Willingness to Pay for Climate Change Mitigation: Evidence from China

Yujie Li[a], Xiaoyi Mu[b, *], Anita Schiller[b], Baowei Zheng[c]

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Abstract

China has become the largest emitter of carbon dioxide in the world. However, the Chinese public's willingness to pay (WTP) for climate change mitigation is, at best, under-researched. This study draws upon a large national survey of Chinese public cognition and attitude towards climate change and analyzes the determinants of consumers' WTP for energy-efficient and environment-friendly products. Eighty-five percent of respondents indicate that they are willing to pay at least 10 percent more than the market price for these products. The econometric analysis indicates that income, education, age and gender, as well as public awareness and concerns about climate change are significant factors influencing WTP. Respondents who are more knowledgeable and more concerned about the adverse effect of climate change show higher WTP. In comparison, income elasticity is small. The results are robust to different model specifications and estimation techniques.

Key words: Willingness to pay; climate change; China; interval regression

Authors' affiliations:

a. School of Statistics, Renmin University of China, Beijing, P.R. China
b. Center for Energy, Petroleum and Mineral Law and Policy, University of Dundee, Dundee, UK
c. School of Journalism and Communication and China Center for Climate Change Communication, Renmin University of China, Beijing, P.R.China
* Correspondence author

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1 Introduction

Since 2006, China has overtaken the United States to become the largest emitter of carbon dioxide in the world (United Nations, 2013). Despite the often-heated debate about what responsibilities China should undertake in international climate change negotiations, little is known about the Chinese public's willingness-to-pay (WTP) for climate change mitigation measures. In this study, we draw upon a large national survey of Chinese public cognition and attitude towards climate change and analyze the determinants of consumers' WTP for energy-efficient and environment-friendly products.

The survey, which was conducted in July-September 2012, has a sample of 4,169 adults from different households over all 31 provinces of mainland China. Respondents were asked, *inter alia*, how much more they would be willing to pay for energy-efficient and environment-friendly products if these products were to cost more. The majority (85 percent) of the respondents indicate that they are willing to pay at least 10 percent more than the market price and the median WTP is 10-20%. We study the determinants of WTP by estimating an interval regression model, with a robustness check using an ordered probit model. In addition to socio-economic variables such as income, age, education and gender, public awareness and concern over climate change are found to be significant factors influencing WTP for climate change mitigation in China.[1] In comparison, the income elasticity of WTP is small.

While there is a large body of literature examining WTP for climate change mitigation programs or environmental preferences in industrialized countries (see, for example, Lee and Cameron, 2008; Aldy *et al*., 2012; and De Silva and Pownall, 2013, among others)[2], much less is known about this issue in developing and emerging economies. Aklin *et al* (2013) study the

[1] We will use the word "knowledge" and "awareness" interchangeably throughout the paper.
[2] For a survey of the recent literature, see, Johnson and Nemet (2010).

relationship between income, education and people's environmental preferences in Brazil using survey data and find that education, but not income, is a significant predictor of environmental preferences. In the case of China, we are aware of only a handful of studies that have examined consumers' WTP for climate change mitigation.[3] Carlsson *et al* (2012) use the contingent valuation method to conduct a multiple country study of WTP for climate change, including China, Sweden, and USA. Their Chinese sample has 1,264 respondents from four cities and they find that university education and income are significant determinants of WTP. Zeng (2011) surveyed 1,400 households in four cities – Beijing, Chongqing, Jiujiang, and Nanning – for their WTP for three different CO_2 reduction scenarios by 2050 and find that education, household income, and occupation are among the important determinants of WTP. In a similar study, Duan *et al* (2014) surveyed 1,653 respondents from four provinces – Beijing, Shanghai, Shandong and Fujian – on the Chinese public's WTP for policies to reduce CO_2 emissions and the analysis shows that age, gender, income, life satisfaction and awareness of climate change are important determinants. Participants who are male, young, and with higher income, higher satisfaction with their current life, and awareness of climate issues are willing to pay more for CO_2 emissions reductions. In another study, Yang *et al* (2014) conducted a survey in one city, Suzhou, on the east coast of China. Their sample has 840 respondents and they find that age, education, income, along with risk perception of climate change and attitude towards government policies (feeling dread of greenhouse gas emissions, confidence in policy and information disclosure) are important factors influencing WTP.

Our study differs from the existing studies on China in two important aspects. The first lies in the data. Our sample covers all 31 provinces and more than 4000 respondents, which is much

[3] In addition, Woo *et al* (2014) survey the residents in Hong Kong about their WTP to reduce CO_2 emissions from alternative electricity generation technologies.

larger and more representative than the samples of any of the previous studies. Second, we also study the role of public awareness and perception in explaining variations of WTP. With the exception of Yang et al (2014) and Duan et al (2014) who touch upon the importance of public awareness and risk perceptions, most of the previous studies focus on socio-economic factors and political preferences. The results show that respondents who are more knowledgeable and more concerned about the adverse effect of climate change have a higher WTP after controlling for their revealed environmental preferences, which are approximated by how often they perform certain environment-friendly activities in their daily lives.

The paper proceeds as follows. The next section describes the survey design and presents the summary statistics of the data. In section 3, we examine the determinants of WTP by estimating an interval regression model and an ordered probit model. Section 4 summarizes our findings and conclusions.

