The willingness to pay for Renewable Energy Sources: the case of Italy*

S. Bigerna[1], P. Polinori[2]

[1]Faculty of Economics, UTIU, s.bigerna@uninettunouniversity.net

[2]Department of Economics, Finance and Statistics, University of Perugia, polpa@unipg.it

Abstract

In reference to the Renewable Sources EU Directive 2009/72/CE including targets for 2020 known as "20-20-20". The specific Italian goal, for 2020, is to attain the share of 17% in RES electricity production. To make investment in renewable attractive, the market price must be profitable and the gap between private and social costs of renewable generally has to be filled with "coercive" tools. Obviously, acceptance of such burden may be controversial, because there results a price increase. In such context it becomes crucial to explore the consistency of consumer's WTP to use green energy in the electricity production. This study is founded on a national survey made in November 2007. The paper focuses mainly on how different elicitation affects respondents and on the gaps between different formats concerning bidding game and stochastic payment card. Finally in all elicitation formats we make a "certainty correction" proposing 5 degree of acceptance: definitely yes and no, probably yes and no and don't know. Empirical analysis shows two main results. Firstly, we found a significant path dependences in respondents answers due to the elicitation formats. Secondly even in the most *conservative* way, we found a substantial willingness of consumers to partially cover the cost of Italian RES goal.

Key Words: *contingent valuation, interval data, stochastic payment card, renewable energy sources.*

JEL: Q26 Q41

* The authors are thankful to Prof. C. A. Bollino with whom we developed many of the ideas presented in this paper. We also thank Dr. Silvia Micheli and the 27th USAEE/IAEE North American Conference participants for their helpful suggestions. The authors gratefully acknowledges the support of the GSE, Rome, Italy. The usual disclaimer applies.

Introduction

The situation of energy resources in many developed countries is bad and getting worse. In the past, a lot of emphasis on climate action was based on the precautionary principle but now the consequences regarding the use of fossil energy have become more evident and also more accepted worldwide thus climate change[1] and resource depletion are real problems to be addressed, in the contest of optimal allocation of public resources.

In this context, renewable energy sources (RES) are essential to reduce harmful emissions and to conserve resources. As a result, researchers have increased their interest in the economic implications of a development of renewable energy used in the production of electricity.

On the supply side, the Italian situation has gradually changed. In fact, until 2005 the large part of renewable commercial production was only made by hydro and wind energy, from 2005 onwards, the industry has developed the use of biomass and photovoltaic as additional sources of renewable energy potential. But one important feature of the RES is their high supply-generation cost and this characteristic has two important consequences on public opinion. Firstly, this high cost prevents the widespread uptake of renewable energy systems in spite of their environmental soundness. Consequently if there is not an actual willingness to pay of consumers, there is need of public funding in order to support RES development. Secondly, if consumers regard some environmental problems as important and think that promoting RES use will mitigate environmental damages, they are likely to attach a value to these RES. Therefore, insofar as consumers think positively of renewable energy technologies, this attitude will influence their willingness to pay (WTP), augmenting the premiums they are potentially apt to pay for such new technology and consequently will, potentially, reduce the needed amount of public funding.

Currently the world demand for energy is about 12 billion tones of oil equivalent per year. The future demand for energy is certainly related to population growth and increase in per capita consumption in the various continents. It is also expected that the economic recovery over the next few years should encourage comeback of world energy consumption to previous growth path. In the long run, according to the IEA reference scenario (World Energy Outlook 2009), global demand for energy is expected to grow at an average annual rate of 1,5% during the period 2007-2030, corresponding to an overall increase about 40%.

Regarding the energy scenario, the Italian political and institutional decision making has followed always the policy objectives of the European Union: with the reference to "renewable" EU Directive 2001/77/EC, the Italian goal for 2010 was set to reach 22% in electricity production from

[1] The problem of climate change is a typical public good financing trade-off problem: it requires the imposition of immediate and painful private costs in exchange for uncertain future public benefits.

renewable sources. The EU Directive 2009/72/CE, named “Climate and energy package” sets forth new targets for 2020 (known as “20-20-20”), indicating as new goals 20% of emission reduction, 20% of total energy satisfied by renewable resources, 20% of energy savings. Italian goal is to attain the share of 17% in RES. To make investment in renewable attractive, the market price has to be higher than price of alternative fossil fuels, because it takes into account the “benefit shadow” of better environmental impact. In this case the gap between private and social costs of renewable, has to be filled with “coercive” tools, such as taxes, subsidies and a complex body of administrative regulation. In a perfect environment, with full information and no constraints on government tax policy, the strategy to switch to the use new energy resources consists in setting up a Pigouvian tax[2], a tax levied on usage of fossil fuels, which is tantamount to taxing the relative pollution. In this way, there is incentive to reduce fossil fuel usage and therefore emissions. Tax revenue can be used to support new resources investment. This is the carbon tax, so simple in theory and so unpopular in practice. In practice, support mechanisms for new energy resources are both price-oriented[3] or quantity-oriented[4]. Economic theory has already shown which is better; it depends on the relative variability, or uncertainty, of the expected costs and benefits. If there is relatively higher uncertainty about costs to implement new technologies, the price mechanisms are better. If there is higher uncertainty about benefits to be achieved, then quantity regulation is superior (Nordhaus 2001).

In Italy, support mechanisms are mixed and following the liberalization of the electricity market, they impose a burden on energy bill of families and businesses. The incentive mechanisms are based both on market regimes (such as the quantity oriented mechanism – “green certificates”) and administrative regimes (such as the price oriented mechanism – “feed in tariffs”, capital incentives, tax credit incentives). In particular, they are: a) incentive rates (CIP 6 / 92) for renewable and assimilated (before 1999); b) system of green certificates (CV) for renewable sources (since 1999); c) system of feed-in tariffs for renewable energy installations to power less than 1MW (200 kW for wind power) since 2005; - feed in premium for plants from solar and particularly for photovoltaic systems (since 2007); - capital grants (local) for some renewable (since 2003). However, taxes may

[2] A Pigouvian tax is a fee paid by the polluter per unit of pollution exactly equal to the aggregate marginal damage caused by the pollution when evaluated at the efficient level of pollution. The fee is generally paid to the government” (Kolstad, 2000).

