Climate change scepticism and public support for mitigation: evidence from an Australian choice experiment

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1. Introduction

Climate change mitigation confronts society with trade-offs between uncertain future benefits and economic costs. Public scepticism surrounding climate change complicates these choices. The concept of climate change 'scepticism' is generally understood as a questioning of the 'scientific consensus' that the global climate is changing, human actions are responsible for the changes, and policy interventions are capable of limiting the changes. A significant proportion of the population of many developed countries believe that claims of climate change are exaggerated and, as a result, they oppose sharing the economic burden of climate change mitigation. Consequently, in the past decades, implementation of climate change mitigation policies in some developed countries, such as Australia and the USA, has been discouraged, impeded or delayed by civic opposition. Within democratic political systems in particular, political leaders are reluctant to promote and implement policies that are not widely popular. Further, in democratic societies, strong public support is crucial for the long-term sustainability of high-cost environmental policy such as climate change mitigation.

Given the implications of public scepticism for climate change mitigation policies, it is important to develop a clear understanding of the nature of scepticism and the relationship between scepticism and public support. Until recently, climate change scepticism has been considered a single-dimensional phenomenon, i.e. the public either believes in climate change or they do not. Several recent studies have highlighted the multifaceted nature of climate change and argued that climate change scepticism is a multidimensional concept (Rahmstorf, 2004; Poortinga et al., 2011). However, the relationship between multidimensional scepticism and support for climate change mitigation has not yet been studied. Therefore, the aim of this study is to fill this research gap with evidence and analysis from a public survey of attitudes towards climate change mitigation in Australia.

Australia presents an ideal case study for examining the relationship between climate change scepticism and public support as it is a democratic country in which political leaders have recently committed to a mitigation scheme after debating for almost half a decade on its desirability. Falling public support for domestic climate change mitigation following the failure of the Copenhagen climate summit in 2010 played an important role in this debate. The proposed Carbon Pollution Reduction Scheme (CPRS), a national emissions trading scheme (ETS), failed to pass the Australian senate three times between 2009 and 2010. Finally, in November 2011, the ruling Labour Government in association with its political allies (i.e. the Greens and key independents) legislated the introduction of a carbon tax to smooth the country's transition to the CPRS in 2015. The carbon tax sparked nationwide criticism and widespread public protests. As a result, the Australian Labour Party's primary vote plummeted to an historical low of 27 percent one week after the details of the carbon tax were announced (Herald/Nielsen Poll, July 2011). With the opposition leader vowing to abolish the carbon tax, the future of Australia's climate change mitigation plan (i.e. the carbon tax leading up to the CPRS in 2015) rests on the outcome of the 2013 election.

Given the socio-political landscape of climate change mitigation in Australia, we present the results of a survey of public attitudes and support for the CPRS in Sydney, Australia. Sampled respondents were asked a series of questions relating to five dimensions of scepticism: (1) trend scepticism over whether climate change has already started; (2) attribution scepticism over whether climate change is caused by human action; (3) impact scepticism over what extent temperature will change if climate change remains unchecked; (4) mitigation scepticism over how effective a proposed mitigation scheme will be in slowing down climate change; and (5) global co-operation scepticism over how likely it is that other major polluting countries will reduce their emissions. While the first four dimensions of scepticism are about individuals accepting or rejecting the scientific conclusions about the cause, consequence and remedy of climate change, global co-operation scepticism reflects individuals' beliefs about each country doing their 'fair' share. Respondents were also asked to state their level of confidence in their beliefs over impact, mitigation and global co-operation scepticism. They were then presented with a choice experiment in which they were asked to make trade-offs between potential future benefits of climate change mitigation (in terms of expected change in average temperature) and their corresponding economic costs.

While the evidence is drawn from an Australian case study, the results have broader implications for public support in other countries. The study offers four contributions to the literature. First, it examines the interplays among five distinct dimensions of climate change scepticism. Second, it explores the link between five forms of scepticism and public support for a climate change mitigation policy. Third, it examines the relationship between individual confidence in beliefs and support for mitigation measures. Finally, it presents the results of the first choice experiment survey on public preferences for an ETS.

The rest of the paper is organized as follows: Section 2 presents a background to the study. Section 3 describes the sample and survey methodology. Section 4 presents the results concerning the nature and sources of scepticism. Section 5 describes the results of the choice experiment. Finally, Section 6 discusses the implications of the results and concludes.

2. Background

Academic research of public perceptions of climate change reveals that, in general, the majority of people believe human activity contributes to climate change (Brechin, 2003; Leiserowitz, 2005). Despite this, however, large majorities oppose mitigation policies. For example, 83 percent of respondents in Australia agreed with the proposition that the world's climate is getting warmer, and 78 percent believed that climate change is human induced (Jackman, 2009). However, 67 percent of respondents refused to pay for climate change mitigation (Akter and Bennett, 2011). A similar trend was observed in the USA with studies finding that most Americans supported the Kyoto Accord and believed that human activity contributes to climate change (Brechin, 2003; Leiserowitz, 2005), yet large majorities opposed mitigation policies such as energy taxes (Leiserowitz, 2005; O'Connor et al., 1999). While attitudes may appear to be different in Europe, evidenced by the strong commitment taken by the European Union (EU) countries such as the EU ETS, some studies suggest that the average European's stance on the issue of climate change mitigation is no different from that of citizens in other industrialized nations (Lorenzoni and Pidgeon, 2006). Political scientists claim that the EU ETS is the outcome of a democratic deficit in the EU which reflects a weak link between public preference and policy change (Skjærseth, 2010). Accordingly, a study conducted in Germany showed that 64 percent respondents were concerned about climate change and 85 percent of them believed climate change poses serious threats to future generations; however, half of the sample was not willing to bear any cost for climate change mitigation (Löschel et al., 2010).

