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ASSESSING THE IMPACT OF MALI'S WATER PRIVATIZATION ACROSS STAKEHOLDERS

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ABSTRACT

Assessing the impact of Mali's water privatization across stakeholders

This paper offers a unique quantitative evaluation of the distribution of the welfare of a water privatization experience in Mali among labor, investors, intermediate input providers, users and taxpayers. The assessment is based on indicator duality and production theory. The paper shows that users benefited through lower real water prices -although users in Bamako did better than the rest and future users will be hurt by insufficient investment. The firm's workers, its intermediate suppliers and investors have also clearly benefited during the short privatization duration. However the paper also shows that taxpayers are the main losers as subsidies are still needed. There are also serious efficiency-equity trade-offs, with an uneven gain distribution within factor categories and foreign actors clearly favored over domestic actors. This easily explains the unhappiness of the Malians. The regulatory decision to correct it explains why the private operator lost its incentive to stay in the country.

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Assessing the impact of Mali's water privatization across stakeholders

1. Introduction

Mali is one the poorest countries in the world. Until very recently, it had also been one of the most persistent in trying to attract private actors in the financing and management of its infrastructures. For many casual observers, if Mali could do it, any country could do it. Since the early 1990s, it tried twice to give a large role to private operators in its water sector. It failed twice. Its latest experience started in 2001 when it transferred the operations of the main company responsible for both water and electricity, Energie du Mali (EDM), to the French operator SAUR.[2] The transfer was supposed to last for 20 years but it lasted less than 5 and ended up in the return to public management of the company.

Because Mali's most recent failure is representative of the limits of large scale private sector participation in the water sector of poor countries, it is important to study in some detail.[3] Its design was supposed to be a showcase of how public private partnerships could help speed up growth in access rates in a particularly socially and politically sensitive sector in poor countries. It ended up illustrating the difficulty of reconciling commercial, governance, local, foreign and social objectives in a fair, transparent and ultimately efficient way.

The failure was a drama for Mali but it also clarified key dimensions of the water access challenge. Water management in all of its dimensions, including the provision of basic water and sanitation services (WSS) is particularly complex in poor countries with scarce water resources. Yet, demography and economics continue to push demand to grow faster. Mali is no exception with a population growing at 3% per year, faster than historical increases in water connection rates.

The delays in investment in the water associated with the crisis between the private operator and the government contributed to Mali's inability to be on track to meet its Millennium Development Goal (MDG) water coverage target of 67% by 2015. When the latest privatization experience was terminated, 60% of its population had access to basic water services; roughly a 5% increase in the 5 years.[4] This means that between 2010 and 2015, Mali will have had to double the performance of the private operator, to reach the MDGs. Unlikely, but possible. To achieve that objective,

it will have to learn from the mistakes of the privatization experience. Many of the poorest countries with similar concerns will learn with Mali.

Many donors will as well have to learn from the mistakes. Mali's showcase privatization experience was indeed closely being monitored by the donor community. This is why this fast and repeated failure has led to a lot of soul searching and analysis among some donors.[5] Their early assessments have mostly focused on descriptions of the institutional and contractual failures of the sector restructuring, emphasizing the undelivered commitments by government and by the operator. Unclear contracts, unfriendly relations between the operator and the regulator, unexpected political interference in some of the key decisions are some of the issues identified in these early assessments of the experience. For the operator, Mali's almost 5 years experience of private operation in a restructured urban WSS failed because of politics. For the newly created independent regulator, users would have been asked to pay excessive prices without its intervention and its efforts to documents excess costs.

None of the assessments so far have offered a quantitative diagnostic of the distribution of credits and blames across actors. A more quantitative, and objective, assessment needs to build on the extent to which the reform actually created value for the sector and the extent to which any value change was distributed fairly between the various actors.[6] To our knowledge, this paper is the first robust ex-post quantitative assessment of winners and losers of a water privatization experiment in Africa that does not simply rely on partial performance indicators.[7] It has been made possible by the simple fact that the new independent regulator has ensured the development of an exceptionally detailed and reliable set of data, by any standard and in particular in the African water sector.[8]

A second contribution is methodological. On this front, we generalize a methodology proposed by Grifell-Tatjé and Lovell (1999, 2008) to a multi-output situation. We also give a clearer interpretation of the scale economies and the isolation of productivity changes impacting profits and losses brought about by the change in management of the firm. These productivity changes can in turn be unbundled into their cost efficiency, technical change and scale effects.

The new method mainly relies on relatively easy to generate accounting information on revenue and expenditures, The method allows the unbundling of this data to increase the transparency of welfare gains and losses of reforms and their

distribution across economic agents—the labor force, the operator and the consumers. It is because this information is, or at least should be, relatively commonly available for privatized or commercialized regulated firms, that the method proposed here is so attractive to assess the outcomes of major reforms in regulated industries.

The paper is organized as follows. Section 2 presents the organization of the sector. Section 3 explains how the changes that took place during the private management can be separated into changes in profits and changes in quantities. Section 4 discusses the data available Section 5 presents a statistical snapshot of EDM. Section 6 presents the quantitative assessment of the welfare effects of the privations experience and their distribution among the various stakeholders. Section 7 concludes.

2. An overview of Mali's water sector management

Mali has largely decentralized responsibilities of its WSS. Outside most of the largest cities, it has empowered 700 local administrative districts (communes) to provide service. The majority of the largest cities are the responsibility of a single large scale operator which has traditionally been a public enterprise, EDM. Central government retains the main responsibility for regulation, policy, and sector support under the overall supervision of the Ministry of Energy, Mines and Water. Within the ministry, the National Department of Hydraulics (DNH) operated the executive, regulation, financial, and technical support to communal WSS service providers. The DNH relies extensively on its regional and sub-regional offices.

The decision to rely on private know-how and financing capacity for its main large scale operator was one of the important characteristics of the most recent efforts aiming at improving service delivery in the sector.[9] Indeed, in 2000, it awarded a concession for the right to run EDM to a private consortium lead by SAUR International (belonging to the French group Bouygues), which had already been involved in the earlier failed management contract.[10]

The government actually granted the private consortium two separate concession contracts: the first for the services of production, transport and distribution of electricity and the second for potable water. The WSS component of the contract included the responsibility for 16 of the 19 urban local governments (including six in

the capital city of Bamako). The main client basis of EDM is the capital of the Republic of Mali, with the largest population, Bamako. The city has about 1,500,000 inhabitants, or about 11% of the total population of Mali. EDM is already responsible for what it calls *Outside Centers* which are secondary towns and cities.

In addition to improvements in the overall operational and financial service performance, EDM was required to contribute to new investments. This was to catalyze expansion of access to piped water service coverage since about 40% of the population of Bamako still relied on water stand pipes. This expansion need was particularly important for the lowest quintiles of the urban population.[11] One of the recurring issues in Mali has indeed been that investment has hardly been able to catch up with population growth. In urban areas, the lag between connection and population growth was maintained by a strong rural-urban migration.

EDM was to be regulated by the Regulation Commission of Water and Energy (CREE) which was created to regulate the urban WSS sector. The CREE was also expected to contribute to WSS sector planning. It was to be responsible for protecting consumer interests, but it also for the promotion and coordination of private sector participation. The CREE proved to be an outstanding generator of data on the performance of the regulated company, working by the book to deliver on its monitoring obligations as a regulator. This was often done in spite of the reluctance of private operators to reveal information so common in regulated services.

The insistence of the regulator to collect the data needed fueled the tension between the regulator and the operator and contributed to end the privatization experience. The contract was supposed to last 20 years. It lasted less than 5 years from 2001 to 2005. In retrospect, multiple mistakes and inaccuracies in the contractual tariff clauses and indexation mechanism elaborated at the time of privatization could be blamed for setting up the stage for a failure.[12] From the viewpoint of this paper, the main upshot is that the many interactions between the operator and the regulator generated a large volume of public data over a 4 year period (2001-2004). This data is now used to offer a quantitative diagnostic of the fiasco of the privatization experience.

3. Setting up the identification of the sources of gains and losses

Most of the data available from balance sheets often covers revenue, cost and profits. To understand the changes brought about by the private operator, we first need to be able to analyze the drivers of its profits and to decompose it into changes in prices and changes in quantities. Next, the changes in quantities can be decomposed into changes reflecting variations in business margins and those reflecting variations in productivity. The changes in productivity can then be unbundled into their scale, cost efficiency and technical change effects. These various decompositions can then be used to assess the gains and losses and the winners and losers of reform.

