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Assessing the impact of Mali's water privatization across stakeholders[1]

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Abstract

This paper offers a 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 an index number inspired by Bennet (1920). We find four main impacts. First, taxpayers are the main losers as subsidies are still needed. Second, users benefited through lower real water prices, although users in Bamako did better than the others and future users will be hurt by insufficient investment. Third, labor, intermediate suppliers and investors have also benefited. Fourth, efficiency-equity trade-offs are for real in the water business in Africa. Indeed, the distribution of the gains within factor categories has not been even, largely favoring foreign actors over domestic actors. This easily explains the unhappiness of the Malians. The regulatory decisions to correct it explains why the private operator lost its incentive to stay in the country.

JEL codes: C60, D24, D33, L32

Keywords: privatization, regulation, efficiency, equity, distributional effects

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1. Introduction

Mali is one the five 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 to a large extent representative of the limits of large scale private sector participation in the water sector of poor countries, it is particularly 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 being a showcase of 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 some 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 when water resources are scarce and growing scarcer, with decreasing precipitation and predictability. Yet, for poor countries as much as for rich countries, demography and economics continue to push demand to grow faster than supply. Mali was 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

[2] The paper focuses only on the water part of the business since failures are more common in water privatization than electricity privatizations.
[3] According to the data reported in the Private Participation in Infrastructure data set of the World Bank (http://ppi.worldbank.org/), in developing countries, about a third of the contracts with large scale private operators in the water sector have failed.

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. What it will learn may also to be useful to many of the poorest countries with similar concerns.

The failure to achieve the MDG objective will actually also be a problem for many donors who will, as well, have to learn from the mistakes. Mali's privatization experience was indeed closely being monitored by the donor community because of its showcase status. This is why the fast failure of this latest privatization experience led to a lot of soul searching and analysis by donors.[5] Their early assessments have mostly focused on descriptions of the institutional and contractual failures of the sector restructuring, emphasizing the fact that some of the expected investments did not take place as planned and that the government did not deliver on its own commitments. 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. None of these assessments really offered a quantitative diagnostic of the distribution of credits and blames across actors for the achievements and failures. The key actors stood firm on their own assessments of the failure. For the operator, Mali's almost 5 years experience of private operation in a restructured urban water and sanitation sector was on its way to success had it not been for politics. For the newly created independent regulator, Mali water users would have been asked to pay excessive water prices, had it not been for its intervention and its efforts to documents excess costs.

One way of assessing the outcome of the experience in a more objective way is to assess 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] The

[4] Source: UN MDG monitoring data base

[5] The German Development Cooperation Agency (KfW for instance) financed a background paper in 2005 summarized in a report summarizing the various private sector participation experiences in Sub-Saharan Africa. The French Development Agency (AFD) did the same in 2006 (Hibou (2006)) and so did the World Bank (Schlirf-Rapti (2005). The Harvard Kennedy School of Government now teaches the experience as a case (Gomez-Ibanez (2005) *EDM (Energie du Mali),* HKS case 1811.

[6] The method has recently been used in 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-Tatje 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

quantitative evaluation of the creation of value through a major policy reform and its distribution in Mali's privatization experience presented here is thus the first main contribution of the paper. To our knowledge, this 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 (2008) to a multi-output situation to assess how changes in the business profit and losses in a sector such as the water and sanitation sector can be decomposed into the sum of a price and quantity changes.[9] We also introduce a modification allowing 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 which it unbundles to increase the transparency of welfare gains and losses associated with the reforms and their distribution across across economic agents—mainly the labor force, the operator and the consumers. It is because this information is, or at least should be, relatively commonly available for

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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 source of TFP 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). The BIDE (2006) analysis included quantitative measurement of the impact of these privatizations on the economy in general and on all major stakeholders: consumers, owners (both domestic and foreign), workers and the government. In four of these case studies, an in-depth welfare analysis was performed following the cost/benefit methodology developed by BIDE. While insightful, the approach did not get allow the detailed distributional assessment offered here because it was not able to rely on the detailed operational data on both supply technology and coverage and on demand we were able to work with here thanks to the transparency efforts of the regulator.

[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).

[9] The methodology is built around indicators suggested by Bennet (1920).

