Cheap Talk and Climate Change:  
A Theory of Discordant Climate Change Policies

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Abstract

A political party’s ideological position regarding climate change can be either pro-growth or pro-environment. However, the ideological position itself does not sufficiently explain climate change denial. To study this issue, I develop a cheap-talk game of the three parties associated with climate change: the government, the climate scientist, and the median voter. I show that a credibility gap is created between the scientist and the government if the preference of the scientist is not perfectly aligned with that of the government. In the case where climate change is likely to be a serious problem, the credibility gap leads to too much burning of fossil fuels. The credibility gap is eliminated and the ex-ante social welfare is maximized if and only if the scientist’s preference is perfectly aligned with that of the government. This is endogenously achieved when the government is allowed to appoint its optimal scientist without election concerns. In the case where the government has election concerns, if the median voter perceives an alarming message from the climate scientist, then even a “right-wing” government must choose an aggressive climate change policy to avoid losing the election. Accordingly, it will prefer to appoint a climate scientist who is unlikely to send an alarming message. Thus the government deliberately creates a credibility gap which may cause distorted climate change policies in a democratic society. Nevertheless, the model predicts that countries with more democratic political institutions will have climate change policies that are more targeted towards renewable energy. I test this prediction with cross-sectional data from 133 countries worldwide in 2011. I show strong empirical evidence that supports my theoretical prediction.

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1 Introduction

Social concern about climate change has been steadily high. According to a national poll on global warming conducted by Stanford University, Resource For the Future, and the New York Times in January 2015, United States citizens perceive climate change (global warming) to be the most serious problem facing the world in the future if nothing is done to address it. At the same time, many people seem to fear that the government is not dealing sufficiently with climate change. As of January 2015, 53% of U.S. citizens thought that the government should do more than a moderate amount about climate change, but only 15% of citizens thought that the government was currently doing more than a moderate amount to deal with climate change\footnote{Figures 1-2 show the results of Global Warming National Poll conducted by SSRS from January 7-22, 2015, organized by Resource For the Future, the New York Times, and Stanford University.}

To explain the underlying disparity in the data about social concerns surrounding climate change, it is natural to consider a hypothesis that the government’s preference for climate change policies may be different from that of the median voter. Specifically, the government may be less concerned about climate change than the median voter. Let us consider two dimensions of economic policy regarding climate change: economic growth and the environment. We consider these two concerns to be on opposite ends of a sliding scale, so that a policy which is more pro-growth will by nature be less pro-environment, and vice versa. We also assume that the right-wing political party prefers pro-growth economic policies, while the left-wing political party prefers pro-environment ones. We specifically consider a pro-growth government which advocates for economic development through the exploitation of natural resources. In simple terms, we assume that such a government is more right wing (pro-growth) than the median voter.

However, this hypothesis does not seem sufficient to explain why governments and policymakers do not act on climate change warnings from the majority of climate scientists. Most climate scientists argue that climate change has been occurring over the last hundred
years, and ninety-seven percent of climate scientists agree that climate-warming trends over the past century are very likely due to human activities. Most of the leading scientific organizations worldwide have issued public statements endorsing this position (See the NASA Global Climate Change website for further details). Human emission of greenhouse gases (GHGs), which have increased exponentially over the last century, are considered to be the
primary cause of climate change, though there is still debate about the eventual negative con-
sequences of such change. The United Nations Framework Convention on Climate Change
(UNFCCC) urges governments to take precautionary actions to reduce GHGs since avoiding
serious climate change-related disaster could become impossible if they wait for certainty
before making any changes.²

Governments rely on climate scientists when they have to decide whether to take action
against climate change, as they do not have the expertise to observe climate change. Thus
climate scientists have been producing numerous scientific reports for policymakers over
the last few decades. Since the Intergovernmental Panel on Climate Change (IPCC) was
established in 1988, there have been five scientific assessment reports. Each successive IPCC
report gained more scientific confidence in identifying human activity as the cause of much
of the recent climate change. The first assessment report, which was released in 1990, was
the first official scientific report from the IPCC that acknowledged that emissions resulting
from human activities were substantially increasing the atmospheric concentrations of the
GHGs. The third report, released in 2001, displayed greater scientific confidence, stating that
“[M]ost of the observed warming over the last 50 years is likely (larger than 66% chance) to
have been due to the increase in GHGs concentrations.” In the fifth report released in 2013,
this reported confidence increased to more than 95%: “[I]t is extremely likely that human
influence on climate caused more than half of the observed increase in global average surface
temperature from 1951-2010.” At this point, climate scientists express strong consensus that
average surface temperatures have increased over the past 100 years and that this increase
is caused primarily by human-induced emissions of GHGs.³

Although the scientific community expresses a strong consensus on human-caused climate

²“...where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures...” UNFCCC Article 3: Principles.
³“Climate change is real. There will always be uncertainty in understanding a system as complex as the world’s climate. However there is now strong evidence that significant global warming is occurring. The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities.” Joint statement of 11 international science academies, 2005.
change, there are drastically different personal beliefs about climate change held by major players in the political arena. In fact, there seems to be a remarkable divergence between the messages of climate scientists and the beliefs of the political arena. Figure 3 shows the percentage of U.S. citizens who believe that effects of global warming are already occurring, by major political party. Republican view on climate change is certainly different from that of Democrats, and as is clear, the belief gap between the two parties has been increasing since 1998. The percentage of Republicans who believe in climate change has decreased since then, even though the scientific community has gained greater scientific confidence in human-caused climate change over the same period of time.

Some politicians refuse to believe the messages sent by climate scientists. For example, Congressman Paul Ryan, Republican of Wisconsin, restated his view on climate change in:

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4While former U.S. vice president Al Gore made a documentary film, *An Inconvenient Truth*, to educate people about climate change, former president George W. Bush pulled out of the Kyoto Protocol, which was signed by the Clinton Administration when Al Gore was the vice president.

5This graph shows responses to the following question from the Gallop Poll: Which of the following statements reflects your view of when the effects of global warming will begin to happen – *they have already begun to happen; they will start happening within a few years; they will start happening within your lifetime; they will not happen within your lifetime; but they will affect future generations; (or) they will never happen*?

6For a specific example, see the prepared statement of Mr. Markey of the Hearing on the Administration’s View on the State of Climate Science from the 111th Congress, which Mr. Markey complains of “systematic suppression of dissenting opinion,” “intimidation,” “manipulation of data and models, possible criminal activity,” and more.
an October 2014 debate, in which he was asked if he thought human activity was to blame for changes to the planet’s climate, by saying “I don’t know the answer to that question. I don’t think science does, either.”

Is this refusal to state a belief in the scientists’ messages simply irrational? To study this issue, I develop a game-theoretic model of the three parties associated with climate change in the socio-economic political context: the government, the climate scientist, and the median voter. I work out the implications of having a government with “right-wing bias”. My basic model shows that a credibility gap between the climate scientist and the government is created if the climate scientist’s preference for what policy to enact is not perfectly aligned with the government. Specifically, if the climate scientist is more favorable toward renewable energy than the government, the credibility gap can result in too much burning of fossil fuels. The “left-wing” climate scientist sends an alarming message about climate change too often. As a result, a “right-wing” policymaker may feel that the “left-wing” climate scientist is sending an alarming message about climate change too often. The policymaker may then discount the alarming message, assuming that it is just exaggeration from the left wing. This may be indeed the case when the state is not bad. However, when the state is truly bad, the scientist cannot credibly communicate the danger. This results in a shortfall of renewable energy, which is very costly to society. To illustrate the credibility gap, we can turn to one of Aesop’s fables, “The Boy Who Cried Wolf.” Since the boy cried wolf too often, nobody believed him when a wolf actually came. If the preferences of the climate scientist and the government could be better aligned, this problem could be mitigated.

The credibility gap is eliminated and the ex-ante social welfare is maximized if and only if the climate scientist’s preference is perfectly aligned with the government. If the government is allowed to appoint its climate scientist, then it would select one whose preference agrees with its own preference. Therefore, we can endogenously eliminate the credibility gap and maximize the ex-ante social welfare. This is a striking result. One might think that if

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7Climate Change Skepticism, the Guardian, Nov 17th 2014.
the government is “right-wing biased” compared to the median voter, then the voter would not want the government to appoint a scientist that shares its preferences, because doing so could lead to bad climate change policies. However, I show that the opposite is true: When a right-wing government appoints its favorite scientist, the \textit{ex-ante} social welfare is maximized. The intuition here is that when the government appoints a scientist, it appoints someone that it trusts not to “cry wolf” too often. This improves information transmission: In a truly dangerous state, the government will trust the alarming message and implement climate change policies accordingly. Thus it is socially optimal for the government to appoint a scientist who it feels comfortable with, even if the scientist is a “right-wing extremist.”

Finally, we introduce election concerns. Under this constraint, if the median voter perceives an alarming message from the climate scientist, then even a right-wing government will be forced to choose an aggressive climate change policy to avoid losing the election. This deviation from its unconstrained optimum (without election concerns) is costly to the government, so it prefers to appoint a climate scientist who is unlikely to send an alarming message, i.e., one with more right-wing views.\footnote{In the opposite case when a left-wing government is in power, the climate change policy distortion causes the government to commit to a more left-wing climate scientist, which means that it is more likely to receive an alarming message.} Intuitively, the right-wing government has a political incentive to distort the communication with the scientific community, because it knows that it will have to respond to an alarming message with stronger climate change policies than it would like. Thus, a government with election concerns deliberately creates a credibility gap by appointing a scientist whose preferences differ from its own. For instance, George W. Bush, former president of the U.S., appointed Dr. John Marburger as the head of the White House Office of Science and Technology Policy. Dr. Marburger served as the presidential science adviser for Bush’s entire time in office, and defended Bush administration policies which were often criticized by most scientists. As soon as Bush took office in 2001, his administration pulled out of the Kyoto Protocol. Dr. Marburger was widely criticized for defending these policies on climate change, particularly his defense against an assertion by
the National Academy of Sciences that political influence was contaminating the scientific research in government agencies. He defended the Bush Administration from accusation that the Bush administration had distorted scientific information that would conflict with its policy preferences, especially on climate change policy and stem cell research. There is a series of evidence that the Bush administration has deliberately distorted the communication with the scientific community.\footnote{See The Union of Concerned Scientists 2004 Scientist Statement on Restoring Scientific Integrity to Federal Policy Making for further details.}

This is in sharp contrast to the case where the government has no election concerns and therefore can choose its unconstrained optimal response to the scientist’s message. In the unconstrained case it prefers to minimize the credibility gap by appointing a scientist with the same preference as itself. Thus, I have a surprising result: Election concerns may be the cause of a credibility gap in a democratic society, and this leads to distorted climate change policies.

Despite this surprising result, I show that there will be more renewable energy when the government has election concerns than when it does not. Thus, from my model, I obtain a theoretical prediction that countries with more democratic political institutions will have climate change policies more targeted towards renewable energy. With cross-sectional data from 133 countries worldwide in 2011, I present strong empirical evidence that supports my theoretical prediction. The level of democracy is significantly and positively associated with the level of climate change policy. This also shows that our hypothesis is true: (1), In many countries, the government’s preference for climate policy is not high when compared to that of its alternative party and the median voters; (2), the fact that the preference of median voters is closer to that of the alternative party raises fears of losing power for the government; and (3), the fears of losing power lead the government to implement much stronger climate change policies to win the election. This democratic procedure of implementing climate change policy will be more likely to occur in countries with a higher level of democracy.