3.1 Decomposing Change in Profit

To model the fact that EDM provides the water infrastructure service in various towns and cities, production and distribution centers, throughout Mali, the operating profit of center *h,* in period t, which produces M outputs and uses N inputs, can be written as follow

$$\pi_h^t = R_h^t - C_h^t = \Sigma_m p_{mh}^t y_{mh}^t - \Sigma_n w_n^t x_{nh}^t, \tag{1}$$

where π_h is operating profit, R_h is revenue, C_h is operating cost, y_{mh} is the output quantity for m = 1,…,M and x_{nh} is the input quantity of n=1,…,N for the production center *h*; p_{mh} is the price of output *m* for the production center *h* and w_n is the price of input *n*. The capital is included among inputs. We introduce the possibility that the unitary revenue (p) could be different depending on the structure of the demand and the characteristics of location, despite the water tariff being the same all over the Republic of Mali.

We have defined an average price per input that is independent of the production center. This is because: i) labor compensations are the same per category; ii) the price of capital is independent of the place where the investment has been made; and (iii) the firm itself is the main provider of some of the production inputs (see, Section 5).

The total profit for the company as a whole (i.e. at company level) in period t is given by

$$\pi^t = \Sigma_h \pi_h^t - C_g^t = \Sigma_h R_h^t - \Sigma_h C_h^t - C_g^t = \Sigma_m p_m^t y_m^t - \Sigma_n w_n^t x_n^t - C_g^t, \qquad (2)$$

where π is the total profit at company level and equals the sum of the differences between revenues and operating costs of the various production centers minus overall expenses; C_g defines the overall general expenses for EDM which cannot be allocated to a particular center.

The operating profit of a production and distribution center h changes over time because both quantities and prices change. We decompose the change in operating profit between period t and t+1 into an aggregate quantity effect and an aggregate price effect as

$$\pi_h^{t+1} - \pi_h^t = [\Sigma_m \bar{p}_{mh}(y_{mh}^{t+1} - y_{mh}^t) - \Sigma_n \bar{w}_n(x_{nh}^{t+1} - x_{nh}^t)]$$

$$+ [(\Sigma_m \bar{y}_{mh}(p_{mh}^{t+1} - p_{mh}^t) - \Sigma_n \bar{x}_{nh}(w_n^{t+1} - w_n^t)], \qquad (3)$$

which decomposes profit change into the contributions of changes in individual quantities and individual prices, each expressed in value terms. The first right-hand side term is an *aggregate quantity effect* and the second is an *aggregate price effect.* The (M+N) components of the aggregate quantity effect are *Bennet quantity indicators* (Bennet, 1920), with price weights $\bar{p}_{mh} = (½)(p_{mh}^t + p_{mh}^{t+1})$ and $\bar{w}_n = (½)(w_n^t + w_n^{t+1})$, and the (M+N) components of the price effect are *Bennet price indicators*, with quantity weights $\bar{y}_{mh} = (½)(y_{mh}^t + y_{mh}^{t+1})$ and $\bar{x}_{nh} = (½)(x_{nh}^t + x_{nh}^{t+1})$. These quantity and price indicators are arithmetic means of Laspeyres and Paasche indicators, and expressed in difference rather than ratio form[13].

These expressions make it easier to assess the behavior of EDM as they highlight how it generates and distributes value. This is done by rearranging the expression for profit change (3) to obtain

$$\Sigma_m \bar{p}_{mh}(y_{mh}^{t+1} - y_{mh}^t) - \Sigma_n \bar{w}_n(x_{nh}^{t+1} - x_{nh}^t) =$$

$$(\pi_h^{t+1} - \pi_h^t) - \Sigma_m \bar{y}_{mh}(p_{mh}^{t+1} - p_{mh}^t) + \Sigma_n \bar{x}_{nh}(w_n^{t+1} - w_n^t) \qquad (4)$$

The left hand side is the Bennet quantity effect which is equal to the sum of the profit variation and the Bennet price effect. This expression is conceptually the same but in indicator form as the one given by Jorgenson and Griliches (1967), who showed that a measure of total factor productivity can be based on quantities (*primal* approach) or prices (*dual* approach). The public institution CERC developed a similar model to provide detailed empirical information of the French public firms (see Grifell-Tatjé and Lovell (2008) for details).

The quantity effect measures the surplus bonus, a proxy measure of creation (destruction) of value by the firm. In the next section, we will show that the Bennet quantity effect in (4) contains more than the productivity effect. It is possible to interpret the price variations (the dual) in terms of 'distribution' of the generated worth among the stakeholders of the firm. This means that EDM generated worth if the value of the quantity effect is positive, and destroyed it if the quantity effect is negative. Bear in mind that the quantity effect accounts both output and input variations. Expressions 6 - 9 give details of the composition of the quantity effect.

From a technical viewpoint, this is how we can use (4) to quantify the gains or losses of the benefits of the quantity effect to the individual recipients. The recipients are residual claimants who receive the change in operating profit ($\pi^{t+1} - \pi^t$), consumers of the water service when they pay less per unit of water, with $p_m^{t+1} < p_m^t \Rightarrow [- \bar{y}_m (p^{t+1} - p^t)] > 0$, m=1,…,M, and individual resource suppliers who receive the changes in individual resource prices, with $w_n^{t+1} > w_n^t \Rightarrow \bar{x}_n(w_n^{t+1} - w_n^t) > 0$, n=1,…,N. Expression (4) thus identifies the individual suppliers that have benefited most from or been most disadvantaged by the quantity effect.

An alternative rearrangement of (4) divides $\Sigma \bar{y}_{mh} (p_{mh}^{t+1} - p_{mh}^t)$ and $\Sigma \bar{x}_{nh}(w_n^{t+1} - w_n^t)$ into positive and negative price effects. In Section 6, we will show that one of the prices of the inputs fell during the period of study. The other prices of the inputs and the prices of the outputs increased at various intensities. Additionally, in almost all the production and distribution centers: $\pi_h^{t+1} > \pi_h^t$. Moving the negative input price effect of input *i* to the left side of (4), yields

$$[\Sigma_m \, \overline{p}_{mh}(y_{mh}^{t+1} - y_{mh}^t) - \Sigma \, \overline{w}_{nh}(x_{nh}^{t+1} - x_{nh}^t)] + \overline{x}_{ni}(w_{ni}^t - w_{ni}^{t+1}) =$$
$$w_i^{t+1} < w_i^t$$

$$(\pi_h^{t+1} - \pi_h^t) - \Sigma_m \, \overline{y}_{mh}(p_{mh}^{t+1} - p_{mh}^t) + \Sigma_{n\neq i} \overline{x}_n(w_n^{t+1} - w_n^t). \qquad (5)$$
$$p^{t+1} < p^t \qquad\qquad w^{t+1} > w^t$$

This expression shows the additional funds available for distribution arising from a reduction in one of the input prices to the quantity effect. The expression on the right of the equality measures the total *worth available or generated* and it is distributed among the *stakeholders* as we have described previously. We will complete this analysis by looking at the evolution of output and input quantities, which is an important outcome in the case of infrastructure concessions as the water concession in Mali.

3.2 Decomposing the Quantity Effect

This section generalizes the methodology proposed by Grifell-Tatjé and Lovell (1999, 2008) to separate price, quantity and economic drivers of profit to a multi-output situation[14]. We start by decomposing the quantity effect defined in expression (4) into its economic drivers, and use economic theory to do so. The set of feasible combinations of output vectors and input vectors is the production set $T = \{(y,x): x$ can produce $y\}$. The set of input vectors that are feasible for any given output vector y is the input set $L(y) = \{x: (x,y) \in T\}$. The cost frontier is defined by $c(y,w) = \min_x\{w^Tx: x \in L(y)\}$. The quantity effect can be decomposed to identify its economic drivers by means of

$$\Sigma_m \, \overline{p}_{mh}(y_{mh}^{t+1} - y_{mh}^t) - \Sigma_n \, \overline{w}_n(x_{nh}^{t+1} - x_{nh}^t) =$$

$$\Sigma_m \left[\overline{p}_{mh} - \left(\frac{\Sigma_n \overline{w}_n x_{Enh}}{y_h^t} \right) \right] \left(y_{mh}^{t+1} - y_{mh}^t \right) \qquad \text{Business margin effect}$$

$$+ \Sigma_m \left(\frac{\Sigma_n \overline{w}_n x_{Enh}}{y_h^t} \right) \left(y_{mh}^{t+1} - y_{mh}^t \right) - \Sigma_n \overline{w}_n(x_{nh}^{t+1} - x_{nh}^t). \qquad \text{Productivity effect (6)}$$

It shows that the quantity effect collapses to a productivity effect only if the *business margin* is zero. In Figure 1, $L^t(y^t) \subset L^{t+1}(y^t)$ on the assumption of positive technical change, where x_E is a cost-efficient input vector from $c^{t+1}(y^t,w^t)$. As a consequence, x_E

is purged of cost inefficiency in resource use and incorporates the improvements in technology. The business margin effect is expressed in value terms, and weight output changes by the margin between Bennet output prices and cost-efficient average operating cost evaluated at arithmetic mean input prices.

