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Abstract Renewable energy sources have a critical role to play in contributing to the diversity, sustainability and security of energy supplies. The main objectives of the paper is to gain an understanding of UK households' preferences for the type of mechanism that is used to support renewables. Two self-designed contingent valuation method (CVM) surveys are used to explore whether the type of payment option has an impact on households' willingness to pay for increasing share of renewable energy in electricity generation. The paper also investigates whether the type of payment mode affects respondents' self-reported certainty of paying their stated valuations.The results indicate that the likelihood of paying a positive amount for supporting renewable energy is higher under a mandatory scheme compared to a voluntary payment option in the UK. Respondents have a higher level of certainty in paying their stated WTP under a mandatory payment scheme.

Keywords Contingent Valuation Method, Payment Method, Renewable Energy, Green Tariffs, Willingness to Pay, Zero Inflated Ordered Probit Model

JEL Classification C35, D10, D12, D80

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Mandatory vs Voluntary Payment for Green Electricity

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August 27, 2013

Abstract

Renewable energy sources have a critical role to play in contributing to the diversity, sustainability and security of energy supplies. The main objectives of the paper is to gain an understanding of UK households' preferences for the type of mechanism that is used to support renewables. The paper analyses households' preferences and willingness to pay under a mandatory scheme where everyone contributes compared to a voluntary scheme where only those who want to pay to support renewables can do so (such as the green tariffs offered by electricity suppliers in the UK). Two self-designed contingent valuation method (CVM) surveys are used to explore whether the type of payment option has an impact on households' willingness to pay for increasing share of renewable energy in electricity generation. The paper also investigates whether the type of payment mode affects respondents' self-reported certainty of paying their stated valuations. The results indicate that the likelihood of paying a positive amount for supporting renewable energy is higher under a mandatory scheme compared to a voluntary payment option in the UK. Respondents have a higher level of certainty in paying their stated WTP under a mandatory payment scheme.

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1 Introduction

One of the key challenges currently facing the UK is to increase the share of renewable energy in electricity generation in order to meet ambitious energy and environmental targets. Renewable energy sources have a critical role to play in contributing to the diversity, sustainability and security of energy supplies. They are central to meeting the UK government's target of generating 15 per cent of energy from renewables by 2020. In 2011, only 3.8 per cent of UK's total energy consumption and 9.4 per cent of UK electricity came from renewable sources (DECC, 2012). The Government faces the formidable challenge of delivering a large increase in UK renewable electricity generation if it is to meet its targets. Due to the higher costs and investment involved in developing and applying renewable energy technology, the targets are unrealistic without regulatory support for their uptake. With this background it is particularly important to consider the type of support mechanism that UK households prefer.

This paper uses two self-designed contingent valuation method (CVM) surveys to explore whether the type of payment option has an impact on households' willingness to pay for increasing share of renewable energy in electricity generation. The surveys seek to measure WTP under mandatory and voluntary payment schemes. To date, only two studies have addressed this issue and they reach the opposite conclusions. Wiser (2007) finds that WTP is higher under a mandatory scheme than under a voluntary one in the United States, whereas in Queensland Australia, Ivanova (2005) finds that WTP for renewable energy is higher under a voluntary scheme. No such study has previously been conducted in the UK.

The research also seeks to add to the literature on CVM since the payment vehicle is a crucial element in contingent valuation surveys. Similar to other aspects of the CVM scenario, the type of payment method can affect the respondent's responses to the elicitation question. There have been numerous studies that analyse the effects of different valuation questions, i.e. open-ended compared to closed-ended or payment card versus dichotomous choice. However, there are relatively few studies that compare different payment vehicles. The aim of this paper is to add to the literature by exploring the sensitivity of CVM valuations to the selected payment mode in the case of valuation of electricity generated from renewables and whether these preferences change over time.

The effects of socioeconomic, demographic and attitudinal variables on willingness to pay for renewable energy is also explored. This analysis helps increase the understanding of who is and is not willing to pay for renewable energy under different payment provision contexts. The paper also investigates whether the type of payment mode affects respondents' self-reported certainty of paying their stated valuations.

In summary, the research questions addressed by this paper are as below.

1) Do UK households prefer voluntary or mandatory support mechanisms for re-

newable energy? Do these preferences change over time?

2) Does willingness to pay differ under a mandatory payment method compared to a voluntary payment option?

3) What socio-economic, attitudinal and behavioural characteristics affect WTP for renewables?

4) Does the type of payment method have an impact on the certainty of respondents paying their stated WTP?

In order to address these questions, two self-designed surveys were conducted. The first survey was run in October 2008 and a follow up survey was conducted in December 2009. For both surveys, half the sample was asked their valuation of electricity from renewables under a mandatory scheme while the other half of the sample was presented with a voluntary option.

The paper is structured in seven sections. The background on the role of renewables in the UK electricity generation mixture and a summary of previous findings on WTP for renewables is developed in Section 2. An overview of the literature on payment method effects in CVM studies is presented in Section 3. The description of the EPRG surveys are provided in the Section 4 and the econometric model is presented in Section 5 followed by the results in Section 6. Section 7 concludes the paper.

2 Evidence on WTP for Renewables

Electricity can be generated from a number of sources such as coal, natural gas, oil, nuclear as well as renewable sources including wind, solar and biomass. UK generates its electricity primarily from coal, natural gas and nuclear. These traditional sources for electricity generally have higher true social cost compared to their market prices due to the pollution produced in the process. Green electricity is generated from renewable energy sources such as solar power, wind power, hydroelectric power, tidal power, and biomass power. Electricity produced from these green sources has a number of public benefits.

Renewable energy sources do not produce pollutants and are considered environmentally friendly. Moreover, they increase fuel diversity and increase energy security by reducing dependence on imported sources such as natural gas, which are vulnerable to political instabilities and trade disputes (Menegaki, Hanley, and Tsagarakis, 2007). Despite these benefits, renewable energy sources constitute only a small part of UK's electricity fuel mix, just under 10 per cent. One of the main inhibiting factors in the uptake of renewable sources is that the cost of "green" electricity is higher than the traditional sources

although they have lower social costs. The high market cost of renewables hinders the wider usage of renewable-energy.

One of the aims of this paper is to identify the factors that can affect WTP for renewables. This section reviews the results of previous studies on WTP for electricity generated from renewable sources.

2.1 WTP for Electricity from Renewable Sources

There are two mechanisms currently in place that support investment in renewable generation capacity in the UK. These are the renewable obligation scheme and the payment of a voluntary "green" premium by individual customers.

The Utilities Act of 2000 created the Renewables Obligation (RO) scheme and came into effect in April 2002. The RO is essentially a financial support mechanism to provide commercial investments to increase the uptake of renewable electricity generation technologies. Under the RO, all licensed electricity suppliers are required to purchase a certain amount of renewable electricity. The suppliers meet their obligation by acquiring renewables obligation certificates (ROC) for each megawatt hour of renewable energy that they purchase or by paying a pre-specified buy-out price which is then passed on the end-consumer tariffs. The Government's Electricity Market Reform (EMR) has now proposed to replace ROCs with a feed-in tariff system from April 2017 onwards. Both the ROC and feed-in tariffs are a type of mandatory payment scheme as the costs are passed on to all end-user consumers.

The deregulated market in the UK also allows consumers to reveal preferences for "green" electricity by offering consumers to pay a voluntary premium through green tariffs. It is indistinguishable to consumers whether electricity they receive is generated through traditional energy sources or from renewables. Electricity is homogenous, it does not differ by the sources used to produce it. However, consumers can regard electricity as a heterogenous product based on its production source. For example, consumers can have preferences for environmentally friendly energy production. These preferences could lead some consumers to regard electricity produced from sources that are carbon neutral, such as wind power, as different from electricity produced from coal. Although these "green" options do not imply that the electricity received by the specific customer are produced solely from renewables, it does guarantee an increase in renewables used in electricity production as a whole.

Existing research generally supports that people are WTP extra for green electricity. Borchers et. al. (2007) use a choice experiment to analyse consumer preferences for voluntary green electricity program in the US. They find that there is a positive WTP for green electricity and in particular for solar sources. Batley et. al. (2001) explore whether consumers are willing to pay extra for green energy using a postal survey in the city of

Leicester. Close to 34 per cent of their 667 sample indicated they would be willing to pay 16 per cent extra for electricity generated from renewable energy sources. Rowlands (2001) utilizing choice experiments finds that 80 per cent of his 480 respondent sample in Ontario Canada were willing to pay extra for green electricity. Close to fifty per cent of the respondents were willing to pay 15 percent extra on electricity generated from renewable sources. Nomura and Akai (2004) also find a positive WTP from Japanese households to pay a flat monthly surcharge for electricity from renewables, with an estimated median WTP value of 2000 yen (around USD 17) per month per household.

