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ESSAYS ON THE INFLUENCE OF DISTRIBUTIVE AND ELECTORAL POLITICS ON THE POLICYMAKING PROCESS

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Dedicated to Ben, Evan, Lyla, Sam & Finn

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ABSTRACT

The three essays below seek to characterize ways in which distributive and electoral politics affect policy outcomes. The first essay concerns the use of incentives or disincentives to achieve a policy goal and asks how the redistributive implications of these policy instruments might affect a population's preferred means by which to achieve this goal, a preference it ultimately exerts through elections. The second essay asks how incumbency and incumbent uncertainty about challenger quality (e.g., with regards to ability to procure distributive benefits for the constituency) affect the policy promises that candidates make in elections. The third essay – co-authored with Chris Berry and Will Howell – investigates whether party leaders manipulate the distribution of federal spending in order to "buy votes" to secure passage of legislation that would not pass otherwise. The animating questions in each case surround the roles that elections and distributive pressures play in shaping the majority preference and thus determining which policies emerge from the policymaking process.[1]

1. Essay-specific abstracts precede each chapter.

CHAPTER 1

INCENTIVES OR DISINCENTIVES?

Abstract

When government seeks to induce a behavior among the population it governs, it may use either incentive policies to reward those that comply with the desired behavior or disincentive policies to punish those who do not comply. This paper asks which type of policy a majority of the population will prefer, and how it compares to the policy a social planner would choose. If the costs of administering a policy increase in the share of the population receiving the reward or punishment, a complementarity exists between using punishments (vis-à-vis rewards) and inducing high levels of compliance with the desired behavior. This complementarity arises from the following asymmetry: increasing compliance by increasing the size of a reward will raise the administrative cost of using rewards, while increasing compliance (equivalently, decreasing noncompliance) by increasing the size of a punishment will lower the administrative cost of using punishments. Considering the majority preference rather than the social planner's only amplifies this logic, so we find a majority tends to prefer larger punishments (and smaller rewards) than the social planner. We ground the results in a variety of policy relevant examples, particularly questions in food policy.

1.1 Introduction

Policymakers employ incentives and disincentives both across and within a wide range of policy domains. The "individual mandate" to procure health insurance for oneself and the accompanying threat of fines if one was found in violation are central to the Affordable Care Act. A key feature of the proposed replacement is a program of subsidies that would serve as an incentive for individuals to purchase health insurance. In the realm of environmental policy, polluting activities are often discouraged through taxes, while initiatives such as Cash for Clunkers reward the retirement of less efficient vehicles and/or subsidize the purchase of more efficient vehicles. Even national education policy has featured both disincentive- and incentive-based policies in recent years in the form of No Child Left Behind and Race to the Top, respectively (Howell 2004, Howell & Magazinnik 2017).

These examples suggest, and it is theoretically plausible, that a policymaker wishing to influence behavior in a population may turn to either rewards or punishments. In what circumstances should individuals that take a desired behavior be rewarded, and in which cases should individuals that fail to comply with a desired behavior receive punishment? How does the normative answer to these questions compare to the positive answer? In particular, when accounting for the redistributive implications of such policies, how does the politically viable policy intervention compare to the policy intervention that maximizes social well being? While much policy aims to promote positive externalities or reduce negative externalities, under what conditions will we observe policies that disincentivize socially beneficial behaviors or incentivize socially harmful behaviors?

This paper approaches these questions by modeling a simple setting in which each member of a population chooses one of two actions. It is known which action is the more socially desirable, so we wish to know first which type of policy – incentive or disincentive – a public-interested social planner would use to encourage this action. Second, we wish to know what policy a majority of the population would support – both whether it will promote the socially desirable or undesirable action and whether incentives or disincentives would serve as the means to do so.

Comparing the social planner's preferred policy to the majority-preferred policy constitutes our approach to characterizing the ways in which the policy outcome of a democratic process may fail to maximize the population's welfare. In both normative and positive contexts, we are interested in the type of policy, i.e., incentive or disincentive, as well as the size of the intervention, i.e., how big is the reward/punishment, how much compliance does it induce? Our aim is to understand how these answers change in response to changes in the rate at which benefit accrues to society from its members taking the socially desirable action, the distribution of preferences over taking that action, and the costs of administering each type of policy intervention.

