

Distributional Incidence of the Water Tariff Subsidies in Casablanca, Morocco

Anne Olivier*, EEP and DIAL

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Abstract

This paper analyzes the distributive impact of water tariff subsidies provided through non linear tariff structures in Casablanca, using the national households consumption survey ENCDM 2000/2001. We first analyze the distributive consequences of the water network expansion, as about one fifth of the households in Casablanca is expected to be connected under the National Initiative for Human Development (INDH) programs. Then we conduct micro-simulation estimations using alternative water tariff structures in order to assess their distributional effects. Due to the selection pattern of the water connection itself, the water demand of unconnected households must be estimated as a preliminary step using a standard Heckman procedure. Water consumption has then been adjusted using standard elasticity assumptions for alternative water pricing. The analysis shows that every tariff structure simulated becomes progressive once the water network is expanded and that the reduction of the first block provides no improvement at constant subsidy level. The most progressive tariff structure are the ones providing a free water allowance, especially when it takes into account the household size. Finally, simulated targeted subsidies do not improve the distribution while the exclusion issue is a rising concern, with more than 50% of the poorest households excluded from such consumption subsidies.

JEL classification: D12, Q21, Q25

Key words : water supply, distribution, tariffs

*Ecole Economie de Paris, Paris, and DIAL, 4 rue d'Enghien, 75010 Paris. Email: olivier@dial.prd.fr

1 Introduction:

Water tariff reforms are recurrent issues in urban Morocco as water consumption subsidies benefit to most of the households connected to the water network (World Bank, 2004), excluding the poorest households that remain unconnected. Recently, the Moroccan government has significantly shifted his approach to poverty reduction in urban settings (Baron and Haoues-Jouves, 2004 and de Miras, 2007). A major component of the National Initiative for Human Development (INDH), launched by The King Mohammed VI in 2005, targets basic services for morocco's poorest urban households. In Casablanca, about 780 000 dwellers from the *Insalubrious Neighborhoods* have thus become eligible to a water and sanitation network connection. Within this changing environment, the tariff concern grows in term of subsidy distribution as well as affordability.

As for all other Moroccan cities, water consumption subsidies in Casablanca are provided through a four Increasing Blocks Tariff (IBT) for domestic customers, while other categories (industrial, administration and public taps) have their own setting. The tariff level within each block however is specific to each water operator, based on its own supply cost. Such increasing block tariff have been highly discredited due to their regressive pattern in incomplete network (Boland and Whittington, 2000 and Komives et al, 2005), however empirical works about their distributional effects remained limited. Recent works from Ruijs et al. (2007) in Brazil and Diakite et al. (2009) in Côte d'Ivoire try to *rehabilitate* the distributional effects of increasing block tariff. Massarutto (2006) advocates that water pricing policies should turn from economic instrument (he claims that efficient price gains are often low) to public finance instrument.

A water reform conducted nationwide in 2006 has modified the water tariff structure in every urban area in Morocco, whether publicly or privately operated, in order to reduce the subsidy level: the social tariff block has been reduced from 8 m³ to 6 m³ per month. However, protests have occurred in Casablanca at the end of 2006 and led Lydec, the water operator ¹, to revert the tariff modification for

¹Lydec, a private operator, has been in charge of the water, sanitation and electricity services for the Grand Casablanca area since 1997.

the city and limit tariff increase that occurred due to this modification²: These tariffs are applied on a meter basis, whatever the number of households the meter supplies, as shared meters are not registered as such. Consequently, shared meters provide more expensive water (as cost per unit consumed) as they reach faster the 8 m³ threshold. The sharing pattern is more commonly distributed in poor groups : in 2001 in Casablanca, 48% of the households of the poorest quintile shared a water connection and 22% of the richest. Therefore, the poorest faced more expensive water while consuming less. Since 2001, such pattern has been attenuated with the meters partition campaign, as 70 000 new water meters have been installed between 2001 and 2004, as a partition of a former existing connection.

This paper analyzes the distributive impact of water tariff subsidies provided through non linear tariff structures in Casablanca, using the national households consumption survey ENCDM 2000/2001. The analysis is conducted with micro simulation for the water consumption : we first analyze the distributive consequences of the water network expansion, as about one fifth of the households in Casablanca is expected to be connected through the INDH programs. Then we conduct micro-simulation estimations using alternative water tariff structures in order to assess their distributional effects. Due to the selection pattern of the water meter itself, the water demand of shared meters and unconnected households must be estimated as a preliminary step using a standard Heckman procedure. Water consumption has then been adjusted using standard elasticity assumptions for alternative water pricing.

2 Description of the data

The 2001 Moroccan Households Consumption Survey (ENCDM 2000/2001), which Casablanca sub sample comprises 1580 households over 4 municipalities, provides the microeconomic data used for the micro simulation and the Distributive Analysis. The data comprises household modules from the main questionnaire (housing conditions including water and electricity supply, demography, labor) as well as

² Without any unit price increase, the reduction of the size of the first block from 8 m³ to 6 m³ per month led to significant bill increase for households consuming about 8 m³ per month.

computed annual total expenditures, water expenditures and electricity expenditures. Descriptive statistics are presented in appendix A.1. All households have been weighted using the extrapolation coefficient given by the National Statistic Institute of Morocco.

Using the essential needs per capita as the basis for the national poverty line³ (Touhami, 1999), vulnerability to poverty in Casablanca amounts to 11.5% of the households in 2001. 13% of the households live in housing considered as basic or *insalubrious*. Table 1 shows the access rate to basic services in Casablanca in 2001, according to living standards : while the city water coverage rate reaches almost 80% of the population, only half of the vulnerable households (54%) owns a house connection (private or shared). The other half relies on public taps. 34% of the households connected to the water network shared their meter with other families in 2001, and 47% among the poorest. Connection rate to the water network remains the main concern for inhabitants of slum or other illegal settlements⁴ as it stands far lower than to the electrical network and even to sewage. Electrical coverage has been expanded in slum areas under specific programs with revocable conditions (they were initially launched by Lydec to limit the frauds), while *condominial sewage* has been build by slum dwellers themselves. Water connection required a legal property title, thus was denied to illegal settlements until the enforcement of the new INDH conditions.

The average annual expenses for water amount 977 Dhs/year for the poorest quintile, i.e. 3,8% of their total expenses, while the water expenses amount 1450 Dh/year for the whole population, i.e. 2,1% of the total expenses. Unconnected households have limited expenses for water as most of them are supplied through public taps, which costs are borne by municipalities.

³The poverty line for urban households in 2001 is 3615 Dirhams per capita and per year, and 3272 for rural households. The Vulnerability line stands at 1.5 times the poverty line.

⁴Illegal settlement is known in Casablanca as the *insalubrious neighborhoods* and is divided in two types: the most known are the *bidonvilles* or slums where inhabitants have build their house or *baraque* on the plot of a private or public owner. They might be enclosed in urban areas or disseminated in rural areas. The other type is the *lotissement clandestin* where inhabitants have bought an apartment built illegally. These are usually settled in periurban areas.

Table 1: Access to electricity, water and sanitation network in Casablanca (2001)

Households ordered by expenses per capita	Electrical connection			Water connection		Sewage
	All	shared*	without meter*	All	shared*	
Quintile 1	85,89 %	46,40 %	14.89 %	52,93 %	46,79 %	79,36 %
Quintile 2	90,02 %	38,48 %	7.64 %	71,12 %	43,19 %	88,89 %
Quintile 3	95,25 %	29,50 %	6.65 %	76,48 %	36,30 %	87,96 %
Quintile 4	96,99 %	28,99 %	2.65 %	87,11 %	35,61 %	92,16 %
Quintile 5	99,17 %	15,70 %	1.20 %	95,06 %	22,09 %	95,64 %
Vulnerable	85,29 %	50.01 %	16.41 %	50.85 %	48.68 %	80.29 %
Non-vulnerable	95.38 %	27.07 %	4.36 %	82.57 %	32.85 %	90.88 %
All	94,14 %	29,34 %	5.70 %	78,66 %	34,11 %	89,57 %

* as a proportion of the connected households

Calculation based on ENCDM 2001 (Casablanca sample- 1580 households).