2 The Survey

The survey was developed by the China Centre for Climate Change Communication at Renmin University of China. The full sample consists of 4,169 households, representing about 0.001 percent of total households, and covers all 332 sub-provincial, prefectural-level municipalities and the four provincial level municipalities (e.g. Beijing, Shanghai, Tianjin and Chongqing) in all the 31 provinces of mainland China.[4] The sampling scheme is as follows. First, the total number of households was divided between the 336 municipalities in proportion to their population according to the 2010 census. Next, within each municipality, the sampled households were randomly selected on the basis of telephone numbers. If one number did not answer, then

[4] A prefecture is the second sub-national division in China's administrative hierarchy. A prefecture is under a province and normally contains several counties or county-level cities.

another randomly chosen number from the same prefecture was called until the predetermined number of samples in each municipality was reached. A small bonus in the form of phone credit was provided to incentivize the response. The survey was conducted in July-September, 2012. Before the full survey was launched, a pilot survey with 200 respondents in Beijing was conducted to validate the questions.

The purpose of the survey was to investigate public cognition of climate change and attitude towards relevant mitigation measures. Respondents were asked a broad array of questions regarding their knowledge about the causes and influence of climate change, opinions about adaptation and mitigation, their behavior relating to energy conservation and environmental protection, the effectiveness of climate change communication, and socio-economic factors. For the present study, we focus on the influencing factors of the stated WTP for climate change mitigation. The full questionnaire has four sections.[5] The first section of the questionnaire asks about the respondents' knowledge and perception about climate change and the following questions are included in this section:

1. How much do you know about climate change?

   (A) I know a lot about it. (B) I know something about it. (C) I know just a little about it. (D) I've never heard of it. (E) Refuse to answer. (F) Don't know.

2. How worried are you about global warming?

   (A) Very worried. (B) Somewhat worried. (C) A little worried. (D) Not worried at all. (E) Refuse to answer. (F) Don't know.

In what follows, the variables *Knowledge* and *Worry* measure the responses to these two questions respectively. *Knowledge* and *Worry* are defined on a range of 1 to 4, with 1 indicating "I've never heard of it" ("Not worried at all") and 4 "I know a lot about it" (Very worried).

[5] The full questionnaire is provided in the web appendix and is available from the corresponding author upon request.

Additionally, this section also asks whether the respondents think climate change is happening (after briefly explaining what climate change is) and whether they think climate change is caused by human activities, natural changes in the environment, or does not happen at all (Question A2 and A3). In the empirical section, we will examine how these beliefs influence WTP.

The next section of the questionnaire focuses on public opinions and attitudes towards climate change mitigation measures and policies, including questions on whether they believe humans can cope with climate change challenges, how much they are willing to pay for energy-efficient and environmentally friendly products, whether they support a range of environment-related policies, and how often they behave environmentally. In particular, the following WTP question is asked in this section:

3. At most, how much more would you be willing to pay for energy-efficient and environmentally friendly products if they cost more than market price?

   (A) I will not pay more. (B) 10%. (C) 11-20%. (D) 21-30%. (E) Over 30%. (F) Refuse to answer. (G) Don't know.

Even though this question is not directly about climate change, we interpret it as a question about WTP for climate change mitigation given the context.[6]

Section 3 of the questionnaire relates to the effectiveness of climate change communication in both the sources of information and channels of communication. The last section asks respondents social demographic information, including age, gender, education, occupation, and household income. Table 1 reports the summary statistics of the variables by where the respondent

[6] It may be argued that participants choose to pay more because of private returns from energy savings rather than paying for global public goods of climate change mitigation. However, given that China derives 90 percent of its primary energy supply from fossil fuels, of which 70 percent is from coal, and that nearly 90 percent of China's CO_2 emission is from burning fossil fuels (Carbon Dioxide Information Analysis Center, 2014), we argue that paying for energy savings is effectively equivalent to paying for CO_2 reduction.

lived during the past 12 months. Because age, household income, and WTP are all measured in intervals, we report the medians instead of means for these variables.

To check the representativeness of the data, we compared household income with the official statistics reported by the National Bureau of Statistics (NBS). According to the NBS, in 2011, the median household disposable income was 55,440 RMB in the urban areas and 24,180 RMB in the rural areas, corresponding well with the household incomes reported in our survey.[7] About 55 percent of the survey respondents live in urban areas. The ratio is slightly higher than that of the urban population in the 2010 census (which was 50 percent) and is most likely because telephones are more common in urban than in rural areas. Both sexes responded to the survey although males have a higher probability in responding to the calls, especially in rural areas. The survey didn't ask the exact age of the respondents, but we know which cohort they belong to. The variable *Age* is thus coded as an ordinal variable ranging from 1 for the cohort of 18-25 years old, 2 for 26-35 years old, to 6 for those older than 65 years. The median age cohort is 36-45 years old in the rural and 26-35 years old in the urban areas, reflecting a generally younger population in the urban areas, which is not surprising as the rapid urbanization offers young people more job opportunities. Education is recorded in four categories, including primary school and below, middle school, high school, and college degrees or above. The variable *Education* is again defined as an ordinal variable ranging from 1 for primary education to 4 for college degree. The mean education attainment of the urban respondents is clearly higher than that of the rural respondents. We note that the share of subjects with a university education is higher than the population share,

[7] The NBS does not directly report household income. Instead, it has data on per capita disposable income and the average household size. In 2011, the median per capita disposable income was 6,194 RMB for the rural and 19,118RMB for the urban. The average household size was 3.9 and 2.9 people respectively in rural and urban areas.

which is common in a telephone survey of adults because better educated family members (typically the head of the household) are more likely to answer the phone.[8]

