Haute école de gestion de Genève
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Consumers Choices among Alternative Electricity Programs in Geneva – An Empirical Analysis *

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Cahier : N°HES-SO/HEG-GE/C--07/6/1--CH

2007

* We thank the students of the Geneva School of Business Administration, who participated in the construction of the survey, the data collection, and the transcription of answers. Without them, this research would not have been possible. Thanks also to Franco Romerio for helpful comments.

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Summary

Services Industriels de Gen`eve (SIG) is the monopoly which delivers natural gas, water and electricity in the Geneva Canton. A few years ago, SIG offered to Geneva households 6 different types of electricity products from which households can choose. Those new electricity products differ in particular because of the origin of their production (natural gas, hydraulic, solar, asf) and of their price. Through a survey research, we investigate what are the main factors which explain household choices among the different products. By using a series of logistic regressions, we assess what determines households' knowledge of the different electricity products which are offered by SIG and the factors explaining their choices among them.

Keywords

Energy prices ; Customer choice ; Logit model.

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December 14, 2007

Abstract

Services Industriels de Genève (SIG) is the monopoly which delivers natural gas, water and electricity in the Geneva Canton. A few years ago, SIG offered to Geneva households 6 different types of electricity products from which households can choose. Those new electricity products differ in particular because of the origin of their production (natural gas, hydraulic, solar, asf) and of their price. Through a survey research, we investigate what are the main factors which explain household choices among the different products. By using a series of logistic regressions, we assess what determines households' knowledge of the different electricity products which are offered by SIG and the factors explaining their choices among them.

JEL Classification: Q41, D12, C35

Keywords: Energy prices, Customer choice, Logit model.

1 Introduction

Energy production and consumption is at the hearth of many policy initiatives in order to achieve sustainable development objectives and to decrease

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greenhouse gas and other environmentally-harmful emissions. In this context, green electricity programs, which propose to consumers alternative electricity products based on renewable energies, have received a widespread interest. As a result green power markets have grown worldwide quite substantially in recent years, although market penetration is still relatively low, i.e. in the order of 1% (see Bird *et al.*, 2002). From a policy perspective, the reasons explaining such a low penetration rate are of course fundamental. In the literature, authors have pointed to several causes (see e.g. Borchers *et al.*, 2007): failure in marketing or communication campaigns; information failures; non correspondence between households' green energy products demand and the products which are supplied. This paper investigates whether the low market penetration rate of green electricity products in Geneva (Switzerland) is due to a lack of information about the product itself and its characteristics, including the own price. In order to test for this hypothesis, we can exploit the fact that the *Services Industriels de Genève* (SIG), the only supplier of electricity, proposed on June 1, 2002 a new range of electricity products, from which households can freely choose. Indeed, concerned by sustainable development, SIG proposes to Geneva customers 6 electricity products, differentiated by the type of energy and its provenance (local or from abroad), which are the following:

- *Initial* (Initial): 100% natural gas, 23.5 cts/kWh.[1]
- *Vitale Bleu* (Blue): 100% hydraulic, 23.8 cts/kWh.
- *Vitale Jaune* (Yellow): 100% renewable energies produced in the canton of Geneva, 25.8 cts/kWh.
- *Vitale Vert* (Green): new renewable energies (solar, asf), 28.8 cts/kWh.
- *Vitale Découverte* (Discovery): 80% Blue + 20% Green, 24.8 cts/kWh.
- *Vitale Engagement* (Engagement): 50% Yellow + 50% Green, 27.3 cts/kWh.

We emphasize that the customer is obliged to notify its choice to SIG if she does not want the default product, which corresponds to the Blue one. There is only one product (the Initial) which is composed by fossil, non-renewable energy. In addition, nuclear power is not represented in the proposed products.In this context, it should be noted that the Geneva Constitution explicitly says that cantonal authorities should promote renewable energies and oppose to nuclear utilities in the Geneva territory and nearby.

