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A fair share: Burden-sharing preferences in the United States and China☆

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ABSTRACT

Using a sequential discrete choice experiment, we investigate preferences for distributing the economic burden of reducing CO_2 emissions in the two largest CO_2-emitting countries: the United States and China. We asked respondents about their preferences for four burden-sharing rules to reduce CO_2 emissions according to their country's relative (1) historical emissions, (2) income level, (3) emissions per capita, and (4) current emissions. We found that respondents overall favored the rule that was least costly for their country. In addition, the willingness to pay was much higher in China, suggesting that how mitigation costs are shared across countries is more important for Chinese than for Americans. To some extent the willingness to pay varies with socioeconomic characteristics and attitudes. For example, university-educated respondents in the United States are willing to pay more for the rule that is the least costly for their own country, compared with those with a lower education level. At the same time, the ranking of the two most preferred rules are generally robust across all socioeconomic groups within each country.

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1. Introduction

By now, the difficulties in forging an international agreement on an effective international climate policy are well known. Why is it so difficult for countries to agree on binding targets? One of many plausible explanations is that different burden-sharing rules may have very substantial economic impacts on individual countries, and the negotiators are most likely sensitive to domestic public opinion and hence want to ensure that the rules are in line with the interests of their country (see, e.g., Lange et al., 2007; Buchholz and Peters, 2005).[3] Pitlik et al. (2011) found that (subjectively measured) self-interest explains attitudes toward economic policies. Driven strictly by self-interest, climate negotiators from developing countries can thus be expected to support burden-sharing rules that favor poor countries, while their counterparts from rich countries will support rules that cater to their interests. Moreover, citizens often adopt opinions that defend the reputation or interests of their country. A critical issue, therefore, is how citizens would prefer to see the economic burden for reducing CO_2 emissions distributed among countries—in other words, their preferences for different burden-sharing rules.

The purpose of this article is to shed light on this issue by presenting the results of a sequential discrete choice experiment that elicits preferences for different burden-sharing rules, conducted among ordinary citizens in the United States and China. We focus on these countries because they are the world's largest emitters of CO_2 and are critical to the outcome of any negotiations to reduce emissions. If the people (and negotiators) of these two countries are prone to evaluate their country more positively in relation to other countries—referred to as having an in-group bias[4] (Tajfel, 1982)—then this can affect the potential to reach agreement.[5] At the same time, these two countries are very different in their ability to pay, which might also affect how citizens respond to the survey.

While there is a vast literature on burden-sharing rules, it is mostly on a country or negotiator level. The country-level studies are often either an assessment of burden-sharing rules (comparing and ranking them) or based on game theory, discussing what is rational behavior for a country or coalition of countries (see, e.g., Burtraw and Toman, 1992; Rose et al., 1998; Cazorla and Toman, 2000; Ringius et al., 2002; Torvanger and Ringius, 2002; Eyckmans and Tulkens, 2003; Torvanger and Godal, 2004; Böhringer and Helm, 2008; Carlsson et al., 2011). Other studies have focused on the preferences of the negotiators, such as Lange et al. (2007, 2010) and Dannenberg et al. (2010).

Lange et al. (2010) found that agents involved in international climate policy preferred a distributional rule that was in line with their personal equity opinion and that had a lower cost for their country. Dannenberg et al. (2010) showed (in a simple nonstrategic game not related to climate change) that climate negotiators are inequality averse and that there are no significant differences in inequality aversion among negotiators from different regions. However, as the authors remark, it is likely that negotiators are affected by public opinion at home, in addition to their own preferences for equality. Other articles discuss the ethical aspects of burden-sharing rules (see, e.g., Miller, 2004; Posner and Sunstein, 2008; Klinsky and Dowlatabadi, 2009). However, we argue that the outcome of future climate negotiations will ultimately depend on how politically acceptable the agreement is to the domestic constituencies in the affected countries.

The burden-sharing rules discussed in the literature can be traced back, in general, to the basic principles of distributive justice: equity, equality, and need (Adams, 1965, pp. 267–99; Deutsch, 1975; Tyler et al., 1997). It seems that most countries appeal to some general principles of justice, but since there are several competing principles that give different results, this does not necessarily facilitate

[3] On the other hand, Falk et al. (2003) argue that fairness models should consider not only that people have preferences over how actions are distributed, but also that many people value the intentions behind the actions; i.e., people take into account the fairness of the proposer's intentions when responding.

[4] Essentially, in-group bias is exhibited whenever someone gives preferential treatment to members of a group to which he or she belongs.

[5] Carlsson et al. (2011) found in their study among Swedish citizens that people's ranking of effort-sharing rules and the willingness to pay are not significantly dependent on whether a respondent could see country names, and hence they did not find any evidence of in-group bias in preferences for effort-sharing rules among Swedes.

the negotiation process.[6] Based on the literature concerning burden-sharing rules in relation to international climate negotiations (see, e.g., Rose et al., 1998; Torvanger and Ringius, 2002; Ringius et al., 2002; Lange et al., 2007, 2010), the burden-sharing rules we study are cost proportional to (1) historical emissions (burden sharing based on historical responsibility), (2) income level (burden sharing based on capacity to pay), (3) equal emissions per capita (burden sharing based on equal right to emit), and (4) current emissions (burden sharing based on current responsibility).

Previous to our study, Cai et al. (2010) also analyzed how the distributional consequences of climate change policies influence policy preferences. However, their study included college students living in the United States and Canada and did not explicitly name any burden-sharing rules. They found that distributional consequences are important to respondents and can significantly affect willingness to pay (WTP).[7] Güth et al. (2009) remark that preferences for "pie" sharing will be context-dependent as well as path-dependent; not taking this into account is embedded with the risk of overgeneralizing. Similar problems of overgeneralization could also appear if preferences of students or agents involved in international climate policy are assumed to be the same as those of citizens.