3 Empirical Strategy

Benefit incidence analysis has been extended for public spending analysis in development countries since late 1970s. However, the lack of desegregated data prevented further work to go on until the years 2000s, where further developments have been made, especially in the field of marginal incidence analysis focusing on the expansion of services (Lanjouw and Ravallion, 1998) or tax reforms (Duclos and Makdissi (2004)). We analyze the incidence of subsidies, using the distribution of the subsidies across households of different levels of income or expenditures. The methodology consists on comparing the Lorenz curves of private households consumption expenditures (used as a proxy for income or welfare) with the concentration curve of the subsidies received by each household. In addition, the targeting performance of the subsidy scheme is estimated using the performance indicator of Coady et al (2004), which compares the subsidy distributed to the poorest compared to the average subsidy.

We use the financial value of the consumption subsidies, as per Komives et al. (2005) i.e. the difference between the supply cost of water for the operator, based on average supply cost, and the actual household bill. We use a proxy for the

average supply cost, in dividing the revenues by the volume of water sold given in Lydec annual reports. The average selling price reaches 10.3 Dhs/ m^3 in 2001, which stands slightly above the average price paid by households, allowing for a general subsidy benefiting the households⁵. In 2006, the average selling price reaches 10.6 Dhs/ m^3 .

The main standard implicit assumptions are twofold: first, the supply cost is uniform across users, whatever their location and housing conditions. Secondly, the supply cost is constant with the quantity consumed, although fixed cost for billing and meter reading are not necessarily low. Both assumptions are likely to be strong ones, as remote users might cost more to be supplied, as well as households living in complex neighborhoods. In addition, in Casablanca, about half of the supply cost comes from the raw water bought from Lydec to the Office National de l'Eau Potable (ONEP) on a volumetric basis. Consequently, an average uniform cost might underestimate the cost for the new network users, expected to be the poorest, and underestimate the subsidy for low consumption users.

In order to simulate the water network expansion towards inhabitants of the *insalubrious* areas, the counterfactual water demand needs to be estimated as a preliminary step. Then, the water demand of all users (formerly connected and newly connected) needs to be calibrated in the context of alternative price structures.

3.1 Estimation of the counterfactual water consumption of shared meter households and unconnected households with selection issue

Due to the selection issue of connection placement, the counterfactual water consumption of shared meter households and unconnected households is estimated using a two-steps procedure based on Heckman's (Heckman, 1979):

The water consumption $Consumption_i$ is measured only for the households equipped

⁵A common practice is also to use the unit price of the second block, assuming that it is set close to the average supply cost, which is 11.2 Dhs/ m^3 in 2001. This price stands higher than the average selling price.

with an individual meter: under static conditions, water consumption is a function of the households characteristics X_i (size, income number of children, type of housing, number of rooms, house equipment,), and the living conditions of the neighborhood Z_i :

$$\ln(\text{Consumption}_i) = \beta_0 + \beta_1.X_i + \beta_2.Z_i + u_i \quad \text{consumption equation}$$

this water consumption can be observed only for households with a positive propension to connect :

$$\alpha_0 + \alpha_1.X_i + \alpha_2.Z_i + \alpha_3.W_i + v_i > 0 \quad \text{selection equation}$$

u_i and v_i are correlated, thus the ordinary least square estimate is biased.

The two-steps Heckman procedure takes into account the selection bias, assuming that the errors terms are jointly normal and

$$\frac{u_i}{\sigma_u} = \rho. \frac{v_i}{\sigma_v} + \epsilon$$

Estimations are conducted separately for households sharing a meter and for unconnected households. Regressions are shown in appendix A.3 to estimate the water consumption of shared meter household and the water consumption of unconnected households.

Based on 2001 data, the simulations draw two cases: with the prediction of the individual water consumption of households sharing a water meter, data simulate the *individualization* of all existing meters (as a proxy of the situation in 2006). With the prediction of water consumption of unconnected households, data simulate the quasi-universal expansion of the water network. The procedure applied to impute residuals to the predicted consumption is detailed in appendix A.4.

3.2 Calibration of the water demand with alternative pricing

Marginal price and average price variations have an impact on households water demand as shown in numerous studies, listed on the State of the Art review of

Arbues et al. (2003). The price elasticity of water demand shall be taken into account while simulating alternative pricing. Based on the early Nordin-Taylor specification, we use the marginal price and a *difference* parameter to take into account the non linearity of the price structure. The *difference* parameter is the difference between the water bill paid by the household and the amount that would be paid if the water was priced at the marginal price. It acts as a virtual income and is considered as such in our specification:

$$\ln(Consumption_i) = \gamma + \alpha * \ln(pmarg_i) + \beta * \ln(income_i + difference_i) + \varepsilon_i$$

Casablanca water tariff comprises a fixed charge (FC) and 4 consumption blocks, which limits are l_0 , l_1 and l_2 , and unit prices p_{00} and p_0^6 , p_1 , p_2 and p_3 , thus the *difference* and the marginal price depend on the consumption level.

The total bill B_i can be expressed as:

$$\begin{aligned} \text{if } C_i \leq l_0 & \quad B_i = FC + p_{00} * C_i \\ \text{if } l_0 < C_i \leq l_1 & \quad B_i = FC + p_0.l_0 + p_1.(C_i - l_0) \\ \text{if } l_1 < C_i \leq l_2 & \quad B_i = FC + p_0.l_0 + p_1.(l_1 - l_0) + p_2.(C_i - l_1) \\ \text{if } C_i > l_2 & \quad B_i = FC + p_0.l_0 + p_1.(l_1 - l_0) + p_2.(l_2 - l_1) + p_3.(C_i - l_2) \end{aligned}$$

the *difference* variable is discreet and depends on the consumption block of each user:

$$\begin{aligned} \text{if } C_i \leq l_0 & \quad pmarg_i = p_{00} \quad \text{and } d_i = d_0 = 0 \\ \text{if } l_0 < C_i \leq l_1 & \quad pmarg_i = p_1 \quad \text{and } d_i = d_1 = l_0.(p_1 - p_0) \\ \text{if } l_1 < C_i \leq l_2 & \quad pmarg_i = p_2 \quad \text{and } d_i = d_2 = l_0.(p_1 - p_0) + l_1.(p_2 - p_1) \\ \text{if } C_i > l_2 & \quad pmarg_i = p_3 \quad \text{and } d_i = d_3 = l_0.(p_1 - p_0) + l_1.(p_2 - p_1) + l_2.(p_3 - p_2) \end{aligned}$$

The water consumption is thus calibrated for each alternative price structure, in a two step procedure : first, the error term ε_i plus the constant are computed for each households in the 2001 conditions, using the observed and predicted consumption C_i , the marginal price $pmarg_i$ for the consumption block and the corresponding difference variable d_i (ε_i is used for γ and ε_i).

⁶In 2001, two different prices are applied within the 1st block, p_{00} is only applied to households consuming in the 1st block, it means 8 m³/month as a maximum. Above this threshold, the unit price for the first 8 m³ is p_0 .

$$\begin{aligned} \ln(C_i) &= \alpha \ln(pmarg_i) + \beta \ln(income_i + d_i) + \varepsilon_i \\ \varepsilon_i &= \ln(C_i) - \alpha \ln(pmarg_i) - \beta \ln(income_i + d_i) \end{aligned}$$

the elasticity parameters α and β have been set arbitrary to average values based on Dalhuisen meta-analysis (Dalhuisen, 2003) with $\alpha = -0.4$ and $\beta = 0.2$. An analysis of the sensitivity to such values is presented in appendix A.6.