Given the apparent contradiction in public attitudes, and political leaders' pursuit of public support for climate change mitigation policies, determinants of public support for climate change mitigation have received significant scholarly attention in both the public perceptions and the economics of climate change literatures. The public perceptions literature defined climate change scepticism as the degree of public disbelief to the conclusions drawn by climate scientists. Rahmstorf (2004) distinguished between climate sceptics based on the aspects of climate science that they disagree with and highlighted three dimensions of climate scepticism: (1) trend; (2) attribution; and (3) impact. Poortinga et al. (2011) used Rahmstorf's framework to explore the determinants of each of these scepticisms and their interplays. They found that impact scepticism was fairly common but trend and attribution scepticism were far less prevalent in their sample. They also found that the different dimensions of scepticism are strongly interrelated; suggesting that people may not distinguish among the different aspects of the climate change debate in the way scientists do.

The findings in the economics of climate change literature suggest that climate change scepticism goes beyond public disbelief in climate science and encompasses climate politics, e.g. domestic policy choice, international co-operation and the cost incidence within the implementing countries (Lee and Cameron, 2008; Carson et al., 2010; Akter and Bennett, 2011). The global public good aspect of climate change requires all major polluting countries to reduce their emissions and bear a fair share of the clean-up cost. However, reaching a legally binding multilateral agreement on a common emissions reductions target remained the key challenge facing the global political leaders in the last decade. The three biggest polluting countries, the USA, India and China, are not part of the first (2005–2012) or second (2013–2020) commitment periods of the Kyoto Protocol, a legally binding international treaty for emissions reduction. Three other industrialized countries, Japan, Canada and Russia, who were part of the first commitment period, have recently withdrawn their support from the second commitment period.

The absence of global solidarity on the issue of climate change mitigation gives rise to another form of scepticism which can be denoted as global co-operation scepticism. The economics of climate change literature suggests that public support for unilateral action on climate change mitigation is often influenced by public beliefs over whether the rest of the world would follow suit. Lee and Cameron (2008) showed that respondents' willingness to pay for emissions reductions was higher when the mitigation costs are shared internationally, rather than being predominantly borne by a small group of countries. Akter and Bennett (2011) also found their respondents stating significantly higher willingness to pay for climate change mitigation when the biggest polluting countries' participation was guaranteed.

Several other studies examined the link between scepticism over climate science and public support for climate change mitigation (Cameron, 2005; Viscusi and Zeckhauser, 2006; Akter and Bennett, 2011). Cameron (2005) and Viscusi and Zeckhauser (2006) showed that individual willingness to pay varies negatively with impact scepticism. Akter and Bennett (2011) found that higher policy uncertainty (i.e. mitigation scepticism) lead to a lower willingness to pay for climate change mitigation. All of these three studies measured scepticism using respondents' self-stated highest, lowest and best guesses of the change in future average temperature and their beliefs of the likelihood of mitigation effectiveness.

Public support is undoubtedly one of the key factors that determines the desirability of a climate change mitigation policy in democratic countries. Research in this area shows scattered links between climate change scepticism and public support. The existing valuation studies have treated climate change scepticism as a single dimensional phenomenon. However, several recent studies suggest that the concept of climate scepticism may encompasses multiple dimensions such as trend and attribution (Rahmstorf, 2004; Poortinga et al., 2011), success of the mitigation instrument and co-operation amongst major emitters (Lee and Cameron, 2008; Akter and Bennett, 2011). Therefore, two important issues remain for further investigation. The first is the relationship and interplay between these different dimensions of scepticism. The second is the impacts of the different dimensions of scepticism on public support for mitigation schemes, i.e. whether all dimensions of scepticism play the same role in determining public support or if some play more important roles than others.

3. Data

The collection of primary data was necessary to understand the link between scepticism and support for climate change mitigation. The data collection process involved focus group discussions, pilot testing and a survey of around 300 Sydney residents in late 2008. This section describes the data collection process.

In order to measure the first two dimensions of scepticism (i.e. trend and attribute), we asked respondents how strongly they agreed or disagreed with the following statements: (1) 'Climate change is caused by human activities'; and (2) 'We are already experiencing climate change'. To measure the remaining three dimensions, i.e. scepticism over impact, mitigation, and global co-operation, numerical scales were developed following the scales used by Cameron (2005), Viscusi and Zeckhauser (2006) and Akter and Bennett (2011). For impact scepticism, respondents were first shown a figure displaying average annual temperature in Australia for the period of 1910 to 2007. It was also mentioned that, over the past 100 years, average temperature in Australia increased by 0.9°C. They were then asked to indicate their highest, lowest, and best guesses of unmitigated temperature change in 2100 relative to the current year (2008). The best guess was used to measure respondents' beliefs. The difference between high and low guesses was used as a measure of confidence in beliefs following Cameron (2005) and Viscusi and Zeckhauser (2006). One might argue that formulating a high and a low guess around one's best guess could be difficult for a sample drawn from the general public. Note that a significant amount of care was taken during the questionnaire design phase to address this concern. The phrasing of the questions that respondents might find challenging was thoroughly tested in subsequent focus group discussions, peer reviews and pre-tests.

A verbal likelihood scale, similar to that used by the Intergovernmental Panel of Climate Change (IPCC), was used to measure mitigation and global co-operation scepticism. First, respondents were asked to state their highest, lowest and best guesses of the likelihood a mitigation scheme would be effective in slowing down climate change under global co-operation. Global co-operation was defined as a situation where, in addition to Australia and the European Union, at least three major emitting countries i.e. the USA, China, and India, implement a similar emissions reduction scheme. Second, respondents were asked to indicate highest, lowest and best guesses of the likelihood that the major polluting countries will participate in a multilateral agreement to curb their emissions.