While the costs entailed in government intervention always deserve attention, as they must not outweigh the benefits, the costs of administering policy interventions play a much larger role here. Specifically, we highlight an inherent difference in the way that costs accrue from incentive and disincentive policies and the implications of this difference for which type of intervention policymakers should, and will, employ. We note that administrative costs associated with policies grow in the share of the population to which they are applied. Further, rewards must be given to all those who comply, while punishments must be given to all those who do not, and they must be given at the same level. From these two suppositions, an important asymmetry follows. Increasing the size of a reward induces greater compliance, which in turn increases the share of the population who must receive the reward, applying upward pressure on administrative costs. Increasing the size of a punishment also induces greater compliance, but this reduces the share of the population who must receive the punishment, applying downward pressure on administrative costs. This suggests a complementarity between higher shares of the population taking the desired behavior and the use of punishments rather than rewards.

We frequently draw on the domain of food policy in motivating the modeling choices and especially in grounding the results. Examples include the Conservation Reserve Program, run by the Farm Services Administration, which incentivizes farmers to lake land out of agricultural production,[1] the infamous "sugary drink taxes,"[2] increasing the value of food stamps when they are used on fruits and vegetables, and the farmer-borne costs entailed in organic certification. In many of these cases, policymakers – and citizens in large part – agree there is a harm not internalized by members of the population. In the first, it is the overuse of land and overproduction of certain crops. In the second and third, it is the adverse effects of poor health that ripple across the U.S. economy. In these cases, policymakers wish to encourage individuals to take a desired behavior, be it more judicious land management and environmental stewardship or healthier consumption choices. This paper asks why incentives are used in some of the policies while disincentives are used in others. In so doing, it also sheds light on policies such as the fourth example, in which a socially beneficial behavior seems to be taxed.

After placing this paper in the context of related literatures, we clarify our modeling of the policymaking environment, which enables us to address the normative point of view of the social planner. We then turn to the political economy of incentives and disincentives. After considering the redistributive implications of each type of policy for members of the population, we inquire as to the pressure that popular support might exert on the choice of policy, how this choice compares to the policy that a social

1. `https://www.fsa.usda.gov/programs-and-services/conservation-programs/`, accessed January 2017.

2. Neuman, William. Sept. 16, 2009. "Proposed Tax on Sugary Beverages Debated." *The New York Times*, accessed at `http://www.nytimes.com/2009/09/17/business/17soda.html`.

planner would have chosen, and some of the vagaries of the majority-preferred policy, such as the possibility of policies that discourage beneficial behavior. We instantiate many of the concepts and claims in the context of U.S. food policy before concluding with a brief review of the insights uncovered herein and ideas for future work on the use of incentives and disincentives.

1.2 Related Literature

> ...the only fair way to begin must be with the tenet that there is no basic or universal rationale for having a general predisposition toward one control mode or the other... Even on an abstract level, it would be useful to know how to identify a situation where employing one mode is relatively advantageous, other things being equal.
>
> Weitzman (1974)

As regards the question of incentives or disincentives, Weitzman's challenge has not been taken up.[3] Certainly a good deal of behavioral work has studied differences likely to arise in individual-level responses to positive and negative inducements (Kaplow & Shavell 2007, Benabou & Tirole 2011). From a rational choice perspective, however, it is yet to be identified in which situations incentives or disincentives are "relatively advantageous." This paper not only seeks to remedy that omission, but also to address the nature of the policies likely to emerge from democratic political processes.

