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Preventing Prevention

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Abstract: *Preventing climate change and damage from natural disasters typically requires policies with up-front costs that promise a flow of benefits over time. Why has obtaining such policies in a competitive electoral democracy proved so intractable? We develop a formal model of electoral accountability in this context, in which politicians have private information about their motivations. The model shows why fully rational voters, though certain that incumbents spend less on disaster prevention than is good for them, reelect incumbents at very high rates. In addition, in such equilibria, voters would punish incumbents who spent more on disaster prevention. This equilibrium is consistent with (and implies) some of the major empirical regularities observed in the literature on voting and disaster prevention. We discuss some implications of our analysis for advancing public debates about disaster and climate change mitigation.*

Some of the most pressing policy problems of the present era involve prevention. Climate change, for example, presents an ominous threat of enormous proportions to human society. Natural disasters such as hurricanes and wildfires (which are in part related to climate change itself) have recently ravaged the United States and its territories at an unprecedented scale. The policy challenge is not just to provide relief for these calamities when they occur, but to prevent them in the first place: The cost-effectiveness of prevention far exceeds that of relief (Healy and Malhotra 2009).

Policy solutions exist to prevent these problems (or prevent them from getting worse). Climate change can be significantly mitigated (and further change prevented) by building renewable energy facilities and shifting away from fossil fuels. Hurricane damage can be substantially prevented with public infrastructure such as improved networks of levees. Wildfire and earthquake damage can be mitigated by investing in the capacity of first responders and through updated building codes. The challenge of solving these problems lies in adopting the best available policy solutions for prevention and mitigation.

It is obvious that adopting known policy solutions to prevent disasters has proved challenging cf. (Healy and Malhotra 2009). A key question is why—and based on an answer to that, what can be done about it. Scholars have pointed to a number of issues. Achen and Bartels (2016) prominently call into question the ability of the mass public to promote its own interests through electoral democracy, due to voter myopia and misperception. Some of their most vivid examples involve natural disasters: voters in agricultural areas punishing incumbents for droughts, voters in coastal areas punishing incumbents for shark attacks. Other scholars suggest that voters simply follow elite cues without forming coherent opinions on specific policies (Campbell et al. 1960, Lenz 2013, Zaller 1992), a process with obvious pathological implications when recognition of future harms is ideologically charged. The spatial distribution of costs and benefits of prevention policy—for example, "NIMBY" problems—also presents a formidable obstacle (Stokes 2016).

What if we eliminated all of these potential obstacles to rational disaster prevention policy? The answer, we will contend, is that the problem remains. We demonstrate this by constructing a world of policy choice and electoral accountability in which voters are fully rational and share a common interest in disaster prevention. Additionally, we assume that voters have no difficulty coordinating on punishments and rewards for politicians that are in their best interest. By construction, policy pathologies in this world cannot arise from voter failure, myopia, ideology, or distributional problems. This is precisely what allows

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us to show that political obstacles to rational prevention policy are at once more fundamental and more insidious than previous research recognizes.

The world we model extends classic treatments of agency problems and electoral politics[1] to consider key elements of natural disaster policy—prevention and relief. In this model, an incumbent politician can spend public funds on a natural disaster prevention project and/or on relief projects in case a natural disaster actually occurs. After observing the incumbent's policy actions and whether a disaster did in fact occur, voters[2] decide to reelect the incumbent or replace him or her with a challenger.

There are four key assumptions about prevention policy in our analysis. First, all prevention policies entail an up-front public cost. Second, prevention policies vary in their stream of future benefits to voters (e.g., their efficacy in actually preventing disasters). On average, prevention projects are very beneficial to voters, but some are more effective than others, and some are not effective at all at preventing disasters. Third, incumbent politicians observe more information than voters about the expected benefits of a given prevention policy. Incumbent politicians, having greater contact with experts such as safety engineers and public works managers, can tell these projects apart; voters cannot. Fourth, incumbents vary in the degree to which they themselves benefit from spending on prevention, even when it is not effective. Prevention projects, as a type of public works spending (e.g., dams, levees, fire breaks, seismic retrofits), entail substantial opportunities for granting favors, as well as outright graft and corruption. We say loosely that some incumbents are "corrupt," in the sense of obtaining benefits from these opportunities. These politicians want to pursue prevention projects even when they are not effective. Other incumbents are (loosely) "honest," in the sense of not benefiting from these opportunities. They do not wish to pursue ineffective prevention projects. Incumbents know whether they are corrupt or honest, but voters do not observe this.

Incumbents all wish to be reelected, but voters only wish to reelect the honest politicians. Voters also wish to give politicians incentives to pursue their preferred policies. Since voters can observe whether a disaster in fact occurs, they have no trouble enforcing their preferred policy of relief spending if and only if there is a disaster. An incumbent pursuing any other policy would lose reelection.

But voters cannot enforce an equilibrium in which incumbents pursue prevention if and only if it is beneficial for voters. The reason is that voters know neither the effectiveness of any specific prevention project nor the honesty of the incumbent; the incumbent knows both. Rational voters know that if they simply trust the incumbent to enact only the socially beneficial prevention projects, the corrupt types will act as though all projects are effective and enact them all.

Therefore, the only possible equilibria involve both types of incumbents pursuing either all possible prevention projects or no possible prevention projects, regardless of social value.[3] If the voter expects neither type of incumbent to pursue any prevention projects, then observing a prevention project is "bad news" about the incumbent's corruption: The corrupt types benefit more from this out-of-equilibrium action than the honest types. This interpretation of actions out of equilibrium supports the equilibrium. "No prevention by any incumbent" is essentially the only equilibrium policy consistent with this interpretation of out-of-equilibrium actions.[4]

The key result of this model is that public policy exhibits a clear pathology: Prevention policy, despite its efficacy and rationality, is not pursued—indeed, it is punished at the ballot box. Instead, public spending is focused on relief after a disaster occurs, despite the social inefficiency of this approach. Qualitatively, this squares with the evidence of prevention pathologies adduced by Healy and Malhotra (2009) and Achen and Bartels (2016). Healy and Malhotra, in particular, demonstrate two empirical patterns about prevention politics: first, that prevention spending is much more cost-effective than relief spending.[5] Yet, second, voters reward politicians who pursue relief spending, and they do not reward

[1] See Ashworth (2012) and Gailmard (2014) for recent reviews of this approach. See, for example, Barro (1973), Ferejohn (1986), Austen-Smith and Banks (1989), Seabright (1996), Persson, Roland, and Tabellini (1997), Fearon (1999), Shi and Svensson (2006), Bueno de Mesquita (2007), and Fearon (2011) for classic expositions.