Insert Figure 1 about here

Interpreting the new information in terms of the impact of reforms

The business margin effect can take a value of zero under one of the following two conditions: i) the volumes of water supplied to different kind of consumers do not change over time; ii) the cost efficient margin [$\bar{p}_m$ - ($\Sigma \bar{w}_n x_{En}$)/y^t] is equal to zero per each product *m*. The business margin effect can of course also be null with a combination of these two conditions. As water tariffs are regulated, the business margin effect shows the distance between the regulated prices and the cost-efficient average costs. In fact, the value of [$\bar{p}_m$ - ($\Sigma \bar{w}_n x_{En}$)/y^t] per output allows an assessment of the regulator's price policy. If the regulated prices cover the cost-efficient average costs, delivering more water is profitable. If it is lower, expansion generates losses for the firm.

The productivity effect in (6) is also expressed in value terms as the difference between weighted output change and weighted input change. The weights on output changes are the cost-efficient average operating cost. The productivity effect decomposes as

$$\sum_m \left(\frac{\Sigma_n \bar{w}_n x_{Enh}}{y_h^t} \right) \left(y_{mh}^{t+1} - y_{mh}^t \right) - \sum_n \bar{w}_n \left(x_{nh}^{t+1} - x_{nh}^t \right) =$$

$$\Sigma_n \bar{w}_n (x_{nh}^t - x_{CEnh}^t) - \Sigma_n \bar{w}_n (x_{nh}^{t+1} - x_{CEnh}^{t+1}) \qquad \text{Cost efficiency effect}$$

$$+ \Sigma_n \bar{w}_n (x_{CEnh}^t - x_{Enh}) \qquad \text{Technical change effect}$$

$$+ \sum_m \left(\frac{\Sigma_n \bar{w}_n x_{Enh}}{y_h^t} \right) \left(y_{mh}^{t+1} - y_{mh}^t \right) - \sum_n \bar{w}_n (x_{CEnh}^{t+1} - x_{En}) \quad \text{Scale effect} \quad (7)$$

The cost efficiency effect shows the contribution to the productivity effect of a change in the cost-efficiency of resource allocation between periods t and t+1, by comparing the value of $(x^{t+1} - x_{CE}^{t+1})$ with that of $(x^t - x_{CE}^t)$, using arithmetic mean input price weights; x_{CE}^t and x_{CE}^{t+1} are a cost-efficient input vectors from $c^t(y^t,w^t)$ and $c^{t+1}(y^{t+1},w^{t+1})$, respectively. A positive cost-efficiency effect measures the financial benefits of an improvement in cost-efficiency, which contributes positively to the productivity effect and enhances profit change. Figure 1 shows the situation where $L^{t+1}(y^{t+1}) \subset L^t(y^t)$ on the assumption that $y^{t+1} > y^t$.

The cost efficiency effect can be decomposed further into a technical efficiency differential and an allocative efficiency differential. This can shed light on the nature of the cost-efficiency effect, since cost-inefficiency decomposes into technical inefficiency (an equiproportionate excess use of all inputs) and allocative inefficiency (a misallocation of inputs in the light of their respective prices). The decompositions are described in the following

$$\Sigma_n \overline{w}_n(x_{nh}^t - x_{CEnh}^t) - \Sigma_n \overline{w}_n(x_{nh}^{t+1} - x_{CEnh}^{t+1}) =$$

$$\Sigma_n \overline{w}_n[(x_{nh}^t - \theta^t x_{nh}^t) - (x_{nh}^{t+1} - \theta^{t+1} x_{nh}^{t+1})] \qquad \text{Technical efficiency effect}$$

$$+ \Sigma_n \overline{w}_n[(\theta^t x_{nh}^t - x_{CEnh}^t) - (\theta^{t+1} x_{nh}^{t+1} - x_{CEnh}^{t+1})], \quad \text{Allocatlive efficiency effect} \quad (8)$$

where $\theta = \min\{\theta: \theta x \text{ can produce } y\} \leq 1$.

The *technical change effect* in expression (7) captures the contribution to productivity change of an improvement in technology between periods t and t+1, evaluated with an input-saving orientation at y^t, by comparing the cost of x_{CE}^t on the surface of $L^t(y^t)$ with that of x_E on the surface of $L^{t+1}(y^t)$, again using Bennet input price weights. A positive technical change effect measures the financial benefits of cost-saving technical progress, which contributes positively to the productivity effect and enhances profit change.

The *scale effect* corresponds to a movement from (y^t,x_E) to (y^{t+1},x_{CE}^{t+1}), which is the same as from $L^{t+1}(y^t)$ to $L^{t+1}(y^{t+1})$ in Figure 1. In fact, it defines a movement along the surface of the production set T^{t+1} because x_E and x_{CE} are cost efficient input

vectors with the technology of period t+1. It captures the contribution of economies of scale to the productivity effect. To see this contribution, let us suppose that the vector $x_{CE}^{t+1} = \lambda x_E$, $\lambda > 1$ with input expansion. On the output side, vector $y^{t+1} = \lambda^{\alpha} y^t$, with $\alpha >=< 1$. We can rewrite the second expression of the scale effect in equation (7) as $\Sigma_n \bar{w}_{nh}(x_{CEnh}^{t+1} - x_{Enh}) = \Sigma_n \bar{w}_{nh}x_{Enh}(\lambda - 1)$. In the case of the output expression of the scale effect in (7), we have $(\Sigma_n \bar{w}_{nh}x_{Enh} / y_h^t)\Sigma_m(y_{mh}^{t+1} - y_{mh}^t) = (\Sigma_n \bar{w}_{nh}x_{Enh} / y_h^t)(y_h^{t+1} - y_h^t)$ and, with $y^{t+1} = \lambda^{\alpha} y^t$, which can be rewritten as $(\Sigma_n \bar{w}_{nh}x_{Enh})(\lambda^{\alpha} - 1)$. This means that the expression that quantifies the scale effect in (7) is equal to

$$\Sigma_n \bar{w}_{nh}x_{Enh}(\lambda^{\alpha} - 1) - \Sigma_n \bar{w}_{nh}x_{Enh}(\lambda - 1) = (\Sigma_n \bar{w}_{nh}x_{Enh})(\lambda^{\alpha} - \lambda), \qquad (9)$$

with constant returns to scale $\alpha = 1$ and equation (9) takes a value equal to zero; with increasing returns to scale $\alpha > 1$ and (9) has a positive value, and with decreasing returns to scale $\alpha < 1$ and (9) is negative. More concretely, this means that if one finds emprically a positive scale effect, it reflects an expansion in the presence of increasing returns to scale, which contributes positively to the quantity effect and enhances profit. When the expansion of the outputs and inputs are not radial, the expression scale effect in (7) also collects the impact of changes in the output and input mixes.

4. Challenges to the implementation for the decomposition of the quantity effect

The main challenge associated to the decompositions is the observability of key variables. For instance, the output quantity *y* and the input quantity vector *x* in decomposition (5) are observed, as are the output price vector *p* and the input price vector *w*. However, the cost-efficient input quantity vectors x_{CE} and x_E are not and must be derived from observed data and the unobserved technologies. We rely on a sequential form of DEA to approximate them. We then solve for the cost-efficient input quantity vectors x_{CE} and x_E.