The calibration of the consumption for each tariff structure is then based on marginal prices and difference for each block, and the selected consumption figure is the one that fulfills the blocks limits:

$$\begin{aligned} \text{if } C_i(p_{00}, d_0) \leq l_0 & \quad C_i = C_i(p_{00}, d_0) \\ \text{if not, if } l_0 < C_i(p_1, d_1) \leq l_1 & \quad C_i = C_i(p_1, d_1) \\ \text{if not, if } l_1 < C_i(p_2, d_2) \leq l_2 & \quad C_i = C_i(p_2, d_2) \\ \text{if not, if } C_i(p_3, d_3) > l_2 & \quad C_i = C_i(p_3, d_3) \end{aligned}$$

4 Results

Water consumption per quintile, observed and predicted, are detailed in Table 2: predicted individual consumption, based on households characteristics, are lower than presently connected ones : they reach 9.6 m³/month for households sharing their meter in 2001 and 8.5 m³/month for unconnected households, as compared to 15 m³/mth for the households equipped with individual meters, which are wealthier households (average total expenditures of connected households amount 89 871 Dhs/year, while average total expenditures of unconnected households amount 44 206 Dh/year only).

Table 2: Observed and predicted water consumption (m³/month)

Connection type in 2001	quintiles of total households expenses					Total
	1	2	3	4	5	
individual meter*	11.6 m ³ /m	11.8 m ³ /m	13.1 m ³ /m	14.5 m ³ /m	19.1 m ³ /m	15 m³/m
shared meter	7.9 m ³ /m	9.1 m ³ /m	9.7 m ³ /m	10.4 m ³ /m	12.8 m ³ /m	9.6 m³/m
unconnected 2001	7.6 m ³ /m	8.7 m ³ /m	9.2 m ³ /m	9.7 m ³ /m	11.2 m ³ /m	8.5 m³/m

* the individual meter consumption are based on water expenses observed in 2001

The distributive analysis is conducted using the distribution of the subsidies among the total population before the network expansion (with observed individual meter water consumption and predicted shared meter water consumption) and after the network expansion (with all households water consumption).

4.1 Distributive analysis of water subsidies in 2001 and 2006

Between 2001 and 2005, only the fixed charge has increased. Following the protest in Casablanca against the social tariff reduction from 8 to 6 m³/mth, an additional block has been re-established between 6 to 8 m³/mth, with a marginal price close the first block. A 6 % increase has been shifted to the next blocks to balance for this adjustment (see the detailed structures in appendix A.2).

The figure 1 shows the subsidy concentration curves for the 2001 and 2006 tariffs. A distribution is progressive when its concentration curve stands above the 45 degree line. It is still relatively progressive when its curve stands between the 45 degree line and the Lorenz curve (the Lorenz curve represents the distribution of the expenses among the population). The tariffs show both a regressive pattern due to the exclusion of the poorest households from the network: The 10% poorest households receive only 7% of the total subsidy in 2001 and 8,4% in 2004. The poorest 20% households receive 15,6% of the total subsidy in 2001 and 17,6% in 2006. The reduced block tariff (which has been rejected) shows an almost neutral pattern in the lower part of the distribution, however with a significant increase of the average prices, thus a reduced subsidy, even for the poorest : the average

subsidy supplied to the first quintile drops from 183.5 Dhs/household.year to 93 Dhs/household.year with the reduced block tariff.

The observed regressivity is mainly due to the exclusion from the network of the poorest households. Once the expansion of the water network is simulated, the 2006 scheme becomes progressive. The 10% poorest receive 12,6% in 2006 and would have receive 14,3% with the reduced block modified tariff (the 20% poorest receive respectively 24,3% and 27,3% of the total subsidy). Due to the average water consumption drop, the subsidy amount to be supplied through the tariff would increase sharply without any price adjustment, up to 293 Dhs/household.year, compared to 208,5 before expansion. The subsidy increase would thus reach 40%. Such a high increase of the total subsidy level could not be considered in the Casablanca context where a cost recovery policy is required in the absence of public subsidies (all water subsidies are cross subsidies, provided by industrial, administration and most probably from the electricity bills as well). The micro-simulation estimates an average price adjustment of +10% to compensate for the average consumption drop.

A zero subsidy has been applied to unconnected households. If we take into account the subsidies provided by municipalities for the free consumption upon public taps, the three pricing combined with the public taps subsidies would be fairly progressive, even without network expansion. Based on a 30 l/cap.d consumption at public taps, the subsidy provided by municipality to slum dwellers amounts 634 Dh per household per year⁷. This amount will be saved by municipality but they would not be transferred to the private water operator to compensate for the supply of low income neighborhoods. A possible move would be to subsidize households for their connection, as the connection cost is high : the lump sum is set at 4000 Dhs for a water and sanitation connection for a household living in the now eligible *Insalubrious* Neighborhood, (it represents more than one month of expenses for most of the unconnected households). Such subsidies are better targeted than water consumption subsidies (Komives et al, 2005).

⁷In 2006, the total amount billed to municipalities for the public taps reached 60 millions Dhs per year for 5,7 millions cubic meter

Figure 1: Distribution of water and sanitation subsidies in 2001 and 2006

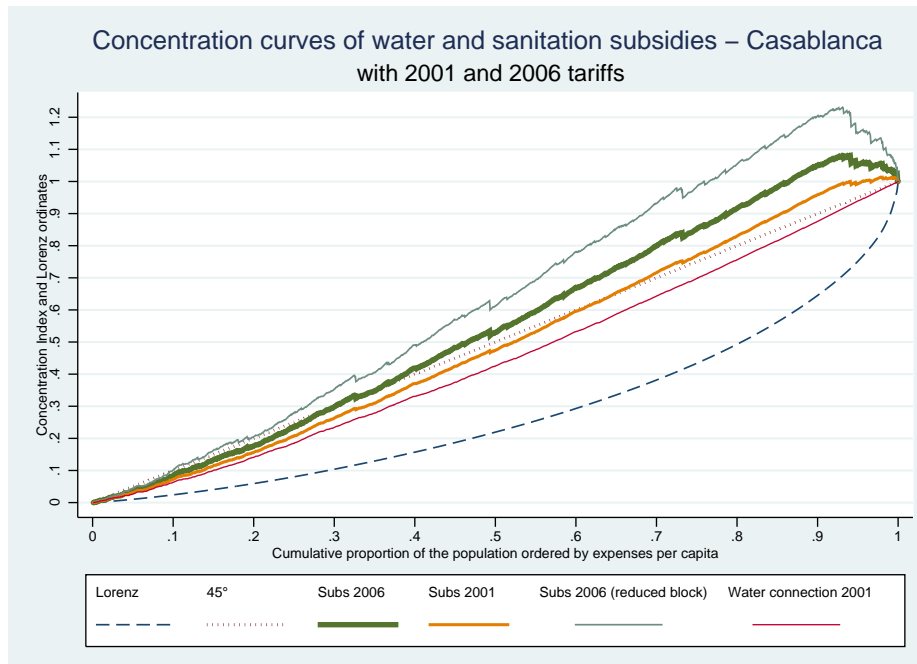
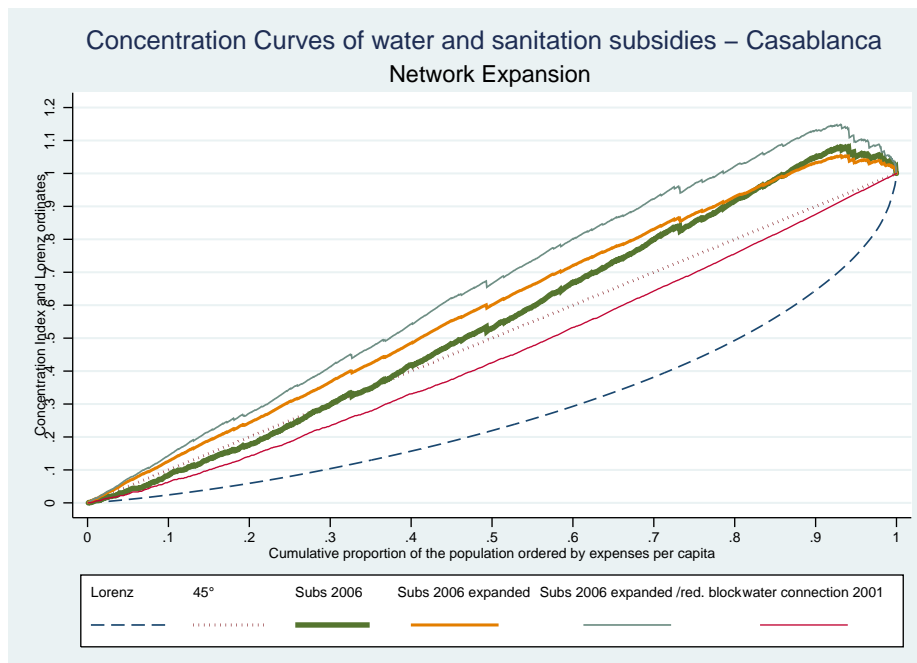