[2] Formally, we model only a single voter, which captures the assumption of a common interest among voters in prevention policy, and the absence of any coordination problems among voters, as described above.

[3] If corrupt and honest types pursue different prevention policies, they will reveal themselves, and the corrupt types will lose reelection. Thus, all equilibria entail the corrupt and honest types behaving in the same way.

[4] If the voter expects all incumbents to pursue all prevention projects, then observing no prevention project is actually good news about the incumbent's honesty: The corrupt type faces a greater cost of this action, by forfeiting the direct benefits of prevention spending. This interpretation of actions out of equilibrium undermines an equilibrium in which all incumbent types pursue all prevention projects.

[5] In Healy and Malhotra's (2009) estimation, a dollar of prevention spending is an order of magnitude more beneficial than a dollar of relief spending.

politicians who pursue prevention spending. Our model shows how this patterns emerges with rational voters who face both uncertainty about the efficacy of specific prevention projects and adverse selection about politicians' honesty.

Like scholars who doubt the efficacy of electoral accountability, we expect prevention policy to be pathological under such a system. Yet in our analysis, such pathologies result from rational choice in light of natural information asymmetries. This is important because the underlying cause of the pathologies ultimately determines the reforms necessary to correct them. We contend simply that, in prescribing such reforms, empiricists should be open to all the possible explanations consistent with the evidence. In line with a distinguished tradition of scholarship,[6] albeit lately beleaguered by shark attacks, droughts, and other disasters, we contend that voter rationality is still very much one of these explanations.[7]

Ultimately, this logic has striking implications for arguments for institutional reform in representative democracy, and for rational prevention policy in particular. If prevailing patterns of voter behavior reveal voter irrationality, then one might conclude that electoral democracy does not produce real accountability, much less "good policy." One could justify calls for the reorientation of the foundations of democracy on this basis (Achen and Bartels 2016). Our argument shows that such calls are premature because their foundations in a clear demonstration of voter irrationality are illusory. Instead, our model reflects fundamental limits of accountability that are possible in any institution, even with fully rational, unified voters, given the information and incentive conflicts at work. Lacking voter irrationality as a clear foundation for institutional reforms, we risk undermining the normative foundations of electoral democracy—including elemental precepts such as "one person, one vote"—without a clear rationale of improved accountability. We are wary that such designs would be socially beneficial.

[6]See Downs (1957), Key (1966), Fiorina (1981), Page and Shapiro (1992), Popkin (1991), Alvarez (1998), and Lupia and McCubbins (1998).

[7]Achen and Bartels (2016) consider many voter pathologies beyond myopia, perhaps the most famous being the tendency of voters to punish incumbents for irrelevant events (shark attacks, etc.). The robustness and significance of this finding is critiqued by Fowler and Hall (2018) and defended by Achen and Bartels (2018). This debate is largely tangential to our argument. We are critiquing the argument that voters must be irrational if they *fail* to hold politicians accountable for seemingly *relevant* events, not that they are irrational when they *do* hold politicians accountable for seemingly *irrelevant* ones. The latter issue is precisely the focus of Ashworth, Bueno de Mesquita, and Friedenberg (2017).

Prevention and Relief in a Political Agency Model

We consider a model in which an incumbent politician is one of two types, $t \in T = \{0, 1\}$, where $t = 1$ with probability $\pi \in (0, 1)$, and this information is private information to the incumbent. The incumbent's type denotes whether he or she has policy goals that (partially) conflict with those of the voter. This is the case when the type is $t = 1$; if the incumbent's type is $t = 0$, then the incumbent's policy goals are identical to those of the voter. In other words, any distortion of the behavior of an incumbent with type $t = 0$ is entirely due to his or her desire to be reelected. Accordingly, it is fair to say that any distortions of a type $t = 0$ incumbent from the voter's best interests are "caused by" elections. We refer to type $t = 1$ politicians as "corrupt" or "biased," and type $t = 0$ politicians as "honest" or "faithful."

Upon observing his or her type, the incumbent (privately) observes the state of nature, $\omega \in \Omega = \{0, 1\}$, where $\omega = 1$ with probability $q \in (0, 1)$. After observing the state of nature, the incumbent chooses a policy, denoted by $x \in X = \{0, 1\}$. We describe x as the *level of prevention* implemented by the incumbent. After x is chosen, an outcome, $y \in Y = \{0, 1\}$, is realized. The outcome $y = 1$ represents a disaster occurring. The probability that a disaster occurs ($y = 1$), conditional on x and ω, is denoted by $p(x, \omega) \in (0, 1)$.[8]

Following the realization of y (i.e., after the disaster has either happened or not), the incumbent chooses whether to pursue relief programs or not, denoted by $z \in \{0, 1\}$, with $z = 1$ representing the delivery of relief and $z = 0$ representing a decision to forego relief.

After y is realized, a voter, V, observes (x, y, z) and then decides whether to reelect the incumbent or replace him or her with a challenger whose type, $t_C \in \{0, 1\}$, is independently drawn with the probability that $t_C = 1$ is π_C. The voter's decision is denoted by $r = 1$ if he or she decides to reelect the incumbent and $r = 0$ otherwise.