There has been some research on willingness to pay and support for renewables in the UK. Longo et. al. (2008) used choice experiments on a sample of Bath residents to assess their WTP for a hypothetical program to support renewable energy sources. They find positive support by the respondents for the renewable energy program especially in the view that it will benefit the public in terms of increasing energy security and reducing impact of climate change. The average willingness to pay estimated by this study is £29.65 to decrease the GHG emissions by 1 per cent a year.

The literature indicates that there is a consumer demand for green electricity. All the studies reviewed, despite their differences in designs, find that consumers generally have a positive WTP for renewable energy policies.

2.2 Factors that Affect WTP

Research on WTP for renewables has generally highlighted a number of socio-economic and behavioural attributes that have an impact on WTP valuations. Income, as expected, has a positive effect on WTP valuations (Rowlands, Scott, and Parker, 2001; Zarnikau, 2003; Roe, Teisl, Levy, and Russell, 2001; Batley, Colbourne, and Urwin, 2001; Longo, Markandya, and Petrucci, 2008; Yoo and Kwak, 2009; Zografakis, Sifaki, Pagalou, Nikitaki, Psarakis, and Tsagarakis, 2010; Zoric and Hrovatin, 2012) but in a few studies it has been found to be insignificant (Hansla, Gamble, Juliusson, and Grling., 2008). In general younger respondents have higher WTP (Zarnikau, 2003). Gender is usually found to be insignificant, although Zarnikau (2003) finds males have higher WTP for renewables than females. Respondents with more liberal political views and with high levels of education are observed to have higher WTP for renewables as well (Longo, Markandya, and Petrucci, 2008).

Past studies have also investigated whether the level of environmentalism of the respondent, usually measured by an index of the number of environmentally friendly actions undertaken by the respondent such as recycling or donating money to an environmental cause, has an impact on WTP. There is evidence that respondents engaged in more environmentally friendly actions have higher WTP for green electricity (Ek, 2005; Longo et al. 2008). Respondents who have implemented energy saving measures are also found to

have higher WTP (Zografakis, Sifaki, Pagalou, Nikitaki, Psarakis, and Tsagarakis, 2010).

Responsibility for paying utility bills is found to have a negative impact on WTP. Those who actually pay their household's electric bill have a lower WTP premium for renewable energy than those who are not responsible for paying utility bills (Zarnikau, 2003; Hite, Duffy, Bransby, and Slaton, 2007). Homeowners also tend to have lower WTP than renters (Zarnikau, 2003). Longo et. al. (2008) find that respondents with children have a higher WTP for renewable energy programs.

There is mixed evidence on the impact of awareness of renewables and energy issues on WTP. Batley et. al. (2001) instituted a split sample survey in Leicester where half the sample was sampled randomly from the city population and the other half was drawn from people who had contact with the Energy Efficiency Advice Centre and were considered to be more aware of energy issues. The authors find no difference in the valuations between the two samples. Zarnikau (2003) observes that exposure to information on renewables has a positive effect on the number of respondents stating a positive WTP, but it has an insignificant effect on the level of WTP valuations. More respondents were willing to pay a premium when given the information on renewables while WTP larger premiums decreased with the information. Zografakis (2010) in his survey of Crete households finds that awareness of climate change and energy issues has a positive impact on WTP. In contrast to the previous studies, Hite et al. (2007) find that awareness of renewable energy programs had a negative impact on WTP.

The third research question addressed by this paper is to analyse the socio-economic and behavioural characteristics that affect WTP for renewables. The characteristics analysed draw from the literature summarized above to include income, age, as well as environmentalist behaviour of the respondents. In addition, the paper explores whether the respondents are affected by the behaviour of other households.

2.3 Stated Valuations and Green Tariffs

While existing research has in general identified a positive WTP for green energy, there is a disconnection between the stated WTP reported in these studies and the actual participation in green electricity programs (Byrnes, Rahimzadeh, Baugh, and Jones, 1995; Wiser, 2007; Holt, 1997). Byrnes et al. (1995) have compared willingness to pay surveys with market simulations or real tariff schemes, and found that only between 12 and 15 per cent of those who state a positive willingness to pay actually pay the premium when given the opportunity.

In the UK it is estimated that only 1 per cent of households have opted for green tariffs (Bird and Brown, 2005). The same low uptake has also been observed in other countries with a deregulated electricity market such as Finland where green electricity options have been available since 1998 but their uptake has remained low. This discrepancy between

stated and actual WTP could be due to a number of factors including bias in the stated preference surveys which could lead to overestimation of WTP premia. Alternatively, it may be that households are not informed about the green energy alternatives.

Borchers et al. (2007) explore an alternative explanation by investigating whether consumers have preferences for specific renewable energy sources compared to "generic" green electricity. They find that respondents have positive WTP for "green" electricity but also WTP differs by green energy source. For example, respondents had a higher preference for solar compared to other renewable energy sources.

Samela and Varho (2006) use interviews to look at the barriers that contribute to the discrepancy between stated and actual uptake in Finland. Although the number of interviews conducted by the authors are relatively few, the emerging theme is that consumers lack trust in green electricity products and electricity companies. The authors propose that the consumers suffer from information gaps due to poor marketing of green electricity products from suppliers. Since consumers may be unfamiliar with green electricity, they require a lot of external information and incentive in order to become active participants.

This paper seeks to analyse a different aspect by looking at whether the type of payment option has an impact on households' willingness to pay to receive electricity from renewable energy sources.

3 Background and Literature Review

The paper builds on several strands of literature which are outlined in this section. First, the empirical evidence on payment method effects within the CVM literature is presented. The discussion then moves on to review issues of temporal variability in survey responses and how the payment mode can influence the certainty of respondents in paying their stated WTP valuations.

3.1 Payment Method Effects in CVM

The payment mode used in CVM studies can vary from entrance fees, utility bills, property taxes, sales taxes, special funds to prices or income taxes. Payment vehicles can generally be classified into two categories: voluntary and mandatory mechanisms. The respondents' stated WTP can be affected by the type of payment vehicle used in the survey, this is termed 'payment method effect' in the CVM literature.

Voluntary payment options, such as charitable donations, can induce respondents to act strategically and overstate their true WTP valuations in order to secure the good in question while knowing that in actuality they will pay less than the stated amount once the good becomes available (Carson, 1997). Expectation in this case is for stated

WTP to be higher under voluntary payment schemes. However, voluntary schemes could also cause the opposite effect. Respondents' valuations may be significantly less under voluntary mechanisms because respondents may find it inequitable if some people do not pay but receive the benefits nonetheless (Kato and Hidano, 2002). Garrod and Willis (1999) suggest that people are more likely to pay for a public good if they believe everyone who is benefiting is contributing to it compared to just a few select individuals.

Coercive vehicles such as taxes, prices or fees can be regarded as more credible payment vehicles than voluntary mechanisms since they ensure that everyone pays. However, taxes can lead to negative reactions from respondents if they do not trust that the money raised will be spent to finance the good in question but rather will be used for a different purpose (Green and Tunstall, 1999). For example, Johnston et. al. (1999) find evidence that respondents WTP is higher under a tax that guarantees to fund the policy in question compared to a tax with no specific guarantee.

There are only a few studies that have tested the impact of the payment vehicle on the respondents' WTP valuations. The results from these studies yield divergent conclusions. Bateman et. al. (1995) in their study on valuations of preserving a wetland found that altering the payment vehicle from charitable fund donation to a tax increased the respondents' willingness to pay by nearly double. Baranzini et. al. (2009) also support this finding, their results indicate that respondents' WTP is 24 per cent higher under a mandatory tax vehicle compared to a voluntary payment vehicle. Jin et. al. (2008) in their CVM study of WTP for conservation of bird species in Macao, also find that respondents state a higher WTP under a mandatory payment mechanism than when a voluntary payment mechanism is used. However, there is some empirical evidence that stated WTP is unaffected by the payment vehicle used in the survey (Bergstrom and Dillman, 1985).

It should be noted that 'payment vehicle effect' should not be confused with 'payment vehicle bias.' Payment vehicle effect refers to variations in offered values due to the type of payment vehicle (Cummings et al., 1986: 209), while "payment bias" arises when the payment vehicle used by the survey is either misperceived or is valued in a way not intended by the researcher (Mitchell and Carson, 1989: 124). If the payment vehicle used by a study is seen as implausible by a respondent then they are likely to modify their bids or refuse to answer the question in protest (Morrison, Blamey, and Bennett, 2000; Jakobsson and Dragun, 1996). This paper analyses the payment vehicle effect and does not deal with payment vehicle bias.