I review the related literature in Section 2. The basic model is discussed in Section 3.
I analyze equilibria where a government does not have election concerns in Section 4, and equilibria with election concerns in Section 5. In Section 6, I show empirical evidence that supports my theoretical results. I conclude in Section 7.

2 Related Literature

My theoretical model is directly related with Crawford and Sobel (1982), in which a better informed sender sends a possibly noisy signal to a receiver, who then takes an action that determines the welfare of both. They characterize the set of Bayesian Nash Equilibria, which I apply to my model. Compared to usual Crawford and Sobel model, the main difference is that in my model there is not just a sender of messages (the scientist) and a receiver who takes an action (the politician), but there is also a third party: the median voter. I consider how communication between the sender and receiver determines the welfare of the third party. Moreover, via election concerns, the third party can influence the cheap-talk game, both by influencing how the receiver responds to messages, and by causing the receiver to deliberately create a credibility gap (by strategic selection of a sender).

My research relates to the democratic political decision-making framework of Schultz, where political parties have more information about the economy than voters. In his research, policymakers are the ones who gather information about the true state of the economy and make decisions, and they are often aided by experts. Schultz examined whether or when policymakers will reveal information truthfully to voters and what consequences these revelations will have. He showed that nonrevealing equilibria exist when political parties have sufficiently different preferences from the median voter’s; and that revealing equilibria exist when one of the parties has a preference close to the median voter. The political decision-making framework in our research differs from his in a few ways. First, as Schultz acknowledges, policymakers often rely on experts’ advice when they make political decisions. I include climate scientists (experts) in the framework to see how experts affect policymakers’
decisions. Second, I assume that voters can observe the message about the true state of the world from climate scientists. This is a plausible assumption because information regarding climate change is not restricted from voters the way it was in prior years. It is now easy for voters to access to the messages from climate scientists (e.g., research papers, newspaper articles, scientific reports available on the Internet, and etc.).

My model is also related with Baliga and Sjöström (2012). They examined how an extremist can influence political decision-making by sending publicly observed messages. They showed that a publicly observed cheap-talk message sent by one country’s extremist can influence the other country’s political decisions. Specifically, an extremist can increase the likelihood of conflict between two different countries.

Public perception of climate change in one of the key factors in determining climate change policies in our model. Leiserowitz (2006) argue the importance of public perception of climate change in the socio-economic political context. The direction of climate change policy (for example, public support or opposition to climate change policies such as carbon taxes or clean energy subsidies) is substantially influenced by public perceptions of climate change. Lorenzoni and Pidgeon (2006) survey how climate change is conceptualized in the Europe and the U.S., and conclude that awareness of climate change is widespread but that it is considered less important than other personal or social issues. Furthermore, the public showed limited understanding of the causes of, and the solutions to, climate change.

A country’s political system may influence its climate change policies in our model. I found several empirical research on the relationship between environmental policies and political systems. Hassler and Krussel (2012) construct a model to quantify how key features of heterogeneity between different regions of the world affect those regions’ preferences for different climate change policies. They show that in the absence of international transfer mechanisms, Pareto-improving policies to curb climate change may not exist. Fredriksson and Neumayer (2013) study the relationship between countries’ democratic capital stocks and climate change policies. Using data for 87 countries starting from as far back as the year
1800, they show that larger democratic capital stocks are associated with more stringent climate change polices. Congleton (1992) provides a simple model to show how different political institutions affect the enactment of environmental regulations. He finds empirical evidence that political institutions play a significant role to the pollution control policies. My contribution to this literature is that I provided a rigorous game-theoretic model to theoretically explain those empirical results; and another empirical result consistent with the previous literature.

Both the causes of and the solutions to climate change involve intrinsic global externalities, which led many governments to the negotiations table for international cooperations against climate change. There is an abundant literature in climate change agreements. It provides important implications for designing climate change agreements. Battaglini and Harstad (2012) analyze a dynamic game where countries decide whether to participate in international environment agreements. They show that participants eliminate the hold-up problem associated with their investments if complete contracts are feasible; however, the free-rider problem is not resolved. If investments are non-contractible, countries face a hold-up problem when they negotiate, but the free-rider problem can be mitigated and significant participation is feasible. Harstad (2012) presents a dynamic game where players contribute to a public bad, invest in technologies, and write incomplete contracts. He shows that investments are sub-optimally small if the contract is short term or close to its expiration date if only the contribution levels are contractible. To encourage investments, the optimal contract is more ambitious if it is short term, and it is tougher to satisfy close to its expiration date and for players with small investment costs.

Public perception of climate change and the associated public consensus may be critical determinants of domestic political decisions about climate change policies. The link between public perception and policy depends on the political system of the country, including the participation of the public and the competitiveness of the political system. Decisions to participate in international climate change agreements should be a part of, and based on,
the domestic political decisions about climate change. Therefore, domestic political decisions about climate change should be considered first before stepping up to the negotiations table for international cooperations against climate change. I examine the socio-economic political context of climate change by examining the domestic political decision-making framework for climate change policies, which involves governments (policymakers), climate scientists, and median voters.

3 Basic Model

I consider a cheap-talk game among a government (policymaker), a climate scientist, and a median voter. I show how a credibility gap is created between the scientific community and the political arena. We note that the messages from climate scientists, which are scientific reports on climate change, are not verifiable by governments. Therefore, the messages themselves are talk-costless, nonbinding, and nonverifiable claims, which make the game a cheap-talk game. I note that the policymaker’s preference is critical when he or she implements climate change policies.

A government (country) produces GHGs by consuming fossil fuels, and I denote the government’s quantity of GHG emissions per capita as $G$. I assume that consuming fossil fuels produces the same quantity of GHGs. Thus we may interpret $G$ as either GHG emissions per capita or fossil fuel consumption per capita. The quantity of energy consumption per capita generated by renewable energy sources (clean energy), which do not emit GHGs, is denoted by $R$. We can also interpret $R$ as the level of clean technology that a country uses to mitigate its GHG emissions. The quantity of total energy consumption per capita is denoted by $y$, which I assume is fixed. I assume that each country has two sources of energy: energy from fossil fuels ($G$) and energy from renewable energy sources ($R$). If a country increases its quantity of renewable energy ($R$) when the total quantity of energy ($y$) is fixed, then it would decrease its consumption of fossil fuels and thereby its GHG emissions ($G$) would fall.
Therefore, we have the following relationship:

\[ G = y - R. \] (1)

If we interpret \( R \) as the level of clean technology employed to mitigate GHGs, then \( G \) is interpreted as the quantity of GHGs mitigated by the clean technology \( (R) \). There is a one-to-one relationship between \( G \) and \( R \): reducing one unit of GHGs or fossil fuels \( (G) \) is equal to increasing one unit of renewable energy \( (R) \).

We normalize \( G \) and \( R \) in (1) to be fractions:

\[ g = 1 - r, \] (2)

where \( g = G/y \) and \( r = R/y \). Since I assume that the total quantity of energy \( (y) \) is fixed, choosing the proportion of total energy due to fossil fuel (or equivalently renewable energy) is what the government cares about in our model. I denote the proportion of total energy due to fossil fuel and the proportion due to renewable energy \( g \) and \( r \), respectively.

When choosing its optimal energy policy, a government considers not only the benefit of consuming fossil fuels \( (g) \) but also the adverse effects from excessive consumption of fossil fuels. Thus I assume that a government’s utility of consuming fossil fuels, \( u(g) \), is represented by a quadratic and concave function of the proportion of total energy due to fossil fuel\(^{10}\):

\[ u(g) = -g^2 + \bar{\beta}g. \] (3)

\( \bar{\beta} \in [0,2] \) is a parameter that represents the general preference for clean environment of a government. It is assumed to be smaller (closer to 0) as countries naturally prefer cleaner environments. Notice that \( u'(g) = 0 \) when \( g = \bar{\beta}/2 \). If a government does not have any preference for a clean environment (i.e., \( \bar{\beta} = 2 \)), then all of its total energy consumption

\(^{10}\)I follow Battaglini and Harstad (2012) among many others.
comes from burning fossil fuels (i.e., $g = 1$). Alternatively, we can interpret that there is no clean technology mitigating GHGs if $\beta = 2$, and thereby $g = 1$.

We can express the utility function (4) as a function of $r$ (the proportion of total energy due to renewable energy or the level of clean technology) by using the one-to-one relationship between $g$ and $r$:

$$u(r) = -1 + \beta + (2 - \beta)r - r^2.$$ (4)

### 3.1 The State of the World

I assume that there are two possible states of the world, *Good State* and *Bad State*. In the *Good State*, there is no possibility that climate change results in disaster, so each government can conduct its business as usual. In the *Bad State*, it is certain that climate change will result in disaster, so each government must take precautionary actions against climate change. The government does not know the true state of the world, and it cannot observe the probability of the *Bad State*. But it has a prior distribution $F$ with a continuous density $f$ over the probability of the *Bad State*, $\theta \in [0, 1] \equiv \Theta$. The climate scientist can observe the probability of the *Bad State*, $\theta$. The utility function of the climate scientist is

$$U^S(r, \theta) = \theta \left[ -1 + \beta_S + (2 - \beta_S)r - r^2 \right] + (1 - \theta) \left[ -1 + \bar{\beta} + (2 - \bar{\beta})r - r^2 \right].$$ (5)

The government’s utility function is

$$U^G(r, \theta) = \theta \left[ -1 + \beta_G + (2 - \beta_G)r - r^2 \right] + (1 - \theta) \left[ -1 + \bar{\beta} + (2 - \bar{\beta})r - r^2 \right].$$ (6)

Notice that the payoff in the *Good State* is the same as (4).

I have a few criteria to define the preferences for energy policies in the *Bad State*, i.e., climate change policies. First, the government’s preference may be different from the climate scientist’s. Note that the government and the climate scientist each have a parameter, $\beta_G$ and
$\beta_S \in [0, 2]$, respectively, when they are in the *Bad State*. They measure how the government and the climate scientist weigh the importance of renewable energy when they are in the *Bad State*. If $\beta_G$ and $\beta_S$ are closer to 0, then the government and the climate scientist prefer higher levels of renewable energy ($r$) when he or she is in the *Bad State*. Second, I assume that both the government and the climate scientist put a greater weight on renewable energy when they are in the *Bad State* than when they are in the *Good State*. Thus we have the following assumption.

**Assumption 1.** $0 \leq \beta_G < \bar{\beta} \leq 2$ and $0 \leq \beta_S < \bar{\beta} \leq 2$.

Notice that the payoff in the *Bad State* has a higher benefit from consuming renewable energy than that in the *Good State*.

We may interpret $\beta_G$ and $\beta_S$ as the ideological positions of the government and the climate scientist, respectively. Recall that we consider two dimensions of economic policy, growth and the environment. If $\beta_S < \beta_G$, then it may be the case where the climate scientist is more biased toward the environment, while the government is more biased toward growth.