The incumbent's payoff function is

$$u_I(x, y, r, t) = tx - \alpha(y(1 - c_z z) + c_x x) + wr,$$

[8]We do not allow for a disaster to be either certain ($p(x, \omega) = 1$) or impossible ($p(x, \omega) = 0$) for uninteresting technical reasons. In particular, allowing for such cases introduces exogenously zero-probability histories (i.e., "paths of play"). Such possibilities simply provide us with more degrees of freedom to make our point and extra notation to carry around without adding to the substantive insight. Accordingly, we rule them out.

and the voter's payoff function is

$$u_V(x, y, r, t_C, t) = -(y(1 - c_z z) + c_x x) - \phi(rt + (1 - r)t_C). \quad (1)$$

The parameters $\alpha > 0$, $w \geq 0$, $c_x \in [0, 1)$, $c_z \in [0, 1)$, and $\phi \geq 0$ are each exogenous and common knowledge. First consider the voter's payoff function. The parameter c_x represents the cost of prevention borne by the voter, c_z represents the efficacy of relief spending, and ϕ represents the adverse selection problem faced by the voter. When $\phi = 0$, the voter does not consider the type of the challenger in his or her calculation of the (net) value of replacing the incumbent. When $\phi > 0$, the voter does consider this shadow of the future when making his or her reelection decision. We assume this particular specification of voter utility for disaster and relief spending because it implies sensible preferences over these variables, as will become clear below.

In the incumbent's payoff function, α represents the "altruistic" motivation of the incumbent, which we assume is independent of the incumbent's type. As $\alpha \to 0$, the incumbent becomes intrinsically indifferent to the voter's welfare (i.e., the incumbent would only consider the voter's welfare if induced to do so by the electoral process, as in canonical electoral agency models), and if $\alpha = 1$, the incumbent's direct preferences mirror those of the voter with respect to disaster and relief spending.

However, even for $\alpha = 1$, the incumbent's payoff differs from the voter's in two important ways. First, the incumbent values holding office. This value is measured by w: Larger values of this parameter represent a stronger office-seeking motivation for the incumbent. As with α, we assume for simplicity that this motivation is independent of the incumbent's type. Second, if $t = 1$, the incumbent values prevention spending directly, irrespective of its effect on the probability of a disaster. The capital projects involved in prevention give politicians opportunities for rent seeking, such as personal profit from corrupt allocation of contracts or "vanity rents" from construction of elaborate projects, even when they are not useful to the public. Type $t = 1$ politicians value these aspects of prevention; type $t = 0$ politicians do not. This is why voters might care about politicians' types.

The state of nature ω affects the probability of a disaster ($y = 1$) for a given prevention level x. We assume that $p(x, 0) < p(x, 1)$ for each $x \in X$, and we focus on the case in which

$$(p(0, 1) - p(1, 1))(1 - c_z) > c_x, \text{ and}$$
$$(p(0, 0) - p(1, 0))(1 - c_z) < c_x, \quad (2)$$

so that prevention spending ($x = 1$) is beneficial to the voter if and only if $\omega = 1$.[9]

The voter's payoff function implies that the optimal complete information policy from the voter's perspective, denoted by $(x^{**}(\omega), y^{**}(y))$ for each state of nature ω and disaster occurrence y, is

$$x^{**}(\omega) = \omega, \text{ and}$$
$$z^{**}(y) = y.$$

Simply put, the voter values prevention spending if and only if a disaster is sufficiently likely, and he or she values relief spending if and only if a disaster actually occurs.

The Information Structure and Disaster Prevention

Our (purposely) sparse framework contains a key element in the informational structure, which is necessary to extend standard political agency models with adverse selection to the context of disaster prevention and relief. As is typical in electoral selection models, the incumbent politician is privately informed about a type t that affects the voter's utility of reelection. Tailoring this general model to the context of natural disasters requires several additional elements. Most importantly, the efficient policy choice from the voters' standpoint is completely determined by the state of the world ω: This determines the risk of a disaster, and disaster prevention spending is efficient if and only if this risk is high. However, the incumbent *privately* observes the state of nature ω. That is, the voters cannot explicitly condition the choice of policy (or reelection) on all the facts on the ground because they cannot observe them. This is a realistic assumption in most realms of policymaking: Voters simply do not have the information required to make *ex post* efficient policy decisions (which is, in some sense, the point of having politicians make them).

Thus, voters are uncertain about two variables: the politician's type and the likelihood of disaster/efficiency of prevention. The latter creates an important tension because of a second key element of disaster prevention policy captured in the model: Prevention entails an up-front cost to voters. The third key element is that both disasters and relief spending are perfectly observable to voters; they can observe whether disaster damage has in fact occurred, and whether the government has done anything about it.

[9]Note that we allow in principle for the possibility that $p(0; 0) < p(1; 0)$, a case in which prevention spending actually *increases* the probability of a disaster when $\omega = 0$. This possibility is relevant for equilibrium behavior when prevention spending is not directly observable, but the occurrence of the disaster is.

Combining these elements is the primary theoretical innovation of this model, as this combination has not been executed in the political agency literature. It is also essential to capturing the strategic dilemmas of disaster policy and lies behind the policy pathologies we identify below.

Strategies and Beliefs

A strategy for the incumbent consists of two functions. The first function is a mapping $\sigma_I^x : \{0, 1\} \times \{0, 1\} \rightarrow [0, 1]$ that selects a probability of setting prevention $x = 1$ for each pair (t, ω). The second function is a mapping $\sigma_I^z : (\{0, 1\})^4 \rightarrow [0, 1]$ that selects a probability of providing relief $(z = 1)$ for each quadruple (t, ω, x, y). When the context is clear, we write $\sigma_I \equiv (\sigma_I^x, \sigma_I^z)$ to denote the incumbent's complete strategy.