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 offers a brief overview of 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 brief 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 in the water and sanitation sector. 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, Energie du Mali (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 (MMEE). 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 reform efforts of the Malian government aiming at improving service delivery in the sector[10]. 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 [11].

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

[10] Mali had already tried to rely on a management contract between 1994 and 1998 but this contract was terminated prematurely in 1995.
[11] 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.

responsibility for 16 of the 19 urban communes (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. Bamako is divided into seven *agencies* which are administrative divisions of Bamako. EDM is already responsible for what we call in the paper *Outside Centers.* These are secondary towns and cities. Each of these towns and cities, including Bamako, defines a water production and distribution center (production center, for short).

In addition to improvements in the overall operational and financial performance of the service, EDM was required to contribute to new investments in order 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[12]. Speeding up the investment process was essential since one of the recurring issues for the country has 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. As a regulator, 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 done to a large extent in spite of the reluctance of private operators to reveal information so common in regulated services, in particular in developing countries[13].

To some extent the insistence of the regulator to collect the data needed to assess the performance of the private operator fueled the tension between the regulator and the French operator which ended with the end to the privatization experience and a return of

[12] The 2001 DHS survey showed that the access to piped water 0% for the lowest quintile and 38% for the 5th quintile.

[13] It is remarkable to observe how easy it is to assess the performance of the water or energy operators in the UK, Germany or Holland for instance and how difficult it is to do so the same in Africa and even in some European countries like Belgium, Italy or Greece for instance.

the responsibility to the public sector. The contract was supposed to last 20 years. It lasted less than five 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[14].

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) which can be used to identify the sources of profits and losses for the operator as well as the location of failures to expand service or improve quality in the areas under the responsibility of the operators. The data has been organized systematically and provides a strong basis for the structured assessment allowed by the methodology discussed next.

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

Since most of the data available from balance sheets often covers revenue, cost and profits, the first step in an effort to understand the changes brought about by the private operator is to analyze the drivers of its profits and to decompose it into changes in prices and changes in quantities. Once that is done, 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.

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:

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

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 = 1,…,M for the production center *h* and w_n is the

[14] 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).

price of input n=1,…,N. The capital is included among the N inputs. We introduce the possibility that the unitary revenue (p) could be different depending on the structure of the demand and the characteristics of the 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. The reasons for this are that: (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

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

where π expresses the total profit at company level which is equal to the sum of the difference between the revenues and operating cost of the various production centers minus the overall expenses; C_g defines the overall expenses for the company which cannot be allocated to a particular center. According to accounting standard practice, we call these *general expenses*.

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

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

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

which decomposes profit change into the contributions of changes in individual quantities and individual prices, with each component expressed in value terms. The first term on the right-hand side is an *aggregate quantity effect* and the second term 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[15].

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

$$\Sigma_m \bar{p}_{mh}(y_{mh}^{t+1} - y_{mh}^{t}) - \Sigma_n \bar{w}_n(x_{nh}^{t+1} - x_{nh}^{t}) = (\pi_h^{t+1} - \pi_h^{t}) - \Sigma_m \bar{y}_{mh}(p_{mh}^{t+1} - p_{mh}^{t}) + \Sigma_n \bar{x}_{nh}(w_n^{t+1} - w_n^{t}). \quad (4)$$

On the left hand side, there 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 as the one given by Jorgenson and Griliches (1967), who showed that a measure of total factor productivity (TFP) can be based on quantities (*primal* approach) or prices (*dual* approach), but in a more restrictive context. They found that quantity variation is equal to price variation, with revenues equal to cost, which is the usual assumption in a macroeconomic framework. In this situation, the quantity effect measures the productivity change.

In the context of the assessment of the interest of such a major policy change as a privatization, it is useful to consider the complementary interpretation at firm level offered by Davis (1955). He interprets the price variations (the dual) in terms of

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[15] 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 us two different paths to decompose the variation in profits. The problem of which weights to use appears to have been resolved with the rediscovery of the Bennet indicator (1920) by Diewert (2005). This author has demonstrated that Bennet quantity and price indicators satisfy many tests similar to those satisfied by the Fisher quantity and price indexes.

