Are all Risk Perceptions Created Equal? Comparing General Risk Assessments and Specific Risk Assessments Associated with Climate Change

James W. Stoutenborough
Arnold Vedlitz
Xin Xing

Institute for Science, Technology and Public Policy
The Bush School of Government and Public Service
Texas A&M University
TAMU 4350
College Station, TX 77843-4350

17 June 2013

This Working Paper is under review.

Corresponding Author: Arnold Vedlitz
Telephone: (979) 845-2929. Fax: (979) 862-8857. E-mail: avedlitz@tamu.edu

Acknowledgement: This material is based upon research conducted by the Institute for Science, Technology and Public Policy in The Bush School of Government and Public Service at Texas A&M University under award NA03OAR4310164 from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. The statements, findings, conclusions, and recommendations are those of the authors and do not necessarily reflect the views of the National Oceanic and Atmospheric Administration or the Department of Commerce.

Are all Risk Perceptions Created Equal? Comparing General Risk Assessments and Specific Risk Assessments Associated with Climate Change

ABSTRACT

For policymaking to address public concerns effectively, policymakers must have a clear understanding of the nature of public concern. Public opinion polls regularly solicit perceptions of risk toward a variety of topics. These assessments though, tend to be general with no specificity offered for a nuanced interpretation. Yet, there is good reason to assume that risk perceptions are not based on the same criteria. If true, policymakers may be unable to address concerns adequately without a better understanding of the drivers of risk perceptions. This project focuses on two primary research questions. 1) Does the public weigh the risk associated with global climate change differently in specific sub-domains? 2) If so, which climate change sub-domains are various members of the public most concerned about when offering a general assessment of global climate change risk? We find that two of the three sub-domains are predictors of a general assessment of risk.

Keywords Public risk assessment; Risk perceptions; Climate change; Policymaking

Organizations routinely analyze risk when solving problems and making decisions. For instance, a business evaluates the risk associated with expanding its production lines, a natural gas company explores the potential risk of contaminating the water supply during hydraulic fracturing, an insurance actuary determines if someone's lifestyle is too risky to offer a basic life insurance policy, and various levels of government discuss and scrutinize the risk (negative externalities) associated with any given policy proposal. Not surprisingly, scholarly efforts to understand risk have grown increasingly common in the last three decades.

From a policy perspective, two aspects of risk must be considered. The first requires an understanding of what, if any, negative externalities may result from any given political decision. These externalities could be anything from creating financial hardship to losing re-election because an official voted against the will of the constituency.

The second aspect that must be considered is the public's perception of the risk associated with an issue domain because that perception can influence the policy agenda. If the public is worried about an issue because it believes the issue presents an unacceptable level of risk, it will demand policy action. Importantly, this action may be the only way to alleviate public worries, even if the policy itself is symbolic in nature (see Edelman 1964). Conversely, if the public is not worried about something, it may question the wisdom of addressing that issue instead of the many it is worried about. When the public's perception of risk is high enough, we would expect the political process to react. However, this assumption relies upon the much less sound assumption that those who make policy decisions actually understand the public's perception of risk on a given topic.

Identifying the public's perceptions of risk is more elusive than identifying its externalities but equally important for the political process. While public opinion polls increasingly ask questions attempting to ascertain risk-related concepts (e.g. concern), these assessments rarely offer the kind of nuance needed to truly understand why the public is worried about something. There are very few, if any, issue domains straightforward enough that there would be no nuance to understand. For instance, a question about the level of concern one might have about being in an airline crash seems fairly simple. However, if the poll were to ask what specifically about an airline crash seems risky, we may find responses vary greatly (e.g. terrorist detonating a bomb, mechanical failure, pilot error, ground control error, another plane flying into their plane). If the public is very concerned about the risk of an airline crash, how exactly should the government react in order to alleviate this fear? If the government is unaware of the specific reasons for these risk perceptions, it may react in a manner that does not actually address enough of these concerns, which will have little impact on the public's perceptions of risk. The more complex the issue domain, the more likely the public may base its evaluation of risk on several different components.

This project explores this dynamic using the issue domain of global climate change (GCC). We seek to determine if the public views the risk within three sub-domains of the GCC issue in a similar manner, and which, if any, of these sub-domains are important predictors of a general assessment of GCC risk. We begin with an examination of the literature pertinent to understanding risk perceptions and an explanation of why we would expect to find that the public relies upon various cues when offering a general assessment of risk. Next, we outline our

analytical strategy for examining these sub-domains and their influence on assessments of the general domain. Finally, we discuss the results of these analyses and offer a discussion of how this type of analysis can benefit the political process. In the end, we find that the public bases its assessments of risk on two of these three sub-domains.

RISK PERCEPTION

Risk perceptions have been examined primarily within psychology for several decades. Psychological studies "have addressed the cognitive and attitudinal process through which risks are interpreted and represented at the individual level, the ways in which particular types of hazards come to be viewed as risky (or not), and the factors that influence the acceptability of particular risks to experts and the public" (Bickerstaff 2004, page 827). Much of this research has focused on relatively small *n* laboratory experiments (e.g. Burns and Slovic 2010; Slovic and Monahan 1995; Slovic et al. 1987) but the use of public opinion polls and assessments focused on basic descriptions of who holds what perspectives have become increasingly common (e.g. Finucane et al. 2000; Slovic et al. 1991; Slovic et al. 2007). Comparatively fewer assessments of risk examinations have utilized regression-based statistical analyses (e.g. Kahan et al. 2007; Satterfield et al. 2004).

Recognizing the benefits of understanding risk perceptions to the policy-making process, public administration scholars and political scientists have begun to integrate risk perceptions into their specific fields. As Leiserowitz has argued, it is essential to understand risk perceptions because they "can fundamentally compel or constrain political, economic and social action to address particular risks" (2005, p. 45). If the public believes that something is risky, even if it is not, this could force policymakers to act. Perhaps more importantly, if the public does not believe an issue is risky, it may be much more difficult for policymakers to legislate on the issue (e.g. cap-and-trade). O'Connor et al. found that risk perceptions "have their own power to account for behavioral intentions" (1999, p. 469) when it comes to an individual's willingness to address GCC. More recently, Stoutenborough and Vedlitz (2012) found that in the United States the public was significantly less likely to support policies designed to mitigate the impact of GCC than were climate scientists, and that risk was a primary predictor of this support.