A strategy for the voter is a mapping $\sigma_V : (\{0, 1\})^3 \rightarrow [0, 1]$ that selects a probability of reelection (i.e., $r = 1$) for each triple (x, y, z). The voter's beliefs are denoted by $\beta : \{0, 1\}^3 \rightarrow [0, 1]$ and designate, for each triple (x, y, z), the voter's subjective probability that $t = 1$ upon observing (x, y). In line with this, note that much of u_V is essentially a welfare benchmark. In the game we analyze in this article, the voter has no direct control over x, y, or z (or, of course, t or t_C). Rather, a central point of this article is that elections are a coarse accountability mechanism (e.g., Fearon 1999). Thus, the voter's incentives when considering whether to reelect $(r = 1)$ or replace $(r = 0)$ the incumbent boil down to

$$\hat{u}_V(r|x, y, z) = -\phi(r\beta(x, y, z) + (1 - r)\pi_C).$$

Thus, regardless of his or her type t, the incumbent prefers *lower* voter beliefs.

Equilibrium

Our equilibrium notion is perfect Bayesian equilibrium (PBE) with beliefs satisfying the D1 refinement. This refinement, a version of "divinity" introduced in the seminal article by Banks and Sobel (1987), requires that beliefs following any out-of-equilibrium path of play assign positive weight only to the incumbent type who would be "most likely" to benefit (out of equilibrium) from that deviation, relative to the expected payoff that type will receive from playing the equilibrium strategy. Informally, this refinement implies that "too much" prevention relative to the equilibrium path of play leads the voter to infer that the incumbent is a corrupt $(t = 1)$ type, since that type benefits directly from prevention spending even when it is not beneficial to the voter. "Too little" prevention relative to the equilibrium path of play must lead the voter to infer that the incumbent is an honest $(t = 0)$ type. D1 does not pin down beliefs following deviations with respect to relief spending, as both types have the same intrinsic preferences with respect to this spending.

An arbitrary equilibrium is denoted by $(\sigma_I^*, \sigma_V^*, \beta^*)$. Before continuing to the analysis, however, it is important to consider what exactly equilibrium "means" in this setting. The foundation of PBE here is consistency between the voter's inferences about the incumbent's type and the incentives faced by *each type* of incumbent. That is, in equilibrium, beliefs and behavior are internally consistent. Accordingly, behavior as described by perfect Bayesian equilibrium is necessarily "rational." Our argument is that a model of completely rational (in fact, arguably "hyper-rational") voters can produce inefficient outcomes in the context of disaster prevention policy and, indeed, be characterized by vote choices that appear pathological.

Equilibrium Analysis

The first result states a key feature of equilibrium voter behavior: If the voter cares about the future $(\phi > 0)$ and believes, given the observed history of play (x, y, z), that the incumbent is more likely to be corrupt $(t = 1)$ than the challenger, the voter must replace the incumbent with the challenger. The converse holds as well: If the incumbent is deemed to be less likely to be corrupt than the challenger, the voter must reelect the incumbent. The following lemma states this formally.

Lemma 1. *Suppose that* $\phi > 0$. *In equilibrium, if* $\beta^*(x, y, z) > \pi_C$, *then* $\sigma_V^*(x, y, z) = 0$. *If* $\beta^*(x, y, z) < \pi_C$, *then* $\sigma_V^*(x, y, z) = 1$.

The proof of this and all formal results is in the appendix. Intuitively, since the voter is better off in the future with honest types than with corrupt types, reelection is determined entirely by the voter's updated beliefs about the incumbent's honesty, compared to his or her expectation of the challenger's honesty. Therefore, electorally, all that matters to incumbents about their policy choices is how they affect voter beliefs about their corruption.

This lemma implies that if incumbents are sufficiently reelection motivated, honest and corrupt types will never make different policy choices in equilibrium. If they did, since a rational voter knows each type's strategy, the voter would be able to tell them apart and only reelect honest types. To prevent this, the corrupt types always simply mimic the honest types. In such cases, the voter cannot learn anything about the incumbent's honesty or corruption from his or her choice of prevention

policy in equilibrium. This is stated formally in the next proposition.[10]

Proposition 1. *Suppose that* $w > 1 + \alpha(1 + c_x)$ *and* $\phi > 0$. *In any PBE* $(\sigma_I^*, \sigma_V^*, \beta^*)$ *and for any triple* (x, y, z) *reached with positive probability under* (σ_I^*, σ_V^*) ,

$$\beta^*(x, y, z) = \pi.$$

Proposition 1, combined with the incumbent's motivations when $t = 1$, implies that if, in an equilibrium strategy profile, (1) the incumbent is reelected with positive probability after engaging in prevention spending *and* (2) prevention spending occurs with positive probability in equilibrium, *then prevention spending must occur with certainty in the equilibrium.* This is because, under the presumption that the incumbent's reelection incentive w is large enough, the corrupt type of the incumbent ($t = 1$) will engage in prevention spending regardless of the state of nature (ω) if the faithful type ($t = 0$) is willing to engage in prevention spending when the disaster risk is higher ($\omega = 1$). This fact, in conjunction with Proposition 1, implies that this type of behavior can be supported in equilibrium only if the faithful type also engages in prevention spending when the disaster risk is low ($\omega = 0$), because otherwise the voter's updated beliefs about the type of the incumbent would be biased toward the corrupt type after observing prevention spending (and would assign probability zero to the corrupt type after observing no prevention spending).

This logic suggests that there are essentially two possible perfect Bayesian equilibria when the incumbent is sufficiently reelection motivated: one in which the incumbent never engages in prevention spending for any state ω ("preventing prevention") and another in which the incumbent engages in prevention spending for all states ω ("all prevention, all the time"). We will show that each of these types of behavior is supportable in equilibrium, but only the first type meets the D1 refinement.

The next proposition characterizes the "preventing prevention" perfect Bayesian equilibrium. This PBE also satisfies the D1 refinement.

