Evaluation of an energy efficiency program for small customers in Geneva

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Abstract

This paper addresses an electricity conservation program (called "*Doubléco*") targeting small consumers, i.e. typically small companies in the service sector and residential consumers. The program was launched in November 2010 by the utility of the canton of Geneva (SIG); by the end of 2012, more than 50,000 participants had registered (out of a potential population close to 200,000). The program is mainly based on monetary incentives for participants to reduce their annual electricity consumption. The participants are also provided with information through newsletters and a website on measures for reducing their energy consumption and are given rebate vouchers for energy efficient appliances.

In this paper we present the evaluation methodology (bottom-up type) that is based on a statistical analysis (treatment effect model) of historical annual electric billing information (2007 to 2013) of all participants and non-participants of the program. We find that the savings triggered by the program amount to 2-3% of the household's total electricity demand, while the respective value for small companies is smaller and much more variable (1-2% savings in year 1 and 2 but slight increase in electricity demand in year 3). Additional analyses are carried out to categorize the types of participants (regarding their support for selected energy strategies) and to address the durability of the savings and insights from research on communication and behavioural change.

Introduction

A single utility, named SIG[1], ("Services Industriels de Genève") supplies electricity to the canton of Geneva (Switzerland)[2]. Its market amounts to about 280,000 customers (households, private and public sector). In 2010, this utility launched a program named *Doubléco* for its small customers (less than 30 MWh/y, reducing hence the numbers of potential participants to 200,000). Every household or small company was free to enrol in this program. Its aim was to generate electricity savings by stimulating the implementation of effective technologies and rational behaviour. The participants committed themselves to reduce their electricity consumption for which they were rewarded with a monetary incentive equal to the electricity tariff; it took the form of a rebate on their bill. The participants were also provided with information through newsletters, a website on measures for reducing energy consumption and occasional rebate vouchers for energy efficient appliances.

This paper evaluates the effectiveness of the *Doubléco* program. This evaluation faces two difficulties 1) the relatively small size of the savings compared to the annual variation of consumption 2) the sample bias of the participants, which means that they are more likely to be in favour of energy saving programmes than the average population.

After a brief description of the *Doubléco* program (section 1) and the data (section 2), the evaluation methodology is explained in section 3, followed by the results (section 4) and by the discussion (section 5). Conclusions are presented in section 6.

[1] This research was financially and technically supported by SIG who provided us with information from their customer data-base for the purpose of this project.

[2] For a presentation of the Swiss electricity market, we refer to the paper by Reynaud and Jeanneret in the same session.

1. The "*Doubléco*" program

At the end of 2010, SIG launched a very intensive campaign on *Doubléco*. Firstly, the ground of the streets of the city was covered in many places with graffiti announcing an invasion of "energy-guzzler[3]". Then, more classical media (internet, newspapers, posters, direct mailing and phone calls) were used to communicate about de program. The recruitment campaign was successful since 50,000 consumers or 25% of all clients consuming less than 30 MWh/y had joined *Doubléco* by the end of 2012 (see Fig. 1 for the development of recruitment). Some clients (3800) participated simultaneously to two programs[4] and were eliminated in the present paper. As shown in Table 1 participants were recruited in four ways:

Table 1. Recruitment in *Doubléco*

Recruitment	Households		Small companies		Total	
	Numbers	Share	Numbers	Share	Numbers	Share
Direct mailing	15'426	34.7%	2'179	35.9%	17'605	34.9%
Website	3'137	7.1%	412	6.8%	3'549	7.0%
Telephone campaign	20'434	46.0%	2'813	46.4%	23'247	46.1%
Others : direct promotion in administrations or business centers	5'409	12.2%	661	10.9%	6'070	12.0%
Total	44'406	100.0%	6'065	100.0%	50'471	100.0%

The recruitment through "telephone calls" was based on random selection, but the process has changed over time: in 2010, the eligible population was cut in three strata (small, medium and large consumers) the same number of people were contacted in each of them; in 2011, the large consumers have been mainly contacted (2,500/10,000 kWh/y); in 2012 the telephonic recruitment was purely random in the whole eligible population. The Figures 3 & 4 below show the impact of this lack of homogeneity on the profile of participant according to their year of enrolment.