Since x_{CE}^t is a cost minimizing input vector for (y^t, w^t, T^t), it can be identified as the solution to the linear program

$$c^t(y^t, w^t) = \min_x \{w^{tT}x : x \geq X^t\lambda, \ Y^t\lambda \geq y^t, \ \lambda \geq 0, \ \Sigma\lambda = 1\}. \qquad (10)$$

In this program, the objective is to find an input quantity vector x that minimizes the expenditure $w^{tT}x$ required to produce y^t, provided that (x,y^t) is feasible with T^t. The data matrices Y^t and X^t contain all outputs and inputs observed in periods $\{1,...,t\}$. The feasibility of (x,y^t) thus requires that (x,y^t) belong to the production set $T^t_{DEA} = \{(x,y^t) : x \geq X^t\lambda, Y^t\lambda \geq y^t, \lambda \geq 0, \sum\lambda = 1\}$. T^t_{DEA} is the DEA approximation to the unobserved production set T^t (Charnes *et al.,* 1978). T^t_{DEA} is constructed sequentially, on the assumption that the activities adopted in previous years are remembered and remain available for adoption in subsequent years. The convexity constraint $\{\lambda \geq 0, \sum\lambda = 1\}$ allows the surface of T^t_{DEA} to satisfy variable returns to scale. The solution of (10) is the cost-efficient input quantity vector x_{CE}^t. We can also calculate x_{CE}^{t+1} by repeating the previous exercise but replacing t with t+1 in (10). Since x_E is the solution to the same cost minimizing problem, but uses technology T^{t+1}, solving for x_E requires expanding the data matrices to X^{t+1} and Y^{t+1} and retaining w^t and y^t. Once the annual cost-efficient input quantity vectors x_{CE} and x_E are calculated, they are inserted into decompositions (6) and (7) to quantify the margin effect, the productivity effect and its decomposition.

Decomposing a cost efficiency effect in (8) involves finding the two unobserved technically efficient input vectors $\theta^t x^t$ and $\theta^{t+1} x^{t+1}$. This requires solving two technical efficiency measurement problems. The general form of these linear programming problems is: $\min_\theta \{\theta: \theta x \geq X\lambda, Y\lambda \geq y, \lambda \geq 0, \sum\lambda = 1\}$, where $\theta = 1$ identifies a technically efficient water production and distribution center and $\theta \leq 1$ indicates the magnitude of the technical inefficiency of a center. When the data are from period t, $\theta = \theta^t$, and when the data are from period t+1, $\theta = \theta^{t+1}$. Once the values of θ^t and θ^{t+1} have been calculated, they can be substituted into equation (8).

5. The Definition of Observations and Variables

The Annual Reports of EDM are our main source of information. It published two types of Annual Reports for the years 2002, 2003 and 2004; the "*Compte Rendu Technique*" and the "*Compte Rendu Financer*". These contain financial and accounting data, as well as some information about physical installations and consumption of materials for the years 2001-2004. EDM reports physical information per town, city and agency regarding the production and distribution of water, e.g.

water produced, power consumption, material consumption, and the length of the distribution network. It also reports information on revenues from the water sold per tariff section for each town, city and agency. We have complemented this public information with internal analytical accounting information provided by the regulator. The creation of the data set was the most time-consuming part of this research. Despite these constraints, some of which are not unusual in microeconomic studies, we believe that the efforts involved in building the data set gives us an unusual opportunity to study the impact of a privatization process in Africa, where the lack of data is currently exceptionally large.

Because of data quality or gaps problems, we focus on five of the seven agencies of Bamako (Fleure, Lafia, Faladie, Quimzam and Badala), excluding Central and Badala – Djelib. We also cover fifteen cities among the *Outside Centers* for which EDM is responsible.[15] To study isolated centers among the Outside Centers, we split, as EDM does, DURI and Isolated Centers[16]. In short, we have 21 observations per year during the period 2001-2004, i.e. 84 observations.

The main difficulty arises from the fact that EDM provides two kinds of services: electricity and water, but does not report the costs separately. Fortunately, thanks to the regulator, we had access to complete analytical accounting records which allocated costs between electricity and water but only for 2003. For the other three years, we assumed that the 2003 *proportions* of cost allocation were also maintained. This is not a strong assumption because there is no reason to expect a great deal of variation in a short run. This procedure has not been applied to the labor input because there is no wage discrimination between the two activities.

Definition of the Output Quantities, Revenues and Prices

We define three kinds of output quantities based on the three levels of consumption used for tariff setting. These are: i) m^3 of water supplied to residential subscribers (quantity ≤ 60 m^3); ii) m^3 of water supplied to public fountains; iii) m^3 of water supplied to industry and high consumption (quantity > 60 m^3). This information is available per town, city and agency.

We also have revenue information: i) per tariff sections; ii) from rent and maintenance of water meters; iii) from fraud recovery. We exclude other revenue sources not directly linked with the production and distribution of water, which

account for less than 1% of the total revenues. We also exclude subsidies from output price but will return to them later. Tariffs are the main revenue source with about 92% of the total in 2004. *Rent and maintenance of water meters* accounted for 7.5% and *fraud recovery* generates 0.5% of the total[17]. The information on tariffs revenue is available for each output. We define average revenue for each kind of output as the ratio between total revenues and water supplied.

Definition of Input Quantities, Costs and Prices

We defined four types of input quantities, as well as the prices and costs associated with these. The input quantities are: i) labor; ii) water production and treatment; iii) renting and maintenance, and (iv) capital. The labor quantity is defined by the *total number of employees in the water service*. A price can easily be assigned to the labor input because there was no wage discrimination between the water and electricity services. The unit cost or input price is thus given by the ratio between the total labor costs and the total number of employees.

The input *water production and treatment quantity* (*treatment quantity* for short) aggregates three components used in the production and distribution of water: electricity, fuel and materials. Their quantities and total costs are available per production and distribution center. They are purchased at company level regardless of where they were consumed, e.g., a kilo of lime has the same price if it is used to treat water in the city of Bamako or in the town of Gao. The average cost is given by the ratio of the total expense of water production and treatment to the total aggregate treatment quantity.[18]

We have used the total number of water connections as a *proxy* of the *renting and maintenance input quantity*. This *proxy* implies that the network maintenance and size depends positively on the number of connections. The data on the number of connections is available for all locations and the total renting and maintenance cost is available at company level. We define an average price as the ratio between the total renting and maintenance cost and the total number of connections.

For the capital input, we start from the value of the assets from the accounting records but it aggregates the value of the installations in the water and electricity sphere. We know the value share of the water assets of total assets for 2003. However, we do not know the depreciation accounting rules that were applied by the former

public monopoly until the year 2000. Thus this is the reason why we use a *proxy* as a quantity of capital: *the length of the distribution network in km.* This information is available per production and distribution center. We define and estimate two sources of capital costs for EDM from its accounting data: i) accounting depreciation and, (ii) interest paid to lenders which includes all the expenses from banking services. Assuming that C_4 is the total cost of the input capital as the sum of these two sources, the unit cost of capital is given by $w_4 = C_4/x_4$, where x_4 is the quantity of capital proxy. This average cost per unit of capital is applied regardless of location.

6. A basic statistical snapshot of EDM

Table 1 shows the statistics for output and, input quantities and prices and for operating cost and profits/losses at company level. A similar table has been created for Bamako and each town and city in the sample as well as for the aggregate of DURI and the aggregate of Isolated Centers. For reasons of space, we only report the one at company level which is the aggregation of the individual statistics from the production center across the Republic of Mali (see Section 5). Table 1 also shows the general expenses for the company as a whole, which are difficult to allocate among the various inputs (see (1)). All nominal values have been converted to real values by deflating by the consumer price index (year 2000=100) reported by the *International Monetary Fund*.

Insert Table 1 about Here

Table 1 suggests that the production and distribution of water incurred losses every year at company level. These were on average of 1.3 billion real CFA francs during the period 2001-2004. This represented about 1.96% of the estimated total assets for the production and distribution of water. This means that the accumulated losses during the period are about 8% of the total water assets. Expression (1) gives more information about how this deficit was generated. Its application shows that the total revenues generated by the firm are thus enough to cover the total operating costs, but not the general expenses. Between 2001 and 2003, EDM received several on-off subsidies. About 11% and 16% of these subsidies were for the production and distribution of water. In real CFA francs, this means quantities of 1.14 and 1.08

billion, which is an average of 0.55 billion per year during the period studied. The subsidies therefore cover less than one third of general expenses.

Furthermore, the total operating expenses excluding the cost of capital are 7.4 billion real CFA francs, and adding the general expenses produces a total cost of 9,2 billion CFA francs which generates a positive profit of 2,3 billion real CFA francs. When the cost of investment is excluded, this produces a positive profit that represents an approximate return on assets of 4%.

Overall, the figures suggest that there should be no expected losses when the revenues are compared with the operating cost for each production and distribution center. In Bamako, the city with the largest population, there are growing profits every year. For the Outside Centers, instead, there are generated losses in almost every year, but revenues still cover the operating expenses, excluding the cost of capital.