Rational choice analyses in political science have instead focused on aspects of the policymaking process surrounding the choice of policy instrument. The large literature

3. Weitzman wrote on price vs. quantity policies; both incentives and disincentives constitute variants of price policies. The difference between price and quantity policies in this and follow-on papers hinges on uncertainty about the benefits and costs of regulation, while in the model herein we rely only on the heterogeneity of actors within a population (Pizer 1997, Grodecka & Kuralbayeva 2015).

on bureaucracy has devoted significant attention to the decision of a political principal to delegate decisions, such as those over the policy instruments, to other actors within the government (Gailmard & Patty 2013). When it comes to the implementation of policy decisions, even Pressman & Wildavsky's (1984) landmark study focuses on the target of policies, rather than the choice of instrument with which to pursue a given target.

In contrast to the work that treats incentive and disincentive policies as entirely interchangeable, public administration and legal scholars exploring alternative approaches to regulation have explicitly weighed "punishment" against "persuasion" (see Gunningham (2012), Baldwin, Cave & Lodge (2012, ch. 7), Lodge & Wegrich (2012, pp. 76-80), and De Geest & Dari-Mattiacci (2013)). While they highlight a variety of potential asymmetries between the regulatory strategies of incentives and disincentives, it is the embrace of these dissimilarities from the outset that prevents this work from speaking to more fundamental, institutional differences. To serve as an effective counterpoint to the notion that incentives and disincentives constitute essentially the same enforcement technology, we must begin more agnostically, framing the two approaches as similarly as possible. Further, without formally modeling the salient features common across policy domains, it is difficult to extend those analyses to speak to the policy that would emerge from the democratic process, much less to compare such predictions to the socially optimal policy.

The economics literature has approached questions of punishment or reward from a number of angles, but few with any political context. For instance, principal-agent models deal directly with behavior change through incentives and disincentives (Holmstrom 1979), but the principals are profit-seeking rather than public-interested or office-motivated. Further, because much of the moral hazard literature consider a single agent (Banks & Sundaram 1998, p. 299), this leaves no room for a true choice between incentives and disincentives. As an example, Dal Bo, Dal Bo & Di Tella (2006) study the use of bribes and/or threats (physical and political) by a group looking to gain influence over government officials. Because the politician will either comply or not, the group will never have to undertake both costly endeavors and may put both on the table. This is no longer the case when applying incentives or disincentives to an entire population.

The economic theory of regulation, inaugurated by Stigler (1971) and Posner (1974), sought to replace the long-standing assumption that regulation served the public interest with the understanding that regulation was the outcome of strategic interaction among competing interest groups (Peltzman 1989, Shleifer 2005). In doing so, it shifted attention away from the evaluation of alternative policy instruments. While Becker's (1983, 1985) pathbreaking work on interest groups does consider taxes and subsidies, they are purely redistributive, separated from any policy seeking to affect behavior.

The literature on public enforcement is almost entirely concerned with the deterrence of undesirable actions through punishment (see Polinsky & Shavell (2000) for a thorough review of the literature). Again, a notable exception comes from Becker (1968), who does consider the use of rewards, as well as punishments, and who appreciates the way that the size and scale of policies affect costs differently in the two types of policies. He stops short, however, of asking why desirable behavior is sometimes induced with incentives and at other times with disincentives, either normatively or positively.

Finally, beginning with Coase (1960), the theory of torts has long appreciated the ostensible symmetry underlying the assignment of liability, asking whether to lay fault with the injurer (e.g., a firm) or the injured (e.g., a consumer) in the event of an accident (Calabresi & Melamed 1972, Miceli 2004).[4] The institutional choice problem

4. Indeed, our question may be placed in the Coasian framework. Should the government retain "property rights" over a domain and exact payment from those that choose $a = 0$, or should the government cede these rights and offer to pay any individuals who choose $a = 1$?

in the study of torts is to choose the least-cost avoider (Posner 2005). In our setting, the social planner seeks to minimize the administrative costs entailed in carrying out the policy, and she has no action available to her analogous to precaution in the torts setting, and nothing akin to transactions costs in determining/enforcing the optimal policy to worry about.