3.2 Temporal Variability of WTP Valuations

Another research question addressed by this study is whether preference for mandatory/voluntary payment modes change over time and whether WTP under the two pay-

ment vehicles is temporally stable. Temporal variability of WTP valuations is an important consideration in CVM research because it is seen as a test of reliability of WTP estimates. Moreover, if WTP estimates are stable across time periods then they can be used for policy application for a number of years which is appealing to policymakers. In order to analyse this question the WTP section of the EPRG 2008 survey was re-administered a year later in December 2009. The stated WTP valuations in the 2008 and 2009 surveys are compared to test temporal stability of valuations.

Any statistically significant difference in valuations across time, does not necessarily indicate that CVM valuations are unreliable. This conclusion can only be drawn if the differences cannot be explained adequately by other factors. For example, true WTP can change due to shifts in demand or supply or due to other factors such as changes in attitudes or preferences in which case variation in stated WTP over years is justified.

Temporal reliability of CVM has been tested by a number of papers. Some studies have conducted the survey with the same sample across different time periods (Loomis, 1990). The shortcoming of using the same sample is that it can suffer from recall bias; respondents can recall their valuation to the initial survey and simply repeat the same stated WTP value. In order to control for recall bias, the follow-up survey can be conducted after a long time lag or a different sample can be used.

A number of researchers have employed the same survey but with different samples within months or maximum two years of the initial survey (Reiling, Boyle, Philips, and Anderson, 1990; Teisl, Roe, Vayda, and Ross, 2003; Carson, Hanemann, Kopp, Krosnick, Mitchell, Presser, Ruud, and Smith, 1997; Downing and Ozuna, 1996). There are two notable exceptions, Whitehead and Hoban (1999) as well as Brouwer and Bateman (2000) conducted the follow-up survey five years after the initial survey.

This paper investigates temporal stability of WTP valuations and their determinants for renewable energy under two payment schemes. This is a particularly pertinent issue due to the timing in which the surveys were administered. The EPRG 2008 survey was conducted slightly after Lehmans Brothers collapsed when there was a high level of uncertainty in employment and financial markets which is likely to have affected the respondents. The EPRG 2009 survey was conducted slightly over a year after the initial survey. In order to account for the effects of the financial crisis a question was added in the 2009 survey for the respondent to indicate how they were affected by the crisis.

The a priori expectation is for the WTP valuations to differ between 2008 and 2009. This is because factors that affect willingness to pay, such as the respondents' income, are likely to have changed between October 2008 and December 2009. In order to avoid recall bias different samples of respondents were used for the surveys but with the same sampling cohorts.

3.3 Respondent Certainty and Payment Vehicle Effects

The last research questions that this paper investigates is whether the degree of certainty with which a respondent states their WTP valuation is affected by the payment mode employed. Traditionally, studies utilizing CVM data assumed that respondents have a single point value for the good or service offered by the CVM scenario. However, this is a simplistic assumption as respondents when answering WTP type questions in a survey setting are likely to have a level of uncertainty attached to the valuation they state.

Respondents' uncertainty could arise from a number of factors some of which is resolvable through survey design. In most cases the respondents are asked to value attributes that they are not familiar with or have not thought about their willingness to pay prior to the survey (Alberini, Boyle, and Welsh, 2003). Some of this uncertainty can be resolved by providing the respondent with clear information in the survey (Loomis and Ekstrand, 1998).

Respondents may not be confident about their stated valuation due to their own socioeconomic or demographic factors factors such as job prospects, future income and household size. Respondents' attitude to the hypothetical scenario presented in the survey can also affect their certainty (Champ and Bishop, 2001). Akter et al. (2009) study the WTP for a voluntary carbon tax on air travel find that respondent attitudes to the program and sense of responsibility increased the certainty levels in their stated WTP valuations. Moreover, respondents who expressed a belief in the effectiveness of the proposed program had higher levels of certainty. Thus, through expressing high levels of certainty, the respondents could be expressing their support for the good or attribute being valued.

These uncertainties are unresolvable at the time of the survey. Thus, the respondent's stated WTP is characterized as a variable with a probability distribution. In order to incorporate the respondent's uncertainty, in the EPRG 2008 and 2009 surveys the respondents were asked to indicate their level of certainty on a 0 to 100 per cent scale in paying their stated WTP in real life. A number of studies including Juster (1966), Savage (1971), Manski (1990) and Fischhoff (1994), recommend this approach of directly asking the respondents for probabilistic assessment of their future behaviour. As Manski notes "even if expectations are not rational, probabilistic intentions data may have greater predictive power than do binary data"' (Manski, 1995, p. 109).

In this paper, the respondents' uncertainty is incorporated into the statistical analysis in analysing WTP. The factors that affect respondents' level of confidence in answering the dichotomous choice WTP questions is also explored. The focus is on whether the type of payment method affects the respondents' certainty in their valuations. This issue has only been addressed by one other study. Stithou (2009) analyses respondent certainty under voluntary and mandatory payment mechanisms in the CVM study of WTP for

conservation of two endangered species in Zakynthos Island in Greece. The paper finds evidence that payment mode affects the certainty level of respondents in their responses to WTP valuation question; a higher level of certainty is expressed under a mandatory payment option.

4 Data Description and Survey Methodology

The dataset used in this study is based on two CVM surveys administered in England, Wales and Scotland in 2008 and 2009. The 2008 EPRG survey was conducted by Accent with a sample size of 2006 respondents while the EPRG 2009 survey was conducted by MORI using an omnibus style survey with a sample size of 2000 respondents.

The surveys were conducted over the internet in contrast to more traditional methods such as by mail, over the phone, or face-to-face interviews. There are a number of advantages to internet surveys (or e-surveys) which led to the selection of this method. Internet based surveys in general are less expensive as they involve fewer and less time-consuming administration and processing procedures. Internet based surveys also have faster response times as well as higher response rates (Lazar and Preece, 1999; Opperman, 1995) compared to the traditional approaches. Furthermore, respondents are under no time pressure when completing surveys online which can improve the validity of responses to complex questions. They also avoid the "interviewer effect" as people responding to the survey are filling in their questionnaires on a computer screen, rather than talking to a person.

While internet base surveys are now widely used, there are some concerns over their representability as the whole population does not have access to the internet. However, this is not that significant an issue in the UK where 63.9 per cent of households have access to the internet at home (ITU, 2007). Moreover, the traditional formats of survey execution (i.e. telephone or in-house surveys) can lead to higher biases than those observed in e-surveys. For instance, telephone and interview surveys tend to be biased towards those who spend most of the time at home such as the retired or the unemployed. In contrast the internet surveys can be accessed in any location with an internet connection. In addition for both surveys, quotas were also imposed for key socio-demographic variables (age, gender, region, social class) to ensure that the sample was representative of the British population.

In order to assess whether the type of payment mechanism has an impact on the willingness to pay valuations of respondents, the EPRG 2008 and 2009 CVM surveys, the sample was split in half. Half of the sample was asked their willingness to pay under a mandatory scheme. In this case the extra money to support renewable energy would be raised through a mandatory surcharge on electricity bills of all homes and businesses in the UK. The second half of the sample was asked their WTP under a voluntary scheme

whereby only those individuals who chose to pay a premium would contribute to support renewables.

The service under the study (i.e. electricity generated from renewable energy) is well known to respondents. Therefore, it was assumed that questions on WTP would not pose difficulties for respondents as it can with environmental goods that are less familiar to the respondents. The WTP question format asked each respondent whether their household would pay a percentage of their current utility bill extra each month over 5 years[1].

4.1 WTP Question and Bidding Structure

CV elicitation questions are of two basics forms: open-ended or closed-ended. The open-ended version asks the respondent to state the maximum amount he/she is willing to pay for the service in question. In a closed-ended format, the respondent is asked whether they are willing to pay a specified amount presented in the question.

In the closed-ended format, the individual is presented with specific WTP values to choose from. There are several formats to present these bids including payment card, discrete choice or discrete choice with follow-up approaches. The payment card elicitation method supplies the respondents with a card listing a number of price increments. This method is still vulnerable to a number of biases associated with the ranges used on the cards. Respondents tend to choose either the first or the last option in the payment cards. Due to the biases associated with the payment card this method was discarded.

Dichotomous choice method provides the respondent with a single monetary value to accept or reject. This format was rejected since it only provides one threshold against which to measure individual's WTP valuations. Dichotomous choice with follow up method is an adaptation which presents a bid which respondents can either accept or reject. If the answer is "yes" to the presented bid then a follow up question is asked using a higher price. If the response to the first question is "no" then the follow up question presents a lower price. The sequence of questions are used to narrow the range in which the respondent's true WTP can lie, thus creating a "double bound". This was seen as the most appropriate closed-ended approach for both surveys, since it provides a double bound on the WTP estimations.