Figure 2: Distribution of water and sanitation subsidy with the network expansion (under constant tariff)



4.2 Targeting performance of the water subsidies

Komives et al. (2007) assess the Benefit Incidence of subsidies in the water and electricity sectors with 26 utilities data using Coady targeting performance framework (Coady et al, 2004). It provides a useful analytical tool as it allows to focus on the poorest, with an analysis of the targeting performance towards a specific group.

The Targeting Performance Indicator is defined as the share of the subsidy benefits received by the poor $\frac{S_P}{S_H}$ divided by the share of the poor in the population $\frac{P}{H}$; it can also be expressed as the average benefit for the poor, divided by the average benefit per households in the population :

$$\Omega = \frac{\frac{S_P}{S_H}}{\frac{P}{H}} = \frac{\frac{S_P}{P}}{\frac{S_H}{H}}$$

Where :

P is the number of households under the poverty line,
H the total number of households of the population concerned,
 S_P the total subsidy received by the poor,
 S_H the total subsidy provided through the tariff structure.

$\Omega = 1$ means that the poorest receive the same subsidy than the whole population, as an average.

Table 3 shows the targeting performance for each scenario: the targeting performance indicator is regressive for the first quintile, before the network expansion ($\Omega < 1$ in 2001 and 2006, it means that the poorest receive less subsidy, as an average that the average population). Ω becomes progressive (1.22) with the network expansion, as the poor households become subsidy recipients. If the total subsidy amount remains constant, it means with a general price increase of 10%, the first quintile would receive 1.4 their share in the population. The average subsidy supplied to the first quintile through the water tariff structure reaches 293 Dhs/household.year once the network is expanded.

Table 3: Water network expansion simulation, with constant subsidy

Scenarii	Tariff Structure applied	Total subsidy (Dh/household.year)	Subs. to 1 st quintile (Dh/household.year)	Performance (Ω)
<i>without network expansion</i>				
2001	2001 tariff	332	259	0.78
scenario 0	2006 tariff	208.5	183,5	0.88
scenario 0 bis	2006 rejected tariff	93	96	1.03
<i>with network expansion</i>				
scenario 1	2006 structure with 10% adjustment	208.5	293	1.4
scenario 1 bis	2006 red. Block tariff	208.5	241	1.16

a -0.4 price-elasticity is applied to water consumption for the 2006 tariff structure .

Remark: As for the reduced block tariff (rejected in 2006), the average subsidy is highly reduced to 93 Dhs/household.year, thus lower than with the actual structure. Under the network expansion scenarii, the subsidy level remains constant.

4.3 Distributive analysis of alternative pricing schemes

Expansion and individual metering is a first condition to improve the distribution of the water subsidies. Once these conditions are fulfilled, alternative pricing might be set up in order to reach a more progressive distribution:

The alternative pricing schemes simulated consist on modifying the quantity targeting scheme, in reducing the first block size, withdrawing the fixed charge or providing free volumes of water. Targeted subsidies might also be provided:

The social block reduction is simulated in reducing the first block from 8 m³ to 6 m³/mth) as it is often recommended to improve the targeting performance. In addition, this tariff change was applied nationwide, except in Casablanca. Fixed charge are regressive thus the removal of the fixed charge improves the progressivity of any structure. However, the drawbacks are important because of the existing fixed cost in the water supply cost and the financial viability that it helps to secure. Free allowance of a basic consumption level is also often advocated as in South Africa. Family size remains a concern for the progressivity of such tarification. We thus simulate a 4m³ /mth, a 6m³/mth as well as a 40 l/cap.d alternative pricing. Eventually, explicit targeting is often presented in the litterature as the only progressive structure. However, as shown by Gomez-Lobo and Contreras (2003) in their comparison study of the Chilean and the Colom-

bian targeted schemes, it usually goes with high exclusion rates that should be carefully studied, as the performance ratio and the distribution do not inform on such drawbacks. We then simulate a 50% subsidy for targeted households, based on two targeting criteria: the first one is the housing type, the second one is a poverty index (see the poverty index in appendix A.5). All simulations are conducted assuming a quasi-universal coverage and a constant subsidy amount.

Table 4 shows the price applied in each structure for the simulation under a constant subsidy level.

The figure 3 shows the concentration curves of the water subsidy under the free allowance scenarii ($4\text{m}^3/\text{month}$, $6\text{m}^3/\text{month}$ et 40 l/cap.d) as well as without any fixed charge. The figure 4 shows the concentration curves of the water subsidy under the targeted subsidy scenarii, based on the poverty index and on the housing type. Distribution dominance is shown in table 5.

Based on the concentration curves analysis, every pricing scheme simulated leads to a progressive subsidy distribution with quasi-universal water coverage. The most progressive distribution are the free volume schemes ($6\text{ m}^3/\text{mth}$ or 40 l/cap.d), the 40 l/cap.d dominating all other distribution. However, the $4\text{ m}^3/\text{mth}$ free volume water scheme does not perform better than the present increasing blocks structure: the present one already provides $8\text{m}^3/\text{mth}$ at a highly subsidized price. As expected, withdrawing the fixed charge improves the subsidy distribution. The social block reduction from 8 to $6\text{ m}^3/\text{mth}$ becomes less progressive than the present structure when the total subsidy level is kept constant.

The targeted subsidy schemes perform rather poorly in such context where a general subsidy is provided in addition to the targeted one: all domestic users benefit from a subsidy as the average price remains below the supply cost in this simulation for comparison purpose. Only the targeted households receive an additional subsidy of 50% of their bill. Poverty index targeting appears more progressive than the simple housing criteria targeting.

