# Appendix: Information and Climate (In)action

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# A Formal Proofs

## Proofs of Domestic Politics Model

### Domestic Politics: Equilibrium

I prove Proposition 1 with a series of two lemmas. The first establishes equilibrium behavior in the climate policy subgame, and the second characterizes the optimal misreporting level given this equilibrium behavior.

Define $\hat{\sigma}(\theta, \omega)$ as the voter's belief that probability that the politician chooses $a = 1$ when she is of type $\theta$ and the state of the world is $\omega$. Define $B(\theta, a, s)$ as proportional to the *ex ante* probability that a politician of type $\theta$ chooses action $a$ and signal $s$ is realized. Then we have

$$B(\theta, 1, s) = P(\theta)\Big(\pi\hat{\sigma}(\theta, 1) + (1-\pi)\hat{\sigma}(\theta, 0)\frac{P(s|s \neq \omega)}{P(s|s = \omega)}\Big).$$
$$B(\theta, 0, s) = P(\theta)\Big(\pi(1 - \hat{\sigma}(\theta, 1)) + (1-\pi)(1 - \hat{\sigma}(\theta, 0))\frac{P(s|s \neq \omega)}{P(s|s = \omega)}\Big).$$

This means that the voter's posterior belief that the politician is competent, following policy choice $a$, is given by

$$\mu(a, s) = \frac{P(a, s|\theta = 1)P(\theta = 1)}{P(a, s|\theta = 1)P(\theta = 1) + P(a, s|\theta = 0)P(\theta = 0)} = \frac{B(1, a, s)}{B(1, a, s) + B(0, a, s)}.$$

**Lemma A.1** *A unique cutoff $\tilde{x}^*$ exists, admitting a unique perfect Bayesian equilibrium to the climate policy subgame. A politician of type $\theta$ chooses policy $a = 1$ given signal $x^\theta$ with probability $\sigma^*(\theta, x^\theta) \in [0, 1]$. These probabilities are*

$$\sigma^*(1, x^1) = x^1 = \omega.$$
$$\sigma^*(0, x^0) = 1 - G(\tilde{x}^*; \omega).$$

*Upon observing policy $a$ and signal $s$, the voter reelects the politician with probability $F(\mu^*(a, s; \tilde{x}^*))$.*

**Proof of Lemma A.1:** It is straightforward that following any history in which the politician chooses policy $a$ and the voter observes signal $s$ the voter has posterior belief $P(\theta = 1|a, s) = \mu(a, s)$, the voter reelects the politician if and only if $\mu(a, s) \geq \varepsilon$, which occurs with probability $F(\mu(a, s))$.

The competent politician, whose signal of $\omega$ is perfect, always chooses $a = 1$ following signal $x^1 = 1$:

$$1 + \beta F(\mu(1, 0)) + (1-\beta)F(\mu(1, 1)) \geq \beta F(\mu(0, 0)) + (1-\beta)F(\mu(0, 1)) \iff 1 \geq -\beta\Delta(0) - (1-\beta)\Delta(1).$$

Similarly, she never chooses $a = 1$ following signal $x^1 = 0$:

$$F(\mu(1, 0)) \leq 1 + F(\mu(0, 0)) \iff \Delta(0) \leq 1.$$

Given the value of her private signal $x^0 = x$, the incompetent politician's posterior belief about the state is $\eta(x) = P(\omega = 1|x) = \frac{\pi g(x;1)}{\pi g(x;1) + (1-\pi)g(x;0)}$. Write $\Delta(s) = F(\mu(1, s)) - F(\mu(0, s))$. The incompetent type therefore chooses $a = 1$ if and only if

$$\begin{aligned}
&\eta(x) + \beta\eta(x)F(\mu(1,0)) + (1-\beta)\eta(x)F(\mu(1,1)) + (1-\eta(x))F(\mu(1,0)) \geq \\
&\qquad (1-\eta(x)) + \beta\eta(x)F(\mu(0,0)) + (1-\beta)\eta(x)F(\mu(0,1)) + (1-\eta(x))F(\mu(0,0)) \\
&\Leftrightarrow \ \eta(x) \geq \frac{1-\Delta(0)}{2+(1-\beta)(\Delta(1)-\Delta(0))}.
\end{aligned}$$

Define $\tilde{x}$ as the signal that solves

$$2\eta(\tilde{x}) - 1 + (1-\beta)\eta(\tilde{x})\Delta(1;\tilde{x}) + (1-\eta(\tilde{x})+\beta\eta(\tilde{x}))\Delta(0;\tilde{x}) = 0, \tag{1}$$

where the cutoff $\tilde{x}$ induces voter posterior beliefs

$$\begin{aligned}
\mu^*(1,0;\tilde{x}) &= \frac{\tau\pi}{\tau\pi + (1-\tau)\pi(1-G(\tilde{x};1)) + (1-\tau)(1-\pi)\frac{\beta}{1-\beta}(1-G(\tilde{x};0))}. \\
\mu^*(1,1;\tilde{x}) &= \frac{\tau}{\tau + (1-\tau)(1-G(\tilde{x};1))}. \\
\mu^*(0,0;\tilde{x}) &= \frac{\tau(1-\pi)\frac{\beta}{1-\beta}}{\tau(1-\pi)\frac{\beta}{1-\beta} + (1-\tau)(\pi G(\tilde{x};1) + (1-\pi)\frac{\beta}{1-\beta}G(\tilde{x};0))}. \\
\mu^*(0,1;\tilde{x}) &= 0.
\end{aligned}$$

Differentiating Equation 1 with respect to $\tilde{x}$ yields

$$2\frac{\partial\eta(\tilde{x})}{\partial\tilde{x}} + (1-\beta)\frac{\partial\eta(\tilde{x})}{\partial\tilde{x}}(\Delta(1;\tilde{x}) - \Delta(0;\tilde{x})) + (1-\beta)\eta(\tilde{x})\frac{\partial\Delta(1;\tilde{x})}{\partial\tilde{x}} + (1-\eta(\tilde{x})\beta\eta(\tilde{x}))\frac{\partial\Delta(0;\tilde{x})}{\partial\tilde{x}}.$$

Since $g(\cdot)$ has the monotone likelihood ratio property, $\eta(\tilde{x})$ is increasing in $\tilde{x}$. Now observe that $\mu^*(1,0;\tilde{x})$ is increasing in $\tilde{x}$ and $\mu^*(0,0;\tilde{x})$ is decreasing in $\tilde{x}$, which means that $\Delta(0)$ is increasing in $\tilde{x}$. Moreover, $\mu^*(1,1;\tilde{x})$ is increasing in $\tilde{x}$ so $\Delta(1)$ is increasing in $\tilde{x}$. Further, by definition of posterior beliefs we have $\Delta(1;\tilde{x}) \geq \Delta(0;\tilde{x})$ so this expression is increasing in $\tilde{x}$. Hence by the intermediate value theorem there is a unique $\tilde{x}^*$ solving Equation 1 such that the incompetent politician plays $a = 1$ when $x^0 > \tilde{x}^*$ and plays $a = 0$ when $x^0 \leq \tilde{x}^*$. ∎

**Corollary A.1** *The equilibrium cutoff $\tilde{x}^*$ is increasing in $\beta$.*

**Proof of Corollary A.1:** Using the definition of the cutoff $\tilde{x}^*$, define the function $I(\tilde{x})$ as

$$I(\tilde{x}) := 2\eta(\tilde{x}) - 1 + (1-\beta)\eta(\tilde{x})\Delta(1;\tilde{x}) + (1-\eta(\tilde{x})+\beta\eta(\tilde{x}))\Delta(0;\tilde{x}),$$

and note that the equilibrium cutoff is defined by the value $\tilde{x}^*$ such that $I(\tilde{x}^*) = 0$. Further observe that, by definition of the existence of the equilibrium cutoff, $\frac{\partial I(\tilde{x})}{\partial\tilde{x}} > 0$. By the implicit function theorem,

$$\frac{d\tilde{x}^*}{d\beta} = -\frac{\partial I(\tilde{x})/\partial\beta}{\partial I(\tilde{x})\ \partial\tilde{x}}.$$

Partially differentiating with respect to $\beta$ yields

$$\frac{\partial I(\tilde{x})}{\partial \beta} = -\eta(\tilde{x})\Big(\Delta(1;\tilde{x}) - \Delta(0;\tilde{x})\Big) + (1-\eta(\tilde{x})+\beta\eta(\tilde{x}))\frac{\partial \Delta(0;\tilde{x})}{\partial \beta}.$$

Now observe that

$$\frac{\partial \mu^*(1,0;\tilde{x})}{\partial \beta} = -\frac{\tau\pi(1-\tau)(1-\pi)(1-G(\tilde{x};0))}{(\tau\pi+\beta(1-\pi)(1-\tau)(1-G(\tilde{x};0))+\pi(1-\tau)(1-G(\tilde{x};1)))^2} < 0,$$

and

$$\frac{\partial \mu^*(0,0;\tilde{x})}{\partial \beta} = \frac{\tau\pi(1-\pi)(1-\tau)G(\tilde{x};1)}{(\beta(1-\pi)(\tau+(1-\tau)G(\tilde{x};0)+\pi(1-\tau)G(\tilde{x};1))^2} > 0.$$

Therefore $\frac{\partial \Delta(0)}{\partial \beta} < 0$. Hence $\frac{\partial I(\tilde{x})}{\partial \beta} < 0$ so by the implicit function theorem, $\frac{d\tilde{x}^*}{d\beta} > 0$. ■

**Lemma A.2** *Given an equilibrium cutoff $\tilde{x}^*$, there exists an optimal $\beta^* \in [0,1]$.*

**Proof of Lemma A.2:** The special interest group's objective function is

$$\max_{\beta\in[0,1]} \; 1-\tau\pi-(1-\tau)\pi(1-G(\tilde{x}^*(\beta);1))-(1-\tau)(1-\pi)(1-G(\tilde{x}^*(\beta);0))-c(\beta).$$

Differentiating with respect to $\beta$ yields the first-order condition

$$(1-\tau)\pi g(\tilde{x}^*(\beta);1)\frac{d\tilde{x}^*}{d\beta} + (1-\tau)(1-\pi)g(\tilde{x}^*(\beta);0)\frac{d\tilde{x}^*}{d\beta} - c'(\beta) = 0.$$

Since the objective function is continuous and $\beta$ is maximized along a compact interval, it must have both a maximum and a minimum. It is clear that the first-order condition must have at least one solution, as rearranging gives

$$(1-\tau)\frac{d\tilde{x}^*}{d\beta}\Big(\pi g(\tilde{x}^*;1)+(1-\pi)g(\tilde{x}^*;0)\Big) = c'(\beta),$$

but this solution may characterize either a maximum or a minimum. A maximum is characterized whenever the second-order condition is negative at the solution to the above first-order condition. The second order condition is

$$\begin{aligned} SOC &= (1-\tau)\pi g(\tilde{x}^*;1)\frac{d^2\tilde{x}^*}{d\beta^2} + (1-\tau)\pi g'(\tilde{x}^*;1)(\frac{d\tilde{x}^*}{d\beta})^2 + (1-\tau)(1-\pi)g(\tilde{x}^*;0)\frac{d^2\tilde{x}^*}{d\beta^2} \\ &+ (1-\tau)(1-\pi)g'(\tilde{x}^*;0)(\frac{d\tilde{x}^*}{d\beta})^2 - c''(\beta). \\ &= (1-\tau)(\frac{d\tilde{x}^*}{d\beta})^2(\pi g'(\tilde{x}^*;1)+(1-\pi)g'(\tilde{x}^*;0)) + \frac{d^2\tilde{x}^*}{d\beta^2}(\frac{d\tilde{x}^*}{d\beta})^{-1}c'(\beta) - c''(\beta), \end{aligned}$$

where the simplification follows from substituting from the first-order condition that $\pi g(\tilde{x}^*;1) + (1-\pi)g(\tilde{x}^*;0) = \frac{c'(\beta)}{1-\tau}(\frac{d\tilde{x}^*}{d\beta})^{-1}$.

The second-order condition is not readily globally concave: the sign of the first term depends on the value of $\tilde{x}^*$ by log-concavity of $g(\cdot)$, the second term depends on the sign of $\frac{d^2\tilde{x}^*}{d\beta^2}$, and the third term is negative. But note that if the second-order condition fails at the critical point, the maximum of the objective function must be on the corner. Further, from the first-order condition, observe that if $c'(\beta) \to 0$, the LHS is strictly positive and so the optimal solution is a corner solution at $\beta^* = 1$. If $c'(\beta)$ is relatively large, the LHS is strictly negative and the optimal solution is a corner solution at $\beta^* = 0$. ■

**Proof of Proposition 1:** Immediate from Lemmas A.1 and A.2. ■

**Domestic Politics: Results**

This section proves Results 1 and 2.

Recall from the main text that the probability of climate action is written as

$$A(\tilde{x}^*) = \tau\pi + (1-\tau)\pi(1 - G(\tilde{x}^*; 1)) + (1-\tau)(1-\pi)(1 - G(\tilde{x}^*; 0)).$$

**Proof of Result 1:** Differentiating with respect to $\beta$ yields

$$\frac{dA(\tilde{x}^*)}{d\beta} = -(1-\tau)\pi g(\tilde{x}^*; 1)\frac{d\tilde{x}^*}{d\beta} - (1-\tau)(1-\pi)g(\tilde{x}^*; 0)\frac{d\tilde{x}^*}{d\beta} < 0.$$

■

Before proving Result 2, I prove a result about the cutoff $\tilde{x}^*$.

**Lemma A.3** *The following are true about the incompetent politician's equilibrium cutoff:*

1. $\lim_{\pi \to 0} \tilde{x}^* = \infty$.
2. $\lim_{\pi \to 1} \tilde{x}^* = -\infty$.

**Proof of Lemma A.3:**

1. It is immediate that when $\pi \to 0$, we have $\eta(x) \to 0$ for any $x$. Then

$$\lim_{\pi \to 0} I(\tilde{x}) = -1 + \lim_{\pi \to 0} \Delta(0; \tilde{x}),$$

where the second term is less than 1 given the definition of the posterior beliefs induced by any $\tilde{x}$. Hence $\lim_{\pi \to 0} I(\tilde{x}) < 0$, which means it is never optimal for the incompetent politician to choose $a = 1$, meaning $\tilde{x}^* \to \infty$.

2. It is immediate that when $\pi \to 1$, we have $\eta(x) \to 1$ for any $x$. Then

$$\lim_{\pi \to 1} I(\tilde{x}) = 1 + (1-\beta)\Delta(1; \tilde{x}) + \beta\Delta(0; \tilde{x}),$$

where the first two terms are positive and the third term is at most -1 given the definition of the posterior beliefs induced by any $\tilde{x}$. Hence $\lim_{\pi \to 1} I(\tilde{x}) > 0$, which means it is always optimal for the incompetent politician to choose $a = 1$, meaning $\tilde{x}^* \to -\infty$.

■

**Proof of Result 2:** Define the function $I_\beta(\beta)$ as

$$I_\beta(\beta) := (1-\tau)\pi g(\tilde{x}^*(\beta);1)\frac{d\tilde{x}^*}{d\beta} + (1-\tau)(1-\pi)g(\tilde{x}^*(\beta);0)\frac{d\tilde{x}^*}{d\beta} - c'(\beta) = 0.$$

Observe that, by Lemma A.3, at $\pi = 0$ and $\pi = 1$, $I_\beta < 0$ for any $\beta > 0$ and $I_\beta = 0$ for $\beta = 0$ so it is optimal for the special interest group to be truthful, $\beta^* = 0$. Further by Rolle's theorem there must be a $\hat{\pi} \in (0,1)$ where $\frac{\partial I_\beta(\beta)}{\partial\pi} = 0$, meaning that $\beta^*$ is nonmonotonic in $\pi$.