The second step was to identify the impacts of the different dimensions of scepticism on respondents' mitigation choices using the choice experiment technique. Choice experiment is a stated preference valuation technique which is widely used to estimate non-market values for environmental goods and services (see for example Hanley et al., 1998; Carlsson et al., 2003). Respondents were presented with a sequence of choices between three alternative scenarios. The scenarios were described by three attributes: cost, average temperature increase and probability of policy success. These attributes were selected and designed in a way to mimic the political debate about how aggressive Australia's mitigation plan should be. Public preference may as well vary depending on how policies are implemented, for example which sectors bear the cost and how the revenue is spent (Carson et al., 2010). We avoided the implementation details to focus on a broader and more general aspect of the CPRS design, i.e. the level of mitigation. The cost of each alternative mitigation scenario was presented using increased household expenditure. The following sentences were included in the scenario description to explain household cost incidence: “If the ‘Carbon Pollution Reduction Scheme’ is implemented, your household’s costs will increase. You will pay higher prices for electricity, fuel, public transport, food in restaurants and groceries. You may choose to reduce your use of electricity and fuel. Even then, the ‘Carbon Pollution Reduction Scheme’ will mean higher costs for your household. The lower the government sets the ‘cap’ on carbon dioxide pollution, the more it will cost.” The ‘average temperature increase’ reflected the increase in temperature corresponding to four different carbon stabilization level as predicted by IPCC (i.e. 750ppm, 650ppm, 550ppm and 450ppm). The ‘probability of policy success’ attribute reflects the scientific uncertainty about that prediction. These two attributes (i.e. ‘average temperature increase’ and ‘probability of policy success’) are logically connected, but they are allowed to vary separately under the efficient experimental design. The idea behind dividing them up is to accommodate uncertainty.

The attributes had multiple levels that differed among the alternatives (Table 1). Respondents were asked five choice questions. A unique ‘choice set’ was presented each time. Each choice set included a ‘status quo’ or ‘no–change’ alternative which had a zero payment level. The other two alternatives had payment levels attached, along with varying levels of the other attributes (Figure 1). A pilot survey of 120 respondents was used to construct a crude guess about the utility function. An experimental design was selected centred on this initial estimate by applying the principles of Db-optimal (or Bayesian) efficient design (Bliemer et al., 2009). The Db-error of the experimental design used for this study was 0.0006.

INSERT FIGURE 1 HERE

INSERT TABLE 1 HERE

The survey was carried out from the third week of November 2008 to the first week of December 2008. This was five months after the release of the CPRS Green Paper that canvassed opinions over the preferred approaches to the CPRS and two weeks before the release of the CPRS White Paper that outlined the final design and targets of the scheme. The survey was programmed and administered by a social survey company that maintains a panel of about 200,000 residents from all over Australia. The database, containing a listing of over 30,000 Sydney residents, was used as the sample frame. The sample frame was divided in half with respect to gender (50% male and 50% female) and age group (50% younger than 35 and 50% older). The sample was divided into three equal groups based on education (33% high school or below, 33% certificate or graduate diploma and 33% university). About 3,000 e-mail invitations were sent, one third of the e-mail invitations were opened and half of those who opened the e-mail completed the Internet-administered survey. In total, 307 completed questionnaires were received.

Table 2 compares the socio-economic characteristics of the sampled households with Sydney population statistics. Although female respondents were slightly over represented in our sample, the difference between the sample and Sydney population sex ratios was not statistically significant at the ten percent level. The educational attainments of the sample were also not significantly different than the Sydney population. However, Z tests for mean differences revealed that the sample respondents' age and weekly household income were significantly different than the median age and weekly average income of the Sydney population. Our sample contained a significantly higher proportion of younger respondents and, on average, sample households earned significantly higher weekly income than the Sydney population.

INSERT TABLE 2 HERE

4. Sources of Climate Change Scepticisms and their Interplays

This section presents the results related to the sources of the five dimensions of climate change scepticism and their interplays. The section is divided into two sub-sections. The first discusses the nature of each type of scepticism and examines their interrelationships. The second presents the results of five regression models which were estimated to identify the sources of each type of scepticism.

4.1 Descriptive Statistics of the Scepticism Attributes and their Correlations

About three-quarters (73%) of respondents either strongly agreed or agreed with the statement that climate change is caused by human action. Seventeen percent neither agreed nor disagreed while the remaining ten percent disagreed. A larger proportion (78%) of the sample agreed with the statement that climate change has already started, 16 percent were unsure and the rest disagreed. However, about a quarter of those who did not believe in human induced climate change (3% of the sample) and 60 percent of those who were unsure (10% of the sample) believed that the climate is changing. This implies that about 13 percent of the sample believe in climate change but do not believe that human beings are causing it.

The mean of respondents' best guess about unmitigated change in average temperature in 2100 relative to 2008 was an increase of 3.8°C. This is lower than the official best estimate temperature change projections in 2100 of 5.1°C (CSIRO, 2008). Two percent of respondents believed that the average yearly temperature would decline in 100 years' time and three percent believed no changes in temperature will occur at all. About a fifth of the sample believed temperature change in future will follow its past trend (i.e. about a 1°C rise). This suggests that about a quarter of respondents do not believe that the impact of unmitigated climate change would be as bad as projected by the climate scientists. The average range of estimates (the average difference between high and low guesses) was about 3°C. Eight percent of the respondents were highly confident about their best guesses, i.e. there was no difference between high and low guesses. Less than one percent of them chose the two extreme ends of the scale which means that they were extremely unconfident.

The mean of respondents' best guess of the probability of the proposed scheme being effective with global co-operation was 45 percent and the median was 50 percent with a maximum of 100 percent and minimum of zero percent. Categorizing the numerical responses according to the IPCC scale suggests that over a third (36%) of the respondents believed it is 'very unlikely' or 'unlikely' for the CPRS to deliver successful mitigation. About a fifth of the sample considered the success of the scheme to be 'less likely than not', while another fifth thought it is 'more likely than not'. The rest (26%) believed that it is either 'likely' or 'highly likely' that the scheme will be effective. More than 80 percent of the respondents believed that the chance of global co-operation on emissions reduction is below 50 percent and half believed that the chance is less than 30 percent, i.e. 'unlikely'.