At the beginning of both surveys the respondents were asked to state their average monthly or quarterly electricity bill. This information was then incorporated into the WTP questions later in the survey to remind the respondents of their current utility payments and to encourage them to take this into consideration before responding to WTP questions. This approach helps anchor the stated values of respondents in the WTP questions to their actual revealed behaviour of how much they currently spend on utilities.

[1]Please refer to Appendix A for a copy of the question

The bidding categories used in both 2008 and 2009 surveys were 3%, 5%, 7%, 10%, 15%, 20% and 25% of the respondent's current electricity bill. The median of the seven bids, 10%, was given as the initial bid to all respondents. The bidding structure leads to 9 willingness to pay categories as presented in Figure 1.

Figure 1: EPRG 2008 Survey - WTP Categories

WTP Categories	**WTP Valuations**
1	$wtp = 0\%$
2	$0\% < wtp < 3\%$
3	$3\% \leq wtp < 5\%$
4	$5\% \leq wtp < 7\%$
5	$7\% \leq wtp < 10\%$
6	$10\% \leq wtp < 15\%$
7	$15\% \leq wtp < 20\%$
8	$20\% \leq wtp < 25\%$
9	$25\% \leq wtp$

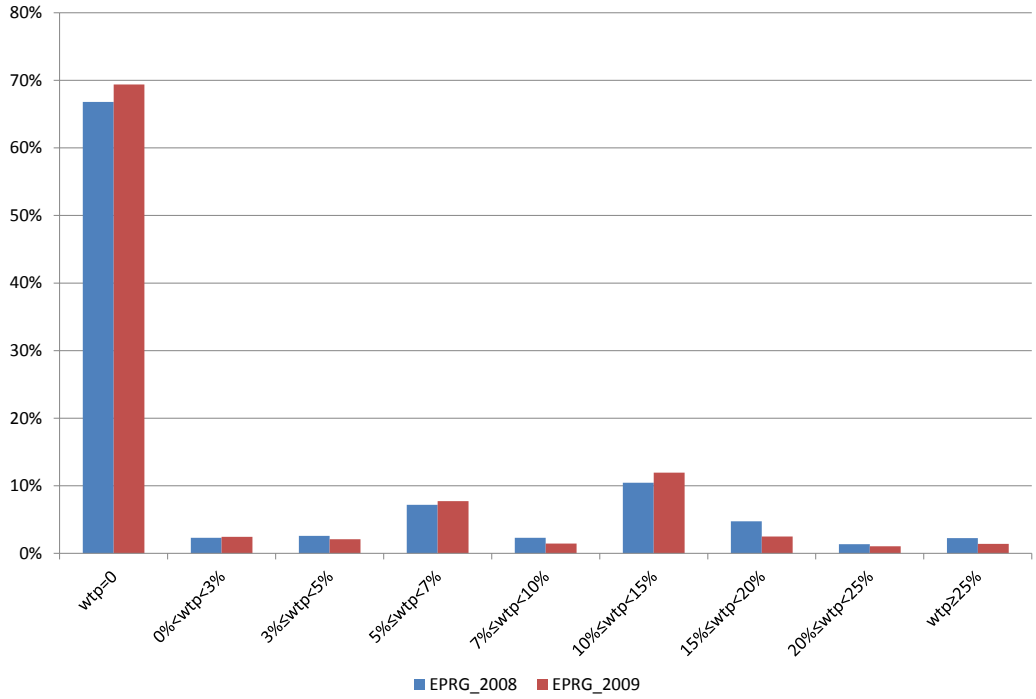
The distribution of WTP valuations in both surveys are presented in Figure 2. The chart displays the percentage of respondents in each WTP category for both years. There is a high propensity of zero WTP responses in both EPRG surveys. In the 2008 survey 67 per cent of respondents stated that their WTP was zero and around 69 per cent of the 2009 sample reported zero WTP.

4.2 Controls for Potential Biases

The willingness to pay questions in both surveys used double bounded dichotomous choice format. There is some evidence that the responses to the follow-up bids can be based on the first bid (Bateman, Langford, Jones, and Kerr, 2001) that the distribution underlying preferences to the first question may not be the same as those to the second bid response. However, the aim of this research is not to estimate a precise WTP value but rather analyse the divergences in WTP based on payment method. To eliminate potential discrepancies that a randomized bid structure would introduce, for this study the same starting bid was given to all respondents. As a result, the results from the EPRG surveys are susceptible to starting-point bias but this is not a major concern since the focus is not to estimate the precise WTP.

CVM surveys that elicit willingness to pay valuations on multiple attributes are also prone to ordering bias. In the 2008 survey, valuations were asked on several attributes thus, it is possible that respondents' valuations will be sensitive to the order in which these attributes are presented. To control for potential ordering bias, the sequence in

Figure 2: Distribution of WTP Categories for EPRG 2008 and 2009 Surveys



which the WTP questions in the EPRG 2008 survey were randomly varied among the respondents.

Some researchers have expressed concern that a significant "hypothetical bias" can occur in CVM studies. There is empirical evidence that respondents responding to hypothetical situations overstated their preferences (Cummings, Harrison, and Rutstrom, 1995; List and Shogren, 1998; Neill, Cummings, Ganderton, Harrison, and McGuckin, 1994). Hypothetical bias can also arise if the respondent is uncertain about the amount they would pay as they may not have thought about the presented situation before. In the 2008 survey, to control for "hypothetical" bias respondent's uncertainty is incorporated into the survey through an additional question that is asked at the end of each willingness to pay section. The question presented below, asks the respondent how certain he/she is that their household will pay the premium if adopted. This question will be incorporated into the regression analysis as presented in the next section.

We know that some people are more certain than others about their answers. On a scale of 0 to 100 percent, where 0% means "'very uncertain"' and 100% means "very certain" how certain are you that your household would support the adoption of the indicated monthly surcharge?

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5 Modelling Willingness to Pay

This section presents a number of different econometric models that are available to analyse responses to contingent valuation questions. Ordered response models that are traditionally used to analyse CVM type data are described as well as alternative models to deal with high number of zero responses.

5.1 Ordered Response Models

The main aim of CVM studies is to estimate respondents' willingness to pay (y_i^*) and to evaluate the impact of covariates on willingness to pay. In most CVM studies the latent variable y_i^* is not observed. Instead the researcher observes whether the respondent accepts or rejects the bid presented and the only conclusion that can be drawn from this observation is the range in which y_i^* can lie. Ordered response models are widely used to analyse such discrete data which has a natural ordering.

An ordered response model is based on an unobserved latent variable y_i^* (where $i = 1, 2, ..., N$) that is modeled as a linear function of personal characteristics $\mathbf{z}_i$ and an error term ε_i (ε_i is assumed to be independent and identically distributed), α is a vector of unknown parameters.

$$y_i^* = \alpha^{'}\mathbf{z}_i + \varepsilon_i. \tag{1}$$

Although y_i^* is not observed, what is observed is an individual's choice y_i (which has discrete ordered value ($y_i = 1, 2, ..., M$)),

$$y_i = j \text{ if } \mu_{j-1} < y_i^* < \mu_j \tag{2}$$

the μ_j are thresholds defining potential outcomes for y_i. The probability of observing a particular ordinal outcome j is

$$\Pr[y_i = j|\mathbf{z}_i] = F(\mu_j - \alpha^{'}\mathbf{z}_i) - F(\mu_{j-1} - \alpha^{'}\mathbf{z}_i) \tag{3}$$

where $F(.)$ is a cumulative density function. These probabilities enter directly into the loglikelihood function which can be written as

$$l(y|\theta) = \sum_{i=1}^{N}\sum_{j=1}^{M} h_{ij} \ln(\Pr[y_i = j|\mathbf{z}_i]) \tag{4}$$

where $\theta = (\alpha, \mu)$ and the indicator h_{ij} is

$$h_{ij} = \left\{ \begin{array}{c} 1 \text{ if } y_i = j \\ 0 \text{ otherwise} \end{array} \right\}.$$

In the case of CVM data, the bids presented in the CVM scenario form the thresholds, μ_j where $\mu_0 = -\infty$, $\mu_1 = 0$ and $\mu_M = +\infty$ which in turn form the M categories within which the unobserved willingness to pay may fall. Since the bids have a natural numerical ordering, y_i is an ordered variable thus the above ordered response model can be used in the analysis. If it is assumed that ε_i are i.i.d. standard normal then y_i^* can now be estimated using an ordered probit model or if ε_i are i.i.d. logistic then an ordered logit model can be utilized.

5.2 The Excess Zero Problem

One of the potential difficulties in modeling WTP responses obtained from CVM surveys is that the distribution of WTP responses tends to be multi-modal and in most cases with a spike at zero. The conventional models that are applied to estimate WTP, such as ordered logit or probit, ignore this potential multi-modality in the dataset. In cases where the data has a high proportion of zeros, these conventional parametric models can fail to represent the empirical distribution of the data which can lead to bias and inconsistent estimates.