The median WTP for the full sample as well as the urban and rural samples is "11-20%". However, there are some differences in the distribution of the WTP between rural and urban respondents. As shown in Table 1a, compared to urban residents, a higher percentage of rural residents are not willing to pay extra for the energy-saving and environment-friendly products, and a lower percentage choose "11-20%". Figure 1 depicts the distribution of WTP for the full sample. "11-20%" is also the mode and mean response. Notably, excluding those answering "I don't know" or "Refuse to answer", only 15 percent of the respondents are not willing to pay extra for the "cleaner" products.[9] With regard to knowledge, on average, urban respondents are slightly more knowledgeable about climate change than their rural counterparts, but the difference is minimal. Similarly, there is no discernible difference between rural and urban respondents when asked "how worried are you about global warming?" Figure 2 presents the distribution of *Knowledge* and *Worry*. While only 10 percent of the respondents claim that they have never heard of the topic, nearly 50 percent acknowledge that they know only a little about it. In terms of "worry", the distribution is clearly skewed to the right in that more than 55 percent of subjects are "somewhat worried". [10]

One might suspect that *Knowledge* is highly correlated with *Worry*. However, as shown in Table 1b, this is not the case. The correlation between *Knowledge* and *Worry* is only 0.18, and the correlation between *Knowledge* and *Education* is 0.27. In contrast, educational attainment has a

[8] For example, the share of people with a university degree in the general population is 8.93% according to the 2010 census, while in our sample the figure is 20%.

[9] With those answering "I don't know" or "refuse to answer" included, the figure is 18 percent. The percentage of zero WTP is similar to Carlsson *et al*.'s (2012) finding in their Chinese sample (12 percent), but lower than that of their US sample (24 percent).

[10] We acknowledge that the answers to the "Worry" question, particularly "somewhat worried" and "a little bit worried", are not well delineated, which may contribute to the low correlation between *Knowledge* and *Worry*.

higher correlation of 0.21 with household income, which is conceivable as better education offers more opportunities to get higher-paid jobs and may also lead to entrepreneurship.

3 The determinants of WTP

We now turn to the econometric analysis of the survey responses to investigate the determinants of WTP. Because the WTP data is only observed at intervals, we estimate an interval regression model. To check the robustness of our results, we also estimate an ordered probit model.

3.1 Results from Interval Regression

Let W^*_i denote individual i's WTP for the extra cost associated with the energy-efficient and environment-friendly products and is determined by

$$W^*_i = X_i\beta + \varepsilon_i \,, \tag{1}$$

where X_i is a vector of covariates, β is a vector of coefficients to be estimated, and ε is the error term. W^*_i is measured in percentage points, but only observed at intervals and right censored, which is denoted as W_i. The covariates include both the socio-economic variables, including *Household Income*, *Age*, *Male*, *Education*, and *Urban*, and the two variables measuring the respondent's awareness of and attitude towards climate change, namely, *Knowledge* and *Worry*. To facilitate the interpretation of the coefficient, income enters equation (1) in the logarithm of the midpoint of each income interval. *Age*, *Education*, *Knowledge* and *Worry* are ordinal variables as previously defined. *Male* and *Urban* are dummy variables which take the value of one if the respondent is male and has lived in an urban area in the past 12 months. When the dependent variable W is observed at intervals and censored, as in our case, interval regression using

maximum likelihood methods is suitable for modeling this type of outcome (Cameron and Trivedi, 2005, p.532-538).

The estimation results are reported in Table 2. Because of missing values of the WTP and covariates, the full sample used for the estimation contains 3,557 observations, still covering all 31 provinces in China[11] (see appendix 1). All specifications include 30 provincial dummy variables to control for the fixed effect. We start with a model specification where only the socio-economic variables are included in the first column. The model with *Knowledge* and *Worry* variables are reported in column (2). The estimated coefficients for the socio-economic variables are similar across specifications. *Income, Age, Education,* and *Male* are found to be statistically significant at the one percent level. The results broadly agree with the existing literature (Zeng, 2011; Carlsson *et al*, 2012; Yang *et al*, 2014; and Duan *et al*, 2014). Not surprisingly, income has a positive effect on an individual's WTP for "greener" products. However, the estimated coefficient for the logged income variable suggests that, even doubling the income, which is the government's target for income growth during the period of 2010 to 2020, WTP will increase only 1.2 percentage points. Given the mean WTP of 11-20%, this suggests an income elasticity of WTP around 0.1, which is smaller than those reported by Carlsson *et al* (2012) for China, but not much different from their estimated income elasticity for the U.S. Consistent with most of the findings in the literature (Diaz-Rainey and Ashton, 2011; Aldy *et al*, 2012 and Duan *et al*, 2014), age is negatively associated with WTP. As age moves up by one cohort (10 years), the WTP decreases by 0.5 percentage point on the basis of the baseline model result in Column (2). Similar to Aklin *et al* (2013) and Yang *et al* (2014), we find that education significantly affects an

[11] One concern is that "refuse to answer" may signal the respondent's attitude towards the question, which could potentially lead to sample selection bias. For the WTP question, the percentage of "refuse to answer" in the full sample is negligible--merely 0.17 percent, with another 3.12 percent of respondents choosing "I don't know". The low percentage of the nonresponsive subjects is unlikely to significantly bias our results..

individual's WTP after controlling for income. Being more educated, e.g., having a college education instead of only a high school diploma, increases the average WTP by 0.7-1.2 percentage points. Male respondents show a higher WTP than females, which is consistent with the findings of Carlsson *et al* (2012) and Duan *et al* (2014). After controlling for the socio-economic effects, urban residents' WTP is not significantly different from that of rural residents. Although not reported, the majority of the provincial fixed effects are not statistically significant. Indeed, after controlling for the impact of socio-economic and cognitive factors, there is no reason to believe that the WTP of consumers in one province would be systematically higher than that in other places.