Table 3 presents the correlation coefficients among all the different dimensions of scepticism and confidence in sceptic beliefs. Significant positive correlations exist among all the scepticism attributes. This implies that, on average and other things remaining the same, respondents being sceptical with regards to one dimension of climate change were also likely to be sceptical with regards to the other dimensions. In almost all cases, the scepticism attributes were significantly positively correlated with respondents' confidence in their beliefs. For example, respondents who believed in human induced climate change stated a significantly higher range around their best guesses of temperature change, the likelihood of policy success and the likelihood of global co-operation. Likewise, respondents who stated a high best guess of temperature change, on average, stated a significantly higher range around their best guess. Similar relationships existed between the best guess likelihood of policy success and its range and the best guess of the likelihood of global co-operation and its range. These findings imply that sceptics were more confident in their beliefs. No statistically significant difference was observed among the ranges around best guesses and respondents' socio-demographic characteristics except for the range of likelihood of global co-operation and education. Respondents with above high school education, on average, stated significantly higher doubts about their best guess likelihood of reaching an agreement on multilateral emissions reduction.

INSERT TABLE 3 HERE

4.2 Determinants of Scepticism Attributes

In this section, we identify the determinants of different types of scepticism. Models 1 and 2 in Table 4 present ordered probit regression results of attribution and trend scepticism respectively. Respondents' level of agreement to the statements 'Climate change is caused by human activities' and 'We are already experiencing climate change' were used as dependent variables in these two models. Respondents' socio-demographic characteristics, such as age, sex, education, income and number of young children, were used as explanatory variables to identify the sceptics' socio-demographic profile. Age was the only significant determinant of both attribution and trend scepticism. No significant influence of the other socio-demographic variables was observed on trend and attribute scepticism.

INSERT TABLE 4 HERE

Model 3 in Table 4 is a Tobit regression model which uses respondents' best guesses of average temperature change in 2100 as the dependent variable. A Tobit model was deemed appropriate because it accounts for the truncated nature of the dependent variable. A dependent variable is truncated if observations are limited within an upper and lower bound. The two-limit Tobit (Maddala, 1984) can deal with dependent variables truncated at both high and low values. In addition to the socio-demographic variables used in Models 1 and 2, Model 3 includes attribution scepticism as an explanatory variable. This is to examine the link between attribution and impact scepticisms controlling for all other factors that may affect impact scepticism. Like Models 1 and 2, respondents' age had a statistically significant negative impact on their best guess temperature change. In addition, the coefficient of income was negative and significant at the five percent level, implying that richer respondents were more sceptical about unmitigated impacts of climate change. Finally, attribution scepticism had a statistically significant positive impact on respondents' best guess of temperature change.

Two additional Tobit regression models were estimated to identify the determinants of mitigation and global co-operation scepticisms. The results are presented in Models 4 and 5 respectively (Table 4). Unlike Models 1, 2, and 3, the coefficients of age were not statistically significant in Models 4 and 5. Female respondents were more optimistic about the likely success of the CPRS than male respondents. Education had a statistically significant negative coefficient in both Models 4 and 5 and the coefficient of income had significant positive signs in Model 4. Like Model 3, the signs of the coefficients of attribution scepticism were positive and statistically significant in both Models 4 and 5. Finally, respondents' familiarity with, and knowledge about, the Kyoto Protocol had significant influences on both mitigation and global co-operation scepticism. Respondents who had only heard about the Protocol but did not know much about it were more optimistic about policy success. Conversely, those respondents who had not only heard about the Protocol but also knew its objectives and status were significantly more sceptical about global co-operation.

5. Mitigation Choices

This section analyses the link between scepticism and public support for climate change mitigation. In the first sub-section, we present the utility framework followed by the regression results in the second sub-section. The final sub-section presents estimates of respondents' willingness to pay for an additional unit of emissions reduction.

5.1 The Utility Framework

The random utility model presents a standard framework to analyse the results of the choice experiment. In this case, the probability of the temperature outcome is itself an attribute, so we used a slight variation of a random expected utility model which can be written generically as:

(1) $$V = \sum_{k=1}^{K} p_k U(X_k, \beta) - \gamma C + \varepsilon$$

Here V is the net expected value of a policy option that costs C and that has K possible mutually exclusive outcomes X_k each occurring with probability p_k. The parameters β and γ are unobserved and need to be estimated from the data in a way that best aligns the actual choices of respondents with the choices predicted by the model. The term ε stands for a random unexplained residual component to values. We will subsequently augment this basic model with an 'alternative specific constant (ASC)', which is frequently used to reflect preferences over general features of a policy option.

The underlying behavioural model is that each respondent picks the policy that has the highest value of V among the available set of options for each set of choices. In our application the status quo outcome is the same in all choice sets for all respondents — a likely rise in average yearly temperature between 5 to 6°C. If the active mitigation option j is chosen, it rises temperatures by T_j with probability P_j. However, with probability $1 - P_j$, the mitigation option fails and provides no change from the no-mitigation temperature outcome of 5–6°C. The utility model for respondent *i* can then be written as:

(2) $$V_{ij} = P_{ij}\, U\,(T_{j,}\, \beta) + (1 - P_{ij})U_0 - \gamma C_{ij} + \epsilon_{ij}$$

(3) $$V_{i0} = U_0 + \epsilon_{i0}.$$

Where j indexes mitigation policies, j = 0 indicates the status quo policy and U_0 is the utility of the no-mitigation outcome. Equations 2 and 3 can be simplified by subtracting U_0 from all V_{ij}, since an additive shift in all V leaves the relative ranking of options unchanged:

(4) $$V_{ij} = P_{ij}\,(U\,(T_{j,}\, \beta) - U_0\,) - \gamma\, C_{ij} + \epsilon_{ij}$$

(5) $$V_{i0} = \epsilon_{i0}.$$

Within this structure, we can specify a simple linear form of utility function in terms of the change of mean temperature from the present:

(6) $$U(T, \beta) - U_0 = \alpha + \beta \Delta T_{ij}.$$

Finally, as mentioned previously, we also add an ASC, for all cases where the policy is an emissions trading scheme (j ≠ 0). The initial estimation problem is then to estimate the unknown parameters [ASC, α, *β, γ*] in the following reduced-form utility model:

(7) $$V_{ij} = ASC + P_{ij}\, \alpha + P_{ij} \Delta T_{ij} \beta - C_{ij} \gamma + \epsilon_{ij}$$

(8) $V_{i0} = \epsilon_{i0}$.