'distribution' of the productivity gains among the stakeholders of the firm. The quantity effect measures the productivity bonus, which could be viewed as a 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. But, according to Davis, the right side, the Bennet price indicator, explains how the generated worth is 'distributed' among the stakeholders of the firm. In the context studied here, this means that EDM generated worth if the value of the quantity effect is positive, and destroyed it if the quantity effect is negative.

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

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

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

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 (2008) to separate price, quantity and economic drivers of profit to a multi-output situation. More specifically, the approach allows an identification of the relationship between the economic opportunity cost of producing water services and the revenues raised by EDM. Grifell-Tatjé and Lovell (1999) suggest introducing a two-level model, in which the first level provides information about the contributions per variable using price and quantity indicators, and the second level, per economic driver[16]. We then propose a derivation of the contribution of Grifell-Tatjé and Lovell (2008) based on a new definition of cost-efficient unit costs as weights, a reasonable assumption in a regulated context. This approach follows the recommendation of Genescà and Grifell-Tatjé (1992) who propose the use of unit costs instead of output prices as weights. The value added is an extension of the model to account for multiple outputs but more importantly a theoretical modification which alters the weights. This new weighting allows a better interpretation of the scale effect and a better fit to the specific situation of this study. Very roughly, this is how we get to expressions (6) and (7) below.

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 $T = \{(y,x): x \text{ can produce } y\}$. 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 $c(y,w) = \min_x\{w^T x: x \in L(y)\}$. The quantity effect can be decomposed to identify its economic drivers by means of

[16] De Witte and Saal (2010) use this approach in their study of Dutch drinking water utilities.

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

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

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

It shows that the quantity effect collapses to a productivity effect only if the *business margin effect* 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. This cost-efficient average operating cost is the same for the category of output, in a center *h*, and equal to $(\Sigma_n \overline{w}_n x_{Enh})/y^t_h$, since the cost of the water treatment and distribution is the same by center regardless of its final consumption.

Insert Figure 1 about here

Interpreting the new information in terms of the impact of reforms

What matters from the assessment conducted here is that 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 $[\overline{p}_m - (\Sigma \overline{w}_n x_{En})/y^t]$ 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 the water tariffs are regulated, the business margin effect allows us to see the distance between the regulated prices and the cost-efficient average costs. In fact, the value of $[\overline{p}_m - (\Sigma \overline{w}_n x_{En})/y^t]$ per output provides us with a tool to assess the regulator's price policy. If the regulated prices cover the cost-efficient average costs deliver more water is profitable, but if the regulated price is lower than the cost-efficient average cost, 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

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

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

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

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

(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 vector 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 this situation where $L^{t+1}(y^{t+1}) \subset L^t(y^t)$ on the assumption that $y^{t+1} > y^t$. It is possible to decompose the cost efficiency effect further, into a technical efficiency differential and an allocative efficiency differential. Such a further decomposition has the potential to 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 two decompositions are described in the following two equations.

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

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

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

(8)

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

The *technical change effect* in expression (7), which may be biased, 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 α >=< 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 equation (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.

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

The main challenge associated with the implementation of the decompositions is related to the observability of the 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 observed, and must be derived from observed data and the technologies. This is a substantive challenge as well since the technologies are unobserved. Our solution is to rely on a sequential form of DEA to approximate them. This enables us to 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

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

In this program, the objective is to find an input quantity vector x that minimizes the expenditure $w^{tT}x = \sum w_n^t x_n^t$ 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 $\{1,\ldots,t\}$. 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; this assumption rules out technical regress. The convexity constraint $\{\lambda \geq 0,\ \sum\lambda = 1\}$ allows the surface of T^t_{DEA} to satisfy variable returns to scale. We can calculate x_{CE}^{t+1} by repeating the previous exercise but replacing t with t+1 in equation (10). The solutions to these programs are the cost-efficient input quantity vectors x_{CE}^t and x_{CE}^t in Figures 1 and in decompositions (6) and (7).