While we have come a long way in our understanding of risk perceptions, there is still much we do not fully understand. Perhaps the most important gap in the literature revolves around what specifically influences a risk assessment. The psychological research suggests this is well known, and that four general psychometric indicators – perceptions of severity, level of understanding, number affected, and likelihood – provide sufficient explanation for risk perceptions (e.g. Fischhoff et al. 1978; [Identifiable Reference]; Slovic 1987, 2000).

However well these indicators explain the psychological components of risk, they do not provide any context for linking risk assessments to the policy process. For risk assessments to provide a meaningful barometer for policy makers, they must understand the context that influenced such a general assessment. For instance, in their assessment of the risk of four specific terrorist threats, [Identifiable Reference] found a variety of explanations for each of these threats. If different measurement items predict four specific threats within a relatively

narrow domain, is it reasonable to assume that any general perception of risk on any topic is based on the same criteria?

There is no reason to believe that everyone evaluates risks for any general issue using the same body of knowledge. For instance, we know there are a variety of reasons why someone may vote for a particular political candidate variety (e.g. Downs 1957), and it is important to understand why the winner won. We also know the public generally did not support the Affordable Care Act, even though it rather strongly supported many of the policy's components. Similarly, we should expect that the public evaluates different aspects of GCC differently, which should influence risk perceptions.

Research into public risk perceptions for GCC has focused on a variety of mental model approaches to understand what influences these perceptions, which many argue provides the necessary context for understanding risk perceptions. These studies tended to emphasize knowledge and/or attitudinal influences on risk perception (e.g. Bostrom et al. 1994; Kellstedt et al. 2008; Kempton 1997; Malka et al. 2009; O'Connor et al. 1999). The examinations of Kempton (1997) and Bostrom et al. (1994) are particularly relevant to this discussion, as they found that the public often develops its views on GCC from a wide variety of sources, many of which are actually unrelated to GCC. Accordingly, there is every reason to believe that general assessments of risk may draw more heavily from some specific risk areas than others. Certainly, it is unlikely that any individual considers the entirety of the issue when assessing risk, particularly when that issue is as complex as GCC.

If the public is drawing their general assessments of risk more from certain areas than others, this is information that may be critical for policy makers. Indeed, if policy makers know the public is primarily concerned about the risks of GCC on public health and not particularly concerned about environmental risks in the broad sense, policy makers would be able to focus their legislation accordingly. Current approaches to understanding risk perceptions do not allow for such distinctions, as they tend to focus on general risk assessments for both their psychometric and knowledge indicators.

Our review of previous research identifies several risk sub-domains within the general GCC risk domain. Much of the debate over GCC can be divided into three sub-domains– public health (e.g. Cifuentes et al. 2001; Frumkin et al. 2008), economic development (e.g. Arndt et al. 2012; Mendelsohn and Neumann 2004; O'Brien and Leichenko 2000), and the environment (e.g. Gates 1993; Rosenzweig and Parry 1994; Walther et al. 2002). If it is common for the public to evaluate a policy by considering different aspects of that policy (e.g. cost, outcomes, impact on their livelihood), then it should be common for the public to consider specific risks when assessing the overall risk for that general issue.

Subsequently, we focus on two primary research questions. 1) Does the public weigh the risk associated with global climate change differently in specific sub-domains? 2) If so, which GCC sub-domains are various members of the public emphasizing when offering a general assessment of global climate change risk? More specifically, we seek to determine if distinct GCC risk perceptions for public health, economic development, and the environment exist, and if so, which are dominating the overall GCC assessments. We also recognize that risk perceptions

do not operate in a vacuum, and that knowledge and/or attitudinal indicators may also provide insight into the context of risk.

Knowledge

Of the two common explanations of risk perceptions, knowledge appears to be essential to risk perception. Recall, psychologists often emphasize that four psychometric indicators – severity, level of understanding, number affected, and likelihood – provide a strong explanation for the development of risk perceptions. Each of these components necessarily relies upon knowledge at their foundation. Sometimes this knowledge is gained through experience (e.g. we do not understand the danger of touching a hot stove until we burn ourselves) or through education (e.g. the U.S. Department of State regularly issues travel advisories to inform the public of the possible threats associated with traveling to a certain country at a given time). Regardless of the method of learning, one cannot accurately assess any of these psychometric indicators without some understanding of the issue. Subsequently, knowledge is a central component of risk perception.

Researchers generally accept that as the public become more knowledgeable about a topic, they are more likely to develop risk and policy assessments congruent with those who are experts on that issue.[1] While conceptually this is not a particularly surprising expectation, it has been shockingly difficult to find empirical support in many issue domains (e.g. Durante and Legge 2005; Evans and Durant 1995; Hansen et al. 2003; Kellstedt et al. 2008). This lack of support has caused many to question whether knowledge is a useful construct for evaluating risk (e.g. Bulkeley 2000), which is surprising given the inherent connection between knowledge and the four psychometric indicators of risk.

Attitudes

Some scholars insist that individual attitudes and beliefs may be better predictors of risk perceptions than knowledge. From this view, risk perception is more strongly influenced by factors such as values, worldview, personal experience, and/or trust (e.g. Hansen et al. 2003; Malka et al. 2009; Peters 2000; Whitmarsh 2008; Wynne 1991, 1996). For instance, Whitmarsh (2008) found that the experiences of flood victims causes them to be more likely believe that GCC is an important issue than those who have not experienced flooding. Malka et al. (2009) have argued that knowledge is not a lone actor and that its influences are filtered by other characteristics like party identification and trust in scientists. Leiserowitz (2005) found that factors such as affect, imagery, and values have a strong influence on risk perceptions.