5.2 Regression Results

This sub-section summarises the regression results obtained from two alternative econometric specifications. A number of alternative utility specifications and econometric approaches were applied to the data. The best suited models are presented in this section. These models were selected based on their abilities to meet the theoretical expectations and the model fit statistics. In particular, we tried a full quadratic specification over temperature and probability in a Latent Class Model. Of the eight possible un-interacted terms (in two classes) beyond the simple temperature-probability interaction for expected temperature, two were significant. However, the simple interaction associated with an expected damage model was preferred under the Bayesian Information Criterion. None of the results of interest changed much either qualitatively or in statistical significance under a full quadratic specification, relative to the preferred specification.

Table 5 presents the results of two Multinomial Logit (MNL) models, one of the simplest and most common regression techniques used in choice data analysis. Both models presented in Table 5 include three core climate change mitigation scenario attributes: *Probability*, *Probability*∆Temperature* and *Cost* of the scheme. In addition, the model includes an ASC. As expected a priori, the coefficients of *Cost* and *Probability*∆Temperature* were negative and statistically significant at the one percent level in both Models 1 and 2. This implies that the higher the expected benefit of mitigation (i.e. the lower the expected temperature rise) and the lower the cost, the higher the support for the mitigation scheme. Eighty-eight percent respondents, who chose a change option at least once in one of the five choice tasks, were asked to indicate the attribute that they cared most about when making their choices. Over 40 percent of respondents mentioned the cost of the policy as being the most important criteria while about a third of the respondents mentioned the likelihood of effectiveness of the CPRS followed by about a quarter of the respondents who stated the aggressiveness of the policy (temperature change) as the most important feature. The coefficients of the ASC were negative and statistically significant at the one percent level. This suggests that there was significant negative utility associated with acting against climate change. The coefficients of *Probability* itself were positive, but not statistically significant at the ten percent level.

INSERT TABLE 5 HERE

Model 1 includes a number of socio-demographic variables (age, sex, education, income, children, employment status) and the five scepticism attributes (trend, attribution, impact, mitigation and global co-operation). Model 2 includes the same set of socio-demographic variables in combination with the indicators of confidence in beliefs. All of these variables were interacted with the ASC. Among the socio-demographic characteristics, the coefficients of sex and income were statistically significant in both models while the coefficients of education, employment status and children were statistically significant in Model 1 only. Note that the potential for non-linear response in income was tested by adding a dummy variable for sample belonging to above and below the national average income. The coefficient of the dummy was not statistically significant. Among the scepticism factors, attribution and mitigation scepticism had a statistically significant influence on respondents' decisions to support the CPRS (Model 1). Those respondents who believed in human induced climate change or those who perceived a high likelihood of policy success in delivering climate change benefits were significantly more likely to support the CPRS. The coefficients of all three variables capturing confidence in beliefs about climate change impact, likelihood of success of the mitigation measure and likelihood of global co-operation were positive and statistically significant at the five percent level in Model 2. This means that the higher the range around the best guess (lower confidence in belief), the higher the likelihood to support the CPRS.

To provide a robust alternative to the MNL estimates, we also present results obtained from an alternative modelling approach known as the Latent Class model (LCM). Although the MNL model is simple to apply, it relies on a number of restrictive assumptions. The two most restrictive assumptions are: (1) preference homogeneity and (2) zero intra-respondent correlation. The implication of the first assumption is that all respondents in the sample have identical preferences for climate change attributes. The second assumption implies that each choice question is answered by a different individual. The choice data for the current study consist of five repeated observations by one individual and so may exhibit some degree of correlation among the responses. Further, given the wide range of individual preferences, levels of concern about climate change, and prior beliefs, the preference homogeneity assumption of the MNL model may result in imprecise estimates of the population parameters. The LCM approach is able to account for both preference heterogeneity and intra-respondent correlation. It depicts a population as consisting of a finite and identifiable number of segments. Preferences are assumed to be homogeneous within each segment but are allowed to differ across segments.

INSERT TABLE 6 HERE

Table 6 presents two LCM regression models. Each model is divided into two segments. These segments represent preferences for two heterogeneous groups in the sample.

Determination of the optimal numbers of segments requires a careful assessment of four model fit statistics: the log likelihood, McFadden's pseudo R^2, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The four statistics improved as more segments were added, supporting the assumption of multiple segments in the sample. However, the marginal improvements diminished from 2 to 3 and 3 to 4 segment models, indicating that a model with two segments was the optimal solution in this empirical application. Approximately three-quarters of the sample belonged to the first segment while the rest belonged to the second. The first part of the regression models display the utility coefficients associated with the climate change mitigation scenario: *Probability*, *Probability**Δ*Temperature*, *Cost* and ASC. The second parts of each model reflect the characteristics that determine membership in each segment.

In the first segment of both Models 1 and 2 (Table 6) the coefficients of *Probability**Δ*Temperature* and *Cost* were negative and statistically significant while the coefficients of *Probability* and ASC were positive. All these core decision variables were also statistically significant at less than five percent level. For the second segment, in both Models 1 and 2, the signs and significance levels of some of the core decision variables changed. Contrary to a priori expectation, the coefficients of *Probability**Δ*Temperature* were positive and the coefficients of *Probability* were negative. None of these coefficients was statistically significant at the ten percent level. As in the first segment, the coefficients of *Cost* were negative and statistically significant at the one percent level in both Models 1 and 2. The coefficients of ASC were positive in both Models 1 and 2 but statistically significant at the ten percent level in Model 1 only.

Model 1 includes respondents' socio-demographic characteristics and the five scepticism dimensions as segment membership criteria. Model 2 uses the measures of confidence in sceptic beliefs instead of the scepticism dimensions. The segment membership coefficients in Model 1 reveal that being male and employed increased the probability of a respondent belonging to this first segment. Being an attribute sceptic or a mitigation sceptic increased the probability of being in the second segment. Model 2 identified two significant determinants of segment membership: respondents' sex and degree of confidence in mitigation scepticism. Male respondents were more likely to belong to segment one and respondents who had less confidence in their belief about mitigation policy's likely success were more likely to be in the first group.

