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To pay or not to pay? Water bill and delay in payment in Bejaia (Algeria): A duration analysis

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Abstract:

Efficient water management does not only involve effective water treatment and delivery to customer but also efficient billing and payment system to ensure financial sustainability. Delays in water bills payment are recognized as a major problem in developing countries but the reasons explaining these situations are scarcely addressed in the literature. To our knowledge, this paper is the first to address this issue.This article addresses this topic with Algeria as a case study. In this context, we identified from a literature review the factors that could affect time to water bill payment and we analyzed the effect of these factors on the time to bill payments through a Kaplan Meyer survival estimates approach. We applied this approach to two datasets, one including 27,363 household subscribers of Algerienne Des Eaux Company (ADE-Bejaia) located in Bejaia city and a second one that we collected in August 2008 made of 172 subscribers. Our results show that price is an explanatory factor in payment delays. A 10% increase in the average price generates a 4.8% increase in the average time to payment. In addition to economic factors, users' dissatisfaction about service quality is a key element in our model.

Keywords: Determinants, payment delays, water demand, Algeria
JEL Classification : L95, Q25, D12

1. INTRODUCTION

The water pricing in Algeria is based on increasing block-rate structure that depend on the user category and its consumption block. The objectives of this pricing policy are to ease access to water to low-income households so that their basic needs are met and to favor parsimonious consumption of water by high-income consumers while insuring financial sustainability (*Section 143 of the Water Act 2005*). According to the Article 139 of the Water Law of 2005 "... The water tariffs must reflect the cost optimization requirements, progress in productivity and improvement of performance indicators and quality of service". The Article 138 of the Act states that "The pricing of water services is based on the principles of financial stability, social solidarity, encouraging water conservation and protection of the quality of water resources. ». Bill payment is legally due at most 15 days after the bill issuance and in case of late payment extra fees are incurred by subscribers. Any mistake on invoice should be claimed within 15 days after issuance and any necessary refund would apply to the next invoice or paid in cash. Unpaid bills are managed by the legal department for recovery and, if unsuccessful, then water supply is stopped. In this situation the user supports the costs for closing and reopening the water-meter.

Despite these payment rules, the water company finances are strongly impeded by long delay on bill payments that translate into difficulties on company management and water service sustainability. Furthermore, Algeria chronically suffers from shortage in water, leakage on not sufficiently maintained water network and problems of water quality that are partly linked to the lack of sufficient financial resources. In this context, identifying the reasons behind long bill payment delay is crucial for better resources management and improvement in water supply sustainability.

In the literature, there are several studies on the Residential water demand estimation and the WTP[1]. However, there are no articles dealing with the issue of payment delays. It's true that knowledge about the determinants of the water demand and of the impact of price changes on welfare are important for sustainable water resource management. But the impact of price increases may also be manifested by an extension of the payment term invoices that can affect the proper functioning of Management Company. For example, Diakite and Thomas (2011) estimate a water demand function in Ivorian towns and after they estimate the impact of increase in the average price by 10 % and 20 %. The results shows that the increase of the average prices (by 10 % and 20 %) gives the welfare losses of 1511 F CFA and 3153 (ie a variation of 0,0578% to 0.12% compared to the average income). In other paper, Dakité et al (2009) evaluate social welfare associated with the existing water tariff and to perform welfare comparisons with the optimal tariffs. The results show that the "household whose consumption is 106 m3/year would pay, according to the simulated tariff, a total water bill of T_{min} equal to 66.24 USD/year. The same water consumption under the current tariff would cost the household $Bill_{Eq}$ of 61.65 USD/year". This analysis is probably interesting for "fairness", but it remains insufficient in terms of social consequences regarding the ability of payments of subscribers and thus their solvency. Moreover, the authors state that "It seems that the poor household would pay slightly more with the simulated tariff than with the existing one, with a welfare change of ($Bill_{Eq}-T_{min}$) at −4.59 USD a year". In this same approach Garcia and Reynaud (2004) simulate the impact of marginal-cost pricing (first-best pricing) and social surplus variations in the Bordeaux Area in French. They find that moving towards efficient prices does not result in important direct welfare effects. On average, the impact of this policy is equal to 0.33 € per user which corresponds to less than 0.4% of the initial net welfare and The yearly aggregate water consumption per user goes from 133.6 to 133.1m^3.

Other papers address the impact of restrictions on welfare. Grafton and Ward (2008), use the consumer's surplus approach to quantify the impact of a water restriction policy on households' welfare in Sydney. They estimate an annual welfare loss of 235 million dollars. Hanemann and Nauges (2005) analyze also the impact of different water restrictions regimes on the households in Los Angeles. In summer time, they find for voluntary programs losses between 13 $ and 106 $. For Hong Kong, Woo (1992) analyzed the determining factors on water demand and estimates the households' welfare impact from reduction of the water supply hours. In three scenarios he

[1] In addition there arefew studies about water demand in developing countries. The few studies addressing this issue are Boone et al (2010), Madagascar; Cheesman et al (2008),Vietnam; Pattanayak et al (2006),Sri Lanka; Ahmad et al (2005), Bangladesh; Nauges and Strand (2005), El Salvador; Persson (2002), Philippines; Asthana (1997), India; Madanat and Humplick (1993), Pakistan; Mu (1990), Kenya; Whittington et al (1990), Haiti

found welfare losses of 1.18 $/hour, 2.29 $/hour and 3.77 $/hour. As in the case of articles on the impact of price changes on welfare, these papers are not asked a key question about the impact of this policy on subscriber behavior. The consequences of restrictions can occur in several ways (eg they can extend their payment period).

The article that refers to this impact, without addressing the issue, is the paper of Olivier (2006) analyzing the effect of water price increase on households in Manaus (Brazil). Author explains that the bills time-to-payment is an adjustment variable to thwart the evolution of prices in. To analyze this phenomenon, the author used a dichotomous variable which takes value 1 if the payment is made within 10 days and 0 otherwise. According to the author's results, the bill payment rate within 10 days doesn't exceed 10 % (all categories includes). In addition, the price increase in Manaus didn't have the same impact on the different categories of subscribers. As the author stated "Only the poorest households, consuming below the billing threshold of 10 m^3/month or on the basis of a pre-established fixed monthly amount, experienced an effective increase in their water bills of 31.5 per cent, i.e. of the same range as the unit price increase. In this category, late payments have increased more than in others. The better off households, having the opportunity to alter their consumption, as they are billed on their actual consumption, reduced the impact of this price increase on their monthly bill, evidencing price elasticity of water consumption of -0.4 to -0.6 on average, in accordance the prior assumed trend and rising with initial consumption level.