There are two modeling options to account for excess zeros based on a mixture distribution. The first is the spike model which uses a degenerate distribution at zero combined with a zero-truncated normal or logit distribution for the non-zero observations.

$$G_{SPIKE}(y;\lambda,\mathbf{x},\alpha) = \left\{ \begin{array}{c} 0 \ \text{ if } y^* < 0 \\ \lambda \text{ if } y^* = 0 \\ F(y;\alpha) \ \text{ if } y^* > 0 \end{array} \right\} \tag{5}$$

$$G_{ZIOP}(y;\lambda,\mathbf{x},\mathbf{z},\alpha) = \left\{ \begin{array}{c} 0 \ \text{ if } y^* < 0 \\ \lambda \text{ if } y^* = 0 \\ F(y;\alpha,\beta) \ \text{ if } y^* \geq 0 \end{array} \right\} \tag{6}$$

The distribution function of the WTP values under a spike model is given by (5), where $F(y;\alpha)$ is an absolutely continuous cumulative distribution function. However, the function $G_{SPIKE}(y;\lambda,\alpha)$ is not a continuous function (An and Ayala, 1996). It has a point mass at $y^* = 0$ represented by the parameter λ which is the share of the sample who stated that their WTP is zero and lies in the interval $[0,1]$.

An alternative model is the zero-inflated ordered probit (ZIOP) developed by Harris and Zhao (2007). ZIOP is similar to the spike model except the zero in the normal distribution is not truncated. In this setup, the zero observations emerge from two different parts of the distribution that have either two different sets of explanatory variables or the same covariates but potentially with different effects.

ZIOP can be thought of as a double-hurdle model that is a combination of a probit model and an ordered probit model. The distribution under ZIOP is given by (6) where α

is the vector of parameters from the ordered probit part and β is the vector of parameters from the probit part.

ZIOP models WTP with two variables, r_i and y_i. The variable r_i is used to model the first hurdle - whether the respondent is willing to pay anything for the attribute in question. This is a binary variable which takes on the value 0 or 1. If the respondent has answered "no" then $r_i = 0$ and if the response is "yes" then $r_i = 1$. This binary variable r_i is related to a latent variable r_i^*

$$r_i^* = \beta' \mathbf{x}_i + u_i$$

where $\mathbf{x}_i$ is a vector of covariates, β is a vector of unknown parameters, and u_i is a standard-normal distributed error term.

The probability that the respondent has a positive WTP, $(r_i = 1)$ is given by

$$\Pr(r_i = 1|\mathbf{x}_i) = \Pr(r_i^* > 0|\mathbf{x}_i) = \Phi(\beta' \mathbf{x}_i)$$

where $\Phi(.)$ is the cumulative distribution function of the univariate standard normal distribution.

The second hurdle in the ZIOP model is the decision on how much the respondent is willing to pay for the attribute. This hurdle is modeled as an ordered probit model. The second latent variable y_i^*, is then

$$y_i^* = \alpha^{'} \mathbf{z}_i + \varepsilon_i$$

where $\mathbf{z}_i$ is the vector of covariates with an unknown vector α and ε_i an error term following a standard normal distribution. It is key to note that the second hurdle allows for zero WTP as well.

In this model we can observe zero WTP if $r_i = 0$, when the respondent's WTP is zero. We can also observe zero WTP if $r_i = 1$ and $y_i = 0$ in which case the individual reports zero WTP because either they are inhibited by the price or due to their budgetary restrictions; this group of respondents could switch to positive WTP if their income was higher or the price offered was lower.

A positive WTP is observed if the respondent has expressed they are willing to pay $(r_i = 1)$ and that $y_i^* > 0$. Given that both ε and u identically and independently follow a standard normal distribution, then the probabilities are

$$\Pr(y|z, x) = \left\{ \begin{array}{c} \Pr(y = 0|\mathbf{z},\ \mathbf{x}) = [1 - \Phi(\beta' \mathbf{x})] + \Phi(\beta' \mathbf{x})\Phi(-\alpha^{'} \mathbf{z}) \\ \Pr(y = j|\mathbf{z},\ \mathbf{x}) = \Phi(\beta' \mathbf{x})[\Phi(\mu_j - \alpha^{'} \mathbf{z}) - \Phi(\mu_{j-1} - \alpha^{'} \mathbf{z})] \end{array} \right\}. \quad (7)$$

From (7) we note that the probability for a zero observation has been "inflated"

since it is a combination of the probability of observing a zero observation from the ordered probit process plus the probability of the individual being a "non-participant" from the binary probit part. Assuming independent observations over respondents, the log likelihood function is given by

$$l(y|\theta) = \sum_{i=1}^{N} \sum_{j=1}^{M} h_{ij} \ln[\Pr(y_i = j|\mathbf{x}_i, \mathbf{z}_i)]$$

where $\theta = (\beta, \alpha, \mu)$ and the indicator h_{ij} is

$$h_{ij} = \left\{ \begin{array}{c} 1 \text{ if individual } i \text{ chooses outcome } j \\ 0 \text{ otherwise} \end{array} \right\}.$$

Spike and ZIOP present two approaches to model WTP data from CVM studies with a high level of zero WTP responses. To date only the spike model has been utilized in the CVM literature. ZIOP which is relatively a more recent model provides a new alternative with an important benefit. Using ZIOP, the factors that affect zero WTP can be considered separately from the factors that affect positive WTP which is not possible under the spike model. This is a particularly important feature in WTP studies because the variables that influence a respondents to state a zero WTP are likely to be different from those stating a positive amount of WTP. Due to this additional insight provided by ZIOP, this paper will apply ZIOP in the estimation instead of the spike model.

5.3 Weighted Likelihood Function Model - Incorporating Uncertainty into WTP Estimation

So far the modelling framework presented has assumed that the respondent knows their true WTP, y_i^*. The discussion has been based on the assertion that any uncertainty on the WTP is coming from the analyst, from the unobserved random error term ε_i. However, in addition to uncertainty from the investigator the respondent may be uncertain about their answer they provide. As outlined in Section 3.3, there are a number of factors that can cause uncertainty among respondents on their stated WTP valuation. The respondent may be uncertain about what it is they are being asked to value, or they may not be sure about their ability to pay the stated amount in the future perhaps due to concerns over changes in employment or future expenses.

Although some of this uncertainty can be resolved by providing more information to the respondent, some uncertainty can never be resolved such as the respondent's confidence about their future income. As a result, the respondent can provide a response to the valuation question but they could have reservations about their ability to pay the stated value.

The respondent's WTP can then be expressed as a latent variable with an added term δ_i to account for the uncertainty originating from the respondent.

$$\widetilde{y_i}^* = y_i^* + \delta_i \tag{8}$$

Substituting from (1), WTP can then be expressed as

$$\widetilde{y_i}^* = \alpha^{'}\mathbf{z}_i + \varepsilon_i + \delta_i. \tag{9}$$

A post-valuation question can be included in the survey to elicit information on the respondent's uncertainty in order to provide an estimate of δ_i. The responses to this question can be incorporated into the standard ordered probit or ZIOP model by adapting the likelihood function as (10).

$$l(y|\theta) = \sum_{i=1}^{N}\sum_{j=1}^{M} w_i\{h_{ij}\ln[\Pr(y_i = j|\mathbf{x}_i, \mathbf{z}_i, \beta, \alpha)]\} \tag{10}$$

The weights w_i are used as a measure of certainty attached by the respondent to their stated valuations. Shaikh et al. (2007) in their review of methods to treating respondent uncertainty in CVM, find that including respondent uncertainty information can improve estimation and accuracy, especially using the weighted likelihood function method as described above.

The surveys used by this paper included a follow-up question on respondents' certainty of paying the amounts they stated. The analysis will incorporate this information through adapting ZIOP with the weighted likelihood function method. The ZIOP distribution (6) is adapted with weights included in the second hurdle as below.

$$G_{ZIOPweighted}(y; \lambda, \alpha, \mathbf{w}) = \left\{ \begin{array}{c} 0 \ \text{ if } y^* < 0 \\ \lambda \text{ if } y^* = 0 \\ \mathbf{w}\{F(y; \alpha, \beta)\} \ \text{ if } y^* \geq 0 \end{array} \right\} \tag{11}$$

5.4 Determining Factors Affecting Certainty in stated WTP - Fractional Logit Model

The last research question of the paper is to analyse the factors that affect the respondents' level of certainty in their stated WTP. The responses on the level of certainty, w_i, are fractional. The fractional logit proposed by Papke and Wooldridge (1996, 2010) allows for analysing this type of dependent variable which takes the values in the unit interval, [0, 1].