In February 2007, 212'000 customers, corresponding to about 82% of the total, had the Blue option, 9.4% the Discovery, 3.5% the Initial, 3% the Horizon (a new product composed of 60% Blue + 40% Green that replaced the Yellow and Engagement at the beginning of February 2007); 1.7% the Green.[2] From those data, we can firstly observe that the great majority of

[1]Currently, CHF 1 corresponds to EUR 0.60 and USD 0.85.

[2]Source: www.sig-ge.ch (SIG website).

customers is with the Blue option, which corresponds to the default option assigned by SIG. Secondly, we notice that the most expensive product (the Green) ranks last in the choices.

The aim of this paper is to assess the main factors explaining households' choices among the different electricity products. There is an extensive literature on green energy programs, most papers assessing the willingness-to-pay for them (e.g. see Zarnikau, 2003), often using stated preferences approaches, analyzing potential biases, e.g. hypothetical bias in contingent valuation method (e.g. see Whitehead & Cherry, 2007). With respect to this literature, the aim and methodology of this paper is somehow peculiar, since our analysis is neither based on a hypothetical scenario (the electricity products are actually offered by SIG), nor on actual data, since we had no access to SIG individual household consumption data. Therefore, we had to rely on a survey in order to explain households' real choices.

The paper is organized as follows. In Section 2, we present the survey research design and briefly analyze some descriptive statistics. In Section 3, we explain the methodology based on logistic regressions. In Section 4, we describe the main qualitative results provided by two different logistic regression models. The conclusions summarize and provide further research directions.

2 Database and Descriptive Statistics

Our database is composed by 545 individuals who were randomly selected and interviewed face-to-face in the streets, during the period August-September 2006. The only conditions for being included in the sample were (i) to live in the canton of Geneva, in order to ensure that interviewed people are necessarily SIG customers and (ii) being aged of at least 18 years old. Note that the entire sample cannot always be used in the empirical analysis in Section 4, because of some missing answers.

Table 1 reports the answers to the question: "Which one among the SIG electricity products do you have at home?".[3] The first interesting surprising result is the huge proportion (almost 40%) of the interviewed people who does not know the electricity type they are consuming. Our first empirical question in Section 4 will thus be devoted to exploring the factors having an impact on the knowledge of the electricity product available at home, in order to highlight who knows his own electricity product and who does not.

Among the people able to say which product has been chosen by their household, the biggest proportion indicates the Blue one. Since this is the option assigned by default (when no other one is explicitly chosen), this is

[3]The complete questionnaire (in French) is available from the authors on request.

Table 1: Electricity products distribution

Product	**N**	**%**	**% without "does not know"**
Initial	88	16.15	26.35
Blue	123	22.57	36.83
Yellow	58	10.64	17.37
Green	26	4.77	7.78
Discovery	22	4.04	6.59
Engagement	17	3.12	5.09
Does not know	211	38.72	–
Total	545	100.00	–

not really surprising. Most people probably decide not to do anything and thus get the Blue product, be it by affinity or by convenience.

Comparing the share of the products in our sample with the data on effective product choice provided by SIG (see above), we observe important disparities. In fact, even if a large proportion (37%) of those knowing their product indicated the Blue one, this figure remains quite remote from the acutal 82%. Consequently, we observe much higher proportions of the other products in our sample than in the population. These observations strengthen our initial hypothesis that most people do not know the product they are consuming at home. Some people probably answered without being certain of the product they had at home, even if we explicitly stressed them to tick the "I do not know" answer if they were unsure about it.

The descriptive statistics as well as the definition of all the variables that were collected are reported in Table 6 in Appendix. Most of the variables are binary and their mean (N / #Observations) can thus easily be interpreted as the percentage of the sample displaying the corresponding characteristic. We note that the socio-economic characteristics of our sample match quite well with those of the whole Geneva population. Concerning the distribution between genders, the male population is slightly over-represented in our sample: 60% against only 48% in the population in 2006 (OCSTAT, 2007). The proportion of foreigners (41%) corresponds with what is observed in the whole population (39%). The mean age of the individuals in the sample is about 35 years, with a minimum of 18, a maximum of 77 and 50% of the individuals being between 26 and 42 (first and third quartiles). Regarding the household composition (not reported in Table 6), 25% are living by themselves, 62% live with their family and 13% with roommate(s).