[3] With regulatory price-driven strategies, financial support is given through investment subsidies, soft loans, tax credits, fixed feed-in tariff or a fixed premium which governments or utilities are legally obliged to pay for renewable energy produced by eligible firms (Green Certificates) or a premium for energy savings actions (White Certificates). In Europe most countries have adopted feed-in tariffs and Germany was the first to adopt this. In general, feed-in tariffs decrease over the years, in order to take into account technological learning curves. The criticisms made to the feed-in tariff scheme emphasize the fact that a system of fixed price levels is not compatible with a free market (Meyer, 2002).

[4] With regard to regulatory quantity-driven strategies, governments define the desired level of energy generated from renewable resources. An important policy is represented by the renewable portfolio standard (RPS), the main tool for implementing green energy in the US. The basic idea of the RPS is as follows: electricity suppliers (or electricity generators) are required to produce a minimum amount of green energy in their portfolio of electricity resources.

be socially and politically unacceptable, because they increase prices. So in such setting it has become crucial to explore the consistency of Italian consumer's WTP in order to use "green energy" in the electricity production. Coherently with the Italian energy scenario, previously sketched, the primary purpose of this study is to estimate consumers' WTP for the development of the RES use in Italy by using a bidding game (BG) method. This method allows to consider that consumers have, potentially, a range of economic values, or a valuation distribution in their mind instead of a single point economic value estimation. In our framework we obtain the consumer's WTP with two different elicitation approaches (downward vs. upward) and consequently our aim is twofold. First we focus mainly on the different elicitation formats and then we pay attention on the different uncertainty degree that affects respondents choices in a stochastic payment card format too. Finally we wish to estimate the market sustainability of the Italian goal in renewable electricity production. The setup of this paper is as follows: section 1 briefly reviews the theoretical background, section 2 shows the methodology, sets out some detail on survey design and on data description; section 3 refers to empirical study and presents results from regressions analysis; further discussion on the empirical results and their policy implications is provided in the final section.

1 Green energy and WTP: the state of the art

The Willingness to pay (WTP) is a method to determine the price of a good, when a market does not exist and therefore the price is unknown. This technique uses survey methods to try to determine the price that people are willing to pay for the good and, in this paper, is used to evaluate environmental benefits in financial terms when markets for environmental quality do not exist. In these cases, the necessary information to conduct cost-benefit analysis is not available, e.g. it is not possible to assess the values of renewable energy or pollution. Indeed, on the use of RES several surveys have been performed in the United States (Farhar, 1999; . Roe et al. 2001; Vossler et al. 2003) United Kingdom (Batley et al. 2001), Australia (Ivanova, 2005), Spanish (Alvarez-Farizo and Hanley, 2002) and Japan (Nomura and Akay 2004). As far as we know in Italy, only one survey Bollino and Polinori, 2006, 2007; Bollino, 2009) has been performed and data have been collected to draw suggestions about consumers energy sources preferences. Even if these studies are not very comparable because they differs in terms of: i) survey periods; ii) countries and institutional context; iii) survey typology; iv) elicitation formats, v) applied methodology and econometric techniques; it can be however useful to summarize their empirical results in order to be able to compare different results in terms of policy implications. Generally, prior studies founded a modest consumer's WTP if compared with the additional cost due to the National policy energy goal. This is one case, for instance, in Ivanova study (Ivanova, 2005) for Queensland and in Batley et al. (2001) economic analysis for UK. In detail, Ivanova analysis (Ivanova, 2005) is a traditional contingent variation surveying 820 respondents in the State of Queensland (Australia), via mail questionnaire, obtaining an overall response rate of 26%. Main objective is to use consumers WTP in order to evaluate market sustainability of the Federal Government Renewable Energy Target (RET), which sets minimum electric energy production share to be generated from RES. Results show that 65% of respondents are willing to pay 22 Australian Dollars per quarter, in order to increase RES use from 10 to 12%. This result, however, shows that Government RET target would not be attainable only with market approach. For U.K., Batley et al. (2001) report a relatively smaller WTP in their study performed via mail questionnaire (2.250 sent, in 1997, response rate 27,2%). Results show that 34% of respondents declares to be willing to pay and additional 16,6% of their actual expenditure, in order to have electricity from RES; according to authors, this is anyway insufficient to eventually achieve a national target of 10% production from RES. Many others studies in literature confirm these results. Nomura and Akay (2004) investigates WTP to increase electricity production from RES, via mail questionnaire (response rate 37%), in several Japanese cities (11 large metropolitan areas and numerous medium and small municipalities). Results estimate consumer WTP about 2 000 yen per month, one of the highest estimates relative to other studies conducted in Japan.

Finally also in Italy, recent estimates of WTP for RES are variable and show a range estimate between 24 and 54€ yearly per household (average Italian household size is roughly 3). Analysis has been conducted with payment card method, but estimated WTP almost doubles when using contingent valuation method (Bollino and Polinori, 2006; 2007; Bollino, 2009).

2 Method and data

In this study we consider Italian household as the typical consumers unit, i.e. households maximize utility subject to budget constraints. The demand for "RES use" can be viewed as any other good or service and therefore we model consumer choice within the utility (expenditure) maximization (minimization) framework. If we allow expenditure to be function of both "RES use" services (R) and a composite good (Z), subject to a utility constraint, we can write the following problem:

$$\text{Min } E(R, Z) \tag{1}$$

$$\textit{sub. to } U = U(R, Z). \tag{2}$$

thus, faced with expenditures for both "RES use" services (R) and a composite good (Z) subject to the utility constraint, the consumer will attempt to minimize the following expenditure function:

$$E^* = E(P_R, P_Z, U) \tag{3}$$

However, given the characteristic of RES it makes sense to think of this as a restricted demand problem where the consumer does not observe P_R and choose R, but rather is offered R and can choose to pay for it or not. Therefore, P_R is replaced with R and then we can rewrite the expenditure function as follows:

$$E^* = E(R, P_Z, U) \tag{4}$$

In this restricted case, the WTP for "RES use" is simply the difference between two expenditure functions with R1 > R0 and the compensating surplus welfare estimate can be derived from the following difference.

$$CS(W_0;W_1) = E(R_0, P_Z, U_0) - E(R_1, P_Z, U_0) \tag{5}$$

This estimate of compensating surplus is a measure of the WTP for "RES use" service. It is the amount that each Italian household is willing to give up and still remain at the previous utility level before the change. Obviously we can think of this WTP as a function of socio-demographic characteristics of respondents. Notice that in the previous literature, with partial exception of Bollino, 2009, this aspect has not been properly considered.