The fractional logit model assumes that the conditional mean of a fractional variable

is

$$E(w_i|\mathbf{q}_i) = H(\mathbf{q}_i\alpha) \tag{12}$$

where $0 \leq w_i \leq 1$ and $\mathbf{q}_i$ is the vector of explanatory variables for the respondent i, α is the coefficient vector. The cumulative distribution function $H(.)$ is assumed to be logistic. The coefficients then can be estimated by maximizing the Bernoulli log likelihood function

$$l(\alpha) = \sum_{i=1}^{N} w_i \log[H(\mathbf{q}_i\alpha)] + (1 - w_i) \log[1 - H(\mathbf{q}_i\alpha)] \tag{13}$$

(Wooldridge, 2010).

6 Results

This section presents the results on the four research questions addressed by this paper. The discussion begins with a summary of the surveyed households' preferences on the type of payment method for supporting renewables. The certainty weighted ZIOP model is used to analyse the effect of the payment method on WTP as well as to determine the socio-economic and behavioural variables that affect respondents' WTP. The section closes with a review of the factors that are found to impact the level of certainty expressed by respondents in their stated valuations.

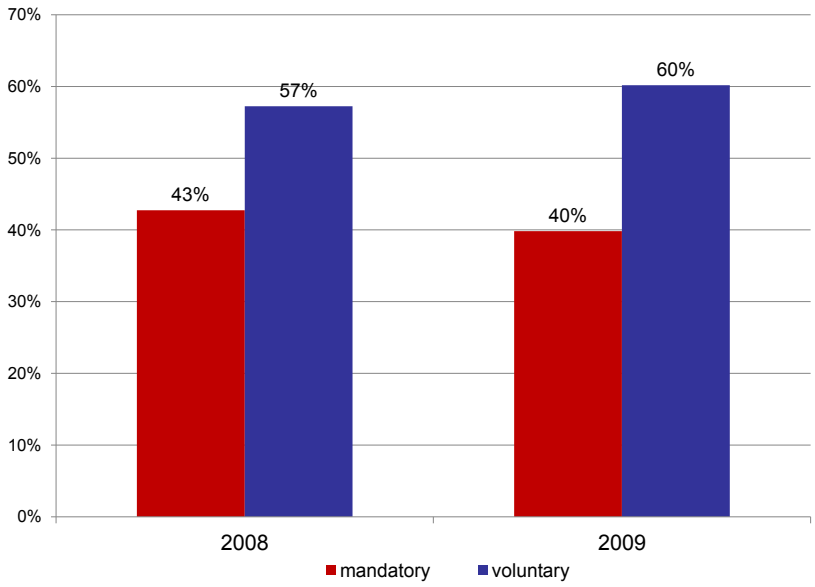
6.1 UK households' preferences - Voluntary vs Mandatory Payment

Both the 2008 and 2009 surveys indicate a high level of support for the voluntary payment option for renewables compared to a mandatory payment scheme (Figure 3).

When presented with the choice between the two payment schemes, close to 60 per cent of the surveyed samples stated that they would prefer a voluntary support scheme. In order to assess whether the stated preference for the voluntary payment option translated to monetary support, the WTP of respondents under both payment schemes was analysed. A number of demographic, behavioural and attitudinal factors are also considered in the analysis (Figure 4). Figure 5 presents the results from both the weighted and unweighted zero inflated ordered probit model [2]. The certainty weighted version of ZIOP regression, which was described in Section 5.3, takes into account the level of certainty expressed by respondents in paying their valuation. The regression analysis was conducted on the pooled sample including all respondents from both 2008 and 2009 surveys.

[2] All estimations were implemented in Stata. The Stata command for ZIOP is written by the author.

Figure 3: Preferred Payment Mechanism



Focusing on the first variable, a dummy is used to distinguish between the sample that was given the voluntary option and the sample presented with the mandatory payment option. The dummy takes the value 1 for the respondents that were asked their WTP under a mandatory scheme. The payment dummy is positive and highly significant in the first hurdle of the model. Thus, while UK households prefer a voluntary payment mechanism, they are more likely to pay under a mandatory scheme.

However, the dummy switches signs in the second hurdle indicating that although households are more likely to pay under a mandatory scheme, the amount of payment is likely to be higher under a voluntary payment option. A mandatory scheme spreads the cost of supporting renewables across the population which could explain the lower valuations stated under this payment method.

The interaction between the respondent's preference for a type of payment method and the payment method that they received in the survey can also impact WTP. The structure of the EPRG surveys allows for interacting the respondent's payment method preference and the payment method they were randomly assigned in the survey. The sample can be split into four groups: those who preferred the mandatory option and received the mandatory option (**MM**), those who preferred mandatory but were asked their WTP under a voluntary scheme (**MV**), those who preferred voluntary but were assigned the mandatory payment scheme in the survey (**VM**) and finally those respondents who stated their preference for voluntary payment and received this option in the survey (**VV**).

The certainty weighted ZIOP model was applied to analyse the effect of these groupings on respondents' WTP for renewables. The results from the regression analysis are presented in Figure 6. The only variable that is different between Figure 5 and Figure

Figure 4: Descriptive Statistics of Variables

Explanatory Variables	Description	Mean	SD	Min	Max
Payment Scheme Dummy	Dummy identifying the payment option received by the respondent; 0=voluntary, 1=mandatory	0.49	0.50	0	1
Payment Scheme Grouping	Identifies the respondent's preferred payment scheme and the scheme they received in the survey; 1=MM, 2=MV , 3=VM, 4=VV	2.69	1.09	1	4
Year Dummy	Identifies year of survey; 0=2008, 1=2009	0.50	0.50	0	1
Gender	1=Male, 2=Female	1.50	0.50	1	2
Age	1 to 6 scale of age of respondent; 0=under 25 years old, 5=over 65 years old	2.63	1.53	0	5
Household Size	1 to 5 scale of number of people in the household; 1=single person household, 5= 5 people or more in the household	2.56	1.21	1	5
Income	1 to 6 scale of household monthly income; 1=Up to £900, 5=Over £4000, 6=Refused to answer question	3.14	1.62	1	6
Environmentalism	0 to 6 scale of level of environmentalism of respondent measured by the number of environmental actions taken by the respondent	3.05	1.54	0	6
Green Tariff Dummy	Dummy identifying whether respondent is already paying a green tariff; 0=not paying green tariff, 1=paying green tariff	0.03	0.16	0	1
Effect of payment by others	1= more interested in paying if know other households also contributing, 2=not affected, 3=less interested	1.71	0.54	1	3
House Ownership	1=own house/flat, 2=rent house/flat, 3=council flat/dorm/assisted living	1.44	0.70	1	3
Responsibility for Paying Utility Bill	Dummy indicating whether respondent is the one responsible for paying the utility bill; 0=not responsible, 1=responsible for payment	0.75	0.43	0	1
Electricity Company Rating	1 to 5 scale rating by respondent of their electricity company on maintaining reasonable prices; 1=very unfavourable, 5=very favourable	3.10	1.23	1	6
Energy Dependence Concern	0 to 3 scale of level of concern expressed by respondent on UK's increasing dependence on imported energy sources; 0=not at all concerned, 3= very concerned	1.35	0.67	0	3
Awareness	0 to 3 scale to account for the number of questions the respondent answered correctly on energy related questions asked to test respondent's awareness; 0= none answered correctly, 3=all correct	1.73	0.85	0	3
Financial Crisis Index	0 to 6 scale to account for the number of ways respondent's household was affected by the crisis; 0=not at all affected, 1=affected by one of the nine items listed ...	2.83	1.70	0	6

6 is the first variable; instead of the payment dummy the analysis used the four sample groupings as explained above.

The respondent's preference for a payment method has a significant effect on their WTP. Compared to the MM group all the other three groups have a lower willingness to pay. In particular the respondents who preferred voluntary payments have lower WTP indifferent of the payment option they were assigned in the survey.

As was hypothesized in Section 3.2, WTP is expected to be different in the 2009 sample than the 2008 sample due to the financial shifts that occurred in the UK during the year in between the two surveys. In order to assess whether the year of the survey had an impact on WTP, a dummy variable was included in the analysis taking the value one for the 2009 survey sample. The year dummy is negative and significant in the second hurdle of both regressions in Figure 5 and Figure 6. In 2009 the willingness to pay of respondents for supporting renewables was lower compared to 2008.