## 4 Information Transmission without Election Concerns

First, I consider the case where the government does not have any election concerns regarding climate change policies. We can think of this case as an authoritarian state with regard to climate change policies. Therefore in this variation of the model, I consider only two players, a government ($G$) and a climate scientist ($S$).

I assume that $\beta_S$ is exogenously given. I consider the message space of the climate scientist, $M \equiv \{m_L, m_H\}$, where $m_L$ indicates a message of *Low* probability of the *Bad State* (a comforting message) and $m_H$ indicates a message of *High* probability of the *Bad State* (an alarming message). The timing of the game is as follows:

**Stage 1.** The climate scientist privately observes the probability of the *Bad State*, $\theta \in \Theta$,
and then sends a message \( m \in M \) to the government.

**Stage 2.** The government observes the climate scientist’s message \( m \) (but not \( \theta \)) and then chooses \( r^*(m) \), its optimal climate change policy.

I define a perfect Bayesian equilibrium, which consists of signaling rules \( q(m|\theta) \) for \( S \), optimal climate change policies \( r^*(m) \) for \( G \), and the \( G \)'s posterior belief \( \rho(\theta|m) \) such that

**\( C1 \)** for each \( m \in \{m_L, m_H \} \), \( r^*(m) \) solves

\[
\max_{r \in \mathbb{R}^+} \int_0^1 U^G(r, \theta) \rho(\theta|m) d\theta
\]

where \( \rho(\theta|m) \) is the government’s posterior belief after observing the climate scientist’s message \( m \) by applying Bayes’ rule whenever possible; and

**\( C2 \)** for each \( \theta \in [0,1] \) and \( m^* \in M \), if \( q(m^*|\theta) > 0 \), \( m^* \) solves

\[
\max_{m \in M} U^S(r^*(m), \theta).
\]

I derive a partially separating equilibrium with a two-step by assuming that \( f \) is a uniform distribution over \( \Theta = [0,1] \). As I assume that there exist only two possible messages \( m \in \{m_L, m_H \} \), there must exist a cut-off point \( x \in \Theta \) such that the climate scientist sends \( m(\theta) = m_L \) if \( \theta < x \), and \( m(\theta) = m_H \) if \( \theta \geq x \).

Suppose that the government will update its belief that \( \theta \) is uniformly distributed over \( [0, x] \) if it receives the comforting message \( m_L \); likewise, it will update its belief that \( \theta \) is uniformly distributed over \( [x, 1] \) when it receives the alarming message \( m_H \). That is,

\[
\rho(\theta|m) = \frac{q(m|\theta) f(\theta)}{q(m)}.
\]
where

\[ q(m) = \int_0^1 q(m|t)f(t)dt. \]

**Lemma 1.** The proportion of renewable energy is higher when the government receives the alarming message \( m_H \) (High probability of the Bad State) than when it receives the comforting message \( m_L \) (Low probability of the Bad State). That is,

\[ r^*(m_L; x) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4}(\bar{\beta} - \beta_G), \]

\[ \leq r^*(m_H; x) = 1 - \frac{\beta}{2} + \frac{x + 1}{4}(\beta - \beta_G). \]

**Proof.** See Appendix

Notice that \( r^*(m_L) \) is the government’s optimal climate change policy if it receives the comforting message \( m_L \) and that \( r^*(m_H) \) is its optimal climate change policy if it receives the alarming message \( m_H \). The government responds to the alarming message with higher proportion of renewable energy.

Since the climate scientist’s utility function is in a quadratic form and thus is symmetric around her optimal climate change policy \( r^S(\theta) \) where

\[ r^S(\theta) = \arg \max_r U^S(r, \theta) = 1 - \frac{\bar{\beta}}{2} + \frac{\theta}{2}(\bar{\beta} - \beta_S), \]

the climate scientist prefers \( r^*(m_L) \) to \( r^*(m_H) \) if the midpoint between \( r^*(m_L) \) and \( r^*(m_H) \) is higher than its optimal energy policy \( r^S(\theta) \). However, she prefers \( r^*(m_H) \) to \( r^*(m_L) \) if \( r^S(\theta) \) is higher than the midpoint. Therefore, for the existence of a partially separating equilibrium with a two-step, the cut-off point \( x \in \Theta \) must be the point where \( r^S(\theta) \) is exactly equal to the midpoint between \( r^*(m_L) \) and \( r^*(m_H) \).

**Proposition 1.** If \( \beta_S \leq \bar{\beta}/4 + 3\beta_G/4 \), there exists a partially separating equilibrium with a.
two-step, where the cut-off point is given by

\[ x = \frac{1}{2} \left( \beta - \beta_G \right) \frac{1}{\beta + \beta_G - 2\beta_S} \in \Theta. \]  

(12)

Proof. See Appendix

4.1 Credibility Gap

Recall that I assumed the climate scientist’s ideological position is exogenously given. If the climate scientist’s ideological position is perfectly aligned with that of the government, i.e., \( \beta_S = \beta_G \), then the cut-off point \( x \in \Theta \) becomes \( 1/2 \).

Definition 1. A credibility gap is the difference between the government’s cut-off point \( x \) and \( 1/2 \).

If a government receives a message from a more left-wing climate scientist, i.e., \( \beta_S' < \beta_G \), then the cut-off point \( x \in \Theta \) becomes smaller than \( 1/2 \). That is, a credibility gap is created by the left-wing scientist. Figure 4 illustrates a credibility gap created by the left-wing scientist. To illustrate, suppose that the exogenous climate scientist has an identical ideological position to a left-wing party, and the right-wing government’s ideological position is different from that, i.e., \( \beta_S = \beta_{LW} < \beta_{RW} \). Then the right-wing government’s cut-off point \( x \) is smaller than \( 1/2 \). The climate scientist and the left-wing party views being close together creates a credibility gap about the scientist for the right-wing government, and therefore the right-wing government is doubtful about the truthfulness of the scientist’s message. The existence of a credibility gap means that a government is less likely to trust that the information being transmitted is unbiased, and thus is doubtful about the veracity of the message sent by the scientist.

Some episodic observations seem to support our theoretical results. For example, many right-wing politicians in the U.S. seem to be skeptical about human-caused climate change, which is strongly supported by climate scientists. As they have gained greater scientific
confidence in human-caused climate change, climate scientists’ political views on climate change policies have become much closer to those of the left wing. Thus right-wing politicians have become more doubtful about human-caused climate change as investigated by the scientific community. Figure 3 shows the percentage of Americans by political party who believe that the effects of global warming have already begun. In 1998, 46% of Americans in both parties believed that these effects had already begun. However, the gap between the two parties has increased since then: In 2013, only 39% of Republicans believed the effects had already begun, but 67% of Democrats did.

When the climate scientist is more left wing than the government, the climate scientist becomes more “alarmist”: he becomes more likely to send the alarming message $m_H$ as $x < 1/2$. To illustrate, suppose that the climate scientist’s ideological position is constant but the ruling party of the government changes from the left wing to the right wing. Then, we would expect that the scientific reports to become more alarming. We may turn to one of Aesop’s fables, “The Boy Who Cried Wolf,” to illustrate the credibility gap created by the left-wing scientist. Since the boy cried wolf too often, nobody believed him when a wolf actually came.

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11 Meet the Republicans in Congress who don’t believe climate change is real, *The Guardian*, Nov 17th 2014.
4.2 Social Welfare

Let us consider a social welfare function to examine the optimal ideological position of the climate scientist. I assume a purely utilitarian social welfare function of citizens of a society. I consider the median voter’s utility function as follows:

$$U^V(r, \theta) = \theta[-1 + \beta_V + (2 - \beta_V)r - r^2] + (1 - \theta)[-1 + \bar{\beta} + (2 - \bar{\beta})r - r^2], \quad (13)$$

where $\beta_V$ is the ideological position that measures how the median voter weighs the importance on renewable energy in the Bad State.

**Assumption 2.** $\beta_V \in [0, \frac{\bar{\beta} + \beta_G}{2})$.

The *ex-ante* social welfare function is the summation of all the median voters’ *ex-ante* utility function. Assuming that the number of the median voters is given by $N$, the *ex-ante* social welfare function is the following.

$$W\{E_\theta U^V[r^*(m(\theta)), \theta]\} = N \cdot E_\theta U^V[r^*(m(\theta)), \theta], \quad (14)$$

where

$$E_\theta U^V[r^*(m(\theta)), \theta] = q(m_L) \int_0^x U^V(r^*(m_L), \theta) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U^V(r^*(m_H), \theta) \rho(\theta|m_H) d\theta.$$ 

I present the optimal ideological position of the climate scientist which maximizes the *ex-ante* social welfare in the following theorem.

**Theorem 1.** The *ex-ante* social welfare is maximized with respect to $\beta_S$ when $\beta_S = \beta_G$, i.e., when there is no credibility gap.

---

12In the real-world, the number of the median voters outweighs the number of climate scientists and policymakers.
This is a striking result: the \textit{ex-ante} social welfare is maximized if the climate scientist's ideological position is aligned with the government's, not the median voter's. This striking result is due to the fact that a credibility gap reduces the \textit{ex-ante} social welfare. If the climate scientist is to the left of the government, a credibility gap is created, and this reduces the \textit{ex-ante} social welfare. As the credibility gap is created by the left-wing climate scientist, the alarming message is sent “too often”. As a result, a “right-wing” policymaker may feel that the “left-wing” climate scientist is sending an alarming message about climate change too often. The policymaker may then discount the alarming message, assuming that it is just exaggeration from the left wing. This may be indeed the case when the state is not bad, i.e., \( x \leq \theta < 1/2 \). However, when the state \textit{is} truly bad, i.e., \( \theta > 1/2 \), the scientist cannot credibly communicate the danger. This results in a shortfall of renewable energy, which is very costly to society.

If the ideological positions of the climate scientist and the government could be better aligned, the problem would be mitigated. Indeed, even if the government’s ideological position on the environment deviates from the median voter’s position, the \textit{ex-ante} social welfare is maximized as long as the climate scientist’s position is aligned with the government’s, not with the median voter’s.

4.3 Endogenous Selection of Scientist

I allow the government to choose its climate scientist in the very first stage of the game (Stage 0). I show how the government selects its optimal climate scientist \((b_s)\) when it does not have any election concerns with regard to its climate change policy. The timing of the game is as follows:

\begin{itemize}
  \item \textbf{Stage 0.} The government chooses a climate scientist with \(\beta_s\).
  \item \textbf{Stage 1.} The climate scientist privately observes the probability of the \textit{Bad State}, \(\theta \in \Theta\),
\end{itemize}
and then sends a message $m \in M$ to the government.

**Stage 2.** The government observes the climate scientist’s message $m$ (but not $\theta$) and then chooses $r^*(m)$, its optimal climate change policy.