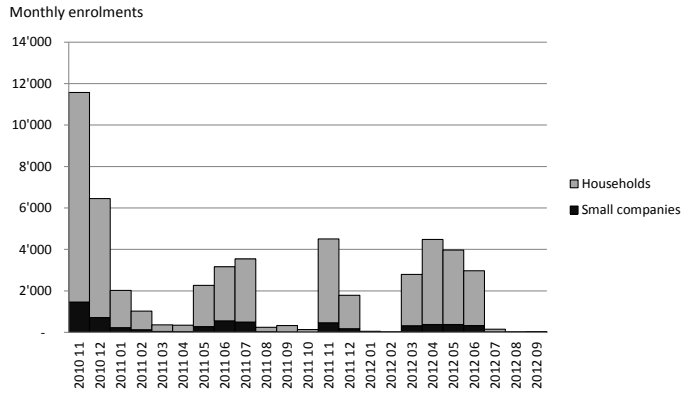


Figure 1. Development of enrolments in *Doubléco*

Once enrolled, the participants received monthly advices by email. These mainly concerned behavioural changes and purchase advices. Furthermore, a dedicated zone of the SIG's website proposed them rebates for energy-efficient appliances. Some participants were also directly offered rebate

[3] Using the French pun about "énergievore".

[4] This other program is named "Ecosocial". It pertains exclusively households, who received new appliances (efficient lighting devices, outlet power strips with external switch, electric kettle boilers) and rebate vouchers to replace existing refrigerators by energy efficient ones.

vouchers for refrigerators. Finally a small number of energy efficiency kits were distributed as promotional measure during enrolment.[5]

2. Preliminary descriptive statistics

2.1 Data

The electric meters for small consumers in Geneva are read only once a year around the same date for a given client. The meter-readings for all customers are distributed over the full year. The starting point of *Doubléco* is November 2010 (first feasible enrolment) and the end point (most recent information) is December 2013. So the participants who began in 2010 can be all observed in the year 1 (2010), 2 (2011) and 3 (2012), but due to the distribution of meter-readings, only a few can be observed for the full period of year 4 (2013). We will therefore not report on year 4. Note that the first meter-reading after enrolment covers less than a full year, and it is necessary to wait one additional year to obtain a full year of data under the umbrella of the program. Our data-set contains the electric meter-readings from January 2005 to December 2013 for all the small customers of the Geneva utility (participants and non-participants). We can thus follow the consumers for a long period of time, assuming that they do not move houses.

The data are anonymous, but we have the following information for each small customer included in the data-set: type of customer (household/company), tariff type (see below), information on whether the customer has moved during the period, whether or not he/she has enrolled to *Doubléco* and if so, the date of enrolment. Moreover, we could know for each participant how he/she was recruited (recruitment mode, see Table 1 above).

2.2 Descriptive analysis

Since the electric meters for small consumers are read only once a year, any change is also determined only once a year, as the difference between the current and the previous year. As the share of electric heating or cooling is negligible in Geneva, no particular weather correction is needed. Decreased electricity requirements from one year to the next are not necessarily caused by energy efficiency improvements or more energy efficient behaviour (one reason could be higher or lower presence at home). Fig. 2 assumes a change in the first year which is compensated in the subsequent year, ultimately resulting in the original level of energy use. Since each decrease in yearly energy use is rewarded the utility has to pay rewards equivalent to 4Δ for the two households shown in Fig. 2, but the total consumption remains stable.

After one year of enrolment, 59% of the households (excluding those which had moved meanwhile) lowered their consumption and received an average reward of 71 Euros (see the histogram below in Fig. 3). For small companies the average gain amounts to 172 Euros. Table 3 shows the mean change of electricity consumption between 2009 (one year before the beginning of the program) and 2013. This is a rough measure for the program effectiveness that we shall analyze more precisely in section 3. It shows that downward changes in energy demand are slightly higher for *Doubléco* participants than for non-participants. As all subsequent tables presented in this section, Table 3 excludes customers who moved houses between 2009 and 2013 (so the number of participants in Table 3 is smaller than the enrolments). Table 3 shows that the mean effects are much lower than the variation of the consumption among individual customers: the mean changes from 2009 to 2013 lie between 3.2% and 5.6% of the mean 2009 consumption, whereas the standard deviations of these changes divided by the same mean 2009 consumption is much higher.

[5] In total, 505 kits containing one LED light bulb and one multi-socket plug adaptor; in addition, a small number of wattmeters and internet smart meters.