The results reveal a number of factors that affect respondents' WTP for supporting renewables. Focusing first on the demographic factors, gender is insignificant in the decision on whether to contribute anything for renewables. However, it is significant in the second hurdle indicating that females are willing to pay less compared to males. Age is a significant factor only in the decision on how much to contribute, older respondents have a lower willingness to pay. As expected income has a significant effect, lower income

Figure 5: Results EPRG Surveys - Payment Method Effects

	POOLED				POOLED			
	Certainty Weighted - ZIOP				ZIOP			
	First Hurdle		Second Hurdle		First Hurdle		Second Hurdle	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Payment Dummy	0.130***	(0.03)	-0.246***	(0.07)	0.130***	(0.03)	-0.223***	(0.06)
Year Dummy	-0.001	(0.03)	-0.148*	(0.07)	-0.001	(0.03)	-0.214***	(0.06)
Gender	-0.006	(0.03)	-0.560***	(0.06)	-0.006	(0.03)	-0.544***	(0.05)
Age (comparison group "25 - 34")								
Under 25	0.072	(0.07)	-0.460***	(0.13)	0.072	(0.07)	-0.401***	(0.11)
35 - 44	-0.038	(0.05)	-0.385***	(0.11)	-0.038	(0.05)	-0.377***	(0.09)
45 - 59	-0.023	(0.05)	-0.517***	(0.10)	-0.023	(0.05)	-0.477***	(0.09)
60 - 65	0.017	(0.06)	-0.385**	(0.13)	0.017	(0.06)	-0.362***	(0.10)
Over 65	-0.002	(0.06)	-0.275*	(0.12)	-0.002	(0.06)	-0.282**	(0.10)
Income (comparison group "Over £4000")								
less than £900	-0.156*	(0.07)	-0.738***	(0.14)	-0.156*	(0.07)	-0.653***	(0.11)
£901 to £1500	-0.141*	(0.07)	-0.504***	(0.11)	-0.141*	(0.07)	-0.522***	(0.10)
£1501 to £2600	-0.082	(0.07)	-0.534***	(0.11)	-0.082	(0.07)	-0.517***	(0.09)
£2601 to £4000	-0.021	(0.07)	-0.441***	(0.11)	-0.021	(0.07)	-0.412***	(0.10)
Refused	-0.165*	(0.07)	-0.502***	(0.14)	-0.165*	(0.07)	-0.611***	(0.12)
Gtariff dummy	5.203	(89.07)	-0.503***	(0.14)	5.203	(89.07)	-0.422***	(0.12)
Effect of payment by others (comparison group "not affected")								
more interested	0.185***	(0.04)	-0.038	(0.07)	0.185***	(0.04)	0.008	(0.06)
less interested	-0.098	(0.07)	-2.093***	(0.40)	-0.098	(0.07)	-1.244***	(0.24)
μ1			0.253**	(0.10)			0.253**	(0.10)
μ2			-4.021***	(0.11)			-3.957***	(0.10)
μ3			-3.679***	(0.11)			-3.545***	(0.09)
μ4			-2.933***	(0.10)			-2.770***	(0.09)
μ5			-2.788***	(0.10)			-2.613***	(0.09)
μ6			-1.757***	(0.10)			-1.591***	(0.09)
Log likelihood:	-5890				-5890			
Number of observations:	4006				4006			

groups are less willing to pay compared to the highest income category.

Moving on to the behavioural variables, it is possible for those already choose to pay a voluntary tariff to have a different WTP. These respondents have already been contributing to support renewables thus they are already paying a higher utility bill. The results in Figure 5 support this, the WTP of those already paying a green tariff is lower than the rest of the sample.

EPRG surveys included a question to assess if the behaviour of other households would affect the respondent. The respondents were asked whether the knowledge that other households were purchasing green electricity would affect their decision to contribute to support renewables as well.[3]. The behaviour of other households does have a strong significant impact on respondents' WTP. Respondents have a higher likelihood of paying a positive amount if other households are also contributing to support renewables. Lower WTP is observed for respondents who stated they would be less interested in green electricity if they knew other households were also participating.

6.2 Explaining Respondent Certainty

The final research question addressed by this paper is with regards to whether the payment vehicle has an impact on the respondents' certainty of actually paying their stated WTP in real life.

Results from a fractional logit regression are presented in Figure 7 for the pooled sample and then for the separate survey samples[4]. The respondents who stated they preferred a voluntary payment option had less certainty of paying their stated WTP. Compared to the MM group, VM and VV groups had lower levels of certainty in their stated WTP.

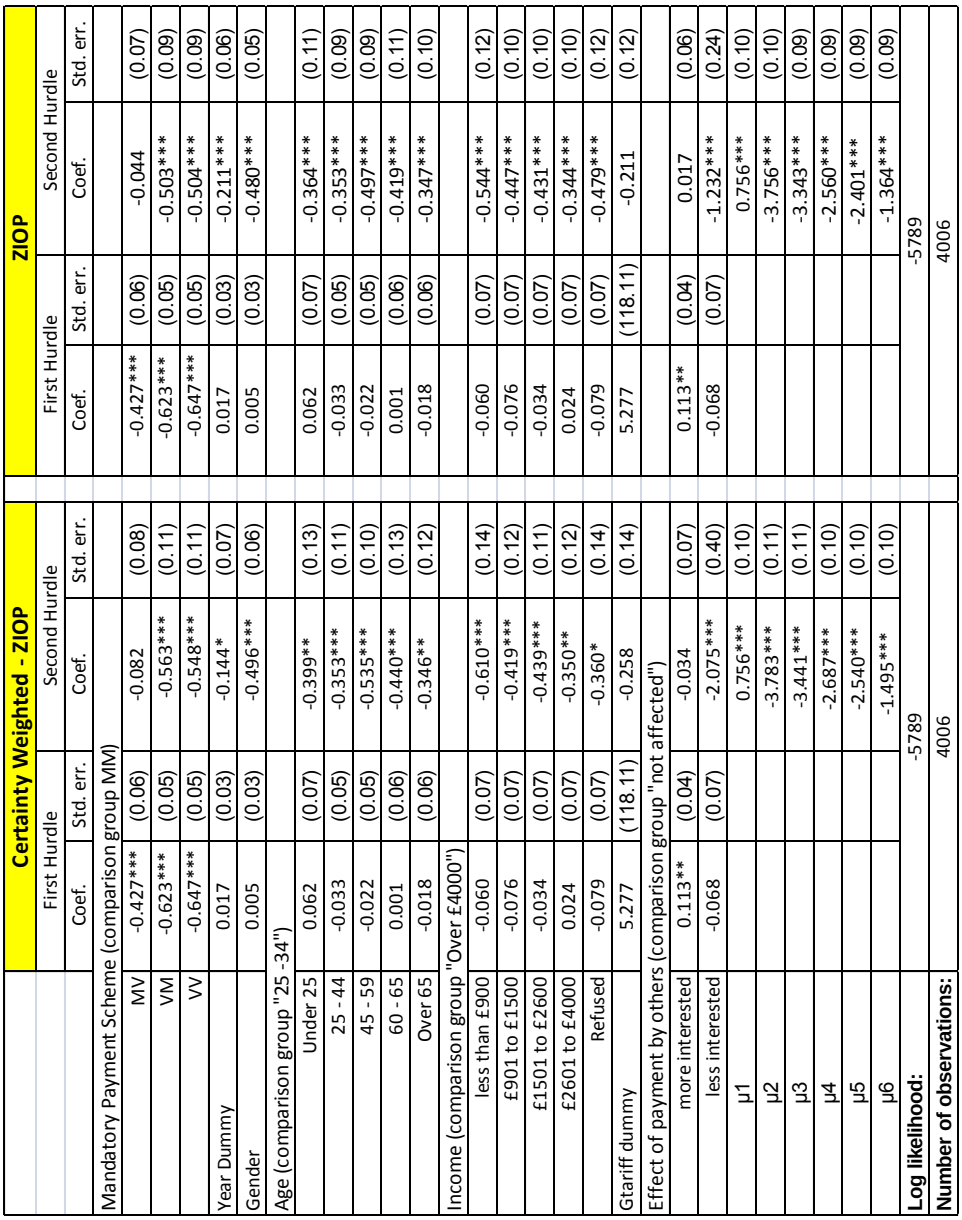
In terms of demographic factors, male and older respondent were more certain in their stated valuations as well as higher income groups. Behaviour of other households is again an important factor. The respondents who stated they would be affected by the behaviour of other households had lower levels of certainty compared to respondents who said they would not be affected by behaviour of others.

Figure 7 also presents the regression results separately for the 2008 and 2009 survey samples. Focusing on the results for the 2008 sample reveal that respondent's perception of their electricity supplier has an impact on certainty of WTP. In the 2008 survey, respondents were asked to rate their electricity supplier based on maintaining fair prices. Compared to those who rate their electricity supplier very favourably, the respondents rating their electricity supplier as neutral or unfavourable were less certain of their valuations.

[3]Please refer to Appendix B for a copy of the question.

[4]The fractional logit model is estimated in STATA using the glm (generalized linear models) command, with logit as the link function.