I define a perfect Bayesian equilibrium, which consists of signaling rules $q(m|\theta)$ for $S$, the optimal climate scientist $\beta^*_S$ and optimal climate change policies $r^*(m)$ for $G$, and the $G$’s posterior belief $\rho(\theta|m)$ such that

**(C1)** for each $m \in \{m_L, m_H\}$, $r^*(m)$ solves
\[
\max_{r \in \mathbb{R}^+} \int_0^1 U^G(r, \theta) \rho(\theta|m) \, d\theta, \tag{15}
\]
where $\rho(\theta|m)$ is the government’s updated belief after observing the climate scientist’s message $m$ by applying Bayes’ rule whenever possible;

**(C2)** for each $\theta \in [0, 1]$ and $m^* \in M$, if $q(m^*|\theta) > 0$, $m^*$ solves
\[
\max_{m \in M} U^S(r^*(m), \theta) \; \text{and} \tag{16}
\]

**(C3)** $\beta^*_S$ solves
\[
\max_{\beta_S \in [0,2]} E_{\theta} U^G[r^*(m(\theta)), \theta]. \tag{17}
\]

I derive a partially separating equilibrium with a two-step by assuming that $f$ is a uniform distribution over $\Theta = [0, 1]$. As I assume that there exist only two possible messages $m \in \{m_L, m_H\}$, there must exist a cut-off point $x \in \Theta$ such that the climate scientist sends $m(\theta) = m_L$ if $\theta < x$, and $m(\theta) = m_H$ if $\theta \geq x$.

Suppose that the government will update its belief that $\theta$ is uniformly distributed over $[0, x)$ if it receives the comforting message $m_L$; likewise, it will update its belief that $\theta$ is
uniformly distributed over \([x, 1]\) when it receives the alarming message \(m_H\). That is,

\[
\rho(\theta|m) = \frac{q(m|\theta)f(\theta)}{q(m)},
\]

where

\[
q(m) = \int_0^1 q(m|t)f(t)dt.
\]

I derive the optimal condition for the government to select its climate scientist in Stage 0. The government chooses a climate scientist who maximizes its \textit{ex-ante} expected payoff in Stage 0. That is, the government chooses \(\beta^*_S\) to solve

\[
\max_{\beta_S} \quad q(m_L) \int_0^x U^G(r^*(m_L), \theta)\rho(\theta|m_L)d\theta + q(m_H) \int_x^1 U^G(r^*(m_H), \theta)\rho(\theta|m_H)d\theta,
\]

where

\[
q(m_L) = \int_0^1 q(m_L|\theta)f(\theta)d\theta = \int_0^x q(m_L|\theta)f(\theta)d\theta + \int_x^1 q(m_L|\theta)f(\theta)d\theta = x,
\]

\[
q(m_H) = \int_0^1 q(m_H|\theta)f(\theta)d\theta = \int_0^x q(m_H|\theta)f(\theta)d\theta + \int_x^1 q(m_H|\theta)f(\theta)d\theta = 1 - x.
\]

From the first-order condition, we obtain

\[
\beta^*_S = \beta_G.
\]

Thus

\[
x = \frac{1}{2} \frac{(\beta - \beta_G)}{\beta + \beta_G - 2\beta^*_S} = \frac{1}{2}.
\]

\textbf{Proposition 2.} If the climate scientist is endogenously chosen by the government, the government selects a climate scientist whose ideological position is perfectly aligned with its own
position, i.e., $\beta^*_S = \beta_G$.

Proof. See Appendix

We can derive an important implication from Proposition 2. The maximized ex-ante social welfare is achieved endogenously if we allow the government to choose its climate scientist. Then it will select a climate scientist whose ideological position agrees with its own position, so the credibility gap will be eliminated.

Corollary 1. The ex-ante social welfare is endogenously maximized if the government can select a climate scientist perfectly aligned with its own ideological position.

Proof. Follow from Theorem 1 and Proposition 2.

This is another striking result. The social welfare is maximized when the government appoints its favorite scientist. The intuition is that when the government appoints a climate scientist, it appoints someone that it trusts not to “cry wolf” too often. This indeed improves the information transmission; in the truly dangerous state, the government will trust the alarming message and implement enough renewable energy. So it is socially optimal for the government to appoint a climate scientist who it feels comfortable with, even if that scientist is a “right-wing extremist”.

5 Information Transmission with Election Concerns

I consider a case where the government has election concerns with regard to climate change policies. I assume that the political system is a full democracy (where the median voters have the power to replace the regime). If the median voter’s ideological position is perfectly aligned with the government, i.e., $\beta_V = \beta_G$, then the government’s optimal climate change policies must be also optimal for the median voter. Thus the government does not have any election concerns with regard to climate change policies. By Corollary 1, we can
eliminate the credibility gap and maximize the ex-ante expected social welfare if we allow
the government to select its climate scientist in this case.

However, if the median voter’s ideological position is not perfectly aligned with the gov-
ernment’s, then the government must have election concerns with regard to climate change
policies in a full democracy.

I consider two political parties, a left wing (LW) and a right wing (RW). I assume that
the left-wing party puts higher weight on renewable energy than the right-wing party in the
Bad State. Thus I have the following assumption.

**Assumption 3.** $\beta_{LW} < \beta_V < \beta_{RW}$.

I assume that the median voter cannot observe the probability of the Bad State ($\theta$). However, they can observe the message from the climate scientist, $m \in M$, as well as the
government’s optimal climate change policies, $r_G(m_L)$ and $r_G(m_H)$ for all $G = \{LW, RW\}$.

Recall that I focus on the case where the government is more right wing than the median
voter. Thus I shall suppose that the right-wing party is in power at the beginning of the
game. In Stage 0, the right-wing government selects its optimal climate scientist while it
considers the following voter constraints (VC).

(VC) $\beta_S^*$ solves

$$
\max_{\beta_S} E_\theta U^{RW}[\hat{r}_{RW}(m(\theta)), \theta]
$$

s.t.

$$
\int_0^x U^V(\hat{r}_{RW}(m_L), \theta) \rho(\theta|m_L) d\theta \geq \int_0^x U^V(r^*_{LW}(m_L), \theta) \rho(\theta|m_L) d\theta \\
\int_x^1 U^V(\hat{r}_{RW}(m_H), \theta) \rho(\theta|m_H) d\theta \geq \int_x^1 U^V(r^*_{LW}(m_H), \theta) \rho(\theta|m_H) d\theta
$$

Note that $\hat{r}_{RW}(m_L)$ and $\hat{r}_{RW}(m_H)$ are the constrained optimum when the government
has election concerns. It is a commitment of climate change policy to prevent the alternative
party from winning the election. The left-hand sides of the voter constraints (18) and (19) are the median voter’s expected utility levels from the climate change policies of the current government (the right wing), $\hat{r}_{RW}(m)$, conditional on the message $m \in \{m_L, m_H\}$. So, conditional on the message, the expected utility of the current policy has to be greater than the expected utility from the alternative party’s policies, $r^{*}_{LW}(m_L)$ and $r^{*}_{LW}(m_H)$, which are the unconstrained optimum specified in Lemma 1. The median voter will choose the alternative party in the next election if he expects strictly higher utility from the climate change policy of the alternative party than that of the current government. Therefore, in order for the current government to maintain its regime, the median voter’s expected utility from the current government’s climate change policy must be higher or at least equal to the expected utility from the alternative party.

The timing of the game is as follows:

**Stage 0.** The government chooses a climate scientist with $\beta_S$.

**Stage 1.** The climate scientist privately observes the probability of the Bad State, $\theta \in \Theta$, and then sends a message $m \in M$ to the government.

**Stage 2.** The government observes the climate scientist’s message $m$ (but not $\theta$) and then announces $\hat{r}_G(m)$, its optimal climate change policy.

**Stage 3.** The median voter observes both the climate scientist’s message $m$ and the government’s optimal climate change policy $\hat{r}_G(m)$.

**Stage 4.** The election takes place. The median voter can either choose the current ruling party; or choose the alternative party if the constraints are not satisfied. If the alternative party takes power, it will choose its optimal climate change policy given $m$. That is, the new
government cannot change the climate scientist and must take the message given.

Note that, in Stage 4, I assume that the new government cannot change the climate scientist (appointed by the current government) and must take the message given. This assumption makes sense because, once climate change is investigated by the climate scientist appointed by the current government, it would be hard for a new scientist to send a different message from the current scientist. As all the data of climate change is already organized, manipulated and presented by the current scientist, there would be little chance to reveal completely new data in the scientific community.

I define a perfect Bayesian equilibrium, which consists of signaling rules $q(m|\theta)$ for $S$, the optimal climate scientist $\beta^*_S$ and optimal climate change policies $r^*(m)$ for $G$, and the $G$’s posterior belief $\rho(\theta|m)$ that satisfy $C1$, $C2$, and $VC$.

I derive a partially separating equilibrium with a two-step by assuming that $f$ is a uniform distribution over $\Theta = [0,1]$. As I assume that there exist only two possible messages $m \in \{m_L, m_H\}$, there must exist a cut-off point $x \in \Theta$ such that the climate scientist sends $m(\theta) = m_L$ if $\theta < x$, and $m(\theta) = m_H$ if $\theta \geq x$.

Suppose that the government will update its belief that $\theta$ is uniformly distributed over $[0,x)$ if it receives the comforting message $m_L$; likewise, it will update its belief that $\theta$ is uniformly distributed over $[x,1]$ when it receives the alarming message $m_H$. That is,

$$\rho(\theta|m) = \frac{q(m|\theta)f(\theta)}{q(m)},$$

where

$$q(m) = \int_0^1 q(m|t)f(t)dt.$$
I first examine partially separating equilibria where the election concerns do not distort the selection of scientist. I consider two cases. First, if the median voter’s ideological position ($\beta_V$) is closer to the ruling party than the alternative party, then the voter constraints (18) and (19) are not active. Therefore, the government appoints a scientist whose ideological position agrees with the ruling party, and then announces the unconstrained climate change policy, $r^*_G(m)$, derived in Lemma 1. Second, suppose that the median voter’s position is equidistant from both parties. Namely, $\beta_V = (\beta_{LW} + \beta_{RW})/2$. Then, the median voter is indifferent between the two parties because their policies are equally far away from its optimum. Let us assume that he votes for the ruling party when he is indifferent. Then the voter constraints are not active, and thus the ruling party can disregard the election concerns. Therefore, the government appoints a scientist whose ideological position agrees with the government, and then announces the unconstrained climate change policy, $r^*_G(m)$, derived in Lemma 1. Notice that we can eliminate the credibility gap in both cases, i.e., $x = 1/2$.

**Proposition 3.** The government (the ruling party) appoints a scientist whose ideological position agrees with its own position, i.e., $\beta^*_S = \beta_G$, and thereby no credibility gap, i.e., $x = 1/2$, in the following two cases:

(i) the median voter’s position is closer to the ruling party; and

(ii) the median voter’s position is equidistant between the two parties, i.e., $\beta_V = (\beta_{LW} + \beta_{RW})/2$.