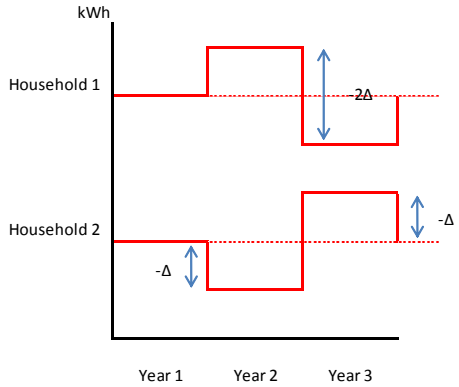


Figure 2. Hypothetical random variations of electricity consumption for three years

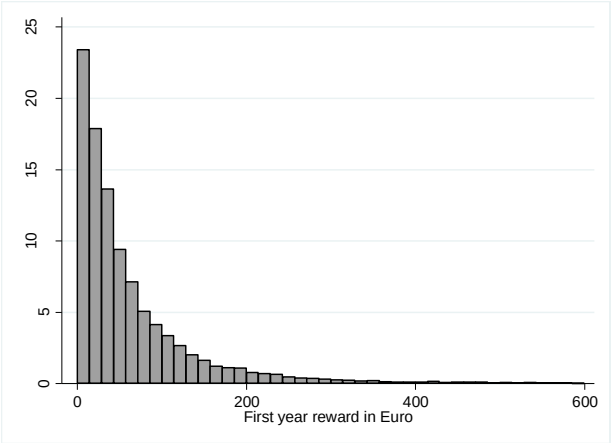


Figure 3. Histogram of the rewards gained by households after one year in *Doubléco*

Table 3: Mean change of electricity consumption for households and small companies between 2009 and 2013

			Mean change of electricity consumption between years 2009 and 2013 : kWh, % and standard deviation in % of the mean 2009 consumption		
		Number	Change in kWh	Change in %	Sd in % of 2009 consumption
Households	Participants	33,976	-165	-5.6 %	38.0%
	Non-participants	99,106	-94	-3.4 %	41.1%
Small companies	Participants	4,519	-345	-5.3 %	35.9%
	Non-participants	13,605	-213	-3.2 %	45.2%

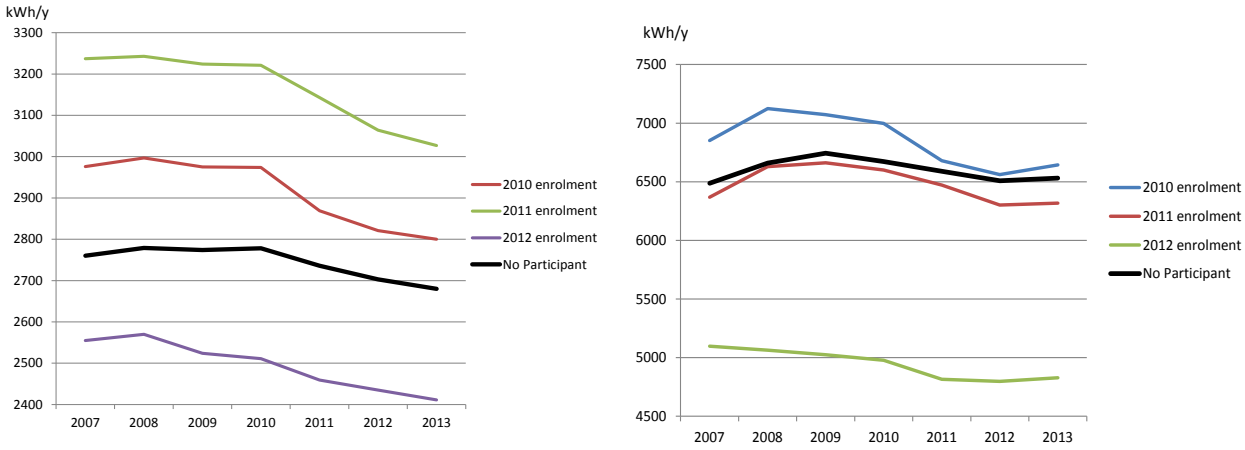
Furthermore, one has to consider that the recruitment campaign ran for almost two years. Thus, in the following, we shall analyse households and small companies according to the year they entered the *Doubléco* program (we shall refer to the entrance year as 'enrolment'). The evolution of the annual average power consumption by year of enrolment is shown in Fig. 3 (households) and in

Fig. 4 (small companies). As the overall variation is small compared to the level of consumption, the vertical axes of both figures are cut. The main findings are:

- since 2011 the average consumption has been declining for participating households, but also for non-participants;
- the mean electricity consumption of the four groups of households (three enrolment years and non-participants) differ very substantially; this is mainly due to the change in the random recruitment mode of the "Telephone calls" as described in Sec. 1;
- the level of electricity used in companies is more homogenous across the years of enrolment (except for the companies enrolled in 2012);
- while, for companies, the curve for non-participants is somewhat flatter than for participants, the difference in profile between the two groups is very limited, i.e. the effectiveness of the *Doubléco* programme is not obvious for companies.