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. The solution to this program is the cost-efficient input quantity vector x_E in Figure 1 and in decomposition (6) and (7). 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 $\theta^{t+1} x^{t+1}$, which requires solving two technical efficiency measurement problems. The general form of these linear programming problems can be expressed as

$$\min_\theta \{\theta\text{: } \theta x \geq X\lambda,\ Y\lambda \geq y,\ \lambda \geq 0,\ \sum\lambda = 1\}, \qquad (11)$$

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 main source of information is the Annual Reports of EDM. 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. Interestingly, 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 various data quality or gaps problems, our analysis focuses on five of the seven agencies of Bamako (Fleure, Lafia, Faladie, Quimzam and Badala), excluding Central and Badala – Djelib [17]. We also cover fifteen cities among the *Outside Centers*

[17] We have limited the role of the agencies in the study. There is information available about the revenues and the number of subscribers per agency. However, the agency is not a place where water is produced for

for which EDM is responsible [18]. To highlight the challenges associated with isolated centers among the Outside Centers, we have split, as EDM does, between DURI and Isolated Centers. 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. In short, in this study, we have 21 observations per year during the period 2001-2004, which total 84 observations on which we base our analysis.

The main difficulty of this study arises from the fact that the company provides two kinds of services: electricity and water, and does not report the costs of each one separately. We overcame this limitation because we had access to complete analytical accounting records which allocated costs between the two activities, electricity and water, for the year 2003. This exercise was not repeated for the other years, 2001, 2002 and 2004. However, it enabled us to ascertain what kind of costs pertains exclusively to each activity. For costs shared between electricity and water, we made the assumption that the *proportions* obtained in the year 2003 by dividing the costs between the two activities were also maintained in the other years. This is not a strong assumption because the other years are close to 2003 and for this reason; we do not expect a great deal of variation. Furthermore, 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 different kinds of output quantities based on the type of consumption which have different tariffs. These are: i) m^3 of water supplied to residential subscribers (quantity $\leq 60\ m^3$); 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.

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supply. There is therefore no specific consumption of inputs and, consequently, the total input quantities of Bamako must be allocated to its agencies, but there is no completely satisfactory way of doing this. Although we have included the agencies in the application, we have limited their role to the first part of the analysis, i.e. the decomposition based on the Bennet indicators. Their results are not reported in this paper, although we have been using them to obtain more knowledge of the city of Bamako.

[18] The names and population of 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.

The following revenue information is available: i) revenues per tariff sections; ii) revenues from rent and maintenance of water meters; iii) revenues from fraud recovery. We excluded 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 excluded subsidies as a component of the price of the outputs. We will return to the analysis of the subsidies paid to the company later. The main source of revenue comes from tariffs, which depend on the amount of water consumed. In 2004, the revenues from this concept accounted for approximately 92% of the total. The income from *rent and maintenance of water meters* accounted for 7.5%. The remainder came from *fraud recovery*. Although the revenues from this area have increased over time, they only accounted for 0.5% of total income in 2004.

The information about revenues from tariffs is available for each output defined above and for each observation, but this is not true of the incomes from rent and maintenance of water meters and fraud recovery. We allocated these about 8% of revenues to each of these outputs and observations, based on information about the number of subscribers and consumption of water[19]. We therefore obtained the total revenues associated with each of the three previously defined outputs per observation. We define an implicit output price or 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*. It is easy to associate a price to the labor input because there was no wage discrimination between the water and electricity services. The unit cost is thus given by the ratio between the total labor costs and the total number of employees. The price of one unit of labor in the water service is therefore the same as in the electricity service, which coincides with the average cost of the firm. However, the total labor cost of

[19] The information on revenues from tariff is available for each of the outputs previously defined, but this is not true of the incomes from rent and maintenance of water meters and fraud recovery. We have a global total amount that we have allocated to each output based on the number of subscribers in the first case, and the consumption of water in the second. The exact procedure is available on request.

production in the water service by center *h* is w_1x_{1h} where x_{1h} defines the number of employees in *h* and w_1 the average cost or indirect price per employee at firm level[20].

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. The quantities of these components are available per production and distribution center. We also have information about the total expenses for each of these components. The three components are bought 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. As with the labor input, we can therefore easily generate an average cost which is given by the ratio of the total expense of water production and treatment to the total aggregate treatment quantity[21]. The total expenses per production center *h* are given by the product w_2x_{2h} where w_2 defines the average expenses or indirect price and x_{2h} the aggregate treatment quantity of center *h*.