In a typical CV study a policy scenario is proposed to interviewees and their WTP to attain it is subsequently elicited. More specifically in our study, respondents were asked to consider the benefits to themselves of developing the RES use in Italy. Each respondent was confronted with a range of: (i) general questions concerning RES and their potential development; (ii) questions on knowledge about Italian energy system; (iii) money amounts (bids) in order to support RES development in Italy, ranking in **part I of the survey** from 5€ to 20€ per electricity bill, with (de)increments by 5€ and in **part II of the survey** from 0 € to up 200€ per electricity bill[5]. In detail the study designed is summarized in figure 1.

[Figure 1]

In order to derive actual estimates of WTP a national survey with 1.596 interviews was administrated at the end of November 2007[6], which is a very good period because before 2008-2009 financial crises alters the long run consumers perception. The stratified sample is representative of 46.8 million individuals, residents of Italy, and the survey was conducted by Istituto Piepoli[7].

Table 1 fully provides sample characteristics and it shows that the sample is highly representative of

[5] Respondents receveid a standard stochastic payment card with the full set of 17 prices (0, 0.05, 0.10, 0.15, 0.30, 0.50, 0.75, 1, 1.5, 2, 5, 10, 15, 20, 30, 50, 100, 200+ € per bill).

[6] A previous survey was conducted at the and of November 2006 by the same institution using only CATI method. Prelimianry results are discussed in Bollino 2009.

[7] Survey was not performed ad hoc. This Survey Company uses CATI and CAWI method to conduct a routinely week survey, and specific questions on environment were added to this survey; this last feature shows the high degree of accuracy in estimating Italian population socio-demographic characteristics because of large experience of interviewers. Author was able to interact with Survey staff, in order to define language of questionnaire. Full raw data set was transferred to author for this elaboration, so in principle no hidden non-stochastic distortion (such as recoding mistakes) should affect results.

Italian Population in terms of male-female ratio, geographical and urban location, demographic characteristics, education and income distribution.

[Table 1]

Figure 2 and table 2 show the statistics of “Knowledge variables”, reporting information on whether respondents have or have not a deep knowledge of the renewable energy taking in account the 2 subsamples (A, B) of the survey.

[Figure 2]

[Table 2]

In the overall sample more than 80% answered to have “good” knowledge of RES while 10-12% affirmed that they do not know them. It is important to underline that in the first group there isn’t only a general and shallow knowledge. Indeed, respondents that affirm to have this accurate knowledge are able to correctly identify different types of renewable energy sources in more than 80% of the cases. Among respondents, there are well known sources such as Solar power, Hydro and Wind Power while there is less knowledge about biomasses and Geothermal power.

Another important result concerns favourable attitude toward renewable energy sources that respondents express not only in ideological terms but also in term of strategic opportunity in the world energy uncertain scenario. Finally table 3 shows location and scale parameters of more important variables.

[Table 3]

The profile of the typical interviewee is a men aged 47, highly educated, married who lives in a family with one child. The family income is around 35 000 € and the family is home owner. About the topic of survey the interviewee believes that the Italian energy scenario will lot worse in the next ten years, he knows the RES, his knowledge is really accurate and he consider RES a strategic opportunity for Italy.

2.1 Elicitation format

In our analysis we adopted a “certainty correction method” proposing, in both parts of survey design, five types of acceptance intensity: “definitely yes” and “no” (DY, DN), “probably yes” and “no” (PY, PN) and “not sure or don’t know” (DK) . Figures 3 and 4 show, in detail, the structures of elicitation formats used in the survey. In line with any contingent valuation study, there is always a risk of incurring in potential bias. However, it has also been shown in the literature that a survey well-designed and carefully administered provides a consistent, sensible, and believable information on willingness to pay. In our design we account for addition one of the advantages of this data set is that we can formally test for differences across the formats to see if one or any of them is providing significantly different estimates of WTP. It is also important to underline that this data set can be useful handling in order to estimate other models.

[Figure 3]

[Figure 4]

In other words, in order to apply the quantitative analysis, the original dataset has been appropriately treated, recoding DK, PN and PY responses[8]. For example if the respondents is faced to 15 € in ascending format and his answer is PY while the answer is DK or PN or DN when he is faced to 20 € we assume that the responses likelihood answers is: 5 (100%); 10 (100%); 15 (75%); 20 (50% or 25% or 0%). Similarly if the respondent is faced to 10 € in descending format and his answer is PY, after two PN responses, we assume the following likelihood answers: 20 (25%); 15 (25%); 10 (75%); 5 (100%).

3 Empirical findings –First results-

3.1 Part I: Willingness to pay

Before presenting the results of regression analysis, it is useful to look first at some non-parametric analysis of willingness to pay. Preliminary results of the bidding game survey are presented in Figure 5. In the first sub sample, respondents are faced with downward order. We notice that 33% of respondents are willing to pay a 20 euro increase in the cost of electricity bill, 38% would accept to pay 15 €, 49% have a WTP equal to 10 euro per a bill while 62% willing to pay no more than 5 €. In the second sub-sample respondents are faced with upward order. In this case 61% have a WTP equal to 5€, 30% are willing to pay 15 € per bill the electricity produced by RES while 14% are willing to pay 15 €. Finally, only 9% would accept to pay 20 euro.

[Figure 5]

Figure 5 shows that as we move from 5€ to 10€ the percentage decrease of 31% while when we move from 10 to 5 € the percentage increase only of 13%. In the next step the difference between the two format is smaller. When we move in ascending format from 10 € to 15 € the percentage decrease of 16% while when we move from 15 to 10 € the percentage increase of 11%. Finally the percentage decreases of 5% when we move from 15€ to 20€ and similarly the percentage increase of the same amount when we move from 20 € to 15€ in ascending order. In order to investigate the elicitation effect we also perform an proportion test; indeed if answers are truthful and free of psychological bias the expectations is:

$$P(Yt|Asc) - P(Yt|Desc) = 0 \qquad (6)$$

[8] Model A: DY as yes - PY, DK, PN as DK - DN as no. Model B: DY and PY as yes; DN and PN as no. Model C no treatment. Model D: DY as yes others as no. Model E: DY and PY as yes others as no. Model F: DY, PY and DK as yes others as no.

where P(Yt|Asc) is the probability of Yes at t bid in ascending order and P(Yt|Desc) is the Yes probability at t bid in descending order.

In other words under the H_0 there is the same proportion of respondents in each of five intervals without regard the bid sequence. Tables 4 and 5 show that it is necessary to reject H_0 in several cases coherently with others researches.