As already indicated above, except studies on the water demand function analysis and few studies on willingness to pay (WTP), works aiming to analyze the factors impacting bills time-to-payment are almost nonexistent. This paper is a contribution to the advancement of this matter. In order to identify putative factors influencing time between bill issuance and subscriber payment, we referred to literature about Willingness-To-Pay (WTP). For example, Kayaga et al (2003) analyzed the impact of these same variables on households WTP. According to their results, the gender, education level, occupation, status in housing and income positively influence their WTP for water supply. However, household size, dwelling type and the existence of alternative water resource doesn't influence this decision. Our rational is that factors affecting WTP affect time-to-payment as well. According to this literature, three groups of variables influence households' WTP:

1. Socio -economic and demographic characteristics of households, that is the education level of family members, number of family members, head of household occupation, family composition, income, expenses and the number of assets;
2. Availability of alternative water supply, the financial costs and time investment required to collect water, the quality and reliability of water supply;
3. The Households’ attitudes toward water management policies.

In this paper, in Sect. 2, we explain the block price system in use for water supply billing in Algeria. In Sect. 3, we summarize the descriptive statistics of the two databases used in this study per i.e a dataset including all subscribers of Bejaia city over 17 quarters from March 2004 until March 2008 (465,171 observations) and a second dataset about 172 subscribers collected over a period of 45 quarters from March 1997 to March 2008.The second dataset is completed with a socio-economic survey of the same 172 subscribers carried out in August 2008 and that allow us to refine the results of our study. In Sect. 4, we analyze the time-to-payment variable using the graphical approach offered by Kaplan-Meier survival analysis then we refine our results with an econometric approach (Weibull). Finally, in the last Section a number of conclusions are drawn.

2. HOUSEHOLDS' BLOCK-RATE TARIFF

As a way to ensure water affordability and economic efficiency, the Algerian authorities have implemented a tiered pricing of four blocks .The price of each block is calculated by multiplying the base price (which is also the price of the first block) by a factor increase. Thus, the price of the second block is the base price weighted by a factor of 3.25, the third block is weighted by a factor of 5.5 and the fourth block is weighted by a factor of 6.5. Under the water act of 2005, the third block is also the price applied to the administration, craft and tertiary services. The last block (Fourth) is applied to industrial's sector and tourism.

Table 01: Presentation and composition of the water bill calculated from ADE dataset

Designation	Price under 2005 (DA/m3)	Price after 2005 (DA/m3)[2]
Block 1]00-25 m³]	**4.30**	**6.30**
Block 2]25-55 m³]	**13.98**	**20.475**
Block 3]55 -82 m³]	**23.65**	**34.65**
Block 4 > 82 m³	**27.95**	**40.95**
Management fee (3 DA/ m³)	**+**	**+**
Water quality fee (4 %)	**+**	**+**
Charge of water conservation (4 %)	**+**	**+**
+ Invoice VAT	**+**	**+**
Sanitation	**+**	**+**
Fixed share (before and after 2003)	**25 DA**	**240 DA**

3. DATASET DESCRIPTION

3.1 Descriptive statistics of the first database (27 363 subscribers)

To analyze the determinants of the invoices' payment term, we procured from the *Algerienne Des Eaux* Company (ADE-Bejaia) a database of all subscribers of Bejaia city (over 40,000 subscribers). After deletion of businesses, administration and industry), we have retained 27,363 subscribers, over a period of 17 quarters (from March 2004 until March 2008). This database is exceptionally rich. Indeed, we have the individual consumption of subscribers since their connection to the public water system with a quarterly billing, which is not the case with other empirical studies, which they are working with aggregated data. This dataset provides information on:

The dependent variable (bills time-to-payment)), that is the number of days between the billing date and the date of payment.

The explanatory variables. In our analysis, we used the following data:

1. Quarterly Rainfall (mm);
2. Invoice amount paid by subscriber by quarter;
3. Quantities consumed by subscriber by quarter;

[2] DA: (Algerian dinar) is the Algerian currency.

4. Average and marginal prices paid by subscriber by quarter;
5. Volumes of water distributed by the ADE by quarter;
6. Dummy for the main three areas where subscribers are located;
7. Kind of housing (house or apartment);
8. Diameters of customer meters;
9. Invoicing types (on the basis of real consumption or a flat-rate pricing);
10. Virtual income by customer by period[3].

Table 2: The main data used for the global database[4]

Variables (N=27363)	Mean	Std.dev	Min	Max
Invoice amount	1076.06	1277.71	240	42878.16
Quantity	33,11	29,78	0	179
Average price	62.85	86.67	10.45	1316.79
Marginal price	15.21	10.27	4,3	40,95
Rainfall	178,58	120,81	11	394
P1	5,82	0,84	4,3	6,3
P2	18,95	2,75	13,98	20,48
P3	32,06	4,66	23,65	34,65
P4	37,89	5,51	27,95	40,95
Supply	4,47	0,42	3,84	5,86
Bejaia (Medina)	0.34	0,47	0	1
Ihadedene	0,39	0,48	0	1
Quartier Seghir	0,26	0,44	0	1
Individual House	0,29	0,45	0	1
Diameter	15,22	1,04	15	20
Real consumption	0,91	0,28	0	1
Virtual income	94488.81	146571	45543.25	682780.4

Our analysis is summarized below:

The total population's average consumption is 33 m3 per quarter with a minimum of 0 m3 and a maximum of 179 m3. The average price paid by subscribers is 62 DA/m3. The average invoice's amount paid by subscribers is 1076 dinars per quarter. 91% of invoices have been established on the real consumption of subscribers. 29 % of subscribers live in houses. 34 % of subscribers live in Bejaia Medina city (neighborhood mostly built before independence). 39% of households live in Ihadedene's new district. 26 % of subscribers live in Seghir's quarter (between the old city and the new Ihedadene's neighborhood). The majority of users are equipped with a water meter of 15 mm. The average rainfall is 186 mm per quarter with a minimum of 11 mm and a maximum of 394 mm.