Output quantities

Total water supplied and sold rose from 30.1 million m^3 in 2001 to 43.2 in 2004, an increase of about 43%. About half goes to residential subscribers, almost 40% to industry and high consumption, and the remainder to public fountains. These percentages have been calculated using the total data in which Bamako consumed 28.7 million m^3 in 2004. In other towns and cities, 45% of the locations sell less than 5% of the water to public fountains, probably the demand from the poorest households unable to pay the cost of being network connection and in some cases, difficulties for EDM to connect from new points of water delivery.

Output prices

The price for each output is calculated as average revenue per type of product. They are different, although the unit production cost is the same. The average revenue of a m^3 of water supplied to a public fountain is about a quarter of that generated by the output of industry and high consumption users, and half that from the output of residential subscribers. Table 1 also shows that the real price per m^3 of water supplied at the end of the period is lower than at the beginning. Output prices have dropped by 2% for industry and high consumption, 3% for residential subscribers and 5% for public fountains. The same roughly applies for all locations (even if not shown in Table 1).

Revenues

The fall in real unit revenue was compensated by an increase in output quantities. Total real revenues increased by over 38% between 2001 and 2004. Across locations, the main source of revenue is the industry and high consumption output, with about 60% of the total. Residential subscribers account for 35%, and public fountains less than 5%.[19]

Input quantities

The behavior of the four inputs over time is not homogeneous. The total numbers of employees remains relatively constant. The treatment quantity index rises until 2003 and falls afterwards, for a net increase of about 10%. The total number of connections and the length of the distribution network increased by 42% and 23% respectively. The increased supply of water is thus driven by the expansion of these two inputs.

Input prices

The evolution of the real unit cost of the inputs: labor, capital, water production and treatment, renting and maintenance, was different. The price of renting and maintenance fell sharply by about 43%. This contrasts with the moderate increase of capital costs by 7%, of water production and water treatment by 30% and finally, of the real average cost of labor by 40% (see Table 1).

Real total cost and real unit cost

The estimation of the input prices and quantities allows us to calculate the real operating cost for each observation. The real average cost is calculated per unit of water *sold* or supplied, not per unit of water *produced*. It can be seen that it declined from 367 real CFA francs in 2001 to 326 in 2004, or a fall of 11%. As an average of the period 2001-04, the input capital represents about 28% of the unit cost, the cost of water production and treatment about 23%, labor expenses about 19%, renting and maintenance about 16% and finally general expenses about 14%. Except for production and treatment expenses, the contribution of the other inputs to the unit cost was quite stable during the period. The reduction in the real unit cost observed is mainly driven by the decline in renting and maintenance expenses.

7. So what is the impact of privatization and its distribution across stakeholders?

To get a robust sense of the impact of the EDM privatization experience, it is useful to discuss first in some detail the Bennet decomposition of its profits into quantity and prices indicators. This sets up the stage for an analysis of the economic drivers of this decomposition.

7.1. The Decomposition of the Bennet Indicators

Bennet price and quantity effect

Our empirical findings are summarized in Tables 2, 3 and 4. They show the real operating profit change at company level, the city of Bamako and the Outside Centers divided between DURI and Isolated Centers. The DURI Centers aggregate the individual information from seven cities and the Isolated Centers show the aggregate information from eight cities. At this point, it is important to remember that the real operating profit excludes general expenses at company level. Furthermore, Tables 2 and 3 are derived from data, using equations (3) and (5) and Table 4 is obtained from equations (6), (7) and (8). All results are averages of three pairs of years: 2001-02, 2002-03 and 2003-04, and these averages conceal some variation among the periods.

Similar behavior can be seen in Table 2. First, there is an improvement in real operating profits, for both the city of Bamako and the Outside Centers, and, consequently, at company level, which is defined as the sum of the previous results.

There is also a similarity in the explanation of how this improvement was achieved. Both Bamako and the Outside Centers have a negative price effect, indicating that increases in the real prices of inputs were not fully passed on to real water prices. This negative impact on prices was more than compensated by the rapid expansion of water supplies, generating a positive quantity effect, except for the Isolated Centers. This is the kind of result that could explain some of the tensions between the operator and the regulator. The operator tended to focus on how it can pass some of the input price increases to the prices of water while the regulator tended to focus on the huge quantity effect.

Table 2 shows that for the company as a whole, there was an average increase of 0.381 billion real CFA francs, resulting from a combination of the 0.74 from the quantity effect and -0.359 from the price effect. The improvement in the real operating profit is basically due to Bamako (308 million) and to some extent, the Outside Centers (73 million). However, these increases hide different situations. Bamako has a positive real operating profit every year, while the Outside Centers have a negative figure in three of the four years. These losses largely originated from the Isolated Centers. This can be seen in Table 2.

Insert Table 2 about here

Value creation

A company has three mechanisms for generating a higher level of profits (or reducing losses): i) the positive quantity effect; ii) increases in product prices; iii) reductions in input prices. When all product prices increase, all the input prices fall and there is a positive quantity effect, with stockholders receiving all of the '*potential*' profits available. However, this 'bonus' can be fully or partially passed on to consumers through lower product prices and to suppliers through higher prices. In this context, what remains, the residual, is what the stockholders receive when tax commitments to the State have been met. Equation (5) represents this idea and Table 3 quantifies it for production and distribution of water in the Republic of Mali.

Insert Table 3 about here

Table 3 shows that, for all locations, the potential profit has been generated by two mechanisms: the quantity effect mentioned earlier and a reduction in the price or unit cost of the input renting and maintenance. The total potential profit or worth available which was 1.12billion real CFA francs, of which 0.74 was from the quantity effect and the remainder was from lower renting and maintenance costs. About 65% of the gains were in Bamako.

The distribution of the value creation

How was this bonus distributed among the various stakeholders: consumers, workers, capital, other production factors and finally, stockholders? This real bonus has not only led to greater business profits, as the increase observed in real operating profit is 381 million real CFA francs, representing 34% of the figure previously calculated. The other stakeholders have also benefited, but in a rather unequal way. It is true that consumers have obtained a moderate reduction in real water prices, but two inputs – labor and water production and treatment – have acknowledged a greater proportion of the potential profit by strong increases in their respective prices. These two production factors now appear as the big winners, having received 48% of the surplus generated, i.e. 0.5 billion real CFA francs.

In contrast, consumers and the capital factor have not benefited as much. In the case of consumers, the reductions in real prices were 0.13 billion real CFA francs, 11.5% of the previously calculated figure. The residential subscribers output have received the most – 75 million – and public fountains the least, with 10 million, which is equivalent to a token 1% of the total. Finally, the increases in earnings for the capital factor accounted for 6.5% of the 1.1 billion calculated above.

To get a fuller picture, it is useful to report a few more details on these results. The costs of the water production and treatment input consisted of costs incurred for the following three components: i) power consumption; ii) fuel consumption and, iii) consumption of water treatment materials. The average percentages of these expenses in the cost of water production and treatment are 71%, 3% and 26% respectively. The main cost is therefore the result of the consumption of electricity, which is supplied by the company itself and which was then charged at one of the highest rate per kwh in West Africa according to the Malian regulator. Although these rates were the consequence of a large number of isolated systems and the end of many subsidies, they soon became a source of tension between the operator and the regulator since

there was a disagreement between the two as to how much of a profit margin for the operator it reflected. The second most important cost is consumption of water treatment materials, which if imported, are also at least partially managed by the company itself since some of the suppliers are spinoff of the main French owner of the business.

Next, we show that wages are undergoing a strong average growth, thereby receiving an important part of the bonus generated. The IMF (2006: 20) reports the "*minimum wages and salaries in the public sector of a high grade Government employee in Mali*". Their figure for 2004, in real annual terms is equivalent to 3.1 million CFA francs. Table 1 shows a figure of 5.9 million real CFA francs, almost double the IMF figure. We can suggest two possible explanations for the difference. First, the company inherited a costly wage structure from the old public monopoly, which was hardly consistent with the employment market of the Republic of Mali. The figure of 4.2 million real CFA francs at the beginning of the period, in Table 1, could support this assumption. Second, the wages of a minority of workers, such as specialized technicians from other countries, the board, and the CEO, account for a considerable proportion of the labor cost. Gomez-Ibanez (2005) explains that the annual payroll cost of the 12-13 expatriates working in EDM added to between 1.5 and 1.9 billion CFA francs, roughly 25% of the salaries of the over 500 Malian workers. In addition, according to Schlirf-Rapti (2005), EDM paid the French owner of the company and other advisors management fees, costing an additional 1.2 to 1.7 billion CFA francs per year and these fees continued to increase throughout the period. The sum of the share of the labor gains achieved accruing to management and expatriates adds up to just above 50%. [20] This is itself is likely to have contributed to fuel the unhappiness of the regulator who felt that the French concessionaire was managing to capture an excessive part of the worth generated, by increasing the price of some of its inputs.