Some particular variables possess missing values. For instance, only 482 people answered the question about income, which still corresponds to a

relatively high response rate of about 90%.

3 Methodological Approach

Most econometric applications in the field of electricity are used to produce estimates of price and income elasticities (see for instance Dubin & McFadden, 1984, for a well know example). As already mentioned, we do not have information concerning the amount of electricity consumed at the household level. Therefore, traditional demand analysis quantifying e.g. the sensitivity of electricity demand to price cannot be implemented. However, since we have to rely on a survey, we have the chance to test whether households even know electricity prices, the amount of electricity they consume and the type of electricity product they have at home. The aim of our paper is thus more sociological, since it intends to explain the consumers' knowledge of the electricity product and their attitude towards the different available products.

The first interesting point to investigate is the knowledge or ignorance of the electricity product available at home. We therefore construct a binary variable y_i (described in Table 2 for our sample) and use it as a dependent variable:

$$y_i = \begin{cases} 1 & \text{if the individual } i \text{ knows his product,} \\ 0 & \text{if he does not.} \end{cases}$$

In order to analyze such a binary dependent variable, we have developed logistic regression models to assess negative/positive effect of many independent variables. This latter approach is rather employed in social sciences to capture the qualitative nature of interdependencies in multivariate analysis (see Jaccard, 2001, for a more detailed explanation). The statistical technique to analyze dummy variables are called binary response models, the most widely used being the logit and probit models. The idea of these models is to predict the probability that an individual will be in which group, knowing her personal characteristics. In this paper, we will make use of a logit model[4], which specifies the probability that individual i knows his product as follows:

$$p_i = Pr[y_i = 1|x_i] = \frac{exp(x_i'\beta)}{1 + exp(x_i'\beta)} \tag{1}$$

where x_i is a vector containing the characteristics of individual i and β is the vector of parameters to be estimated. The likelihood function of a sample

[4]A probit model would have given very similar results.

Table 2: Knowledge of the electricity product available at home

Knowledge	**Whole sample**		**Sample Table 4**	
	N	**%**	**N**	**%**
No (0)	211	38.72	159	35.89
Yes (1)	334	61.28	284	64.11
Total	545	100.00	443	100.00

composed of N individuals writes:

$$\mathcal{L}(\beta) = \sum_{i=1}^{N} f(y_i|x_i) = \sum_{i=1}^{N} p_i^{y_i} \cdot (1-p_i)^{1-y_i} \tag{2}$$

The estimation of the parameters of interest is finally obtained by maximizing the log-likelihood function:

$$\ln \mathcal{L}(\beta) = \sum_{i=1}^{N} \ln f(y_i|x_i) = \sum_{i=1}^{N} y_i \cdot \ln p_i + (1-y_i) \cdot \ln (1-p_i) \tag{3}$$

where the p_i are given by (1).

The coefficients of the regression will only be interpreted in a qualitative manner. Because of non-linearity, the coefficients are indeed only qualitatively related to the impact of the covariate on the probability of knowing the available product.[5]

In a second step, we concentrate in unraveling the factors determining the choice of the electricity product. For this question, we will only use the data of those individuals who know the type of electricity product they are using. Since people who answered having the Yellow, Green, Discovery and Engagement products are very sparse, it would be difficult to obtain precise estimates for each of these categories alone. We thus decided to bring them together in what we call the "Other renewable energies". We then have to explain the choice among the three different alternatives given in Table 3, which means that the variable we want to explain now writes:

$$y_i = \begin{cases} 0 & \text{if the individual has the Initial product,} \\ 1 & \text{if he has the Blue product,} \\ 2 & \text{if he has one of the Other renewable energies.} \end{cases}$$

[5]In order to have an idea of the quantitative effect of each covariate, one could compute the marginal effects for the "mean" individual or even for any individual of the sample.