1.3 Modeling the Policy-Making Context

The setting consists of a single period in which all members of a population choose $a \in \{0, 1\}$ exactly once. The population consists of a unit mass of individuals. Denote a member of the population by i, and let i's *ex ante* valuation for taking the desired action as v^i (i.e., in the absence of any incentives or disincentives).[5] We assume the valuations are distributed according to a continuously differentiable cdf $F(\cdot)$, with $\underline{v} \leq v_i \leq \overline{v}, \forall i$. Note that v^i may be negative, indicating a latent propensity to take $a = 0$, or positive, indicating that i would comply with the desired behavior without any further inducement. Indeed, we assume $\underline{v} < 0 < \overline{v}$, such that there are *ex ante* compliers and non-compliers in the population.[6]

When members of the population choose $a = 1$ instead of $a = 0$, it imparts social benefit (or, equivalently, reduces social harm). As such the social planner – a public-interested policymaker – would only consider policies that encourage $a = 1$ or $a = 0$. In principle, however, a policy may encourage either $a = 1$ or $a = 0$, and indeed redistributive implications may lead to majority support for a policy of incentives for $a = 0$

5. This term captures the net benefit of taking $a = 1$ or $a = 0$. Indeed, set $u^i(0) = 0$, so $\forall i, v^i = u^i(1)$.

6. The concept of heterogenous valuations is particularly salient for incentives or disincentives to grow certain crops. The border between growing regions ought not to be thought of as entirely rigid nor entirely malleable. Between two regions, farmers can switch between crops more easily than those firmly inside a given growing region. How far into an area the margin is found depends on the size of the policy intervention.

or disincentives for $a = 1$. We focus first on the social planner's optimal policy, though, because it serves as a benchmark for the subsequent analyses and is interesting in its own right as a study of correcting market failure. Further, we consider monetary incentives and disincentives, namely subsidies and taxes, though the analysis is amenable to other kinds of incentive and disincentive policies.[7]

A social planner wishing to encourage citizens to take action $a = 1$ rather than $a = 0$ may reward those who comply, punish those who do not, both, or neither. To capture the constraints of policymaking, we assume that the policy cannot impose different levels of reward or punishment across the population. This requires that any individual in the population receiving a reward receives the same level of reward, and similarly for punishments.[8] We proceed at first as though all members of the population are subject to the policy, i.e., that we cannot distinguish a subpopulation of interest to whom the policy applies and the remainder of the population to whom it does not. We later consider the presence of an "unaffected" subpopulation. We suppose further that the policymaker has full information, sidestepping issues of probabilistic enforcement.

Incentives, R, and disincentives, P, enter additively into the utility functions of individuals so as to abstract from behavioral concerns, and we assume individuals choose $a = 1$ in the case of indifference. It follows immediately that i chooses $a = 1$ if and only if the utility she derives from complying plus any rewards offered is at least as large as the utility she receives from choosing $a = 0$ minus any threatened punishments, i.e.,

7. We use taxes and fines interchangeably, as in "carbon tax," where the tax is a penalty, not redistributive in purpose.

8. Consider the Environmental Quality Incentives Program (EQIP). This is a reward-based initiative encouraging a variety of sustainable practices in agriculture. A central problem of enforcement of this program has been larger operations receiving funds for practices they would have already undertaken, and which do not represent additional efforts taken towards sustainability (Wilde 2013, pp. 50-51). For example, large-scale animal feeding operations have applied and received funding for setting up waste storage lagoons – a necessary endeavor for these facilities and one that need not have been incentivized. Yet that is the nature of rewards. They must be applied to all who comply and are in the eligible population. `https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/`, accessed January 2017.

$v_i + R \geq -P$. We then have the following result regarding *ex post* compliance.

Fact 1.1. *A member of the population i chooses $a = 1$ iff $v^i \geq -R - P$. The measure of the population choosing $a = 1$ is then $1 - F(-R - P)$, while the measure of the population choosing $a = 0$ is $F(-R - P)$.*

The social planner takes into account any externalities from compliance (positive from choosing $a = 1$ and/or negative from choosing $a = 0$), the utility that members of the population derive from their chosen action, and the deadweight costs of administering policies. Let the function $W : [0, 1] \to \mathbb{R}$ represent the external benefit to society from a fraction of the population choosing $a = 1$. We assume that $W(\cdot)$ is continuously differentiable, with $W' > 0$. We do not consider the possibility that members of a population impose heterogeneous external costs and/or benefits through their actions.