The main contribution of our study is that we use identical surveys of representative citizens in both the United States and China to estimate willingness to pay and elicit preferences for different burden-sharing rules. As far as we know, this is the first study that systematically compares preferences of ordinary citizens for burden-sharing rules, although there is conventional wisdom that citizens of different countries have preferences that are in line with the best interests of their own country. Our main finding shows quite distinct and dramatically counterposed preferences for burden sharing among U.S. and Chinese citizens. In particular, U.S. citizens prefer the rule that is most advantageous for the United States but simultaneously is the least advantageous—or most costly—for the Chinese. Chinese preferences are almost a mirror image: their willingness to pay is highest for the rule that favors China most and happens to disfavor the United States most. This suggests that there is in-group bias among both American and Chinese respondents, and that, in line with the results by Lange et al. (2010), citizens strongly prefer rules that are advantageous to their respective countries.

Also, among Chinese respondents, we found that the preferences for an advantageous rule are stronger than those of U.S. respondents. Since the total costs to be divided are considerable, this implies that negotiations will be difficult and protracted, which is problematic if, as suggested by the IPCC (2007), action is urgent. Considering the issues and costs at stake, we believe that countries should make a careful and sustained effort to understand each other's preferences and expose their biases as a first step in international negotiations.

This article is organized as follows. Section 2 gives a description of the survey and the sampling framework. In Section 3, we present the results of the sequential discrete choice experiment. Section 4 concludes.

2. Description of the survey

The survey consisted of four independent sections. In the first section, we elicited general attitudes about climate change. The main purpose of this section was to discover whether the respondents believe that climate change is occurring and if they believe that actions can be taken to reduce or stop such change. In the second section, the survey provided information on the effects of climate change, summarized from the IPCC's *Fourth Assessment Report*. (The information is presented in the appendix, in Table A1.) Respondents' attitudes toward reducing global CO_2 emissions were also elicited in this section. The last part of Section 2 asked a number of WTP questions for different reductions of CO_2

[6] Equity theory is based on the justice principle that reward should be in proportion to contribution. For example, someone who works two hours should earn twice as much as someone working one hour. With a need-based principle, the ones with the greatest need receive the most; with an equality principle, resources are divided equally among individuals.

[7] Instead of naming any burden-sharing rules, Cai et al. (2010) asked their respondents to rate how mitigation costs should be allocated among various domestic payers (individual taxpayers, consumers, energy users, industry, energy producers, and government) and international payers (industrialized countries; countries of the former Soviet Union; densely populated countries, such as China and India; the United States and its major trading partners; developing countries, which are beginning to pollute heavily; smaller developing countries; and countries in proportion to their pollution).

emissions using a payment card. (The results of this section are reported in Carlsson et al., 2012.) In this section, the respondents were told to assume that the costs of reducing CO_2 emissions would be shared among the countries according to their emissions today. The third section of the survey contained a scenario about the different burden-sharing rules and the sequential discrete choice experiment regarding the rules for allocating the responsibilities for the cost of CO_2 reductions across countries, which is the focus of this article. Finally, Section 4 of the survey asked questions about the respondents' socioeconomic characteristics.

In the choice experiment, we emphasized to the respondents that they should choose allocation (or burden-sharing) rules, *given* a 60 percent reduction of emissions. Hence, the purpose of the experiment was not to estimate WTP for emissions reductions per se; instead, the emissions reduction level was kept constant. We did this to be able to isolate the preferences for the different burden-sharing rules and thus avoid confounding preferences for the different rules with preferences for different levels of reduction. Moreover, we believe that it was actually advantageous to include the WTP questions on the levels of CO_2 reductions before our experiment about burden-sharing rules. In this way, it was clear to the respondents that the third part of the survey did not concern the level of the reduction, and they had already had the opportunity to express their preferences for the reductions. In addition, there is no difference in total costs of reducing CO_2 by 60 percent among the different effort-sharing rules.[8] Other studies have shown that the perception of distributive justice is also affected by efficiency concerns, i.e., whether an allocation of resources is made in an efficient way (Konow, 2000). Since in the present study we are not primarily interested in such a trade-off, we have kept costs constant among the effort-sharing rules. Hence, more specifically, we gave the following instructions to the respondents:

> Reducing CO_2 emissions is costly, and an important question is how costs should be shared among countries. Suppose that countries have reached an international agreement that global reductions of CO_2 emissions should be 60 percent. We will now present four alternative "rules" for distributing the costs among countries to achieve this reduction. All four rules would result in the same cost to the world economy, but different costs to different countries.

In the sequential discrete choice experiment, the respondents chose between two alternatives in each choice situation, where the alternatives differed with respect to the burden-sharing rule and the annual cost to the household. Each respondent answered four choice sets. The burden-sharing rule attribute had four possible levels, as noted above (historical emissions, income level, emissions per capita, and current emissions). While more rules could have been developed, we felt additional rules would have excessively increased the cognitive burden to respondents. Also, these four are the main rules in the literature.[9]

The other attribute, household cost per month until 2050, had four levels based on the results of pilot studies in both China and the United States. Examples of the typical ways in which this cost could be realized were provided, such as increased energy and gasoline prices.[10] Both the monthly and annual costs for a household were shown to ensure that the respondents understood how much they had to pay. The attribute levels are summarized in Table 1. The costs were presented in U.S. dollars (USD) for the U.S. sample and in Chinese yuan (CNY) for the Chinese sample; the table, however, reports purchasing-power-parity PPP-adjusted USD values for China (CNY 3.4 = 1 USD).[11]

[8] This could, for example, be achieved through a permit trading scheme. However, exemplifying with a particular policy instrument can potentially be problematic, since subjects might have preferences for a policy instrument; see, e.g., Cai et al. (2010). Hence, we decided not to mention this in the survey.

[9] We also limited the discussion to CO_2 emissions, instead of all greenhouse gases, to make the survey cognitively less demanding for the respondents.