Research generally supports that these attitudes and beliefs shape the way an individual interprets a given set of events, body of information, or any other factors that are related to the risk event in question. In recognition of this research, we control for the influence of three general categories of attitudes that have been illustrated to influence public risk perceptions (e.g. Kellstedt et al. 2008; [Identifiable Reference]). Specifically, we examine the influence of efficacy, ecological values, and trust on the three sub-domains of GCC risk perceptions.

[1] This expectation is related to the underlying roles fulfilled by the four psychometric indicators.

The social amplification of risk framework was revised by Kasperson et al. (2003) to loosely integrate the influence of social distrust on risk. However, this relationship is still a bit murky, as Kasperson et al. have acknowledged, "a host of questions surrounds the interpretation of trust" (2003, p. 32–33). Distrust can enhance desires to reduce risk through political activism, intensify public responses to risk events, and enhance risk perceptions (e.g. English 1992; Flynn et al. 1993; Löftstedt and Horlick-Jones 1999). Distrust can cause the public to overestimate the potential of risk (e.g. [Identifiable Reference]). For GCC, trust is "an important correlate of interpretation of risk and resultant support or opposition to policy choice in the face of risk" (Kellstedt et al. 2008, p. 115).

Trust has an interesting way of influencing human behavior. Eagly and Chaiken (1993) and Miller and Krosnick (2000) found that those who have higher levels of trust in the media are more likely to be influenced by the media. In other words, when one trusts an entity, they are more likely to be influenced by that entity. Psychological research reveals that trust is composed of two basic characteristics – social value similarity and competence (Cvetkovich and Nakayachi 2007). When people believe an entity shares similar values and is competent in what it does, they are more likely to have higher levels of trust in that entity, which also explains why they are more likely to be influenced. Accordingly, those who have higher trust in an entity should be more likely to express risk perceptions consistent with those expressed by that entity.

Cultural theorists argue that values and worldviews strongly influence risk perception because they tend to guide other attitudes (e.g. Bickerstaff 2004; Bostrom 1998; Whitmarsh 2008). People with different values tend to have distinguishable ideas about risk, causing the same problem to gain more attention from one type of person while being ignored by others (e.g. Schiefele 1992). In this context, ecological values are often considered to be deeply held convictions about the proper role of humans within the environment. Within the domain of these values, GCC presents many environmental problems and ecological risks, such as rising sea levels, increased frequency and severity of droughts, species migration, increased desertification, health concerns, and the resulting economic implications of each of these. Extant research indicates that as ecological values go up, there is greater concern about the risks of GCC (e.g. Kellstedt et al. 2008; Whitmarsh 2008). Whitmarsh found that ecological values have an extremely positive influence on perceptions of the risk of GCC and suggested "respondents who believe the environment is delicate, resources are limited, and non-human life has intrinsic value are more likely to believe climate change is real" (2008, p. 365).

Finally, beliefs of environmental efficacy should also influence risk perceptions. Environmental efficacy reflects the belief that individuals have the capacity to produce a positive impact on the environment through their actions. Not surprisingly, those who believe that they can change things for the better are also more likely to express concern for GCC (e.g. Kellstedt et al. 2008).

ANALYTICAL STRATEGY

Sample

To determine the extent to which the public views the risk associated with GCC differently depending upon the sub-domain, we used a national survey of adults in the United

States conducted as part of a National Oceanic and Atmospheric Administration grant.[2] The interviews averaged around forty minutes, and 1093 were completed.

The Sub-Domain Test

The survey solicited perceptions of GCC risk in three specific domains – public health, economic development, and the environment. These are the sub-domain dependent variables. Respondents were prompted with the phrase, "In your opinion, what is the risk of global warming and climate change exerting a significant impact on the following." Participants were given four possible answer choices for each sub-domain – no risk, small risk, moderate risk, and high risk. The answer options were coded from 0 to 3 from lowest risk perception to highest.

Due to this coding scheme, an ordered logit is the most appropriate statistical approach to examine the ordered, but not continuous, dependent variables (McKelvey and Zavoina 1975). Though not often tested, Long (1997) has argued that analyses using an ordered logit must be cognizant of the potential for violations of the parallel regression assumption, which holds that the influence of a variable is constant across the entire range of the dependent variable.

Violations of this assumption will yield results that may not accurately reflect the influence of a specific independent variable on the dependent variable (e.g. Robinson et al. no date). We tested for the parallel regression assumption in our models using the Brant Test (Williams 2006), and, consequently, we determined it was best to use a generalized ordered logit (GOLOGIT) to estimate the model (Williams 2006).

In addition to being a more precise analytical tool, the GOLOGIT has the benefit of allowing for a more nuanced interpretation of the influence of the independent variables on the dependent variable (Robinson et al. no date; Williams 2006).[3] A typical ordered logit analysis presumes that the influence of the estimated coefficient is uniform across the range of the dependent variable, even if it is not. When using a GOLOGIT, those variables that do not have a uniform influence are allowed to vary across the range of the dependent variable. This allows these variables to potentially gain or lose statistical significance as they moves up the dependent variable. Accordingly, the GOLOGIT allows for an analysis of the relative impact of these variables at any given level.

As the literature on risk perceptions consistently notes, three general categories of influences are expected to shape these perceptions – attitudes, knowledge, and general demographics. [Identifiable Reference] recently suggested that it would be easy to measure the wrong construction of knowledge in a survey instrument, and that this may explain the inability to find support for the influence of knowledge on risk perceptions. They also demonstrate that a carefully designed assessed measure of knowledge can capture the scientific construction of

[2] The national public survey used a national random sample, conducted by telephone from July 13 to August 10, 2004.

[3] The GOLOGIT simultaneously estimates all of the equations. This leads to results that differ slightly from those found if the different levels are modeled separately as binary outcomes (Williams, 2006).

knowledge.[4] Similarly, we expect that those with greater assessed knowledge would be more likely to perceive higher levels of risk for each of the three issue sub-domains.