For time-to-payment variable, we generated a summary table:

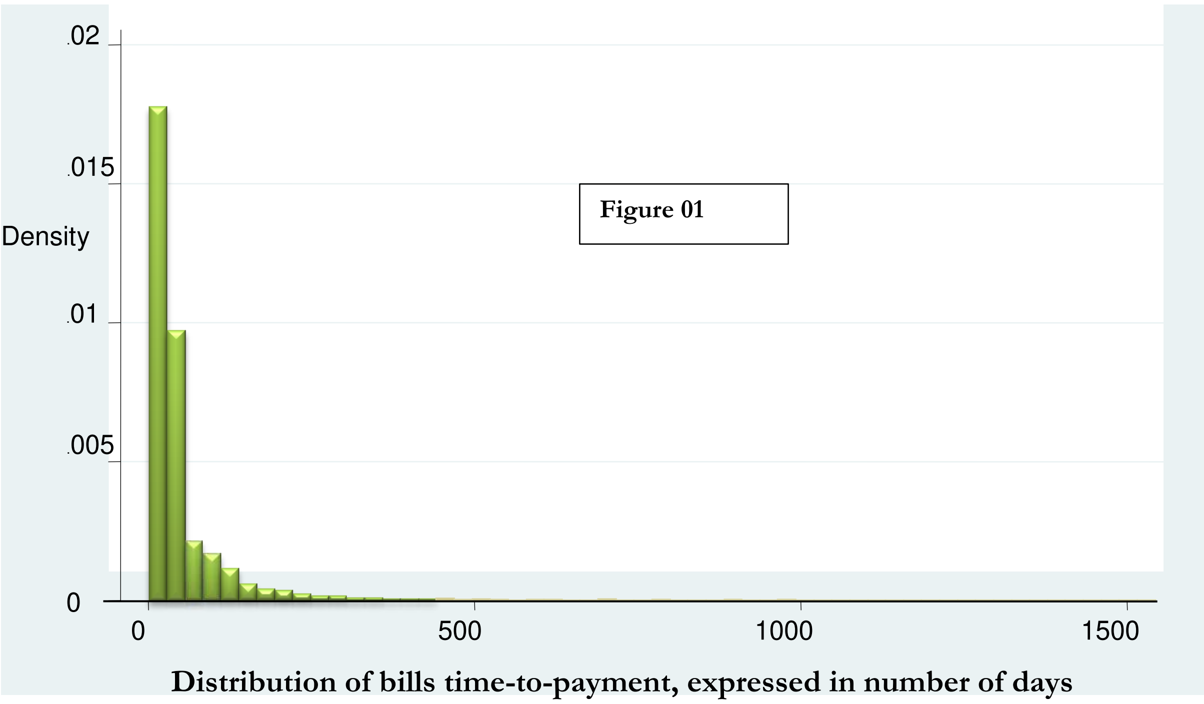
[3] This variable is computed by adding average household income and the difference variable of Nordin (1976). This parameter was calculated according to the method used by several authors. Miyawaki et al (2010), Mansur and Olmstead (2007), Martinez and Nauges (2004), and of Nauges Blundell (2002) , Reitveld et al (2000) , Corral et al (1999) and Chicoine and Ramamurthy (1986).

[4] For more details about the variables, see Appendix.

Table 3: Distribution of bills time-to-payment, expressed in number of days

		Bejaia City	
	Percentiles		
1 %	3		
5%	7		
10 %	9	Number of Observations	465 171
25 %	15	Invoices settled before the deadline	442 715
		Invoices' average time-to-payment value	52.90
50 %	27	Average time-to-payment of all invoices until the cut-off-date[5]	69.76
		Std. Dev	149.07
75 %	45		
90 %	115	Variance	22224.16
95 %	192	Skewness	5,57
99 %	481	Kurtosis	40.46

This results summarized in table 3 confirms the finding previously described in the introduction about water bills collection difficulties. While payment deadline is contractually set to 15 days, the average time-to-payment is 69 days, with a median of 28 days. Only 1% of the bills are paid in less than three days, 25% before the 15th days and 99% are paid in 481 days and more. The Skewness and Kurtosis parameters confirm that our distribution is spread at right with a leptokurtic form. To properly assess the shape of this variable, we generated the histogram of this distribution



[5] This date corresponds to the day of collection of information.

3.2 Descriptive statistics of the survey dataset

In order to deepen our analysis, we've interviewed 172 subscribers in August 2008. This survey yielded a more detailed picture of households' socio-economic characteristics, which helped to provide better parameters estimation. In fact, don't take into account the socio-economic characteristics of households which can lead to overestimation or underestimation of the parameters. The main information that we used to estimate our model is shown in the following table:

Table 4: Descriptive statistics of the sample

Variable	Mean	Std.dev	Min	Max
Quantity	32.04	27.90	0	157
Invoice amount	633.84	793.61	26.75	11507.26
Price : Block 1	4.71	1.17	2.2	6.3
Price : Block 2	14.94	4.73	2.5	20.48
Price : Block 3	25.27	8.01	4.25	34.65
Price : Block 4	29.87	9.46	5	41.95
Average price	29.95	40.30	3.82	333.75
Marginal price	22.48	8.43	2.2	40.57
Real cons/ flat-rate pricing	0.89	0.31	0	1
school (père)	6.92	3.49	1	18
HH size	6.63	2.29	1	16
Nbr girls	2.13	1.50	0	7
Nbr Of boys	2.47	1.51	0	8
Children – 18years	3.06	2.05	0	11
Children + de 18 years	3.57	2.17	1	16
Nbr of cars	0.85	0.85	0	4
House size	148.34	69.84	25	540
Nbr of room	5.27	2.45	1	22
Nbr Kitchens	1.18	0.50	0	4
Nbr Bathroom	1.22	0.65	0	4
Nbr Restroom	1.48	0.70	1	4
Second home	0.31	0.46	0	1
Nbr hours supply	5.02	4.00	1	24
Other resources	0.61	0.48	0	1
Water quality	0.19	0.39	0	1
Service quality	0.09	0.29	0	1
Income	28667.34	17519.36	5000	100000
Pay more	0.99	0.70	0	1
Rainfall	156.17	122.93	0	429

Analysis of descriptive statistics provides information about our sample:

• The sample's average consumption is 32 m3 per quarter, while the average consumption of the total population is 33 m^3perquarter;