Proposition 2. *Suppose that* $w > 1 + \alpha(1 - c_z - c_x)$ *and* $\phi > 0$. *There is an equilibrium satisfying the D1 refinement in which prevention spending never occurs, regardless of either the incumbent's type or the realized state of nature. Formally, the following strategy-belief profile,* $(\sigma_I^*, \sigma_V^*, \beta^*)$, *is a perfect Bayesian equilibrium with beliefs satisfying the D1 refinement:*

$$\sigma_I^{x*}(t, \omega) = 0 \text{ for all } (t, \omega) \in T \times \Omega,$$

$$\sigma_I^{z*}(t, \omega, x, y) = y \text{ for all } (t, \omega, x) \in T \times \Omega \times X,$$

$$\sigma_V^*(x, y, z) = \begin{cases} 1 & \text{if } x = 0 \text{ and } y = z, \\ 0 & \text{otherwise,} \end{cases}$$

$$\beta^*(x, y, z) = \begin{cases} 1 & \text{if } x = 1, \\ \pi & \text{otherwise.} \end{cases}$$

Note that the conditions in Proposition 2 do not restrict the probability of disaster p or cost of prevention spending c_x. Thus, in this equilibrium, *the incumbent's choice of prevention spending is invariant to the efficiency of prevention spending.* Accordingly, the incumbent's career concerns lead to inefficient prevention spending, precisely because the voter is rational and attempting to ferret out "bad types" of incumbents.[11]

The next proposition demonstrates the importance of the D1 refinement on beliefs, by relaxing this requirement of PBE. Specifically, it presents an "all prevention, all the time" equilibrium in which, consistent with Proposition 1, honest and corrupt incumbents choose the same level of prevention spending—in this case, high prevention spending in all states of the world.

Proposition 3. *Suppose that* $w > 1 + \alpha(1 - c_z - c_x)$ *and* $\phi > 0$. *The following strategy-belief profile,* $(\sigma_I^*, \sigma_V^*, \beta^*)$, *is a perfect Bayesian equilibrium:*

$$\sigma_I^{x*}(t, \omega) = 1 \text{ for all } (\mathrm{t}, \omega) \in \mathrm{T} \times \Omega,$$

$$\sigma_I^{z*}(t, \omega, x, y) = y \text{ for all } (\mathrm{t}, \omega, \mathrm{x}) \in \mathrm{T} \times \Omega \times \mathrm{X},$$

$$\sigma_V^*(x, y, z) = \begin{cases} 1 & \text{if } \mathrm{x} = 1, \\ 0 & \text{otherwise,} \end{cases}$$

$$\beta^*(x, y, z) = \begin{cases} 1 & \text{if } \mathrm{x} = 0, \\ \pi & \text{otherwise.} \end{cases}$$

Of course, the "preventing prevention" PBE from Proposition 2 continues to exist even without the D1 refinement; relaxing D1 adds the "all prevention" equilibrium in Proposition 3 as well. The difference is that in the "all prevention" PBE, the honest type's equilibrium behavior is supported by the perverse off-path voter inference that an incumbent who *does not* engage in spending must be the corrupt type. Since this assumes off-path incumbent behavior in conflict with the incumbent's intrinsic preferences, it is strange, but since this is an off-path event in the constructed equilibrium, nothing in PBE rules this out. That is what D1 is designed to avoid.

Thus, the D1 refinement rules out an equilibrium in which all incumbents engage in prevention spending

[10]Note that Proposition 1 does not utilize the D1 belief refinement, thereby strengthening the conclusion.

[11]The equilibrium described in Proposition 2 is not unique (even among PBE with beliefs satisfying the D1 refinement). Nonetheless, as we show in the appendix (Proposition 4), among equilibria with beliefs satisfying the D1 criteria, the nonuniqueness is with respect only to the choice of relief spending, z.

regardless of ω. As with the "preventing prevention" equilibrium, the "all prevention" equilibrium exists even though it is inefficient (though the relative inefficiency of the two equilibria will in general differ).

Implications

The essence of our argument is that in a realistic information environment, an electoral agency model with fully rational but asymmetrically informed voters is observationally equivalent to a model with irrational voters (e.g., myopic voters)—and both yield pathological prevention policy. In our model, voters reward relief spending but punish prevention spending, and policy makers pursue relief projects but not prevention projects in equilibrium. This matches the empirical results of Healy and Malhotra (2009), which, as noted in that article, can also be explained by voter myopia (cf. Achen and Bartels 2016). A natural question is what to do with this finding, both for empirical analysis and institutional reform. We consider these in turn.

Empirical Analysis

The key to differentiating the rational agency model and a myopic voter model of preventing prevention is that the observational equivalence we identify is only local; that is, it holds only under some parameter ranges of our model. The models make different predictions as we move away from these ranges. Empirical analysis should leverage these differences. This may require experimental manipulation of parameters that seldom occur in reality, though some observational analysis is possible.

The primary parameter of interest is the voter's knowledge of disaster frequency. Policy is pathological in the rational agency model of this article because voters are unsure of both the policy maker's honesty (type t) and the state of the world ω that determines disaster likelihood. In contrast, policy is pathological in the myopic voter model because voters do not use available information rationally. While the models produce an observational equivalence when rational voters are unsure of ω, the equivalence breaks down when voters know ω. Specifically, rational voters can use the information about ω effectively in holding the incumbent accountable, whereas myopic voters cannot.

Formally, it is straightforward to see that if V also observed ω when making his or her vote choice and the incumbent knows this, then there will be an equilibrium in which all incumbents, regardless of type, would pursue prevention if and only if $\omega = 1$, and all would be reelected. Furthermore, this equilibrium is the Pareto-efficient equilibrium for the voter because, even with knowledge of ω, the voter will not learn the incumbent's true type in any equilibrium so long as the incumbent's reelection motivations, w, are large enough. Thus, while knowledge of the underlying risk for disaster ω does *not* allow rational voters to fully solve their adverse selection problem (i.e., incumbents still pool, and corrupt incumbents are still reelected), it *does* solve the policy problem of preventing prevention.