We have used the total number of water connections as a *proxy* of the *renting and maintenance input quantity*. With this *proxy*, we are saying that the maintenance of the water network and meters depends of the number of connections. As a result, when the number of connections increases we expect the levels of maintenance and number of meters to follow the same behavior and also increase. The information about the number of water connections is very complete and available for towns, cities and agencies. The total renting and maintenance cost is also available at company level. We define an implicit price, w_3, which is given by the ratio between the total renting and maintenance

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[20] The following information was available for the labor input: i) number of employees of the water subsidiary; ii) number of employees of the commercial subsidiary; iii) number of employees of the services shared by each of the towns and cities defined previously. The employees, who are not in the water subsidiary, work in both activities: water and electricity. We therefore need to allocate a number of these employees to water. We can easily calculate the ratio of *water subsidiary employees* to the *total employees*. Using this share, we can allocate the employees of *commercial* and *common services* to water. If we define α_h = water subsidiary employees/total employees in *h*, we have: labor quantity = total number of employees in water service = number of water subsidiary employees + α_h.(number of employees in commercial subsidiary) + α_h.(number of employees in shared services).

[21] In this context, $w_{2n} = C_{2n}/x_{2n}$, $n = 1,2,3$ 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*, $C_{2h} = \sum_n C_{2nh}$, where $C_2 = \sum_h C_{2h} = \sum_h \sum_n C_{2nh}$. The cost shares at center *h*, are $\delta_{nh} = C_{2nh}/C_{2h}$, n= 1,2,3; h = 1,2,…,H, where $\sum_n \delta_{nh} = 1$, h = 1,2,…,H. We can define a *treatment quantity index*, center *h*, as

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

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 $w_2 = C_2/x_2$.

cost and the total number of water connections. The total renting and maintenance cost of a specific production and distribution center *h*, is defined by $w_3.x_{3h}$, where x_{3h} represents the number of water connections by observation *h*.

In the case of the input capital, we have information about the value of the assets from the accounting records, but they present aggregated information on 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. Additionally, this information is not available for each of the observations. We therefore decided to use a *proxy* as a quantity of the input capital. This is defined by *the length of network distribution in km*, and this information is available per production and distribution center. For the case of the input capital, we defined two sources of costs: i) accounting depreciation and, (ii) interest paid to lenders which includes all the expenses from banking services. As we know the total assets that belong to the water service, we can estimate the accounting depreciation and the expenses from this service. Assuming that C_4 is the total cost of the input capital as the sum of these two concepts, the unit cost or indirect price is given by $w_4 = C_4/x_4$, where x_4 expresses the kilometers of network distribution. As mentioned previously, this average cost per unit of capital is applied regardless of their location. The total cost of the input capital, observation *h*, is therefore given by $w_4.x_{4h}$.

6. A basic statistical snapshot of EDM

Although Table 1 only shows the statistics for the data of output quantities, input quantities, output prices, input prices, operating cost and profits/losses at company level, we have created information identical to Table 1 for Bamako and each town and city in the sample as well as the Outside Centers (DURI and Isolated Centers). In fact, the information in Table 1 is merely an aggregation of the individual statistics from towns and cities across the Republic of Mali. Table 1 also shows the general expenses for the company as a whole, which are difficult to allocate among the various inputs; see expression (1). All nominal values have been converted to real values by deflating by the consumer price index (year 2000=100) of the Republic of Mali reported by the *International Monetary Fund* (IMF).

Insert Table 1 about Here

Table 1 shows that the production and distribution of water incurred losses every year at company level. These were on average of (1,306,433,472) real CFA francs during the period 2001-2004. To put this figure in perspective, it represented approximately 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. It was defined as

$$\pi = \Sigma_h R_h - \Sigma_h C_h - C_g = 11{,}440{,}805{,}155 - 10{,}998{,}659{,}707 - 1{,}748{,}578{,}920,$$

where 11,440,805,155 real CFA francs are the total average revenues, 10,998,659,707 the total average operating cost which includes the cost of capital and 1,748,578,920 the average general expenses. We can therefore see that the total revenues generated by the firm are enough to cover the total operating costs, but not the general expenses.