**Proof.** See Appendix

5.1 Deliberately Created Credibility Gap

I now examine partially separating equilibria where the ideological position of the median voter is closer to the alternative party. In this case, the government (the ruling party) has fears of losing power at Stage 0 when it chooses its optimal climate scientist. That is, the
voter constraints (18) and (19) are strictly binding. In order for the government (the ruling party) to win the election at Stage 4, the government announces the constrained optimum policy, $\hat{r}_G(m_L)$ and $\hat{r}_G(m_H)$, which are stronger than the unconstrained policies derived in Lemma 1, i.e., more aggressive renewable energy policies.\footnote{The constrained optimum climate change policies are weaker than the unconstrained policies, i.e., less aggressive renewable energy policies, when the left wing is the ruling party of the government.} The fears of losing power cause a distortion of the government’s optimal climate change policy.

The policy distortion causes another distortion in Stage 0. That is, the government does not appoint a scientist whose ideological position agrees with its own position. As a result, a credibility gap is created between the government and the climate scientist. Recall that we focus on the case where the government is more right-wing than the median voter. In Stage 0, the right-wing government knows that it must announce the constrained optimum policy, which is stronger than its unconstrained policy in Stage 2. The distortion of climate change policies causes the right-wing government to appoint a more right-wing climate scientist than itself at Stage 0, i.e., $\beta^*_S > \beta_{RW}$. Intuitively, the right-wing government has a political incentive to distort the communication with the scientific community, because it knows that it will have to respond to an alarming message with stronger climate change policies than it would like. Thus, the government’s election concerns cause it to deliberately create a credibility gap by appointing a scientist whose ideological position differ from its own. This is in sharp contrast to the case where the government has no election concerns and therefore can choose its unconstrained optimal response to the scientists message – in the unconstrained case it prefers to minimize the credibility gap by appointing a scientist with the same ideological position as itself. Thus, we have a surprising result: election concerns may be the cause of a credibility gap in a democratic society, and this leads to distorted climate change policies.

Proposition 4. If the ideological position of the median voter is closer to that of the alternative party,

(i) the right-wing government appoints a more right-wing climate scientist, $\beta^*_S > \beta_{RW}$;
(ii) the right-wing government commits to higher proportions of renewable energy than the unconstrained policies derived in Lemma 1. That is, the constrained policies are

\[
\hat{r}_{RW}(m_L; x) = 1 - \frac{b}{2} + \frac{x}{4}(\bar{b} - 2\beta_V + \beta_{LW});
\]

\[
\hat{r}_{RW}(m_H; x) = 1 - \frac{b}{2} + \frac{x + 1}{4}(\bar{b} - 2\beta_V + \beta_{LW}).
\]

Proof. See Appendix

The right-wing government commits to a climate scientist more inclined to the right wing, i.e., \(\beta_S^* > \beta_{RW}\), because it knows that it will have to commit to higher levels of renewable energy (the constrained optimum policies); and it becomes less likely to receive the alarming message as \(x > 1/2\). In Stage 3, it commits to higher levels of renewable energy than those derived in Lemma 1. The commitment of higher renewable energy is due to the fact that the right-wing government has fears of losing power. The median voter and the left-wing party being close together raises fears of losing power in the next election at Stage 4. The fears of losing power lead the government to commit to higher levels of renewable energy, which will make it win the next election at Stage 4. That is, the right-wing party’s commitment of climate change policies must be at least as good as the alternative party’s policy. Figure 6 shows the distortion of climate change policy due to the fears of losing power for the right-wing government\(^{16}\).

These results are interesting. The fears of losing power, which arises from the fact that the ideological position of the median voter is closer to the alternative party, are the cause

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\(^{16}\)In the case where the left wing is in power at the beginning of the game and the median voter is closer to the right wing, the results are the reverse of the Proposition 4: the government appoints a more left-wing climate scientist, i.e., \(\beta_S^* < \beta_{LW}\); and the government commits to lower levels of renewable energy than the unconstrained policies specified in Lemma 1. That is, the constrained policies are

\[
\hat{r}_{LW}(m_L) = 1 - \frac{\bar{b}}{2} + \frac{x}{4}(\bar{b} - 2\beta_V + \beta_{RW});
\]

\[
\hat{r}_{LW}(m_H) = 1 - \frac{\bar{b}}{2} + \frac{x + 1}{4}(\bar{b} - 2\beta_V + \beta_{RW}).
\]

Proof. See Appendix
of a credibility gap in a democratic country. Although we cannot achieve the maximized \textit{ex-ante} social welfare if the government has the fears of losing power, we can achieve more moderate climate change polices compared to the case without the fears.

We may find anecdotal evidence of Proposition 4 in the Bush administration. George W. Bush, former president of the U.S., appointed Dr. John Marburger as the head of the White House Office of Science and Technology Policy. Dr. Marburger served as the presidential science adviser for Bush’s entire time in office, and defended Bush administration policies which were often criticized by most scientists. As soon as Bush took office in 2001, his administration pulled out of the Kyoto Protocol. Dr. Marburger was widely criticized for defending these policies on climate change, particularly his defense against an assertion by the National Academy of Sciences that political influence was contaminating the scientific research in government agencies. He defended the Bush Administration from accusation that the Bush administration had distorted scientific information that would conflict with its policy preferences, especially on climate change policy and stem cell research. In 2004, a number of leading scientists released a statement in which they charged the Bush administration with widespread and unprecedented “manipulation of the process through which science enters into its decisions.” There is a series of evidence that the Bush administration has deliberately distorted the communication with the scientific community.\footnote{The \textit{New York Times} Obituary, July 29, 2011; John H. Marburger, Bush Science Advisor, Dies at 70 The \textit{Union of Concerned Scientists} Scientific Integrity in Policy Making, An Investigation of the Bush Administration’s Misuse of Science, March 2004; Further Investigation, July 2004}
Corollary 2. Political institutions affect the government’s climate change policies:

(i) In the case where the government does not have any fears of losing power (the voter constraints are non-binding or weakly binding), we can eliminate the credibility gap and maximize the ex-ante social welfare;

(ii) In the case where the government has the fears of losing power (the voter constraints are strictly binding), the credibility gap is deliberately created by a distortion in selection a climate scientist while we achieve more moderate climate change polices.

Proof. Follow from Propositions 3 and 4.

Figure 7 graphically illustrates a credibility gap between the government and the climate scientist. If the government has no fears of losing power, then it can appoint a climate scientist whose ideological position agrees with its own position. Thus the credibility gap is eliminated, which is the forty-five degree line where $\beta_G = \beta_S$, so $x = 1/2$. If the government has the fears of losing power, the right-wing government commits to a more right-wing climate scientist to ensure re-election; and the left-wing government commits to a more...
left-wing climate scientist to ensure re-election. As a result, a credibility gap is created by
election concerns, between the government and the climate scientist.

5.2 Uninformed Voters

The public perception of climate change is also a critical factor in determining climate
change policies. Even in a democratic society, an unconcerned public can cause policymakers
neglect climate change warnings from the scientific community if policymakers’ ideological
position is different from the climate scientists.

I consider the case where the median voter observes the government’s optimal climate
change policy \( \hat{r}_G(m) \), but do not observe the climate scientist’s message \( m \) in Stage 4. In
this case, the median voter can infer from the government’s optimal climate change policy
\( \hat{r}_G(m_H) \) (or \( \hat{r}_G(m_L) \)) that the probability of the Bad State is high (or low). However, they do
not directly observe which message was sent from the climate scientist. Thus the government
can deviate from the optimal policy that it should choose in accordance with the message
from the climate scientist, if it is profitable for the government. Note that I do not solve
for an equilibrium here; however, I show that the government can deviate to out of the
equilibrium path if the median voter does not observe the climate scientist’s message.

**Proposition 5.** We cannot achieve climate change policies accordant with the climate sci-
entist when the median voter is uninformed. The right-wing government deviates from
\( \hat{r}_{RW}(m_H) \) to \( \hat{r}_{RW}(m_L) \) but not in the opposite direction\(^{18}\)

**Proof.** See Appendix □

As in Schultz’s 1995 model in which voters do not directly observe the true state of the
world, the government’s optimal climate change policy may not reflect the true probability
of the Bad State if the voters do not directly observe the message from the climate scientist.
This is the cost of a society in which voters do not monitor research on climate change:

\(^{18}\)The left-wing government deviates from \( \hat{r}_{LW}(m_L) \) to \( \hat{r}_{LW}(m_H) \) but not in the opposite direction.
climate change policy may not be aligned with the true state of climate change. In order to achieve a climate change policy in accordance with climate scientists, the public must be aware of the true state of climate change investigated by those scientists, and they should take the government’s climate change policy into consideration when they vote.

**Theoretical Prediction**  Recall that under my hypothesis, the ruling governments’ preferences for climate change policy are not high as compared to their alternative parties and the median voters. Furthermore, the preference of the median voters is much closer to that of the alternative party. Therefore, in a democratic country, Corollary 2 suggests that the government, for fears of losing power, will implement more moderate climate change policies closer to the median voters’ preference. That is, elections may at least partly mitigate the problem of the biased government preferences. More sharply, I obtain the prediction that countries with more democratic political institutions will have climate change policies more targeted towards renewable energy. In the next section, I empirically test this result.

6  **Empirical Analysis**

I test a hypothesis that political institutions affects climate change policies (Corollary 2). I first describe the data, then empirical (OLS) model, and finally discuss the estimation results.

6.1  **Data**

I use data on climate change polices from International Energy Statistics of the U.S. Energy Information Administration. I collect the proportion of electricity generation due to renewable energy of 133 countries in 2011. This is $r$ in our theoretical model.

I use data on political regime characteristics from the Polity IV data set (Marshall et al., 2014). They constructed an index ranging 0 to 10 for each regime (democracy and autocracy).
I use the difference between the two indexes (Polity II index) followed by previous literature (Baliga et al., 2011 among many others). The Polity II index ranges from -10 to 10, where more democratic countries have a higher index.

I collect data on GDP per capita (constant 2005 US$) from the World Bank Open Data. KP commitments are the reduction targets of Annex I countries of the Kyoto Protocol in percent emission reductions relative to the levels in 1990. The Kyoto Protocol established a legally binding commitment to reduction of GHGs of developed countries for the period of 2008-2012. Annex I is the group of developed countries with the legally binding commitments to reduction of GHGs for the period of 2008-2012.

6.2 OLS Model

I include several control variables in our regression equation. I use GDP per capita to control for the variations in clean technology across countries. Developed countries with higher GDP per capita would have accumulated higher levels of clean technology to generate electricity from renewable energy sources. Therefore, they would use renewable energy at a cheaper cost than developing countries with low GDP per capita. Then it is possible that they use larger proportions of renewable energy than developed countries. On the other hand, it is possible that developed countries would use smaller proportions of renewable energy because of the increasing marginal cost of generating electricity from renewable energy. Even though developed countries have accumulated more stocks of clean technology, they may face a higher marginal cost of generating electricity from renewable energy since developed countries consume higher levels of energy per capita. In any case, I control for them by including GDP per capita.

Most of Annex I countries of the Kyoto Protocol are developed countries, but the levels of commitment are different across countries. Countries with higher commitments to reduction of GHGs may exert more efforts to generate more electricity from renewable energy. I include the levels of reduction target to control for any effects from the binding commitment.
The OLS regression equation is as follows:

\[ R_i = \alpha_0 + \alpha_1 Polity_i + \alpha_2 GDP_i + \alpha_3 KPcommit_i + \epsilon_i, \]  

(20)

where \( R_i \) is the log of the proportion of total electricity generation due to renewable energy, \( Polity_i \) is the Polity II index of country \( i \), and \( KPcommit_i \) is an Annex I country \( i \)’s emission reduction target in the UNFCCC.