The internalized effects of individuals' actions on their utility across the population are given by the "sum" of the valuations of all those who comply by choosing $a = 1$. As our population is a continuum, we write $\int_{-R-P}^{\bar{v}} v f(v) dv$, where $\{i | v^i \in [-R - P, 0)\}$ constitutes the set of *ex post* compliers that would not have complied without the inducement of any incentives or disincentives. Recall that v^i accounts for the benefits and costs of compliance to members of the population. As such, foregone utility or profit, or the cost of adopting a new technology, would be included in v^i. This quantity is decreasing in compliance, exerting downward pressure on the social planner's utility as more individuals switch from their *ex ante* preferred choice of behavior. This would be the distortionary effect of a policy intervention, as typically conceived of in the welfare economics literature.

Total rewards distributed are of the sum $R \cdot [1 - F(-R - P)]$, as the entire measure of those choosing $a = 1$ must be given the reward, which is of size R. This represents an addition to the utility of those receiving the reward but must be financed through taxation. Transfers have no net effect on the social planner's utility. Total punishments equal $P \cdot F(-R-P)$, as the measure of those choosing $a=0$ must receive the punishment. This represents a subtraction from the utility of those receiving the punishment but is then redistributed to the population as a whole, so it is also not taken into account by the social planner.

Such transfers, however, are not administered without costs. We account for the gain or loss from transfers in our formulation of the deadweight costs to policy. Let $C_p : [0,1] \to \mathbb{R}$ and $C_r : [0,1] \to \mathbb{R}$ be functions giving the administrative cost incurred to achieve a given level of compliance via disincentives and incentives, respectively. Note that $C_p(1-F) > 0$ and $C_r(1-F) > 0$. To capture the notion that the costs of administering a policy are increasing in the measure of individuals to whom the policy is applied (those receiving rewards and/or those receiving punishments), suppose $C_p'(1-F) < 0$ and $C_r'(1-F) > 0$.[9]

The two types of policy share many costs in common. In many instances, most monitoring costs are incurred across the entire population and would be necessary for either type of policy. It is likely, though, that certain forms of rewards, such as tax credits, require a smaller administrative apparatus than punishments. In any case, we may wish to let the fixed costs of the two types of policies differ from one another. To allow for this flexibility, let $C_p(1) \geq 0$ and $C_r(0) \geq 0$.

Example The figures illustrating key results that appear throughout the paper all employ the same simple functional forms, which we specify here as examples to ground the descriptions above of the components of the model.

Letting $v^i \sim U(\underline{v}, \overline{v})$, then $F(v) = \frac{v-\underline{v}}{\overline{v}-\underline{v}}$, and where $a < 0 < b$. *ex ante* compliance

9. It is likely that administrative costs also increase in the size of the reward and/or punishment, as well. The formulation above provides the most straightforward analytical approach to drawing out the central insights of the model, however, so we proceed as though administrative costs of a policy depend only on the measure of individuals to whom that policy is applied. Importantly, allowing administrative costs to increase in the size of the policy as well as in the share of the population recieving the reward or punishment does not alter any of the substantive conclusions presented below.

is then $1 - F(0) = \frac{\overline{v}}{\overline{v}-\underline{v}} \in (0,1)$. The effect on individuals' utility of changing their behavior is given by $\int_{-R-P}^{\overline{v}} vf(v)dv = \frac{\overline{v}^2-(-R-P)^2}{2(\overline{v}-\underline{v})}$ Further, suppose:

$$\begin{aligned}
W(1-F(-R-P)) &= g \cdot [1-F(-R-P)] = g \cdot \left(\frac{\overline{v}+R+P}{\overline{v}-\underline{v}}\right),\ g>0 \\
C_p(1-F(-R-P)) &= C_p \cdot F(-R-P) = C_p \cdot \frac{-R-P-\underline{v}}{\overline{v}-\underline{v}},\ C_p>0 \\
C_r(1-F(-R-P)) &= C_r \cdot [1-F(-R-P)] = C_r \cdot \frac{\overline{v}+R+P}{\overline{v}-\underline{v}},\ C_r>0
\end{aligned}$$

In these examples, there is no fixed administrative cost of either type of policy, i.e., $C_r(0) = C_p(1) = 0$.