In 2009, the Swiss Government adopted the same standards for electric appliances as the European Union (2009/125/CE), which introduced drastic measures in 2010 and 2011 (in particular the phase-out of incandescent light-bulbs and class B and C refrigerators). Hence the appliances reaching the end of their life cycle were replaced by more efficient ones by both participants and non-participants. This may explain the declining trend for all curves since 2010 according to Fig. 3. The different levels of power use across the enrolment years may be explained by the way the participants were recruited.

The situation of the companies is probably different; in addition to the previous assumptions, the economic depression may have contributed as well to the decline of electricity consumption in 2011 and 2012[6]. As with the hypothesis about consumer engagement, this hypothesis is difficult to prove; this should be kept in mind when interpreting the results.



Figures 3 & 4 Annual average power consumption of households (3) and small companies (4) (kWh/y), by year of enrolment

As first appraisal, the descriptive analysis shows that:

- The variation of annual consumptions is important, so the effect of *Doubléco* should be carefully distinguished from the spontaneous variations in which it is intimately mixed.
- The trends of two groups are negative, so comparisons between Participants and Non-participants are compulsory to prevent overestimation of *Doubléco* effect.

[6] The effect of economic depression on the households is unlikely: the unemployed persons spend more time at home; hence the electric consumption may increase.

3. Evaluation methodology

3.1 Choice of the statistical method

Following the main stream of evaluation methods, we applied the treatment analysis (Cameron & al. 2005, Mahone & Haley, 2001). This method concerns measuring the impact of interventions or policies on an outcome of interest, some individuals are subjected to that interventions (treatment group), other are not (control group). The hypothetical effect on the outcome can be evaluated by comparing the two groups. This comparison is particularly useful when one suspects that some selection bias in the sampling process could corrupt the evaluation. In our situation where randomization was impossible, we suspected such a bias and we sought for a way to test its existence. We argue that clients with susceptibility to electricity conservation programs also have a probability to choose more sustainable options for electricity supply. Information is available on the latter because in Geneva, customers are free to choose among five kinds of electricity tariffs which represent different types of production. The cheapest tariff includes electricity generated using fossil fuels with compensation of CO_2 emissions, the second cheapest is 100% hydroelectric and the three more expensive options contain increasing quantities of solar electricity. For convenience we refer to the five tariffs as 'red' (fossil fuels), 'blue' (hydroelectric), and 'green 1', 'green 2' and 'green 3' (solar electricity). When this pricing system was introduced in June 2002, all customers were billed by default with the "blue" tariff and they were informed about the other tariff options. They hence had to take action to register for another tariff. As a consequence the vast majority of electricity consumers did not make any change and accepted the blue tariff (see table 4[7]).

Table 4 shows that the 'Green' and "Red" pricing systems are over-represented among the *Doubléco* participants. This over-representation is consistent with the design of Doubléco, based on reward and information, indeed, the Doubléco program aims at using both drivers (economic incentive and environmental awareness); therefore one may expect to see both kinds of motivations among participants. In any case we draw the preliminary conclusion that ecological concern is not the only driver relevant for the selection. It should be noted that the overrepresentation of some tariffs is not as yet a measure of the bias but confirms that the assumption of a risk of selection bias should be tested (see section 3.2).

Table 4. Distribution of tariffs among all clients and *Doubléco* participants (eligible customers only)

Price system	Total	*Doubléco* Participant	*Doubléco* Participation rate
Red	5,299	1,600	30%
Blue	172,919	38,343	22%
Green 1	19,387	6,658	34%
Green 2	5,654	2,203	39%
Green 3	3,722	1,365	37%
Total	206,981	50,169	24%

3.2. Treatment effect model

3.2.1 Model principles and assumptions. A treatment-effect model estimates the effect of binary choice, z_i (indicating whether or not the household or company *i* is participating in *Doubléco*), on a

[7] The total of Table 4 differs slightly from Table 1, this is due to administrative problems (people leaving their apartment before the first meter-reading, changing their tariff…).