7.2. The economic drivers of the quantity effects

In the methodological part of the paper, we showed how the quantity effect can be decomposed using the economic theory of production. Table 4 shows the results of this breakdown. First, the Bennet quantity indicator is explained by a margin effect

and a productivity effect. The latter is further decomposed into three economic components: cost efficiency, technical change and scale effect.

Insert Table 4 about here

In Table 4, we see that productivity gains are the main factor explaining the quantity effect, but with a contribution close to the margin effect. In fact, the margin effect is important and, in the case of Outside Centers, it is more than three times higher than the contribution of the productivity effect.

The business margin effect

The margin effect evaluates variations in quantities of outputs by comparing the product price with the *efficient* unit cost, not with the observed unit cost. In this context, we might ask whether the price regulation of the product is correct.

In a context of perfect competition, product prices would in the long run reflect the unit cost, which would be efficient due to the pressure of competition, and an additional amount in accordance with the risk taken in the industry. It is not easy to apply this simple idea to the case of a water production and supply service. To start with, to encourage rational water use, progressive tariffs associated with the quantity consumed are required, but the cost per unit of water supplied (under the assumption of constant returns to scale) remains the same regardless of the price.

As outputs have expanded sharply, the margin effect in Table 4 apparently indicates that product prices are higher, but adjust to efficient unit costs. However, these results can be deceptive, as they are for the aggregate figures. Looking at the individual results of $[\bar{p}_m - (\Sigma \bar{w}_n x_{En})/y^t]$ per product, it can be seen that the price of the public fountains output cannot cover the efficient unit cost for any of the observations from the sample in any of the years. Additionally, the price of the residential subscribers output is greater than the efficient unit cost for only a few observations. By contrast, in all the observations, the price of the industry and high consumption product is greater than its efficient unit cost. A clear process of cross-subsidy between the different products is visible. The final result is that income from industry and high consumption is more than sufficient to cover the losses on the other two products and explains the contribution of 352 million real CFA francs of the margin effect to the quantity effect.[21]

The Productivity Effect

Table 4 shows that the productivity gains are generalized. The contribution of the productivity effect is 388 million real CFA francs. For Bamako, productivity improvements account for about 65% of the Bennet quantity indicator. In contrast, in the Outside Centers, it accounts for less than 25% of the quantity effect. The Isolated Centers explain this low contribution with a figure that is still positive but negligible.

These increases in total factor productivity are fully explained by technical change and economies of scale. Technology, which is defined by the best practice frontier, has been expanding during the study period, leading to a fall in efficient production costs. This technology presents increasing returns to scale. The expansion in this technology has enabled savings on inputs per unit of output, producing additional cost reductions. Although this information is not included in Table 4, all the observations in the sample had a positive average technical change. At company level, these two effects represented an improvement in profits of 436 and 103 million real CFA francs respectively. As in previous cases, the main contribution is from the city of Bamako.

We have defined the outputs by the m^3 of water supplied (or sold). However, there could be a gap between the water *produced* and the water sold. Water supplied could be much less than produced. An old or poorly maintained distribution network may explain the difference, as does illegal connections to the pipes. The average ratio of water supplied compared to sold was 70% in 2004—i.e. losses of about 30%, an improvement from the 40% of 2001. There is a wide variability in these numbers when we consider the production centers. Bamako is one of the poor performers with ratios between 35% - 45%, and other towns and cities present better values between 10% - 20%. However, in all cases, there is an improvement in the ratio of water supplies to water produced which would mostly explain the positive technical change component.

These important improvements due to technical change and economies of scale have been partly counteracted by a negative cost efficiency that has been quite unequal between observations. For Bamako, the difference between observed costs and efficient costs worsens very slightly. For the Isolated Centers, the negative figure for cost efficiency is greater than the positive one for technical change. As seen in equation (8), cost efficiency change can also be broken down into technical efficiency

and allocative efficiency. The negative figure of 105 million real CFA francs for the Isolated Centers is entirely explained by technical inefficiency. The inefficiency of these centers increased every year, denoting an inability to follow the shift of the production frontier which was achieved for the best observations. The DURI Centers present a different situation, with greater but moderate allocative rather than technical inefficiency.

8. Conclusions

This paper shows how, with a relatively standard set of detailed accounting data, a combination of index theory and non-parametric frontier analysis techniques can be used to assess ex-post the impact of a major policy reform such as privatization. We illustrate the techniques on a study of the production and supply of water in the period 2001-04, when this service was privatized in Mali. It has allowed an explicit modeling of the multi-output nature of the business, defining three products: public fountains, residential subscribers and industry and high consumption. It has also allowed an identification of the gains and losses to the various economic agents interested in water supply (consumers, investors, workers and suppliers of other inputs as well as the state). In addition, it has allowed identifying the extent to which gains and losses can be associated with changes in productivity and potential profit margins for the operators.

The first observation from the results is that, for the company as a whole, the production and distribution of water continued to generate losses every year after privatization. Income covered operating costs including the cost of investments, but not general expenses. This is common for the water sector in poor countries. In Mali, the losses were generated by the Isolated Centers. Cross-subsidies, where the profits from some low cost production centers cover others' losses to a small extent, were insufficient to meet general expenses. Moreover, the calculation of efficient unit costs shows that the prices of the public fountains and residential subscriber products are far below these costs. This deficit is compensated for by income from industry and high consumption, which is by far priced above its efficient unit cost.

Second, consumers have benefited more than argued by some of the critics of the privatization. Indeed there was a sharp increase in the amount of water supplied

for all three outputs, which was accompanied by a slight fall in their real prices. This increase in quantity benefits to users was also a source of gains for the operator since there was an improvement in real operating profits despite the negative price effect and despite the fact that the increases in input prices were not fully passed on in water sale prices.

Third, we document a significant productivity gains. The increases in TFP are fully explained by technical change and economies of scale. These improvements were partly offset by a negative cost efficiency effect. This negative effect is particularly important for isolated Centers and originates in a worsening of technical efficiency. Overall, however, the consumption and productivity net gains have not been strong enough to compensate the inability of the company to significantly improve its global financial situation since the subsidy requirements continue to be strong.

The last and maybe most politically sensitive observation is the distribution of the value created by the private operator across stakeholders. Taxpayers have clearly not been saved by the reform since subsidies continue in the sector. Consumers have not benefited as much as they were led to expect. Although real product prices fell slightly during the period, the labor and water production and treatment inputs gained a lot more than users from the value creation, as their prices increased sharply. This could mean that workers have been important winners. But management and the dozen of expatriates who worked for the company captured over 50% of the gains that we assessed the labor factor. Moreover, the increase in prices paid for intermediate inputs may have also accrued to the foreign investors since many through outsourcing of some of the contracts to affiliates of the company. As EDM could control the changes in key input prices through internal pricing techniques, it could indeed have controlled the distribution of gains from value creation to favor some of its providers and some of its staff. This is one of the regulator's claims but it could not be substantiated from the existing accounting data and it remains an unsettled matter.

In sum, the main lesson from this evaluation is that the gains from reform need to be shared a lot more cautiously than they were in this experience. It is very likely that more upfront transparency in the gains of the reform—and there were real gains-- would have gone a long way in avoiding the dispute. The significant gains observed for providers of intermediate inputs such as software, consultant advice and some

chemicals, the high management fees and the high and the growing cost of expatriates and losses were probably the result of common practices in the industry. But a growing suspicion of the importance of these gains revealed by accounting requirements progressively put in place by the regulators have all fueled the resentment of the regulator and many in the population as the regulator disseminated some of the information in the media. Similar concerns were expressed for water experiences in developing countries.

From a wider perspective, the case study shows that although a privatization experience generates gains, the real problem is the extent to which these gains must accrue to the private operators to ensure their willingness to commit to finance investment in a poor country. As their expectations are not met, we observe fewer deals than many donors had hoped for. This may also explain why management contracts are making a come-back in this sector.

Ultimately, a key contribution of this paper has thus been to increase the transparency of the difficult trade-offs between the desire to achieve a fair distribution of the gains from easily documented improvements in the sector and the possible need to skew that distribution to provide incentive to investors to take on a long term commitment to deal with risks in uncertain environments that require long term financial commitments.