By contrast, an irrational/myopic voter will use information about ω ineffectively. Specifically, when selecting between the responsive equilibrium described above (in which prevention spending occurs if and only if $\omega = 1$) and the unresponsive equilibrium that is observationally equivalent to the one presented in Proposition 2, a myopic voter would prefer the unresponsive equilibrium. This is because, even when informed that $\omega = 1$, a myopic voter still sees prevention spending as an investment that may not pay off in the short run. Since prevention payoffs may only come in the future even when $\omega = 1$, a myopic voter would pathologically underweight these benefits and would not reward prevention spending.

Disaster Propensity, Prevention Policy, and Voter Rationality. This comparison of our model with that of a myopic voter suggests that disaster propensity should, in some cases, be correlated with prevention investment under the rational agency model, but not under the myopic voter model. Locations that are very disaster-prone represent cases approximating $\omega = 1$. Observational empirical work on this point is ongoing, but recent evidence is consistent with this implication of the agency model. Neumayer, Plümper, and Barthel (2014) find in cross-country evidence that prevention investment for a specific type of disaster is greater, and disaster damage is lower, the greater is a country's chance of experiencing that type of disaster. Similarly, Keefer, Neumayer, and Plümper (2011) find an inverse relationship between a country's earthquake propensity and the mortality it experiences from earthquakes.[12]

Experimentally Evaluating the Model. Of course, inference from observational data is difficult in settings with imperfect and asymmetric information. Accordingly, the cleanest tests of the mechanism in our model would be

[12]Though it is beyond the scope of our model, it would be interesting to extend the theory and data analysis to compare democracies versus autocracies. On one hand, secure autocrats do not face the signaling pressure to avoid prevention that democratic politicians do in our model. On the other hand, it is not especially clear that autocrats internalize the welfare of citizens to a great extent. Moreover, secure autocrats may implement projects more often but ineffectively due to corruption.

experimental. Both laboratory and survey experiment platforms would fit naturally. Survey experiments could prime subjects with information about disaster propensity and candidates' electoral motivations, and for placebo tests, other variables that our model suggests are irrelevant. Subjects could then be presented with hypothetical positions or votes by incumbents and asked to evaluate them. The hypothesizes treatment effect would be that when disaster propensity is very high, subjects should be more supportive of prevention spending.

A laboratory experiment would be especially useful because it would allow analysis of strategic behavior by both voters and policy makers, and experimental design could map directly into the model. With voter uncertainty about ω, policy makers should avoid prevention expenditures even when they know $\omega = 1$. With voter certainty that $\omega = 1$, the results should show willingness to invest, as well as voter rewards from it.

In short, we suggest that future empirical analysis should focus on cases in which the rational agency model and myopic (or otherwise irrational) voter models imply different behavior. This will allow empirical determination of whether the mechanism for preventing prevention that we identify above is compelling.

Institutional Reform

As different theories of prevention policy pathologies turn on different explanations, they also imply different solutions. Recently, Achen and Bartels (2016) have presented evidence of limited voter competence in disaster management (and numerous other domains). From this, they conclude that beneficial institutional reforms would insulate public policy decisions of this nature from democratic pressures.

As we have shown, a rational model with asymmetric information also produces policy pathologies, but it calls for very different remedies. In a rational choice framework, the key to good decision making and effective accountability is information. With high-quality information about the state of the world, voters would be better able to hold elected officials accountable for prevention decisions. Voter uncertainty about the proper prevention decision precludes this. Accordingly, providing voters with information about this state from politically independent auditors should help inform decision making. At present in the United States, this information is often provided in a decentralized, ad hoc manner. Public subsidies for the development and dissemination of information would be a worthwhile first step to combating prevention policy pathologies.

We accept that this is not a small task, given rational ignorance; presenting high-quality information to voters does not imply they will internalize it. Yet the challenge of motivating consumption of policy-relevant information is neither an insurmountable hurdle (Lupia 2016) nor a reason to abandon foundational institutions of democratic accountability such as mass elections. Given the substantial normative appeal and historical experience with these institutions, it seems reasonable to focus on straightforward, local reforms to provide better information to voters, before experimenting with more profound institutional changes.

Conclusion

This article develops a model of electoral accountability with adverse selection in the context of disaster prevention and relief. Voters are uncertain about the benefit politicians obtain from prevention projects as a form of rent seeking. In view of this uncertainty, voters must ask what information is conveyed about politicians' motivations if they engage in the construction of disaster prevention projects. Although many equilibria are possible in our model, a natural restriction on off-equilibrium-path beliefs suggests that voters consider it "bad news" about the incumbent's type if she does in fact pursue prevention policies. In turn, incumbents must ask what information it conveys to voters if they engage in preventio pending. Given the inference voters draw from prevention spending in equilibrium, incumbents who desire to hold office, regardless of their preference for rent seeking at voters' expense, will forego disaster prevention projects. Thus, the natural equilibrium of our model involves relief spending in response to a disaster, but no prevention spending in advance of it, even when this is beneficial for voters. Prevention is prevented by information asymmetries and incumbents' electoral motivations.

The result is important because it suggests that voters' empirical tendency to reward relief but not prevention spending by incumbents is consistent with rational choice, as conjectured by Healy and Malhotra (2009). This tendency is not necessarily due to voter irrationality or some behavioral pathology of voters. To be sure, elections induce suboptimal policy choices by incumbents in our model. But this is inherent in the limits of the election as an instrument of accountability, in the face of uncertainty about politicians' motivations and interests. The attendant suboptimal policy is the best that voters can achieve from this institution given this information asymmetry.

Fundamentally, our model implies that it is premature to call for reorienting the foundations of

representative democracy away from preferences of individual voters, as Achen and Bartels (2016) do. Such a move risks undermining the normative foundations of electoral democracy, including elemental precepts such as "one person, one vote," without a clear corresponding benefit of mitigating policy pathologies. Without an unambiguous inference that irrationality lies behind the empirical patterns adduced in the political behavior literature, there is no case that public accountability (or the quality of policy outcomes) would necessarily be improved by taking accountability mechanisms out of the hands of individual voters. Indeed, in our model, voters use their tools of accountability rationally and to the greatest possible effect, given the strategic environment. Rather than locating the cause of these patterns and pathologies in the irrationality of voters, our analysis points up the inherent limitations of accountability in environments with limited information, limited contracting tools, and competing imperatives of moral hazard and adverse selection.