[10] Wiser (2007) found that the WTP to support climate change policy depends on the payment vehicle used in the study. For example, with a collective payment mechanism, the elicited WTP is higher, compared with using voluntary payment mechanisms. In our study, we did not test for different payment vehicles, but rather made clear how the payments would be made and kept this consistent across countries.

[11] We obtained the Chinese bids using PPP-adjusted values, and then rounded them separately from the U.S. bids. This explains why the Chinese bids are a bit different from the U.S. bids.

Table 1
Attributes.

Attributes	Description
Income level (capacity to pay)	Countries with high income levels must pay a larger share of the costs than countries with low income levels. This option says that countries with greater ability to pay should pay more
Emissions level today (current responsibility)	Countries with currently high emissions levels must pay a larger share of the costs than countries with currently low emissions levels. This option says that those countries that are currently a larger part of the problem should pay more
Historical emissions level (historical responsibility)	Countries with a history of high emissions levels must pay a larger share of the costs than countries with a history of lower emissions. This option recognizes that CO_2 builds up in the atmosphere over many years. Thus, countries with a history of high emissions should pay more because they caused more of the problem
Emissions per capita	Countries with emissions per person greater than an agreed amount must pay, and they must pay more the higher their emissions per person are[a]
Yearly cost for the household until year 2050 (in USD)	United States: $168, $240, $288, $336 China: $159, $229, $300, $318

[a] This rule recognizes that very populated countries may have high total emissions but only as a result of high population, not as a result of a high-energy-using lifestyle.

In order to illustrate more clearly to the respondent what the four burden-sharing rules imply, we created four groups relating to country income and current emissions. How much each group would pay differs, depending on which rule is used to distribute the costs of reducing CO_2 emissions. Table 2 shows the information provided to the respondents regarding different distributions of costs under each alternative rule and also information about the world population share of each group.[12] Moreover, to avoid any kind of misunderstanding, we also gave clear examples about how the information in Table 2 should be interpreted.

As can be seen in Table 2, only 13 percent of the world's population lives in the high-income and very-high-emissions countries; however, their shares of the costs are much larger for all the rules. On the other hand, 40 percent of the world's population lives in the low-income and low-emissions countries, but their shares of the costs are much smaller for all rules (ranging from 0 percent to 8 percent, depending on the rule). In particular, the rule on historical emissions has the lowest cost for China, while the rule generating its highest cost is based on current emissions. Exactly the opposite is true for the United States: the rule with the lowest cost is based on current emissions, and the rule with the highest cost is historical emissions.

The choice sets were created with a linear D-optimal design principle (Huber and Zwerina, 1996; Carlsson and Martinsson, 2003).[13] In total, 16 choice sets were generated, with two alternatives in each set. (An example of a choice set is given in the appendix, in Table A2.) After random blocking, each respondent was presented with four choice sets. Hence, we had four versions of the survey applied at random. Note that the cost described to each household was uncorrelated with the burden-sharing rules. A choice situation where the country's emissions reduction is unrelated to the cost to the household is, of course, rather artificial, but it is an inherent part of the method. If the two attributes were highly correlated, there would be no trade-off to observe and no possibility to tease out a willingness to pay for the effort-sharing rules. Importantly, during the numerous focus groups we held, there were no signs that people found it difficult to accept these scenarios.

A standard concern when using a choice experiment (or other stated preference method) is the risk of hypothetical bias. The empirical evidence of hypothetical bias in a choice experiment is mixed (see, e.g., Carlsson and Martinsson, 2001; Lusk and Schroeder, 2004; Johansson-Stenman and Svedsäter,

[12] The data on income and emissions come from *World Development Indicators* (World Bank, 2009).

[13] An optimality criterion is a single number that summarizes how good a design is, and it is maximized or minimized by an optimal design. D-optimal designs are designs provided by an intensive search using computer algorithms. A design is D-optimal if it minimizes the generalized variance of the parameter estimates.

Table 2
Information on the effects of the four burden-sharing rules.

	Distribution of costs according to attributes[a]				
	Share of the world's population	Share of the world's income	Share of emissions today	Share of historical emissions	Equal emissions per capita
Country groups by income and current emissions level					
Countries with high income and very high emissions (e.g., United States and Canada)	13%	47%	42%	67%	55%
Countries with high income and high emissions (e.g., Sweden and France)	7%	16%	11%	12%	7%
Countries with low income and medium emissions (e.g., China and South Africa)	40%	29%	40%	18%	38%
Countries with low income and low emissions (e.g., Ethiopia and India)	40%	8%	7%	3%	0%

[a] Share of the world's income corresponds to the capacity to pay rule, share of emissions today is the current responsibility rule, share of historical emissions corresponds to the historical responsibility rule, and equal emissions per capita corresponds to the equal right to emit rule.

2008). To reduce the probability of a hypothetical bias, following Carlsson et al. (2005) and List et al. (2005), we used a cheap-talk script,[14] as follows:

> Before making your choices, please consider how an increased cost would affect your ability to buy other things. Previous studies of this kind have shown that people claim to be willing to pay more money than they actually would in a real situation. It is important to us that respondents answer these questions as truthfully as possible.

2.1. Administration of the U.S. and Chinese surveys

The surveys were conducted in November and December 2009. The questionnaire was designed with the aid of 10 focus groups across the two countries. Careful attention was given to developing a survey that was understandable and credible. The survey was also designed to be self-administered

[14] There are other suggestions for how to reduce hypothetical bias, for example, ex-post calibration of the WTP responses using follow-up questions on certainty (see, e.g., Champ et al., 1997; Champ and Bishop, 2001) and using time-to-think protocols (Cook et al., 2007; Whittington et al., 1992).

on the computer to eliminate interviewer bias and strategic answering to please the interviewer. In China, the survey was conducted on laptops in special rooms with invited respondents. In the United States, the respondents took the survey online. These different procedures were necessary as so few Chinese have computers and online access. The survey yielded 909 responses in the United States and 1264 responses in China.