Efficiency-equity trade-offs are thus alive and well in the water sector of poor countries. Increased transparency and accountability allowed by improved regulatory accounting will simply make them sharper, more public and hence more debatable. If managed properly, this increased transparency of decision making processes should however make final decisions, one way or another, more acceptable to all actors.

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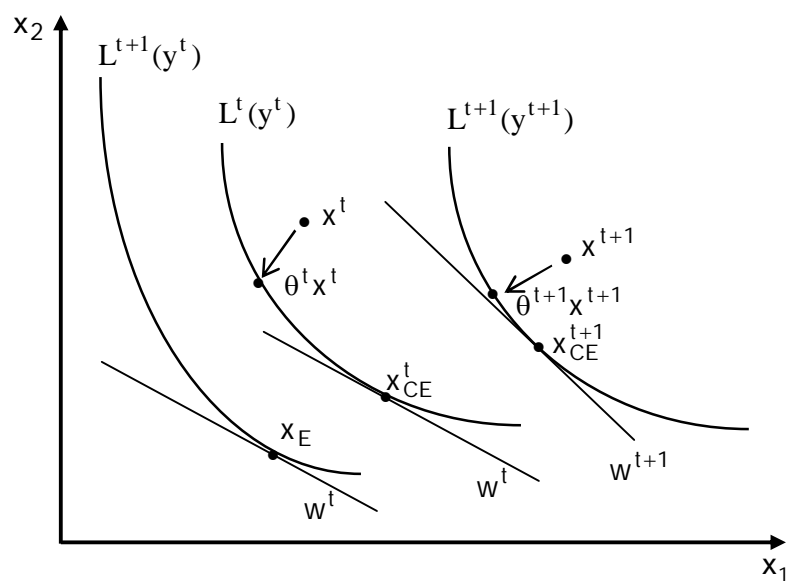
Figure 1. The Productivity Effect Decomposition (N = 2)

Table 1. Summary Statistics at Company Level, 2001 - 2004	2001	2002	2003	2004	2001 - 04
Total Operating Profit (2000 CFA francs)	-1,648,779,803	-868,650,510	-1,647,143,239	-1,061,160,336	-1,306,433,472
Total Operating Revenues (2000 CFA francs)	9,403,951,594	11,635,298,514	11,687,019,724	13,036,950,789	11,440,805,155
Water Sold Adjusted by Internal Consumption (m^3)	30,130,818	34,170,104	38,431,767	43,214,873	36,486,890
Revenue per m^3 (2000 FCA francs)	312	341	304	302	315
Y_1 **Residential Subscribers** (m^3)	15,235,640	16,337,925	19,574,947	21,692,166	18,210,170
p_1 (2000 CFA francs)	220	256	218	213	227
Y_2 **Public Fountain** (m^3)	3,275,777	3,210,534	3,888,205	5,024,031	3,849,637
p_2 (2000 CFA francs)	119	139	115	114	122
Y_3 **Industry & High Consumption** (m^3)	11,619,401	14,621,645	14,968,615	16,498,676	14,427,084
p_3 (2000 CFA francs)	487	479	465	475	477
General Expenses (2000 CFA francs)	1,538,137,478	1,620,134,847	1,741,152,299	2,094,891,057	1,748,578,920
Production Cost (2000 CFA francs)	9,514,593,919	10,883,814,177	11,593,010,665	12,003,220,067	10,998,659,707
Unit Cost per m^3 of Water Sold (2000 CFA francs)	367	366	347	326	351
x_1 **Labor Quantity** (#)	460	414	501	463	459
w_1 (2000 CFA francs)	4,257,762	5,778,547	5,636,851	5,971,257	5,411,104
x_2 **Material Index**	7,411,257	7,756,407	8,843,271	8,183,741	8,048,669
w_2 (2000 CFA francs)	337	346	332	438	363
x_3 **Connections** (#)	62,222	77,705	82,755	88,147	77,707
w_3 (2000 CFA francs)	31,558	32,392	24,615	17,863	26,607
x_4 **Capital Quantity** (Length Distribution Network - Km)	2,050	2,127	2,311	2,531	2,255
w_4 (2000 CFA francs)	1,508,609	1,547,721	1,643,197	1,612,777	1,578,076

Table 2. Real Operating Profit Change Decomposition

Real Mean Result Periods 2001-02, 2002-03, 2003-04 (2000 CFA, francs)

Period 2001 - 04		Operating Profit Change	=	Bennet Price Indicator	+	Bennet Quantity Indicator
Company Level	Mean	381,457,682		-358,891,996		740,349,678
	Std. Dev.	77,807,431		53,232,630		129,018,446
Bamako	Mean	308,191,893		-217,438,540		525,630,434
	Std. Dev.	96,963,586		484,981,321		398,625,697
Outside Centers	Mean	73,265,789		-141,453,455		214,719,244
	Std. Dev.	18,055,898		11,779,073		18,092,554
Centers DURI	Mean	113,121,775		-48,178,317		161,300,092
	Std. Dev.	16,662,608		12,444,371		19,924,737
Isolated Centers	Mean	-39,855,986		-93,275,138		53,419,152
	Std. Dev.	13,253,467		11,514,538		13,097,994

Table 3. Quantity Indicator Dual Decomposition

Real Mean Result Periods 2001-02, 2002-03, 2003-04 (2000 CFA, francs)

Period 2001-04		Quantity Indicator	+	Maintenance Price	=	$\Pi^{t+1} - \Pi^t$	-	Price Residential Subscribers	-	Price Public Fountains	-	Price High Consumption	+	Labor Price	+	Water Treatment Price	+	Capital Price
Company Level	Mean	740,349,678		380,864,077		381,457,682		-75,702,337		-9,965,755		-43,470,269		253,559,100		283,745,436		73,313,177
	Std. Dev.	129,018,446		49,375,514		77,807,431		8,361,823		1,360,032		6,533,083		40,344,643		46,117,411		7,424,442
BAMAKO	Mean	525,630,434		206,581,056		308,191,893		-31,295,020		-5,204,476		-563,020		166,984,787		189,799,926		30,172,367
	Std. Dev.	398,625,697		27,884,937		96,963,586		116,382,509		15,224,111		296,307,533		251,802,552		23,202,417		18,974,559
Outside Centers	Mean	214,719,244		174,283,021		73,265,789		-44,407,317		-4,761,278		-42,907,248		86,574,313		93,945,510		43,140,810
	Std. Dev.	18,092,554		8,170,099		18,055,898		4,599,171		618,447		6,736,198		1,890,259		4,794,379		3,027,426
Centers DURI	Mean	161,300,092		70,362,444		113,121,775		-19,153,171		-2,202,659		-13,220,521		39,170,819		30,772,451		14,021,139
	Std. Dev.	19,924,737		7,136,271		16,662,608		4,717,126		637,403		8,116,182		2,463,907		3,910,454		1,306,575
Isolated Centers	Mean	53,419,152		103,920,577		-39,855,986		-25,254,146		-2,558,619		-29,686,727		47,403,494		63,173,058		29,119,671
	Std. Dev.	13,097,994		9,232,838		13,253,467		4,810,186		645,521		5,702,611		1,372,821		5,131,234		3,929,154

Table 4. Quantity Indicator Economic Decomposition

Real Mean Result Periods 2001-02, 2002-03, 2003-04 (2000 CFA, francs)

Period 2001-04		Quantity Indicator	=	Margin Effect	+	Productivity Effect	Productivity Effect			Cost Efficiency	
							Cost Efficiency	+	Technical Change Effect	+	Scale Effect	Technical	Allocative
EDM.SA	Mean	740,349,678		352,026,739		388,322,939	-151,336,811		436,236,396		103,423,354	-122,025,551	-29,311,260
	Std. Dev.	129,018,446		45,794,085		84,783,731	16,005,347		57,700,092		24,456,220	-7,626,597	-1,831,954
Bamako	Mean	525,630,434		186,699,117		338,931,316	-13,739		241,871,142		97,073,914	0	-13,739
	Std. Dev.	398,625,697		264,580,928		134,389,519	4,907,019		8,204,383		135,198,952	-5,748,501	-461,381
Outside Centers	Mean	214,719,244		165,327,622		49,391,622	-151,323,072		194,365,254		6,349,440	-122,025,551	-29,297,521
	Std. Dev.	18,092,554		13,424,057		12,569,272	16,360,701		7,621,510		3,910,537	-8,135,037	-1,953,168
Centers DURI	Mean	161,300,092		112,175,502		49,124,590	-46,405,729		92,634,662		2,895,658	-15,597,345	-30,808,384
	Std. Dev.	19,924,737		18,337,885		3,503,114	8,004,607		9,305,984		3,863,544	-2,228,192	-4,401,198
Isolated Centers	Mean	53,419,152		53,152,120		267,032	-104,917,343		101,730,592		3,453,783	-106,428,206	1,510,864
	Std. Dev.	13,097,994		5,023,615		16,716,381	21,400,780		6,465,481		4,217,805	-13,303,526	188,858

[2] The paper focuses only on the water part of the business which tends to be the most politically sensitive.