5.3 Implicit Price of Mitigation

The implicit price of, or willingness to pay for, an attribute indicates the average amount respondents are willing to pay for a unit change in this attribute. Generally, implicit prices are calculated using the following formula:

$$\text{(9)} \qquad \text{Implicit Price} = -1 * \left(\frac{\beta_j}{\beta_{cost}}\right)$$

Where β_j is the estimated non-cost attribute coefficients, and β_{cost} is the estimated cost coefficient. The sample average implicit price of one additional unit of mitigation (Probability*ΔTemperature) estimated from the MNL model was AUD 90 per month per household. This amount is less than two percent of the monthly sampled household income and about 50 percent of the projected increase in household expenditure due to the introduction of the CPRS that aims to reduce Australia's emissions by five percent below the 2000 level by 2020 (The Commonwealth Treasury, 2008). This estimated average implicit price can be decomposed using the information obtained from the LCM model. For the first segment of the sample (72% of the respondents), the average implicit price was AUD 122 per month per household. The willingness to pay of the second segment of the population was negative (AUD -5).

The estimated implicit price reflects household willingness to pay for changes in both probability of policy success and temperature rise. Assuming two mitigation options such that Option 1 offers a 4°C rise in temperature in 2100 with a 50 percent probability of success (4°C*0.5) and Option 2 offers more aggressive abatement resulting in a 2°C rise in temperature in 2100 with the same probability of success (50%) as in Option 1 (2°C*0.5). On average, respondents would be willing to pay AUD 90 per month to move from mitigation Option 1 to 2. This means, WTP for an additional 1°C equivalent of emissions reductions, keeping probability of policy success constant, is AUD 45. Considering another mitigation option, Option 3, which offers the same level of emissions reduction as in Option 1 (4°C) but involves a higher probability of policy success (75%). Willingness to pay to move from Option 1 to Option 3 is AUD 90. This means that, for each additional percentage increase in the probability of policy success, keeping temperature change constant, respondents are willing to pay an additional AUD 3.6 per month (approximately).

The estimated implicit price for probability of policy success can be used to understand how mitigation scepticism may affect individual valuation for the CPRS. Consider the Australian CPRS which aims to reduce Australia's emissions to 60 percent below the 2000 level by 2050 (Department of Climate Change and Energy Efficiency, 2008). Under the condition that the rest of the world commits to emissions reductions, this mitigation target is 'likely' (67 to 90% probability) to increase of an end-of-century global temperature between 2.1°C and 2.7°C as opposed to the 'no mitigation' case of a 5.85°C increase of global temperature

(CSIRO, 2008). Half of our sample believed that the likelihood of the CPRS delivering any mitigation is 50 percent even when the rest of the world cuts back their emissions. This discrepancy between scientists' projection and public belief of policy success would reduce the perceived benefit of the CPRS by AUD 100 per household.

6. Discussion and Conclusion

The study presented in this paper aims to understand the nature and sources of climate scepticism; and to examine the relationship between scepticism and public support for climate change abatement. The results suggest that scepticism was prevalent in our sample regarding five different dimensions of climate change: trend, attribution, impact, mitigation, and global co-operation. However, the intensity of scepticism varied depending on its type. We observed a low prevalence of attribution, trend, and impact scepticism, while scepticism about the effectiveness of mitigation measures and global co-operation was more widespread. This implies that, although the majority of respondents accepted the existence of human induced climate change and its overarching negative consequences, they were not entirely convinced that climate change could be mitigated by cutting back emissions or that the cost of mitigation will be shared internationally.

The different dimensions of climate scepticism were found to be inter-related as significant overlaps were identified among sceptics' beliefs. Being sceptical with regards to one dimension of climate change increases the likelihood of being sceptical with regards to other dimensions. Older people were more sceptical about trend, attribution, and the impacts of climate change, while highly educated respondents were more sceptical about mitigation effectiveness and global co-operation. Economic well-being disparately influenced impact and mitigation scepticism: High income earners were more sceptical about the impact of climate change and less sceptical about the effectiveness of the mitigation scheme. Information or knowledge about multilateral initiatives on global emissions reduction such as the Kyoto Protocol was a determinant of mitigation and global co-operation scepticism. Respondents who had only heard about the Protocol but did not know much about it were significantly more optimistic about the success of mitigation policy. On the contrary, respondents who knew about the Protocol's current status, were significantly more pessimistic about the prospect of global co-operation than the rest.

Attribution scepticism seemed to remain at the very core of climate change scepticism. Respondent's level of agreement about human activities being the key contributor of climate change was found to be a common source of impact, mitigation, and global co-operation scepticism. This scepticism also played a role in individual voting intentions for climate change mitigation. Respondents who more strongly believed in human induced climate change were more likely to support the mitigation scheme regardless of its benefit and economic cost.

Our choice experiment results showed that individuals made choices by trading off the uncertain benefits of climate change abatement against the corresponding economic costs. The lower the individual share of economic cost, the higher the level of support for emissions reduction. The expected benefit of the mitigation scheme also played a significant role in individual's decisions to support or oppose the scheme. The higher the expected benefit of mitigation (i.e. lower expected temperature rise), the higher the support for the scheme.

Although our sample was drawn from a non-representative internet panel, the regression results showed that none of the socio-demographic variables except respondents' sex was a significant determinant of class membership. Given that the sample sex ratio was not statistically different than the Sydney population's sex ratio the findings can be roughly generalized to develop a broad understanding of Sydney household's preferences for the CPRS. A minor improvement in precision could perhaps be achieved through explicit re-weighting or conditioning based on sex, but this effect is likely dwarfed by other sources of error. Sydney households were found to be divided in their preferences for climate change mitigation. At least two-thirds of the Sydney households possessed significant positive benefit for the CPRS while the rest exhibited zero value. This finding is consistent with the persisting dilemma in the public sphere regarding action against climate change and the roller-coaster ride for the national emissions reduction plan over the past five years. What is interesting is that attribute and mitigation scepticisms are the key determinants of this divide and dilemma as the attribution and mitigation sceptics were more likely to belong to the group that held zero value for emissions reduction. This implies, among all the five dimensions of climate change scepticism these two forms of scepticism matters the most in determining public support for climate change mitigation.