Table 4: Simulations scénarii with constant subsidy level

scénarii	tariff structure	marginal price
<i>without network expansion</i>		
scenario 0 (2006 tariff)	IBT 4 blocks 2006	
scenario 0bis (rejected tariff)	IBT (reduced 1 st block to 6 m^3/mth)	
<i>with network expansion</i>		
scenario 1 (tariff 2006 adjusted)	IBT 4 blocks	$pmarg06 \times 1.10$
scenario 1b (tariff 2006 red./adjusted)	IBT reduced block	$pmarg06 \times 0.936$
scenario 2 (w/o fixed charge)	IBT 4 blocks w/o fixed charge	$pmarg06 \times 1.318$
scenario 3 (free 4 m^3/mth)	free 4 m^3/mth and volum.price above	$pmarg = 14.089 Dh/m^3$
scenario 3b (free 6 m^3/mth)	free 6 m^3/mth and volum. price above	$pmarg = 22.367 Dh/m^3$
scenario 3t (40 l/pers .j)	free 40 l/cap.d and vol. price above	$pmarg = 34.731 Dh/m^3$
scenario 4 (housing targeting)	vol. price and 50% red for eligible HH	$pmarg = 9.566 Dh/m^3$
scenario 5 (poverty index targeting)	vol. price and 50% red for eligible HH	$pmarg = 9.816 Dh/m^3$

Figure 3: Distribution of the water subsidy under block tariff structures

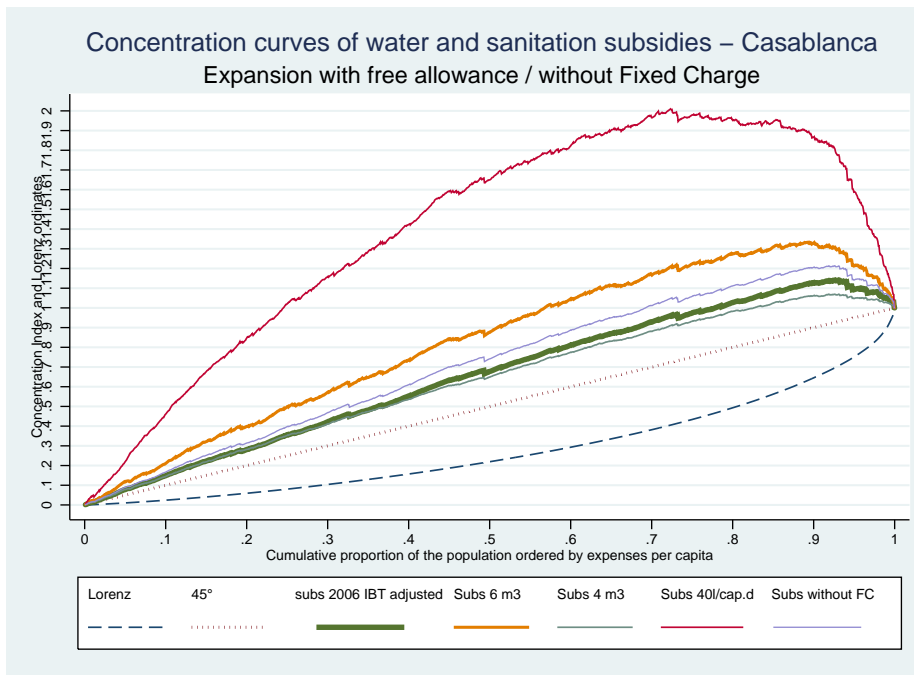


Figure 4: Distribution of the water subsidy under targeted schemes

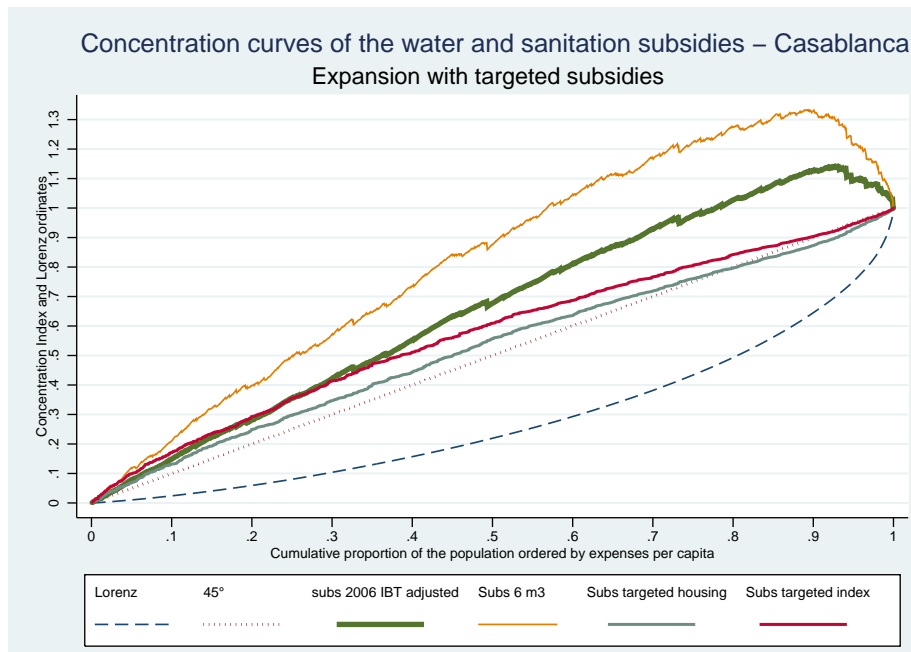


Table 5: Dominance of the concentration curves and targeting performance of tariff scenarii

	scenario 1b (IBT 2006 reduced block)	scenario 2 (without FC)	scenario 3 (4 m ³ /mth)	scenario 3b (6 m ³ /mth)	scenario 3t (40l/cap.d)	scenario 4 (housing targ.)	scenario 5 (index target.)	Perf. (Ω)
scenario 1	-	+	nd	+	+	- *	nd	1.41
scenario 1b		+	+	+	+	nd	nd	1.16
scenario 2			-	+	+	-	-	1.57
scenario 3				+	+	-	nd	1.41
scenario 3b					+	-	-	1.99
scenario 3t						-	-	4.23
scenario 4							+	1.24
scenario 5								1.46

+ means that the structure in rows dominates the structure in columns, - that it is dominated by the structure in columns. n.d. means that the dominance is not determined.

* except for the low part of the distribution (up to 10% of the poorest households) where this scenario dominates the present situation. The targeting performance Ω refers to the 1st poverty quintile

These results are robust for water supply costs fixed at smaller and higher levels than the one selected for the simulations. The distribution progressivity decreases with the amount of subsidy provided. In addition, the targeting performance decreases with the size of the targeted group: it is higher for the group of vulnerable households (11.8%) than for the 40% poorest households. The study of the sensitivity of the results to the price elasticity parameter shows also that dominance remains the same within the 0 to -0.45 range of price elasticity applied. Table 14 in appendix A.6 shows that the average subsidy distributed with the 2006 tariff increases if the elasticity is higher, as a smaller part of the consumption reaches the unsubsidized blocks. For the same reason, the targeting performance decreases if the elasticity increases. For each simulation, the higher the elasticity, the more the marginal price must be increased in order to compensate for the drop in consumption.

4.4 Further consequences on households of alternative pricing schemes

The distributive analysis does not inform on a possible exclusion of poor households from the subsidy provision, however this might be a critical issue for targeted subsidies given the health consequences of potable water supply. 70% of the first quintile households do not live in a house considered as insalubrious (as per ENCDM criteria), thus would be excluded from a targeted scheme based on such criteria. The poverty index targets the poor better, however only 45% of the first quintile would be targeted with this index-based targeting. The consequence of the exclusion from the subsidy delivery might be two folds : either an increase of the water bill (a water bill above 5% of the total expenses is considered as a burden) or a rationing of the water consumption. Such rationing below the subsistence level might lead to severe health consequences (for example the cholera outburst in South Africa in 2000 has led to the decision to provide everyone with a minimum level). Thus, when the objective of a tariff structure aims at supplying water at an affordable price, the targeting performance of the structure is not a sufficient parameter. Table 6 provides a synthesis of tariff structures performance as per the risks and objectives of such structures. Detailed data are provided in Appendix A.7.