Knowledge and *Worry* are found to be both statistically significant and economically meaningful. Consumers who are more knowledgeable about climate change and who are more worried about its negative impact are willing to pay more for energy efficient and environmentally friendly products. The estimated coefficient for *Knowledge* indicates increasing consumers' knowledge about climate change by one level is, on average, associated with a 1.1 percentage point higher WTP. Not surprisingly, concerns about the adverse effect of climate change (*Worry*) have an even larger effect. On average, a higher level of *Worry* is associated with a 1.5 percentage point higher WTP. The result agrees with Yang *et al* (2014) in that the dread of climate change is an important influencing factor of WTP.

One potential concern with the *Knowledge* and variables is that they could be correlated with the error term in the *WTP* equation and bias the estimated coefficients. Someone who is environmentally conscious and therefore willing to pay more for environmentally friendly products, is more likely to become knowledgeable about climate change. To examine this issue, we make use of information on respondents' environment-related behavior. Section two of the

questionnaire includes a question asking to what extent they behave environmentally in ten different types of daily activities including turning off lights when they are not used, turning off electronic appliances like TV and computers when they are not used, recycling, and saving water.[12] The answers to this question include "1 always", "2 often", "3 sometimes", "4 rarely" and "5 never". We create a variable "Act" which is the average score of the ten types of activities with a coding scheme of 5 for "always" and 1 for "never", so that a higher value of "Act" indicates a respondent who is more environment-conscious. Since *Act* represents the environment-consciousness of a respondent, the inclusion of this variable should help control the correlation between *Knowledge* and the error term in equation (1). Column 3 of Table 2 reports the estimation results when *Act* is added to the regression. As one would expect, the effect of environmental consciousness on WTP is significant and large. Take the estimated value for example, someone who 'often' acts environmentally has an average of 2 percentage points higher WTP than someone who 'sometimes' behaves environmentally. The inclusion of this variable indeed somewhat lowers the effect of *Knowledge* and *Worry*, but they remain statistically significant and economically meaningful. That is, after controlling for their revealed environmental preferences, respondents who are more knowledgeable and more concerned about climate change are still willing to pay more for energy-saving and environmentally friendly products. The results for other variables are quite similar to those reported in column (2).

Since our main WTP question is not directly about climate change, another potential concern is that it may include respondents who are not genuinely paying for climate change. For example, if they don't believe climate change is caused by human activities, or if they don't think

[12] The ten questions are: 1) turn off the lights when they are not needed; 2) turn off electronics like TV and computer when they are not being used; 3) reuse things you already have instead of buying new things; 4) use reusable shopping bags; 5) reduce the use of disposable dishware and cups; 6) reduce the use of air conditioning; 7) save water as much as possible, for example, when you brush your teeth and shower; 8) buy locally grown food; 9) classify garbage; and 10) walking, bicycling, or taking public transport instead of driving.

changes to human behaviors are required to cope with climate change, their answers to the WTP question may mainly reflect their calculations of private returns from energy-savings. In order to examine whether our results systematically differ across the subgroups, we created two dummy variables, *Cause* and *Cope*. *Cause* is equal to one if a respondent believes climate change is caused mainly by human activities and zero otherwise (Question A3 in the questionnaire). Similarly, *Cope* is equal to one if a respondent agrees that 'human beings can't easily meet the challenges posed by climate change unless we change our behavior' and zero otherwise (Question B1 in the questionnaire). In the full sample, 59 percent of respondents think climate change is caused mainly by human activities and another 32 percent think it is caused by natural changes in the environment, whereas 76 percent agree that changes in human behavior are required to cope with climate change.[13]

The estimation results for the model, with the inclusion of these dummy variables, are reported in columns (4) and (6) respectively. The estimated coefficients for *Cause* and *Cope* are both positive yet not statistically significant at the five percent level, indicating, on average, a slightly higher WTP from those who either believe climate change is mainly caused by human activity or think changes in human behavior are necessary to cope with climate change. Next, we investigate if income or knowledge of and concern about climate change affect WTP differently by including a set of interaction terms between the group dummy (*Cause* or *Cope*) and the logged income, *Knowledge* and *Worry* variables. The results are reported in columns (5) and (7) of Table 2. None of the interaction terms is statistically significant at the five percent level. Thus, there is no evidence that the effect of income or knowledge of and concern about climate change on a

[13] It is entirely possible that someone who does not believe climate change is caused by human activities yet agrees that changes in human activities are necessary to cope with the challenges of climate change. An analogy would be earthquake which is not caused by human activities yet humans can adapt to mitigate the influence of earthquake, for example, by strengthening the building qualities.

respondent's WTP varies systematically with his/her perception about the causes of climate change or attitude towards climate change mitigation. Taken together, the results indicate that, despite a slightly higher average WTP from those who believe in anthropogenic climate change, the difference is not significant and the determinants of WTP for these "greener" products are similar across the subgroups. In what follows, we will, therefore, focus the discussion on the results from the full sample.

So far we have treated the categorical variables (*Age, Education, Knowledge* and *Worry*) as ordinal variables. While this approach allows us to estimate the average effect of a variable on the stated WTP, it imposes linearity on the impact of each variable. In table 3, we replace these categorical variables with a set of dummy variables where the omitted category represents the group which has the lowest value in each of the variables (i.e., the group aged 18-25 and having only primary education, who know nothing about climate change and do not worry about it). The result confirms varying degrees of nonlinearity in the effect of these variables. For example, while the estimated coefficient for the group aged 56-65 is about 2.2-3 percentage points lower than the reference group, there are no significant differences between the groups aged 26-35 and 46-55, and the 36-45 cohort has a slightly higher WTP. While all consumers with middle school or higher education have indicated a significantly higher WTP, there is no significant difference between those with high school education and those who are college-educated. As for the cognition and attitude variables, there is some nonlinearity in the *Knowledge* variable as well. From the full sample, those who know "a little bit" about climate change are willing to pay about 1.5 percentage points more than those who have never heard of it and those claiming to "know something" are willing to pay another 1.5 percentage points more, however those who "know a lot" do not appear to be willing to pay much more than those "who know something". In contrast, the

effect of *Worry* is rather linear in that those who are more concerned about the adverse effect of global warming are willing to pay more.