[Table 4]

[Table 5]

The results confirm that with a few rare exceptions there are always different proportions, consequently exist path dependences in WTP estimate. A great deal of literature has emerged concerning how to calculate overall WTP. Turnbull (1976) originally utilized a measure that provides a lower bound mean (LBM) estimate of WTP that is calculated as follows:

$$LBM = \pi_0(p_0) + \sum_{i=1}^{m} \pi_i(p_i - p_{i-1}) \tag{7}$$

Later Kristrom (1990) recommended a method that offers a higher estimate of WTP for any given data set that is probably more realistic than Turnbull. The Kristrom mean (KM) is defined as:

$$KM = LBM + \frac{1}{2}p_0(1-\pi_0) + \sum_{i=1}^{m}\frac{1}{2}|\pi_i - \pi_{i-1}|(p_i - p_{i-1}) + \frac{1}{2}\pi_k(p^* - p_k) \tag{8}$$

where π_i are the percentages who support a given bid p_i; m is the numbers of bid offered after the initial bid p_0 and p* is the estimated bid price where π falls to zero.

Both Turnbull and Krinstrom measures utilize the data from the survey in order to obtain WTP estimates; table 6 shows the results. We can see that it is the descending bid dichotomous choice format that provides the highest WTP and the highest variance around the mean, while the ascending formats and full sample display enough close mean WTP and standard deviations around the respective means.

[Table 6]

One of the benefits of this type of analysis is that it helps to hypothesize about expected results from the follow regression analysis. It should come as no surprise that the WTP from descending bid format would have a higher value. These preliminary and descriptive results confirm many previous results (Vossler et al., 2003; Wang and Whittington, 2005; Welsh and Poe, 1998) that underline how the choice of elicitation method can significantly influence estimates.

3.2 Part I: Regression analysis

In order to isolate the effect of the two elicitation procedures on the estimated mean WTP in the first part of the survey we conducted additional analyses in which we treated the data obtained from the bidding game at a specific price, from 5 to 20, as if it was the individual's answer to a single referendum question. A new data set was thus constructed by randomly assigning a price to each respondent and these new data were then analyzed applying dichotomous choice models and ordered models. Table 7 shows estimate results, for brevity we report only ascending elicitation and full sample results.

[Table 7]

Table 7 shows that the highest mean WTP obtained is 9.39 € with confidence interval of [9.24 – 9.50], when DY, PY and DK are all treated as DY responses in a referendum model. This estimated mean WTP is not so much higher than the estimate obtained using "no treated" data, 9.19 €, with a confidence interval of [9.10 – 9.30]. This analysis confirms that the difference in the mean WTP estimates obtained from the different methods is largely due to the elicitation procedure.

3.3 Part II: WTP and Regression analysis

In order to partially avoid the problem that WTP can be sensitive to the elicitation format, we conducted a second step in which we propose a stochastic payment card approach to respondents. Indeed, the payment card method is consistent with important guidelines (e.g. U.K. Government guidelines) and also many scholars assert that this method could be more intensively employed in CV studies (Champ et al. 2003; O'Garra and Mourato 2007; Atkinson et al. 2005).

Details of the WTP responses are presented in table 8. The first column labeled WTP refers to the amount (from lowest to highest) that consumers would be willing to pay to use RES while the second one labeled "frequency" provides detailed information on how consumers are willing to pay to reduce harmful emissions and to conserve resources. The third column labeled "cumulative" reports the number of consumers who were willing to pay at least the indicated amount. The forth column "survival" describes the percentage of the sample at each value on the payment card who were willing to pay at least the indicated amount.

[Table 8]

As expected, results show that the proportion of respondent who are willing to pay decreases with the amount presented and the proportion is larger when "yes category" includes also PY and DK responses. (as shown in graph 1). This is especially evident at the rightmost end of the tail, for amounts greater than 20 euro.

[Graph 1]

Payment card data may be analyzed in several ways and in particular it is possible to treat the data as interval data because respondents maximum WTP may lie between the value recorded on the card and the higher value of the next card. Consequently we use parametric interval regression method. Following Cameron and Huppert (1989) the WTP probability associated with the choice of the respondents is:

$$P(t_{1i}) = P(t_{1i} \leq WTP < t_{ui}) \tag{8}$$

Since WTP is non-negative and its distribution is skewed we use a lognormal conditional distribution:

$$\log WTP_i = x_i^{'}\beta + \varepsilon_i \tag{9}$$

where ε_i is distributed normally, with zero mean and standard deviation σ. Probability of choosing t_{1i} can be written:

$$P(t_{1i}) = \Phi((\log t_{ui} - x_i^{'}\beta)/\sigma) - \Phi((\log t_{1i} - x_i^{'}\beta)/\sigma) \tag{10}$$

where Φ is the standard normal cumulative density function. The corresponding log likelihood function can be written:

$$\log L = \sum_{i=i}^{T} \log[(\Phi((\log t_{ui} - x_i^{'}\beta)/\sigma) - \Phi((\log t_{1i} - x_i^{'}\beta)/\sigma)] \tag{11}$$

We have estimated the optimal values of β and σ, mean and median WTP (Cameron and Huppert, 1989; Hanemann W.M. and Kanninen B. 1999).

$$medianWTP = \exp(x_i^{'}\beta) \tag{12}$$

$$meanWTP = \exp(x_i^{'}\beta)/\sigma) - \exp(\sigma/2)] \tag{13}$$

and we have computed confidence interval according to Krinsky and Robb's simulation model. Table 9 contains the results of econometric models that confirm prior expectations.

A relevant finding is that the knowledge of RES affects the WTP so as the conviction that RES could play an important role in Italian energy future; both parameters of variables "Know RES" and "Scenario" are indeed highly significant in the firsts two models. Higher level of education and better occupation which proxies higher income are associated, coeteris paribus, with ~~an~~ higher WTP.

We notice that there exists a clear gender difference in the WTP; in fact, men are willing to pay less if compared with women and this result characterizes all three estimated models. The same marked difference holds for older respondents compared to younger ones: it is this latter category that exhibit a higher WTP.

Residents in North and Center Italy exhibit a higher WTP to support the renewable energy diffusion while people who live in municipality greater than 100000 inhabitants are willing to pay less to achieve the same aim if compared with the small towns residents. In term of household characteristics, family size is seen to negatively influence WTP in all the models considered. Finally the variable labeled "acting consistently"[9] in the procedure of response to the questionnaire has a negative influence on the WTP. This is an interesting result that captures unobservable individual characteristics which could be referred to the honesty of respondents.