1.4 The Social Planner's Optimal Policy

The social planner – a public-interested policymaker – thus faces the following problem:

$$\max_{P,R\in\mathbb{R}_+^2} W(1-F(-R-P)) + \int_{-R-P}^{\infty} vf(v)dv - \mathbb{I}_{P>0} \cdot C_p(1-F(-R-P)) - \mathbb{I}_{R>0} \cdot C_r(1-F(-R-P)), \tag{1.1}$$

subject to the constraint that this be greater than social welfare under the status quo, which is given by $W(1-F(0)) + \int_0^{\overline{v}} vf(v)dv$.

As a preliminary step in understanding the social planner's optimal type and size of policy, we first show that it is never optimal to use both incentives and disincentives to encourage the same behavior. This result stems from the opposing directions in which the administrative costs of punishment and reward policies respond to increases in compliance with the desired behavior among the population. The result reduces the social planner's problem to comparing the optimal punishment-based policy and the optimal reward-based policy. This significantly simplifies the ensuing analysis and is itself an interesting insight.

Lemma 1.1. *It is never optimal to use strictly positive levels of both punishments and rewards.*

The proof, which may be found in Section 1.10.1 of the Appendix, builds upon the administrative costs of punishments decrease in compliance with $a = 1$ achieved, while the administrative costs of rewards increase in compliance. If there exists a level of compliance with $a = 1$, say $1 - \tilde{F}$, at which $C_r(1 - \tilde{F}) = C_p(1 - \tilde{F})$, then for all $1 - F > 1 - \tilde{F}$, punishments are the cheaper method of encouraging $a = 1$, while for all $1 - F < 1 - \tilde{F}$, rewards are the cheaper method. To achieve the level of compliance $1 - \tilde{F}$, the social planner would be indifferent among the two types of policies but would want to use only incentives or only disincentives, so as not to double up on costs. Hence, the least-cost approach to achieving any level of compliance never entails using both types of policies in concert.[10]

Lemma 1.1 allows us to narrow our focus to the cases in which the policymaker will use only punishments or only rewards, if she intervenes at all. The social planner's problem may now be stated as follows: determine the optimal size of reward, R^*, if restricted to only use rewards; determine the optimal size of punishment, P^*, if restricted to only use punishments; having found the optimal size of each type of policy, then compare social welfare under P^* and R^* to find the optimal type (and size) of policy.

Equations 1.2 and 1.3 characterize the solutions to the problems of choosing an optimal P and an optimal R as individual policies. The social planner maximizes $W(1 - F(-P)) + \int_{-P}^{\overline{v}} vf(f)dv - C_p(1 - F(-P))$ with respect to P to find the best

10. As remarked on in the Appendix, this result is robust to expanding the influences on administrative cost to include the size of the policy itself (i.e., P, R), not just the measure of individuals to whom a policy is applied.

choice for the size of punishment to obtain:

$$[P] : W'(1-F) \cdot f - P^* \cdot f = C_p'(1-F) \cdot f. \tag{1.2}$$

The social planner maximizes $W(1 - F(-R)) + \int_{-R}^{\bar{v}} vf(v)dv - C_p(1 - F(-R))$ with respect to R to find the best choice for the size of reward to obtain:

$$[R] : W'(1-F) \cdot f - R^* \cdot f = C_r'(1-F) \cdot f. \tag{1.3}$$

These two equations implicitly characterize the best choice of P and the best choice of R, were the policymaker restricted to each type of policy, respectively. Under the limited assumptions we have deployed, however, do the equations indeed characterize maxima? Can we guarantee uniqueness? What is needed for existence? Will the social planner prefer P^* or R^*? Rather than invoke additional assumptions to ensure uniqueness or even the existence of interior solutions given by Equations 1.2 and 1.3, and to characterize social planner's most preferred policy, we employ results from the theory of monotone comparative statics.