The Chinese survey was administered in four cities—Shanghai, Nanning, Jiujiang, and Chongqing—chosen by the Chinese Ministry of the Environment as being representative of Chinese cities in size, location, and income. Respondents were randomly selected to participate in the survey via neighborhood-based databases used in previous surveys (Krupnick et al., 2010).[15] The respondents in the U.S. survey were reached by a survey company, Knowledge Networks. The participants were recruited by telephone, using random digit dialing and address-based sampling, and are representative of the U.S. population for gender, age, race, and income. Participants aged 18 years and older were randomly selected and invited to take the survey.[16]

2.2. Characteristics of respondents

Descriptive statistics of the U.S. and Chinese samples are presented in Table 3. There are some differences in the distribution of the socioeconomic characteristics between the two countries. In particular, the share of subjects with a university education is high in the Chinese sample.[17] A number of attitudinal responses are also reported in the table. Notably, 23 percent of the citizens in the United States believe that the temperature has not increased globally, while in China only 5 percent of the respondents believe this.

3. Results

To analyze the responses, we applied a standard random utility framework and estimated a random parameter logit model, where the choice depends on the two attributes of the choice experiment. The burden-sharing rules attribute is effects-coded, so we can directly compare *all* the rules with each other and between the two countries.[18] The three coefficients associated with the burden-sharing rule attribute are assumed to be random and normally distributed. Furthermore, we allow for correlation among the random parameters. Since there are large income differences within both countries, we estimate three separate cost coefficients for low, medium- and high-income respondents for both U.S. and Chinese samples. Low-income respondents are those belonging to the 20 percent of the country sample with the lowest income, and high-income respondents are those belonging to the 20 percent of the sample with the highest income. These three income coefficients are assumed to be fixed, which means that marginal utility of income is assumed constant within each income group.[19]

[15] This is a registration system used by local communities to provide reproductive service to married couples. Older people are also reached by this system because so many young married couples live with their parents.

[16] To obtain a more representative panel, if a household does not have a computer or Internet access, Knowledge Networks provides a laptop computer and free Internet access.

[17] In Beijing, for example, the share of people with a university education is around 20 percent (Beijing Statistical Yearbook, 2009), while in our sample, 42.8 percent have a university education.

[18] "Effects-coded" means that instead of normalizing the WTP to zero for one of the attribute levels, we normalized the sum of WTP to zero (see, e.g., Louviere et al., 2000).

[19] Using a likelihood ratio test, we can reject the null hypothesis of a common cost coefficient for all respondents in both the U.S. (p-value = 0.000) and Chinese (p-value = 0.010) samples. For the U.S. sample all three cost coefficients are significantly different using a standard t-test, while for the Chinese sample, it is only the cost coefficient for the low-income group that is significantly lower than the coefficient for the two other groups. In order to facilitate the presentation of the results, we therefore use different cost coefficients for the three income groups in all our analyses for both countries. For the U.S. sample, the absolute value of the cost coefficient decreases with increasing income, which implies a decreasing marginal utility of income. For the Chinese sample, the absolute value of the cost coefficient is actually the lowest for the low-income group, which oddly implies an increasing marginal utility of income.

Table 3
Descriptive statistics.

Variable	Description	United States			China		
		Mean	Min.	Max.	Mean	Min.	Max.
Female	=1 if female	0.520	0	1	0.464	0	1
University educ.	=1 if completed university education	0.308	0	1	0.430	0	1
Income	Monthly income in USD '000 (Std. dev.)	3.407 (2.812)	0.208	16.67	1.250 (0.864)	0.123	3.92
Low income	=1 if household belongs to low-income group	0.220	0	1	0.208	0	1
Medium income	=1 if household belongs to medium-income group	0.549	0	1	0.564	0	1
High income	=1 if household belongs to high-income group	0.231	0	1	0.228	0	1
Use tax money in U.S./China	=1 if tax money should primarily be used in own country	0.443	0	1	0.560	0	1
Own country should reduce	=1 if own country should decrease CO_2, if other countries do not	0.709	0	1	0.799	0	1
No global temperature increase	=1 if respondent believes temperature has not increased globally	0.232	0	1	0.045	0	1
Positive WTP	=1 if respondent has a positive WTP for reducing CO_2 emissions by 60%	0.756	0	1	0.868	0	1
Democrat	=1 if Democrat (U.S.)	0.375	0	1			
Republican	=1 if Republican (U.S.), reference category	0.245					
Green Party	=1 if Green Party (U.S.)	0.011	0	1			
Other party	=1 if other party (U.S.)	0.083	0	1			
Independent	=1 if independent (U.S.)	0.286	0	1			
No. of respondents		909			1264		

We estimate three models for each country. The first model includes only the attributes of the experiment.[20] In the second model, we include a set of household characteristics. This is done by allowing the covariates of random parameter means to interact with a set of household characteristics. In the third model, we add a set of attitudinal responses and a response variable based on the first part of our survey. That is, we include a binary variable that is equal to one if the respondent is willing to pay anything at all to reduce CO_2 emissions by 60 percent (and zero otherwise); for details on this part of the survey, see Carlsson et al. (2012). All models are estimated using Nlogit 4.0 with simulated maximum likelihood using Halton draws with 500 replications (see Train, 2003 for details). The coefficients of the random parameter models are presented in Table 4.

The results of the first model reveal considerable differences between the two countries. For example, in the U.S. sample, the coefficient for historical emissions is negative, whereas in the Chinese sample, the coefficient is positive. We will return to the difference between the two samples in the next section when we look at the willingness to pay. Moreover, the standard deviations show that there is considerable unobserved heterogeneity regarding the preferences for the burden-sharing rules. The second model reveals that, in the U.S. sample, there are no differences among any of the groups with respect to the ranking of the burden-sharing rules. In the Chinese sample, though, there are some significant differences. The third model reports that in the U.S. sample, attitudes do not seem to explain preferences for the burden-sharing rules, whereas in China, they affect the preferences to some extent. We will discuss this in more detail in Section 3.2.