Partially differentiating yields

$$\begin{aligned}
\frac{\partial I_\beta(\beta)}{\partial\pi} &= (1-\tau)\Big[g(\tilde{x}^*;1)\frac{d\tilde{x}^*}{d\beta} + \pi g'(\tilde{x}^*;1)\frac{d\tilde{x}^*}{d\pi}\frac{d\tilde{x}^*}{d\beta} + \pi g(\tilde{x}^*;1)\frac{d^2\tilde{x}^*}{d\beta d\pi} \\
&\quad - g(\tilde{x}^*;0)\frac{d\tilde{x}^*}{d\beta} + (1-\pi)g'(\tilde{x}^*;0)\frac{d\tilde{x}^*}{d\pi}\frac{d\tilde{x}^*}{d\beta} + (1-\pi)g(\tilde{x}^*;0)\frac{d^2\tilde{x}^*}{d\beta d\pi}\Big]. \\
\Leftrightarrow \frac{\partial I_\beta(\beta)}{\partial\pi} &= (1-\tau)\Bigg[\Big(g(\tilde{x}^*;1) - g(\tilde{x}^*;0)\Big)\frac{d\tilde{x}^*}{d\beta} + \Big(\pi g'(\tilde{x}^*;1) + (1-\pi)g'(\tilde{x}^*;0)\Big)\frac{d\tilde{x}^*}{d\pi}\frac{d\tilde{x}^*}{d\beta} \\
&\quad + \Big(\pi g(\tilde{x}^*;1) + (1-\pi)g(\tilde{x}^*;0)\Big)\frac{d^2\tilde{x}^*}{d\beta d\pi}\Bigg].
\end{aligned}$$

Observe that at $\pi = 0$ and $\pi = 1$, $\frac{\partial I_\beta(\beta)}{\partial\pi} = 0$, implying that such points are extrema, and we know that $\beta^* = 0$ in these cases. But because $\beta \in [0,1]$, these must be minima. Then the point $\hat{\pi}$ which is defined by Rolle's theorem must be an interior maximum such that $\beta^*$ is increasing when $\pi < \hat{\pi}$ and decreasing when $\pi > \hat{\pi}$. Such a $\hat{\pi}$ is characterized by $\frac{\partial I_\beta(\beta)}{d\pi} = 0$ and $\frac{\partial^2 I_\beta(\beta)}{d\pi^2} \leq 0$. ■

**Corollary A.2** *The equilibrium signal cutoff $\tilde{x}^*$ is decreasing in $\pi$.*

**Proof of Corollary A.2:** By the implicit function theorem,

$$\frac{d\tilde{x}^*}{d\pi} = -\frac{\partial I(\tilde{x})/\partial\pi}{\partial I(\tilde{x})\ \partial\tilde{x}}.$$

Partially differentiating with respect to $\pi$ yields

$$\frac{\partial I(\tilde{x})}{\partial\pi} = 2\frac{\partial\eta(\tilde{x})}{\partial\pi} + (1-\beta)\frac{\partial\eta(\tilde{x})}{\partial\pi}\Big(\Delta(1;\tilde{x}) - \Delta(0;\tilde{x})\Big) + (1 - \eta(\tilde{x}) + \beta\eta(\tilde{x}))\frac{\partial\Delta(0;\tilde{x})}{\partial\pi}.$$

Now, $\frac{\partial\eta(\tilde{x})}{\partial\pi} = \frac{g(\tilde{x};1)g(\tilde{x};0)}{((1-\pi)G(\tilde{x};0)-\pi G(\tilde{x};1))^2} > 0$, $\frac{\partial\mu^*(1,0;\tilde{x})}{\partial\pi} = \frac{\beta\tau(1-\tau)(1-G(\tilde{x};0))}{(-\pi+\beta(-1+\pi+\tau-\tau\pi)+(1-\tau)(\beta(1-\pi)G(\tilde{x};0)+\pi G(\tilde{x};1)))^2} > 0$ and $\frac{\partial\mu^*(0,0;\tilde{x})}{\partial\pi} = -\frac{\tau\beta(1-\tau)G(\tilde{x};1)}{(\beta(1-\pi)(\tau+(1-\tau)G(\tilde{x};0))+\pi(1-\tau)G(\tilde{x};1))^2} < 0$. Then $\frac{\partial\Delta(0)}{\partial\pi} > 0$ and $\frac{\partial I(\tilde{x})}{\partial\pi} > 0$ so by the implicit function theorem, $\frac{d\tilde{x}^*}{d\pi} < 0$. ■

**Extension: Pro-Climate Interest Group**

Suppose that instead of a special interest group biased against climate action, the group that disseminates information to the voter is in favor of ambitious climate policies. Specifically, the group designs a signal $s \in \{0, 1\}$ according to the experiment

$$\mathcal{E}(s = 0, \omega = 0) = 1 - \gamma. \quad \mathcal{E}(s = 1, \omega = 0) = \gamma.$$
$$\mathcal{E}(s = 0, \omega = 1) = 0. \quad \mathcal{E}(s = 1, \omega = 1) = 1.$$

The interest group therefore chooses the parameter $\gamma \in [0, 1]$. All of the analysis remains as before. I characterize the equilibrium of the climate policy subgame and show that the special interest's optimal choice of $\gamma$ exists, as in the main text for an anti-climate interest group.

**Lemma A.4** *A unique cutoff $\tilde{x}^*$ exists, admitting a unique perfect Bayesian equilibrium to the climate policy subgame with a pro-climate interest group. A politician of type $\theta$ chooses policy $a = 1$ given signal $x^\theta$ with probability $\sigma^*(\theta, x^\theta) \in [0, 1]$. These probabilities are*

$$\sigma^*(1, x^1) = x^1 = \omega.$$
$$\sigma^*(0, x^0) = 1 - G(\tilde{x}^*; \omega).$$

*Upon observing policy $a$ and signal $s$, the voter reelects the politician with probability $F(\mu^*(a, s; \tilde{x}^*))$.*

**Proof of Lemma A.4:** The voter observes $(a, s)$ and retains the politician when $\mu(a, s) \geq \varepsilon$, occurring with probability $F(\mu(a, s))$.

The competent politician always follows her signal. If $x^1 = 1$, playing $a = 1$ is optimal:

$$1 + F(\mu(1, 1)) \geq F(\mu(0, 1)) \;\Leftrightarrow\; 1 \geq -\Delta(1).$$

Similarly, if $x^1 = 0$, the competent politician chooses $a = 0$:

$$\gamma F(\mu(1, 1)) + (1 - \gamma)F(\mu(1, 0)) \leq 1 + \gamma F(\mu(0, 1)) + (1 - \gamma)F(\mu(0, 0)) \;\Leftrightarrow\; \gamma\Delta(1) + (1 - \gamma)\Delta(0) \leq 1.$$

Given the signal $x^0 = x$, the incompetent type chooses $a = 1$ iff

$$\begin{aligned} \eta(x) + {}&\gamma(1 - \eta(x))F(\mu(1, 1)) + (1 - \gamma)(1 - \eta(x))F(\mu(1, 0)) + \eta(x)F(\mu(1, 1) \geq \\ &(1 - \eta(x)) + \gamma(1 - \eta(x))F(\mu(0, 1)) + (1 - \gamma)(1 - \eta(x))F(\mu(0, 0)) + \eta(x)F(\mu(0, 1)) \\ \Leftrightarrow\;& 2\eta(x) - 1 + (\gamma - \gamma\eta(x) + \eta(x))\Delta(1) + (1 - \gamma)(1 - \eta(x))\Delta(0) \geq 0. \end{aligned}$$

Let $\tilde{x}$ be the value of $x$ that solves this at equality. The posterior beliefs induced by these strategies are

$$\mu(1, 0) = 0.$$
$$\mu(1, 1) = \frac{\tau\pi\frac{\gamma}{1-\gamma}}{\pi\frac{\gamma}{1-\gamma}(\tau + (1 - \tau)(1 - G(\tilde{x}; 1))) + (1 - \pi)(1 - G(\tilde{x}; 0))}.$$
$$\mu(0, 0) = \frac{\tau}{\tau + (1 - \tau)G(\tilde{x}; 0)}.$$

$$\mu(0,1) = \frac{\tau(1-\pi)}{(1-\pi)(\tau + (1-\tau)G(\tilde{x};0)) + (1-\tau)\pi\frac{\gamma}{1-\gamma}G(\tilde{x};1)}.$$

Differentiating the incompetent type's constraint with respect to $x$ yields

$$2 - \frac{\partial\eta(x)}{\partial x}(1-\gamma)(\Delta(1)+\Delta(0)) + (\gamma(1-\eta(x))+\eta(x))\frac{\partial\Delta(1)}{\partial x} + (1-\eta(x))(1-\gamma)\frac{\partial\Delta(0)}{\partial x}.$$

Since $\mu(0,0)$ is decreasing in $\tilde{x}$, $\Delta(0)$ is increasing in $\tilde{x}$. Similarly, $\mu(1,1)$ is increasing in $\tilde{x}$ and $\mu(0,1)$ is decreasing in $\tilde{x}$. Hence by the intermediate value theorem there is a $\tilde{x}^*$ such that the incompetent type plays $a=1$ iff $x^0 \geq \tilde{x}^*$. ■

**Corollary A.3** *The equilibrium signal cutoff $\tilde{x}$ is decreasing in $\gamma$ in the model with a pro-climate interest group.*

**Proof of Corollary A.3:** Define the function

$$I_\gamma(\tilde{x}) := 2\eta(\tilde{x}) - 1 + (\gamma - \gamma\eta(\tilde{x}) + \eta(\tilde{x}))\Delta(1;\tilde{x}) + (1-\gamma)(1-\eta(\tilde{x}))\Delta(0;\tilde{x}).$$

Clearly, $I_\gamma(\tilde{x})$ is increasing in $\tilde{x}$ and the point $\tilde{x}^*$ is defined by $I_\gamma(\tilde{x}^*)=0$. By the implicit function theorem,

$$\frac{d\tilde{x}^*}{d\gamma} = -\frac{\partial I_\gamma(\tilde{x})/\partial\gamma}{\partial I_\gamma(\tilde{x})/\partial\tilde{x}}.$$

Differentiating with respect to $\gamma$ yields

$$\frac{\partial I_\gamma(\tilde{x})}{\partial\gamma} = (1-\eta(\tilde{x}))(\Delta(1;\tilde{x}) - \Delta(0;\tilde{x})) + (\gamma - \gamma\eta(\tilde{x}) + \eta(\tilde{x}))\frac{\partial\Delta(1;\tilde{x})}{\partial\gamma}.$$

Now, $\mu(1,1)$ is increasing in $\gamma$ and $\mu(1,0)$ is decreasing in $\gamma$ so $\frac{\partial\Delta(1;\tilde{x})}{\partial\gamma} > 0$. Hence $\frac{\partial I_\gamma(\tilde{x})}{\partial\gamma} > 0$ so by the implicit function theorem $\frac{d\tilde{x}^*}{d\gamma} < 0$. ■

**Lemma A.5** *Given equilibrium behavior in the climate policy subgame with a pro-climate interest group, there exists an optimal $\gamma^* \in [0,1]$.*

**Proof of Lemma A.5:** The special interest then chooses $\gamma$ to maximize the probability of climate action, given by the objective function

$$\max_{\gamma\in[0,1]} \tau\pi + (1-\tau)\pi(1-G(\tilde{x}^*(\gamma);1)) + (1-\tau)(1-\pi)(1-G(\tilde{x}^*(\gamma);0)) - c(\gamma).$$

Differentiating with respect to $\gamma$ yields the (rearranged) first-order condition

$$-(1-\tau)\pi g(\tilde{x}^*;1)\frac{d\tilde{x}^*}{d\gamma} - (1-\tau)(1-\pi)g(\tilde{x}^*;0)\frac{d\tilde{x}^*}{d\gamma} = c'(\gamma)$$

and second-order condition

$$-(1-\tau)\frac{d^2\tilde{x}^*}{d\gamma^2}\Big(\pi g(\tilde{x}^*;1) + (1-\pi)g(\tilde{x}^*;0)\Big) - (1-\tau)(\frac{d\tilde{x}^*}{d\gamma})^2\Big(\pi g'(\tilde{x}^*;1) + (1-\pi)g'(\tilde{x}^*;0)\Big) - c''(\gamma),$$

with characterization analogous to the proof in Lemma A.2. ■

**Extension: Politician and Interest Group Signal**

In the main model, the politician is unable to condition her strategy on the signal $s$ sent by the interest group. I now relax that assumption. This means that the politician's strategy is now a function of her type $\theta$, her private signal $x^\theta$, as well as the public signal $s$.

It is straightforward to observe that the interest group's signal has no effect on the competent type: since she knows $\omega$ perfectly already, there is no incentive to deviate from her equilibrium strategy as posited in the main text. Hence, $\sigma^*(1, x^1, s) = x^1 = \omega$.

Now consider the incompetent type. Define $\rho(x^0, s; \beta) = P(\omega = 1|x^0, s; \beta)$ to be the incompetent type's posterior belief that $\omega = 1$ given her private signal $x^0$ and the realization of the interest group's message $s$ given $\beta$. Since $s = 1$ is a truthful message, $\rho(x^0, 1) = 1$ for any value of $x^0$. Hence in the subgame following $s = 1$, the incompetent type chooses $a = 1$ iff

$$1 + F(\mu(1, 1)) \geq F(\mu(0, 1)),$$

which is always satisfied, so $\sigma^*(0, x^0, 1) = 1$. Hence following $s = 1$, there is a pooling equilibrium on $a = 1$. Off path, $\mu(0, 1) = 0$ as it is the incompetent type who would possibly deviate.

Following $s = 0$, the incompetent type does not know if the special interest is truthful reporting $\omega = 0$ or if with some probability $\beta$ it misreported. Her posterior belief is $\rho(x^0, 0; \beta) = \frac{g(x^0;1)\beta\pi}{g(x^0;1)\beta\pi + g(x^0;0)(1-\pi)}$. Then the incompetent type's problem is to choose $a = 1$ whenever

$$\rho(x^0, 0; \beta) + F(\mu(1, 0)) \geq (1 - \rho(x^0, 0; \beta)) + F(\mu(0, 0)) \;\Leftrightarrow\; 2\rho(x^0, 0; \beta) - 1 + \Delta(0) \geq 0.$$

It is clear that $\mu(1, 0) = 0$ but $\mu(0, 0)$ is decreasing in the probability that the incompetent type takes action (analogous to proof of Lemma A.1). Then there is a cutoff $\tilde{x}^*$ such that the incompetent type plays $a = 1$ iff $x^0 \geq \tilde{x}^*$. Hence $\sigma^*(0, x^0, 0) = 1 - G(\tilde{x}^*; \omega)$.

Now observe that $\frac{\partial \rho(x^0,0;\beta)}{\partial \beta} = \frac{\pi(1-\pi)g(x^0;1)g(x^0;0)}{(g(x^0;1)\pi\beta + g(x^0;0)(1-\pi))^2} > 0$ for any $\beta$ and any signal $x^0$, as the politician rationally discounts the special interest group's signal as reporting is more likely to be biased. Moreover, $\frac{\partial \mu(0,0)}{\partial \beta} > 0$ from Corollary A.1. The result that $\frac{d\tilde{x}^*}{d\beta} > 0$ holds if $\frac{\partial \rho(x^0,0;\beta)}{\partial \beta} < \frac{\partial \mu(0,0)}{\partial \beta}$, or the voter's posterior belief about the politician's competence is more responsive to special interest reporting than the incompetent politician's posterior belief about the state of the world. Such a condition is both theoretically plausible within the context of the model as the politician has more information at her disposal than the voter does. Additionally, the incompetent politician, in seeking to be reelected, would prefer that the voter has a higher assessment of her competence.

## Proofs of International Cooperation Model

### International Cooperation: Equilibrium

I prove Proposition 2 in a series of lemmas. To prove equilibrium existence in the subgame, I proceed in several steps. First I assume that competent types are willing to follow their signal, $a_i = x_i^1$ to prove that incompetent types have equilibrium strategies that are cutoffs: incompetent types play $a_i$ iff their signal $x_i^0$ exceeds some cutoff $k_i$, holding fixed the behavior in country $j$ and the beliefs of voter $i$ (Lemma A.7). I then characterize the conditions needed for competent types to follow their signal in equilibrium, namely when $\tau_i$ is greater than some threshold $\overline{\tau}_i$ (Lemma A.8). I make this assumption for the rest of the analysis (Assumption A.1). I then endogenize the behavior of politician $j$ into incompetent politician $i$'s cutoff to show that there are cutoffs that are mutual best responses (Lemma A.9). Finally, I endogenize voter $i$'s posterior beliefs as a function of the cutoff strategies (Lemma A.10). I then state existence of the optimal misreporting levels in Lemmas A.12 and A.13.