Furthermore, the total operating expenses excluding the cost of capital are 7,432,520,703 real CFA francs, and adding the general expenses produces a total cost of 9,181,099,623 CFA francs which generates a positive profit of 2,259,705,532 real CFA francs. When the cost of investment is excluded, this produces a positive profit that represents an approximate return on assets of 4%.

During the period studied, the company received a number of subsidies in the form of one-off payments. These occurred in 2001 and 2003 and they consisted of 10,850 and 7,200 million nominal CFA francs for the two activities: electricity and water. 11% and 16% of these sums could be considered subsidies for the production and distribution of water. In real CFA francs, this means quantities of 1,134 and 1,083 million, which is an average of 554 million per year during the period studied. We have seen that the general expenses represent 1,748 million real CFA francs. The subsidies from the regulator therefore cover less than one third of the general expenses. Of course, the figure of the subsidies differs greatly from the cost of the input capital, which averages 3.566 million real CFA francs.

Judging by the figures above, we do not expect losses when the revenues are compared with the operating cost for each production and distribution center. In the case of Bamako, the city with the largest population, there are profits every year, with a clear trend towards an increase. The story changes completely in the Outside Centers, which generated losses in almost every year, but revenues are still sufficient to cover the operating expenses, excluding the cost of capital.

Output quantities

The total water supplied and sold rose from 30.1 million m^3 in 2001 to 43.2 in 2004, an increase of about 43%. It is also apparent that about half of the water sold goes to residential subscribers, almost 40% to industry and high consumption, and the remainder (about 10%) to public fountains. These percentages have been calculated using the totals and are highly influenced by the city of Bamako, which consumed 28.7 million m^3 in 2004. Looking at the percentages for the other towns and cities, we found different results, with about 45% of the observations selling less than 5% of the water to public fountains. The water sold to public fountains may reflect the demand from the poorest households. They could have an affordability problem due to being unable to pay the cost of being connected to the water network. The cost of a connection usually depends on the distance between the house and the nearest water pipe. However, it could also reflect a connection problem because the firm cannot satisfy the demand from new points of water delivery.

Output prices

As we have seen, the price for each output is calculated as average revenue per type of product. The first thing that can be observed is that the prices of the outputs are different, although the unit cost of producing them is the same. The average revenue of a m^3 of water supplied to a public fountain is about a quarter of the that generated by the output industry and high consumption, and half that from the output of residential subscribers. The second thing that we can appreciate in Table 1 is that the real price per m^3 of water supplied at the end of the period is lower than at the beginning. The three outputs present the same decreasing tendency, with a reduction of about 2% for industry and high consumption, 3% for residential subscribers and 5% for public fountains. Although they are not included in Table 1, the same numbers can be seen for Bamako and the Outside Centers. They do not change greatly when a comparison is made between the DURI and Isolated Centers.

Revenues

We have seen that the real unit revenue has fallen over time, but this reduction has been compensated for an important increase in output quantities. Total real revenues therefore increased by more than 38% between 2001 and 2004. As expected, the main source of revenue is the industry and high consumption output, which accounts for about 60% of the total. This is followed by residential subscribers with 35%, and finally public fountains with less than 5%.[22] These figures are very similar for Bamako and the Outside Centers.

Input quantities

The behavior of the four inputs over time is not homogeneous because one of them does not undergo a great deal of variation, the other two increases in the period under investigation and the fourth shows no clear trend. First, we can see that the total numbers of employees at the beginning and at the end of the period are very similar. The treatment quantity index rises until 2003 and falls afterwards, but the final balance is an increase of about 10%. The two inputs that increase the most are the total number of connections and the length in total kilometers of the distribution network. The variation in the former is about 42% and in the latter it is about 23%.The increased supply of water mentioned above is therefore mainly based on 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 is the only one to fall sharply, by about 43%, between the beginning and the end of the period. 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). We comment on the increase in the unit cost of labor in some detail in the next section.