[Table 9]

Based on the estimated parameters and of the equations (12) and (13) is it possible to compute mean and median WTP of the second sub-sample, which are shown in table 10, together with some policy implications. In table 10 we show the individual household mean WTP and we compute the total WTP for Italy, comparing it with an estimate of the total annual subsidy needed in Italy to comply with the UE climate change package for year 2020. We can see that a measre of the market sustainability of RES , i.e. the cover capacity range, lies between 13% and 37%, according to different estimation models, but a typical result is around 25% of the annual cost if we consider the WTP estimated using the full sample. Lastly, it is interesting to notice that the difference between the Third model and the Conservative model (only DY 0 yes), is 19% of the cover capacity of annual subsidy cost.

[Table 10]

Conclusions

Concerning policy implication, in previous analysis (Bollino and Polinori, 2006; 2007; Bollino, 2009) the findings support the view that in Italy there is some consensus on the development of RES. In monetary value, this consensus is estimated as 35% of the total subsidy cost. In this paper we use more than one econometric procedure in order to obtain more robust statistical results and, consequently, more relevant policy indication too. Firstly we found a significant path dependences in respondents answers due to the elicitation formats. Another important result concern that also in conservative way we found a substantial willingness of consumers to partially cover the cost of RES goal.

References

B. Alvarez-Farizo and N. Hanley, Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain, *Energy Policy,* vol. 30, pp. 107-116, 2002.

S.L. Batley, D. Colbourne, P.D. Fleming and O. Urwin Citizen versus consumer: challenges in

[9] The dummy variable "Consistency" is defined to compare responses to the two questions on the degree of knowledge about RES. If the interviewee answers yes (or no) to first question and correctly (or incorrectly) identifies the different types of RES in the second question the dummy variable is equal to one, zero otherwise.

the UK green power market, *Energy Policy,* vol. 29 pp. 479-487, 2001.C.A. Bollino, The willingness to pay for renewable energy souces: the case of Italy with Socio Demographic determinants, *The Energy Journal,* vol. 30, pp. 81-96, 2009

C.A. Bollino and P. Polinori, An assessment of consumer willingness to pay for Renewable Energy Sources use in Italy: a payment card approach, 26th USAEE/IAEE North American Conferences "Energy in a Word of Changing Costs and Technologies", Ann Arbor – Michigan – USA, September 24-27, 2006.

C.A. Bollino and P. Polinori, How much Italians are willing to pay for Renewable Energy Sources. A comparison of two methodological approaches, 30th Conference OAEE/IAEE, "From Restructuring to Sustainability: Energy Policies for the 21st Century", Wellington, New Zealand 18-21 February, 2007.

B.C. Farhar, WTP for electricity from renewable resources: a review of utility market research, *NREL WP,* n. 550.26148, 1999.

M. Genius and E. Strazzera, Modelling elicitation effects in contingent valuation studies, in Scarpa R. – Alberini A. (eds.) Application and Simulation Methods in Environmental and Resources Economics, Springer, Dordrecht,chap. 12, pp. 223-246, 2005.

G. Ivanova, Queensland Consumers' Willingness to Pay for Electricity from Renewable Energy Sources, Australia New Zeland for Ecological Economics, (anzsee2005papers), 2005.

B. Kristrom, 1990, A Non-Parametric Approach to the Estimation of Welfare Measures in Discrete Response Valuation Studies, *Land Economics,* vol. 66, n. 2, pp. 135-139, 1990.

N. Nomura, and M. Akay, WTP for green electricity in Japan as estimated through contingent valuation method, *Applied Energy,* vol. 78, pp. 453-463, 2004.

E. Mentzakis, M. Ryan, M. and P. McNamee Incorporating uncertainty into payment card contingent valuation. http://www.economics.mcmaster.ca/faculty/mentzak (last visit 2/5/2011).

B. Roe, M. Teisl, A. Levy and M. Russel, US consumers' WTP for green electricity, *Energy policy,* 29, 917-925, 2001.

B.W. Turnbull, The Empirical Distribution Function with Arbitrary Grouped, Censored and Truncated Data, *Journal Royal Statist. Soc. Ser. B,* vol. 38, pp. 290-295, 1976.

C.A. Vossler, R.G. Ethier, G.L. Poe and M.P. Welsh, Payment certainty in discrete choice Contingent Valuation responses: result from a field validity test, *Southern Economic Journal,* vol. 69, n.4, pp. 886-902, 2003. H. Wang,

H. Wang and D. Whittington, Measuring individuals' valuation distribution using stochastic payment card approach, *Ecological Economics,* vol. 55, pp. 143-154, 2005.

M.P. Welsh and G.L. Poe, Elicitation effects in Contingent Valuation: comparisons to a multiple bounded discrete choice approach, *Journal of Environmental and Management,* vol. 36, pp. 170-185, 1998.

Figure 1: valuation study design

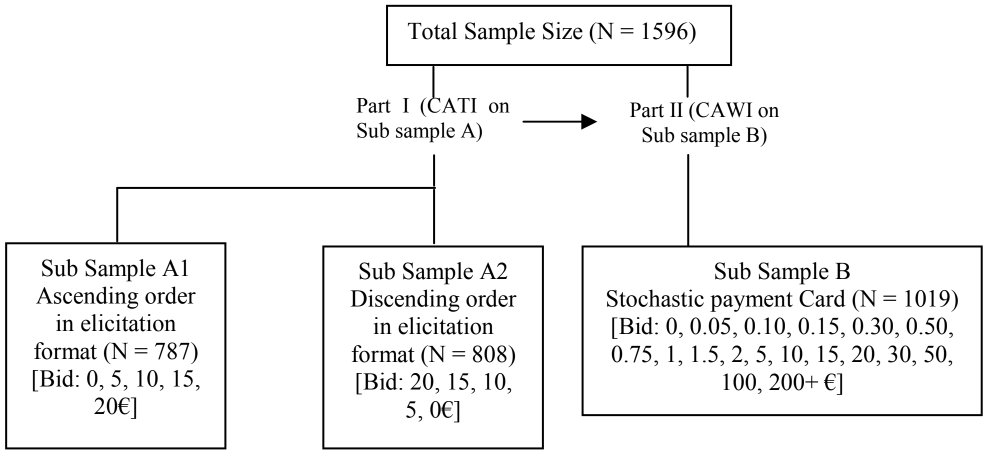

Table 1: Survey respondent (1596 Obs.) and Country (Italy) resident characteristics