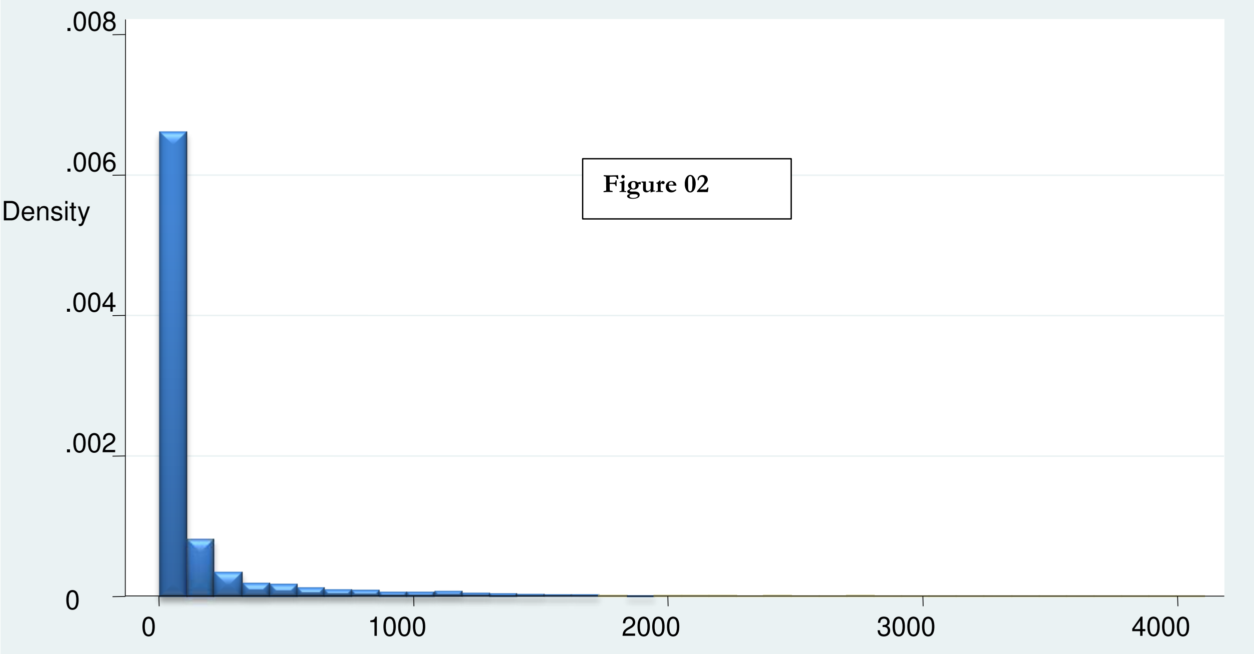
• The average price paid by the sample is 29.95 DA, while the average price of the total population is 62 DA/m3. This difference is probably related to the difference between the two periods, the quantities consumed, the price change, due the increase of the invoice's fixed share in 2003. In fact, before this date the amount of the subscription was 25 DA and since the reform of 2003, the subscription's amount has raised to 240 DA.

• 89% of the invoices were established based on real consumption;
• The average size of households in our sample is 6.63 persons;
• The average size of the homes is 148 m2, with a minimum of 25 and a maximum of 540 m2;
• 31 % of the sample declared having a second home;
• 61 % of the sample said they've an alternative source of water;
• 19% said to be satisfied about the water quality;
• 9 % said to be satisfied about the water quality services;
• The average monthly household income for the period is 28,667 DA;
• The average rainfall for the period (1997-2008) is 158 mm per quarter.

Table 5: Distribution of bills based on time-to-payment expressed in number of days

Sample			
	Percentiles		
1 %	9		
5 %	15		
10 %	18	Number of Observations	7740
25 %	25	Invoices settled before the deadline	7057
		Invoices' average time to payment	176.59
50 %	35	Average time to service cut-off after invoice issuance	223.38
		Std. Dev	411.21
75 %	111		
90 %	467	Variance	169099.1
95 %	966	Skewness	4.34
99 %	2247	Kurtosis	25.47

Table 5 summarizes the distribution of bills according to their time-to-payment. This analysis shows that the survey results are quite different from those obtained from the total population of Bejaia City. In particular, the total population's time-to-payment value is 53 days while the average time-to-payment of the sample is 176 days. This difference could be explained by the difference in the collection period for the two dataset. Indeed, the analysis of the total population of Bejaia City is spread over 17 quarters, while the sample is observed over 45 quarters. For the same reason we observe that the mean time-to-service cut-off are strongly different as well with 4068 days for our survey dataset and only 1511 days for the total population (between 31 March 2004 and 20 May 2008). Finally, the shape of the distribution of the time-to-payment variable is leptokurtic and is spread right, as for the total population distribution. To assess the variable distribution, we generated its histogram.



Distribution of bills time-to-payment, expressed in number of days

It's clear that the distribution of our duration variable doesn't follow a normal distribution. A glance at the graphics results shows a high concentration of paid invoices between 0 and 100 days, then the variable decays very fast after this period.

4. SURVIVAL ANALYSIS OF INVOICES

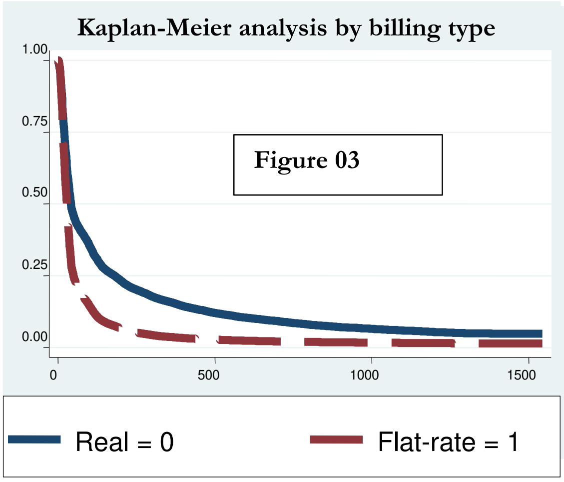
To study the bills time-to-payment variable, we used the Kaplan-Meier approach. This approach aims to observe the shape of our variable when segregating data according to:

1. Billing type (Real consumption/ flat-rate pricing);
2. Dwelling type (house or apartment);
3. Subscribers' localization (Bejaia center Ihadadene and City seghir).
4. The consumption block;
5. The existence of a second house;
6. The perceived water quality;
7. The perceived water service quality.

The results of this analysis are presented in the next part of this article and are followed by the statistical analysis to determine whether or not differences are significant.