3.2 Results from the Ordered Probit Model

To check the robustness of our results, in this section we estimate an ordered probit model to examine the impact of socio-economic and cognition variables on the probability of a respondent's stated WTP falling into one of the answer categories.[14] The ordered probit model assumes that a consumer's true underlying WTP, denoted by W_i^*, is unobservable and the respondent's choice of WTP, denoted by W_i, is observed by the researcher. W_i falls into one of the ordered categories, denoted as category j. In this case, there are five categorical choices: 0, 10%, 11-20%, 21-30% and greater than 30%.

$$W_i = \begin{cases} 1 & if\ 0 \le W_i^* < C1, \qquad for\ j = 1 \\ j & if\ C_{j-1} \le W_i^* < Cj \qquad for\ j = 2,3,4 \\ 5 & if\ C_4 \le W_i^* \qquad for\ j = 5 \end{cases} \tag{2}$$

where C_j are unknown cutoff parameters to be estimated. Let $F(.)$ denote the standard normal cumulative distribution function, then the probability $Pr(W_i = j)$ is

$$Pr(W_i = j) = \begin{cases} Pr(0 \le W_i^* < C1) \\ \quad = F(C_1 - X'\beta) - F(-X'\beta), \qquad for\ j = 1 \\ Pr\left(C_{j-1} \le W_i^* < Cj\right) \\ \quad = F\left(C_j - X'\beta\right) - F\left(C_{j-1} - X'\beta\right), \qquad for\ j = 2,3,4 \\ Pr(C_4 \le W_i^*) \\ \quad = 1 - F(C_4 - X'\beta) \qquad for\ j = 5 \end{cases} \tag{3}$$

The estimation results using dummy variables for *Age*, *Education*, *Knowledge* and *Worry* are reported in Table 4. Columns 1-3 are for the full sample and columns 4 and 5 are, respectively, for the subsample of those who believe climate change is caused mainly by human activities and

[14] While not reported, we also estimated an ordered logit model. The results are similar to those reported in Table 4.

those who generally agree that changes to human behavior are required to cope with climate change. The results are qualitatively similar to those reported in Table 2 & 3. An individual with a higher income, young, better educated, male, more knowledgeable and more concerned about climate change, and more environmentally conscious in daily life is more likely to choose a higher WTP for energy-saving and environment-friendly products. The pattern is largely consistent between the full sample and the more restricted samples although, among those who believe climate change is caused by human activities, age (other than the 26-35 cohort) and education are generally not statistically significant because of the large standard errors.

To facilitate interpretation, in Table 5 we compute the marginal effects of each variable on the probability of choosing a possible answer for the WTP question using the full sample estimation result of the ordered probit model that is reported in column 3 of Table 4. As income increases, the probability of choosing a higher WTP increases, and the probability of choosing a lower WTP decreases. Respondents who are younger, better educated, male and those who are more environmentally conscious in daily life are more likely to choose a higher WTP. Similarly, a respondent who is more knowledgeable and more concerned about climate change is more likely to have a higher WTP. It is noteworthy that the marginal effects of *Knowledge* and *Worry* are large. For example, looking at the fourth column, a respondent who 'knows something about it' has 2.2 percentage points higher probability of WTP 21-30% for the environmentally friendly products than the reference case person who has never heard of it. In comparison, the effect of doubling income can only increase the probability of choosing that particular answer by one percentage point.[15] *Worry* has an even larger effect.

4 Conclusion

[15] Doubling the income would increase the logarithm of the income by 0.693. So, the marginal effect of doubling the income is to increase the probability of WTP being 21-30% by 0.97 percentage points.

This paper draws upon data from a large national survey covering all 31 provinces in mainland China. The survey finds that 85 percent of the respondents are willing to pay at least 10 percent more for energy-efficient and environment-friendly products if they cost more than otherwise would be. We employ an interval regression model and an ordered probit model to study the determinants of stated WTP for climate change mitigation. The results show that income, education, age, gender, and public knowledge and concerns about the adverse effect of climate change are important factors influencing consumers' WTP. In particular, consumers who are more knowledgeable about climate change and more concerned about its effects have a significantly higher WTP. In comparison, income elasticity is small. The result is robust to different model specifications and estimation methods as well as more restricted samples.

The outcome of international climate change negotiation depends crucially on each nation's willingness to commit to reducing greenhouse gas emissions which, in turn, is subject to the acceptance of citizens. As the economy grows and environmental problems worsen, China, currently the largest carbon emitter in the world, has shown a greater willingness to take on more responsibility to curb its carbon emissions.[16] If the policy goal is to increase the public's WTP for climate change adaptation and mitigation measures, our study suggests that improving public knowledge about climate change and its impact through efforts such as education, communication, and public awareness campaigns might be an effective way of building political support for climate policies.

The research can be extended in several ways. First, although the main WTP question in our survey directly asks consumers about their "out-of-pocket" WTP rather than some conjectural questions that are subject to future uncertain climate scenarios, it is after all a stated instead of

[16] For example, on 5 December 2012, the head of the Chinese delegation at the Doha climate talks pledged that "We will make our due contribution" to cutting greenhouse gas emissions (The Guardian).

revealed WTP. It would be interesting to study how the results compare with actual revealed WTP using consumers' purchase data of different products with varying energy-efficiency and environmental attributes. Second, given the important role of public knowledge in influencing the stated WTP, a natural extension is to study which types of information, communication channels and consumer engagement activities are most effective in raising public awareness.