Variables	Survey Respondents	Country Residents
- Gender [(a)]		
Male	47.78%	48.40%
Female	52.22%	51.60%
- Macro regions [(a)]		
North-West	26.11%	26.21%
North-East	19.69%	18.66%
Center	19.64%	19.14%
South (with Sic, Sar)	34.55%	36.00%
- Municipality size[(a)]		
≤ 5000	17.47%	18.58%
5001- 10000	13.67%	14.11%
10001 - 30000	23.69%	22.81%
30001 - 100000	21.96%	21.29%
100001 - 500000	11.65%	10.98%
> 500000	11.55%	12.23%
- Age[(a)]		
15-17	3.55%	3.54%
18-24	9.92%	9.53%
25-34	16.78%	17.98%
35-44	18.85%	17.77%
45-54	16.68%	15.52%
55-64	14.36%	13.89%
> 64	19.84%	21.77%
- Marital status[(a)]		
Single	27.99%	27.76%
Divorced	1.14%	1.23%
Separeted	1.58%	1.92%
Married or Cohabiting	61.75%	61.19%
Widowed	6.71%	7.90%
Status not response	0.84%	---
- Education[(a)]		
None and Primary School	33.50%	31.16%
Secondary School and Professional training	35.60%	32.50%
High School	23.90%	29.30%
University or /and higher degree	7.00%	7.04%
- Income (€)[(b)]		
Mean	28658.80	24893.70
Centili - 10%	9822.22	8918.90
25%	14801.18	13175.46
50%	24682.57	20152.32
75%	34088.30	30998.86
90%	47981.99	44049.82
- Professional status[(a)]		
Enterpreneurs		1.36%
Professional class	6.32%	1.83%
Cooperative members		1.36%
Self employed	5.70%	6.92%
Civil servant and earning employee	33.27%	31.45%
Unemployed workers	4.05%	5.62%
Students	12.44%	11.34%
Housewifes	13.38%	15.30%
Pensioners	23.89%	20.64%
Others	0.96%	4.17%
- Household size[(a)] *(members)*		
1	10.71%	24.89%
2	23.20%	27.08%
3	23.74%	21.58%
4	32.03%	18.96%

5	8.49%	5.80%
6 or more	1.83%	1.69%

Figure 2: Knowledge of RES

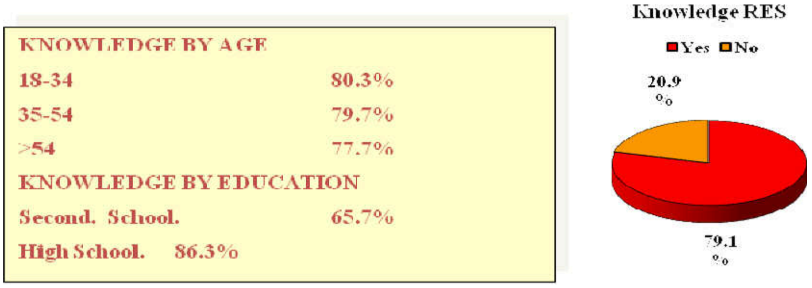

Table 2: attitudinal, and behavioural variables		
Answers	Sample A (1595 Obs.)	Sample B (1019 Obs.)
Knowledge of the type of RES		
knowledge not response	12.35%	10.47%
correct	81.13% [(a)]	82.21% [(c)]
wrong	6.52% [(b)]	7.31% [(d)]
Are you for or against the development of RES ?		
complitely in fovour	59.47%	58.88%
quite in favour	29.59%	31.85%
uncertain	8.97%	7.69%
quite opposed	0.89%	0.89%
complitely opposed	1.08%	0.49%
In your view, the development of RES in Italy will improve or worsen the current Italian energy situation?		
improve a lot	46.06%	44.38%
improve a little	37.18%	42.11%
have no effect	13.02%	8.88%
To worsen a little or a lot	3.75%	4.44%
Italy has to increase by 2010 production of energy from RES to 22% (today it is 15%). Do you agree?		
yes complitely	54.6%	54.3%
yes partially	27.4%	30.7%
little in agree	8.9%	8.2%
no	2.4%	2.5%
no response	6.7%	4.1%

[(a)] 0.46 photovoltaic,0.12 windenergy,0.08 hydropower
[(b)(d)] 0.05 nuclear,0.02 oil
[(c)] 0.43 photovoltaic,0.15 windenergy,0.09 hydropower

Table 3: Descriptive Statistics RHS variables				
Variable	Sub Sample A		Sub Sample B	
	Mean	St. Dev.	Mean	St. Dev.
Income (000)	35.049	11.897	34.820	11.996
Geo5	2.789	1.366	2.745	1.386
City	2.377	1.187	2.394	1.192
Sex	1.485	0.500	1.521	0.500
Age	47.653	17.543	46.299	17.915
Professional Status	5.983	3.316	6.028	3.236
High Education	0.495	0.500	0.462	0.499
Scenario	0.031	0.174	0.039	0.195
Know RES	0.239	0.180	0.232	0.181
Househ. Size	3.177	1.233	3.131	1.218