Table 6: Performance of simulated alternative tariff structures related to the risks and objectives of the tariff (under a constant subsidy)

Scenarii	Progressivity	Exclusion (Q1)	Rationing (a) (Q1)	Water poor (b) (Q1)	relative expenses (Q1)
scenario 1 (IBT 8m ³)	++	+	-	+	+
scenario 1b (IBT 6m ³)	+	+	-	+	+
scenario 2 (IBT 8m ³ without FC)	++	+	-	+	+
scenario 3 (free allowance 4 m ³ /mth)	++	+	--	+	+
scenario 3b (free allowance 6 m ³ /mth)	+++	-	--	+	++
scenario 3t (free allowance 40 l/cap.d)	++++	++	+++	+++	+++
scenario 4 (Housing targeting)	++	--	-	+	+
scenario 5 (poverty index targeting)	++	--	-	+	+

(a) Rationing means the proportion of households consuming less than 40 l/cap.d set as the subsistence level

(b) Water poor means the proportion of households spending more than 3% of their total expenditures

Under the water demand specification applied for the simulation, water consumption decreases due to the marginal price increase in each scenario . The proportion of households consuming less than 40 l/cap.d increases in each scenario (except for the free 40 l/cap.d). Because of the consumption moderation, the water expenditure ratio remains below 3% in each scenario. With other demand specifications, like a specification allowing for an inelastic consumption level (Martinez-Espineira and Nauges, 2004 and Gaudin et al., 2001), household would not limit their consumption below this threshold and their water expenditure would increase.

5 Conclusion

The majority of households connected to the water network in Casablanca benefit from cross subsidies for their water consumption, as per in other Moroccan cities : data base from Lydec, the water, sanitation and electricity operator for Casablanca region shows in 2005 that 90% of the domestic users pay an average price lower than the average selling cost. The tariff reform conducted nationwide in 2006 aimed at limiting the water consumption subsidies in reducing the first

block (social block), however this led to significant price increase for households consuming above this threshold and protests have caused the tariff change to be reverted in Casablanca. The distribution issue of the water consumption subsidies is getting more and more acute in the Moroccan context as the National Initiative for Human Development (INDH) targets urban exclusion, specifically households of the *Insalubrious Neighborhoods*. About a fifth of Casablanca dwellers has become eligible to the water and sanitation network since 2005. Such dwellers are expected to consume water within the highly subsidized block and thus increase the need for subsidies.

With the microsimulation of the water consumption, we have shown that increasing block tariffs are progressive once the network connection becomes quasi-universal. A tariff increase would be necessary to compensate for the average water consumption drop due to the newcomers (+10% here). The reduction of the size of the first highly subsidized block, as applied in other Moroccan cities has brought no improvement in terms of distribution. Free allowance schemes report the most progressive pattern, although $4 \text{ m}^3/\text{mth}$ would not be sufficient to supply a subsistence consumption to most poor households. They are also the most performant in term of affordability and exclusion mitigation. Due to the family size variability, an allowance per capita (40 l/cap.d) appears to be the most progressive scheme. Such scheme would probably be costly to monitor, thus the cost should be withdrawn from the supplied subsidy in order to compare with other pricing alternative. Targeted subsidy schemes have not shown significant improvement compared to the distribution of the present IBT and they present a major drawback which is the exclusion rate. Komives et al (2005) survey had already shown a high correlation between the improvement of the progressivity of subsidy schemes and the increase in the exclusion rate. Likewise, Gomez-Lobo and Conteras (2003) analysis of the Chilean and Colombian scheme had underlined the exclusion rate of such targeted schemes that are widely used as references.

A Appendix

A.1 Descriptive statistics of *Casablanca* sample (ENCDM 2001)

Table 7: Descriptive statistics of *Casablanca* sample (ENCDM 2001 /1580 households)

Variable	Obs.	Mean*	[95 % CI*]	
total expenses (Dhs/year)	1580	80 124	76 094	84 155
expenses per capita (Dhs/year)	1580	16 577	15 522	17 632
water expenses (Dhs/year)	1559	1 162	1 086	1 237
household size	1580	5.58	5.46	5.7
children	1580	1.44	1.37	1.50
old person	1580	.28	.26	.31
urban	1580	.9656	.956	.9746
water connection	1580	.7866	.7663	.8068
shared water connection	1219	.3411	.3145	.3678
sewage	1580	.8957	.8807	.9108
public tap	1580	.1487	.1312	.1663
well	1580	.0175	.0111	.0240
elec connection	1580	.8877	.8721	.9033
shared elec connection	1580	.2605	.2388	.2821
owner	1580	.5175	.4929	.5422
rooms	1580	2.81	2.74	2.89
indiv housing	1580	.8548	.8374	.8722
toilets	1580	.9661	.9571	.9750
kitchen	1580	.9072	.8929	.9215
unsalubrious housing	1580	.1311	.1144	.1477
tradi house	1580	.0526	.0416	.0636
modern house	1580	.5884	.5642	.6127
apartment	1580	.1611	.1430	.1793
villa	1580	.0454	.0352	.0557
housekeepers	1580	.0677	.0553	.0801
mobile phone	1580	.4281	.4037	.4525
home phone	1580	.4049	.3807	.4291
Mohammedia	1580	.0529	.0419	.0639
Sbata	1580	.1630	.1448	.1812
Hassani	1580	.1433	.1260	.1606
Fida	1580	.1229	.1067	.1391
Othmane	1580	.2471	.2258	.2684
Anfa	1580	.1918	.1724	.2113
Bernoussi	1580	.0789	.0656	.0922

* weights are the extrapolation coefficients given by the National Statistic Institute of Morocco

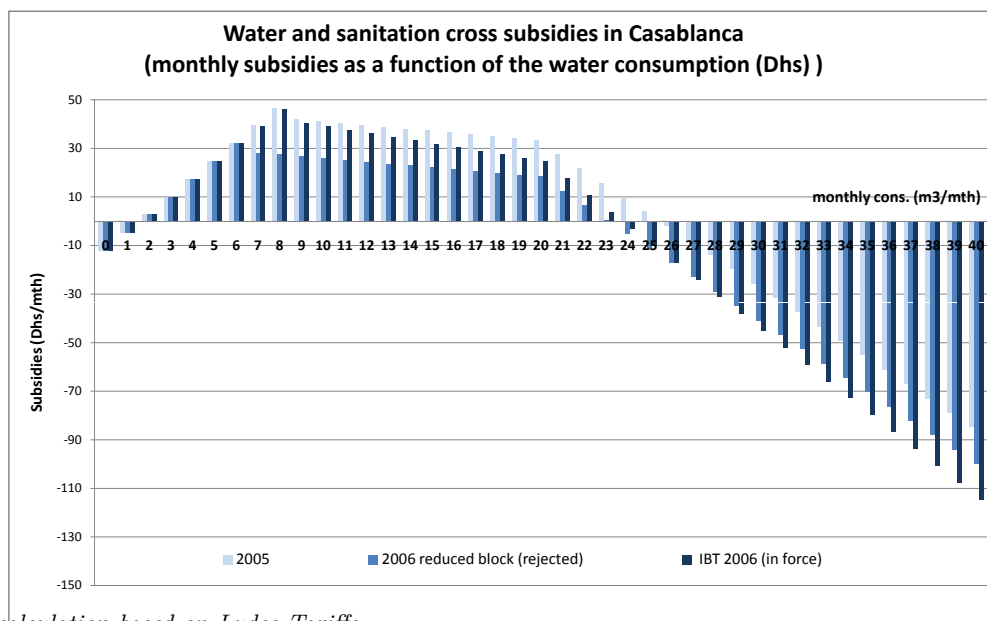
A.2 Casablanca Tariffs and Subsidies

Table 8: Casablanca Tariff Structures from 2001 to 2006

	2001	2005	2006 (rejected)	2006 (in force)
consumption limits (m ³ /mth)				
l_0	8	8	6	6
l_1	20	20	20	8
l_2	40	40	40	20
fixed charge exc. taxes (Dh/mth)				
	7,06	11,96	11,96	11,96
marginal prices exc.taxes (Dh/m ³)				
p_{00} *	2,94	3,27	3,27	3,27
p_0	3,38	3,78	3,78	3,83
p_{01} *				3,47
p_1	10,61	11,46	11,46	4,01
p_2	15,55	16,51	16,51	12,04
p_3	15,60	16,56	16,56	17,56