Table 3: Electricity products (grouped)

Products	**Whole sample**		**Sample Table 5**	
	N	**%**	**N**	**%**
Initial (0)	88	26.35	74	26.06
Blue (1)	123	36.83	100	35.21
Other renewable energies (2)	123	36.83	110	38.73
Total	334	100.00	284	100.00

Given that the dependent variable has more than two possible outcomes, we have to use an unordered multinomial logit model, in which the probability that individual i has chosen alternative j among m possibilities is given by:

$$p_{ij} = Pr[y_i = j|x_i] = \frac{exp(x_i'\beta_j)}{1 + \sum_{\substack{k=1 \\ k\neq j}}^{J} exp(x_i'\beta_k)}, \qquad j = 1, \ldots, m. \tag{4}$$

As for the simple logit model, the estimation of the parameters is made by maximizing the log-likelihood function, which now writes:

$$\ln \mathcal{L}(\beta) = \sum_{i=1}^{N} \sum_{j=1}^{m} y_{ij} \cdot \ln p_{ij} \tag{5}$$

where the p_{ij} are given by (4)

For the empirical estimations, we choose the Blue product as the base category because this is the electricity type attributed by default. However, the results do not depend of the base category and any of the three alternatives could play this role. The coefficients of this estimation have to be interpreted as deviations from the base category: a positive coefficient indicates that the person has a greater probability of being in the alternative category than in the base one.

4 Empirical Qualitative Results

The results concerning the knowledge of the electricity product consumed by the household are displayed in Table 4. We remark that only a few coefficients are statistically different from zero.

The age has a positive effect on the knowledge of the electricity product, which means that older people are better informed than younger ones. The latter are probably not very interested in energy market. As can be expected, we find that people responsible for paying the households' bills know more

Table 4: Logit model explaining the knowledge of the available electricity product

Variable	Coefficient	Variable	Coefficient
nation1	-0.71^{*}	liberalp0	-1.02^{**}
	(0.36)		(0.49)
age	0.05^{***}	sd3	-0.91^{**}
	(0.01)		(0.44)
resp1	0.70^{**}	es3	1.48^{*}
	(0.30)		(0.77)
web1	1.06^{***}	reduc0	-0.81^{*}
	(0.28)		(0.45)
booklet1	0.54^{*}	reduc2	0.52^{*}
	(0.28)		(0.27)
price3	-1.01^{**}	Log likelihood	-211.7
	(0.50)	Number of Obs.	443

Notes:
- Only significant coefficients appear in the Table. The complete list of variables contained in the estimation is the following: woman, nation1, nation2, age, npers, income0, income1, income3, income4, income5, bills1, resp1, web1, booklet1, crit0, crit1, wtp0, wtp2, wtp3, wtp4, price0, price2, price3, liberalp0, liberalp2, liberalp3, liberalq0, liberalq2, liberalq3, sd0, sd2, sd3, es0, es2, es3, reduc0, reduc1, reduc2, plus a constant term.
- Reference category is: man, nation0, income2, bills0, resp0, web0, booklet0, crit2 + crit3, wtp1, price1, liberalp1, liberalq1, sd1, es1.
- $^{*}/^{**}/^{***}$ indicates that the coefficient is significant at the 0.1/0.05/0.01 level.
- Standard errors between parentheses.

often their electricity product, since those people are probably also responsible for the choice of the product for their household. Similarly, people who already visited the SIG internet website have a greater probability to be in the "knowing group". The same for those individuals who are interested in the booklets received at home from SIG. By visiting the website or reading these booklets, they clearly show their intention of being informed.

The probability of not knowing the energy product is higher when the individual is unable to judge whether SIG electricity prices are high or low. People ignoring how SIG are concerned by sustainable development and those thinking that liberalizing the electricity market would not lower prices are in the same situation. A possible explanation to these results is that those people are not interested at all by the electricity market and make therefore

no effort to get information about it. The consequence is that they more often ignore the electricity type they consume.

Finally, some more variables are significant at the ten percent level (es3, reduc0 and reduc2), but the sign of their coefficient is hardly interpretable or even contradictory. If the respondent answered that she "does not know" the importance of energy saving (es3), she knows more probably her electricity product. The contrary would have been logical. We also expected everyone acting so as to reduce his electricity consumption, even in different ways - turning off lights (reduc0) or using low intensity bulbs (reduc2) - to have a greater knowledge of the product she has at home. We however do find opposite signs for these variables. The fact that the coefficients are only slightly significant proves that the effects are not well established.

