

At the sectoral level, as expected we observe strong increases in the cost of capital in the electricity producing sector (+17.97 percent). The strongest decrease in the rental rate of capital outside the utility sector is found in the “other industries” category (–0.58 percent) and in tourism (–0.55 percent). On the other hand, the increase in the price of electricity produces a strong drop in its demand whenever there is some demand flexibility. When the demand for electricity is determined by a Leontief function (as in the production sectors) the increase in price will be transmitted into an increase in production cost. This will lead to an increase in the producer price of goods that use electricity intensively in their production process.

At this point it is useful to highlight how higher electricity prices affect other productive sectors of the economy (table 5). The two factors that exert the greatest relative impact on output in the productive sector are the cost of electricity (used as an input in production for many sectors) and the cost of unskilled labour. Sectors that use relatively more unskilled labour and less electricity will derive the greatest advantage from higher electricity prices, as their production costs will drop relative to those of other sectors. The two sectors in this group are the edible oils (+0.38 percent) and the fish industries (+0.07 percent). Output increases, very slightly, in just five other sectors increase. The greatest decreases are in tourism (–0.19 percent) and refineries and energy (–0.15 percent).

Table 5 Variation in value added or output by sector

Sector	Baseline	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Agriculture	23.06	0.01	0.02	0.08	0.02	0.11	0.11	0.08	0.11
Forestry	1.71	0.01	–0.01	0.18	0.04	0.19	0.16	0.18	0.10
Livestock	17.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fish industries	4.98	0.07	0.04	0.37	0.19	0.39	0.31	0.37	0.27
Edible oil industries	0.95	0.38	0.37	1.12	0.90	0.70	0.81	1.12	1.11
Other food industries	14.29	0.02	0.02	0.07	–0.01	0.05	0.07	0.07	0.07
Mining	3.19	0.01	0.01	0.04	0.01	0.03	0.03	0.04	0.03
Other industries	14.94	–0.11	–0.11	–0.26	–0.29	–0.31	–0.26	–0.26	–0.27
Refineries & energy	0.83	–0.15	–0.11	–0.50	–0.52	–0.46	–0.45	–0.50	–0.36
Construction	9.12	–0.05	–0.07	0.01	–0.12	0.01	–0.04	0.01	–0.07
Tourism	2.07	–0.19	–0.20	–0.52	–0.66	–0.55	–0.66	–0.52	–0.58
Telecom	7.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Utilities	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	10.65	0.01	0.01	0.04	–0.01	0.04	0.05	0.04	0.06
Electricity	2.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial services	30.24	–0.05	–0.05	–0.05	–0.12	–0.06	–0.05	–0.05	–0.06
Other services	46.20	–0.04	–0.03	–0.06	–0.08	–0.04	–0.04	–0.06	–0.04
Public services	22.08	0.00	0.00	0.17	0.86	0.15	0.13	0.17	0.15

Baseline or reference period variables are in billion CFA francs

After factor prices, the other key element that will affect household welfare following a tariff increase is the price of goods and services. As mentioned, the price of electricity increases exogenously by 10.6 percent in simulation 1A. That increase will have a direct impact on the cost of the household consumption basket for the 28.1 percent of households that consume electricity. When excluding the electricity price, we observe an increase in most other market prices (table 6), with the strongest drop found in commercial services (–0.31 percent) followed by other services (–0.30 percent). Those decreases will have a positive effect on the welfare of households that do not consume electricity, a great many of which are poor (table 2)[14]. As the rental rates of capital tend to decrease as well as wages, the combined income and price effect becomes ambiguous. The situation will be clarified by the poverty and inequality analysis offered in section 6.

14 It is important to note that in a CGE context, we look at relative price changes. As we have a price index that is exogenous, other prices change relative to this price index following the different policy simulations we have performed.