Consistency	0.309	0.462	0.329	0.470
	N. = 1596		N. = 1019	

Figure 3: Elicitation format

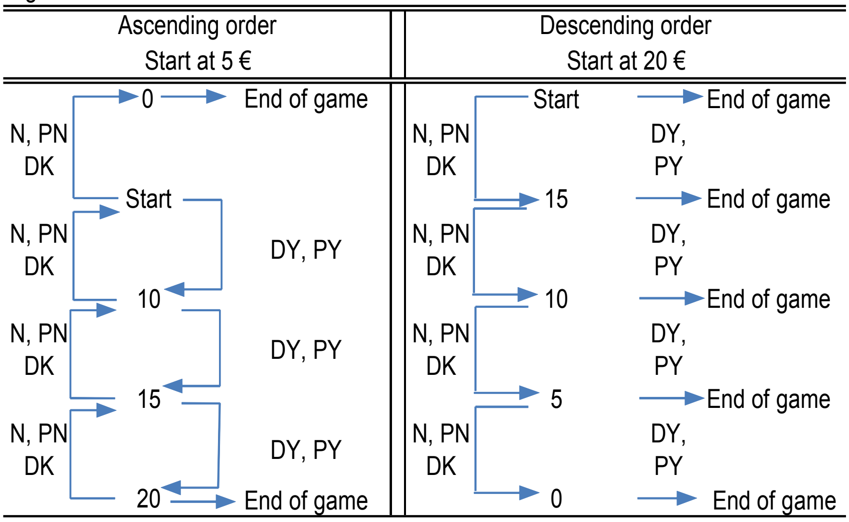

Figure 4: Instruct the respondent to circle an answer for each of 17 prices					
Bid (€)	DN	PN	DK	PY	DY
0	0%	25%	50%	75%	100%
0.05	0%	25%	50%	75%	100%
0.1	0%	25%	50%	75%	100%
0.15	0%	25%	50%	75%	100%
0.3	0%	25%	50%	75%	100%
0.5	0%	25%	50%	75%	100%
0.75	0%	25%	50%	75%	100%
1	0%	25%	50%	75%	100%
1.5	0%	25%	50%	75%	100%
2	0%	25%	50%	75%	100%
5	0%	25%	50%	75%	100%
10	0%	25%	50%	75%	100%
15	0%	25%	50%	75%	100%
20	0%	25%	50%	75%	100%
30	0%	25%	50%	75%	100%
50	0%	25%	50%	75%	100%
100	0%	25%	50%	75%	100%
200+	0%	25%	50%	75%	100%

Figure 5: the descriptive results of the survey (Part I).

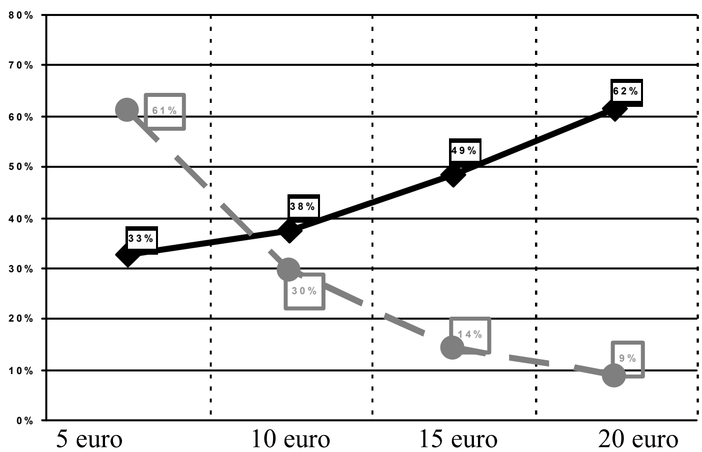

Table 4: Proportions test -Case I: Overall proportions-				
Models	Var.	Mean	Std. Er.	Sign.
D	***Pro(Y/As)***	***0.1308***	***0.0060***	
	Pro(Y/Ds)	***0.1408***	***0.0061***	
	Diff. In Prob	***-0.0099***	***0.0086***	
	H0	***Diff=0***		***n.s.***
E	Pro(Y/As)	0.2847	0.0080	
	Pro(Y/Ds)	0.4489	0.0087	
	Diff. In Prob	-0.1643	0.0119	
	H0	Diff=0		***
F	Pro(Y/As)	0.3241	0.0083	
	Pro(Y/Ds)	0.4824	0.0088	
	Diff. In Prob	-0.1583	0.0121	
	H0	Diff=0		***

Note: .01 - ***; .05 - **; .1 - *; Mod D: Yes = DY;
Mod. E: Yes = DY + PY; Mod. F: Yes = DY + PY + DK

Table 5: proportions test -Case II: Single bid proportions-

Models	Bids	Var.	Mean	Std. Er.	Sign.
D	5	Pro(Y/As)	0.3064	0.0164	
		Pro(Y/Ds)	0.1795	0.0135	
		Diff. In Prob	0.1270	0.0212	
		H0	Diff=0		***
D	***10***	***Pro(Y/As)***	***0.1299***	***0.0119***	
		Pro(Y/Ds)	***0.1411***	***0.0122***	
		Diff. In Prob	***-0.0112***	***0.0171***	
		H0	***Diff=0***		***n.s.***
D	15	Pro(Y/As)	0.0530	0.0080	
		Pro(Y/Ds)	0.1225	0.0115	
		Diff. In Prob	-0.0696	0.0140	
		H0	Diff=0		***
D	20	Pro(Y/As)	0.0340	0.0064	
		Pro(Y/Ds)	0.1200	0.0114	
		Diff. In Prob	-0.0860	0.0131	
		H0	Diff=0		***
E	***5***	***Pro(Y/As)***	***0.6129***	***0.0173***	
		Pro(Y/Ds)	***0.6126***	***0.0171***	
		Diff. In Prob	***0.0002***	***0.0243***	
		H0	***Diff=0***		***n.s.***
E	10	Pro(Y/As)	0.2963	0.0162	
		Pro(Y/Ds)	0.4827	0.0176	
		Diff. In Prob	-0.1863	0.0239	
		H0	Diff=0		***
E	15	Pro(Y/As)	0.1412	0.0124	
		Pro(Y/Ds)	0.3738	0.0170	
		Diff. In Prob	-0.2325	0.0210	
		H0	Diff=0		***
E	20	Pro(Y/As)	0.0883	0.0101	
		Pro(Y/Ds)	0.3267	0.0165	
		Diff. In Prob	-0.2385	0.0193	
		H0	Diff=0		***
F	**5**	***Pro(Y/As)***	***0.649433***	***0.016944***	
		Pro(Y/Ds)	***0.644802***	***0.016836***	
		Diff. In Prob	***0.004631***	***0.023886***	
		H0	***Diff=0***		**n.s.**
F	10	Pro(Y/As)	0.3417	0.0168	
		Pro(Y/Ds)	0.5099	0.0176	
		Diff. In Prob	-0.1682	0.0244	
		H0	Diff=0		***
F	15	Pro(Y/As)	0.1803	0.0137	
		Pro(Y/Ds)	0.4109	0.0173	
		Diff. In Prob	-0.2306	0.0220	
		H0	Diff=0		***
F	20	Pro(Y/As)	0.1248	0.0117	
		Pro(Y/Ds)	0.3639	0.0169	
		Diff. In Prob	-0.2390	0.0206	
		H0	Diff=0		***

Notes: .01 - ***; .05 - **; .1 - *; Mod D: Yes = DY;
Mod. E: Yes = DY + PY; Mod. F: Yes = DY + PY + DK