The second part of our analysis intends to explain what influences the choice of an electricity product over another. The results of the multinomial logit regression run for that purpose are displayed in Table 5.[6] Once again, only a few coefficients are statistically significant, especially for the Other renewable energies.

Swiss citizens coming from another canton than Geneva are less likely to choose the Initial product than the Blue one. Older people choose the Initial product with a lower probability as well. Younger people being usually more concerned with budget constraints, they surely seek the cheapest solution, neglecting environmental problems. Households pertaining to the lowest income class (less than CHF 3'000 per month) are more likely to elect the Initial product, which is coherent since it is the cheapest. Similarly, people who indicate they are interested in SIG bills, those choosing their product on the basis of prices and those qualifying SIG prices as expensive or very expensive have a larger probability to be in the Initial group than in the Blue one. People claiming they would agree to pay a surplus of 10% or even more to have green energy have a higher probability to choose the Initial product, which seems contradictory.

Those ignoring how liberalization would affect the electricity prices choose more frequently the Initial product. Finally, people thinking that energy saving is weakly or not important have a greater probability of pertaining to the Initial product, which may indicate that such people do not give any credit to sustainable development and they choose the cheapest energy, despite the fact that it is non-renewable.

[6] All variables are the same as for the logit estimation except that we dropped the category 1 of the variable on the perception of SIG's electricity prices because it induced some collinearity problems.

Table 5: Multinomial logit model explaining the choice of the electricity product

Initial vs. Blue		**Other renewable energies vs. Blue**	
Variable	**Coefficient**	**Variable**	**Coefficient**
nation1	-1.14^{**}	crit0	-1.10^{*}
	(0.58)		(0.61)
age	-0.04^{**}	wtp3	1.90^{**}
	(0.02)		(0.78)
income0	1.33^{*}	sd0	1.52^{***}
	(0.74)		(0.55)
bills1	0.88^{*}	sd2	0.70^{*}
	(0.50)		(0.39)
resp1	0.85^{*}	es0	2.56^{**}
	(0.51)		(1.14)
crit0	1.85^{*}		
	(1.08)		
wtp3	2.27^{***}		
	(0.88)		
liberalp3	3.19^{***}		
	(1.22)		
es0	2.97^{**}		
	(1.20)		
Log Likelihood	-235.01		
Number of Obs	284		

Notes:
- Only significant coefficients appear in the Table. The complete list of variables contained in the estimation is the following: woman, nation1, nation2, age, npers, income0, income1, income3, income4, income5, bills1, resp1, web1, booklet1, crit0, crit1, wtp0, wtp2, wtp3, wtp4, price2, price3, liberalp0, liberalp2, liberalp3, liberalq0, liberalq2, liberalq3, sd0, sd2, sd3, es0, es2, es3, reduc0, reduc1, reduc2, plus a constant term.
- Reference category is: man, nation0, income2, bills0, resp0, web0, booklet0, crit2 + crit3, wtp1, price0+price1, liberalp1, liberalq1, sd1, es1.
- $^{*}/^{**}/^{***}$ indicates that the coefficient is significant at the 0.1/0.05/0.01 level.
- Standard errors between parentheses.
- Blue product is the base outcome. The third set of coefficients (Initial vs. Other renewable energies) can be easily retrieved from the two presented in the Table: coef[Initial vs. Other renewable energies] = coef[Initial vs. Blue] - coef[Other renewable energies vs. Blue].

Moving to the second part of Table 5, one can discover which factors influence the specific choice between the Blue and the Other renewable energies products. People whose criterion for choosing energy is the price do not often pick out the Other renewable energies. Indeed, these electricity products are more expensive. On the contrary, a higher willingness to pay for greener electricity involves a greater probability of choosing one of the Other renewable energies products.