4.1 - Kaplan – Meier Approach

4.1.1 – Bejaia City Case (N = 27 363 Subscribers)



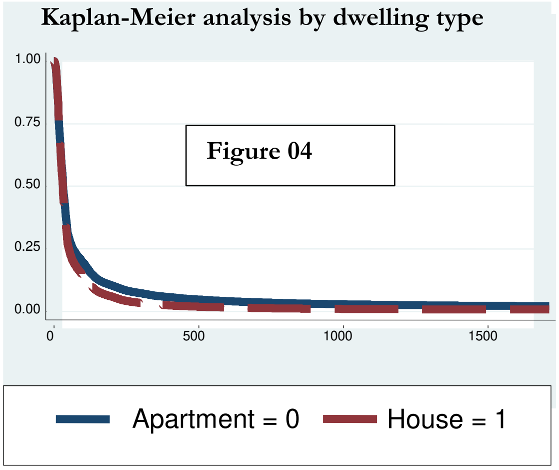
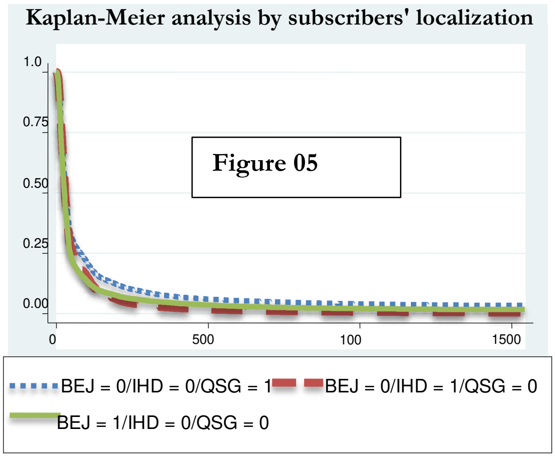


Figure 3 shows the Kaplan-Meyer curves representing time-to-payment variable depending on the billing type, that is to say real consumption (blue curve) versus flat-rate pricing (red curve).Both curves undergo a sharp decrease and slowly reach a plateau. This indicates that most bills payment events (75%) are occurring in a timeframe of x to y a day which is far beyond the legally defined period of 15 days. It is noticeable that subscribers billed on flat-rate pricing pays their bills faster than those charged on real consumption. As our dataset indicates, this is likely correlated to the fact that the mean bill amount in the case of flat-rate pricing is lower than the real consumption pricing. . On flat-rate pricing, price is fixed regardless of quantity consumed by the subscriber and is modest and uniform. For our dataset, the mean billing amount for subscribers on flat-rate pricing is of 320DA while it is of 633DA for subscribers on real consumption billing.

Figure 4 presents the result of this analysis using grouping according to the type of housing, either a house (red curve) or a flat (blue curve). In several studies this variable is used as a proxy of income (citations). The results of this figure show that the subscribers living in a house settle their bills quicker than those who live in a flat.



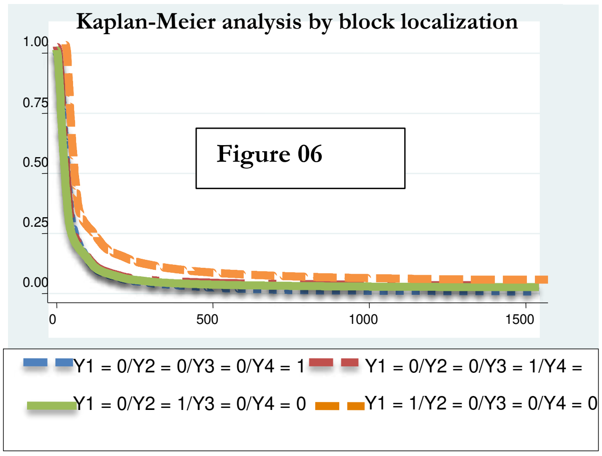
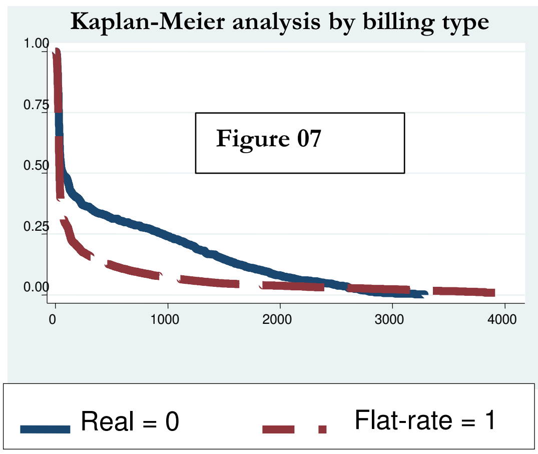
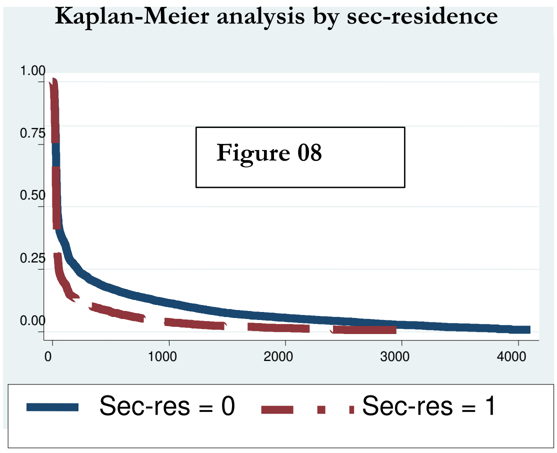


Figure 05 shows the analysis of our dataset based on grouping by three main areas of Bejaia City. We observe that subscribers living in the ancient city (Bejaia Medina) pay their bills quicker than those who live in the two other districts. However, beyond approximately 15 days, this does not hold true anymore and subscribers from Ihaddadene become more reactive.

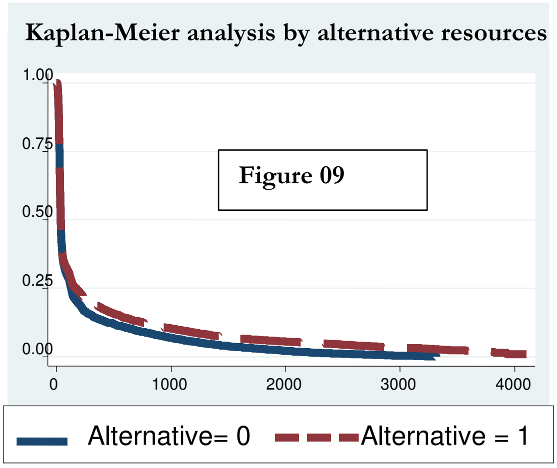
On Figure 06, the analysis uses the consumption block as grouping criteria. It indirectly shows the relation between marginal price paid by the subscriber and time-to-payment value. It appears that customers whose consumption does not exceed the first block pay their bills quicker. However, later on the timeline, this trend reverses and this group is less prone to pay bills. This may be related to the standard of leaving of this group of subscribers that belong to the so called social block (first block which is directed to low income households. Nevertheless, despite the subsidies associated with this block, many households are likely still find difficulties to pay their bills.