3.1. Willingness to pay for the four burden-sharing rules

In order to compare the relative importance of the various burden-sharing rules between the two countries, we focus on the estimated WTP for the rules. The WTP measures are based on the first model with only the attributes of the experiment. We report the mean and standard deviations of WTP for each burden-sharing rule. Mean WTP is the ratio of the marginal utility given by the attribute coefficients in the numerator and the cost coefficient in the denominator. Since we estimate three cost-coefficients, based on income groups, mean WTP is estimated as the average WTP among these three income groups where the groups are weighted by their sample frequency.[21] The standard deviation is the ratio of the standard deviation coefficient for the attribute in the numerator and the cost coefficient in the denominator. Standard errors are simulated using the Krinsky–Robb procedure (Krinsky and Robb, 1986). The estimated WTP in PPP-adjusted USD values for the burden-sharing rules are reported in Table 5.[22] The first column recapitulates the essential characteristics of each rule—its implied burden for the two country groups to which the United States and China belong, respectively.

Chinese respondents have on average considerably higher WTP for distributive preferences than U.S. citizens. This is a remarkable result, given that Chinese incomes are about one-third of U.S. incomes on average. This could be because U.S. respondents do not have a strong preference for the burden-sharing rules or because many respondents, as a way of protesting against the survey, ignored the burden-sharing rules. At the same time, our major interest is not in the absolute level of WTP, but in the ranking for the burden-sharing rules and the comparison between countries with respect to the ranking of the rules.

The ranking of the burden-sharing rules based on mean WTP is very different in the two countries; in fact, it is just the opposite for the most and least preferred rules. For the Chinese respondents, the ranking of the rules in terms of mean WTP is the same as the ranking of the rules in terms of the costs for the country (see Table 2). They have the strongest preference for the rule based on historical

[20] The models do not contain any alternative specific constant since the experiment involved a choice between two generic alternatives. However, in the U.S. sample, the alternative specific constant is significant at the 5 percent level in the first model. This could be an indication of that some respondents had a tendency to choose one of the generic alternatives without careful consideration of the attribute levels. However, since the estimated mean WTP values do not change almost anything by including or excluding an alternative specific constant, we present results without the constant for both countries.

[21] Assume an additive and separable utility function in attribute (a) and price (p): $V(\mathrm{a,p}) = \beta_a a + \beta_p p$. Differentiating the equation and keeping the utility fixed ($\mathrm{d}V = 0$) the marginal WTP for attribute a can be calculated as: $\mathrm{MWTP} = -(\partial V/\partial a)/(\partial V/\partial p) = \beta_a/\beta_p$.

[22] CNY 3.4 = USD 1 at the time of the survey.

Table 4
Random parameter logit basic model (i), with household characteristics (ii) and with household characteristics and attitudinal variables (iii) (standard errors in parentheses).

	United States			China		
	(i) Coeff.	(ii) Coeff.	(iii) Coeff.	(i) Coeff.	(ii) Coeff.	(iii) Coeff.
Random parameters						
Historical responsibility	−0.145*** (0.051)	−0.109 (0.078)	−0.210 (0.147)	1.158*** (0.150)	0.858*** (0.202)	1.539*** (0.455)
Equal right to emit	−0.201*** (0.057)	−.242*** (0.088)	−0.363** (0.167)	−0.674*** (0.115)	−0.697*** (0.172)	−1.681*** (0.395)
Capacity to pay	0.088 (0.061)	0.122 (0.096)	0.382** (0.188)	0.569*** (0.115)	0.742*** (0.181)	1.385*** (0.404)
Fixed parameters						
Cost (100 dollar)×						
Low-income	−1.75*** (0.152)	−1.747*** (0.152)	−1.762*** (0.153)	−0.124** (0.060)	−0.125** (0.060)	−0.127** (0.061)
Medium-income	−1.285*** (0.093)	−1.289*** (0.093)	−1.289*** (0.093)	−0.320*** (0.044)	−0.323*** (0.044)	−0.327*** (0.044)
High-income	−0.880*** (0.121)	−0.897*** (0.122)	−0.890** (0.123)	−0.244*** (0.060)	−0.242*** (0.060)	−0.237*** (0.059)
Heterogeneity in means						
Historical responsibility×						
Female		0.032 (0.096)	0.039 (0.096)		0.559** (0.238)	0.545** (0.237)
University education		−0.170 (0.105)	−0.172 (0.106)		0.084 (0.235)	0.221 (0.241)
Use tax money in U.S./China			0.122 (0.104)			−0.264 (0.237)
Own country should reduce			−0.067 (0.131)			−0.158 (0.303)
Temperature has not increased			0.084 (0.136)			−0.181 (0.575)
Positive WTP for reducing CO_2 emissions			0.092 (0.138)			−0.513 (0.367)
Equal right to emit×						
Female		0.090 (0.108)	0.048 (0.107)		−0.373* (0.206)	−0.379* (0.206)
University education		−0.013 (0.116)	−0.051 (0.117)		0.456** (0.208)	0.295 (0.211)
Use tax money in U.S./China			−0.157 (0.115)			0.444** (0.210)
Own country should reduce			0.189 (0.146)			0.299 (0.263)
Temperature has not increased			−0.260* (0.151)			−0.148 (0.504)
Positive WTP for reducing CO_2 emissions			0.201 (0.155)			0.647** (0.321)
Capacity to pay×						
Female		−0.036 (0.121)	−0.009 (0.122)		−0.016 (0.214)	−0.032 (0.215)
University education		−0.050 (0.130)	−0.003 (0.132)		−0.379* (0.217)	−0.302 (0.223)
Use tax money in U.S./China			−0.084 (0.131)			−0.415* (0.221)
Own country should reduce			−0.104 (0.166)			−0.647** (0.285)
Temperature has not increased			0.061 (0.172)			0.735 (0.549)
Positive WTP for reducing CO_2 emissions			−0.252 (0.176)			0.060 (0.329)
Standard deviations						
Historical responsibility	0.538*** (0.129)	0.542*** (0.128)	0.542*** (0.131)	3.106*** (0.300)	3.091*** (0.297)	3.085*** (0.297)
Equal right to emit	0.805*** (0.108)	0.811*** (0.109)	0.791*** (0.158)	2.627*** (0.265)	2.616*** (0.263)	2.619*** (0.250)
Capacity to pay	1.054*** (0.119)	1.055*** (0.114)	1.065*** (0.168)	2.807*** (0.226)	2.806*** (0.225)	2.783*** (0.139)
Pseudo R^2	0.135	0.140	0.144	0.143	0.143	0.149
No. of individuals	911	911	911	1264	1264	1264
No. of observations	3643	3643	3643	5056	5056	5056