### 6.3 Empirical Results

I find strong empirical evidence that supports our theoretical results (Corollary 2): the political institution of a country affects the government’s climate change policy. The level of democracy has a significant and positive relationship with the government’s climate change policy. The governments implement stronger climate change policies as their political institutions are closer to a full democracy.

The theoretical model may explain the intuition behind this empirical results. It may be the case that, in many countries, the governments’ preferences of climate change policy are not high as compared to their alternative parties and the median voters. Furthermore, the preference of the median voters is much closer to that of the alternative party. In a democratic country, the median voters and the alternative party being close together raises fears of losing power for the government. The fears of losing power lead the government to implement climate change policies closer to the median voters’ preference. That is, the election concerns make the government to implement much stronger climate change policies than its preferred policies. This democratic procedure of implementing climate change policies will be more likely to occur in countries with higher levels of democracy.

In specification (1), I include only one control variable, the log of GDP per capita. I estimate that a 1% increase in GDP per capita is associated with approximately 34% decrease in the proportion of electricity due to renewable energy with the 1% significance
Table 1: OLS Regression Results: Political Institution and Climate Change Policy

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable: $R$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Polity II</td>
<td>0.092**</td>
</tr>
<tr>
<td></td>
<td>(0.041)</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>-0.344***</td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
</tr>
<tr>
<td>KP commitment</td>
<td>-0.081*</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
</tr>
<tr>
<td>Non Annex I (dummy)</td>
<td>-0.915**</td>
</tr>
<tr>
<td></td>
<td>(0.426)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.730</td>
</tr>
<tr>
<td></td>
<td>(0.718)</td>
</tr>
<tr>
<td>Observations</td>
<td>133</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Note: *, **, *** denote the significance level at 10%, 5%, and 1%, respectively. Robust standard errors are in parentheses.

... continue with the rest of the text...
tricity due to renewable energy as they are mostly developing countries without any binding commitments to reduction GHGs. In specification (4), I include all control variables, GDP per capita, the KP commitments, and the dummy of non-Annex I countries. The coefficient on the Polity II index falls to 0.077, but it is still statistically significant with the 10% significance level.

7 Conclusion

The subject of climate change is by nature complex and full of uncertainties, and these complications often result in discordant climate change policies. I incorporate some of them into our game-theoretic model to examine why climate change policies are sometimes discordant, and suggest a solution to achieve accordant climate change policies.

I develop a game-theoretic model of the three parties associated with climate change: the government, the climate scientist, and the median voter. The climate scientist tells the government about the state of climate change. Since the governments cannot verify the truthfulness of scientific reports, the scientist’s message is considered “cheap talk”.

In the basic model, where all preferences are exogenous and the government has no election concerns, I show that a credibility gap between a climate scientist and a government is created if their preference for what policy to enact is not perfectly aligned with the government. If the government is allowed to select its climate scientist, then it would select a climate scientist whose preference agrees with its own preference. Then we can eliminate the credibility gap and maximize the ex-ante social welfare. I show a striking result: the ex-ante social welfare is maximized if and only if the preference of the scientist is perfectly aligned with the government, not the median voter. This is due to the fact that a credibility gap reduces the ex-ante social welfare.

I show that election concerns may be the cause of the credibility gap in a democratic society. The right-wing government has a political incentive to distort the communication
with the scientific community, because it knows that it will have to respond to an alarming message with stronger climate change policies than it would like when it has binding election concerns. My contribution from our research to this literature is that I theoretically showed that climate change denial can be a rational behavior in a democratic society.

From my model, I obtain a theoretical prediction that countries with more democratic political institutions will implement climate change policies more targeted towards renewable energy. With cross-sectional data from 133 countries worldwide in 2011, I present strong empirical evidence that shows my theoretical prediction is true. The level of democracy is significantly and positively associated with the level of climate change policy. This also shows that our hypothesis is true: in many countries, the government’s preference for climate policy is not high as compared to that of its alternative party and the median voters; and the preference of the median voters being closer to the alternative party raises fears of losing power for the government. The fears of losing power lead the government to implement much stronger climate change policy to win the election. This democratic procedure of implementing climate policy will be more likely to occur in countries with higher level of democracy.

Additionally, I show that if voters cannot observe the message from the climate scientist, then the climate change policy that a government puts into place may be discordant with the recommendations of the climate scientist. The right wing government deviates to the climate change policy accordant with the comforting message when the climate scientist sends the alarming message. The left wing government deviates to the climate change policy accordant with the alarming message when the climate scientist sends the comforting message. This is the cost of a society in which voters do not monitor research on climate change: climate change policy may not be aligned with the true state of climate change. In order to achieve a climate change policy in accordance with climate scientists, the public must be aware of the true state of climate change investigated by those scientists, and they should take the government’s climate change policy into consideration when they vote.
My research presents a theoretical model that shows how a climate scientist affects domestic political decisions on climate change policies. One may argue that climate change policies are inherently related with international positive externalities, so one should include another player in the model to see how a scientist affects a climate game between two different players. I leave that for the future research.
Appendix

Proof of Lemma 1. In Stage 2, the government solves

$$\max_{r \in \mathbb{R}^+} \int_0^1 U^G(r, \theta) \rho(\theta|m) d\theta = - \int_0^1 \theta (\beta_G - \bar{\beta} - (\beta_G - \bar{\beta})r) \rho(\theta|m) d\theta - (1 - \bar{\beta}) + (2 - \bar{\beta})r - r^2,$$

where

$$\int_0^1 \theta \rho(\theta|m) d\theta = \begin{cases} x/2, & \text{if } m(\theta) = m_L \\ (x + 1)/2, & \text{if } m(\theta) = m_H. \end{cases}$$

Note that there is a unique interior solution to this maximization problem due to the strict concavity of $U^G(r, \theta)$ in $r$. From the first-order condition, we obtain

$$r^*(m_L; x) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4} (\bar{\beta} - \beta_G),$$

$$r^*(m_H; x) = 1 - \frac{\bar{\beta}}{2} + \frac{x + 1}{4} (\bar{\beta} - \beta_G).$$

Thus, $r^*(m_L; x) < r^*(m_H; x)$ if $\bar{\beta} > \beta_G$ and $x > 0. \blacksquare$

Proof of Proposition 1. In Stage 1, the climate scientist solves

$$\max_{m \in \Omega} U^S(r^*(m), \theta) = \theta [\beta_S - \bar{\beta} - (\beta_S - \bar{\beta})r^*(m)] - 1 + \bar{\beta} + (2 - \bar{\beta})r^*(m) - r^*(m)^2$$

s.t.

$$r^*(m) = \begin{cases} r^*(m_L), & \text{if } m(\theta) = m_L \\ r^*(m_H), & \text{if } m(\theta) = m_H. \end{cases}$$

Note that the climate scientist faces a binary decision in Stage 1. She can choose either
Due to the quadratic form of $U^S(r^*(m), \theta)$ in $r,$

$$U^S(r^*(m_L), \theta) \leq U^S(r^*(m_H), \theta), \quad \text{if} \quad r^S(\theta) \geq \frac{r^*(m_L) + r^*(m_H)}{2}.$$ 

$$U^S(r^*(m_L), \theta) \geq U^S(r^*(m_H), \theta), \quad \text{if} \quad r^S(\theta) \leq \frac{r^*(m_L) + r^*(m_H)}{2}.$$ 

Thus, in order for a partially separating equilibrium with a two-step to exist, $x$ must be the point where

$$r^S(x) = \frac{r^*(m_L) + r^*(m_H)}{2},$$

which is equivalent to

$$1 - \frac{\bar{\beta}}{2} + x \frac{\beta - \beta_s}{2} = 1 - \frac{\bar{\beta}}{2} + x \frac{\beta - \beta_G}{4} + \frac{1}{8} (\beta - \beta_G).$$

Solving for $x$, we obtain

$$x = \frac{\frac{1}{2} (\beta - \beta_G)}{\beta + \beta_G - 2\beta_s}.$$ 

Since $\beta_G < \bar{\beta}$ by Assumption 1, and $x$ must be strictly positive,

$$\beta_s < \frac{\bar{\beta} + \beta_G}{2}.$$ 

Furthermore, it must be that $x \leq 1$. Thus

$$\beta_s \leq \frac{\bar{\beta} + 3\beta_G}{4}.$$ 

\[\blacksquare\]
Proof of Theorem 1. The social planner solves

\[
\max_{b_s} W \{ E_\theta U^V[r^*(m(\theta)), \theta] \} = N \cdot E_\theta U^V[r^*(m(\theta)), \theta],
\]

where

\[
E_\theta U^V[r^*(m(\theta)), \theta] = q(m_L) \int_0^x U^V(r^*(m_L), \theta) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U^V(r^*(m_H), \theta) \rho(\theta|m_H) d\theta
\]

\[
r^*(m_L) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4}(\bar{\beta} - \beta_G),
\]

\[
r^*(m_H) = 1 - \frac{\bar{\beta}}{2} + \frac{x + 1}{4}(\bar{\beta} - \beta_G),
\]

\[
x = \frac{\frac{1}{2}(\bar{\beta} - \beta_G)}{\beta + \beta_G - 2\beta_S}.
\]

Note that

\[
E_\theta U^V[r^*(m(\theta)), \theta] = q(m_L) \int_0^x U^V(r^*(m_L), \theta) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U^V(r^*(m_H), \theta) \rho(\theta|m_H) d\theta
\]

\[
= x \left\{ \frac{x}{2} [\beta_V - \bar{\beta} - (\beta_V - \bar{\beta}) r^*(m_L)] - 1 + \bar{\beta} + (2 - \bar{\beta}) r^*(m_L) - r^*(m_L)^2 \right\}
\]

\[
+ (1 - x) \left\{ \frac{x + 1}{2} [\beta_V - \bar{\beta} - (\beta_V - \bar{\beta}) r^*(m_H)] - 1 + \bar{\beta} + (2 - \bar{\beta}) r^*(m_H) - r^*(m_H)^2 \right\}.
\]

From the first-order condition with respect to \(b_s\),

\[
-(1 - \frac{\bar{\beta}}{2}) x' + \frac{1}{4} (4 - \frac{3}{2} \bar{\beta} - \beta_V) x' + \frac{x}{2} (\frac{\beta_V}{2} - \bar{\beta}) x' = 0,
\]

where \(x' = \frac{dx}{d\beta_S} = \frac{\bar{\beta} - \beta_G}{(\beta_G + 2\beta_S)^2} > 0\).