Recall that $\hat{\sigma}_i(\theta_i, \omega)$ is voter $i$'s belief about the probability that politician $i$ chooses $a_i = 1$ when she is of type $\theta$ and the state of the world is $\omega$. Define $B(\theta_i, a_i, s_i, a_j)$ as proportional to the *ex ante* probability that a politician $i$ of type $\theta$ chooses action $a_i$ and signal $s_i$ is realized by the special interest group in country $i$ and politician $j$ chooses action $a_j$.

$$B(\theta_i, 1, s_i, a_j) = P(\theta_i)\Big(\pi\hat{\sigma}_i(\theta_i, 1)P(a_j|\omega = 1) + (1-\pi)\hat{\sigma}_i(\theta_i, 0)\frac{P(s_i|s_i \neq \omega)}{P(s_i|s_i = \omega)}P(a_j|\omega = 0)\Big).$$

$$B(\theta_i, 0, s_i, a_j) = P(\theta_i)\Big(\pi(1-\hat{\sigma}_i(\theta_i, 1))P(a_j|\omega = 1) + (1-\pi)(1-\hat{\sigma}_i(\theta_i, 0))\frac{P(s_i|s_i \neq \omega)}{P(s_i|s_i = \omega)}P(a_j|\omega = 0)\Big).$$

Upon observing politician $i$'s policy $a_i$, the special interest's signal in country $i$ $s_i$, and politician $j$'s policy $a_j$, voter $i$ has a posterior belief about politician $i$'s competence $\mu_i(a_i, s_i, a_j) = P(\theta_i = 1|a_i, s_i, a_j)$,

$$\mu_i(a_i, s_i, a_j) = \frac{P(a_i, s_i, a_j|\theta_i = 1)P(\theta_i = 1)}{P(a_i, s_i, a_j|\theta_i = 1)P(\theta_i = 1) + P(a_i, s_i, a_j|\theta_i = 0)P(\theta_i = 0)} = \frac{B(1, a_i, s_i, a_j)}{B(1, a_i, s_i, a_j) + B(0, a_i, s_i, a_j)}.$$

**Lemma A.6** *The following statements are true regarding the ordering of voter i's posterior beliefs:*

- $\mu_i(1, 1, a_j) \geq \mu_i(0, 1, a_j) \;\Leftrightarrow\; \hat{\sigma}_i(1, 1) \geq \hat{\sigma}_i(0, 1)$.
- $\mu_i(1, 0, 1) \geq \mu_i(0, 0, 1) \;\Leftrightarrow\; \frac{\beta_i}{1-\beta_i}\frac{\pi}{1-\pi} \geq \frac{\tau_j\hat{\sigma}_j(1,1)+(1-\tau_j)\hat{\sigma}_j(0,1)}{\tau_j\hat{\sigma}_j(1,0)+(1-\tau_j)\hat{\sigma}_j(0,0)}\frac{\hat{\sigma}_i(0,1)-\hat{\sigma}_i(1,1)}{\hat{\sigma}_i(1,0)-\hat{\sigma}_i(0,0)}$.
- $\mu_i(1, 0, 0) \geq \mu_i(0, 0, 0) \;\Leftrightarrow\; \frac{\beta_i}{1-\beta_i}\frac{\pi}{1-\pi} \geq \frac{\tau_j(1-\hat{\sigma}_j(1,1))+(1-\tau_j)(1-\hat{\sigma}_j(0,1))}{\tau_j(1-\hat{\sigma}_j(1,0))+(1-\tau_j)(1-\hat{\sigma}_j(0,0))}\frac{\hat{\sigma}_i(0,1)-\hat{\sigma}_i(1,1)}{\hat{\sigma}_i(1,0)-\hat{\sigma}_i(0,0)}$.
- $\mu_i(1, 0, 1) \geq \mu_i(1, 0, 0) \;\Leftrightarrow\; \frac{\hat{\sigma}_i(1,1)}{\hat{\sigma}_i(0,1)} \geq \frac{\hat{\sigma}_i(1,0)}{\hat{\sigma}_i(0,0)}$.
- $\mu_i(1, 1, a_j) \geq \mu_i(1, 0, a_j) \;\Leftrightarrow\; \frac{\hat{\sigma}_i(1,1)}{\hat{\sigma}_i(0,1)} \geq \frac{\hat{\sigma}_i(1,0)}{\hat{\sigma}_i(0,0)}$.
- $\mu_i(0, 1, a_j) \geq \mu_i(0, 0, a_j) \;\Leftrightarrow\; \frac{1-\hat{\sigma}_i(1,1)}{1-\hat{\sigma}_i(0,1)} \geq \frac{1-\hat{\sigma}_i(1,0)}{1-\hat{\sigma}_i(0,0)}$.
- $\mu_i(0, 1, 1) \geq \mu_i(0, 1, 0) \;\Leftrightarrow\; \frac{\hat{\sigma}_i(1,1)}{\hat{\sigma}_i(0,1)} \geq \frac{\hat{\sigma}_i(1,0)}{\hat{\sigma}_i(0,0)}$.

- $\mu_i(0,0,1) \geq \mu_i(0,0,0) \;\Leftrightarrow\; \frac{1-\hat{\sigma}_i(1,1)}{1-\hat{\sigma}_i(0,1)} \geq \frac{1-\hat{\sigma}_i(1,0)}{1-\hat{\sigma}_i(0,0)}$.
- $\mu_i(a_i,1,1) = \mu_i(a_i,1,0)$.

**Proof of Lemma A.6:** Straightforward from definition of posterior beliefs. ■

Write $\Delta_i(s_i,a_j) = F(\mu_i(1,s_i,a_j)) - F(\mu_i(0,s_i,a_j))$ as the difference in politician $i$'s reelection probabilities from playing $a_i = 1$ and $a_i = 0$ when interest group $i$ generates signal $s_i$ and politician $j$ plays $a_j$.

**Corollary A.4** *Suppose competent politicians follow their signal, $\hat{\sigma}_i(1,1) = 1$ and $\hat{\sigma}_i(1,0) = 0$. The following statements are true:*

- $\Delta_i(1,a_j) \geq 0$.
- $\Delta_i(1,a_j) \geq \Delta_i(0,a_j)$.
- $\Delta_i(s_i,1) \geq \Delta_i(s_i,0)$.

**Proof of Corollary A.4:** Immediate from Lemma A.6 and the definition of $\Delta_i(s_i,a_j)$. ■

Define the set of domestic fundamentals, which is the set of country-specific electoral returns in the climate policy subgame, as $\Lambda_i = \Big(\Delta_i(1,1),\ \Delta_i(1,0),\ \Delta_i(0,1),\ \Delta_i(0,0)\Big)$.

**Lemma A.7** *Fix $\Lambda_i$ and assume that competent politicians follow their signal. Politician $i$'s best response is in cutoff strategies: there exists a cutoff $k_i$ such that the incompetent politician chooses $a_i = 1$ iff $x_i^0 \geq k_i$.*

**Proof of Lemma A.7:** Let $y_j = P(a_j = 1|x_i)$ be the probability that politician $j$ chooses $a_j = 1$ given what politician $i$ knows about the state of the world from her realized signal $x_i^0 = x_i$. Then, $y_j = \tau_j\eta(x_i) + (1-\tau_j)\eta(x_i)\hat{\sigma}_j(0,1) + (1-\tau_j)(1-\eta(x_i))\hat{\sigma}_j(0,0)$. Observe that $y_j$ is increasing in $\eta(x_i)$ (and hence in $x_i$ by the monotone likelihood ratio property): $\frac{\partial y_j}{\partial \eta(x_i)} = \tau_j + (1-\tau_j)(\hat{\sigma}_j(0,1) - \hat{\sigma}_j(0,0)) \geq 0$, which follows from monotonicity of strategies in the state of the world.

Given $\Lambda_i$, the incompetent politician plays $a_i = 1$ following signal $x_i$ iff

$$
\begin{aligned}
&\eta(x_i)\bigg[y_j\Big[1+\beta_i F(\mu_i(1,0,1)) + (1-\beta_i)F(\mu_i(1,1,1)\Big] + (1-y_j)\Big[\beta_i F(\mu_i(1,0,0)) + (1-\beta_i)F(\mu_i(1,1,0))\Big]\bigg] \\
&\qquad + (1-\eta(x_i))\bigg[y_j\Big[1+F(\mu_i(1,0,1))\Big] + (1-y_j)F(\mu_i(1,0,0))\bigg] \geq \\
&\eta(x_i)\bigg[y_j\Big[\beta_i F(\mu_i(0,0,1)) + (1-\beta_i)F(\mu_i(0,1,1))\Big] + (1-y_j)\Big[1+\beta_i F(\mu_i(0,0,0)) + (1-\beta_i)F(\mu_i(0,1,0))\Big]\bigg] \\
&\qquad + (1-\eta(x_i))\bigg[y_j F(\mu_i(0,0,1)) + (1-y_j)\Big[1+F(\mu_i(0,0,0))\Big]\bigg]. \\
&\Leftrightarrow\; 2y_j - 1 + (1-\eta(x_i)+\eta(x_i)\beta_i)\Big(y_j\Delta_i(0,1) + (1-y_j)\Delta_i(0,0)\Big) + \eta(x_i)(1-\beta_i)\Big(y_j\Delta_i(1,1) + (1-y_j)\Delta_i(1,0)\Big) \geq 0.
\end{aligned}
\tag{2}
$$

Differentiating with respect to $\eta(x_i)$ yields

$$2\frac{\partial y_j}{\partial \eta(x_i)}+(1-\beta_i)\Big(y_j\Delta_i(1,1)-y_j\Delta_i(0,1)+(1-y_j)\Delta_i(1,0)-(1-y_j)\Delta_i(0,0)\Big)+(1-\eta(x_i)+\eta(x_i)\beta_i)\frac{\partial y_j}{\partial \eta(x_i)}\Big(\Delta_i(0,1)-\Delta_i(0,0)\Big)>0.$$

Hence, incompetent politician $i$'s net gain from playing $a_i = 1$ is increasing in $x_i$ such that by the intermediate value theorem she adopts a cutoff strategy and plays $a_i = 1$ iff $x_i^0 \geq k_i$. ■

**Lemma A.8** *Assume $\tau_j \geq \overline{\tau}_j$. The competent politician $i$ always follows her signal.*

**Proof of Lemma A.8:** Proof is analogous for politician $j$. Let $y_{j\omega} = P(a_j = 1|\omega)$ be the competent politician's updated beliefs about politician $j$'s behavior given that she knows the state of the world perfectly.

Suppose a competent politician $i$ observes $x_i = 1$. She plays $a_i = 1$ iff

$$\begin{aligned} y_{j1}\Big[1+\beta_i F(\mu_i(1,0,1)) + (1-\beta_i)F(\mu_i(1,1,1))\Big] + (1-y_{j1})\Big[\beta_i F(\mu_i(1,0,0)) + (1-\beta_i)F(\mu_i(1,1,0))\Big] \geq \\ y_{j1}\Big[\beta_i F(\mu_i(0,0,1)) + (1-\beta_i)F(\mu_i(0,1,1))] + (1-y_{j1})\Big[\beta_i F(\mu_i(0,0,0)) + (1-\beta_i)F(\mu_i(0,1,0))\Big]. \\ \Leftrightarrow\ y_{j1} + \beta_i\Big(y_{j1}\Delta_i(0,1) + (1-y_{j1})\Delta_i(0,0)\Big) + (1-\beta_i)\Big(y_{j1}\Delta_i(1,1) + (1-y_{j1})\Delta_i(1,0)\Big) \geq 0. \end{aligned}$$

By following her signal, $\Delta_i(1,1) = \Delta_i(1,0)$ and $\Delta_i(0,1) \geq \Delta_i(0,0)$ by Corollary A.4; the inequality holds.

Similarly, suppose a competent politician $i$ observes $x_i = 0$. She plays $a_i = 0$ iff

$$\begin{aligned} y_{j0}F(\mu_i(0,0,1)) + (1-y_{j0})\Big[1 + F(\mu_i(0,0,0))\Big] \geq y_{j0}F(\mu_i(1,0,1)) + (1-y_{j0})F(\mu_i(1,0,0)) \\ \Leftrightarrow\ (1-y_{j0})(1-\Delta_i(0,0)) - y_{j0}\Delta_i(0,1) \geq 0. \end{aligned}$$

This inequality need not hold; by way of contradiction, suppose it doesn't hold. Then this means that the competent type plays $a_i = 1$ regardless of her signal. Therefore, $\mu_i(0, s_i, a_j) = 0$ because any $a_i = 0$ must be played by the incompetent type.

Consider the incentives for the incompetent type. Suppose the incompetent type receives signal $x_i^0 = x_i$ and has beliefs $y_j = P(a_j = 1|x_i)$. The incompetent type plays $a_i = 1$ iff Equation 2 is satisfied, which in this case reduces to

$$2y_j-1-F(0)+(\eta(x_i)\beta_i y_j+(1-\eta(x_i))y_j)F(\mu_i(1,0,1))+\eta(x_i)(1-\beta_i)F(\mu_i(1,1,1))+(\eta(x_i)\beta_i(1-y_j)+(1-\eta(x_i))(1-y_j))F(\mu_i(1,0,0)) \geq 0,$$

where the simplification comes from the fact that $\mu_i(0, s_i, a_j) = 0$ and that by Lemma A.6, $\mu_i(1,1,1) = \mu_i(1,1,0)$. In a pooling equilibrium, it would also be true that $\mu_i(1, s_i, a_j) = \tau_i$, meaning the voter would learn nothing about the competent politician's type from $a_i = 1$. Substituting this into the incompetent politician's incentive constraint yields

$$2y_j - 1 - F(0) + F(\tau_i) \geq 0,$$

however, by the intermediate value theorem, there are some values of $x_i$ where this constraint holds and some where it does not (because $y_j$ is increasing in $x_i$). Hence pooling on $a_i = 1$ is not always optimal: there exists a cutoff $\hat{x}_i$ such that the incompetent politician plays $a_i = 1$ iff $x_i \geq \hat{x}_i$ and $a_i = 0$ otherwise. Then we know that in such an equilibrium, $\sigma(1,1) = \sigma(1,0) = 1$,

$\sigma(0,1) = 1 - G(\hat{x}_i;1)$, and $\sigma(0,0) = 1 - G(\hat{x}_i;0)$. Further, by first-order stochastic dominance, $G(\hat{x}_i;0) \geq G(\hat{x}_i;1) \implies \sigma(0,1) \geq \sigma(0,0)$ so by Lemma A.6 we have $\mu_i(1,0,0;\hat{x}_i) \geq \mu_i(1,0,1;\hat{x}_i)$.

Returning the competent politician's constraint, recall that she plays $a_i = 1$ following $x_i^1 = 0$ iff

$$(1-y_{j0})(1-F(\mu_i(1,0,0;\hat{x}_i))) - y_{j0}F(\mu_i(1,0,1;\hat{x}_i)) + F(0) \leq 0.$$

Note that if $x_i \geq \hat{x}_i$, then the incompetent politician is pooling, so $\mu_i(1,0,0;\hat{x}_i) = \mu_i(1,0,1;\hat{x}_i) = \tau_i$. But if $x_i \leq \hat{x}_i$, there is separation between the competent and the incompetent types, so posterior beliefs are bounded below by $\tau_i$, $\mu_i(1,0,0;\hat{x}_i) \geq \mu_i(1,0,1;\hat{x}_i) \geq \tau_i$. Clearly this is hardest to satisfy at the lower bound, yielding

$$1 - y_{j0} - F(\tau_i) + F(0) \leq 0.$$

Since the LHS is increasing in $\tau_j$ and the RHS is constant, there is a value $\overline{\tau}_j$ such that when $\tau_j \leq \overline{\tau}_j$ the constraint is satisfied, but that contradicts the hypothesis that $\tau_j \geq \overline{\tau}_j$. ■

To continue with the analysis, maintain the following assumption such that Lemma A.8 holds.