Given the increased emphasis on the importance of attitudes influencing risk perceptions, we included several attitudinal indicators to ensure that we did not omit a predictor. Specifically, we controlled for trust in experts, trust in the media, efficacy, ecological values and the belief that scientists actually understand GCC. As noted, those who trust an entity are more likely to be influenced by that entity. Therefore, those who trust the media should be more likely to perceive risk as the media does - generally that GCC is occurring and is bad. There has been a scientific consensus about GCC since at least the early 2000s (Oreskes 2004). Therefore, those who trust experts in GCC ought to be more likely to perceive higher levels of risk. Those with greater efficacy should be more aware of their impact on the environment, which should translate to greater concern about issues like GCC. Similarly, those with greater ecological values should be more aware of the environmental impact of society in general, which should cause them to have greater concern about environmental issues. Those with confidence in the science should express perceptions of risk that are consistent with the results of that science.

Finally, the risk perception literature has consistently recognized the importance of controlling for demographic characteristics. We controlled for the standard battery of demographics. Specifically, we controlled for gender, race, age, education, income, party identification, and political ideology.

The General Risk Test

We examined the second research question using all of the variables described above, with similar expectations. However, the dependent variable for this analysis differs from those used above. The dependent variable is based on an eleven-point scale assessment of the respondent's level of concern about GCC, where 0 = completely unconcerned and 10 = extremely concerned. Though an eleven-point scale, this dependent variable is also ordered and non-continuous; thus necessitating an ordered logit analysis. Unfortunately, we were concerned about using the variable as originally coded due to the skewed nature of the variable, with relatively few observations at the lower end of the scale, particularly at 0 and 1. This can create estimation concerns (McCullagh and Nelder 1989). Fortunately, we easily corrected this concern by collapsing the scale, but retaining the nature of the data, by recoding 0 and 1 as 0, 2 and 3 as 1, 4 through 6 as 2, 7 and 8 as 3, and 9 and 10 as 4. This created a variable where there were sufficient observations in each level to prevent concerns generated by empty bins. As with the other set of analyses, this analysis also indicated violations of the parallel regression assumption, and was estimated using a GOLOGIT.

The only difference between the three analyses described above and the general assessment of risk analysis is that we added each of the three sub-domain risk perceptions as independent variables. This enables the model to determine what respondents were likely considering when they provided their general assessment of risk.

[4] Additional information concerning the variables used in these analyses, including the specific questions used to build indexes, can be found in Appendix Table 1.

RESULTS

We begin with an examination of the three sub-domain risk perceptions before turning our attention to the general assessment. We start with the perceptions of the risk to public health caused by GCC. Next, we examine the risk for economic development. Finally, we examine the risk to the environment.

The presentation of the results of the GOLOGIT differs from the tradition approach. Due to the estimation of variables that violated the parallel regression assumption at the different levels of the dependent variable, we present the results for each of these levels within the tables below. Level 1 represents estimates that contrast those who responded "no risk," 0, against all others; Level 2 contrasts responses of "no risk" and "small risk," 0 and 1, against the others; and Level 3 contrasts "no risk" to "moderate risk" against "high risk," 3.[5] We also estimated gamma values for these estimates, which enables us to determine if the estimates at higher levels in the dependent variable are significantly different from those at the lowest level. Those levels that are significantly different from the lowest level identified where the violations of the parallel regression assumption occurred.[6]

Public Health

The results of our examination of public perceptions of the risk to public health caused by GCC are presented in Table1. The GOLOGIT revealed that those with greater knowledge are more likely to believe that GCC poses an increase in public health risk. Those with stronger ecological values are also more likely to perceive higher levels of health risk. Respondents with greater efficacy are more likely to perceive a health risk, but the GOLOGIT revealed that this influence decreases as the model moves up the levels of the dependent variable. In other words, the difference in risk perceptions is greatest between those with no efficacy and those with the highest efficacy scores at the lowest level of the dependent variable – between "no risk" and the other risk options. While the estimate at the highest level of the dependent variable is still statistically significant, the gamma values indicate that the estimate itself is significantly lower than that found at the lowest level of the dependent variable.

[Insert Table 1 about here]

As the risk literature suggests, we found that a number of demographic characteristics are associated with risk perceptions. Those who are older in age, with less income, and more liberal are more likely to perceive risk. The GOLOGIT estimations for white respondents found that whites are less likely to indicate "high risk" and less likely to indicate either "moderate risk" or "high risk," but there is not a significant difference between the races at the lowest level of the dependent variable. Similarly, the GOLOGIT estimations for education revealed that those with more education are less likely to perceive "high risk" for public health, but the analysis failed to find a significant difference caused by education in the other two levels of the dependent variable.

[5] This general pattern is similarly found in the general assessment model, but it includes one additional ordered category, going up to Level 4.

[6] To simplify the reporting of the results, we simply indicate which levels were significantly different. Specific coefficient estimates and standard errors are available upon request.

Economic Development

The determinants of perceptions of risk caused by GCC on economic development are presented in Table 1. Again, we found that attitudinal, knowledge, and demographic characteristics are important predictors of risk perceptions. Results suggest that the determinants for economic development risk perceptions differ slightly from those for public health. The model indicates that, similar to health, those with greater knowledge are more likely to perceive GCC as a risk to economic development.

Several attitudinal indicators also provide a strong influence. Those with stronger ecological values and those that believe that scientists understand GCC are more likely to perceive risk. Interestingly, the GOLOGIT revealed that those who trust experts are more likely to perceive at least a moderate amount of risk, but the model is unable to find a difference in trust in experts at either of the other two levels. The analysis found that the influence of efficacy does not differ from that found for public health. Again, the GOLOGIT indicated that the influence of efficacy decreases, though it is still statistically significant, at the higher levels of the dependent variable.

The model also suggests that demographic differences can influence the perception of risk caused by GCC on economic development. Specifically, those who are white or wealthy are less likely to perceive risk. Conversely, those who are older in age are more likely to believe that GCC causes risk for economic development.

Environment

The analysis of perceptions of risk caused by GCC on the environment is also presented in Table 1. Unlike the previous two sub-domains, environmental risk is not predicted by knowledge. In other words, those who know more about GCC are no more likely to view this as risky as those who know nothing. Not surprisingly, those who trust the media are more likely to indicate this as a "high risk" situation, but the influence of the media is not found at the lower levels of the dependent variable. Those who have stronger ecological values and those who believe scientists understand GCC are more likely to believe that GCC causes greater risk for the environment. Finally, the decreasing influence of efficacy on risk perceptions is again present, but the measure is nonetheless statistically significant.