Table 6 Variation in market prices

Sector	Reference	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Agriculture	1.03	–0.11	–0.11	–0.35	–0.33	–0.28	–0.28	–0.35	–0.33
Forestry	1.07	–0.21	–0.22	–0.45	–0.51	–0.36	–0.39	–0.45	–0.52
Livestock	1.00	–0.21	–0.22	–0.37	–0.55	–0.25	–0.34	–0.37	–0.44
Fish industries	1.00	–0.26	–0.27	–0.65	–0.66	–0.62	–0.63	–0.65	–0.69
Edible oil industries	1.18	–0.16	–0.15	–0.48	–0.41	–0.21	–0.13	–0.48	–0.44
Other food industries	1.10	–0.15	–0.15	–0.36	–0.37	–0.24	–0.16	–0.36	–0.37
Mining	1.01	–0.04	–0.04	–0.08	–0.09	–0.07	–0.07	–0.08	–0.09
Other industries	1.17	–0.11	–0.11	–0.22	–0.19	–0.07	0.00	–0.22	–0.22
Refineries & energy	1.04	–0.18	–0.17	–0.54	–0.43	–0.39	–0.40	–0.54	–0.49
Construction	1.01	–0.28	–0.32	–0.47	–0.63	–0.38	–0.49	–0.47	–0.65
Tourism	1.01	–0.11	–0.11	–0.15	–0.12	–0.02	0.00	–0.15	–0.17
Telecom	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water–Utilities	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Transport	1.02	–0.17	–0.16	–0.46	–0.41	–0.40	–0.38	–0.46	–0.43
Electricity	1.02	10.58	10.58	40.63	40.63	40.63	40.63	40.63	40.63
Commercial services	1.02	–0.31	–0.32	–0.66	–0.80	–0.64	–0.65	–0.66	–0.70
Other services	1.01	–0.30	–0.27	–0.82	–0.64	–0.71	–0.69	–0.82	–0.69
Public services	1.00	0.00	0.00	–0.17	0.12	–0.15	–0.13	–0.17	–0.15

In the second simulation (1B) we add a transfer to poor households connected to the electrical grid. The transfer is designed to compensate for the direct effect of the increase in the price of electricity. The differences from the previous simulation are relatively small, with a few notable exceptions. The decrease in the skilled wage is slightly greater, and aggregate household income decreases less (by –0.11 percent versus –0.16 percent). The same is true for government, which loses less revenue in this scenario. For firms the situation is unchanged. The main change comes in government savings, as the funds for the transfer program come from this source. The weaker increase in government savings (+2.64 percent for simulation 1B, versus +3.31 percent for 1A) produces a larger decrease in total investment (–0.30 percent versus 0.24 percent). The unskilled wage remains unchanged. The decrease in the skilled wage is likely to have a negative effect on households that depend on this type of labour, which we will analyze in the next section. The effect on output by sector (table 5) and market prices (table 6) are not markedly different from the previous simulation and thus do not require detailed analysis. We note, however, that the largest difference in market price occurs in the construction sector, which moves to –0.32 percent in simulation 1B from –0.28 percent in 1A. Regarding output, the greatest change between the two simulations occurs in refineries and energy (from –0.15 percent to –0.11 percent).

Simulation 1D models a 40.6 percent increase in the price of electricity, combined with a targeted transfer program for the poor. The amplitude of the effects is stronger (not surprisingly), implying that we will detect greater effects on poverty and inequality, analyzed in the next section. But the macro and sectoral values show no changes in sign, except that the output for transport services moves from a very slight increase in 1A (+0.01 percent), 1B (+0.01 percent), and 1C (+0.04 percent) to an equally slight decrease in 1D (–0.01 percent).

5.2 Second set of simulations: CAPEX funding plus transfer program, under various funding options

We will analyze the last four simulations simultaneously. As a group they explore the best way to generate the income necessary to finance transfers to poor households while maintaining government expenditure constant. The results of the four simulations differ very little at the macro and even at the sectoral level. Because the transfers to the poor households connected to Senelec's grid do not represent a very large sum, the increases in various taxes and transfers necessary to fund the program generate limited general equilibrium effects. Funding the transfer program through foreign grants shows the strongest differences from the other simulations.