* only for households consuming up to 8m³/mth

Figure 5: Monthly water consumption and water connection - Casablanca



A.3 : Regressions tables

Ordinary Least Squares

	Coef.	t
(connected households total expenses <400 000Dhs/year)		
Number of obs =	750	
F(19, 730)	12.76	
R-squared =	0.2493	
Adj R-squared =	0.2297	
Root MSE =	0.4755	
<i>ln_water_cons</i>	Coef.	t
<i>ln_total_exp</i>	.1799635	5.01
<i>urban</i>	.5404695	2.97
<i>household_size</i>	.0551898	5.75
<i>rooms</i>	.0349618	2.42
<i>children</i>	-.0446465	-2.69
<i>old_persons</i>	.0556141	1.78
<i>house_keepers</i>	.142726	2.06
<i>parking</i>	.2128399	2.13
<i>well</i>	-.4429805	-2.83
<i>indpt_act</i>	.0480736	1.02
<i>transfers</i>	.1562584	2.12
<i>pension</i>	.1274665	2.46
<i>rente</i>	.1350559	1.61
<i>hiring_act</i>	.1516498	1.50
<i>indpt_act_aux</i>	-.0943785	-1.61
<i>kitchen</i>	-.0681886	-0.39
<i>indiv_housing</i>	-.141327	-1.48
<i>villa</i>	.2952274	2.73
<i>appart</i>	-.0984423	-2.19
<i>constant</i>	-.2635185	-0.59

Heckman selection model :

individual meter among households already connected in 2001 (households with total expenses <300 000 Dhs/year)		individual meter for households unconnected in 2001 (households with total expenses <200 000 Dhs/year)			
<i>ln_water_cons</i>	Coef.	z	<i>ln_water_cons</i>	Coef.	z
<i>ln_total_exp</i>	.1738429	4.77	<i>ln_total_exp</i>	.2312568	5.59
<i>urban</i>	.526356	2.86	<i>urban</i>	.7341521	4.01
<i>household_size</i>	.0613247	6.37	<i>household_size</i>	.0588111	6.02
<i>rooms</i>	.0620352	3.89	<i>rooms</i>	.0505217	3.30
<i>children</i>	-.0553047	-3.29	<i>children</i>	-.052452	-3.07
<i>old_persons</i>	.0487617	1.52	<i>old_persons</i>	.0619449	1.93
<i>house_keepers</i>	.1553444	2.15	<i>house_keepers</i>	-.057039	0.70
<i>parking</i>	.2363676	2.45	<i>parking</i>	.1475276	1.16
<i>indpt_act</i>	.0492487	1.05	<i>well</i>	-.1170752	-0.79
<i>transfers</i>	.1817426	2.47	<i>indpt_act</i>	.0707692	1.46
<i>pension</i>	.1276691	2.46	<i>transfers</i>	.2427892	3.15
<i>rente</i>	.1304881	1.56	<i>pension</i>	.1972669	3.38
<i>hiring_act</i>	.1632579	1.55	<i>rente</i>	.2730535	2.93
<i>indpt_act_aux</i>	-.0997746	-1.68	<i>hiring_act</i>	.1746659	1.49
<i>rente_aux</i>	-.1259494	-1.50	<i>act_salarie_aux</i>	-.0916517	-1.64
<i>constant</i>	-.5771108	-1.34	<i>act_indpt_aux</i>	-.1131692	-1.88
selection variables for indiv_water_meter		selection variable for water_connection			
<i>ln_total_exp</i>	-.0718977	-0.78	<i>ln_total_exp</i>	1.040363	8.70
<i>urban</i>	-.2392768	-0.58	<i>urban</i>	2.252576	8.42
<i>household_size</i>	.0258895	1.10	<i>rooms</i>	.2919797	4.96
<i>rooms</i>	.3452338	8.32	<i>children</i>	-.1731965	-4.28
<i>children</i>	-.0184023	-0.45	<i>house_keepers</i>	1.05927	2.12
<i>old_persons</i>	-.0625387	-0.77	<i>well</i>	-.1327981	-3.15
<i>house_keepers</i>	.1833148	0.76	<i>transfers</i>	.441362	1.87
<i>parking</i>	.6538136	1.63	<i>pension</i>	.5731179	3.03
<i>rente_aux</i>	-.8164903	-4.59	<i>rente</i>	.5375918	1.61
<i>pension_aux</i>	.1736	1.21	<i>act_salarie_aux</i>	-.573121	-3.59
<i>indiv_housing</i>	1.188864	8.53	<i>indpt_act_aux</i>	-.2914758	-1.64
<i>appart</i>	.7139796	5.73	<i>hiring_act_aux</i>	-.2171493	-3.49
<i>home_phone</i>	.3633282	3.83	<i>indiv_housing</i>	.7027451	3.79
<i>constant</i>	-.9565675	-0.94	<i>appart</i>	1.774565	6.10
<i>rho</i>	.3246402		<i>trad_house</i>	-.6690663	-3.01
<i>sigma</i>	.4864995		<i>An_fa</i>	-.9090861	-4.10
<i>lambda</i>	.1579373		<i>Bernoussi</i>	-.1296725	-5.31
LR test of indep. eqns. (rho = 0)	chi2(1) = 6.74		<i>Fida</i>	-.1591872	-0.63
			<i>Othmane</i>	-.6831236	-3.43
			<i>Sbata</i>	-.1551103	-7.30
			<i>Mohammedia</i>	-.5320233	-1.76
			<i>constante</i>	-.13.3914	-10.65
			<i>rho</i>	.3944379	
			<i>sigma</i>	.4808084	
			<i>lambda</i>	.1896491	
			LR test of indep. eqns. : (rho = 0):	chi2(1) = 12.35	

A.4 Prediction of the water consumption of unconnected households

Under a static framework, water consumption is a function of the households characteristics and their housing conditions X_i (income, size, children, housing type, rooms, housing equipment) and of other local variables Z_i . This function is supposed to be log-linear:

$$\ln(C_i) = \beta_0 + \beta_1.X_i + \beta_2.Z_i + u_i$$

The consumption is observed for households with an individual meter only, it means only if the propensity to connect to an individual meter is positive:

$$R^* = \alpha_0 + \alpha_1.X_i + \alpha_2.Z_i + \alpha_3.W_i + v_i \quad \text{with} \quad R^* > 0$$

Error terms u_i and v_i are correlated. We assume that they are jointly normal.

$$\frac{u_i}{\sigma_u} = \rho \cdot \frac{v_i}{\sigma_v} + \epsilon$$

with $(1 - \rho^2)$ the standard variation of ϵ

The latent variable R^* can not be observed thus the standard deviation is unknown. We assume that $\sigma_v = 1$.

Thus $\ln(C_i)$ can be written as $\beta_0 + \beta_1.X_i + \beta_2.Z_i + \sigma_u.(\rho.v_i + \epsilon)$

and for unconnected households,

$$R^* < 0 \text{ thus } v_i < -(\alpha_0 + \alpha_1.X_i + \alpha_2.Z_i + \alpha_3.W_i)$$

For the predicted consumption of unconnected households, residuals v_i and ϵ are taken from a Uniform distribution, with an additional condition for v_i , as v_i must be smaller than $-(\alpha_0 + \alpha_1.X_i + \alpha_2.Z_i + \alpha_3.W_i)$, the predicted selection variable.