* Denote statistically significant at the 10% level.
** Denote statistically significant at the 5% level.
*** Denote statistically significant at the 1% level.

Table 5
Annual household WTP in PPP-adjusted U.S. dollars for the United States and China.

Burden-sharing rule	United States		China	
	Mean	Std. dev.	Mean	Std. dev.
Historical responsibility (U.S. 67%; China 18%)	−11.22*** (3.9)	41.60*** (10.2)	130.01*** (20.7)	348.8*** (59.3)
Equal right to emit (U.S. 55%; China 38%)	−15.56*** (4.5)	62.19*** (9.0)	−75.63*** (14.1)	294.98*** (50.1)
Capacity to pay (U.S. 47%; China 29%)	6.8 (4.8)	81.49*** (10.5)	63.92*** (14.0)	315.13*** (49.8)
Current responsibility (U.S. 42%; China 40%)	19.97*** (3.7)	185.28*** (19.4)	−118.30*** (18.8)	958.92*** (141.1)

Standard errors are in parentheses.
*** Denote statistically significant at the 1% level.

responsibility, which is also the least costly for China, while the current responsibility rule is least preferred (i.e., the most expensive rule for China). U.S. respondents, on the other hand, have the strongest preference for the current responsibility rule, followed by the capacity to pay rule; the equal right to emit rule is the least preferred one. Thus, U.S. respondents also rank the preferences in accordance with the cost for their own country, at least to some extent. The two most preferred rules are the ones that result in the lowest cost for the United States. However, the least preferred rule, the equal right to emit rule, is actually less costly than the historical responsibility rule, the second least preferred rule.

At the same time, the estimated standard deviations are also very large compared with the mean WTPs. This means that there is also high heterogeneity in terms of preferences and rankings of the rules within the two countries. Considering the complexity of the issue, and that very little experience and few clear norms exist to guide respondents' preferences for distributing the economic burden of decreasing CO_2 emissions, this result is not that surprising. The implication of the relative large standard deviations is that there is a non-negligible probability of "opposed" preferences, where for a certain rule a significant fraction of the population may have a negative WTP while the majority has a positive WTP. Nevertheless, the two countries are similar in that their respondents express preferences that are strongly correlated with how advantageous a particular rule is for their country. This result is in line with findings by Lange et al. (2010). Although that study investigated preferences of international agents, whereas ours looks at the preferences of ordinary citizens, both find that the ranking of rules is driven by the costs of the rules.

This finding could explain the difficulties in reaching agreement on the same rule in any negotiation regarding reduction of CO_2 emissions. The difficulty is reinforced by the huge difference in the WTP for the Chinese respondents. The WTP difference between the historical and current responsibility rules in the Chinese sample is about 300 USD (while the difference for the United States is about 44 USD); 300 USD corresponds to around 2 percent of the annual average household income of the Chinese sample.[23] Although the WTP values are considerably higher in China than in the United States, the relative differences among the WTP estimates across all four rules is about the same: in both countries, the WTP for the most preferred rule is about twice as big as for the least preferred rule, and the rule ranked as the second best has a WTP at most half the size of that for the highest-ranked rule.

Carlsson et al. (2012) estimated the annual WTP for decreasing the global CO_2 emissions by 60 percent (compared with business as usual) until 2050 to be around 340 USD in the United States, and around 100 USD in China. (This study is based on the same sample and survey as this one.) Thus, the WTP values for reducing emissions are considerably larger than the WTP values for different rules in the United States. In China, however, we find that the WTP for one burden-sharing rule, compared with another, is as big as the WTP for the climate issue itself. We conclude that the Chinese respondents

[23] Two percent seems quite high. Possible explanations for this finding are that (1) a large amount of income may go unreported in the Chinese sample; or (2) respondents are unfamiliar with or skeptical of the ability of the government to collect or otherwise levy costs they were being asked to pay.

view the climate issue primarily as an issue of fairness, while the U.S. respondents are more focused on overall costs.

3.2. Willingness to pay for different respondent groups

In this section, we discuss differences in WTP and ranking of the rules among different groups of respondents within each country. The coefficients and standard deviations of the random parameter model with the interactions are reported in the appendix, in Table A3. Table 6 presents the mean WTP estimates for the different groups of respondents,

Except for political preferences (which are discussed in more detail below), in the U.S. sample, there are no differences among any of the groups with respect to the ranking of the two most preferred burden-sharing rules: all the groups rank the current responsibility rule as the best principle and the capacity to pay rule as second most preferred. However, there are some differences in the magnitudes of the WTPs across the different respondent groups. For example, university-educated participants have a significantly higher WTP for the current emissions responsibility rule than other respondents. Thus, the preferences in the United States are group-serving, which is even stronger among the university educated, perhaps because they have greater facility with numbers.