Table 6: WTP non parametric estimate (€ per a bill)

Method		Discending	Ascending	Full Sample
LMB	Mean	4.25	3.27	3.47
	St. dev	*3.68*	*2.31*	*2.79*
KM	Mean	7.36	5.67	6.01
	St. dev	*6.37*	*4.00*	*4.83*

Table 8: Details of payment responses									
Bid (€)	DY as yes			Dy and PY as yes			DY, PY and DK as yes		
	Freq.	Cumul.	Surviv.	Freq.	Cumul.	Surviv.	Freq.	Cumul.	Surviv.
0	63	1019	1.000	48	1019	1.000	48	1019	1.000
		956	0.938		971	0.953		971	0.953
0.05	34	922	0.905	0	971	0.953	0	971	0.953
0.1	0	922	0.905	0	971	0.953	0	971	0.953
0.15	19	903	0.886	48	923	0.906	48	923	0.906
0.3	82	821	0.806	0	923	0.906	0	923	0.906
0.5	0	821	0.806	0	923	0.906	0	923	0.906
0.75	61	760	0.746	64	859	0.843	64	859	0.843
1	58	702	0.689	59	800	0.785	59	800	0.785
1.5	19	684	0.671	53	747	0.733	53	747	0.733
2	136	547	0.537	92	655	0.642	33	714	0.700
5	107	440	0.432	29	626	0.614	55	658	0.646
10	166	274	0.269	323	303	0.297	264	395	0.387
15	111	163	0.160	108	194	0.191	117	277	0.272
20	141	21	0.021	151	43	0.042	156	121	0.119
30	16	5	0.005	32	11	0.011	97	24	0.024
50	3	3	0.002	4	8	0.007	5	19	0.019
100	1	1	0.001	3	5	0.005	4	15	0.015
200+	0	1	0.001	4	1	0.001	9	6	0.006

Graph 1 WTP relative frequencies

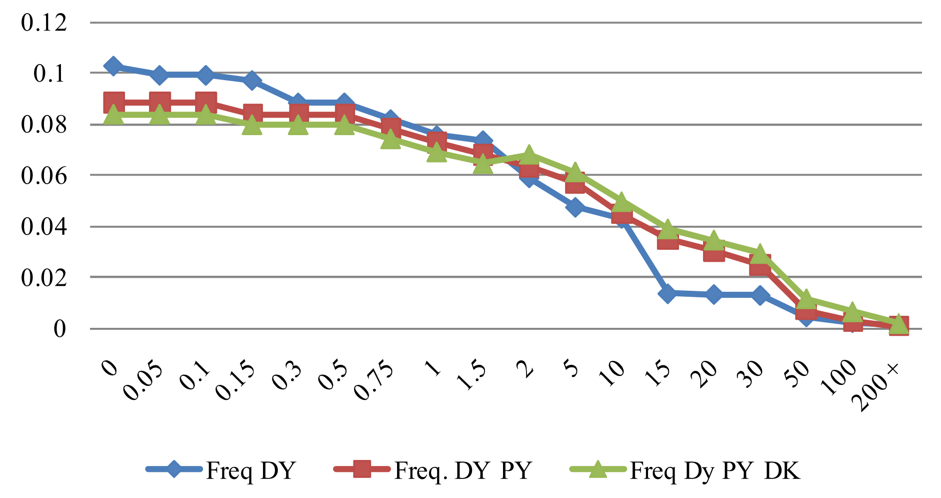

Table 9 Interval data for WTP support introduction of RES in Italy

Variables	(I) DY as yes		(II) PY as yes		(III) DK as yes	
Income (000)	0.0636		0.0499		0.0479	
	(0.0081)	***	(0.0086)	***	(0.0090)	***
Geo5	0.1620		0.1219		0.1522	
	(0.0469)	***	(0.0500)	**	(0.0532)	***
City	-0.0755		-0.0928		-0.1251	
	(0.0498)		(0.0522)	*	(0.0544)	**
Sex	-0.2879		-0.2651		-0.3159	
	(0.1180)	**	(0.1246)	**	(0.1307)	**
Age	-0.2660		-0.2029		-0.2281	
	(0.0458)	***	(0.0497)	***	(0.0518)	***
Professional Status	0.1062		0.0933		0.0725	
	(0.0221)	***	(0.0241)	***	(0.0250)	***
High Education	0.1915		0.0661		0.0689	
	(0.1161)	*	(0.1229)		(0.1292)	
Scenario	-0.6978		-0.6232		-0.1382	
	(0.3292)	**	(0.3090)	**	(0.3185)	
Know RES	0.5772		0.6877		0.4341	
	(0.3366)	*	(0.3485)	**	(0.3732)	
Househ Size	-0.2689		-0.1922		-0.2298	
	(0.0628)	***	(0.0686)	***	(0.0726)	***
Consistency	-0.3039		-0.3134		-0.2324	
	(0.1263)	**	(0.1292)	**	(0.1355)	*
Constant	0.6994		1.2600		2.0909	
	(0.4311)		(0.4497)	***	(0.4619)	***
/lnsigma	0.5640		0.4885		0.5725	
	(0.0228)		(0.0254)		(0.0244)	
sigma	1.7577		1.6299		1.7727	
	(0.0400)		(0.0414)		(0.0433)	
Obs.	1019		1019		1019	
McKelvey and Zavoina's R2	0.106		0.094		0.118	
LR chi2(11)	117.49		103.83		134.25	
median WTP	5.05		7.06		9.95	
[95% Conf. Interval]	[3.12 - 6.34]		[5.42 - 8.39]		[8.23 - 11.79]	
mean WTP	12.16		15.95		24.14	
[95% Conf. Interval]	[10.25 - 13.94]		[13.72 - 18.39]		[22.23 - 26.79]	

Table 10: Policy implications Sub Sample B						
Mean/Median WTP (Euro)		Annual electric bill (Nr.)	Households (Nr.)	Total annual WTP (Euro)	Annual subsidy cost (Euro)	Market sustainability of RES (%)
A) Payment card methods						
1a) No parametric computation						
LBM	3.47			454,098,274		12.97%
KM	6.01	6	21,810,676	786,492,977	3,500,000,000	22.47%
2a) Parametric estimation						
Interv. Data Regr. (I) model	5.05			660,863,483		18.88%
Interv. Data Regr. (II) model	7.06			923,900,235		26.40%
Interv. Data Regr. (III) model	9.95			1,302,097,357		37.20%