Thus we obtain

\[
x = \frac{\frac{1}{2}(\bar{\beta} - \beta_V)}{\beta - \beta_V} = \frac{1}{2}.
\]
Since \( x = \frac{1}{2}(\bar{\beta} - \beta_G) \),
\[
x = \frac{1}{2}(\bar{\beta} - \beta_G) = \frac{1}{2}.
\]

Thus \( \beta^*_S = \beta_G \). ■

**Proof of Proposition 2.** In Stage 0, the government solves

\[
\max_{\beta_S \in [0, 2]} q(m_L) \int_0^x U^G(r^*(m_L), \theta) \rho(\theta|m_L)d\theta + q(m_H) \int_x^1 U^G(r^*(m_H), \theta) \rho(\theta|m_H)d\theta
\]

\[
= x \left\{ \frac{1}{2}[\beta_G - \bar{\beta} - (\beta_G - \bar{\beta})r^*(m_L)] - 1 + \bar{\beta} + (2 - \bar{\beta})r^*(m_L) - r^*(m_L)^2 \right\}
\]

\[
+ (1 - x) \left\{ \frac{x + 1}{2}[\beta_G - \bar{\beta} - (\beta_G - \bar{\beta})r^*(m_H)] - 1 + \bar{\beta} + (2 - \bar{\beta})r^*(m_H) - r^*(m_H)^2 \right\}
\]

where \( r^*(m_L) = 1 - \frac{\bar{\beta} + x}{4}(\beta - \beta_G) \),
\[
r^*(m_H) = 1 - \frac{\bar{\beta} + x + 1}{4}(\beta - \beta_G),
\]
\[
x = \frac{1}{2}(\bar{\beta} - \beta_G) \quad \frac{\beta_G - 2\beta_S}{\beta + \beta_G - 2\beta_S}.
\]

From the first-order condition with respect to \( \beta_S \),

\[-(1 - \frac{\bar{\beta}}{2})x' + \frac{1}{4}(4 - \frac{3}{2} \bar{\beta} - \beta_G)x' + \frac{x}{2}(\frac{\beta_G}{2} - \bar{\beta})x' = 0,
\]

where \( x' = \frac{ds}{d\beta_S} = \frac{\bar{\beta} - \beta_G}{(\beta + \beta_G - 2\beta_S)^2} > 0. \)

Thus we obtain
\[
x = \frac{1}{2}(\bar{\beta} - \beta_G) = \frac{1}{2}.
\]

(27)

Since \( x = \frac{1}{2}(\bar{\beta} - \beta_G) \),
\[
x = \frac{1}{2}(\bar{\beta} - \beta_G) \quad \frac{\beta_G - 2\beta_S}{\beta + \beta_G - 2\beta_S} = \frac{1}{2}.
\]

Thus \( \beta^*_S = \beta_G \). ■
\textbf{Proof of Proposition 3.} Suppose that the right wing is the ruling party of the government. If the voter constraint (18) is non-binding or weakly binding,

\[ \left[ \frac{x}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r_{RW}^*(m_L) - r_{LW}^*(m_L)] - [r_{RW}^*(m_L)^2 - r_{LW}^*(m_L)^2] \geq 0. \] \hspace{1cm} (28)

The above constraint (28) becomes

\[ 2 - \bar{\beta} + \frac{x}{2}(\bar{\beta} - \frac{\beta_{LW} + \beta_{RW}}{2}) \geq 2 - \bar{\beta} + \frac{x}{2}(\bar{\beta} - \beta_V). \] \hspace{1cm} (29)

Thus \( \beta_V \geq \frac{\beta_{LW} + \beta_{RW}}{2} \).

If the voter constraint (19) is non-binding or weakly binding,

\[ \left[ \frac{x + 1}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r_{RW}^*(m_H) - r_{LW}^*(m_H)] - [r_{RW}^*(m_H)^2 - r_{LW}^*(m_H)^2] \geq 0. \] \hspace{1cm} (30)

The above constraint (30) becomes

\[ 2 - \bar{\beta} + \frac{x + 1}{2}(\bar{\beta} - \frac{\beta_{LW} + \beta_{RW}}{2}) \geq 2 - \bar{\beta} + \frac{x + 1}{2}(\bar{\beta} - \beta_V). \] \hspace{1cm} (31)

Thus \( \beta_V \geq \frac{\beta_{LW} + \beta_{RW}}{2} \).

In Stage 0, the right wing government solves the following constrained maximization problem:

\[
\max_{\beta_S \in [0, 2]} q(m_L) \int_0^x U_{RW}(\hat{r}_{RW}(m_L), \theta) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U_{RW}(\hat{r}_{RW}(m_H), \theta) \rho(\theta|m_H) d\theta \\
= x \{ \frac{x}{2}[\beta_{RW} - \bar{\beta} - (\beta_{RW} - \bar{\beta})\hat{r}_{RW}(m_L)] - 1 + \bar{\beta} + (2 - \bar{\beta})\hat{r}_{RW}(m_L) - \hat{r}_{RW}^*(m_L)^2 \} \\
+ (1 - x) \{ \frac{x + 1}{2}[\beta_{RW} - \bar{\beta} - (\beta_{RW} - \bar{\beta})\hat{r}_{RW}(m_H)] - 1 + \bar{\beta} + (2 - \bar{\beta})\hat{r}_{RW}(m_H) - \hat{r}_{RW}^*(m_H)^2 \}
\]

s.t. \[ \left[ \frac{x}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r_{LW}^*(m_L) - \hat{r}_{RW}(m_L)] - [r_{LW}^*(m_L)^2 - \hat{r}_{RW}(m_L)^2] \leq 0 \]

\[ \left[ \frac{x + 1}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r_{LW}^*(m_H) - \hat{r}_{RW}(m_H)] - [r_{LW}^*(m_H)^2 - \hat{r}_{RW}(m_H)^2] \leq 0. \]
Form the Lagrangian function:

\[
L = q(m_L) \int_0^x U_{RW}(\hat{r}_{RW}(m_L), \theta) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U_{RW}(\hat{r}_{RW}(m_H), \theta) \rho(\theta|m_H) d\theta
- \lambda_1 \left\{ \left[ \frac{x}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r^*_{LW}(m_L) - \hat{r}_{RW}(m_L)] - [r^*_{LW}(m_L)^2 - \hat{r}_{RW}(m_L)^2] \right\}
- \lambda_2 \left\{ \left[ \frac{x + 1}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r^*_{LW}(m_H) - \hat{r}_{RW}(m_H)] - [r^*_{LW}(m_H)^2 - \hat{r}_{RW}(m_H)^2] \right\}. \tag{32}
\]

Note that the voter constraints (18) and (19) are not active. Therefore, from the first-order condition, we obtain: \( \lambda_1 = 0 \) and \( \lambda_2 = 0 \): \( \beta^*_S = \beta_{RW} \).

Likewise, \( \beta^*_S = \beta_{LW} \) in the case where the left wing is the ruling party and \( \beta_V \leq \frac{\beta_{RW} + \beta_{LW}}{2} \) (the constraints (22) and (23) are non-binding or weakly binding).

**Proof of Proposition 4.** Suppose that the right wing is in power at the beginning of the game. Note that the constraints (18) and (19) are strictly binding if \( \beta_V < \frac{\beta_{RW} + \beta_{LW}}{2} \).

At the constrained optimum \( \hat{r}_{RW}(m_L) \) and \( \hat{r}_{RW}(m_H) \), it must be that

\[
\left[ \frac{x}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r^*_{LW}(m_L) - \hat{r}_{RW}(m_L)] - [r^*_{LW}(m_L)^2 - \hat{r}_{RW}(m_L)^2] = 0 \tag{33}
\]

\[
\left[ \frac{x + 1}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta}) \right] [r^*_{LW}(m_H) - \hat{r}_{RW}(m_H)] - [r^*_{LW}(m_H)^2 - \hat{r}_{RW}(m_H)^2] = 0, \tag{34}
\]

where \( r^*_{LW}(m_L) \) and \( r^*_{LW}(m_H) \) are the unconstrained optimum specified in Lemma 1.

Solving (33) and (34) for \( \hat{r}_{RW}(m_L) \) and \( \hat{r}_{RW}(m_H) \), respectively, yields

\[
\hat{r}_{RW}(m_L) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4}(\bar{\beta} - 2\beta_V + \beta_{LW}); \tag{35}
\]

\[
\hat{r}_{RW}(m_H) = 1 - \frac{\bar{\beta}}{2} + \frac{x + 1}{4}(\bar{\beta} - 2\beta_V + \beta_{LW}). \tag{36}
\]

In Stage 0, the right wing government solves the following constrained maximization
problem:

$$\max_{\beta \in [0,2]} q(m_l) \int_0^x U^{RW}(\hat{r}_{RW}(m_L), q) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U^{RW}(\hat{r}_{RW}(m_H), q) \rho(\theta|m_H) d\theta$$

$$= x \left\{ \frac{x}{2} [\beta_{RW} - \beta - (\beta_{RW} - \beta) \hat{r}_{RW}(m_L)] - 1 + \beta + (2 - \beta) \hat{r}_{RW}(m_L) - \hat{r}_{RW}(m_L)^2 \right\}$$

$$+ (1 - x) \left\{ \frac{x + 1}{2} [\beta_{RW} - \beta - (\beta_{RW} - \beta) \hat{r}_{RW}(m_H)] - 1 + \beta + (2 - \beta) \hat{r}_{RW}(m_H) - \hat{r}_{RW}(m_H)^2 \right\}$$

s.t. $$\left\{ \begin{array}{l}
\left[ \frac{x}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_L) - \hat{r}_{RW}(m_L)] - [\hat{r}_{LW}^*(m_L)^2 - \hat{r}_{RW}(m_L)^2] \leq 0 \\
\left[ \frac{x + 1}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_H) - \hat{r}_{RW}(m_H)] - [\hat{r}_{LW}^*(m_H)^2 - \hat{r}_{RW}(m_H)^2] \leq 0.
\end{array} \right.$$  

Form the Lagrangian function:

$$\mathcal{L} = q(m_l) \int_0^x U^{RW}(\hat{r}_{RW}(m_L), q) \rho(\theta|m_L) d\theta + q(m_H) \int_x^1 U^{RW}(\hat{r}_{RW}(m_H), q) \rho(\theta|m_H) d\theta$$

$$\quad - \lambda_1 \left\{ \left[ \frac{x}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_L) - \hat{r}_{RW}(m_L)] - [\hat{r}_{LW}^*(m_L)^2 - \hat{r}_{RW}(m_L)^2] \right\}$$

$$\quad - \lambda_2 \left\{ \left[ \frac{x + 1}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_H) - \hat{r}_{RW}(m_H)] - [\hat{r}_{LW}^*(m_H)^2 - \hat{r}_{RW}(m_H)^2] \right\}. \quad (37)$$

From the first-order condition, we obtain the following solution $$\beta^*_S$$, $$\lambda_1^*$$, and $$\lambda_2^*$$ such that

(i) $$\left[ \frac{x}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_L) - \hat{r}_{RW}(m_L)] - [\hat{r}_{LW}^*(m_L)^2 - \hat{r}_{RW}(m_L)^2] = 0$$

$$\left[ \frac{x + 1}{2} (\beta - \beta_V) + (2 - \beta) \right] [\hat{r}_{LW}^*(m_H) - \hat{r}_{RW}(m_H)] - [\hat{r}_{LW}^*(m_H)^2 - \hat{r}_{RW}(m_H)^2] = 0,$$

where $$x = \frac{1}{2} (\beta - \beta_{RW}) (\beta_{RW} - 2\beta_S)$$ and $$\hat{r}_{RW}(m_L)$$ and $$\hat{r}_{RW}(m_H)$$ are the constrained maximum.