continuous and fully observed variable, the outcome, Δ_i which, in our case, is the difference between two annual electricity consumptions:

$$\Delta_i = x_i{}' \beta + \delta z_i + \epsilon_i \quad (1)$$

The variation of the electricity consumptions, Δ_i, is "explained" by two sets of observable variables: a column vector x_i ($x_i{}'$ is the transposed row vector) and w_i. The realisation 0/1 of the z_i indicator depends on the outcome of a latent variable z_i^*. This latent z_i^* is called an "index" function and explained the unobserved part of a comportment, which takes only value 0/1 according to whether or not z_i^* crosses a threshold. For example, z_i^* could be interpreted as a measure the ecological awareness. We assumed z_i^* to depend linearly on the second vector of observed variables, w_i, and additionally on a random component u_i :

$$z_i^* = w_i{}'\gamma + u_i \quad (2)$$

The link between the latent variable and the binary choice z_i is established through the threshold:

$$z_i = \begin{cases} 1, \text{if } z_i^* > 0 \\ 0, \text{otherwise} \end{cases} \quad (3)$$

The two random components ϵ_i and u_i are supposed bivariate normal with zero mean and covariance matrix

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \quad (4)$$

The correlation parameter conveys the relation between the decision to participate and the size of the saving Δ_i, in other words it measures the bias effect of the enrolment.

Because of the complexity due to eq. (3) and (4) the deterministic part of eq. (1) cannot be interpreted as conditional expectation; The difference in expectation values for energy use depending on whether or not the client is participating in *Doubléco* is given by (cf. Maddala, 1983, 117-122):

$$E(\Delta_i | z_i = 1) - E(\Delta_i | z_i = 0) = \delta + \rho\sigma \left[\frac{\varphi(w_i\gamma)}{\Phi(w_i\gamma)\{1-\Phi(w_i\gamma)\}} \right] \quad (5)$$

where φ is the standard normal density and Φ the corresponding cumulative function. The second term on the right-hand side of the equation measures the magnitude of the bias. In the *Doubléco* evaluation we expect a negative δ. If the correlation between the error terms ϵ_i and u_i is zero (no bias), the treatment effect is simply the estimator of δ. When there is a selection bias, δ underestimates the effect in absolute value ($\rho < 0$) or overestimates it ($\rho > 0$).

3.2.2. Model specification. In the following we explain the variables of the model, namely Δ_i, x_i and w_i:

- The electricity savings Δ_i instigated by the *Doubléco* program are defined as the difference in kWh between the annual consumption of year t_0+n and year t_0 of customer i. The baseline year t_0 is 2009, and n depends on the year of enrolment. For those who entered *Doubléco* in 2010, n takes the values 1,2 and 3; for those who entered during 2012, n takes the values 1 and 2. As mentioned above, only a part of the first year (n=1) is observed under *Doubléco* because of the annual meter-readings. We shall estimate separately the parameters explaining Δ_i for year n=1,2 or 3, for simplicity we do not index Δ_i with n.

- The vector x_i has two components: 1) the constant 1 corresponding to the estimated parameter β_1; 2) the electricity consumption (kWh) in 2009, before participation in *Doubléco*, corresponding to parameter β_2. The product $x_i{}'\beta$ measures the overall mean variation of both participants and non-participants. Because of the heterogeneity of the population, this variation is not constant but related to the level of consumption in 2009.

- The explanatory variables, w_i, for the probability model (eq. 2) are dummy indicators corresponding to the five pricing-systems of Table 4. The five elements of the estimated vector γ give the relative weight of each system on the probability to participate to *Doubléco*. The values of the components of γ are expected to be mostly negative because the mean probability of participation is less than 50%.

4 Results

4.1 Model implementation

As already mentioned we estimated separately the model for households and companies, but also for year 1, 2 and 3. We renounced to estimate a panel model because its complexity: we should have estimated simultaneously a latent structure, a panel structure and the autocorrelation of the data. Moreover, we use the same baseline year (2009) for all the clients; "year 1" stands for the year of enrolment whatever this year is (2010, 2011 or 2012). "Year 2" is the second year after enrolment and so on[8].