**Assumption A.1** *Both politicians are sufficiently likely to be competent: $\tau_i \geq \overline{\tau}_i$ and $\tau_j \geq \overline{\tau}_j$.*

Now we endogenize the behavior of politician $j$ into politician $i$'s best response (and vice versa).

**Lemma A.9** *Fix $\Lambda_i$. There exist cutoffs $(\tilde{x}_i, \tilde{x}_j)$ that are mutual best responses.*

**Proof of Lemma A.9:** By Lemma A.7, the incompetent politician in both countries has a well-defined cutoff $k_i$ such that $i$ plays $a_i = 1$ iff $x_i^0 \geq k_i$ holding fixed the strategy of politician $j$. Since politician $j$ is playing a cutoff strategy, we know that $y_j = \tau_j\eta(x_i) + (1-\tau_j)\eta(x_i)(1-G(k_j;1)) + (1-\tau_j)(1-\eta(x_i))(1-G(k_j;0))$ given that $x_i^0 = x_i$. Observe that $\frac{\partial y_j}{\partial k_j} = -(1-\tau_j)\Big(\eta(x_i)g(k_j;1) + (1-\eta(x_i))g(k_j;0)\Big) < 0$.

Define $\hat{I}(k_i,k_j;\Lambda_i)$ as the incompetent politician $i$'s indifference condition between playing $a_i = 1$ and $a_i = 0$ that endogenizes the cutoff of the incompetent politician $j$:

$$\begin{aligned}\hat{I}(k_i,k_j;\Lambda_i) :&= 2y_j(k_i,k_j) - 1 + (1-\eta(k_i)+\eta(k_i)\beta_i)\Big(y_j(k_i,k_j)\Delta_i(0,1) + (1-y_j(k_i,k_j))\Delta_i(0,0)\Big) \\ &\quad + \eta(k_i)(1-\beta_i)\Big(y_j(k_i,k_j)\Delta_i(1,1) + (1-y_j(k_i,k_j))\Delta_i(1,0)\Big).\end{aligned}$$

Hence, the cutoffs $(\tilde{x}_i, \tilde{x}_j)$ therefore solve the system

$$\hat{I}(\tilde{x}_i,\tilde{x}_j;\Lambda_i) = 0 \quad \text{and} \quad \hat{I}(\tilde{x}_j,\tilde{x}_i;\Lambda_j) = 0.$$

To show the system has a unique solution, I use the implicit function theorem. The Jacobian matrix is

$$\mathbf{J} = \begin{bmatrix} \frac{\partial \hat{I}(k_i,k_j;\Lambda_i)}{\partial k_i} & \frac{\partial \hat{I}(k_i,k_j;\Lambda_i)}{\partial k_j} \\ \frac{\partial \hat{I}(k_j,k_i;\Lambda_j)}{\partial k_i} & \frac{\partial \hat{I}(k_j,k_i;\Lambda_j)}{\partial k_j} \end{bmatrix}.$$

Differentiating $\hat{I}(k_i,k_j;\Lambda_i)$ with respect to $k_j$ yields

$$\frac{\partial \hat{I}(k_i,k_j;\Lambda_i)}{\partial k_j} = 2\frac{\partial y_j}{\partial k_j} + (1-\eta(k_i)+\eta(k_i)\beta_i)\frac{\partial y_j}{\partial k_j}\Big(\Delta_i(0,1)-\Delta_i(0,0)\Big) + \eta(k_i)(1-\beta_i)\frac{\partial y_j}{\partial k_j}\Big(\Delta_i(1,1)-\Delta_i(1,0)\Big) < 0.$$

Since the determinant $|\mathbf{J}| = \frac{\partial \hat{I}(k_i,k_j;\Lambda_i)}{\partial k_i}\frac{\partial \hat{I}(k_j,k_i;\Lambda_j)}{\partial k_j} - \frac{\partial \hat{I}(k_i,k_j;\Lambda_i)}{\partial k_j}\frac{\partial \hat{I}(k_j,k_i;\Lambda_j)}{\partial k_i} > 0$, the system has a unique solution at the cutoffs $(\tilde{x}_i, \tilde{x}_j)$ are well-defined. ■

Now we need to endogenize voter $i$'s beliefs by writing $\Delta_i(s_i, a_j)$ as a function of equilibrium strategies. By Lemma A.9, there exists a pair of cutoffs $(\tilde{x}_i, \tilde{x}_j)$ such that incompetent politician $i$ plays $a_i = 1$ iff $x_i^0 \geq \tilde{x}_i$ (same for incompetent politician $j$), and that competent politicians always follow their signals. Moreover, given $\tilde{x}_j$, we can write $\tilde{y}_{j1} = P(a_j = 1|\omega = 1, \tilde{x}_j) = \tau_j + (1-\tau_j)(1-G(\tilde{x}_j;1))$ and $\tilde{y}_{j0} = P(a_j = 1|\omega = 0, \tilde{x}_j) = (1-\tau_j)(1-G(\tilde{x}_j;0))$. This induces the following posterior beliefs for voter $i$:

$$\mu_i(1,0,1;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i \pi \tilde{y}_{j1}}{\pi \tilde{y}_{j1}(\tau_i + (1-\tau_i)(1-G(\tilde{x}_i;1))) + (1-\tau_i)(1-\pi)\frac{\beta_i}{1-\beta_i}(1-G(\tilde{x}_i;0))\tilde{y}_{j0}}.$$

$$\mu_i(1,1,1;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i}{\tau_i + (1-\tau_i)(1-G(\tilde{x}_i;1))}.$$

$$\mu_i(1,0,0;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i \pi (1-\tilde{y}_{j1})}{\pi(1-\tilde{y}_{j1})(\tau_i + (1-\tau_i)(1-G(\tilde{x}_i;1))) + (1-\tau_i)(1-\pi)\frac{\beta_i}{1-\beta_i}(1-G(\tilde{x}_i;0))(1-\tilde{y}_{j0})}.$$

$$\mu_i(1,1,0;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i}{\tau_i + (1-\tau_i)(1-G(\tilde{x}_i;1))}.$$

$$\mu_i(0,0,1;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i(1-\pi)\frac{\beta_i}{1-\beta_i}\tilde{y}_{j0}}{(1-\pi)\frac{\beta_i}{1-\beta_i}\tilde{y}_{j0}(\tau_i + (1-\tau_i)G(\tilde{x}_i;0)) + (1-\tau_i)\pi G(\tilde{x}_i;1)\tilde{y}_{j1}}.$$

$$\mu_i(0,1,1;\tilde{x}_i,\tilde{x}_j) = 0.$$

$$\mu_i(0,0,0;\tilde{x}_i,\tilde{x}_j) = \frac{\tau_i(1-\pi)\frac{\beta_i}{1-\beta_i}(1-\tilde{y}_{j0})}{(1-\pi)\frac{\beta_i}{1-\beta_i}(1-\tilde{y}_{j0})(\tau_i + (1-\tau_i)G(\tilde{x}_i;0)) + (1-\tau_i)\pi G(\tilde{x}_i;1)(1-\tilde{y}_{j1})}.$$

$$\mu_i(0,1,0;\tilde{x}_i,\tilde{x}_j) = 0.$$

The following table summarizes the sign of the derivative of voter $i$'s posterior beliefs with respect to the cutoffs $\tilde{x}_i$ and $\tilde{x}_j$.

| $\mu_i(a_i, s_i, a_j; \tilde{x}_i, \tilde{x}_j)$ | $\frac{\partial \mu_i(a_i,s_i,a_j;\tilde{x}_i,\tilde{x}_j)}{\partial \tilde{x}_i}$ | $\frac{\partial \mu_i(a_i,s_i,a_j;\tilde{x}_i,\tilde{x}_j)}{\partial \tilde{x}_j}$ |
|---|---|---|
| $\mu_i(1,1,1)$ | + | 0 |
| $\mu_i(1,1,0)$ | + | 0 |
| $\mu_i(1,0,1)$ | + | + |
| $\mu_i(1,0,0)$ | + | - |
| $\mu_i(0,1,1)$ | 0 | 0 |
| $\mu_i(0,1,0)$ | 0 | 0 |
| $\mu_i(0,0,1)$ | - | + |
| $\mu_i(0,0,0)$ | - | - |

Table A.1

Signing derivatives with respect to $\tilde{x}_i$ follow analogously from the proof of Lemma A.1. Derivatives with respect to $\tilde{x}_j$ can be signed because the monotone likelihood ratio property implies hazard rate ordering. From Table A.1, it is evident that all $\Delta(s_i, a_j)$ are increasing in $\tilde{x}_i$.

**Lemma A.10** *There exist cutoffs $(\tilde{x}_i^*, \tilde{x}_j^*)$ that are mutual best responses.*

**Proof of Lemma A.10:** Define $\hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)$ as the incompetent politician $i$'s indifference condition that endogenizes both the cutoff of the incompetent politician $j$ $\tilde{x}_j$ and the electoral returns in country $i$ $\Lambda_i$ given equilibrium strategies defined by such cutoffs:

$$\hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i) = 2y(\tilde{x}_i, \tilde{x}_j)-1+(1-\eta(\tilde{x}_i)+\eta(\tilde{x}_i)\beta_i)\Big(y(\tilde{x}_i, \tilde{x}_j)\Delta_i(0,1;\tilde{x}_i, \tilde{x}_j)+(1-y(\tilde{x}_i, \tilde{x}_j))\Delta_i(0,0;\tilde{x}_i, \tilde{x}_j)\Big)+\eta(\tilde{x}_i)(1-\beta_i)\Delta_i(1,0;\tilde{x}_i, \tilde{x}_j). \tag{3}$$

Differentiating with respect to $\tilde{x}_i$ yields

$$\frac{\partial \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)}{\partial \tilde{x}_i} = \frac{\partial \hat{I}(\tilde{x}_i; \tilde{x}_j, \Lambda_i)}{\partial \tilde{x}_i}+(1-\eta(\tilde{x}_i)-\eta(\tilde{x}_i)\beta_i)(y(\tilde{x}_i, \tilde{x}_j)\frac{\partial \Delta_i(0,1)}{\partial \tilde{x}_i}+(1-y(\tilde{x}_i, \tilde{x}_j))\frac{\partial \Delta_i(0,0)}{\partial \tilde{x}_i})+\eta(\tilde{x}_i)(1-\beta_i)\frac{\partial \Delta_i(1,0)}{\partial \tilde{x}_i} > 0.$$

Hence endogenizing voter $i$'s beliefs preserves optimality of the cutoff strategy for incompetent politician $i$.

Finally, differentiating with respect to $\tilde{x}_j$ yields

$$\frac{\partial \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)}{\partial \tilde{x}_j} = \frac{\partial \hat{I}(\tilde{x}_i, \tilde{x}_j; \Lambda_i)}{\partial \tilde{x}_j}+(1-\eta(\tilde{x}_i)-\eta(\tilde{x}_i)\beta_i)(y(\tilde{x}_i, \tilde{x}_j)\frac{\partial \Delta_i(0,1)}{\partial \tilde{x}_j}+(1-y(\tilde{x}_i, \tilde{x}_j))\frac{\partial \Delta_i(0,0)}{\partial \tilde{x}_j}) < 0.$$

Therefore, there exist cutoffs $(\tilde{x}_i^*, \tilde{x}_j^*)$ solving the system

$$\hat{I}^*(\tilde{x}_i^*, \tilde{x}_j^* \Lambda_i(\tilde{x}_i^*, \tilde{x}_j^*)) = 0 \text{ and } \hat{I}^*(\tilde{x}_j^*, \tilde{x}_i^*, \Lambda_j(\tilde{x}_j^*, \tilde{x}_i^*)) = 0.$$

Analogous to Lemma A.9, the solution to the system is unique by the implicit function theorem by constructing the Jacobian matrix $\mathbf{J}$ and demonstrating that $|\mathbf{J}| > 0$. ■

**Lemma A.11** *A unique pair of cutoffs $(\tilde{x}_i^*, \tilde{x}_j^*)$ exists, admitting a unique perfect Bayesian equilibrium to the international climate policy subgame. A politician of type $\theta$ in country $i$ chooses policy $a_i = 1$ given signal $x_i^\theta$ with probability $\sigma^*(\theta_i, x_i^\theta) \in [0,1]$. These probabilities are*

$$\sigma^*(1, x_i^1) = x_i^1 = \omega.$$
$$\sigma^*(0, x_i^0) = 1 - G(\tilde{x}_i^*; \omega).$$

*Upon observing policies $a_i$ and $a_j$ and signal $s_i$, the voter in country $i$ reelects the politician with probability $F(\mu_i^*(a_i, s_i, a_j; \tilde{x}_i^*, \tilde{x}_j^*))$.*

**Proof Lemma A.11:** Following any history in which politician $i$ chooses policy $a_i$, voter $i$ observes signal $s_i$, and politician $j$ chooses policy $a_j$, the voter has posterior belief $P(\theta_i = 1|a_i, s_i, a_j) = \mu(a_i, s_i, a_j)$ as defined above, and reelects politician $i$ iff $\mu(a_i, s_i, a_j) \geq \varepsilon_i$, which occurs with probability $F(\mu(a_i, s_i, a_j))$.

By Lemma A.8, the competent politician always follows her signal. By Lemma A.10, the incompetent politician plays a cutoff strategy such that she plays $a_i = 1$ iff $x_i^0 \geq \tilde{x}_i^*$, where $\tilde{x}_i^*$ exists and is a best response to both politician $j$'s behavior and voter $i$'s posterior beliefs. ■

**Corollary A.5** *Politician $i$'s cutoff $\tilde{x}_i^*$ is increasing in $\beta_i$.*

**Proof of Corollary A.5:** By the implicit function theorem,

$$\frac{d\tilde{x}_i^*}{d\beta_i} = -\frac{\begin{bmatrix} \frac{\partial \hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i)}{\partial \beta_i} & \frac{\partial \hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i)}{\partial k_j} \\ \frac{\partial \hat{I}^*(\tilde{x}_j,\tilde{x}_i,\Lambda_j)}{\partial \beta_i} & \frac{\partial \hat{I}^*(\tilde{x}_j,\tilde{x}_i,\Lambda_j)}{\partial k_j} \end{bmatrix}}{|\mathbf{J}|}.$$

It is clear that $\frac{\partial \hat{I}^*(\tilde{x}_j,\tilde{x}_i,\Lambda_j)}{\partial \beta_i} = 0$. Now differentiate $\hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i)$ with respect to $\beta_i$ to get

$$\frac{\partial \hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i)}{\partial \beta_i} = \eta(\tilde{x}_i)(y\Delta_i(0,1)+(1-y)\Delta_i(0,0)-\Delta_i(1,0))+(1-\eta(\tilde{x}_i)+\eta(\tilde{x}_i)\beta_i)(y\frac{\partial \Delta_i(0,1)}{\partial \beta_i}+(1-y)\frac{\partial \Delta_i(0,0)}{\partial \beta_i}).$$

Now, $\mu_i(1,0,1;\tilde{x}_i,\tilde{x}_j)$ is decreasing in $\beta_i$ and $\mu_i(0,0,1;\tilde{x}_i,\tilde{x}_j)$ is increasing in $\beta_i$ so $\Delta_i(0,1)$ is decreasing in $\beta_i$. Similarly, $\mu_i(1,0,0;\tilde{x}_i,\tilde{x}_j)$ is decreasing in $\beta_i$ and $\mu_i(0,0,0;\tilde{x}_i,\tilde{x}_j)$ is increasing in $\beta_i$ so $\Delta_i(0,0)$ is also decreasing in $\beta_i$. Hence $\frac{\partial \hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i)}{\partial \beta_i} < 0$ so the determinant of the matrix in the numerator is negative; by the implicit function theorem, $\frac{d\tilde{x}_i^*}{d\beta_i} > 0$. ■

**Lemma A.12** *Fix $\beta_j$. Given equilibrium behavior in the international coordination game, special interest i's best response $\hat{\beta}_i(\beta_j) \in [0,1]$ exists.*

**Proof of Lemma A.12:** Fix $\beta_j$ (the proof is analogous for special interest $j$ fixing $\beta_i$). Since $\beta_j$ is a parameter, this proof is identical to Lemma A.2 albeit that the incompetent politician's cutoff is $\tilde{x}_i^*$ and not $\tilde{x}^*$ (although these cutoffs have the same relevant properties).