We measured attitudinal certainty numerically using self-stated ranges around individual's best guess estimates for climate change impact, probabilities of policy effectiveness and global co-operation. Our results consistently showed that sceptics were more confident in their beliefs than non-sceptics. This finding is contrary to what was reported by Poortinga et al. (2011) who found non-sceptical individuals were more certain about their beliefs while sceptical individuals expressed mixed feelings and conflicting perceptions of risks and benefits. We tested the relationship between individual's lack of confidence in their beliefs and their decisions to support mitigation action and found that lack of confidence in outcomes is associated with a positive impact on support for climate change mitigation measures.

However, lack of confidence in outcomes does not necessarily imply ignorance, since there is true uncertainty. Those having doubts in their beliefs were more likely to support actions against climate change than others. Particularly, those respondents who were doubtful about their best guess probabilities of policy effectiveness were significantly more likely to support the mitigation scheme. This finding is analogous to the precautionary principle which is based on the notion of giving nature the benefit of the doubt.

The findings of our study nevertheless suggest that a considerable degree of scepticism prevails over major polluting countries' role in curbing global emissions and whether climate change can be prevented even if the major polluting countries take action. The scepticism regarding major polluters' contribution in global emissions reduction is understandable given the outcomes of the multilateral climate treaties in the past. However, it is unclear why almost half of the respondents believed there was less than a 50 percent chance of the proposed mitigation scheme being effective in slowing down climate change if the major polluting countries cut their emissions. This question appears to be an important pathway for future research in the literature of public perceptions of climate change. Further, our study focused on scepticisms surrounding climate change mitigation. Similar scepticisms may also prevail regarding climate change adaptation measures. The link between adaptation scepticism and public support for climate change adaptation policies could be an important topic for future research.

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Figure 1 **Example of a choice question**

18. Which of the following schemes do you prefer? (TICK ONE BOX)

	How much average temperature is expected to rise in 100 years time under each scheme?	How likely it is that the average temperature will rise that much under each scheme? Not so Likely / Somewhat Likely / Likely / Highly Likely — 33% 50% 66% 90% 100%	How much each scheme will cost your household per month? [*Note that this is not a tax or levy. The increase in cost is due to the rise in prices of necessary goods and services.]
☐ No Scheme	5 °C to 6 °C	Likely	$ 0
☐ Scheme A	2 °C to 3 °C	Not so Likely	$ 400
☐ Scheme B	3 °C to 4 °C	Likely	$ 300

Table 1 **Summary of attributes, their levels and coding**

Attributes	Levels	Coding
Expected rise in temperature 100 years from now	1 to 2	1.5
	2 to 3	2.5
	3 to 4	3.5
	4 to 5	4.5
Chances that the rise in temperature will be achieved	Not so likely (33% to 50% chance)	0.41
	Somewhat likely (50% to 66% chance)	0.58
	Likely (66% to 90% chance)	0.78
	Highly likely (90% to 100% chance)	0.96
Rise in household expenditure per month	AUD 50	50
	AUD 100	100
	AUD 200	200
	AUD 300	300
	AUD 400	400

Table 2 **Summary statistics of respondents' socio-economic characteristics**

Respondent characteristic		Sample	Sydney average
Sex ratio (male/female)		0.83	1.00 [a]
Respondent age distribution (%)	Under 35 years	53	36[b]
	Over 35 years	47	64[b]
Highest level of education (%)	Year 12 or below	28	36
	Certificate	35	21
	Bachelor's degree or above	37	44
Gross average household income (AUD/week)		1480	1360

Notes:

[a] This is the male-female ratio for population aged between 15 years to over 65 years.

[b] This is the percentage of population aged between 15 years to over 65 years.

Source: Australian Bureau of Statistics (2009)

Table 3 **Correlation coefficients among different dimensions of climate change scepticism**

	Attribution[a]	Trend[b]	Impact[c]	Mitigation[d]	Global co-operation[e]	Range-Impact[f]	Range-Mitigation[g]	Range- Global co-operation[h]
Attribution[a]	1							
Trend[b]	0.70***	1						
Impact[c]	0.21***	0.30***	1					
Mitigation[d]	0.25***	0.18***	0.12**	1				
Global co-operation[e]	0.15***	0.16***	0.18***	0.52***	1			
Range- Impact[f]	0.18***	0.24***	0.36***	0.11**	0.15***	1		
Range- Mitigation[g]	0.13**	0.10*	0.13**	0.34***	0.30***	0.20***	1	
Range- Global co-operation[h]	0.15**	0.10*	0.06*	0.35***	0.40***	0.22***	0.54***	1

Notes:

***: p<0.01; **: p<0.05; *: p<0.10.

[a]Climate change is caused by human activities (Strongly disagree=1, Strongly agree=5)

[b]We are already experiencing climate change (Strongly disagree=1, Strongly agree=5)

[c]Best guess of unmitigated temperature change in 100 years.

[d]Best guess of likelihood that the CPRS will deliver climate change mitigation.

[e]Best guess of likelihood that the major polluting countries will reduce their emissions.

[f]Range around the best guess of unmitigated temperature change in 100 years.

[g]Range around the best guess of likelihood that the CPRS will deliver climate change mitigation.

[h]Range around the best guess of likelihood that the major polluting countries will reduce their emissions.