4.2 Results

The treatment-effect estimation provides us with three interesting types of results: 1) the relative probability of sub-populations to participate in the program (through the estimators related to the variables for the types of tariff), 2) the measure of the bias, and 3) the evaluation of the savings taking into account that bias (through the complementary model expressed in equation (5)). Table 5 (households) and Table 6 (small companies) show the results generated with Stata 12 software. The parameters of equation (1) which explain the saving in kWh (Δ_i) relative to the baseline year 2009 are followed by those of equation (2) and (4) to establish the probability of participation. We re-estimated the model for year 1, 2 and 3 separately.

The standard errors of eq. (1) are much higher for companies compared to households. The main reason is the higher heterogeneity of this group (larger consumption and variance). Other possible explanations are the sample smaller size of companies compared to households and the influence of the economic depression on the companies' level of activity.

The parameters of eq. (2) indicate the probability to join *Doubléco* as a function of the tariff type. Recalling that the smallest value indicates lowest probability, we conclude that the "blue" tariff has the lowest probability, whereas the three green tariffs increase notably that probability; they are also close to each other. Finally the effect of the "Red" tariff is located between the green and blue ones. This confirms that the probability to enrol in *Doubléco* does not seem to be exclusively correlated to the environmental sensitivity. At first glance, we can suppose that the engagement depends on the fact the customer did or did not react to the information delivered by the utility of Geneva about the different pricing-systems they had to choose. But this reaction is certainly related to the two key drivers of the program: economic considerations and ecological concern.

The estimated correlation coefficients (ρ) are systematically positive, meaning that a simple estimation method of the savings (by averaging or by ordinary least squares) would overestimate the effect of *Doubléco*. The mean savings are given in Table 7. We recall that the enrolment takes place in the course of year 1, which explains why the savings during year 1 are lower than in year 2. In year 3, the savings of the households diminish, whereas the companies increase their consumptions. This is perhaps the effect of a decreasing involvement. In a survey of 432 households in spring of 2012, less than 40% of participants remembered *Doubléco* (see discussion below).

[8] We also produced estimations by grouping observations by year of enrolment and taking the reference year as the year preceding the enrolment, but this increases the number of models and results, partly because the non-participants are to be redefined three times. So the results are not reported here. The main conclusion is that the enrolment year influences slightly the estimated savings.

Table 5. Analysis for households – Model estimated parameters for equation (1), (2) and (4)

	Δ_i year 1		Δ_i year 2		Δ_i year 3	
Eq (1)	Coeff.	Std Dev.	Coeff.	Std Dev.	Coeff.	Std Dev.
Constant: β_1	134.9	8.5	169.0	7.9	184.7	9.5
2009 con-sumption: β_2	-0.0363	0.000649	-0.0658	0.00095	-0.0819	0.00116
Participant (0/1) : δ	-184.8	33.4	-263.1	45.8	-269.3	53.6
Eq (2)						
Red: γ_1	-0.557	0.022	-0.780	0.025	-0.766	0.026
Blue: γ_2	-0.774	0.004	-1.127	0.005	-1.118	0.005
Green 1: γ_3	-0.406	0.011	-0.664	0.012	-0.654	0.013
Green 2: γ_4	-0.267	0.019	-0.508	0.022	-0.483	0.023
Green 3: γ_5	-0.308	0.025	-0.568	0.029	-0.559	0.031
Eq (4)						
ρ	0.114		0.114		0.116	
σ	656		840		964	

Table 6 : Analysis for small companies - Model estimated parameters for equation (1), (2) and (4)

	Δ_i year 1		Δ_i year 2		Δ_i year 3	
EQ (1)	Coeff.	Std Dev	Coeff.	Std Dev.	Coeff.	Std Dev.
Constant: β_1	206.6	47.7	192.1	54.1	220.5	69.6
2009 con-sumption: β_2	-0.0260	0.0011	-0.04803	0.00205	-0.0539	0.0026
Participant (0/1) : δ	-596.5	194.8	-497.6	322.8	-748.0	404.4
Eq (2)						
Red: γ_1	-0.605	0.047	-0.757	0.053	-0.740	0.055
Blue: γ_2	-0.776	0.012	-1.104	0.015	-1.092	0.015
Green 1: γ_3	-0.490	0.033	-0.763	0.039	-0.731	0.040
Green 2: γ_4	-0.321	0.060	-0.526	0.068	-0.523	0.070
Green 3: γ_5	-0.459	0.069	-0.686	0.081	-0.671	0.085
Eq (4)						
ρ	0.295		0.118		0.203	
σ	1010		1659		2067	