Figure 6: Results EPRG Surveys - Payment Method Effects



	Certainty Weighted - ZIOP				ZIOP			
	First Hurdle		Second Hurdle		First Hurdle		Second Hurdle	
	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.	Coef.	Std. err.
Mandatory Payment Scheme (comparison group MM)								
MV	-0.427***	(0.06)	-0.082	(0.08)	-0.427***	(0.06)	-0.044	(0.07)
VM	-0.623***	(0.05)	-0.563***	(0.11)	-0.623***	(0.05)	-0.503***	(0.09)
VV	-0.647***	(0.05)	-0.548***	(0.11)	-0.647***	(0.05)	-0.504***	(0.09)
Year Dummy	0.017	(0.03)	-0.144*	(0.07)	0.017	(0.03)	-0.211***	(0.06)
Gender	0.005	(0.03)	-0.496***	(0.06)	0.005	(0.03)	-0.480***	(0.05)
Age (comparison group "25 -34")								
Under 25	0.062	(0.07)	-0.399**	(0.13)	0.062	(0.07)	-0.364***	(0.11)
25 - 44	-0.033	(0.05)	-0.353***	(0.11)	-0.033	(0.05)	-0.353***	(0.09)
45 - 59	-0.022	(0.05)	-0.535***	(0.10)	-0.022	(0.05)	-0.497***	(0.09)
60 - 65	0.001	(0.06)	-0.440***	(0.13)	0.001	(0.06)	-0.419***	(0.11)
Over 65	-0.018	(0.06)	-0.346**	(0.12)	-0.018	(0.06)	-0.347***	(0.10)
Income (comparison group "Over £4000")								
less than £900	-0.060	(0.07)	-0.610***	(0.14)	-0.060	(0.07)	-0.544***	(0.12)
£901 to £1500	-0.076	(0.07)	-0.419***	(0.12)	-0.076	(0.07)	-0.447***	(0.10)
£1501 to £2600	-0.034	(0.07)	-0.439***	(0.11)	-0.034	(0.07)	-0.431***	(0.10)
£2601 to £4000	0.024	(0.07)	-0.350**	(0.12)	0.024	(0.07)	-0.344***	(0.10)
Refused	-0.079	(0.07)	-0.360*	(0.14)	-0.079	(0.07)	-0.479***	(0.12)
Gtariff dummy	5.277	(118.11)	-0.258	(0.14)	5.277	(118.11)	-0.211	(0.12)
Effect of payment by others (comparison group "not affected")								
more interested	0.113**	(0.04)	-0.034	(0.07)	0.113**	(0.04)	0.017	(0.06)
less interested	-0.068	(0.07)	-2.075***	(0.40)	-0.068	(0.07)	-1.232***	(0.24)
μ1			0.756***	(0.10)			0.756***	(0.10)
μ2			-3.783***	(0.11)			-3.756***	(0.10)
μ3			-3.441***	(0.11)			-3.343***	(0.09)
μ4			-2.687***	(0.10)			-2.560***	(0.09)
μ5			-2.540***	(0.10)			-2.401***	(0.09)
μ6			-1.495***	(0.10)			-1.364***	(0.09)
Log likelihood:	-5789				-5789			
Number of observations:	4006				4006			

Figure 7: Factors Affecting Respondents' Certainty in Paying their Stated Valuation

	Pooled			2008			2009	
	Coef.	Std. err.		Coef.	Std. err.		Coef.	Std. err.
Payment Scheme (comparison group MM)								
MV	-0.021	(0.08)		0.060	(0.11)		-0.102	(0.10)
VM	-0.516***	(0.10)		-0.315*	(0.13)		-0.666***	(0.16)
VV	-0.434***	(0.11)		-0.231	(0.17)		-0.668***	(0.14)
Year Dummy	0.137*	(0.07)						
Gender	-0.218***	(0.07)		-0.168	(0.10)		-0.258**	(0.09)
Age (comparison group "25 - 34")								
Under 25	-0.210	(0.12)		0.001	(0.18)		-0.319	(0.17)
25 - 44	0.103	(0.10)		0.282*	(0.14)		-0.074	(0.16)
45 - 59	0.145	(0.10)		0.179	(0.15)		-0.048	(0.14)
60 - 65	0.212	(0.12)		0.14	(0.16)		-0.004	(0.18)
Over 65	0.244*	(0.12)		-0.033	(0.20)		0.137	(0.16)
Income (comparison group "Highest Quintile")								
First Quintile	-0.476***	(0.13)		-0.495*	(0.19)		-0.447**	(0.17)
Second Quintile	-0.278*	(0.12)		-0.264	(0.17)		-0.342*	(0.16)
Third Quintile	-0.247*	(0.11)		-0.269	(0.15)		-0.231	(0.16)
Fourth Quintile	-0.113	(0.12)		-0.135	(0.16)		-0.082	(0.17)
Refused	-0.612***	(0.13)		-0.528*	(0.21)		-0.567**	(0.18)
Gtariff dummy	-0.083	(0.14)		-0.003	(0.19)		-0.179	(0.22)
Effect of payment by others (comparison group "not affected")								
more interested	-0.275***	(0.06)		-0.286**	(0.09)		-0.187*	(0.09)
less interested	-1.718***	(0.31)		-1.236**	(0.47)		-2.060***	(0.50)
Household Size				-0.110**	(0.04)			
Electricity Company Rating (comparator "very favourable")								
very unfavourable				-0.001	(0.27)			
unfavourable				-0.433*	(0.22)			
neutral				-0.433*	(0.19)			
favourable				-0.219	(0.21)			
Environmentalism Index				0.103***	(0.03)			
Financial Crisis Impact Index (comparison group "not at all affected")								
1							-0.438*	(0.17)
2							-0.369*	(0.16)
Constant	2.164***	(0.17)		2.288***	(0.36)		1.871***	(0.37)
Number of observations:	1278			664			614	
Significance: * p<0.05, ** p<0.01, *** p<0.001								

The timing of the EPRG surveys coincided with a highly volatile and economically uncertain period in the UK. Only a month prior to the 2008 survey Lehman Brothers filed for bankruptcy. The year in between the two surveys coincided with a period of declining asset prices and increasing uncertainty on employment. It is very likely that the respondents were influenced by the economic situation during this period. A question was included in the 2009 survey to capture the effect of the financial crisis on the respondents. Respondents were given a list of ways they could have been impacted by the crisis including losing their job and facing decreasing value of property[5]. The respondents checked all the areas from the list that applied to them. An index was formed from their responses indicating the total number of areas checked by the respondent. The index is zero if the respondent stated they had not been affected by the recession. The last column in Figure 7 presents the results for the 2009 sample regression which included this additional index on the financial crisis impact. The results indicate that compared to those who were not affected by the crisis, those affected by one or two of the listed areas had lower levels of certainty.

7 Conclusions

The primary objective of this paper has been to investigate payment method effects on WTP for renewables and the certainty expressed by UK households in actually paying their stated valuations. The findings presented in the previous section display a mixed picture. UK households prefer a voluntary payment scheme to support renewables, however, they are more likely to contribute under a mandatory scheme as well as being more certain of their WTP.

The amount of stated monetary contribution is found to be higher under a voluntary scheme but respondents are less certain in paying the amount that they state. However, behaviour of other households can have a highly significant positive effect. Overall, the policy conclusion that can be drawn from this research is that voluntary measures are unlikely to provide a substantial and sustained support for renewables in the UK. A mandatory provision, such as a public service obligation, where everyone in the society contributes is likely to be the more financially sustainable alternative. The EPRG surveys also reveal the profile for the "green consumer": male, affluent, 25-35 years old, and environmentally conscious.

[5]Please refer to Appendix C for a copy of the question.

Appendices

A EPRG 2008 and 2009 Survey Question - WTP for Supporting Renewables

Bearing in mind that your current bill is xxx would you be willing to pay 10% of your current electricity bill extra per month on a long term basis eg for more than five years, for electricity generated from renewable energy sources? Please answer this question bearing in mind how much you are able to afford.

1. Yes - would pay
2. No - would not pay this much

B EPRG 2008 Survey - Question on the Behaviour of Other Households

Which one of the following statements do you most agree with?

1. My household would be more interested in purchasing renewable energy if we knew that many other households were also purchasing renewable energy.
2. My household would not be affected by the behaviour of other households when deciding whether to purchase renewable energy.
3. My household would be less interested in purchasing renewable energy if we knew that many other households were also purchasing renewable energy.

C EPRG 2009 Survey - Question on the Effects of the Financial Crisis

Which of the following have you been affected by in the last year? (please tick ALL that apply)

1. A decrease in the amount of your disposable household income
2. A decrease in the value of your property
3. A decrease in personal borrowing
4. A decrease in investment income
5. Increased food bills
6. Increased household bills including electricity heating
7. You or a close family member has been made redundant
8. You have been unable to find a job
9. You are having to use your savings to make ends meet
10. None of the above, I have not been affected by the recession

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