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Table 1 Descriptive Statistics

	Rural		Urban		Total	
	N	Median/Mean (std. dev.)	*N*	Median/Mean (std. dev.)	*N*	Median/Mean (std. dev.)
Age	1477	26-35	2676	26-35	4161	26-35
Education	1480	2.491 (0.923)	2678	3.274 (0.851)	4169	2.995 (0.954)
Male (1=yes)	1480	0.612 (0.487)	2678	0.556 (0.497)	4169	0.577 (0.494)
Household income (1000RMB)	1332	20-30	2342	50-60	3681	30-40
WTP	1429	11-20%	2594	11-20%	4032	11-20%
Knowledge	1470	2.201 (0.760)	2664	2.419 (0.760)	4145	2.341 (0.767)
Worry	1475	2.924 (0.848)	2673	2.936 (0.794)	4159	2.932 (0.814)

Note: **N** represents the number of responses except those who chose "Don't know" or "Refused to answer" the particular question. The statistics are medians for Age, Household income, and WTP, and means and standard deviations (in parentheses) for Education, Male, Knowledge, and Worry.

Table 1a. Distribution of WTP between Urban and Rural

	Zero	10%	11-20%	21-30%	>30%	Total
Rural	21%	25%	24%	13%	17%	100%
Urban	12%	25%	30%	15%	17%	100%

Table 1b. Correlation Coefficients

	Education	Knowledge	Worry
Knowledge	0.267 (0.000)		
Worry	0.074 (0.000)	0.177 (0.000)	
Household income	0.209 (0.000)	0.080 (0.000)	0.017 (0.287)

The significance levels (p-values) are displayed in parentheses.

Table 2 Interval Regression Results for Stated WTP

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log (Income)	1.725*** (0.252)	1.694*** (0.221)	1.754*** (0.239)	1.811*** (0.232)	1.367*** (0.395)	1.741*** (0.246)	1.488*** (0.433)
Age	-0.426*** (0.162)	-0.509*** (0.168)	-0.624*** (0.182)	-0.652*** (0.193)	-0.667*** (0.178)	-0.628*** (0.175)	-0.631*** (0.186)
Education	1.167*** (0.247)	0.782*** (0.267)	0.699*** (0.258)	0.579** (0.287)	0.591** (0.273)	0.673** (0.292)	0.678** (0.271)
Male	2.272*** (0.434)	2.258*** (0.426)	2.494*** (0.441)	2.406*** (0.424)	2.429*** (0.463)	2.438*** (0.456)	2.445*** (0.423)
Urban	-0.180 (0.529)	-0.168 (0.549)	-0.232 (0.507)	-0.435 (0.521)	-0.433 (0.516)	-0.281 (0.548)	-0.292 (0.529)
Knowledge		1.142*** (0.289)	0.926*** (0.308)	0.956*** (0.315)	1.171** (0.480)	0.890*** (0.331)	0.686 (0.578)
Worry		1.514*** (0.287)	1.372*** (0.291)	1.251*** (0.281)	0.922** (0.416)	1.248*** (0.295)	0.713 (0.520)
Act			2.024*** (0.471)	2.172*** (0.450)	2.165*** (0.433)	2.063*** (0.439)	2.077*** (0.425)
Cause				0.313 (0.465)	-8.271 (5.116)		
Income x Cause					0.723 (0.464)		
Knowledge x Cause					-0.375 (0.597)		
Worry x Cause					0.638 (0.551)		
Cope						0.965* (0.500)	-5.224 (5.184)
Income x Cope							0.338 (0.491)
Knowledge x Cope							0.256 (0.673)
Worry x Cope							0.718 (0.622)
Constant	-6.389** (2.702)	-11.875*** (2.971)	-18.470*** (3.248)	-19.203*** (3.213)	-14.153*** (4.733)	-18.650*** (3.285)	-14.112*** (4.884)
No of obs.	3,557	3,557	3,557	3,467	3,467	3,529	3,529
pseudo LL	-6688	-6660	-6647	-6424	-6422	-6573	-6573

For variable definitions, see text. Province fixed effects are included in all specifications. Bootstrapped standard errors based on 250 replications are reported in parentheses. *** (**, *) indicates significance at 1 percent (5, 10 percent) level.

Table 3 **Interval Regression Results for Stated WTP**

Variable	(1)	(2)	(3)
Log(Income)	1.750***	1.714***	1.773***
	(0.241)	(0.237)	(0.261)
Age 26-35	-1.492***	-1.545***	-1.636***
	(0.539)	(0.559)	(0.591)
Age 36-45	-0.940	-1.235*	-1.427**
	(0.664)	(0.653)	(0.646)
Age 46-55	-1.358**	-1.616**	-1.948***
	(0.683)	(0.721)	(0.697)
Age 56-65	-2.285**	-2.462**	-2.949***
	(0.900)	(0.963)	(0.924)
>Age 65	-2.111	-2.470*	-3.044*
	(1.469)	(1.500)	(1.642)
Middle School	2.355**	1.943**	1.848**
	(0.937)	(0.868)	(0.868)
High School	4.057***	3.247***	3.041***
	(0.867)	(0.935)	(0.883)
College and above	4.183***	2.964***	2.714***
	(0.958)	(0.936)	(0.911)
Male	2.287***	2.270***	2.498***
	(0.431)	(0.426)	(0.445)
Urban	-0.124	-0.110	-0.173
	(0.482)	(0.478)	(0.525)
Knowledge – a little		1.597**	1.308*
		(0.733)	(0.698)
Knowledge - something		2.920***	2.404***
		(0.808)	(0.774)
Knowledge - a lot		3.059**	2.448**
		(1.193)	(1.049)
Worry – a little		2.308**	2.350***
		(1.011)	(0.912)
Worry - somewhat		3.151***	2.926***
		(0.867)	(0.852)
Worry – very		4.941***	4.608***
		(0.943)	(0.937)
Act			2.011***
			(0.436)
Pseudo LL	-6682	-6652	-6640
No. of obs.	3,557	3,557	3,557

Notes same as Table 2.