Special interest $i$ has the objective function

$$\max_{\beta_i \in [0,1]} 1 - A_i\Big(\tilde{x}_i^*(\beta_i,\beta_j)\Big) - c(\beta_i).$$

Differentiating with respect to $\beta_i$ yields the first-order condition

$$-\frac{dA_i}{d\beta_i} - c'(\beta_i) = 0,$$

and second-order condition

$$SOC = -\frac{d^2 A_i}{d\beta_i^2} - c''(\beta_i),$$

where $\frac{d^2 A_i}{d\beta_i^2} = -(1-\tau_i)\frac{d^2\tilde{x}_i^*}{d\beta_i^2}\Big(\pi g(\tilde{x}_i^*(\beta_i,\beta_j);1)+(1-\pi)g(\tilde{x}_i^*(\beta_i,\beta_j);0)\Big)-(1-\tau_i)(\frac{d\tilde{x}_i^*}{d\beta_i})^2\Big(\pi g'(\tilde{x}_i^*(\beta_i,\beta_j);1)+(1-\pi)g'(\tilde{x}_i^*(\beta_i,\beta_j);0)\Big)$. Similar to the argument made in the proof of Lemma A.2, a solution $\hat{\beta}_i(\beta_j)$ exists, either as the solution to the first-order condition or on the corner. ■

**Lemma A.13** *Given equilibrium behavior in the international climate policy subgame, there exists an optimal pair $(\beta_i^*,\beta_j^*) \in [0,1]^2$.*

**Proof of Lemma A.13:** Since each interest group's best response is well-defined as shown in Lemma A.12, we now endogenize the behavior of the other interest group. Define the function

$Z(\beta_i, \beta_j)$ as (analogous for group $j$):

$$Z(\beta_i, \beta_j) := (1-\tau_i)\frac{d\tilde{x}_i^*}{d\beta_i}\Big(\pi g(\tilde{x}_i^*(\beta_i, \beta_j); 1) + (1-\pi)g(\tilde{x}_i^*(\beta_i, \beta_j); 0)\Big) - c'(\beta_i),$$

where $\hat{\beta}_i(\beta_j)$ is the solution to $Z(\hat{\beta}_i, \beta_j) = 0$ for a fixed $\beta_j$, and $\frac{\partial Z(\hat{\beta}_i, \beta_j)}{\partial \beta_i} < 0$, by definition of $\hat{\beta}_i(\beta_j)$ being utility maximizing. The equilibrium levels of misreporting $(\beta_i^*, \beta_j^*)$ are defined as the solution to the system

$$Z(\beta_i^*, \beta_j^*) = 0 \text{ and } Z(\beta_j^*, \beta_i^*) = 0.$$

To show that this system has a unique solution, define the Jacobian matrix as

$$\mathbf{J} = \begin{bmatrix} \frac{\partial Z(\beta_i^*, \beta_j^*)}{\partial \beta_i} & \frac{\partial Z(\beta_i^*, \beta_j^*)}{\partial \beta_j} \\ \frac{\partial Z(\beta_j^*, \beta_i^*)}{\partial \beta_i} & \frac{\partial Z(\beta_j^*, \beta_i^*)}{\partial \beta_j} \end{bmatrix}.$$

We know that $\frac{\partial Z(\beta_i^*, \beta_j^*)}{\partial \beta_i} < 0$ and $\frac{\partial Z(\beta_j^*, \beta_i^*)}{\partial \beta_j} < 0$. Differentiating with respect to $\beta_j$ yields

$$\begin{aligned}\frac{\partial Z(\beta_i, \beta_j)}{\partial \beta_j} &= (1-\tau_i)\frac{d^2\tilde{x}_i^*}{d\beta_i d\beta_j}\Big(\pi g(\tilde{x}_i^*(\beta_i, \beta_j); 1) + (1-\pi)g(\tilde{x}_i^*(\beta_i, \beta_j); 0)\Big) \\ &+ (1-\tau_i)\frac{d\tilde{x}_i^*}{d\beta_i}\frac{d\tilde{x}_i^*}{d\beta_j}\Big(\pi g'(\tilde{x}_i^*(\beta_i, \beta_j); 1) + (1-\pi)g'(\tilde{x}_i^*(\beta_i, \beta_j); 0)\Big).\end{aligned}$$

While $\frac{\partial Z(\beta_i, \beta_j)}{\partial \beta_j}$ is not readily signed, observe that by symmetry, $sgn\frac{\partial Z(\beta_i, \beta_j)}{\partial \beta_j} = sgn\frac{\partial Z(\beta_j, \beta_i)}{\partial \beta_i}$. Then it is apparent that $|\mathbf{J}| \neq 0$, and hence nonsingular, so a solution to the system exists. ■

**Proof of Proposition 2:** Immediate from Lemmas A.11 and A.13. ■

**International Cooperation: Results**

This section proves Results 3, 4, 5, 6, and 7.

**Proof of Result 3:** Immediate from Lemma A.10 and the implicit function theorem,

$$\frac{d\tilde{x}_i^*}{d\tilde{x}_j} = -\frac{\partial \hat{I}^*(k_i, \tilde{x}_j, \Lambda_i)/\partial \tilde{x}_j}{\partial \hat{I}^*(k_i; \tilde{x}_j, \Lambda_i)/\partial k_i} > 0.$$

■

**Proof of Result 4:** By the implicit function theorem,

$$\frac{d\tilde{x}_j^*}{d\beta_i} = -\frac{\begin{bmatrix} \frac{\partial \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)}{\partial \tilde{x}_i} & \frac{\partial \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)}{\partial \beta_i} \\ \frac{\partial \hat{I}^*(\tilde{x}_j, \tilde{x}_i, \Lambda_j)}{\partial \tilde{x}_i} & \frac{\partial \hat{I}^*(\tilde{x}_j, \tilde{x}_i, \Lambda_j)}{\partial \beta_i} \end{bmatrix}}{|\mathbf{J}|}.$$

It is clear that $\frac{\partial \hat{I}^*(\tilde{x}_j, \tilde{x}_i, \Lambda_j)}{\partial \beta_i} = 0$. From Corollary A.5, $\frac{\partial \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i)}{\partial \beta_i} < 0$ so the determinant of the matrix in the numerator is negative (as $\frac{\partial \hat{I}^*(\tilde{x}_j, \tilde{x}_i, \Lambda_j)}{\partial \tilde{x}_i} < 0$). Then $\frac{d\tilde{x}_j^*}{d\beta_i} > 0$. ■

**Proof of Result 5:** Country $i$'s ($j$ analogous) probability of climate action is

$$A_i(\tilde{x}_i^*) = \tau_i \pi + (1-\tau_i)\pi(1 - G(\tilde{x}_i^*; 1)) + (1-\tau_i)(1-\pi)(1 - G(\tilde{x}_i^*; 0)).$$

Differentiating with respect to $\beta_i$ yields

$$\begin{aligned}
\frac{dA_i}{d\beta_i} &= -(1-\tau_i)\frac{d\tilde{x}_i^*}{d\beta_i}\Big(\pi g(\tilde{x}_i^*; 1) + (1-\pi) g(\tilde{x}_i^*; 0)\Big) < 0. \\
\frac{dA_j}{d\beta_i} &= -(1-\tau_j)\frac{d\tilde{x}_j^*}{d\beta_i}\Big(\pi g(\tilde{x}_j^*; 1) + (1-\pi) g(\tilde{x}_j^*; 0)\Big) < 0.
\end{aligned}$$

Then, using the definitions of coordinated climate action, unilateral climate action, and coordinated climate inaction from the text, differentiating with respect to $\beta_i$ yields

$$\begin{aligned}
\text{coordinated climate action:} &\quad A_i \frac{dA_j}{d\beta_i} + \frac{dA_i}{d\beta_i} A_j < 0. \\
\text{unilateral climate action:} &\quad \frac{dA_i}{d\beta_i}(1-2A_j) + \frac{dA_j}{d\beta_i}(1-2A_i). \\
\text{coordinated climate inaction:} &\quad -(1-A_i)\frac{dA_j}{d\beta_i} - \frac{dA_i}{d\beta_i}(1-A_j) > 0.
\end{aligned}$$

A sufficient condition that unilateral climate action is increasing in $\beta_i$ is thus if $A_i > \frac{1}{2}$ and $A_j > \frac{1}{2}$.
■

Before proving Result 6, I prove a result about the cutoffs $\tilde{x}_i^*$ and $\tilde{x}_j^*$ (analogous to Lemma A.3).

**Lemma A.14** *The following are true about the incompetent politician i's equilibrium cutoff (analogous for j):*

1. $\lim_{\pi \to 0} \tilde{x}_i^* = \infty$.
2. $\lim_{\pi \to 1} \tilde{x}_i^* = -\infty$.

**Proof of Lemma A.14:**

1. It is immediate that when $\pi \to 0$, we have $\eta(x) \to 0$ for any $x$, which also implies that $y(\tilde{x}_i, \tilde{x}_j) = (1-\tau_j)(1 - G(\tilde{x}_j; 0))$. Then

   $$\lim_{\pi \to 0} \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i) = 2y(\tilde{x}_i, \tilde{x}_j) - 1 + y(\tilde{x}_i, \tilde{x}_j)\Delta_i(0, 1; \tilde{x}_i, \tilde{x}_j) + (1 - y(\tilde{x}_i, \tilde{x}_j))\Delta_i(0, 0; \tilde{x}_i, \tilde{x}_j).$$

   From the definition of the posterior beliefs induced by the cutoff, we know that $\Delta_i(0, 1; \tilde{x}_i, \tilde{x}_j) < 0$ and $\Delta_i(0, 0; \tilde{x}_i, \tilde{x}_j) < 0$. Hence $\lim_{\pi \to 0} \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i) < 0$, which means it is never optimal for the incompetent politician to choose $a = 1$, meaning $\tilde{x}_i^* \to \infty$.

2. It is immediate that when $\pi \to 1$, we have $\eta(x) \to 1$ for any $x$, which also implies that $y(\tilde{x}_i, \tilde{x}_j) = \tau_j + (1-\tau_j)(1 - G(\tilde{x}_j; 1))$. Then

   $$\lim_{\pi \to 1} \hat{I}^*(\tilde{x}_i, \tilde{x}_j, \Lambda_i) = 2y(\tilde{x}_i, \tilde{x}_j) - 1 + \beta_i y(\tilde{x}_i, \tilde{x}_j)\Delta_i(0, 1; \tilde{x}_i, \tilde{x}_j) + \beta_i(1 - y(\tilde{x}_i, \tilde{x}_j))\Delta_i(0, 0; \tilde{x}_i, \tilde{x}_j) + (1-\beta_i)\Delta_i(1, 0; \tilde{x}_i, \tilde{x}_j).$$

Now, given the posterior beliefs induced by the cutoffs, $\Delta_i(1,0;\tilde{x}_i,\tilde{x}_j)$ is constant in $\pi$, but $\Delta_i(0,1;\tilde{x}_i,\tilde{x}_j) > 0$ and $\Delta_i(0,0;\tilde{x}_i,\tilde{x}_j) > 0$. Hence $\lim_{\pi\to 1} \hat{I}^*(\tilde{x}_i,\tilde{x}_j,\Lambda_i) > 0$, which means it is always optimal for the incompetent politician to choose $a = 1$, meaning $\tilde{x}_i^* \to -\infty$.

■

**Proof of Result 6:** Recall that $(\beta_i^*, \beta_j^*)$ is the solution to the system of equations

$$Z(\beta_i,\beta_j) = (1-\tau_i)\frac{d\tilde{x}_i^*}{d\beta_i}\Big(\pi g(\tilde{x}_i^*(\beta_i,\beta_j);1) + (1-\pi)g(\tilde{x}_i^*(\beta_i,\beta_j);0)\Big) - c'(\beta_i) = 0.$$
$$Z(\beta_j,\beta_i) = (1-\tau_j)\frac{d\tilde{x}_j^*}{d\beta_j}\Big(\pi g(\tilde{x}_j^*(\beta_j,\beta_i);1) + (1-\pi)g(\tilde{x}_j^*(\beta_j,\beta_i);0)\Big) - c'(\beta_j) = 0.$$

Observe that, by Lemma A.14, at $\pi = 0$ and $\pi = 1$, $Z(\beta_i,\beta_j) < 0$ for any $\beta_i > 0$ and any $\beta_j$, and $Z(\beta_j,\beta_i) < 0$ for any $\beta_j > 0$ and any $\beta_i$. Furthermore, $Z(\beta_i,\beta_j) = 0$ for $\beta_i = 0$ and $Z(\beta_j,\beta_i) = 0$ for $\beta_j = 0$. Hence $(\beta_i^*,\beta_j^*) = (0,0)$ is an equilibrium.

Further by Rolle's theorem there must be a $\hat{\pi}_i \in (0,1)$ where $\frac{\partial Z_(\beta_i,\beta_j)}{\partial\pi} = 0$, and there must be a $\hat{\pi}_j \in (0,1)$ where $\frac{\partial Z_(\beta_j,\beta_i)}{\partial\pi} = 0$, meaning that $\beta_i^*$ and $\beta_j^*$ are nonmonotonic in $\pi$. Note that it need not be the case that $\hat{\pi}_i = \hat{\pi}_j$.

Consider $\beta_i^*$ (analogous for $\beta_j^*$). Partially differentiating yields

$$\begin{aligned}\frac{\partial Z(\beta_i,\beta_j)}{\partial\pi} = (1-\tau)\Big[& g(\tilde{x}_i^*;1)\frac{d\tilde{x}_i^*}{d\beta_i} + \pi g'(\tilde{x}_i^*;1)\frac{d\tilde{x}_i^*}{d\pi}\frac{d\tilde{x}_i^*}{d\beta} + \pi g(\tilde{x}_i^*;1)\frac{d^2\tilde{x}_i^*}{d\beta_i d\pi} \\ & - g(\tilde{x}_i^*;0)\frac{d\tilde{x}_i^*}{d\beta_i} + (1-\pi)g'(\tilde{x}_i^*;0)\frac{d\tilde{x}_i^*}{d\pi}\frac{d\tilde{x}_i^*}{d\beta_i} + (1-\pi)g(\tilde{x}_i^*;0)\frac{d^2\tilde{x}_i^*}{d\beta_i d\pi}\Big].\end{aligned}$$

Observe that at $\pi = 0$ and $\pi = 1$, $\frac{\partial Z(\beta_i,\beta_j)}{\partial\pi} = 0$, implying that such points are extrema, and we know that $\beta_i^* = 0$ in these cases. But because $\beta_i \in [0,1]$, these must be minima. Then the point $\hat{\pi}_i$ which is defined by Rolle's theorem must be an interior maximum such that $\beta_i^*$ is increasing when $\pi < \hat{\pi}_i$ and decreasing when $\pi > \hat{\pi}_i$. Such a $\hat{\pi}_i$ is characterized by $\frac{\partial Z(\beta_i,\beta_j)}{d\pi} = 0$ and $\frac{\partial^2 Z(\beta_i,\beta_j)}{d\pi^2} \leq 0$. ■

**Proof of Result 7:** Given the definitions from the main text of $A_i(\tilde{x}_i^*)$ and $R_i(\tilde{x}_i^*)$:

$$R_i(\tilde{x}_i^*) - A_i(\tilde{x}_i^*) = \tau_i(1-\pi) + (1-\tau_i)(1-\pi)(2G(\tilde{x}_i^*;0) - 1).$$

Differentiating with respect to $\beta_i$ and $\beta_j$ yields

$$\frac{d(R_i(\tilde{x}_i^*) - A_i(\tilde{x}_i^*))}{d\beta_i} = 2(1-\tau_i)(1-\pi)g(\tilde{x}_i^*;0)\frac{d\tilde{x}_i^*}{d\beta_i} > 0.$$
$$\frac{d(R_i(\tilde{x}_i^*) - A_i(\tilde{x}_i^*))}{d\beta_j} = 2(1-\tau_i)(1-\pi)g(\tilde{x}_i^*;0)\frac{d\tilde{x}_i^*}{d\tilde{x}_j^*}\frac{d\tilde{x}_j^*}{d\beta_i} > 0.$$

■

# B Additional Descriptive Figures

Figure A.1 demonstrates that the lion's share of these laws are related to climate mitigation. The growth of mitigation laws over time is notable, especially as nearly all NDCs under the Paris framework include mitigation measures. Moreover, as mitigation is nationally costly but provides global benefits, theories of collective action would predict a stagnation or underprovision of mitigation laws. Other laws aim to address adaptation, disaster risk management, and loss and damages. These policies, while much more difficult to measure, are also increasing in frequency as climate change's effects become more pronounced, especially in the Global South.