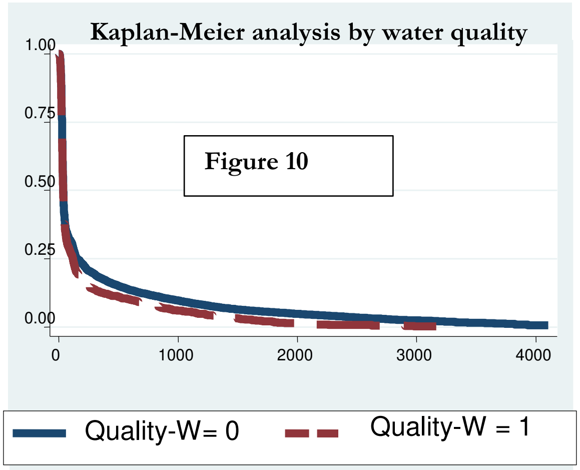
4.1.2 Sample case (N =172 Subscribers)



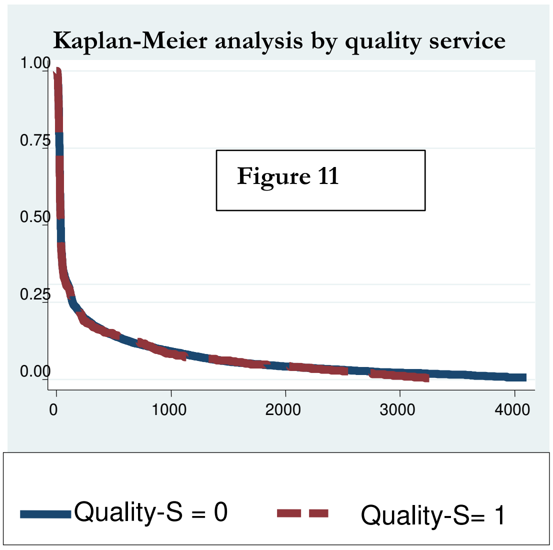


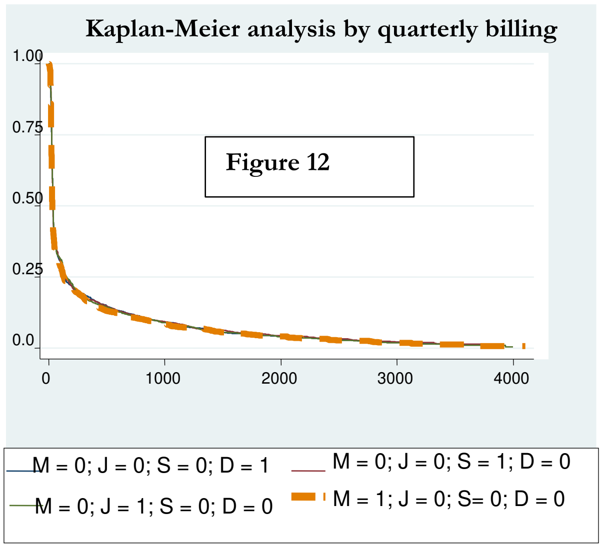
The Kaplan-Meier analysis for data grouped by billing type (real consumption red curve/ flat-rate pricing blue curve) shows that the curve of survival probability of the subscribers billed at flat-rate pricing decreases faster than those invoiced at actual consumption pricing (Figure 7). Analysis grouped on the criteria of owning a secondary residence (red curve) or not (blue curve) shows that customers owing a secondary residence pays their invoice more promptly. Obviously, customers that can afford a second house are more likely to pay their bill on time or faster. That is why several authors use this variable as a proxy of income for estimation of the water demand.





Figures 9 and 10 are Kaplan-Meier curves for data grouped on the criteria of existence of alternatives source of water supply (yes red curve/no blue curve) and perceived (good red curve and bad blue curve) quality respectively. The subscribers exclusively connected on the public network are the quickest to pay their bills, probably fearing water supply cut-off and penalties ensuing payment delay and service reopening. Regarding the perception of water quality, it seems that if the subscribers are dissatisfied by the water quality, they are less liable to pay their bills and tend to postpone their payment. Therefore, it seems that some of the delays could be explained by subscribers' discontentment about water quality.





Finally, quality of service and quarterly billing doesn't have an impact on time-to-payment probability curves.

4.2 Models

As we have already mentioned before, our "time-to-payment" variable doesn't follow a normal distribution. Thus traditional estimators are not appropriate in this kind of distribution. This is clearly visible at a glance on the Kaplan -Meier analysis presented in the previous sections. The curves shape follows a Weibull distribution and this requires us to estimate duration models. To identify the factors affecting water bill duration, we used the basic equations of survival analysis:

$$F(T) = \int_0^t f(x)dx$$

With *F(T)* is the cumulative distribution function.T is the elapsed time between the billing date and the payment date and f(x) is the probability density function indicating that the event has been realized at the instant t).

$$S(t) = \exp\left[-\int_0^T h(x)dx\right] = \exp\left[-H(T)\right]$$

S(t) is the probability that a bill survives beyond time *t*[6].

$$h(t) = F(T)/S(T)$$

h(T) is the relationship between F(T) et S(T) designating the probability that the invoice at time *T* experiences the result in the next time.

$$H(T) = \int_0^T h(x)dx$$

H(T) is a cumulative hazard function of probability that the invoice at time *T* experiences the result in the next time.

4.2.1 - General model of the total population

The specification used to estimate the duration of the time-to-payment variable for all subscribers of Bejaia City takes the following form:

$$Duration_{it} = \beta_0 + \beta_1 Variable_{it} + \beta_2 Rain_t + \beta_3 Supply_t + \beta_4 Diam_i + \beta_5 Virtuel - income_{it} +$$
$$\beta_6 March_t + \beta_7 june_t + \beta_8 December_t + \beta_9 \text{Invoicing - types}_{it} + \beta_{10} BJA_i + \beta_{11} IHD_i + \beta_{12} House_i + \varepsilon_{it}$$

4.2.2-General model of the sample (172 subscribers)

The specification used to estimate the determinants of the time-to-payment variable for the sample takes the following form:

$$Duration_{it} = \beta_0 + \beta_1 Variable_{it} + \beta_2 Surface_{it} + \beta_3 Rain_t + \beta_4 Income_{it} + \beta_5 hours_t$$
$$+ \beta_6 Household - size_{it} + \beta_7 Study + \beta_8 March_t + \beta_9 june_t + \beta_{10} december_t +$$
$$\beta_{11} Invoicing - Types_{it} + \beta_{12} quality_i + \beta_{13} Sec - res_i + \beta_{14} other\_res_i + \varepsilon_{it}$$

However, to deepen our analysis and to see the impact of different tariff variables, we'll estimated, each time, four variants of our general model. (Using the average price, the marginal price, the invoice amount and the amount of water consumed).