To facilitate this approach, we reframe the social planner's decision as jointly determining the optimal level of compliance and optimal type of policy. The type of policy is taken to be one choice variable, and the level of *ex post* compliance achieved is taken to be the other.[11] With regards to the type of policy, we will be interested in the attractiveness of using punishments relative to the attractiveness of using rewards to achieve a given level of *ex post* compliance. We treat the decision to deploy an active policy intervention or to remain at status quo levels of compliance $(P, R = 0)$ as a subsequent decision, in which the optimal policy intervention is compared to the status quo.

11. The equivalence of this approach is established, and the approach fully explicated, in the Appendix.

Optimal Policy Intervention The social planner's most-preferred policy intervention, characterized by an optimal level of compliance and an optimal type of policy that together specify $P^* > 0$ or $R^* > 0$.

We seek to derive results about the way in which the optimal choice of type and size of policy changes as a function of changes in the exogenously given elements of the model. In a problem with two choice (i.e., endogenous) variables, the first step is to characterize the relationship between the two. The next lemma establishes that the *ex post* level of compliance and the use of disincentives (as opposed to incentives) are complements. This is a direct result of the asymmetric way in which administrative costs accrue under each incentive and disincentive policies.[12]

Lemma 1.2. *An increase in the level of compliance, $1 - F$, is more attractive under the use of disincentives than under the use of incentives. Equivalently, the use of disincentives is increasingly attractive relative to the use of incentives as compliance increases.*

Any exogenous change which leads to an increase (resp. decrease) in the optimal value of at least one of the choice variables will indirectly lead to an increase (resp. decrease) in the other, where all increases/decreases are weak and where we use the ordering $p > r$. An exogenous change that increased the optimal level of compliance would make the use of punishments increasingly attractive relative to the use of rewards, though rewards may still be the optimal policy. This approach ensures that any indirect effects that occur among the choice variables reenforce the direct effect of the exogenous variable on the optimal policy. Only if a change in an exogenous variable leads to an increase in one choice variable but a decrease in the other will we be unable to be sure of the overall effect of the change in the variable on the optimal policy.

12. Equation 1.7 and the surrounding discussion in Appendix 1.10.1 suffice as a proof of the assertion.

The parameters of interest are the functions $W(\cdot)$, $F(\cdot)$, $C_p(\cdot)$, and $C_r(\cdot)$. We look for complementarity between each exogenous element and the choice variables. Proposition 1.1 makes clear that such conclusions are possible for some parameters but not with others. We split the Proposition into parts to facilitate the exposition and explanation of the result for each parameter.[13]

Proposition 1.1 (a)**.** *As the added value to society from additional compliance with* $a = 1$ *rather than* $a = 0$ *increases at all levels of compliance: the level of compliance in the optimal policy intervention increases; the administrative cost of using disincentives to achieve the optimal level of compliance decreases, while the cost of using incentives increases; and the optimal policy intervention becomes more attractive relative to the status quo.*