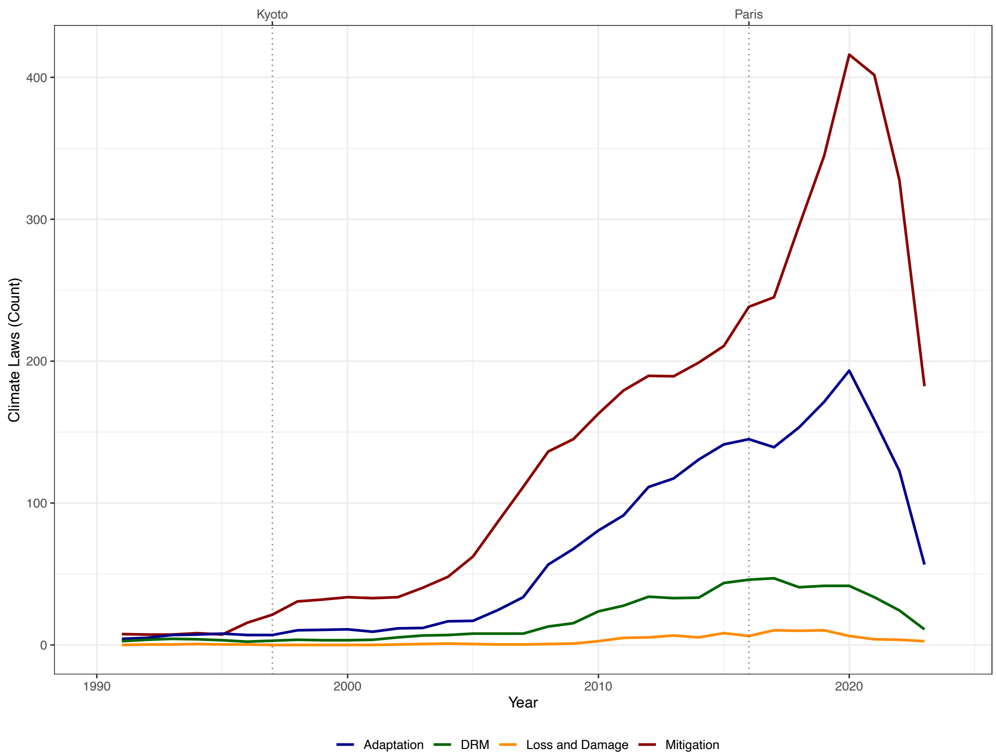


Figure A.1: Climate Laws by Type

Unsurprisingly, many of the laws enacted address reforms to the energy industry, as shown in Figure A.2 where laws are graphed by sector. The passage of these laws demonstrate how fossil fuel companies or other firms with "climate-forcing assets" (Colgan, Green and Hale 2021) have become increasingly at risk over time. While energy laws are consistently the most commonly passed climate law, there has been a spike in economy-wide initiatives in the 2020s; these laws intend to cut across sectors, representing large-scale societal investments like the Inflation Reduction Act in the United States or the European Union's European Green Deal.

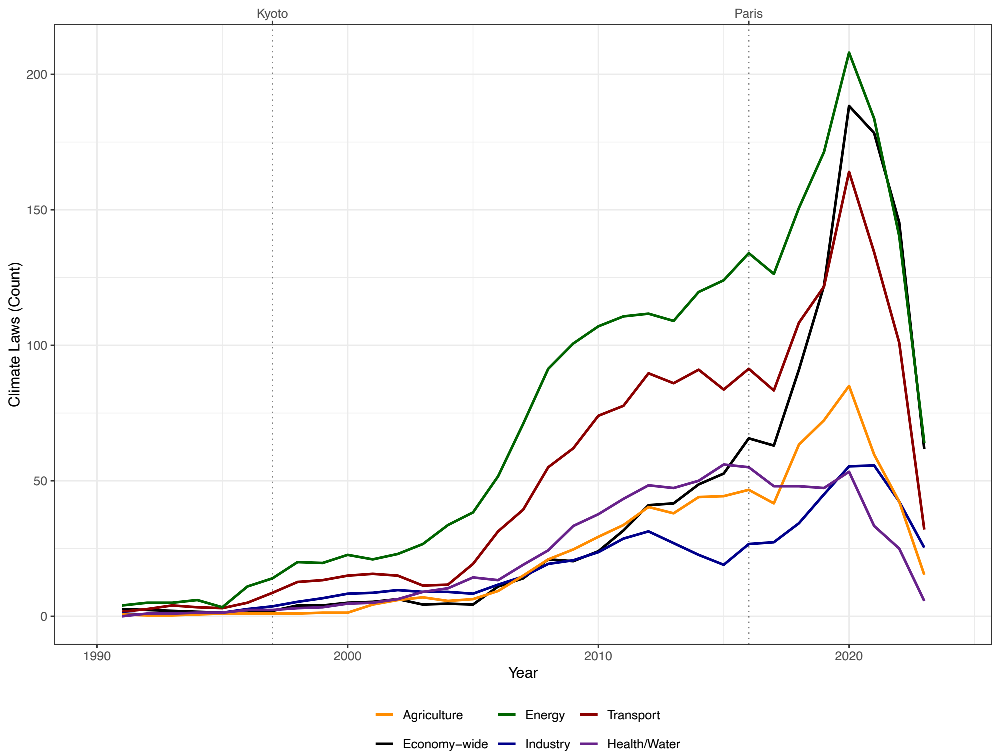


Figure A.2: Climate Laws by Sector

Figure A.3 of the figure examines the evolution of policy instruments used to address climate change. While initial efforts predominantly relied on command-and-control regulations, the early 2010s marked a shift toward the adoption of subsidies and incentives as central tools. Subsidies, in particular, play a pivotal role in fostering domestic industries to accelerate the green transition. Their increasing use is noteworthy, especially in light of the temptations to free-ride, as predicted by collective action theories, as these policy instruments aim to lessen the burden of costly abatement or adjustment. Also notable is the steady growth in laws that provided for climate change research, contributing to the accumulation of knowledge about the severity of global warming. These investments and the subsequent accumulation of knowledge have contributed to the scientific understanding which ultimately facilitates more climate policymaking and pushes back on the ability for special interests to misreport, as will be detailed in the theoretical argument.

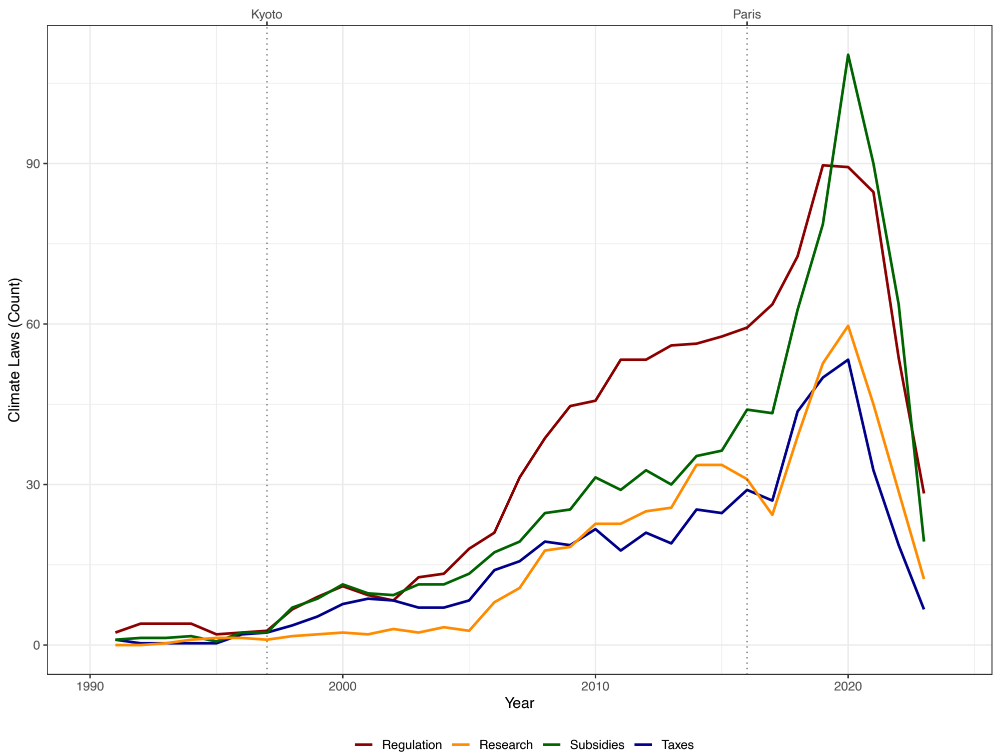


Figure A.3: Climate Laws by Policy Instrument

Figure A.4 displays the number of climate laws normalized by the number of adopting countries in each year. The increasing trend in law adoption over time is robust to this normalization.

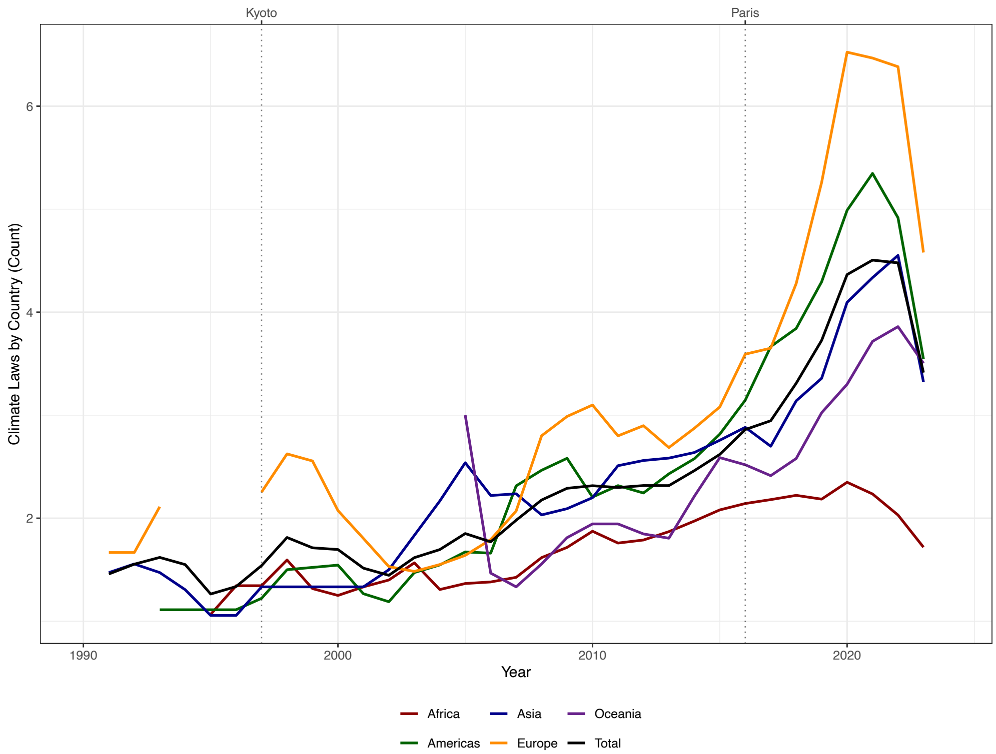


Figure A.4: Climate Laws Normalized by Country

Figure A.5 shows the correlation in the OECD Environmental Policy Stringency Index across countries. The figure shows that all cross-country correlations of environmental policy stringency are positive, and almost all of the are statistically distinguishable from zero (those that are not are in red). These positive correlations are meaningful because they suggest that increases in climate ambitions across countries are complementary, not substitutable, as theories based in free-riding would predict.

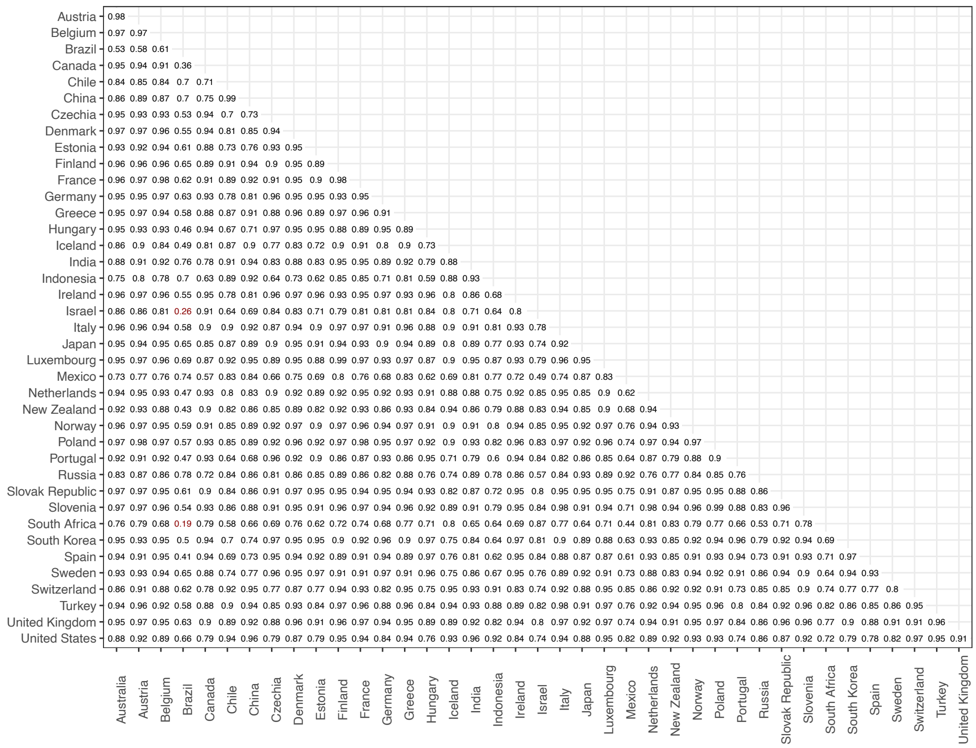


Figure A.5: Correlation Between Countries' Environmental Policy Stringency, 1990-2020

The Climate Actions and Policies Measurement Framework (CAPMF) by Nachtigall et al. (2024) presents an alternative approach to measuring policy stringency than the OECD's EPS. It is constructed similarly to the EPS, but relies on more policy instruments and also factors in international policy commitments. Rather than aggregate to a single index, the CAPMF aggregates up to the levels of sectoral policies, cross-sectoral policies, and international policies. Figure A.6 thus illustrates these measures for 49 countries between 1990 and 2022. Similar to the EPS in Figure 3, countries' policy stringencies are increasing over time.