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 total real cost at company level is the sum of all

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

the operating costs, including the cost of capital plus the general expenses. The real average cost is calculated per unit of water *sold* or supplied, not per unit of water *produced* (the ratio between total real cost and quantity of water sold). 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 has a higher cost, with a share in the unit cost of about 28%, followed by the cost of water production and treatment (23%), labor expenses (19%), renting and maintenance (16%) and finally general expenses (14%). Except for production and treatment expenses, the contribution of the other inputs to the unit cost was quite stable during the period. In fact, 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 protected the users from some of the input price increases while the regulator tended to focus on the huge quantity effect.

Table 2 shows that for the company as a whole, there was on average increase of 381 million real CFA francs, resulting from a combination of the 740 from the quantity effect and -359 from the price effect. Note that 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. In the former case, there was an average increase in the real operating profit and in the latter, an average improvement in the losses. These losses largely originated from the Isolated Centers. In fact, Table 2 shows that on average, the losses worsened, increasing by 40 million real CFA francs, which is the result of the inability to compensate for the negative sign of the price recovery with the improvement in the quantity effect[23].

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*'

[23] Note that each town and city in the sample shows a different situation and, in addition, the water supply service outside Bamako is relatively small. For example, there were on average ten workers working in this field in 2004. Due to the small size, the results could be sensitive to relatively minor changes in quantities. Consequently, when we look at the individual results of each town and city we might expect behavior different from that described above for the aggregated figures. However, this does not seem to be the case in the decomposition of the price effect and the quantity effect in Table 2, in which twelve observations out of a total of fifteen have a negative Bennet price indicator and a positive Bennet quantity indicator.

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 the potential profit has been generated by means of two mechanisms: the quantity effect mentioned above and a reduction in the price or unit cost of the input renting and maintenance. This behavior is generalized and can be seen in Bamako, in the DURI and Isolated Centers and hence at company level. We can easily calculate the total potential profit or worth available which was 1,121 million real CFA francs, of which 740 was from the quantity effect and the remainder was from a saving of 381 real CFA francs associated with lower renting and maintenance costs. Of the above figure, 65% arose in the city of 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. 538 million real CFA francs.

By contrast, consumers and the capital factor have not benefited as much, as they have received much smaller proportions of the bonus available. In the case of consumers, the reductions in real prices were 129 million 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 1,121 million 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.

As regards the employment factor, we found that wages are undergoing a strong average growth, thereby receiving an important part of the bonus generated. The *International Monetary Fund* (2006: 20) reports the "*minimum wages and salaries in the public sector of a high grade Government employee in Mali*". The figure from the IMF for the last year, 2004, in real annual terms is equivalent to 3,107,465 CFA francs. Table 1 shows a figure of 5,971,257 real CFA francs, almost double the IMF figure. We do not have the information to explain this difference, but can suggest two possible explanations. First, that 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 4,257,762 real CFA francs at the beginning of the period, in Table 1, could support this assumption. The second is that 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 working for the company. 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%. [24] 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. Obviously, it could also have been used to pay the workers well, to cut some subsidies or to generate new subsidies.

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

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[24] Schlirf-Rapti (2005) reports the information for each year Turing the 2001-2003 period. Schirf-Rapti was an advisor to the regulator and it is thus very likely that the information he reported was the most precise available. Gomez-Ibanez (2005) who visited Mali to write his case study, 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% .

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 $[\overline{p}_m - (\Sigma \overline{w}_n x_{En})/y^t]$ 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[25].

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 the city of Bamako, productivity improvements account for about 65% of the Bennet quantity indicator. By contrast, in the case of 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

[25] From a theoretical point of view, it could be argued that product prices must cover the efficient unit costs. To put this argument in perspective, this would involve more than doubling the prices for public fountains because, as an average for the period, the price of this output does not amount to 50% of its efficient unit cost. For residential subscribers, the product price covers about 85% of its efficient unit cost. These increases would have an immediate effect on the most disadvantaged strata of the population. 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.