Demographic characteristics also play an important role in determining risk perceptions for the environment. The analysis found that men, whites, and conservatives are less likely to perceive risk. Conversely, those who are older in age are more likely to believe that GCC causes greater risk for the environment.

General Assessment of Risk

Before we begin an assessment of general risk perceptions, it is important to demonstrate that the three sub-domains are distinct concepts to the public. As noted, at first glance the results for the public health and economic development sub-domains appeared to differ slightly. Though there are similarities in the models, they all identify unique predictors of each sub-domain that indicate that they are conceptually distinct.

While the unique predictors may indicate distinct concepts, they did not present empirical evidence of this. Subsequently, we estimated two simple analyses to determine if they are distinct. First, we estimated the correlations between the sub-domains. As presented in Table 1, all three correlations fall between 0.6 and 0.7, which suggests a fairly strong correlation. However, the raw correlation estimates can be misleading by suggesting that more covariation exists than actually does. Therefore, we also present the squared correlations in the brackets. These allow for a direct interpretation of the relationship between two variables. We found that 39.94% of the variance between the public health and economic development variables is in common. In other words, 60.06% of the variance is not in common. The data also indicates that 47.05% of the variance between the public health and environment sub-domains is in common, and 46.92% of the variance between the economic development and environment sub-domains is in common. Since all three variables have less than 50 percent of their variation in common, it provides some support that they are distinct concepts.

[Insert Table 2 about here]

However, given the amount of variation in common for each of the three measures, we decided to conduct a second battery of tests. T-Tests are used to determine if the difference between the means for two variables are significantly different from zero. In other words, we are able to determine if the two variables are significantly different from one another, which would indicate that we are measuring distinct concepts. The T-Tests for all three sub-domain relationships indicate that they are all statistically significantly different from one another. While easily significant at the $p < .05$ level, the T-Test comparing the public health and economic development sub-domains is the smallest, which helps explain why the previous analyses resulted in estimates that are only slightly different. Regardless, the T-Tests indicate each of the three sub-domains is a distinct concept, and that they can be distinct indicators of general assessments of risk.

The analyses of the three sub-domain risk perceptions indicate that the public does not view all risk caused by GCC the same. Indeed, in the three models, only efficacy, ecological values, and age are found to have a consistent relationship with all risk perceptions. A respondent's race is found to be important in nearly every instance, except when comparing "no risk" to the others for public health. Otherwise, these four indicators are the only constant influences. Other than party identification, the other variables are found to have a significant influence on one of these domains.

These differences indicate that general assessments of risk may capture one or more of these specific domains, at the exclusion of others. It also means that examinations relying upon general assessments may not provide information that is as useful as needed for policy makers because we do not know the standard used by the public in their evaluations.

Our examination of a general assessment of the risk of GCC can be found in Table 3. The results of this analysis are illuminating. We find that two of the sub-domains are likely being considered when evaluating a general assessment of risk. Specifically, we found that public health risk and economic development risk are both strong predictors of general risk. On the other hand, we failed to find much of a relationship between environmental risk and general risk.

[Insert Table 3 about here]

Additionally, we found that those who trust experts believe scientists understand GCC, have stronger ecological values, and greater efficacy are more likely to report a higher level of risk. Interestingly, the analysis failed to find the shrinking influence of efficacy that is present in all three of the sub-domain risk perceptions.

Consistent with some previous examinations, we found that there is not much of a relationship between knowledge and general risk (e.g. Kellstedt et al. 2008). Finally, we found that those who are older in age and liberals are more likely to report higher general risk assessments. The GOLOGIT revealed that men are more likely to report lower levels of risk than women. Additionally, those with more education are less likely to report higher levels of risk.

DISCUSSION

We began this project seeking to determine if the public views the risk associated with specific sub-domains of GCC in the same manner, and if the public relies upon any of these sub-domains when asked to provide a general assessment of GCC risk. The results indicate that there is much more to public risk perceptions than currently recognized in the literature. Subsequently, there are several implications associated with these findings.

First, the results indicate that the public does not consider all aspects of GCC when offering a general assessment of GCC risk. As expected, they tend to base their views on their perceived risk on specific sub-domains of GCC. Specifically, we find that general assessments of risk are driven primarily by public health and economic considerations. Accordingly, these results suggest it may be beneficial for public opinion polls to include follow-up risk perception questions that will allow scholars and interested parties the ability to narrow in on the precise nature of the public's general assessment.

The lack of influence for environmental risk on a general assessment of risk was unexpected. GCC is typically presented as an environmental issue. Indeed, environmentalists are leading the charge for change. However, for reasons beyond the scope of the current project, views of environmental risk do not appear to be influential. Additional research is definitely needed to understand better why this relationship exists.

Second, we find that knowledge is a strong predictor of two of the three domain-specific risk perceptions. In both of these, trust in media is not a major factor. However, we are unable to identify a significant influence for knowledge on the environment-specific risk, but we find trust in media to be important at the highest level of risk. Perhaps the increased media attention to the environmental impacts of GCC is detrimental to causing the public to view this as a problem. Additionally, including public health risk and economic development risk in the general assessment model may have mitigated the knowledge influence.

Finally, these results have implications for GCC issue advocacy and policy making. The results indicate that if advocates for policies to mitigate the impact of the United States on GCC want to be successful, they might consider changing the focus of their arguments. Educating the

public on the environmental impacts of GCC, which has been the focus for some time (see for instance Kempton, 1997, p.14), apparently does not have the desired impact, as those with more knowledge are no more likely to perceive risk. Perhaps more importantly, risk assessments for the environment are not shaping general risk assessments. Instead, those urging policy action need to focus on risk to public health and economic development caused by GCC. These sub-domains appear to be the ones the public rely upon when developing their views about GCC. Similarly, if the government wants to alleviate public concern about GCC, these results suggest they need to focus their attention on public health and economic concerns more than on environmental concerns. By emphasizing either of these two sub-domains, public officials may find greater support from the public to pass GCC policy.