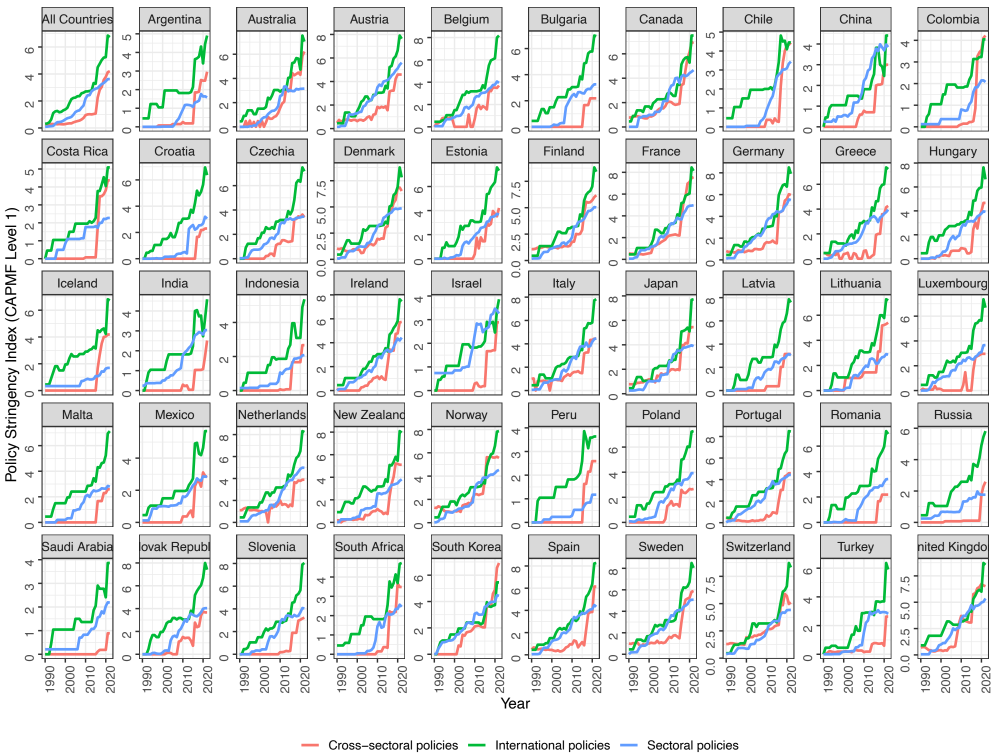


Figure A.6: Environmental Policy Stringency over Time using CAPMF

# C Exxon Source Documents

Exxon scientist James Black's 1978 memo notes the scientific consensus that the climate is affected by fossil fuels. Notably, he writes that "present thinking holds that man has a time window of five to ten years before the need for hard decisions regarding changes in energy strategies might become critical." The summary section of the memo is presented in Figure A.7. The entire document is available at https://climateintegrity.org/uploads/deception/1978-Exxon-BlackMemo.pdf.

THE GREENHOUSE EFFECT

J. F. Black, Products Research Division
Exxon Research and Engineering Co.

SUMMARY

The earth's atmosphere presently contains about 330 ppm of $CO_2$. This gas does not absorb an appreciable amount of the incoming solar energy but it can absorb and return part of the infrared radiation which the earth radiates toward space. $CO_2$, therefore, contributes to warming the lower atmosphere by what has been called the "Greenhouse Effect."

The $CO_2$ content of the atmosphere has been monitored since 1957 at two locations, the Mauna Loa Observatory, Hawaii and the South Pole. These and other shorter studies show that $CO_2$ is increasing. If the increase is attributed to the combustion of fossil fuels, it can be calculated that the $CO_2$ content of the atmosphere has already been raised by about 10 to 15% and that slightly more than half of the $CO_2$ released by fossil fuel combustion is remaining in the atmosphere. Assuming that the percentage of the $CO_2$ remaining in the atmosphere will stay at 53% as fossil fuel consumption increases, one recent study predicts that in 2075 A.D., $CO_2$ concentration will peak at a level about twice what could be considered normal. This prediction assumes that fossil fuel consumption will grow at a rate of 2% per year until 2025 A.D. after which it will follow a symetrical decrease. This growth curve is close to that predicted by Exxon's Corporate Planning Department.

Mathematical models for predicting the climatic effect of a $CO_2$ increase have not progressed to the point at which all the feedback interactions which can be important to the outcome can be included. What is considered the best presently available climate model for treating the Greenhouse Effect predicts that a doubling of the $CO_2$ concentration in the atmosphere would produce a mean temperature increase of about 2°C to 3°C over most of the earth. The model also predicts that the temperature increase near the poles may be two to three times this value.

The $CO_2$ increase measured to date is not capable of producing an effect large enough to be distinguished from normal climate variations. As an example of normal variations, studies of meteorological and historical records in England indicate that the mean temperature has varied over a range of about ±0.7°C in the past 1000 years. A study of past climates suggests that if the earth does become warmer, more rainfall should result. But an increase as large as 2°C would probably also affect the distribution of the rainfall. A possible result might be a shift of both the desert and the fertile areas of the globe toward higher latitudes. Some countries would benefit but others could have their agricultural output reduced or destroyed. The picture is too unclear to predict which countries might be affected favorably or unfavorably.

- 2 -

It seems likely that any general temperature increase would be accentuated in the polar regions, possibly as much as two- or three-fold as mentioned above. Any large temperature increase at high latitudes would be associated with a reduction in snow cover and a melting of the floating ice-pack. Present thinking suggests that there would be little or no melting of the polar ice-caps in response to warmer temperatures on a time scale over which the Greenhouse Effect is predicted to apply.

A number of assumptions and uncertainties are involved in the predictions of the Greenhouse Effect. The first is the assumption that the observed $CO_2$ increase can be attributed entirely to fossil fuel combustion. At present, meteorologists have no direct evidence that the incremental $CO_2$ in the atmosphere comes from fossil carbon. The increase could be at least partly due to changes in the natural balance. There is considerable uncertainty regarding what controls the exchange of atmospheric $CO_2$ with the oceans and with carbonaceous materials on the continents.

Models which predict the climatic effects of a $CO_2$ increase are in a primitive stage of development. The atmosphere is a very complicated system, particularly on a global scale. In existing models, important interactions are neglected, either because they are not completely understood or because their proper mathematical treatment is too cumbersome. Substantial efforts are being expended to improve existing models. But there is no guarantee that better knowledge will lessen rather than augment the severity of the predictions.

The Greenhouse Effect has been the subject of a number of international scientific conferences during the past two years. These meetings have identified the information needed to definitely establish the source and ultimate significance of the $CO_2$ increase in the atmosphere. Present thinking holds that man has a time window of five to ten years before the need for hard decisions regarding changes in energy strategies might become critical. The DOE is presently seeking Congressional support for a research program which will produce the necessary information in the required time. This program is described.

Figure A.7: James Black's Memo to Exxon Executives, 1978

Exxon scientist Roger Cohen's 1982 memo summarizes findings about Exxon's internal climate modeling. It documents the projected relationship between increased carbon dioxide in the atmosphere and changes in the Earth's climate. It further discusses the scientific consensus around this result. The first two pages of the memo are displayed in Figure A.8. The entire document is available at https://www.climatefiles.com/exxonmobil/1982-exxon-memo-summarizing-climate-modeling-and-co2-greenhouse-effect-research/.

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EXXON RESEARCH AND ENGINEERING COMPANY

CORPORATE RESEARCH
SCIENCE LABORATORIES

P. O. Box 45, Linden, N. J. 07036

DUANE G. LEVINE, Director

ROGER W.COHEN, Director
Theoretical and Mathematical Sciences Laboratory

September 2, 1982

H. N. WEINBERG
SEP 2 1982

Mr. A. M. Natkin
Office of Science and Technology
Exxon Corporation
1251 Avenue of the Americas
New York, New York 10020

Dear Al:

I would like to summarize the findings of our research in climate modeling and place our results in the context of the existing body of knowledge of the $CO_2$ greenhouse effect.

Although the increase of atmospheric $CO_2$ is well documented, it has not yet resulted in a measurable change in the earth's climate. The concerns surrounding the possible effects of increased $CO_2$ have been based on the predictions of models which simulate the earth's climate. These models vary widely in the level of detail in which climate processes are treated and in the approximations used to describe the complexities of these processes. Consequently the quantitative predictions derived from the various models show considerable variation. However, over the past several years a clear scientific consensus has emerged regarding the expected climatic effects of increased atmospheric $CO_2$. The consensus+ is that a doubling of atmospheric $CO_2$ from its pre-industrial revolution value would result in an average global temperature rise of $(3.0 \pm 1.5)^{\circ}C$. The uncertainty in this figure is a result of the inability of even the most elaborate models to simulate climate in a totally realistic manner. The temperature rise is predicted to be distributed nonuniformly over the earth, with above-average temperature elevations in the polar regions and relatively small increases near the equator. There is unanimous agreement in the scientific community that a temperature increase of this magnitude would bring about significant changes in the earth's climate, including rainfall distribution and alterations in the biosphere. The time

+National Research Council Panel Report, Carbon Dioxide and Climate: A Second Assessment, National Academy Press, Washington, D.C., 1982.

Mr. A. M. Natkin - 2 - August 25, 1982

required for doubling of atmospheric $CO_2$ depends on future world consumption of fossil fuels. Current projections indicate that doubling will occur sometime in the latter half of the 21st century. The models predict that $CO_2$-induced climate changes should be observable well before doubling. It is generally believed that the first unambiguous $CO_2$-induced temperature increase will not be observable until around the year 2000.

It should be emphasized that the consensus prediction of global warming is not unanimous. Several scientists have taken positions that openly question the validity of the predictions of the models, and a few have proposed mechanisms which could mitigate a $CO_2$ warming. One of the most serious of these proposals has been made by Professor Reginald Newell of MIT. Newell noted that geological evidence points to a relative constancy of the temperature of the equatorial waters over hundreds of millions of years. This constancy is remarkable in view of major climatic changes in other regions of the earth during this period. Newell ascribed this anchoring of the temperature of the equatorial waters to an evaporative buffering mechanism. In this mechanism, when heating increases at the equator, most of the extra energy induces greater rates of evaporation rather than raising temperatures. Newell proposed that this effect might greatly reduce the global warming effect of increased atmospheric $CO_2$.

In our climate research we have explored the global effects of Newell's evaporative buffering mechanism using a simple mathematical climate model. Our findings indicate that Newell's effect is indeed an important factor in the earth's climate system. As Newell predicted, evaporative buffering does limit $CO_2$-induced temperature changes in the equatorial regions. However, we find a compensatingly larger temperature increase in the polar regions, giving a global averaged temperature increase that falls well within the range of the scientific consensus. Our results are consistent with the published predictions of more complex climate models. They are also in agreement with estimates of the global temperature distribution during a certain prehistoric period when the earth was much warmer than today.

In summary, the results of our research are in accord with the scientific consensus on the effect of increased atmospheric $CO_2$ on climate. Our research appears to reconcile Newell's observations and proposed mechanism with the consensus opinion.

We are now ready to present our research to the scientific community through the usual mechanisms of conference presentations and publications in appropriate journals. I have enclosed a detailed plan for presenting our results.

Figure A.8: Roger Cohen's Memo on Exxon Climate Science, 1982

In 1996 and 1998, Exxon released pamphlets to the masses that sought to inject doubt into the public discourse about the validity of climate science and the subsequent need for policy action. Figure A.9 displays the introductory letter from Exxon Chairman Lee Raymond to the document "Global climate change: everyone's debate." The full document is available at https://www.climatefiles.com/exxonmobil/1998-exxon-pamphlet-global-climate-change-everyones-debate/. The pamphlet "Global warming: who's right?" admonishes readers not to "ignore the facts" about climate change and is available at https://climateintegrity.org/uploads/deception/1996-Exxon-Global-Warming-Whos-Right.pdf.

Exxon shares with people around the world the goal of protecting Earth's environment. We take seriously our responsibility to conduct our operations in an environmentally sound way. For that reason, for many years, we've carefully studied and worked to increase understanding of the issue of global climate change — often referred to as "global warming." It's one of the knottiest and most contentious scientific subjects. Essentially, the question is whether the use of fossil fuels — oil, natural gas and coal — is causing Earth's temperature to rise beyond normal variation.

Our analysis indicates that the current state of climate science is too uncertain to provide clear answers to many key questions about global climate change. Even if global warming were a proven threat — which it is not — targets agreed on in Kyoto, Japan, fail to provide a fair, practical or cost-effective solution.

Because fossil fuels account for about 90 percent of the energy people use in the world today and form the basis for economic growth, everybody has a stake in the debate. Clearly, Exxon employees, shareholders and customers are especially affected.

This booklet will help inform you about the science, economics and other aspects of the issue. It will tell you about the many steps Exxon and others are taking — from research to reforestation.

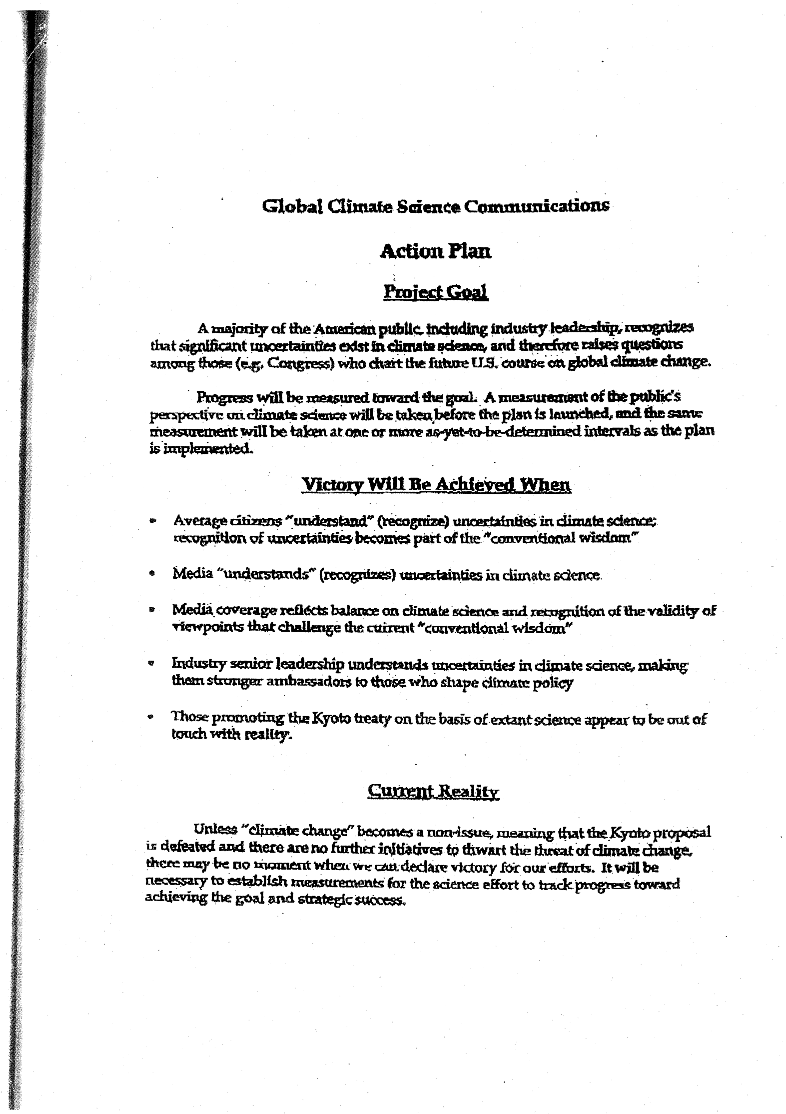
We hope to gain your interest in this matter, and we encourage you to join the important debate about global climate change.

Lee R Raymond

Lee R. Raymond
*Chairman*

Figure A.9: "Global climate change: everyone's debate," 1996

The "Victory Memo" of 1998 makes the goal to inject uncertainty into the public sphere clear: "victory will be achieved when average citizens 'understand' (recognize) uncertainties in climate science," and "recognition of uncertainty becomes part of the 'conventional wisdom."' Figure A.10 provides an excerpt of the memo describing the goals of the public informational campaign, the entire memo can be found at https://www.climatefiles.com/trade-group/american-petroleum-institute/1998-global-climate-science-communications-team-action-plan/.



**Global Climate Science Communications**

**Action Plan**

**Project Goal**

A majority of the American public, including industry leadership, recognizes that significant uncertainties exist in climate science, and therefore raises questions among those (e.g. Congress) who chart the future U.S. course on global climate change.

Progress will be measured toward the goal. A measurement of the public's perspective on climate science will be taken before the plan is launched, and the same measurement will be taken at one or more as-yet-to-be-determined intervals as the plan is implemented.

**Victory Will Be Achieved When**

- Average citizens "understand" (recognize) uncertainties in climate science; recognition of uncertainties becomes part of the "conventional wisdom"
- Media "understands" (recognizes) uncertainties in climate science.
- Media coverage reflects balance on climate science and recognition of the validity of viewpoints that challenge the current "conventional wisdom"
- Industry senior leadership understands uncertainties in climate science, making them stronger ambassadors to those who shape climate policy
- Those promoting the Kyoto treaty on the basis of extant science appear to be out of touch with reality.

**Current Reality**

Unless "climate change" becomes a non-issue, meaning that the Kyoto proposal is defeated and there are no further initiatives to thwart the threat of climate change, there may be no moment when we can declare victory for our efforts. It will be necessary to establish measurements for the science effort to track progress toward achieving the goal and strategic success.