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. The water supplied could be much less than the water produced. An old or poorly maintained distribution network may explain the difference, as does illegal connections to the pipes, among other reasons. We have calculated an average ratio of water supplied compared to sold of 70% in 2004, which means losses of about 30% of the water produced. At the beginning of the period, 2001, the figure was 40% so there was an improvement of about 10% during the period. 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. It can therefore be seen that, for the case of the city of Bamako, the difference between observed costs and efficient costs worsens very slightly. By contrast, 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 has illustrated 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 have illustrated the techniques on a study of the production and supply of water in the period 2001-04, when this service was privatized in Mali. The technique 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 is that, for the company as a whole, the production and distribution of water continued to generate losses every year. Income covers operating costs including the cost of investments, but not general expenses. This is likely to be a very common problem for the water sector in many of the poorest countries of the world. In the case of Mali, the financial losses are generated by the towns and cities making up the Isolated Centers. In fact, there is a process of cross-subsidies, where the profits from some production centers cover others' losses to a small extent, but are not sufficient to meet general expenses. But cross-subsidies continue to be more complex. 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 priced above its efficient unit cost.

The second dimension of the impact that stands out is that consumers seem to have benefited more than argued by some of the critics. 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 the source of gains for the operator since there was an improvement in real operating profits despite a negative price effect and despite the fact that we found that the increases in input prices were not fully passed on in water sale prices.

The third major impact was the significant productivity gains. The increases in total factor productivity are fully explained by technical change and economies of scale. These important improvements arising from technical change and economies of scale were partly counteracted by a negative cost efficiency effect. This negative cost efficiency effect is particularly important in the case of 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 observable and hence politically sensitive impact is the distribution of the value created by the private operator among the different stakeholders. Taxpayers have clearly not been saved by the reform since subsidies continue to be important 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 in fact one of the claims of the regulator but it could not be substantiated from the existing accounting data. The extent to which this is a real issue could thus not be settled and unfortunately, it was never settled by an offer of increased transparency of that data by the operator.

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-- and hence in the discussion of their distribution 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 Latin America and Sub-saharan Africa.

It is important to keep in mind also that the privatization experience did generate gains. If the capture of these gains by the private operators is essential in ensuring their willingness to commit to finance investment in poor countries, we may end up with a lot fewer deals than many donors had hoped for. This may explain why management contracts are likely to make a strong return in this sector. In the last 5 years, traditional foreign investors have been less willing to take on the risk of investing in water in the poorest countries without some of the opportunities they had managed to have up to then to generate steady predictable flows of cash through various forms of creative internal pricing practices for physical inputs, management and skills.

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 alive and well in Africa and increased transparency and accountability allowed by improved regulatory accounting will simply make then sharper, more public and hence more debatable. If managed properly, this increased transparency of decision making processes should make final decisions, one way or another, more acceptable to all actors.

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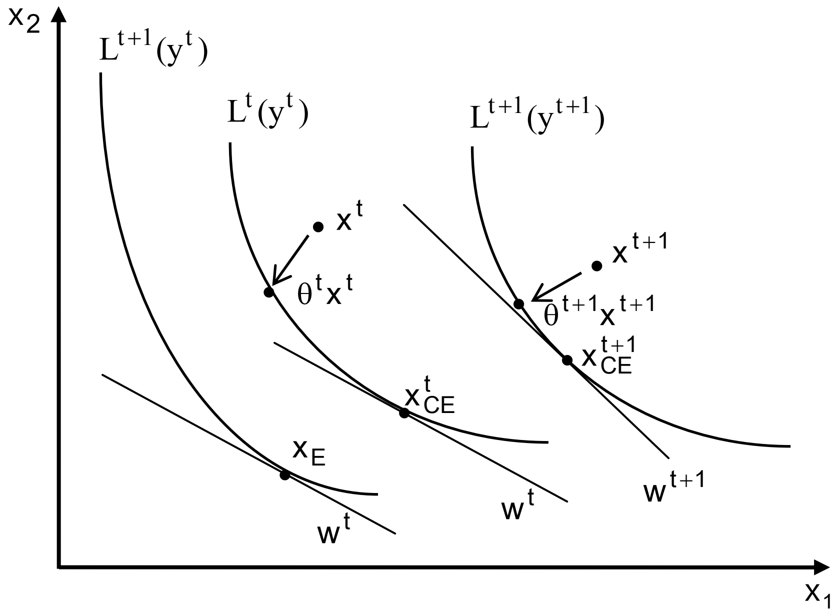

Figure 1. The Productivity Effect Decomposition (N = 2)

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***