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6 $S(t) = \int_T^\infty f(x)dx = 1 - F(T)$

5. RESULTS

5.1 Determinants of the time to payment for all subscribers of Bejaia City

Table 6: Weibull models Results for total population

Variables	Weibull _t	Weibull _t	Weibull _t	Weibull _t
Invoice amount				3.39e-05***
				(1.42e-06)
Quantity			0.00140***	
			(6.26e-05)	
Marginal price		0.00231***		
		(0.000209)		
Average price	0.000992***			
	(4.54e-05)			
September	*Reference*	*Reference*	*Reference*	*Reference*
March	-0.0278***	-0.0198***	-0.0170***	-0.0179***
	(0.00557)	(0.00559)	(0.00558)	(0.00558)
June	-0.0261***	-0.0198***	-0.0173***	-0.0182***
	(0.00546)	(0.00547)	(0.00546)	(0.00546)
December	-0.0930***	-0.0889***	-0.0878***	-0.0882***
	(0.00609)	(0.00610)	(0.00610)	(0.00610)
Supply	0.126***	0.125***	0.123***	0.124***
	(0.00648)	(0.00647)	(0.00646)	(0.00647)
Cité Seghir	*Reference*	*Reference*	*Reference*	*Reference*
BEJ	-0.339***	-0.350***	-0.357***	-0.356***
	(0.00509)	(0.00512)	(0.00512)	(0.00511)
IHD	-0.339***	-0.350***	-0.354***	-0.352***
	(0.00533)	(0.00534)	(0.00534)	(0.00533)
House	-0.188***	-0.195***	-0.198***	-0.198***
	(0.00457)	(0.00459)	(0.00458)	(0.00458)
flat-rate pricing	-0.659***	-0.944***	-0.970***	-0.950***
	(0.0139)	(0.00735)	(0.00735)	(0.00711)
Virtuel income	3.95e-09	9.58e-09	1.73e-08	9.10e-09
	(1.68e-08)	(1.68e-08)	(1.68e-08)	(1.68e-08)
Penalty	0.0114***	0.0115***	0.0116***	0.0115***
	(9.05e-05)	(9.05e-05)	(9.04e-05)	(9.04e-05)
ln_p	-0.226***	-0.226***	-0.226***	-0.226***
	(0.00103)	(0.00103)	(0.00103)	(0.00103)
P	0.7978666	0.7975201	0.7979107	0.7978487
	0.0008211	.0008209	0.0008212	0.000821
Constant	4.275***	4.575***	4.595***	4.585***
	(0.0331)	(0.0299)	(0.0299)	(0.0299)
Observations	464,954	464,954	464,954	464,954

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The estimation of different models gives relatively consistent results. The value of P = 0.79 confirms the relevance of Weibull models in our case. The average price elasticity is 0.03. In other words, a 10% increase on water price increases the bill time-to-payment payment by 0.3% (Appendix 01). Similar results are observed for estimated models using marginal price, quantity consumed and the invoice amount. All of these variables have a positive influence on bill time-to-payment. A 10% increase in the marginal price leads to a 0.8% increase of the time-to-payment variable. An increase of 10% of the amount consumed or of the total bill amount causes respectively a 0.5% and a 0.01% increase of the time-to-payment variable. Our results are in accordance with the simple fact that part of the delays on bills payment are due to financial difficulties. Stated otherwise, for two users of same socio-economic characteristics (ceteris paribus), the one who pays a bill higher on average than other would have a time-to- payment value higher of 0.3% on average.

However, the price and water quantity consumed are not the only variables explaining this phenomenon. Rainfall also has a positive effect on the time-to-payment, and it's visible through the supply variable which has positive effect on the delay. Indeed, when water resources are scarce as in summer, water management companies apply restriction on water availability thus preventing subscribers to take the desired quantities. Then, during rainfall periods, the water supply needs can be better covered leading to higher consumption, which causes greater payment delays.

The three seasonal dummies also explain the collection of bills. It seems that customers have less trouble paying their bills in winter than in summer. This is probably due to seasons considered .Indeed, in summer, with average temperatures around 86 °F and rainfall close to zero, the consumption increases and leads to an increase of the bills amount, which leads to a longer duration.

Living in a house negatively influences time-to-payment. In fact, living in a house reduces the average time-to-payment of approximately 7 days. It is reasonable to think that people who are able to afford a house are more susceptible to have a higher standard of living. Subscribers living in the old city (Bejaia Medina) and in Ihadadane area seem to pay their bills quicker than those living in the neighborhood of low-income housing as in Seghir's area. Living in these two districts lowers the time-to-payment of approximately 12 days on average. Finally, bills based on actual consumption seem to be more difficult to recover than those based on a flat-rate pricing.

5.2 Determinants of the time-to-payment variable for the sample

Table 7: Weibull models Results for sample

Variables	Weibull _t	Weibull _t	Weibull _t	Weibull _t
Quantity	0.00692***			
	(0.000669)			
Invoice amount		0.000248***		
		(2.50e-05)		
Average price			0.00611***	
			(0.000575)	
Marginal price				0.00667***
				(0.000606)
Water Quality	0.162***	0.157***	0.259***	0.252***
	(0.0578)	(0.0580)	(0.0576)	(0.0575)
Penalty	0.0217***	0.0215***	0.0222***	0.0220***
	(0.00119)	(0.00119)	(0.00119)	(0.00119)
Flat-rate pricing	-0.999***	-0.920***	-0.443***	-0.459***
	(0.0637)	(0.0619)	(0.0667)	(0.0656)
Study level	-0.000143	-0.00117	-0.000942	1.11e-05
	(0.00607)	(0.00607)	(0.00608)	(0.00609)
Household size	0.0908***	0.0961***	0.123***	0.123***
	(0.00853)	(0.00847)	(0.00862)	(0.00861)
Size house	0.00188***	0.00186***	0.00178***	0.00169***
	(0.000282)	(0.000282)	(0.000284)	(0.000283)
Second home	-0.713***	-0.715***	-0.770***	-0.766***
	(0.0428)	(0.0429)	(0.0425)	(0.0425)
Number of hours	-0.0164***	-0.0161***	-0.0162***	-0.0162***
	(0.00471)	(0.00471)	(0.00471)	(0.00471)
Other Resources	0.140***	0.132***	0.115**	0.107**
	(0.0449)	(0.0450)	(0.0452)	(0.0452)
Income (base 1000)	-0.00903***	-0.00968***	-0.00887***	-0.00882***
	(0.00115)	(0.00115)	(0.00115)	(0.00115)
Constant	5.078***	5.067***	4.445***	4.464***
	(0.114)	(0.115)	(0.124)	(0.123)
Ln_P	-0.410***	-0.412***	-0.412***	-0.412***
	(0.00839)	(0.00839)	(0.00840)	(0.00839)
Observations	7,606	7,606		