Table 4 **Ordered Probit Results for Stated WTP**

Variable	(1)	(2)	(3)
Log(Income)	0.150***	0.147***	0.153***
	(0.021)	(0.021)	(0.019)
Age 26-35	-0.102**	-0.106**	-0.114**
	(0.051)	(0.049)	(0.047)
Age 36-45	-0.066	-0.090*	-0.107**
	(0.057)	(0.055)	(0.052)
Age 46-55	-0.108*	-0.126**	-0.155**
	(0.064)	(0.061)	(0.063)
Age 56-65	-0.200**	-0.211**	-0.254***
	(0.084)	(0.091)	(0.084)
>Age 65	-0.171	-0.205	-0.254*
	(0.131)	(0.132)	(0.154)
Middle School	0.291***	0.247***	0.238***
	(0.095)	(0.095)	(0.087)
High School	0.450***	0.371***	0.352***
	(0.091)	(0.097)	(0.089)
College and above	0.482***	0.365***	0.343***
	(0.093)	(0.099)	(0.091)
Male	0.177***	0.180***	0.200***
	(0.037)	(0.036)	(0.037)
Urban	0.012	0.014	0.009
	(0.042)	(0.041)	(0.048)
Knowledge – a little		0.180**	0.153**
		(0.075)	(0.071)
Knowledge - something		0.292***	0.246***
		(0.079)	(0.074)
Knowledge - a lot		0.293***	0.239**
		(0.095)	(0.099)
Worry – a little		0.292***	0.295***
		(0.099)	(0.093)
Worry - somewhat		0.369***	0.348***
		(0.086)	(0.088)
Worry – very		0.495***	0.465***
		(0.095)	(0.096)
Act			0.176***
			(0.034)
Pseudo LL	-5462	-5425	-5412
No. of obs.	3,557	3,557	3,557

Notes same as in Tables 2 & 3.