Concentrating on the variables central to welfare changes at the household level—namely factor prices and the prices of goods and services—we note that variations in wages are almost identical. Funding the transfer program through an increase in the household income tax (simulation 2C) produces effects that are almost identical to those of simulation 1C. The other three options produce differentiated effects on the two sectoral variables of interest (rental rate of capital and market prices). With regard to the rental rate of capital (table 4), the funding options that involve increases in the VAT (simulation 2A) and import duties (2B) produce the most marked differences over simulation 1C. The greatest difference (0.73 percent) is found in edible oils when the VAT is used to fund the transfers. With regard to market prices (table 6), the largest average differences are produced by the import duty option; once again the largest difference (0.35 percent) occurs in the edible oil industries. In the next section we will see whether the sectoral differences produce differential effects on poverty and inequality. The final comment to be made in this section is that, of the four funding options, the foreign aid option (simulation 2D) produces the strongest effects on market prices and the rental rate of capital. Thus it could potentially have the greatest effect on poverty and inequality.

6 The effect of power price increases on poverty and income distribution

We will now analyze the differential effects of the various policy scenarios on poverty and inequality. We divide Senegalese households into three categories—those living in the capital, those living in other urban areas, and those living in rural areas—reflecting the major differences in the cost of extending the electrical network in those areas. Next we distinguish households that are connected to the grid from those that are not. The results of these breakdowns appear in table 8.

Table 8 Decomposition of groups and some statistics

Decomposition	Definition	Percent
Region	Dakar	33.39
	Other urban	26.44
	Rural	40.17
Electricity supply	Not supplied	71.89
	Supplied	28.11

Source: ESAM I.

6.1 Poverty

To get an average benchmark, we will first look at changes in poverty at the national level before analyzing the regional decomposition. We report three measures of poverty—incidence (or headcount), depth, and severity—following the usage of Foster, Greer, and Thorbecke (1984). Incidence, which reports the share of poor in the total population, is the most common index, but it provides a limited view of poverty. In the baseline case, the measure of poverty incidence (FGT0) at the national level reveals that 57.86 percent of Senegal's population is poor (table 9). That figure corresponds to the official statistic reported by Senegal for the base year. A second measure—depth of poverty (FGT1), captures the difference between the income of the poor and the poverty line. It is a richer measure of poverty than is the proportion of the poor in the population. The third measure—the severity of poverty (FGT2)—is the square of the poverty depth. It has the effect of giving greater weight to the very poor. Table 9 reports the effect of all eight simulated reform policies on each of the three poverty measures.

Table 9 Variation of poverty indexes at the national level in Senegal

National									
	Reference (percent)	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Poverty headcount (FGT0)	57.86	0.24	0.17	0.65	0.54	0.58	0.48	0.48	0.54
Depth of poverty (FGT1)	25.05	0.17	0.10	0.52	0.28	0.27	0.26	0.32	0.26
Severity of poverty (FGT2)	13.79	0.21	0.13	0.64	0.37	0.37	0.35	0.42	0.35

Source: Computed by the authors using the Foster, Greer, and Thorbecke (1984) indices.

As one would expect, increasing cost recovery without providing any compensation to the poor results in a deterioration in the three poverty measures. The first simulation 1A (a 10.6 price increase with no compensatory transfers to the poor) delivers an increase of 0.24 percent in the incidence of poverty, 0.17 percent in its depth, and 0.21 percent in its severity (table 9). The other simulated price increase without transfers program (simulation 1C) produces similar but somewhat stronger effects. Surprisingly, however, the differential effects are minor considering the size of the price increase (40.6 percent vs. 10.6 percent). The mystery is explained by the relatively small portion of household connected to the grid (28.1 percent) and of those connected, and the poor households represent less then half of this group.

In the second simulation (1B) poor households that consumed electricity received a cash transfer. Although their number is small, the transfer produces a positive effect at the national level by reducing, but not reversing, the poverty-inducing effect of the previous simulation, revealing that the direct negative effect of the price increase is weaker then its general equilibrium effect.