Figure A.10: Victory Memo, 1998

"The Greenhouse Effect" is a report published by a working group of Shell scientists in 1988 documents potential climate impacts, including rising sea levels, ocean acidification, and human migration, from continued fossil fuel production. The document's summary is shown in Figure A.11; the full document is available at https://www.documentcloud.org/documents/4411090-Document3.html.

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SUMMARY

Man-made carbon dioxide, released into and accumulated in the atmosphere, is believed to warm the earth through the so-called greenhouse effect. The gas acts like the transparent walls of a greenhouse and traps heat in the atmosphere that would normally be radiated back into space. Mainly due to fossil fuel burning and deforestation, the atmospheric CO2 concentration has increased some 15% in the present century to a level of about 340 ppm. If this trend continues, the concentration will be doubled by the third quarter of the next century. The most sophisticated geophysical computer models predict that such a doubling could increase the global mean temperature by 1.3-3.3°C. The release of other (trace) gases, notably chlorofluorocarbons, methane, ozone and nitrous oxide, which have the same effect, may amplify the warming by predicted factors ranging from 1.5 to 3.5°C.

Mathematical models of the earth's climate indicate that if this warming occurs then it could create significant changes in sea level, ocean currents, precipitation patterns, regional temperature and weather. These changes could be larger than any that have occurred over the last 12,000 years. Such relatively fast and dramatic changes would impact on the human environment, future living standards and food supplies, and could have major social, economic and political consequences.

There is reasonable scientific agreement that increased levels of greenhouse gases would cause a global warming. However, there is no consensus about the degree of warming and no very good understanding what the specific effects of warming might be. But as long as man continues to release greenhouse gases into the atmosphere, participation in such a global "experiment" is guaranteed. Many scientists believe that a real increase in the global temperature will be detectable towards the end of this century or early next century. In the meanwhile, greater sophistication both in modelling and monitoring will improve the understanding and likely outcomes. However, by the time the global warming becomes detectable it could be too late to take effective countermeasures to reduce the effects or even to stabilise the situation.

The likely time scale of possible change does not necessitate immediate remedial action. However, the potential impacts are sufficiently serious for research to be directed more to the analysis of policy and energy options than to studies of what we will be facing exactly. Anticipation of climatic change is new, preventing undue change is a challenge which requires international cooperation.

With fossil fuel combustion being the major source of CO2 in the atmosphere, a forward looking approach by the energy industry is clearly desirable, seeking to play its part with governments and others in the development of appropriate measures to tackle the problem.

Figure A.11: "The Greenhouse Effect," 1988

The Global Climate Coalition was a lobbying group of several large oil and gas companies that operated between 1989 an 2001. Its primary function was to coordinate messaging against global climate action like the ratification of the Kyoto Protocol. In 1995, the GCC internally circulated *Predicting Future Climate Change: A Primer*, which summarized the state of climate science. Notably, it reads, "The scientific basis for the Greenhouse Effect and the potential impact of human emissions of greenhouse gases such as CO2 on climate is well established and cannot be denied." Figure A.12 displays the introduction to the primer. The full document is available at https://www.ucsusa.org/sites/default/files/attach/2015/07/Climate-Deception-Dossier-7_GCC-Climate-Primer.pdf

**APPROVAL DRAFT**

**Predicting Future Climate Change: A Primer**

In its recently approved Summary for Policymakers for its contribution to the IPCC's Second Assessment Report, Working Group I stated:

> ...the balance of evidence suggests that there is a discernable human influence on global climate.

The Global Climate Coalition's Science and Technical Advisory Committee believes that the IPCC statement goes beyond what can be justified by current scientific knowledge.

This paper presents an assessment of those issues in the science of climate change which relate to the ability to predict whether human emissions of greenhouse gases have had an effect on current climate or will have a significant impact on future climate. It is a primer on these issues, not an exhaustive analysis. Complex issues have been simplified, hopefully without any loss of accuracy. Also, since it is a primer, it uses the terminology which has become popular in the climate change debate, even in those cases where the popular terminology is not technically accurate.

Introduction and Summary

Since the beginning of the industrial revolution, human activities have increased the atmospheric concentration of $CO_2$ by more than 25%. Atmospheric concentrations of other greenhouse gases have also risen. Over the past 120 years, global average temperature has risen by 0.3 - 0.6°C. Since the Greenhouse Effect can be used to relate atmospheric concentration of greenhouse gases to global average temperature, claims have been made that at least part of the temperature rise experienced to date is due to human activities, and that the projected future increases in atmospheric concentrations of greenhouse gases (as the result of human activities) will lead to even larger increases in future temperature. Additionally, it is claimed that these increases in temperature will lead to an array of climate changes (rainfall patterns, storm frequency and intensity, etc.) that could have severe environmental and economic impacts.

This primer addresses the following questions concerning climate change:

1) Can human activities affect climate?

   The scientific basis for the Greenhouse Effect and the potential impact of human emissions of greenhouse gases such as $CO_2$ on climate is well established and cannot be denied.

2) Can future climate be accurately predicted?

   The climate models which are being used to predict the increases in temperature which might occur with increased atmospheric concentrations of greenhouse gases are limited at present both by incomplete scientific understanding of the factors which affect climate and

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**APPROVAL DRAFT**

by inadequate computational power. Improvements in both are likely, and in the next decade it may be possible to make fairly accurate statements about the impact that increased greenhouse gas concentrations could have on climate. However, these improvements may still not translate into an ability to predict future climate for at least two reasons:

- limited understanding of the natural variability of climate, and
- inability to predict future atmospheric concentrations of greenhouse gases.

The smaller the geographic area considered, the poorer the quality of climate prediction. This is a critical limitation in our ability to predict the impacts of climate change, most of which would result from changes in a local or regional area.

3) Have human activities over the last 120 years affected climate, i.e. has the change been greater than natural variability?

   Given the limitations of climate models and other information on this question, current claims that a human impact on climate has already been detected, are unjustified. However, assessment of whether human activities have already affected climate may be possible when improved climate models are available. Alternatively, a large, short term change in climate consistent with model predictions could be taken as proof of a human component of climate change.

4) Are there alternate explanations for the climate change which has occurred over the last 120 years?

   Explanations based on solar variability, anomalies in the temperature record, etc. are valid to the extent they are used to argue against a conclusion that we understand current climate or can detect a human component in the change in climate that has occurred over the past 120 years. However, these alternative hypotheses do not address what would happen if atmospheric concentrations of greenhouse gases continue to rise at projected rates.

Can Human Activities Affect Climate?

The Sun warms the Earth and is the source of energy for the climate system. However, as shown in Figure 1, the process by which this occurs is complicated. Only about half of the incoming radiation from the Sun is absorbed by the Earth's surface. About a quarter is absorbed by the atmosphere, and the remainder is reflected back into space by clouds, dust and other particulates without being absorbed, either by the surface or atmosphere.

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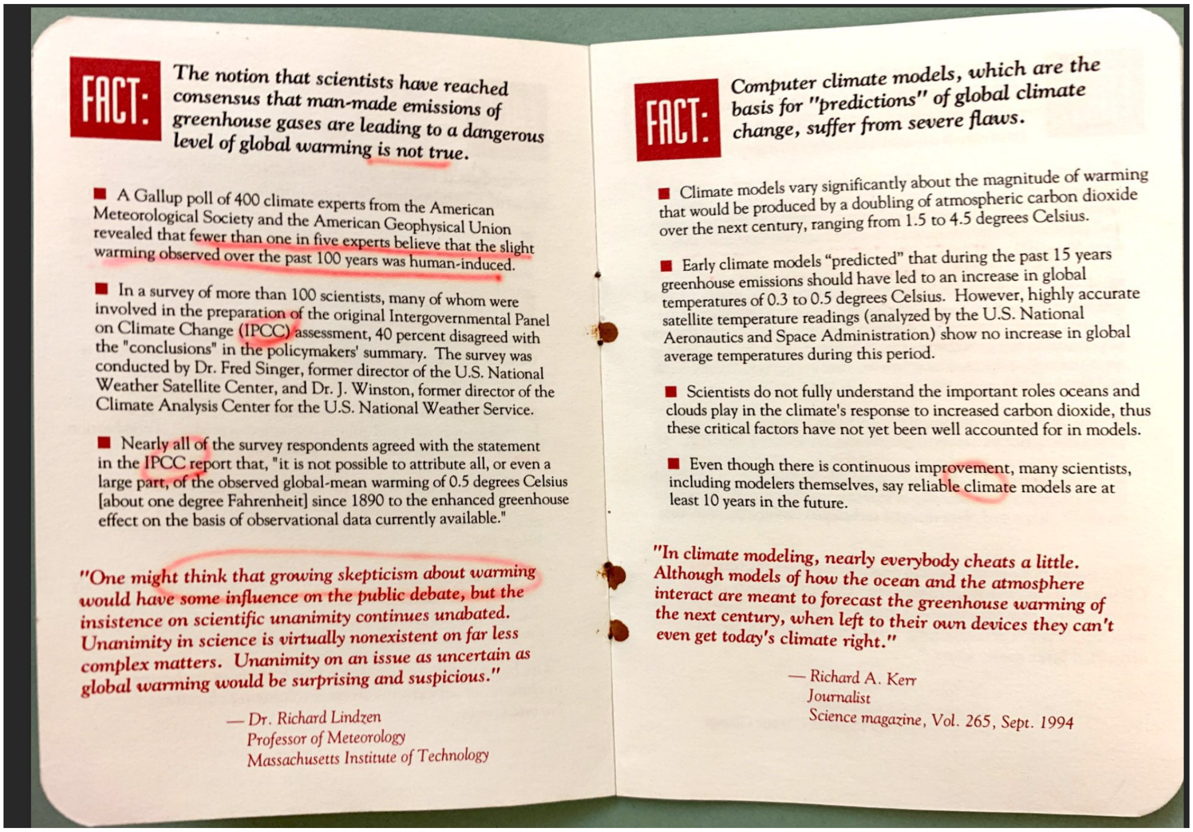
Figure A.12: *Predicting Future Climate Change: A Primer*, 1995

While the GCC internally circulated *Predicting Future Climate Change: A Primer*, its public-facing publications of the time were very different. In 1995, it also published "Climate Change: Your Passport To The Facts," a booklet allegedly intended to introduce readers to essential facts about climate change. Facts include that "the notion that scientists have reached consensus that man-made emissions of greenhouse gases are leading to a dangerous level of global warming is not true" and "computer climate models, which are the basis for "predictions" of global climate change, suffer from severe flaws." Figure A.13 shows an excerpt of the booklet, with the full document available at https://www.worthingtoncaron.com/documents/1995-CLIMATE-CHANGE-YOUR-PASSPORT.pdf



**FACT:** ***The notion that scientists have reached consensus that man-made emissions of greenhouse gases are leading to a dangerous level of global warming is not true.***

■ A Gallup poll of 400 climate experts from the American Meteorological Society and the American Geophysical Union revealed that fewer than one in five experts believe that the slight warming observed over the past 100 years was human-induced.

■ In a survey of more than 100 scientists, many of whom were involved in the preparation of the original Intergovernmental Panel on Climate Change (IPCC) assessment, 40 percent disagreed with the "conclusions" in the policymakers' summary. The survey was conducted by Dr. Fred Singer, former director of the U.S. National Weather Satellite Center, and Dr. J. Winston, former director of the Climate Analysis Center for the U.S. National Weather Service.

■ Nearly all of the survey respondents agreed with the statement in the IPCC report that, "it is not possible to attribute all, or even a large part, of the observed global-mean warming of 0.5 degrees Celsius [about one degree Fahrenheit] since 1890 to the enhanced greenhouse effect on the basis of observational data currently available."

***"One might think that growing skepticism about warming would have some influence on the public debate, but the insistence on scientific unanimity continues unabated. Unanimity in science is virtually nonexistent on far less complex matters. Unanimity on an issue as uncertain as global warming would be surprising and suspicious."***

— *Dr. Richard Lindzen*
*Professor of Meteorology*
*Massachusetts Institute of Technology*

**FACT:** ***Computer climate models, which are the basis for "predictions" of global climate change, suffer from severe flaws.***

■ Climate models vary significantly about the magnitude of warming that would be produced by a doubling of atmospheric carbon dioxide over the next century, ranging from 1.5 to 4.5 degrees Celsius.

■ Early climate models "predicted" that during the past 15 years greenhouse emissions should have led to an increase in global temperatures of 0.3 to 0.5 degrees Celsius. However, highly accurate satellite temperature readings (analyzed by the U.S. National Aeronautics and Space Administration) show no increase in global average temperatures during this period.

■ Scientists do not fully understand the important roles oceans and clouds play in the climate's response to increased carbon dioxide, thus these critical factors have not yet been well accounted for in models.

■ Even though there is continuous improvement, many scientists, including modelers themselves, say reliable climate models are at least 10 years in the future.

***"In climate modeling, nearly everybody cheats a little. Although models of how the ocean and the atmosphere interact are meant to forecast the greenhouse warming of the next century, when left to their own devices they can't even get today's climate right."***

— *Richard A. Kerr*
*Journalist*
*Science magazine, Vol. 265, Sept. 1994*

Figure A.13: "Climate Change: Your Passport To The Facts," 1995

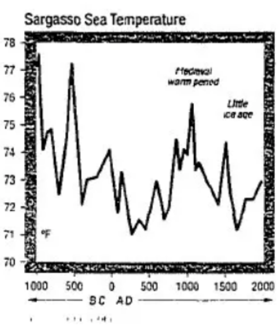
ExxonMobil published a series of newspaper ads in order to sow doubt into the public about climate science. In the spring of 2000, ExxonMobil rad the ad "Unsettled Science" in major news outlets (e.g., the *New York Times*), displayed in Figure A.14. These ads also tried to discredit climate scientists. Scientists like Lloyd Keigwin later responded in the *Wall Street Journal* complaining that ExxonMobil had distorted his work by suggesting it supported the notion that global warming was just a natural cycle.[1]

# Unsettled Science

Knowing that weather forecasts are reliable for a few days at best, we should recognize the enormous challenge facing scientists seeking to predict climate change and its impact over the next century In spite of everyone's desire for clear answers it is not surprising that fundamental gaps in knowledge leave scientists unable to make reliable predictions about future changes

A recent report from the National Research Council (NRC) raises important issues, including these still-unanswered questions (1) Has human activity already begun to change temperature and the climate, and (2) How significant will future change be?

The NRC report confirms that Earth's surface temperature has risen by about 1 degree Fahrenheit over the past 150 years Some use this result to claim that humans are causing global warming, and they point to storms or floods to say that dangerous impacts are already under way Yet scientists remain unable to confirm either contention




Geological evidence indicates that climate and greenhouse gas levels experience significant natural variability for reasons having nothing to do with human activity Historical records and current scientific evidence show that Europe and North America experienced a *medieval warm period* one thousand years ago, followed centuries later by a *little ice age* The geological record shows even larger changes throughout Earth's history Against this backdrop of large poorly understood natural variability, it is impossible for scientists to attribute the recent small surface temperature increase to human causes

Moreover, computer models relied upon by climate scientists predict that lower atmospheric temperatures will rise as fast as or faster than temperatures at the surface However, only within the last 20 years have reliable global measurements of temperatures in the lower atmosphere been available through the use of satellite technology These measurements show little if any warming

Even less is known about the potential positive or negative impacts of climate change In fact, many academic studies and field experiments have demonstrated that increased levels of carbon dioxide can promote crop and forest growth

So, while some argue that the science debate is settled and governments should focus only on near-term policies—that is empty rhetoric Inevitably, future scientific research will help us understand how human actions and natural climate change may affect the world and will help determine what actions may be desirable to address the long-term

Science has given us enough information to know that climate changes may pose long-term risks Natural variability and human activity may lead to climate change that could be significant and perhaps both positive and negative Consequently, people, companies and governments should take responsible actions now to address the issue

One essential step is to encourage development of lower-emission technologies to meet our future needs for energy We'll next look at the promise of technology and what is being done today

ExxonMobil

Figure A.14: "Unsettled Science," 2000

[1] https://insideclimatenews.org/news/22102015/exxon-sowed-doubt-about-climate-science-for-decades-by-stressing-uncertainty/