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Appendix

Formal Proofs

This appendix proves Lemma 1, Propositions 1, 2, and 3, and an ancillary result (Proposition 4) showing that the equilibrium in Proposition 2 is unique up to the choice of prevention spending z.

Lemma 1. *Suppose that* $\phi > 0$. *In equilibrium, if* $\beta^*(x, y, z) > \pi_C$, *then* $\sigma_V^*(x, y, z) = 0$. *If* $\beta^*(x, y, z) < \pi_C$, *then* $\sigma_V^*(x, y, z) = 1$.

Proof. If the incumbent is reelected ($r = 1$), Equation (1) implies that the voter obtains expected (continuation) utility $v_1 = -\phi\beta^*(x, y, z)$. If the incumbent is not reelected ($r = 0$), Equation (1) implies that the voter obtains expected utility $v_0 = -\phi\pi_C$. If $\beta^*(x, y, z) > \pi_C$, then $-\phi\beta^*(x, y, z) < \phi\pi_C$, so $v_0 > v_1$ and not reelecting I is the best response. If $\beta^*(x, y, z) < \pi_C$, then $-\phi\beta^*(x, y, z) > \phi\pi_C$, so $v_0 < v_1$ and reelecting I is the best response. ■

Proposition 1. *Suppose that* $w > 1 + \alpha(1 + c_x)$ *and* $\phi > 0$. *In any PBE* $(\sigma_I^*, \sigma_V^*, \beta^*)$ *and for any triple* (x, y, z) *reached with positive probability under* (σ_I^*, σ_V^*),

$$\beta^*(x, y, z) = \pi.$$

Proof. Let $(\sigma_I^*, \sigma_V^*, \beta^*)$ be a PBE and consider any (x, y, z) reached with positive probability under (σ_I^*, σ_V^*). For the purpose of obtaining a contradiction suppose, contrary to the hypothesis, that

$$\beta^*(x, y, z) \neq \pi. \tag{A1}$$

Let (x_0, y_0, z_0) be a triple reached with positive probability under (σ_I^*, σ_V^*) such that

$$\beta^*(x_0, y_0, z_0) > \pi,$$

and let (x_1, y_1, z_1) be a triple reached with positive probability under (σ_I^*, σ_V^*) such that

$$\beta^*(x_1, y_1, z_1) < \pi.$$

By the supposition that there exists a triple (x, y, z) reached with positive probability under (σ_I^*, σ_V^*) satisfying Inequality (A1), such triples (x_0, y_0, z_0) and (x_1, y_1, z_1) must exist under (σ_I^*, σ_V^*). By Lemma 1, $\sigma_V^*(x_0, y_0, z_0) = 0$ and $\sigma_V^*(x_1, y_1, z_1) = 1$. Now consider the following possibilities:

1. $x_0 = x_1, y_0 = y_1, z_0 \neq z_1$. The biased incumbent is not best responding when choosing z following $(1, \omega, x_0, y_0)$ for some $\omega \in \Omega$. In particular, for some $\omega \in \Omega$, setting $\sigma_I^{z'}(1, \omega, x_0, y_0) = \sigma_I^{z*}(0, \omega, x_0, y_0)$ will strictly increase the biased incumbent's conditional expected payoff by at least $1 - c_z > 0$ (it might increase it by $1 + c_z$). Thus, σ_I^{z*} is not sequentially rational, given β^*. This logic also implies that we can presume that $z_0 = z_1$ for the remainder of the proof.
2. $x_0 = x_1$, $y_0 \neq y_1$, $z_0 = z_1$. Because ω is independent of t and y depends only on ω and x, $\beta^*(x, y, z) = \beta^*(x, 1 - y, z)$ for any (x, y, z) reached with positive probability on the equilibrium path of play. This implies that we can presume that $y_0 = y_1$ (and, by Step 1 above, $z_0 = z_1$) for the remainder of the proof.
3. $x_0 \neq x_1, y_0 = y_1, z_0 = z_1$. The biased incumbent is not best responding when choosing $x = x_0$ following $(1, \omega)$ for some $\omega \in \Omega$. In particular, Step 1 above, combined with the supposition that $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a PBE, implies that $\sigma_I^{z*}(1, \omega, x_1, y) = \sigma_I^{z*}(0, \omega, x_1, y)$ for each $y \in Y$, which implies that

$$\beta^*(x_1, y, z) > \pi$$

for all (x_1, y, z) reached with positive probability (of which there is at least one). Thus, setting $\sigma_I^{x'}(1, \omega) = \sigma_I^{x*}(0, \omega)$ for all $\omega \in \Omega$ implies that the biased incumbent's conditional expected payoff for any ω will increase by at least $w - \alpha(1 + c_x) - 1$. Because we have supposed that $w > 1 + \alpha(1 + c_x)$, it follows that σ_I^{x*} is not sequentially rational, given β^*.

Because we can consider triples (x_0, y, z) and (x_1, y, z), it now follows that presuming that Inequality (A1) is satisfied by any triple (x, y, z) reached with positive probability under (σ_I^*, σ_V^*) implies that σ_I^* is not sequentially rational with respect to β^*, contradicting the supposition that $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a PBE. Thus, for any PBE $(\sigma_I^*, \sigma_V^*, \beta^*)$ and for any triple (x, y, z) reached with positive probability under (σ_I^*, σ_V^*), it must be the case that

$$\beta^*(x, y, z) = \pi,$$

as was to be shown. ■

Proposition 2. *Suppose that* $w > 1 + \alpha(1 - c_z - c_x)$ *and* $\phi > 0$. *The following strategy-belief profile,* $(\sigma_I^*, \sigma_V^*, \beta^*)$, *is a perfect Bayesian equilibrium with beliefs satisfying the D1 refinement:*

$$\sigma_I^{x*}(t, \omega) = 0 \text{ for all } (\mathrm{t}, \omega) \in \mathrm{T} \times \Omega,$$

$$\sigma_I^{z*}(t, \omega, x, y) = y \text{ for all } (\mathrm{t}, \omega, \mathrm{x}) \in \mathrm{T} \times \Omega \times \mathrm{X},$$

$$\sigma_V^*(x, y, z) = \begin{cases} 1 & \text{if x} = 0 \text{ and y} = \mathrm{z}, \\ 0 & \text{otherwise}, \end{cases}$$

$$\beta^*(x, y, z) = \begin{cases} 1 & \text{if x} = 1, \\ \pi & \text{otherwise}. \end{cases}$$

Proof. We first verify the claim that $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a PBE and then verify that β^* satisfies the D1 refinement.