A partial equilibrium analysis of the price increase plus transfer would certainly have shown a reduction in poverty (or no change), because all poor households directly affected by the price increase would have received a compensating cash transfer. Our results show that the negative effect of the price increase on wages and on the rental rate of capital dominates the direct effect of the increase. They also show that the households negatively affected in the first simulation were not the poor households that consume electricity. Simulation 1D, which differs from simulation 1B only in the magnitude of the price increase, shows that the transfers have a similar poverty-reducing effect but not strong enough to reverse the negative effects of the increase on the poverty indexes.

When the transfer program is funded from sources other than government savings (simulations 2A–D), it produces a very similar effect at the national level. We observe slight differences in the headcount ratio for simulations 2B and 2C, where the impact of the price increase is weaker than for simulations 2A and 2D. Simulation 2C (household income tax) produces the greatest differences from simulation 1D, but once again the differences are small.

Will our findings change if we apply the poverty analysis to various segments of the population? Tables 10–12 summarise the variations in the three poverty indexes when the simulations are run on distinct segments. When using empirical distribution to compute the poverty headcount index, as we do here, we often obtain weak or no effects, because too few households in any given category can be observed around the poverty line. For example, the poverty headcount among Dakar residents is unaffected in simulation 1A and 1B (table 10). In this context the poverty depth and severity indexes are much more informative.

Table 10 Variation in poverty incidence by regional/educational decomposition

Groups	Reference (percent)	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	33.76	0.00	0.00	1.09	0.40	0.71	0.40	0.40	0.40
Other urban areas	43.01	1.01	0.80	1.44	0.80	0.80	0.80	0.80	0.80
Rural	71.28	0.15	0.10	0.44	0.52	0.52	0.44	0.44	0.52
Unconnected	72.59	0.24	0.19	0.59	0.67	0.71	0.59	0.59	0.67
Connected	41.66	0.21	0.00	1.06	–0.41	–0.41	–0.41	–0.41	–0.41

Source: Authors' calculations.

The first three rows of table 10 do suggest, however, that the two cost-recovery scenarios and the transfer program would affect users differently, depending on where they lived. Although the signs do not change, the intensity of the simulated effects varies by region. We observe an increase in the poverty headcount ratio for all simulations and groups, with the exception or Dakar group where no effect is observed. The other urban group shows the strongest effect for all simulations; Dakar households show the weakest effect in most simulations (the exceptions are 1C and 2A).

The last two rows of the table track the difference in the poverty-headcount impact of price increases on households connected to the electricity grid and those not connected. Our comment about changes at the national level is confirmed here: the transfer program is indeed positive for connected households and negative for those not connected. The only negative scenarios for connected households are the two simulations (1A and 1C) not involving transfers. It is interesting that simulation 1A has a stronger negative effect on nonconnected households than on connected ones (0.24 percent versus 0.21 percent), whereas simulation 1C has a stronger effect on the connected households (1.06 percent versus 0.59 percent). If the direct effect of the price increases were the main factor at work, this reversal would not occur. Instead, it is clear that general equilibrium effects on prices and wages play a more important role in determining the final effects of higher power prices on households than does the price of electricity, considered only in its direct effect.

The effects of simulations 1A and 1C on poverty among connected households appear greater when poverty is measured using the other two poverty indexes—depth and severity (tables 11 and 12).

Examining now the depth and severity indexes of the three regional groupings, we note that the negative effects of the simulations on the other urban households are attenuated in all simulations compared with their effect on the poverty headcount. This is also partially true of rural households, but the severity index for rural households produce stronger effects than the headcount index in half the simulations. As for the Dakar households, the picture is reversed. The depth and severity indexes show stronger negative effects under the first three simulations (two of which involve no transfers). Interestingly, the transfer program produces a positive effect—that is, a reduction in the poverty indexes—in three scenarios: 1D, 2B, and 2D. For Dakar residents, therefore, the combined price increase and transfer program produces positive general equilibrium effects; the transfer program helps cancel the negative partial equilibrium effect.