A.5 Water Poverty Index using Principal Component Analysis:

Table 10: Principal Component Analysis

Variable	Score
villa	0.1339
apartment	0.1573
traditional house.	-0.1331
modern house	0.0929
room	-0.0528
unsalubrious housing	-0.2648
rural housing	-0.0218
other housing	-0.0685
toilets	0.1978
kitchen	0.2702
bathroom sink	0.3703
shower	0.3122
bathtub	0.2262
1 room	-0.2471
2 rooms	-0.1230
3 rooms	0.1323
4 rooms	0.1150
5 rooms	0.1004
individ. housing	0.1946
individ. elec. connection	0.3474
elec. connection	0.2568
owner	0.1603
home phone	0.2962

Table 11: Households distribution

Index quintiles	minimum	maximum
quintile 1	-6.140774	-2.033339
quintile 2	-2.028191	-0.3785837
quintile 3	-0.35867	0.9413348
quintile 4	0.9636498	1.960228
quintile 5	1.964764	3.602437
Total	-6.140774	3.602437

A.6 Sensitivity to parameters :

Sensitivity to the choice of the targeted group

The targeted group in the analysis is the poorest quintile. The targeted group might be increased to the 40% poorest households as per Komives et al (2005) survey. In Casablanca, households vulnerable to poverty represent 11.8% of the population based on national poverty lines⁸. This group might also be the targeted group. Table 12 present the results. It shows that the targeting performance ordering is the same for each targeted group. However, for each structure analysed under the expansion scenario, the indicator is weaker when the group is broader.

Table 12: Simulation with constant subsidy level - sensitivity to the targeted group

scenarii	subs. to vulnerable (Dhs/hh.year)	Perf. (Ω)	subs. to 1 st quintile (Dhs/hh.year)	Perf. (Ω)	subs. to 1 st &2 ^d quintiles (Dhs/hh.year)	Perf. (Ω)
<i>without water network extension</i>						
scenario 0 (2006 tariff)	180.25	0.86	183.5	0.88	218.15	1.05
scenario 0bis (2006 tariff rejected)	98.39	1.05	95.79	1.03	114.61	1.23
<i>with network extension</i>						
scenario 1 (2006 tariff -adjusted)	315.51	1.51	293.03	1.41	288	1.38
scenario 1b (2006 tariff -rejected)	251.8	1.21	241.12	1.16	244.26	1.17
scenario 2 (without Fixed Charge)	357.78	1.72	327.54	1.57	317.98	1.53
scenario 3 (free 4 m ³ /mth)	305.42	1.47	293.96	1.41	279.26	1.34
scenario 3b (free m ³ /mth)	452.17	2.17	415.28	1.99	383.28	1.84
scenario 3t (free 40 l/cap.d)	955.53	4.58	882.79	4.24	741.64	3.56
scenario 4 (housing targeting)	280.51	1.35	259.33	1.24	231.27	1.11
scenario 5 (poverty index targeting)	350.17	1.68	305.19	1.46	266.25	1.28

Sensitivity to the supply cost:

The average supply cost for 2001 has been assumed to be 10.3 Dh/m³ and 10.64 Dh/m³ for 2006. Table 13 shows that the targeting performance decrease when the supply cost is far from the price paid by the users, i.e. when the average subsidy increase.

⁸The Haut Commissariat au Plan has defined the vulnerability threshold as 1.5 the poverty threshold, thus 5 424 *Dhs/cap.year* in 2001 for urban households and 4 909 *Dhs/cap.year* for rural households.

Table 13: Targeting performance : Sensitivity to the supply cost level

	supply cost (Dhs/m ³)					
	10	10.6 (basis)	11	11.5	12	12.5
Average subsidy (Dhs/hh.year)	137.6	208.5	255.7	314.8	373.8	432.9
	Targeting performance indicator (Ω)					
<i>scenarii with network expansion</i>						
scenario 1 (2006 tariff - adjusted)	1.7	1.41	1.38	1.21	1.15	1.11
scenario 1b (2006 tariff - rejected)	1.35	1.16	1.12	1.03	0.99	0.96
scenario 2 (without fixed charge)	1.96	1.57	1.43	1.32	1.24	1.18
scenario 3 (free 4 m ³ /mth)	1.73	1.41	1.33	1.2	1.13	1.08
scenario 3b (free 6 m ³ /mth)	2.60	1.99	1.91	1.59	1.47	1.38
scenario 3t (free 40 l/cap.d)	5.97	4.23	3.61	3.11	2.76	2.5
scenario 4 (housing targeting)	1.47	1.24	1.16	1.09	1.05	1.01
scenario 5 (poverty index targeting)	1.8	1.46	1.34	1.24	1.18	1.13

Sensitivity to price-elasticity

The simulations have been conducted with a -0.4 elasticity of the water consumption to the marginal price. Such level leads to consumption variations under the new tariff structures. The sensitivity to the elasticity parameter is studied using the range of 0 to -0.45, based on the 2001 consumption levels. As for previous simulations, all scenarii are compared with the same average subsidy level, i.e. the level of 2006 before the network expansion.

Table 14 shows that the average subsidy distributed with the 2006 tariff increases if the elasticity is higher, as a smaller part of the consumption reaches the unsubsidized blocks. For the same reason, the targeting performance decreases if the elasticity increases. For each simulation, the higher the elasticity, the more the marginal price must be increased in order to compensate for the drop in consumption. Distribution dominance are unchanged within the parameter range.

Table 14: Targeting performance: Sensitivity to price -elasticity level

	Price -elasticity					
	$\alpha = 0$	$\alpha = -0.3$	$\alpha = -0.35$	$\alpha = -0.4$	$\alpha = -0.45$	
Average subsidy (Dh/hh.year)	186,4	203,1	205,8	208,5	211	
	base					
	Subsidy to 1 st quintile (Dh/hh.year) and Targeting performance indicator (Ω)					
	Sub Q_{20}	Ω	Sub Q_{20}	Ω	Sub Q_{20}	Ω
scenario 1 (2006 tariff -adjusted)	288	1,55	292	1,44	293	1,42
scenario 2 (without fixed charge)	331	1,78	328	1,62	330	1,60
scenario 3 (free 4 m^3/mth)	250	1,34	285	1,40	289	1,41
scenario 3b (free 6 m^3/mth)	341	1,83	400	1,97	407	1,98
scenario 3t (free 40 l/cap.d)	691	3,71	851	4,19	867	4,21
scenario 4 (housing targeting)	244	1,31	256	1,26	259	1,24
scenario 5 (poverty index targeting)	288	1,55	301	1,48	305	1,46
					293	1,41
					328	1,57
					294	1,41
					415	1,99
					883	4,23
					259	1,24
					305	1,46
						293
						325
						298
						426
						906
						261
						307

A.7 Simulation with constant subsidy level (208.5 Dh/hh.year)

Table 15: Simulation with constant subsidy level (208.5 Dh/hh.year)

sénarii	subsidy to quintile 1 (Dh/hh.year)	Perf. (Ω)	HH under threshold ($C < 40$ l/cap.d)	<i>water poor</i> (<i>bill.</i> > 5% of tot exp.)	water ratio (Quintile 1)	average price (Quintile 1) (Dh/m ³)
<i>without water expansion</i>						
scenario 0 (2006 tariff)	183.5	0.88	29.5 %	6.7%		
<i>with water expansion</i>						
scenario 1 (adjusted 2006 tariff)	293.03	1.41	18.1 %	7.8 %	3.3 %	7.7
scenario 1b (reduced block tariff)	241.12	1.16	20 %	5.5 %	2.7 %	7
scenario 2 (w/o FC)	327.54	1.57	22.8 %	6.9 %	2.7 %	6.2
scenario 3 (free 4 m ³ /mth)	293.96	1.41	27.2 %	5.1 %	2 %	3.6
scenario 3b (free 6 m ³ /mth)	415.28	1.99	31.1 %	5.4 %	1.5 %	2.7
scenario 3t (free 40 l/cap.d)	882.79	4.23	1.6 %	6.5 %	0 %	4.4
scenario 4 (housing target.)	259.33	1.24	26.1 %	4.1 %	2.7 %	8.3
scenario 5 (index target.)	305.19	1.46	24.8 %	4.2 %	2.6 %	7.4

References

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