The results concerning the implication of SIG into sustainable development are somewhat contradictory. On the one hand, people considering SIG as weakly involved in sustainable development elect more frequently the Other renewable energies. That could indicate that they are trying to push SIG toward more environmentally safe products. On the other hand, people considering SIG as being strongly implied in sustainable development opt more often for the Other renewable energies as well. Taking both of these estimates together, the results are difficult to interpret in terms of the perception of SIG involvement in sustainable development.

Lastly, considering that energy saving is weakly important increases the probability of choosing the Renewable energies product. We note however, that the Initial Product possess almost the same coefficient. The results concerning the Other renewable energies are thus not really clear. However, one should keep in mind that they are obtained by gathering several different types of products because of a lack of observations.

5 Conclusions

In this paper, we analyzed the choices of the inhabitants of the Geneva Canton between several alternative electricity programs. Our study is based on a questionnaire administered to 545 persons during the months of August and September 2006. The first interesting and surprising result to highlight is that a huge proportion (almost 40%) of the interviewed people do not know what kind of electricity is available at home.

We thereafter studied the factors having an impact on the knowledge of the product itself as well as the factors influencing the choice between the different products. Because the variables we wanted to explain are either binary or categorical, we based our estimations on logistic regressions.

An improvement of our paper could be made with a larger dataset. Indeed, with more observations, one could apply a multinomial logit model without having to gather together several types of electricity. Finally, we have to note that a possible flaw of our questionnaire is that we cannot be sure that people were right when telling us which product they have at home. A more reliable analysis could be made either on the basis of the SIG files, either by interviewing people at home. However, both of these techniques

would remove the possibility to observe if people do know or ignore the electricity type they consume.

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Appendix

Table 6: Variables description and descriptive statistics

Variable	Description	Category		N	# Obs
gender	Gender	0	Man	322	540
		1	Woman	218	540
nation	Nationality	0	Swiss, from Geneva	194	531
		1	Swiss, but not from Geneva	114	531
		2	Foreigner	223	531
age	Age in years	–	(continuous variable)	–	523
npers	Number of people in HH	–	(continuous variable)	–	531
income#	HH monthly income	0	$<$ CHF 3′000	64	482
		1	CHF 3′000 – 5′000	95	482
		2	CHF 5′001 – 7′000	140	482
		3	CHF 7′001 – 9′000	102	482
		4	CHF 9′001 – 15′000	57	482
		5	$>$ CHF 15′000	24	482
bills	Interested in SIG bills	0	No	208	544
		1	Yes	336	544
resp	Person responsible for paying bills in HH	0	No	174	541
		1	Yes	367	541
web	Did already visit SIG internet website	0	No	352	545
		1	Yes	193	545
booklet	Interested in booklets distributed by SIG	0	No	282	545
		1	Yes	263	545
crit#	Electricity choice criterion	0	price of energy	306	540
		1	cleanliness of energy	191	540
		2	geographical origin of energy	36	540
		3	other reason	7	540
wtp#	Willingness-to-pay for green energy	0	nothing	205	542
		1	1 – 5%	148	542
		2	5 – 10%	103	542
		3	$>$ 10%	41	542
		4	does not know	45	542
price#	Judgment of SIG prices	0	cheap or very cheap	19	544
		1	correct	160	544
		2	expensive or very expensive	303	544
		3	does not know	62	544
liberalp#	Liberalization would lower price	0	strongly disagree or disagree	72	545
		1	neither agree nor disagree	77	545
		2	agree or strongly agree	330	545
		3	does not know	66	545
liberalq#	Liberalization would increase product quality	0	strongly disagree or disagree	155	545
		1	neither agree nor disagree	130	545
		2	agree or strongly agree	193	545
		3	does not know	67	545
sd#	Implication of SIG in sustainable development	0	weak/nil	74	541
		1	moderate	177	541
		2	strong/total	180	541
		3	does not know	110	541
es#	Importance of energy saving	0	weak/nil	53	542
		1	moderate	100	542
		2	strong/total	362	542
		3	does not know	27	542
reduc#	Actions to reduce electricity consumption	0	turn off light	486	542
		1	turn off device (no standby)	324	539
		2	use of low intensity bulbs	279	537

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