Table 11 Variation in depth of poverty by regional/educational decomposition

Groups	Reference (percent)	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	12.64	0.35	0.06	1.08	–0.07	0.02	–0.01	0.10	–0.02
Other urban areas	16.60	0.38	0.19	1.10	0.42	0.43	0.39	0.48	0.40
Rural	32.15	0.12	0.10	0.35	0.31	0.29	0.28	0.34	0.28
Unconnected	33.54	0.15	0.13	0.45	0.42	0.41	0.40	0.46	0.40
Connected	15.69	0.41	–0.21	1.24	–1.10	–1.05	–1.09	–1.00	–1.10

Source: Authors' calculations.

The second set of simulations demonstrates that the best ways to fund the transfer program would be through increases in import duties (2B) or through foreign aid (2D). The least desirable option would be the household income tax (2C), which produces the strongest negative effect on the three regional groups using both the depth and severity indexes.

Table 12 Variation in severity of poverty by regional/educational decomposition

Groups	Reference (percent)	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
Dakar	6.37	0.43	0.08	1.32	–0.05	0.07	0.03	0.15	0.02
Other urban areas	8.74	0.40	0.20	1.19	0.44	0.45	0.42	0.51	0.42
Rural	18.03	0.16	0.13	0.48	0.42	0.40	0.38	0.45	0.39
Unconnected	19.11	0.19	0.17	0.57	0.54	0.52	0.51	0.57	0.51
Connected	7.92	0.48	–0.30	1.46	–1.45	–1.38	–1.43	–1.31	–1.43

Source: Authors' calculations.

The most interesting overall conclusion of these simulations may be that the general equilibrium effects of the cost-recovery strategy seem to dominate the direct price effect. Compensatory transfers help attenuate the direct negative effect of price increases (at least among connected households), but not the general equilibrium effect. It is also interesting to note that households not directly affected by the increases—namely the rural households and unconnected urban households—nevertheless suffer the most from the reforms. Another finding—one relatively common in the context of macro–micro modelling—is that the poverty headcount is not a very sensitive measure; the depth and severity indexes are more efficient in capturing the marginal effects of policy reforms such as those at issue here. Finally, our analysis of the alternative schemes for funding the transfer program reveals that the two schemes that are most favourable to most groups are the foreign aid option (2D) followed by an increase in import duties (2B).

6.2 *Income distribution*

We used the S-Gini index to assess the effect of power price increases on income distribution in Senegal as a whole and among subgroups of the population. The changes in equality from simulation to simulation are relatively small (table 13). A change of 0.38 percent is the largest recorded for any group in any simulation. All of the simulated policies reduce inequalities at the national level and for the subgroups analyzed, except for simulations 1A and 1C. This is somewhat surprising, since both the reforms and the various funding schemes simulated in section 5 tended to leave households in Dakar relatively better off on average than the other two regional groups.

In the regional decomposition the intra- and inter-group contributions to total change in inequality are quite different. The inter-group redistribution contributes to reducing overall inequality in all cases except simulation 1A, where the effect is nil, but the intra-group redistribution contributes to an increase in overall inequality for scenarios 1A and 1C. Inter-group inequality change dominates intra-group change in all cases but 1A. Dakar and other urban households see the greatest reduction in inequality in all of the simulations that include the transfer program. In the two non-transfer scenarios, it is rural households that experience the most favourable change in inequality.

Table 13 Variation in Gini index

Groups	Reference	Simulation set 1				Simulation set 2			
		Sim 1A	Sim 1B	Sim 1C	Sim 1D	Sim 2A	Sim 2B	Sim 2C	Sim 2D
National	0.485	0.01	–0.01	–0.03	–0.05	–0.11	–0.11	–0.18	–0.10
Intergroup	0.322	0.00	–0.02	–0.07	–0.06	–0.14	–0.14	–0.23	–0.13
Intragroup	0.163	0.03	0.00	0.06	–0.02	–0.04	–0.05	–0.09	–0.04
Dakar	0.482	0.04	–0.01	0.07	–0.10	–0.15	–0.15	–0.23	–0.15
Other urban areas	0.440	0.05	–0.01	0.08	–0.07	–0.13	–0.14	–0.24	–0.13
Rural	0.417	0.00	0.00	–0.03	0.00	–0.04	–0.04	–0.09	–0.04
Intergroup	0.262	0.01	0.00	–0.07	–0.01	–0.10	–0.10	–0.20	–0.10
Intragroup	0.223	0.01	–0.02	0.02	–0.10	–0.11	–0.11	–0.16	–0.11
Unconnected	0.407	0.00	–0.01	–0.03	–0.01	–0.04	–0.04	–0.10	–0.03
Connected	0.478	0.05	–0.05	0.07	–0.23	–0.29	–0.30	–0.38	–0.29