(ii) $$\lambda_1^* = \frac{(\beta - \beta_{RW})^2 (x - \frac{1}{2})}{(\beta_{RW} - \beta_{LW})^2 (\beta - \beta_V) (1 - x)} > 0$$. Note that it must be that $$\beta^*_S > \beta_{RW}$$ (equivalently, $$x > \frac{1}{2}$$) since the denominator of $$\lambda_1^*$$ is always strictly positive.

(iii) $$\lambda_2^* = \frac{(\beta - \beta_{RW})^2 (x - \frac{1}{2})}{(\beta_{RW} - \beta_{LW})^2 (\beta - \beta_V) (1 - x - \frac{\beta_{LW}}{2})} > 0.$$
Note that $\lambda^*_2 > 0$ if $x > \frac{1}{2}$ and
\[
\frac{1}{2} \leq -\frac{1}{2}(2 - \frac{\bar{\beta}}{2} - \frac{\beta_V}{2}) + \sqrt{\frac{1}{4}(2 - \frac{\bar{\beta}}{2} - \frac{\beta_V}{2})^2 + 6(1 - \frac{\beta_V}{2})(\frac{\bar{\beta}}{2} - \frac{\beta_V}{2})} < x. \tag{38}
\]

Notice that the numerator of $\lambda^*_2$ is positive only if $x > \frac{1}{2}$, and the denominator of $\lambda^*_2$ is positive only if the condition (38) is satisfied.

In sum, it must be that $\beta^*_S > \beta_{RW}$ (equivalently, $x > \frac{1}{2}$). ■

Suppose that the left wing is the ruling party of the government. Note that the voter constraints (18) and (19) are strictly binding if $\beta_V > \beta_{LW} + \beta_{RW}$.

At the constrained optimum $\hat{r}_{LW}(m_L)$ and $\hat{r}_{LW}(m_H)$, it must be that
\[
\frac{x}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta})\left[r^*_{RW}(m_L) - \hat{r}_{LW}(m_L)\right] - \left[r^*_{RW}(m_L)^2 - \hat{r}_{LW}(m_L)^2\right] = 0 \tag{39}
\]
\[
\frac{x + 1}{2}(\bar{\beta} - \beta_V) + (2 - \bar{\beta})\left[r^*_{RW}(m_H) - \hat{r}_{LW}(m_H)\right] - \left[r^*_{RW}(m_H)^2 - \hat{r}_{LW}(m_H)^2\right] = 0, \tag{40}
\]

where $r^*_{RW}(m_L)$ and $r^*_{RW}(m_H)$ are the unconstrained optimum specified in Lemma 1.

Solving (39) and (40) for $\hat{r}_{LW}(m_L)$ and $\hat{r}_{LW}$, yields
\[
\hat{r}_{LW}(m_L) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4}(\bar{\beta} - 2\beta_V + \beta_{RW}); \tag{41}
\]
\[
\hat{r}_{LW}(m_H) = 1 - \frac{\bar{\beta}}{2} + \frac{x + 1}{4}(\bar{\beta} - 2\beta_V + \beta_{RW}). \tag{42}
\]

In Stage 0, the left wing government solves the following constrained maximization prob-
\[\max_{\beta_s \in [0, 2]} q(m_L) \int_0^x U^{LW}(\hat{r}_{LW}(m_L), \theta) \rho(\theta|m_L)d\theta + q(m_H) \int_x^1 U^{LW}(\hat{r}_{LW}(m_H), \theta) \rho(\theta|m_H)d\theta
\]

\[= x\left\{ \frac{x}{2}[\beta_{LW} - \beta - (\beta_{LW} - \beta)\hat{r}_{LW}(m_L)] - 1 + \beta + (2 - \beta)\hat{r}_{LW}(m_L) - \hat{r}_{LW}(m_L)^2 \right\}
\]

\[+ (1 - x)\left\{ \frac{x + 1}{2}[\beta_{LW} - \beta - (\beta_{LW} - \beta)\hat{r}_{LW}(m_H)] - 1 + \beta + (2 - \beta)\hat{r}_{LW}(m_H) - \hat{r}_{LW}(m_H)^2 \right\}
\]

s.t. \[\left[ \frac{x}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_L) - \hat{r}_{LW}(m_L)] - [r_{RW}^*(m_L)^2 - \hat{r}_{LW}(m_L)^2] \leq 0
\]

\[\left[ \frac{x + 1}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_H) - \hat{r}_{LW}(m_H)] - [r_{RW}^*(m_H)^2 - \hat{r}_{LW}(m_H)^2] \leq 0.
\]

Form the Lagrangian function:

\[\mathcal{L} = q(m_L) \int_0^x U^{LW}(\hat{r}_{LW}(m_L), \theta) \rho(\theta|m_L)d\theta + q(m_H) \int_x^1 U^{LW}(\hat{r}_{LW}(m_H), \theta) \rho(\theta|m_H)d\theta
\]

\[- \lambda_1\left\{ \frac{x}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_L) - \hat{r}_{LW}(m_L)] - [r_{RW}^*(m_L)^2 - \hat{r}_{LW}(m_L)^2] \right\}
\]

\[- \lambda_2\left\{ \frac{x + 1}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_H) - \hat{r}_{LW}(m_H)] - [r_{RW}^*(m_H)^2 - \hat{r}_{LW}(m_H)^2] \right\}.
\]

From the first-order condition, we obtain the following solution \(\beta_s^*, \lambda_1^*, \text{ and } \lambda_2^*\) such that

(i)

\[\left[ \frac{x}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_L) - \hat{r}_{LW}(m_L)] - [r_{RW}^*(m_L)^2 - \hat{r}_{LW}(m_L)^2] = 0
\]

\[\left[ \frac{x + 1}{2}(\beta - \beta_V) + (2 - \beta)\right][r_{RW}^*(m_H) - \hat{r}_{LW}(m_H)] - [r_{RW}^*(m_H)^2 - \hat{r}_{LW}(m_H)^2] = 0,
\]

where \(x = \frac{\beta - \beta_{LW}}{\beta_{LW} - 2\beta_S}\) and \(\hat{r}_{LW}(m_L)\) and \(\hat{r}_{LW}(m_H)\) are the constrained maximum.

(ii) \(\lambda_1^* = \frac{\beta_{LW} - \beta_{RW}}{\beta_{LW} - \beta_{SW}}\) \(\frac{1}{x(\beta - \beta_V)(2 - \beta)} > 0\). Note that it must be that \(\beta_s^* < \beta_{LW}\) (equivalently, \(x < \frac{1}{2}\)) since the denominator of \(\lambda_1^*\) is always strictly negative.

(iii) \(\lambda_2^* = \frac{\beta_{LW} - \beta_{RW}}{\beta_{LW} - \beta_{SW}}\) \(\frac{1}{x(\beta - \beta_V)(2 - \beta)} > 0\).

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Note that $\lambda^*_2 > 0$ if $x < \frac{1}{2}$ and
\[
-\frac{1}{2}(2 - \frac{\bar{\beta}}{2} - \frac{\beta_G}{2}) + \sqrt{\frac{1}{4}(2 - \frac{\bar{\beta}}{2} - \frac{\beta_G}{2})^2 + 6(1 - \frac{\beta_G}{2})(\frac{\bar{\beta}}{2} - \frac{\beta_G}{2})} < x < \frac{1}{2}.
\] (44)

Notice that the numerator of $\lambda^*_2$ is negative only if $x < \frac{1}{2}$, and the denominator of $\lambda^*_2$ is negative only if the condition (44) is satisfied.

In sum, it must be that $\beta^*_S < \beta_{LW}$ (equivalently, $x < \frac{1}{2}$). ■

**Proof of Proposition 5.** The maximizer of the government’s ex-ante utility function $E_{\theta}U^G[r^*(m(\theta)), \theta]$ is

\[
\arg\max_r E_{\theta}U^G[r^*(m(\theta)), \theta] = q(m_L) \int_0^x U^G(r^*(m_L), \theta)\rho(\theta|m_L)d\theta \\
+ q(m_H) \int_x^1 U^G(r^*(m_H), \theta)\rho(\theta|m_H)d\theta = 1 - \frac{\beta_G + \bar{\beta}}{4}. \quad (45)
\]

In the case where the constraints are non-binding or weakly binding, notice that

\[
r^*(m_L) = 1 - \frac{\bar{\beta}}{2} + \frac{x}{4}(\bar{\beta} - \beta_G) \leq 1 - \frac{\beta_G + \bar{\beta}}{4},
\]

\[
r^*(m_H) = 1 - \frac{\bar{\beta}}{2} + \frac{x + 1}{4}(\bar{\beta} - \beta_G) \geq 1 - \frac{\beta_G + \bar{\beta}}{4}.
\]

Since $E_{\theta}U^G[r^*(m(\theta)), \theta]$ is in a quadratic form and the government prefers $r^*(m_L)$ to $r^*(m_H)$ if

\[
1 - \frac{\beta_G + \bar{\beta}}{4} - r^*(m_L) = \frac{1-x}{4}(\bar{\beta} - \beta_G) \leq \frac{x}{4}(\bar{\beta} - \beta_G) = r^*(m_H) - 1 + \frac{\beta_G + \bar{\beta}}{4}, \quad (46)
\]

which is equivalent to $x \geq \frac{1}{2}$. That is, the government prefers $r^*(m_L)$ to $r^*(m_H)$ if $x \geq \frac{1}{2}$ and vice versa. Note that $x = \frac{1}{2}$ when the constraints (18) and (19) are non-binding or weakly binding. Thus the government does not have any incentive to deviate from the given
message. ■

In the case where the right wing is in power at the beginning of the game, and the constraints (18) and (19) are strictly binding (equivalently, $\beta_V < \frac{\beta_{LW} + \beta_{RW}}{2}$), the government deviates from $\hat{r}_{RW}(m_H)$ to $\hat{r}_{RW}(m_L)$ at Stage 3 since

$$\hat{r}_{RW}(m_H) - 1 + \frac{\beta_{RW} + \bar{\beta}}{4} - 1 + \frac{\beta_{RW} + \bar{\beta}}{4} - \hat{r}_{RW}(m_L) = -\beta_V + \frac{\beta_{LW} + \beta_{RW}}{2} > 0.$$  

In the case where the left wing is in power at the beginning of the game, and the constraints (18) and (19) are strictly binding (equivalently, $\beta_V > \frac{\beta_{LW} + \beta_{RW}}{2}$), the government deviates from $\hat{r}_{LW}(m_L)$ to $\hat{r}_{LW}(m_H)$ at Stage 3 since

$$\hat{r}_{LW}(m_H) - 1 + \frac{\beta_{LW} + \bar{\beta}}{4} - 1 + \frac{\beta_{LW} + \bar{\beta}}{4} - \hat{r}_{LW}(m_L) = -\beta_V + \frac{\beta_{LW} + \beta_{RW}}{2} < 0.$$  

■
References