The mean savings are given in Table 7; they include the bias correction according to Eq. (5). In Table 3, the difference between 2009 and 2013 consumptions for participant and non-participant households reads -165-(-94) =-71 Wh/y, to be compared to the -64 Wh/y in the Table 7, the bias effect is then relatively low. For small companies, this effect offsets the estimation of the treatment without bias (δ=-748) and Eq 5 gives +17.2 Wh/y with a large standard deviation; Table 3 gives a saving of -345+213=-132 Wh/y. So for small companies the bias seems to be important, nevertheless other phenomena, like the economic cycle, may have interfered with these results. Moreover, the results according to Eq. (5) (with correction of the bias) seem to indicate that the energy savings instigated by *Doubléco* are small but statistically significant. These results are in accordance to those reported in the literature. Delmas et al. (2013) performed a meta-analysis of 156 published trials from 1975 to 2012 and concluded: "*A savings effect of 1.99% is found for high quality studies that include*

statistical controls such as weather, demographics, and – most importantly – a control group. In contrast, lower quality studies without such statistical controls find a savings effect of 9.57%".

Table 7. Estimated mean savings according to eq. (5)

	Δ_i **year 1**	Δ_i **year 2**	Δ_i **year 3**
Households			
Estimated mean change due to *Doubléco* (kWh) relative to 2009	-56.4	-86.9	-64.0
Std Dev.	2.7	6.7	7.8
Mean consumption 2009	2930	2930	2930
Change in percent	-1.92	-2.97	-2.18
Small companies			
Estimated mean change due to *Doubléco* (kWh) relative to 2009	-87.1	-137.6	+17.2
Std Dev.	9.2	11.6	25.1
Mean consumption 2009	6460	6460	6460
Change in percent	-1.35	-2.13	+0.28

The large size of the "Participant" sample induces small standard deviations (cf. Tables 5 & 6). Moreover, the standard deviation of the mean saving in Table 7 is small, but increase each year.

5 Discussion

We address three main questions in the following sections, namely: 1) the analysis of the program activities and the results, 2) the persistence of the effect of the campaign, and 3) the communication with respect of the framework of the behaviour change theories.

5.1 Crossing the analysis of the program activities and the results

Because of the lack of information, we are not able to quantify the number of appliances bought by the participants (either directly or using vouchers). As mentioned in sec 2.2, many households who bought a refrigerator were removed from the sample because they got the vouchers by participating to another SIG's program. Even knowing exactly how many appliances the participants had bought and the performance of these new equipments, it would remain hard to estimate the savings because the same information would be still missing for the non-participants.

The treatment effect model is designed to analyse complex phenomena, like testing a new medical treatment, and so is *Doubléco*. This program has used many communication strategies, distributed various information and vouchers, created a dedicated website, and rewarded systematically any decrease of consumption. Like for a new medicine, the complexity of the interactions makes it impossible to analytically decompose the various factors. This is why we focus directly on the results in terms of savings

5.2 Persistence of the program effects

The program is a mix of behavioural change and changes in purchase habits for efficient appliances. One can therefore expect a rather good persistence because the appliances remain in place, even if the instigated behavioural changes gradually disappear. Nevertheless, the difference between participants and non-participants will decrease because sooner or later only more efficient appliances will be in the market. In the hypothetical case that participants buy more systematically LED whereas non-participants buy CFL, the gap will reduce because the difference in consumption between a LED and a CFL is lower than between a CFL and a bulb light.

This is the intrinsic effect of many programs which finally accelerate the turnover of equipment in the "Participant group". But at the end, the "non Participant group" must also renew his equipment in a market proposing more efficient appliances according to the new standards of the European Union.

In our case, we should wait for one or two years to complete our data base and to provide a more meaningful evaluation of the persistence. For the time being, it is instructive to consider the outcome of a survey organised by the utility. In the spring of 2012, a sample of 436 households was interviewed. Among them 291 (67%) did not participate in *Doubléco* while 145 did. They were asked if they knew the program: 26% of the non-participants gave a positive answer, for the participants the share was 37%. This finding indicates a low memory of the *name* of the program already two years after the beginning of the campaign. Nevertheless, the Table 7 provide an interesting fact: the savings of the households after 3 year are still measurable (-64 kWh). Maybe efficient comportments last longer than the memory of their origin.

According to the rule of the program, the households could not get more than two rewards. Among the 11,362 households enrolled in 2010, 4,080 (36%) lowered continuously their consumption, however they did not get any reward in 2013. The persistence is still an open question.