Only one of the attitudinal variables seems to matter for the levels of WTP in the U.S. sample. Those who do *not* believe that the temperature has increased globally are significantly more negative toward the equal right to emit rule, a rule that is the second most expensive rule for the United States and instead favors several of the EU countries, India, and countries in Africa. While few of the socioeconomic and attitudinal variables have explanatory power in the U.S. sample, the China sample is different. For example, whereas gender has no significant impact on the size of the WTP in the U.S. sample, females living in China have significantly higher WTP than male respondents for the historical responsibility rule, and significantly lower WTP for the equal right to emit rule. Also, attitudes seem to play a role in explaining the level of WTP (although attitudes and WTP may be two related ways of expressing what people prefer). Those who agree with the opinion that tax money should be primarily used to reduce CO_2 in China appear to favor the equal right to emit rule (the second most costly rule for China) more and like the capacity to pay rule (the second least costly rule for China) less than those who disagree that tax money should primarily be used in their own country. Thus, it is possible that people are willing to pay a larger share of the reduction costs if they know that the money is used for their own country. Finally, those who have a positive WTP for a reduction of CO_2 emissions are less negative toward the equal right to emit rule.

We also estimated two additional models where the burden-sharing attribute coefficients were interacted with political preferences of the respondents. The coefficients and standard deviations of the random parameter model with these interactions are reported in the appendix, in Table A3, for the U.S. sample. For the Chinese sample, all interaction terms were insignificant: there were no significant differences in WTP between members and nonmembers of the Communist Party (those results are not reported but are available from the authors upon request). The WTP estimates for the various groups in the United States are reported in Table 7.

Table 7 shows that political preferences do have a clear impact on the WTP for the burden-sharing rules. Both the ranking of the rules and the size of the WTPs vary across the various U.S. political parties. Green Party supporters differ most from the others, not only in environmental attitudes, but also regarding the ranking of the burden-sharing rules. They rank the equal right to emit rule as most preferred and the capacity to pay rule as least preferred. However, only their WTP for the equal right to emit rule is statistically significant, probably due to the very small sample size of Green Party members.

Most of the differences in WTP among the different voters are not significantly different from zero using two-sided *t*-tests. However, Republicans have significantly different WTP than Democrats for three out of four principles. Furthermore, the difference in WTP between Green Party supporters and Republicans is statistically significant for two out of four principles. Finally, since the supporters of the three largest political parties all rank the current responsibility rule first, Americans seem to have very strong and homogenous preferences that those countries that currently emit most should bear the highest cost for reducing CO_2 emissions.

Table 6
Annual household willingness to pay in PPP-adjusted U.S. dollars for different respondent groups.

Rules	United States			China		
	Male	Female	*t*-test: *p*-value†	Male	Female	*t*-test: *p*-value†
Historical responsibility	−12.9**	−9.9*	0.686	95.0***	155.5***	0.025
Equal right to emit	−17.1***	−13.4***	0.652	−64.3***	−106.4***	0.072
Capacity to pay	7.3	6.6	0.943	73.3***	69.7***	0.883
Current responsibility	22.7***	16.7***	0.404	−104.0***	−118.8***	0.560
Rules	United States			China		
	No university	University	*t*-test: *p*-value†	No university	University	*t*-test: *p*-value†
Historical responsibility	−7.3	−20.5***	0.105	118.1***	142.7***	0.367
Equal right to emit	−14.0***	−17.9**	0.655	−90.4***	−57.6***	0.159
Capacity to pay	7.0	6.8	0.985	78.4***	44.8**	0.187
Current responsibility	14.2***	31.6***	0.023	−106.1 ***	−130.0***	0.361
Rules	Use tax money in U.S.		*t*-test: *p*-value†	Use tax money in China		*t*-test: *p*-value†
	Do not agree	Agree		Do not agree	Agree	
Historical responsibility	−15.5***	−6.1*	0.244	139.4***	110.1***	0.279
Equal right to emit	−9.8*	−21.9***	0.182	−111.4***	−62.1***	0.040
Capacity to pay	9.8	3.3	0.517	97.5***	51.4***	0.070
Current responsibility	15.6***	24.7***	0.239	−125.4***	−99.4***	0.307
Rules	United States			China		
	Own country should reduce		*t*-test: *p*-value†	Own country should reduce		*t*-test: *p*-value†
	Do not agree	Agree		Do not agree	Agree	
Historical responsibility	−7.7	−12.8***	0.611	137.1***	119.5***	0.608
Equal right to emit	−25.5***	−11.0**	0.192	−110.4***	−77.1***	0.265
Capacity to pay	12.6	4.6	0.532	129.0***	57.2***	0.027
Current responsibility	20.6***	19.2***	0.882	−155.7***	−99.6***	0.091
Rules	United States			China		
	Temperature has not increased		*t*-test: *p*-value†	Temperature has not increased		*t*-test: *p*-value†
	Do not agree	Agree		Do not agree	Agree	
Historical responsibility	−12.8***	−6.4	0.532	123.9	103.8	0.759
Equal right to emit	−10.5**	−30.5***	0.091	−83.1*	−99.5*	0.777
Capacity to pay	5.8	10.5	0.729	68.0	149.6**	0.207
Current responsibility	17.6***	26.4***	0.382	−108.8	−153.9**	0.471
Rules	United States			China		
	Positive WTP		*t*-test: *p*-value†	Positive WTP		*t*-test: *p*-value†
	No	Yes		No	Yes	
Historical responsibility	−16.7*	−9.6**	0.508	172.5**	115.5***	0.177
Equal right to emit	−26.9***	−11.4**	0.195	−146.1.1***	−74.3***	0.051
Capacity to pay	21.6*	2.2	0.160	65.8*	72.6***	0.860
Current responsibility	22.0***	18.8.***	0.756,	−92.2**	−113.7***	0.577

* Denote WTP is statistically significant at the 10% level.
** Denote WTP is statistically significant at the 5% level.
*** Denote WTP is statistically significant at the 1% level.
† *p*-Values for the *t*-tests of equal WTP between the categories.