Source: Authors' calculations.

Among the four alternatives for funding the transfer scheme, the household income tax option proves to contribute the most to reducing inequality. This is not surprising, as most households that pay income tax in Senegal are relatively rich, and the households receiving the transfers are poor. The other three funding scenarios have almost identical distributional effect on all groups. As expected, the funding scenarios have less effect on rural households and unconnected households. The decomposition analysis based on connection to the network produced expected results. We observe very little impact on unconnected households (from 0.00 percent to 0.10 percent). Among connected households, we see reductions in inequality ranging from 0.05 percent in simulation 1A to 0.38 percent in simulation 2C (funding of the transfer program through the household income tax).

7 Conclusion

In this paper we used a macro–micro CGE modeling approach (CGEMMS) to analyze the impact of price reform in the electricity sector on poverty and inequality in Senegal. We also investigated the effects of (a) a transfer scheme designed to compensate the poor for price increases, and (b) four different ways of funding the transfer program. We adapted the approach of Boccanfuso, Cabral, and Savard (2005) by integrating into their model the specificities of the electricity market in Senegal. We chose the CGE microsimulation sequential approach proposed by Chen and Ravallion (2004) because it accommodates conditional transfers within the model.

The approach presented here can help policy makers assess the potential impact of price increases in the context of privatization of utilities or simple price reforms. Our cost-recovery simulations clearly produce positive effects for Senegal's electrical utility, but negative ones for government, households, and firms. The compensatory transfer program for poor households directly affected by higher power prices attenuates the negative effect for those households. However, the negative general equilibrium effect on factor payments overrides the positive general equilibrium effect of the goods and services price decreases and hence, other households are negatively affected by those scenarios. It is important to highlight that the transfer program is relatively cheap because so few of the poor are presently connected to the grid.

Our analysis also shows that three options for funding the transfer program (increases in the VAT, in import duties, or in foreign aid) produce similar effects; any one of the options could be used at the discretion of policy makers. Of course, foreign aid must be available, and the side-effects of raising import duties would have to be taken into account. An increase in the VAT would seem the most appropriate tool to raise the funds internally.

The most important lesson of our research is the importance of taking into account the general equilibrium effect of proposed reforms to fully capture their impact on poverty and inequality. Few poor households are connected to the electrical grid. Moreover, few of the poorest households are likely to benefit from early extensions of the network. Thus it is not surprising that increases in power prices have little direct effect on most poor households, whereas a much larger group will be affected by the general equilibrium effects of the increases.

Analyses similar to that presented here can be very useful in policy making by illuminating the paths by which the effects of reforms are transmitted to the poor, by measuring the strength of those effects, by providing clues to the design of effective compensatory policies for groups disproportionately affected by the reforms. Reforms of the electricity sector should include an aggressive program to extend the network and increase access of the poor. In addition, because the general equilibrium effects on the poor can be clearly negative, it is important in reform campaigns to explore alternative targeting policies to compensate the poor for such negative effects.

In future work, we will test some counterfactual hypotheses on the depreciation of Senegal’s power generation facilities, investment targets, and the impact of Senelec’s sustained deficits on public deficits and public expenditure. All are important issues lying at the heart of the debate over the country’s electricity sector. The new problems faced by the company since early 2006 have increased the urgency of reforms in the sector; further investigation of the impact of proposed reforms can shed needed light onto this debate.

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