APPENDIX

[Insert Appendix Table 1 about here]

REFERENCES

Arndt C, Chinowsky P, Robinson S, *et al*. 2012. Economic development under climate change. Review of Development Economics 16(3): 369–377

Bickerstaff K. 2004. Risk perception research: socio-cultural perspectives on the public experience of air pollution. Environment International 3(6): 827–840

Bostrom A. 1997. Risk perceptions: experts vs. laypeople. Duke Environmental Law & Policy Forum 8:101–113

Bostrom A, Granger MM, Baruch F, *et al*. 1994. What do people know about global climate change? 1. mental models. Risk Analysis 14(6): 959–970

Bulkeley H. 2000. Common knowledge? Public understanding of climate change in Newcastle, Australia. Public Understanding of Science 9(3): 313–330

Burns WJ and Slovic P. 2010. Predicting and modeling public response to a terrorists strike. In: Slovic P (ed), The Feeling of Risk: New Perspectives on Risk Perception. Earthscan, Washington, DC, USA

Cifuentes L, Borga-Aburto VH, Gouveia N, *et al.* 2001. Hidden health benefits of greenhouse gas mitigation. Science 293(5533): 1257–1259

Cvetkovich G and Nakayachi K, 2007. Trust in a high-concern risk controversy: a comparison of three concepts. Journal of Risk Research. 10(2): 223–37

Downs A. 1957. An Economic Theory of Democracy. Harper and Row, New York, NY, USA.

Durant RF and Legge JS Jr, 2005. Public opinion, risk perceptions, and genetically modified food regulatory policy: reassessing the calculus of dissent among European citizens. European Union Politics 6(2): 181–200

Eagly AH and Chaiken S. 1993 The Psychology of Attitudes. Harcourt Brace Jovanovich, Fort Worth, TX, USA

Edelman M. 1964. The Symbolic Uses of Politics. University of Illinois Press, Urbana, IL, USA

English MR.1992. Siting Low-Level Radioactive Waste Disposal Facilities: The Public Policy Dilemma. Quorum, New York, NY, USA.

Evans G and Durant J. 1995. The relationship between knowledge and attitudes in the public understanding of science in Britain. Public Understanding of Science 4(1): 57–74

Finucane ML, Slovic P, Mertz CK, Flynn J, and Satterfield TA. 2000. Gender, race and perceived risk: the 'white-male' effect. Health, Risk, & Society 2(2): 159–172

Fischhoff B, Slovic P, Lichtenstein S, Read S, and Combs B, 1978. How safe is safe enough: a psychometric study of attitudes toward technological risks and benefits. Policy Sciences 9(2): 127–152

Flynn J, Slovic P, and Mertz CK. 1993. The Nevada initiative: a risk communication fiasco. Risk Analysis 13(5): 497–502

Frumkin H, Hess J, Luber G, *et al*. 2008. Climate change: the public health response. American Journal of Public Health 98(3): 435–445

Gates DM. 1993. Climate Change and its Biological Consequences. Sinauer Associates, Sunderland, UK

Hansen J, Holm L, Frewer L, *et al*. 2003. Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. Appetite 41(2): 111–121

Kahan DM, Braman D, Gastil J, *et al.* 2007. Culture and identity-protective cognition: explaining the white-male effect in risk perception. Journal of Empirical Legal Studies 4(3): 465–505

Kasperson JX, Kasperson RE, Pidgeon N, *et al.* 2003. The social amplification of risk: assessing fifteen years of research and theory. In: Pidgeon N, Kasperson RE, and Slovic P (eds), The Social Amplification of Risk. Cambridge University Press, New York, NY, USA

Kellstedt PM, Zahran S, and Vedlitz A. 2008. Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. Risk Analysis 28(1): 113–126

Kempton W. 1997. How the public views climate change. Environment: Science and Policy for Sustainable Development 39(9): 12–21

Leiserowitz A. 2006. Climate change risk perception and policy preferences: the role of affect, imagery, and values. Climatic Change 77(1): 45–72

Löftstedt RE and Horlick-Jones T. 1999. Environmental regulation in the UK: politics, institutional change, and public trust. In: Cvetkovich G and Löftstedt RE (eds), Social Trust and the Management of Risk. Earthscan, London, UK

Long SJ. 1997. Regression Models for Categorical and Limited Dependent Variables. Sage, Thousand Oaks, CA, USA

Malka A, Krosnick JA, and Langer G. 2009. The association of knowledge with concern about global warming: trusted information sources shape public thinking. Risk Analysis 29(5): 633–647

McCullagh P and Nelder JA. 1989. General Linear Models, 2nd ed. Chapman and Hall, Boca Raton, FL, USA

McKelvey RD, and Zavoina W.1975. A statistical model for the analysis of ordinal level dependent variables. Journal of Mathematical Sociology 4(1): 103–120

Mendelsohn R and Neuman JA (eds). 2004. The Impact of Climate Change on the United States Economy. Cambridge University Press, Cambridge, UK.

Miller JM and Krosnick JA. 2000. News media impact on the ingredients of presidential evaluations: politically knowledgeable citizens are guided by a trusted source. American Journal of Political Science 44: 301–315

O'Brien KL and Leichenko RM. 2000. Double exposure: assessing the impacts of climate change within the context of economic globalization. Global Environmental Change 10(3) 221–232

O'Connor RE, Bord RJ, and Fisher A. 1999. Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Analysis 19(3) 461–471

Oreskes N. 2004. Beyond the ivory tower: the scientific consensus on climate change. Science 306(5702): 1686

Peters H. 2000. From information to attitudes? Thoughts on the relationship between knowledge about science and technology and attitudes toward technologies. In: Dierkes M and von Grote C (eds), Between Understanding and Trust: The Public, Science and Technology. Harwood Academic, Amsterdam.