Table 7
Annual household WTP in PPP-adjusted U.S. dollars for different political affiliations in the U.S. sample.

Burden-sharing rule	Democrats	Republicans	Independent	Green Party	Other parties
Historical responsibility	−7.4	−15.7**	−13.9*	8.5	−8.0
Equal right to emit	−5.0	−33.3***	−13.2*	74.1*	−28.2*
Capacity to pay	−4.8	15.8*	9.1	−50.7	31.8*
Current responsibility	17.2***	33.1***	18.0***	−31.9	4.5

* Denote WTP is statistically significant at the 10% level.
** Denote WTP is statistically significant at the 5% level.
*** Denote WTP is statistically significant at the 1% level.

4. Conclusions

The negotiations on climate change have been faltering, and it is clear that national leaders are nervous about making commitments that may turn out to be very expensive, particularly when they are unsure about the support of their citizenry. Among the many unsettled issues, we considered how the ordinary citizens of the United States and China feel about the allocation of mitigation costs among different countries, not as a matter of attitudes, but as trade-offs that will cost them money.

In our choice experiment, we directed the respondents to choose allocation rules (or burden-sharing rules), *given* a 60 percent reduction of emissions (with the same total reduction cost globally). We considered four primary burden-sharing rules in our analysis, according to (1) each country's historical emissions, (2) each country's income (capacity to pay), (3) same emissions per capita for all countries, and (4) each country's current emissions. The results from our study suggest that both American and Chinese respondents strongly prefer rules that are advantageous to their respective countries. Because of the position of these countries on historical versus current CO_2 emissions, and with respect to economic development, the rules that these two groups favor are quite different. Specifically, the U.S. respondents prefer the current emissions rule, followed by the capacity to pay and the historical emissions rule. The Chinese respondents, on the other hand, prefer the historical emissions rule, while the current emissions rule is the least preferred.

We also investigated whether different respondent groups within each country have different preferences for the burden-sharing rules. We found that university-educated respondents in the United States have more than double the WTP for the rule that favors their country compared with those with lower education. Hence, there is, at least for the moment, no sign that greater education would lead to a higher probability of reaching compromise on burden allocation across countries.

In summary, burden-sharing rules have dramatically different consequences, which can be measured in terms of very large financial flows. It is not surprising, therefore, that respondents from both the United States and China prefer the rule that gives their own country the most economic advantage, but the Chinese clearly care more about this. The results presented in this study highlight the difficulties countries will have in finding agreement on the same burden-sharing rule. The fact that the Chinese and the U.S. respondents both chose the capacity to pay rule as second best may, perhaps, give some hope and direction for coming climate negotiations and compromises.

Appendix A.

See Tables A1–A3.

Table A1
Global Emissions reduction, temperature increase, and its effects.

Global emissions reduction	85% reduction	60% reduction	30% reduction
Temperature increase	2 °F increase	3 °F increase	4 °F increase
Harvest	Harvests in countries near the equator decrease by 4–6%. Harvests in countries in the Northern Hemisphere increase by 1–3%	Harvests in countries near the equator decrease by 10–12%. Harvests in countries in the Northern Hemisphere are unaffected	Harvests in countries near the equator decrease by 14–16%. Harvests in the Northern Hemisphere decrease by 0–2%
Increased flooding and storms	Small tropical islands and lowland countries (e.g., Bangladesh) experience increased flooding and storm	Additional low-lying areas in the Americas, Asia, and Africa experience increased flooding and storms	Populous cities face increased flood risks from rivers and ocean storms. Existence of small island countries is threatened
Threatened ecosystems	Sensitive ecosystems, such as coral reefs and the Arctic ecosystem, are threatened	Most coral reefs die. Additional sensitive ecosystems and species around the world are threatened	Sensitive and less-sensitive ecosystems and species around the world are threatened

Table A2
Example of choice set in the U.S. Survey. Choice 1. Choose between these two alternative ways of decreasing global emissions by 60 percent.

Distribution of cost	Alternative 1 Share of the world income	Alternative 2 Equal emissions per capita
Countries with high income and very high emissions (e.g., United States and Canada)	47% 	55% 
Countries with high income and high emissions (e.g., Sweden and France)	16% 	7% 
Countries with low income and medium emissions (e.g., China and South Africa)	29% 	38% 
Countries with low income and low emissions (e.g., Ethiopia and India)	8% 	0%
Yearly (monthly) cost for your household until 2050	$ 336 (28)	$ 168 (14)
I would choose:	□ Alternative 1	□ Alternative 2

Table A3
Random parameter logit with political preferences for the United States.

	Coeff.	Std. err.
Random parameters		
Historical responsibility	−0.202**	0.096
Equal right to emit	−0.428***	0.110
Capacity to pay	0.204*	0.123
Fixed parameters		
Cost×		
Low-income	−0.018***	0.002
Medium-income	−0.013***	0.001
High-income	−0.009***	0.001
Heterogeneity in means		
Historical responsibility×		
Democrat	0.107	0.122
Independent	0.023	0.130
Green Party	0.311	0.506
Other party	0.099	0.199
Equal right to emit×		
Democrat	0.365***	0.138
Independent	0.259*	0.147
Green Party	1.383***	0.555
Other party	0.065	0.217
Capacity to pay×		
Democrat	−0.266*	0.157
Independent	−0.086	0.166
Green Party	−0.857	0.581
Other party	0.205	0.243
Standard deviations		
Historical responsibility	0.530	0.130
Equal right to emit	0.777	0.10
Capacity to pay	1.043***	0.122
Pseudo R^2	0.141	
No. of individuals	911	
No. of observations	3634	

* Denote coefficient statistically significant at the 10%, 5%, and 1% levels, respectively.
** Denote coefficient statistically significant at the 10%, 5%, and 1% levels, respectively.
*** Denote coefficient statistically significant at the 10%, 5%, and 1% levels, respectively.

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