5.3 Insights from research on communication and behavioural change

To address the factors influencing the energy-saving behaviour we refer to Delmas et al. (2013). They define four main strategies and evaluate how they facilitate conservation behaviour. These strategies are: (1) Energy feedback information, (2) Information on conservation strategies, (3) Pecuniary strategies, (4) Power of norm.

Doubléco definitely applied strategies based on by (2) and (3) which are not very effective according to Delmas et al. Among their conclusions, we point out the fact that "*the effect of 'Energy savings tips' is a relatively low involvement strategy*" (ib. p. 735). Considering the findings of Delmas et al., the communication strategy of *Doubléco* should have induced relatively poor results. Worse, the monetary incentive evaluated in the meta-analysis tends to increase electricity consumption. The hypothetical explanation of this paradox is the rebound effect. However, in Geneva, the financial benefit is so small with respect to the household budget that its impact should be tiny. An average reward of 71 Euros, doubled by the reduction of the bill, represents about 0.4% of the median income of a single family in Geneva, and 0.14% of a married one. Despite Delmas' argument, *Doubléco* succeeded in a significant, though small, saving.

More generally, Brounen et al. (2013) insist on the "energy awareness and literacy"; according to their survey (1721 Dutch households) 53% of the respondents are not aware of their monthly electricity consumption. Our table 4 supports this statement: 84% of the customers did not react to the utility's information, even if they could lower their electricity bill; in fact only 3% did it and the rest (13%) chose a higher price.

We have measured the effect of *Doubléco*, in the expected direction, with sufficient precision, although Delmas argues that monetary rewards are counterproductive. Let us try to understand this apparent contradiction between the Delmas' meta-analysis and our results. The

Theory of planned behaviour (Ajzen 1985) can help us: in that theory, behaviours are influenced by the normative belief, the knowledge but also by the perceived behavioural control. This latter consists in the conviction that one can succeed in implementing a new behaviour. Going back to the *Doubléco* program, we put forward that the participants are self confident about their ability to modify their electricity consumption as long as they can directly influence it. This is a necessary but not sufficient condition: their normative belief should yet support the curtailment effort. The sub-population who chose green tariffs manifests clearly a normative belief in such engagement. Moreover, as Gadenne et al. (2011) wrote: "*A feeling of moral obligation is a considerable behaviour motivator*". So, to a certain extent, a moral obligation can substitute for normative belief. Gadenne et al. (2011) reviewed many articles describing environmental drivers; many of them are moral (as feeling guilty). Another driver for this moral obligation is the non-material benefit of social gratification in the form of belonging to a community (Hoffman 2010). This is fully in line with the attempt of *Doubléco* to organize their participants as a community (newsletter, dedicated website and special offers).

Recent research at University of Geneva studies the role of emotions in decision making (Brosch et al. 2014). Hence, a new dimension is added to the theory of planned behaviour in view of the finding that "emotions can be important drivers of decisions making". To conclude, we think that Delmas is right by arguing that price incentive is insufficient to curtail consumption; on another side, we hypothesize that *Doubléco* succeeded because it has activated normative believes, self-confidence and possibly positive emotion beyond economic mechanisms.

6 Conclusions

We propose two conclusions: one regarding the evolution of the program, the other concerning the methodology.

The *Doubléco* program ended in June 2012. The utility considered it as successful and decided to propose a new billing system since summer 2013. It is called "*Bonus*" and introduces two main differences that are the following:

- There is no more enrolment, every household or company participates;
- A 10% discount is calculated on the bill, as soon as the consumption has lowered by 4% rate or more.

One may wonder about the fact that SIG decided to change the name of the program rather than to benefit from the value capitalized in *Doubléco.* Moreover, the communication for *Bonus* has not been as intensive as for *Doubléco.* Finally, the *Bonus* program has been completed in spring 2014, by a new one: *Activéco*. The participants must firstly enrol on a dedicated website, then fill a questionnaire about the size of their apartment, read monthly their own meter and deliver this information to the utility via the website. The website gives the possibility to the customer to follow his own consumption and to compare it to other similar consumers. This *Activéco* program gives also some advices to reduce consumption. The combination of these two programs is close to the previous *Doubléco*, after correction of the main inefficiencies.

Concerning the methodology, further improvements are necessary; it is recommended to develop multiple treatment effects models in order to simultaneously analyze the recruitment mode and/or the enrolment year (Di Falco et al., 2011). Moreover, it would be commendable to build a dynamic model in order to evaluate more precisely the persistence of behavioural change.

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