Robinson SE, Liu X, Stoutenborough JW, *et al*. no date. Explaining popular trust in the Department of Homeland Security. Journal of Public Administration Research and Theory

Rosenzweig C and Parry ML. 1994. Potential impact of climate change on world food supply. Nature 367(6459): 133–138

Satterfield TA, Mertz CK, and Slovic P. 2004. Discrimination, vulnerability, and justice in the face of risk. Risk Analysis 24(1): 115–129

Schiefele U. 1992. Topic interest and levels of text comprehension. In: Renninger KA, Hidi S, and Krapp A (eds), The Role of Interest in Learning and Development. Erlbaum, Hillsdale, NJ, USA

Slovic P. 1987. Perception of risk. Science 236(4799): 280–285

Slovic P. 2000.The Perception of Risk. Earthscan, London, UK

Slovic P and Monahan JH.1995. Probability, danger and coercion: a study of risk perception and decision-making in mental health law. Law and Human Behavior 19(1): 49–65

Slovic P, Flynn JH, and Layman M. 1991. Perceived risk, trust, and the politics of nuclear waste. Science 254(5038): 1603–1607

Slovic P, MacGregor DG, and Kraus NN. 1987. Perception of risk from automobile safety defects. Accident Analysis & Prevention 19(5): 359–373

Slovic P, Peters E, Grana J, *et al.* 2007. Risk perception of prescription drugs: results of a national survey. Drug Information Journal 41(1): 81–100

Stoutenborough JW and Vedlitz A. 2012. Public opinion and climate-related policy solutions: a comparison of the policy preferences of the public, stakeholders, and climate scientists. Presented at the Annual Meeting of the Midwest Political Science Association, Chicago, IL, USA

Walther GR, Post E, Convey P, *et al*. 2002. Ecological responses to recent climate change. Nature 416(6879): 389–395

Whitmarsh L. 2008. Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioral response. Journal of Risk Research 11(3): 351–374

Williams R. 2006. Generalized ordered logit/partial proportional odds models for ordinal dependent variables. Stata Journal 6(1): 58–82

Wynne B. 1991. Knowledges in context. Science, Technology, and Human Values 16(1): 111–121

Wynne B. 1996. Misunderstood misunderstandings: social identities and public uptake of Science. In: Irwin A and Wynne B (eds), Misunderstanding Science? The Public

Reconstruction of Science and Technology. Cambridge University Press, New York, NY, USA

Table 1: Determinants of Global Climate Change Related Risks

	Public Health		Economic Development		Environment	
	Coefficient	Prob.	Coefficient	Prob.	Coefficient	Prob.
Attitudinal Indicators						
Trust Experts	-.002 (.048)	.964			-.025 (.048)	.589
Level 1	-	-	-.001 (.070)	.979	-	-
Level 2	-	-	.145 (.052)*	.006	-	-
Level 3	-	-	-.017 (.054)	.751	-	-
Trust Media	.063 (.052)	.228	.035 (.052)	.494		
Level 1	-	-	-	-	-.051 (.094)	.590
Level 2	-	-	-	-	.076 (.065)	.238
Level 3	-	-	-	-	.121 (.060) †	.045
Scientists Understand	.110 (.098)	.261	.158 (.095)	.097	.206 (.099)	.039
Efficacy						
Level 1	1.740 (.279)	.000	1.646 (.267)	.000	2.200 (.319)	.000
Level 2	1.063 (.218)**	.000	.964 (.215)**	.000	1.526 (.240)*	.000
Level 3	.603 (.228)***	.008	.788 (.237)**	.001	.983 (.239)**	.000
Ecological Values	1.148 (.206)	.000	.476 (.202)	.019	1.190 (.213)	.000
Knowledge	1.173 (.372)	.002	.888 (.368)	.016	.602 (.379)	.113
Demographics						
Male	-.132 (.148)	.373	.005 (.147)	.968	-.255 (.151)	.091
White			-.410 (.202)	.042	-.670 (.211)	.002
Level 1	.033 (.436)	.939	-	-	-	-
Level 2	-.638 (.266) †	.017	-	-	-	-
Level 3	-.903 (.231)*	.000	-	-	-	-
Age	.011 (.004)	.011	.012 (.004)	.007	.014 (.004)	.002
Education			-.005 (.038)	.881	-.017 (.039)	.653
Level 1	.076 (.067)	.262	-	-	-	-
Level 2	.036 (.045)	.421	-	-	-	-
Level 3	-.090 (.047)*	.054	-	-	-	-
Income	-.054 (.024)	.027	-.051 (.024)	.038	-.029 (.025)	.249
Republican	-.133 (.190)	.484	-.116 (.190)	.542	-.103 (.196)	.598
Ideology	-.091 (.049)	.063	-.074 (.049)	.128	-.144 (.050)	.004
Cut Point 1	-4.562 (1.274)	.000	-1.933 (.881)	.028	-2.236 (.953)	.019
Cut Point 2	-4.226 (.941)	.000	-3.174 (.870)	.000	-3.720 (.920)	.000
Cut Point 3	-3.247 (.953)	.001	-3.939 (.907)	.000	-5.154 (.940)	.000
Number of Cases	713		700		708	
Wald Chi2	215.28	.0000	169.56	.0000	247.61	.0000
McFadden's R2	.1435		.1087		.1772	
Log Likelihood	-800.104		-824.538		-749.014	

Standard error in parentheses. Two-tailed tests. For variables in violation of the parallel regression assumption: Level 1 corresponds to the contrast between 0 against all of the other ordered categories; Level 3 represents the contrast between the 0, 1, and 2 categories against the 3 category. Gamma test if coefficient estimates at Levels 2, or 3 are significantly different than at Level 1: † p < .100; * p < .05; ** p < .01; *** p < .001.

Table 2: Correlation and T-Test Comparisons of the Sub-Domains

		Public Health	Economic Development	Environment
Public Health	Correlation	1.000		
	T-Test	-		
Economic Development	Correlation	.632 [39.94%]	1.000	
	T-Test	.058 (.026)*		
Environment	Correlation	.686 [47.05%]	.685 [46.92%]	1.000
	T-Test	-.099 (.024)***	-.158 (.024)***	-

Note: Squared correlations are in brackets. This indicates the percentage of the variance of each variable that is in common. The T-Test tests if the differences in the mean of two variables are no different than zero. The coefficient represents the difference between the means. Standard errors are in parentheses. * p < .05; ** p < .01; *** p < .001.