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The estimates obtained from the sample of 172 subscribers are consistent those of the total population. The average prices and marginal, the amount of water consumed and the invoice amount are positively impacting time-to-payment. A 10% increase in average price increases of 4.8% time-to-payment. In other words, two users having the same socio-economic characteristics, the one paying an average price 10% higher would experience a 8 days increase of its time to payment. Analysis of the impact of the marginal price and the amount consumed demonstrates the same effect. Increasing by 10 % any of these two parameters would result in a 9 days increase of the time-to-payment. A 10% increase of the house surface leads to a modest 1.4% increases the time-to-payment by, corresponding to 2.5 days. This is probably a consequence of the volume consumed proportionally to the house size (more bathrooms, more restrooms...).

Subscribers owning a second home have a time-to-payment value reduced by 50 days compared to those owning only one. This is in line with the idea that better-off are more prone to pay their bill on time as they are not financially limited and that financial limitation is a major reason for long time-to-payment. The existence of an alternative source of water supply increases the time-to-payment by 10 days. This result is surprising and goes against our expectations. Our initial rational was that the access to an alternative source of water supply would contribute to reduce the water quantity consumed and thereof bill amounts and the time-to-payment. More work will be needed to clarify this contradiction but it is also possible that subscribers having the option to use an alternative source of water supply do not feel constrained by the threat of water supply cut-off and tend to delay their payment.

When income increases by 10%, time-to-payment is reduced of 7% to 7.4%, i.e. 13 days. The daily duration of tap water availability negatively affects the bill time-to-payment. This result may be the consequence of dissatisfaction of the households about this policy, but it may also be the result of consumption generated by the storage habits in Algeria.

If the water quality is considered good by the subscriber, these parameters increase payment period of approximately 13 days (estimated by the invoice amount and the quantity consumed). Household size appears, also, as a very crucial element of invoice payment. This result is probably due to the financial difficulties of many families (over costs and over spending). This situation increase the amount consumed and affect the households' financial conditions. If the subscriber is penalized for failure to pay, this fee will lengthen the time-payment of the invoice. Finally, flat-rate pricing, as in the case of the total population, reduces the invoice duration payment about 44 days (in the models estimated with average price and marginal price). In summary, it seems that some invoices paid late are due to socio-economic characteristics of subscribers. However, another part appears to reflect the customers' dissatisfaction about the management quality.

6. CONCLUSION

The analysis of the determinants of the duration of payment of invoices reveals that the tariff variables partly explain the level recorded in the province of Bejaia delays. Indeed, a 10% increase in the average price increase time resolution of 4.8 %, or about 8 days. The same observation was also highlighted through the analysis of models with the marginal price. A 10% increase in price would result in a marginal increase in the duration of 9 days. However, the tariff variables are not the only ones to explain this phenomenon. Rainfall had a positive impact over time. This effect is probably due to the increase in volume delivered during periods of heavy rainfall, increasing the volumes consumed and therefore the amounts charged. This observation is corroborated by the positive relationship between the quantity supplied and the duration of payment (estimated to total population models). The variables related to the level of living of households (income, housing type, location of the neighborhood, second home) negatively influence the duration payment. This result brought to light a real difficulty in paying bills from one part of the population for financial reasons.

The flat rate billing seems to negatively influence the billing period for paying invoices. This was highlighted in all estimated models. This result is probably related to tariffs in this type of billing, which are often less than the amounts paid in the case of a billing based on actual consumption of subscribers. Household size also explains the saved and the interpretation is probably related to the amount consumed by families, which would increase the amount of their bills, then they already have financial difficulties delays.

In conclusion, the problem of bill collection is, in the case of the province of Bejaia, partly due to socio -economic constraints, but it is also the result of local management practices that create dissatisfaction among customers. This finding was confirmed by the commercial director of the ADE. According to him most of the delays and uncovered bills are due to discontent subscribers regarding the service provided by the ADE (water shortages, water quality, etc.) In this way, in order to find a solution to this situation, the company must make efforts to improve the quality of service offered.

Appendix 1: Description of variables

variable	Designation
Duration $_{it}$	Is the gap in number of days between the billing date and the payment date.
Variable $_{it}$	1. *Variable* $_{it}$ is the average price paid by the subscriber "i" at time "t" in Model 1; 2. *Variable* $_{it}$ is the marginal price paid by the subscriber "i" at time "t" in Model 2; 3. *Variable* $_{it}$ is the amount consumed by the individual "i" at time "t" in Model 3; 4. *Variable* $_{it}$ is the amount of the bill paid by the subscriber "i" at time "t" in Model.
Rain $_{t}$	Is the quarterly rainfall in millimeters (mm).
Supply $_{t}$	Is the volume of water distributed by the company (supply) by quarter.
Diam $_{i}$	Is the diameter of the subscriber tap.
Virtuel_income $_{it}$	This variable is computed by adding average household income and the difference variable of Nordin (1976).
March, June, September, December	Are billing quarters (are dummy taking the value 1 if the invoice corresponds to the billing quarter and 0 otherwise).
Invoicing-type $_{it}$	As a dummy that takes the value 1 if the billing is done on the real consumption and 0 otherwise.
BEJ, IHD,IHD	It's dummy taking 1 if the customer lives in the area and 0 otherwise
House $_{i}$	Is a dummy that takes the value 1 if the customer lives in a house and 0 otherwise.
Surface $_{i}$	Is the area of the house of the subscriber m^2.
Income $_{it}$	Is the income of the subscriber i at time t.
Hours $_{it}$	Is the number of hours water supply by day.
Household_size $_{it}$	Taille du ménage (nombre de personnes).
Study $_{i}$	The educational level of the head of the family.
Quality $_{i}$	Is a dummy that takes the value 1 if the customer finds that the water quality is good and 0 otherwise.
Sec-res $_{i}$	Is a dummy variable that takes the value 1 if the subscriber has a second home and 0 otherwise.
Other_res $_{i}$	Is a dummy variable that takes the value 1 if the customer has an alternative water (wells, springs, fountains ..) and 0 otherwise.

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