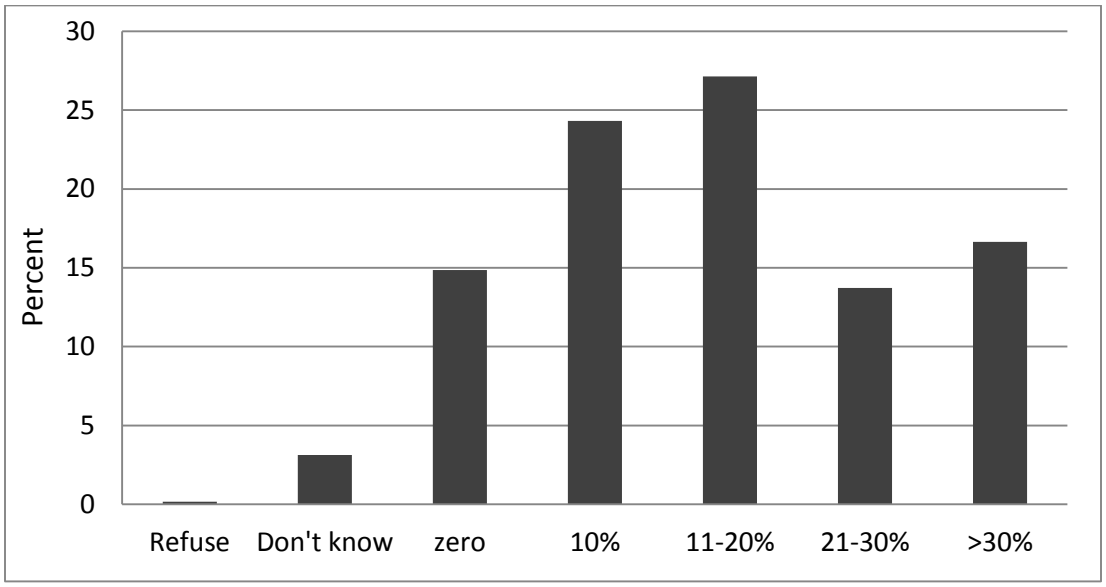
Table 5 Marginal Effect of Stated WTP

Variable	0	10%	11-20%	21-30%	>30%
Log(Income)	-0.033***	-0.022***	0.004***	0.014***	0.037***
	(0.005)	(0.003)	(0.001)	(0.002)	(0.005)
Age 26-35	0.024**	0.016**	-0.003**	-0.010**	-0.027**
	(0.011)	(0.008)	(0.001)	(0.005)	(0.013)
Age 36-45	0.022*	0.015*	-0.003*	-0.009*	-0.024*
	(0.012)	(0.008)	(0.002)	(0.005)	(0.013)
Age 46-55	0.032**	0.022**	-0.004**	-0.014**	-0.036**
	(0.012)	(0.008)	(0.002)	(0.005)	(0.014)
Age 56-65	0.053***	0.036***	-0.007**	-0.023***	-0.059***
	(0.02)	(0.014)	(0.003)	(0.009)	(0.022)
>Age 65	0.052*	0.036*	-0.007	-0.023*	-0.059*
	(0.032)	(0.021)	(0.004)	(0.014)	(0.035)
Middle School	-0.051**	-0.035**	0.007**	0.022**	0.057**
	(0.022)	(0.015)	(0.003)	(0.009)	(0.024)
High School	-0.074***	-0.051***	0.010***	0.032***	0.083***
	(0.023)	(0.015)	(0.003)	(0.01)	(0.025)
College and above	-0.072***	-0.049***	0.009***	0.031***	0.081***
	(0.023)	(0.016)	(0.003)	(0.01)	(0.026)
Male	-0.044***	-0.030***	0.006***	0.019***	0.049***
	(0.008)	(0.006)	(0.001)	(0.004)	(0.009)
Urban	0.000	0.000	0.000	0.000	0.000
	(0.009)	(0.006)	(0.001)	(0.004)	(0.010)
Knowledge 2	-0.033**	-0.022**	0.004**	0.014**	0.037**
	(0.015)	(0.01)	(0.002)	(0.006)	(0.017)
Knowledge 3	-0.053***	-0.036***	0.007***	0.023***	0.059***
	(0.015)	(0.011)	(0.002)	(0.007)	(0.018)
Knowledge 4	-0.052***	-0.035***	0.007**	0.022***	0.058***
	(0.019)	(0.013)	(0.003)	(0.008)	(0.022)
Worry 2	-0.063***	-0.043***	0.008***	0.027***	0.071***
	(0.021)	(0.014)	(0.003)	(0.009)	(0.024)
Worry 3	-0.075***	-0.051***	0.01***	0.032***	0.084***
	(0.019)	(0.013)	(0.003)	(0.008)	(0.021)
Worry 4	-0.100***	-0.068***	0.013***	0.043***	0.112***
	(0.02)	(0.013)	(0.003)	(0.008)	(0.022)
Act	-0.038***	-0.026***	0.005***	0.017***	0.043***
	(0.007)	(0.005)	(0.001)	(0.003)	(0.008)

The table reports the marginal effects of each variable on the stated WTP based on the full sample estimation of the ordered probit model (column 3 in Table 4). *** (**, *) indicates significance at 1 percent (5, 10 percent) level.

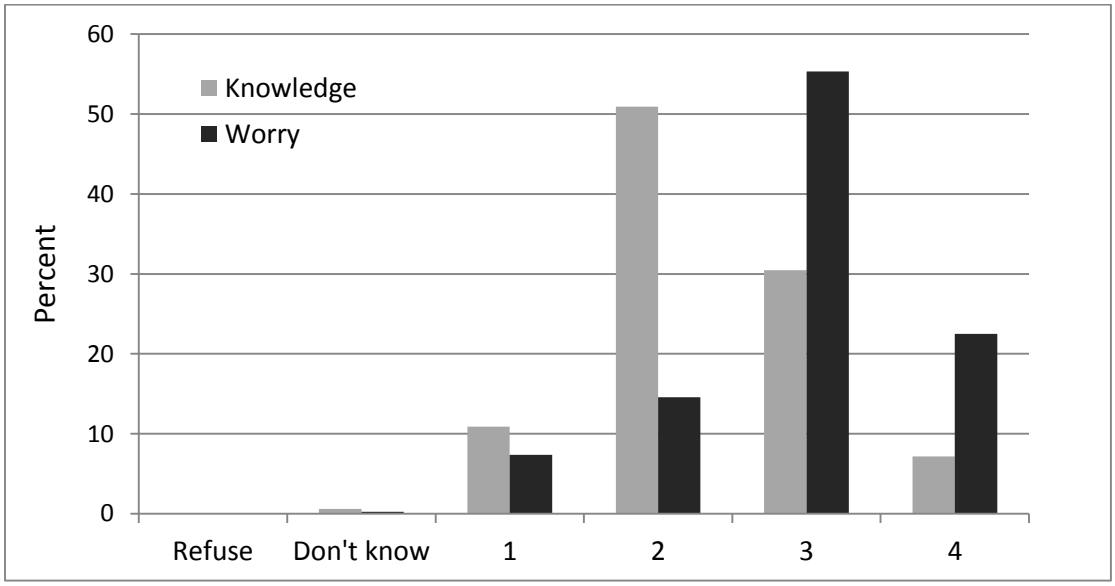
Figure 1

Distribution of WTP for energy-saving and environment-friendly products



The total number of observations is 4,169. The horizontal axis indicates the possible answers to the question "How much more will you pay for energy efficient and environment-friendly products?" The vertical axis depicts the distribution (in percentage).

Figure 2 Distribution of "Knowledge" and "Worry"



The figure shows the histogram of "Knowledge" and "Worry", where 1 indicates the least knowledgeable (least worried) and 4 indicates the most knowledgeable (most worried).

Appendix 1 Distribution of Survey Subjects

Province	Full Sample	Restricted Sample
Anhui	183	159
Beijing	56	47
Chongqing	86	72
Fujian	114	100
Gansu	79	69
Guangdong	328	274
Guangxi	160	129
Guizhou	99	89
Hainan	29	27
Hebei	217	176
Heilongjiang	117	105
Henan	335	290
Hubei	175	153
Hunan	197	168
Inner Mongolia	80	71
Jiangsu	244	203
Jiangxi	139	123
Jilin	89	81
Liaoning	142	125
Ningxia	18	14
Qinghai	20	19
Shaanxi	119	106
Shandong	292	242
Shanghai	67	54
Shanxi	108	88
Sichuan	246	204
Tianjin	38	34
Tibet	10	7
Xinjiang	70	62
Yunnan	142	126
Zhejiang	170	140
Total	**4169**	**3557**

Note: The restricted sample refers to the final sample used for empirical analysis.