Table 3: Determinants of General Global Climate Change Risk

	Coefficient	Prob.
Domain-Specific Risk		
Public Health	.474 (.110)	.000
Economic Development	.247 (.108)	.022
Environment	-.043 (.124)	.728
Attitudinal Indicators		
Trust Experts	.116 (.050)	.021
Trust Media	.049 (.054)	.356
Scientists Understand	.303 (.100)	.003
Efficacy	.917 (.198)	.000
Ecological Values	1.314 (.214)	.000
Knowledge	.100 (.381)	.792
Demographics		
Male		
Level 1	-1.228 (.439)	.005
Level 2	-.845 (.268)	.002
Level 3**	.021 (.188)	.910
Level 4**	.266 (.206)	.197
White	-.288 (.211)	.172
Age	.010 (.005)	.034
Education		
Level 1	.109 (.087)	.211
Level 2†	-.029 (.067)	.660
Level 3**	-.172 (.048)	.000
Level 4*	-.109 (.050)	.032
Income	.025 (.025)	.324
Republican	-.166 (.194)	.391
Ideology	-.178 (.052)	.001
Cut Point 1	-3.337 (1.537)	.030
Cut Point 2	-3.094 (1.231)	.012
Cut Point 3	-3.655 (.980)	.000
Cut Point 4	-6.589 (1.022)	.000
Number of Cases	687	
Wald Chi2	327.69	.0000
McFadden's R2	.2218	
Log Likelihood	-791.351	

Standard error in parentheses. Two-tailed tests. For variables in violation of the parallel regression assumption: Level 1 corresponds to the contrast between 0 against all of the other ordered categories; Level 3 represents the contrast between the 0, 1, and 2 categories against the 3 and 4 categories; Level 4 examines the contrast between the 0, 1, 2 and 3 categories against the 4 category. Gamma test if coefficient estimates at Levels 2, 3, or 4 are significantly different than at Level 1: † p < .100; * p < .05; ** p < .01; *** p < .001.

Appendix Table 1: Variable Definitions

Variable	Operation
	Dependent Variables
Public Health	Measured using a 4-point scale. "In your opinion, what is the risk of Global Warming and Climate Change exerting a significant impact on the following: Public Health in your state?" 0 = no risk, 3= high risk
Economic Development	Measured using a 4-point scale. "In your opinion, what is the risk of Global Warming and Climate Change exerting a significant impact on the following: Economic development in your state?" 0 = no risk, 3= high risk
Environment	Measured using a 4-point scale. "In your opinion, what is the risk of Global Warming and Climate Change exerting a significant impact on the following: Impact on the environment in your state?" 0 = no risk, 3= high risk
General Risk	Measured using an 11-point scale. "Now, I'd like to list some specific issues that concern people. On a scale from 0 to 10, with 0 indicating completely unconcerned and 10 indicating extremely concerned, rate these issues on how worried you are about them right now." Rescaled such that 0–1 = 0, 2–3=1, 4–6=2, 7–8=3, and 9–10=4
	Attitudinal Indicators
Ecological Values	Measured as an index that average respondent concern for GW using a 4-point scale where 3 = strongly agree and 0 = strongly disagree, respondents were asked to state their agreement with (1) We are approaching the limit of people the earth can support; (2) When humans interfere with nature it produces disastrous consequences; (3) Plants and animals have as much right to exist as humans; (4) The earth is like a spaceship with limited resources; (5) Balance of nature is delicate; (6) If things continue on their present course, we will experience a major ecological catastrophe; and (7) Todays policies must consider the needs of future generations.
Trust Media	Measured as an index that averages responses to 4 items. Using an 11-point scale, respondents were asked to indicate the trustworthiness of information on climate change provided by newspapers, television news, radio, and the Internet, with 10 = very trustworthy, and 0 = not trustworthy at all. Rescaled such that 0–1 = 0, 2–3=1, 4–6=2, 7–8=3, and 9–10=4
Trust Experts	Measured as an index that averages responses to 4 items. Using an 11-point scale, respondents were asked to indicate the trustworthiness of information on climate change provided by government agencies, nonprofit organizations, environmental interest groups, and other interest groups, with 10 = very trustworthy, and 0 = not trustworthy at all. Rescaled such that 0–1 = 0, 2–3=1, 4–6=2, 7–8=3, and 9–10=4
Scientists Understand	Measured using a 4-point scale. Respondents were asked "How clearly do you think scientists understand Global Warming and Climate Change," with 1 = very unclear understanding and 4 = very clear understanding.
Efficacy	Measured as an index that average respondent concern for GW using a 4-point scale where 3 = strongly agree and 0 = strongly disagree, respondents were asked to state their agreement with (1) I believe my actions have an influence on GW; (2) My actions to reduce the effects of GW in my community will encourage others to reduce their effects; (3) I have an obligation to future generations to reduce my impact on GW.
	Knowledge
Knowledge	Measured using an average of correct responses to six questions. Measured as percent of the following statements correctly answered: (1) Nitrous Oxide is a greenhouse gas, (2) The major cause of increased atmospheric concentration of greenhouse gases is human burning of fossil fuels, (3) Biological diversity will increase as global temperature increases, and (4) Aerosols are airborne particles that are known to contribute to the formation of clouds and precipitation. (5) Forest growth is likely to decrease as a result of climate changes that are caused by Global Warming, and (6) Water vapor is the principal greenhouse gas.
	Demographic Indicators
Male	Measured nominally as 1 = male, and 0 = female
Income	Measured as the estimated annual household income (11 ordered categories representing $10,000 increments where a range of $10,000 to $19,999 would be coded 15)
White	Measured nominally as 1 = white, and 0 = nonwhite
Ideology	Measured as a 7-point scale, with 1 = strongly liberal, and 7 = strongly conservative
Age	Measured in years.
Education	Measured in years of education.
Republican	Measured nominally as 1 = Republican, and 0 = Democrat or no preference