[3] According to the data reported by the World Bank (http://ppi.worldbank.org/), in developing countries, about 1/3 of the contracts with large scale private operators in the water sector have failed.

[4] Source: UN MDG monitoring data base.

[5] The German Development Cooperation Agency (KfW (2005)), the French Development Agency did the same in 2006 (Hibou (2006)) and the World Bank (Schlirf-Rapti (2005) have all analyzed the experience. Harvard's Kennedy School of Government now teaches the experience as a case (Gomez-Ibanez (2005)*)*.

[6] Antecedents can be found in the case of regulated industries (Denny et al. (1981) for the Canadian Telecommunications sector, Salarian (2003) for the Australian Railways, Lawrence and Richards (2004) for an Australian port terminal, Grifell-Tatjé and Lovell (2008) for the US postal sector, De Witte and Saal (2010), Blazquez Gomez and Grifell-Tatjé (2008) for the Spanish electricity sector, many following the lead of Puiseux and Bernard (1965) and CERC (1969a,b and 1972) who had explored the distributional impacts of productivity changes at SNCF (the French railways) and Electricite de France, the national French electricity operator. Note that Denny et al. (1981), De Witte and Saal (2010), Blazquez Gomez and Grifell-Tatjé (2008) do not try to assess the generation and distribution of value. Salarian (2003) and Lawrence and Richards (2004) have a generation-distribution focus, but do so in a different methodological context focusing on a ratio (index numbers) rather than differences (indicators) as we do here. Moreover, they do not try to explain the sources of total factor productivity (TFP) changes in a second stage.

[7] Between 2005 and 2006, the World Bank commissioned 8 cases studies of water sector privatization in Africa managed by the Boston Institute for Developing Economies (BIDE). While insightful, their approach did not get allow the detailed distributional assessment offered here.

[8] Earlier studies, (Estache and Kouassi (2002) and Kirkpatrick *et al.* (2006) have focused on efficiency measured based on cross-country panels or have focused on more traditional efficiency measures applied to a single country –Uganda—(Mugisha, 2007; Mbuvi and Tarsim, 2011).

[9] Mali had already tried to rely on a management contract between 1994 and 1998 but this contract was terminated prematurely in 1995.

[10] Technically, the government of Mali sold 60% of the shares it held in the national water and electricity operator (EDM) to the private consortium composed lead by SAUR International.

[11] According to the 2001 DHS survey, access to piped water is 0% for the lowest quintile and 38% for the 5th quintile.

[12] As pointed out by Schlirf-Rapti (2005), these mistakes or inaccuracies did not reflect well on the many actors who had contributed to the design of the privatization (investment banks, consultants, international and bilateral development agencies).

[13] We decompose the change in operating profit between period t and t+1 into an aggregate quantity effect and an aggregate price effect as

$$\pi_h^{t+1} - \pi_h^t = [\Sigma_m p_{mh}^t(y_{mh}^{t+1} - y_{mh}^t) - \Sigma_n w_n^t(x_{nh}^{t+1} - x_{nh}^t)]$$
$$+ [\Sigma_m y_{mh}^{t+1}(p_{mh}^{t+1} - p_{mh}^t) - \Sigma_n x_{nh}^{t+1}(w_n^{t+1} - w_n^t)].$$

The first expression on the right of the equation is the *quantity effect* and it resembles a quantity index of the Laspeyres type (fixing the prices in p^t, w^t) in its construction, and the second expression is the *price effect* and it resembles a price index of the Paasche type (fixing the quantities in y^{t+1}, x^{t+1}), but both are expressed in terms of difference rather than rates. It is possible to use a Paasche-type structure to measure the quantity effect, with a different expression obtained. This would be:

$$\pi_h^{t+1} - \pi_h^t = [\Sigma_m p_{mh}^{t+1}(y_{mh}^{t+1} - y_{mh}^t) - \Sigma_n w_n^{t+1}(x_{nh}^{t+1} - x_{nh}^t)]$$
$$+ [\Sigma_m y_{mh}^t(p_m^{t+1} - p_m^t) - \Sigma_n x_{nh}^t(w_n^{t+1} - w_n^t)],$$

where the *quantity effect* is similar to a Paasche index (fixing the prices in p^{t+1}, w^{t+1}) and the *price effect* is similar to a Laspeyres index (setting the quantities at y^t, w^t). As a consequence, the two equations, by using distinct weights, show two different paths to decompose the variation in profits. The choice of weights has been resolved with the rediscovery of the Bennet indicator (1920) by Diewert (2005). He demonstrated that Bennet quantity and price indicators satisfy many tests similar to those satisfied by the Fisher quantity and price indexes.

[14] Antecedents of this methodology are, e.g. Eldor and Sudit (1981), Kendrick and Creamer (1961), Kurosawa (1975, 1991), Miller (1984), Genescà and Grifell-Tatjé (1992). Recent applications can be found in De Witte and Saal (2010), Sahoo and Tone (2009), Arocena *et al.* (2011) and Grifell-Tatjé (2011).

[15] The towns and cities in the study are: Bougouni (30,000 inhabitants); Gao (38,000); Mopti (118,000); Nioro (69,100); Kati (40,000); Kayes (90,000); Koulikoro (118,686); Koutiala (96,600); Segou (100,000); Sikaso (130,700); Tombouctou (31,973); Markala, Kita, San and Selingue on which we could not get reliable information about their population.

[16] The cities that define the DURI Centers are: Markala, Kati, Kayes, Kita, Koulikoro, Selingue, and Segou. The other cities, Bougouni, Gao, Mopti, Nioro, Koutiala, San, Sikasso, Tombouctou, are the Isolated Centers.

[17] We had to allocate the global total amount of income of water meters and fraud recovery to each output based on the number of subscribers and the consumption of water. The exact procedure is available on request.

[18] $w_{2n} = C_{2n}/x_{2n}$, $n = 1,2,3$ defines the price of component n at company level, where C_{2n} expresses the total cost of component n and x_{2n} the total consumption of n. The cost of component n, in h, is thus given by $C_{2nh} = w_{2n}x_{2nh}$, n = 1,2,3; the total cost of water production and treatment, in h, $C_{2h} = \Sigma_n C_{2nh}$, where $C_2 = \Sigma_h C_{2h} = \Sigma_h \Sigma_n C_{2nh}$. The cost shares at center h, are $\delta_{nh} = C_{2nh}/C_{2h}$, n= 1,2,3; h = 1,2,...,H, where $\Sigma_n \delta_{nh} = 1$, h = 1,2,...,H. We can define a *treatment quantity index*, center h, as

$$x_{2h} = x_{21h}^{\delta 1h} . x_{22h}^{\delta 2h} . x_{23h}^{\delta 3h}, \qquad\qquad h=1,2,\dots,H.$$

where x_{21} defines power consumption (Kwh); x_{22} fuel consumption (liters); x_{23} consumption of materials water treatment (kilos). The implicit price or average cost of center h is given by the ratio: $w_{2h} = C_{2h}/x_{2h}$, h = 1,...,H which is equal by construction to $w_2 = C_2/x_{2..}$

[19] If we look at the information at town or city level, the revenues from the public fountains vary rarely account for more than 5%.

[20] Schlirf-Rapti (2005) reports the information for each year from 2001 to 2003. Since he was an advisor to the regulator, his information should be accurate. Gomez-Ibanez (2005) reported the same figures he collected from the regulator. We used it to approximate in our estimates the share of gains to the labor factor that was retained by management and expatriates during the full period. It adds up to 52%.

[21] From a theoretical viewpoint, it could be argued that product prices must cover the efficient unit costs. This would involve more than doubling the prices for public fountains. For residential subscribers, the product price covers about 85% of its efficient unit cost. These increases would have an immediate effect on the poorest. A larger percentage of the population would not have access to water, as they would not be able to pay for it or would pay for it by reducing their consumption of other goods.