Table 4 **Determinants of scepticism: Ordered Probit and Tobit regression results of scepticism indicators (mean value of the coefficients and standard errors in the parentheses)**

Explanatory Variables	Model 1: Attribution scepticism[a]	Model 2: Trend scepticism[b]	Model 3: Impact scepticism[c]	Model 4: Mitigation scepticism[d]	Model 5: Co-operation scepticism[e]
Age	-0.18*** (0.05)	-0.15*** (0.05)	-0.25* (0.14)	-1.41 (1.20)	-1.45 (1.08)
Sex	0.09 (0.13)	0.15 (0.13)	0.45 (0.38)	6.00* (3.17)	3.59 (2.87)
Education	-0.05 (0.05)	-0.05 (0.06)	-0.14 (0.16)	-3.26** (1.30)	-2.78** (1.21)
Income (in '000 AUD)	0.003 (0.002)	0.001 (0.003)	-0.014** (0.006)	0.12*** (0.05)	0.04 (0.04)
Children (<18 years old)	-0.03 (0.06)	-0.06 (0.06)	-0.04 (0.18)	1.02 (1.51)	-0.28 (1.37)
Attribution scepticism[a]	–	–	0.65*** (0.18)	6.63*** (1.52)	3.45** (1.36)
Heard about Kyoto Protocol[f]	–	–	–	11.38*** (3.95)	2.97 (3.58)
Knew about Kyoto P rotocol[g]	–	–	–	-7.42 (3.67)	-7.62* (4.25)
Constant	–	–	3.7***	19.78*	32.93***

			(1.3)	(10.53)	(9.52)
Sigma			3.18*** (0.13)	25.74*** (1.06)	23.29*** (0.97)
Model statistics					
Log-likelihood	-388	-366	-768	-1396	-1349
LR Chi squared	16 (df=5, p<0.01)	11 (df=5, p<0.05)	26 (df=6, p<0.001)	46 (df=8, p<0.0001)	30 (df=8, p<0.0001)
N	307	307	307	307	307

Notes:

***: p<0.01; **: p<0.05; *: p<0.10.

Dependent variables:

[a]Climate change is caused by human activities (Strongly disagree=1, Strongly agree=5).

[b]We are already experiencing climate change (Strongly disagree=1, Strongly agree=5).

[c]Best guess of unmitigated temperature change in 100 years.

[d]Best guess of likelihood that the CPRS will deliver climate change mitigation.

[e]Best guess of likelihood that the major polluting countries will reduce their emissions.

[f]Respondents only heard about the Kyoto Protocol but did not know much about its objectives and status.

[g]Respondents not only heard about the Kyoto Protocol but also knew its objectives and status.

Table 5 **Results of the choice experiment: Multinomial logit (MNL) model**

	Model 1	Model 2
Explanatory Variables	Coefficient (SE)	Coefficient (SE)
Climate change mitigation scenario attributes		
Probability*ΔTemperature	-0.36*** (0.06)	-0.34*** (0.06)
Cost	-0.004*** (0.0006)	-0.004*** (0.0004)
Probability	0.35 (0.35)	0.32 (0.34)
ASC	-1.80*** (0.41)	0.69** (0.30)
Socio-demographic factors		
ASC*Age	-0.02 (0.05)	-0.06 (0.05)
ASC*Sex (Male=0, Female=1)	-0.60*** (0.14)	-0.40*** (0.13)
ASC*Education (high school or below =0, above high school=1)	0.15* (0.08)	-0.04 (0.08)
ASC*Income (per household per month)	0.07*** (0.02)	0.08*** (0.02)
ASC*Children (have children=1, otherwise=0)	0.30** (0.14)	0.16 (0.12)
ASC*Employment (currently employed=1,	0.55***	0.22

otherwise=0)	(0.17)	(0.16)
Scepticism factors		
ASC*Climate change has already started	0.01 (0.09)	–
ASC*Climate change is human induced	0.72*** (0.09	–
ASC*Best guess of temperature change	-0.01 (0.02)	–
ASC*Best guess probability of policy success	0.012*** (0.003)	–
ASC*Best guess probability of global co-operation	0.003 (0.004)	–
ASC*Range of best guess of temperature change	–	0.06** (0.03)
ASC*Range of best guess probability of policy success	–	0.02*** (0.005)
ASC*Range of best guess probability of global co-operation	–	0.01*** (0.005)
Model fit statistics		
Log-likelihood	-1450	-1514
McFadden Pseudo R-squared	0.23	0.22
N	1535	1535

Notes:

***: p<0.01; **: p<0.05; *: p<0.10.

Table 6 **Results of the choice experiment: Latent Class Model (LCM)**

	Model 1		Model 2	
	Segment 1	Segment 2	Segment 1	Segment 2
Explanatory Variables	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Utility function: Climate change mitigation scenario attributes				
Probability*ΔTemperature	-0.55*** (0.08)	0.07 (0.14)	-0.56*** (0.08)	0.08 (0.13)
Cost	-0.005*** (0.0005)	-0.015*** (0.001)	-0.004*** (0.0005)	-0.015*** (0.001)
Probability	1.05** (0.44)	-0.80 (0.77)	1.03** (0.44)	-0.54 (0.73)
ASC	3.60***	0.54*	3.63***	0.37

	(0.22)	(0.30)	(0.23)	(0.30)
Segment function: Socio-demographic and scepticism factors				
Age	-0.01 (0.12)	–	0.16 (0.61)	–
Sex	-0.95*** (0.32)	–	-0.63** (0.29)	–
Education	-0.24 (0.20)	–	-0.19 (0.20)	–
Income	0.05 (0.05)	–	0.08 (0.06)	–
Children	0.40 (0.31)	–	0.25 (0.30)	–
Employment	0.72* (0.40)	–	0.036 (0.036)	–
Climate change has already started	0.04	–	–	–

	(0.22)			
Climate change is human induced	0.78*** (0.20)	–	–	–
Best guess of temperature change	-0.03 (0.05)	–	–	–
Best guess probability of policy success	0.012* (0.006)	–	–	–
Best guess probability of global co-operation	0.004 (0.008)	–	–	–
Range of best guess of temperature change	–	–	0.08 (0.07)	–
Range of best guess probability of policy success	–	–	0.02* (0.01)	–
Range of best guess probability of global co-operation	–	–	0.009 (0.01)	–
Constant	-2.54***	–	0.16	–

	(0.91)		(0.61)	
Model fit statistics				
Log-likelihood	-1240	–	-1255	–
McFadden Pseudo R-squared	0.26	–	0.26	–
Chi squared	893 (df=20, p<0.001)	–	863 (df=18, p<0.001)	–
N (groups)	307	–	307	–

Notes:

***: p<0.01; **: p<0.05; *: p<0.10.