$(\sigma_I^*, \sigma_V^*, \beta^*)$ *is a PBE.* We first verify that the players' strategies are sequentially rational, given β^*, and then demonstrate the consistency of β^* with these strategies. To see that σ_I^* is sequentially rational, note first that deviating from σ_I^{z*} results in a payoff loss of w for all $(t, \omega, y) \in \{0, 1\}^3$ if $x = 0$. If $x = 1$, this deviation results in no change to the incumbent's payoff, as this is off the equilibrium path.

Considering σ_I^{x*}, note that choosing $x = 1$ after either ω will result in a payoff of at most $1 - \alpha c_x$, versus a worst-case payoff (given σ_I^{z*}) of $w - \alpha(1 - c_z)$ after choosing $x = 0$. Thus,

$$w > 1 + \alpha(1 - c_z - c_x) \Rightarrow w - \alpha(1 - c_z) > 1 - \alpha c_x,$$

so any deviation from σ^{x*} results in a strictly lower payoff.

The voter's strategy, σ_V^*, given β^*, is clearly a best response: On the equilibrium path, the voter is indifferent between replacing and reelecting the incumbent. Off the equilibrium path, the voter is similarly indifferent unless $x = 1$. In this case, given β^*, the voter's best response is to replace the incumbent.

Note that β^* is correct on the equilibrium path of play, so that $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a PBE.

β^* *satisfies the D1 refinement.* The type $t = 1$ incumbent clearly has greater incentive to deviate with respect to x, given σ_V^*, and both types of incumbent have equal incentive to deviate with respect to the choice of z. Thus, β^* satisfies the D1 refinement. ■

Proposition 3. *Suppose that $w > 1 + \alpha(1 - c_z - c_x)$ and $\phi > 0$. The following strategy-belief profile, $(\sigma_I^*, \sigma_V^*, \beta^*)$, is a perfect Bayesian equilibrium:*

$$\sigma_I^{x*}(t, \omega) = 1 \text{ for all } (\mathrm{t}, \omega) \in \mathrm{T} \times \Omega,$$

$$\sigma_I^{z*}(t, \omega, x, y) = y \text{ for all } (\mathrm{t}, \omega, \mathrm{x}) \in \mathrm{T} \times \Omega \times \mathrm{X},$$

$$\sigma_V^*(x, y, z) = \begin{cases} 1 & \text{if x} = 1, \\ 0 & \text{otherwise,} \end{cases}$$

$$\beta^*(x, y, z) = \begin{cases} 1 & \text{if x} = 0, \\ \pi & \text{otherwise.} \end{cases}$$

Proof. Demonstrating that (σ^*, β^*) is a perfect Bayesian equilibrium is straight-forward, mirroring the argument for Proposition 2, and therefore omitted. Instead, we demonstrate that the beliefs in this equilibrium, β^*, do not satisfy the D1 refinement.

Let $U^*(t)$ denote the equilibrium expected payoff of an incumbent of type t and

$$D(x, t, \omega) = \{r : p(x, \omega)u_I(x, 1, r, t) + (1 - p(x, \omega))u_I(x, 0, r, t) \geq U^*(t)\}$$

denote the set of responses by the voter that yield an incumbent of type t a weakly higher payoff than his or her equilibrium expected payoff, conditional on the state of nature, ω. Given the equilibrium strategies, σ^*,

$$D(0, 0, 0) = \{1\},$$

$$D(0, 0, 1) = \{\},$$

$$D(0, 1, 0) = \{\},$$

$$D(0, 1, 1) = \{\}.$$

Thus, if the voter observes $x = 0$, the D1 refinement requires that β assign zero probability to $t = 1$ because such an incumbent can never do at least as well from choosing such prevention spending and do as well as he or she can do by following his or her equilibrium strategy. Accordingly, β^* does not satisfy the D1 refinement. ■

The following proposition demonstrates that the equilibrium constructed in Proposition 2 is essentially unique insofar as any other equilibrium differs only with respect to the choice of relief spending.

Proposition 4. *Suppose that $w > 1 + \alpha(1 - c_z - c_x)$ and $\phi > 0$. If $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a perfect Bayesian equilibrium with beliefs satisfying the D1 refinement, then*

$$\sigma_I^{x*}(t, \omega) = 0 \text{ for all } (\mathrm{t}, \omega) \in \mathrm{T} \times \Omega,$$

$$\beta^*(x, y, z) = \begin{cases} 1 & \text{if x} = 1, \\ \pi & \text{otherwise.} \end{cases}$$

Proof. Suppose that $(\sigma_I^*, \sigma_V^*, \beta^*)$ is a perfect Bayesian equilibrium and β^* satisfies the D1 refinement.

By Proposition 1, $\beta^*(x, y, z) = \pi$ for any (x, y, z) on the equilibrium path. Thus, suppose that $\sigma_I^{x*}(t, \omega) > 0$ for some $(t, \omega) \in \{0, 1\}^2$. Given the structure of σ_I^{x*}, all information sets in which $x = 1$ are off the equilibrium path, and β^* correctly assigns probability 1 to $t = 1$ in such information sets. ■

Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix B: A Model with Candidate Skill
Appendix C: Politician's Value of Office Correlated with Type