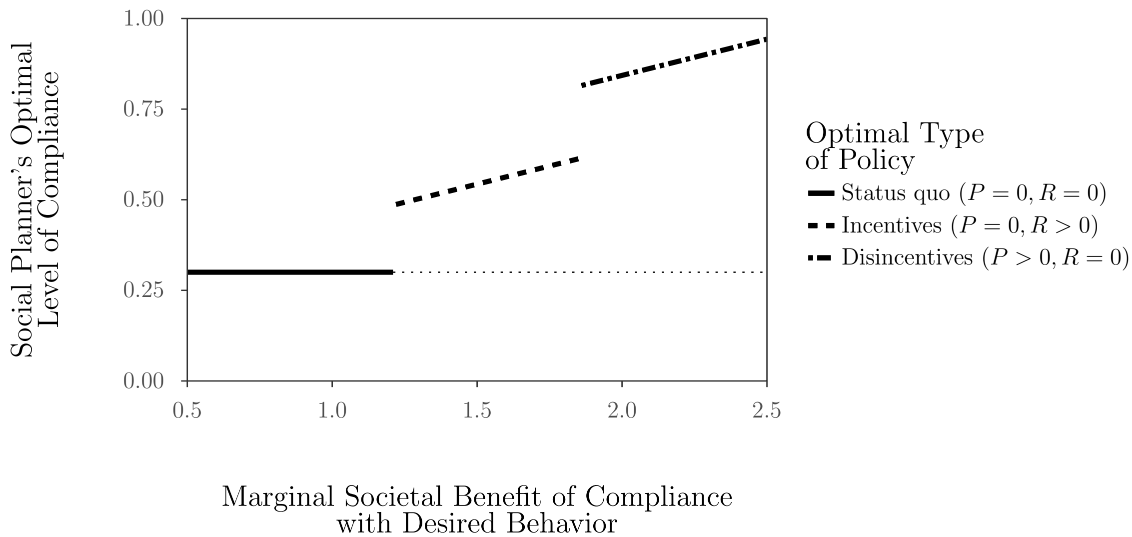
Part (a) of the proposition regards the externality at the heart of the social planner's problem – conceived of either as the societal benefit that accrues from greater compliance with $a = 1$ and/or the social cost from individuals choosing $a = 0$. Increasing the benefit of additional compliance with $a = 1$ at all levels of compliance (i.e., for all $1 - F \in [0, 1]$) leads the social planner to want higher *ex post* levels of compliance. Even though there is no direct effect on the optimal type of policy, because of the complementarity between higher levels of *ex post* compliance and the use of punishments rather than rewards, the change increases the attractiveness of using disincentives relative to using incentives. While increasing the benefit of additional compliance with $a = 1$ increases the social planner's utility from the status quo, it increases the social planner's utility from the optimal policy intervention by at least as much.

Figure 1.1 depicts the comparative statics from part (a). As the marginal societal benefit from additional compliance increases (at all levels of compliance), the optimal

13. Each part follows immediately from a more formal, corresponding statement given in Appendix 1.10.1.

level of compliance is weakly increasing. Accordingly, the optimal type of policy moves from rewards to punishments. Further, once a policy intervention is optimal (vis-à-vis the status quo), policy intervention remains optimal as additional compliance yields even higher marginal societal benefit.

Figure 1.1: The effect of increasing the marginal benefit to society of compliance on the optimal level of compliance and type of policy



Notes: The dotted line represents the status quo level of compliance. As per the functional forms given in the example above, g is the marginal societal benefit, or W' in the notation of the model.

A useful characterization of the result, albeit not entirely precise, goes as follows. Policy domains in which a small increase in the share of the population choosing $a = 1$ relative to the status quo yields large but rapidly diminishing increases in societal benefit (or reduction of societal cost) favor the use of rewards. Policy domains in which small levels of non-compliance with $a = 1$ bear high societal cost (or forgo large societal benefits) favor the use of punishments.

Consider the rewards in the form of monopolistic market power that are granted to patent and copyright holders. When inducing innovation of any given product or even artistic creation, most benefit accrues at low levels of "compliance" but levels off at higher levels of compliance. This suggests that rewards are likely to be optimal. The seeming absurdity of the notion that we might penalize people for not innovating is in fact a reflection of the inefficiency of punishing a large segment of the population in order to spur innovation by those with the highest *ex ante* valuation for innovating (likely those best positioned to do so). For actions in which the order and well-functioning of society depend on nearly full compliance (e.g., safe driving, respecting property rights, not committing violent acts), small levels of non-compliance achieved with a (possibly large) punishment often most efficiently attain the external benefit of compliance without incurring excessive administrative costs.

This insight comprises the most direct answer to the normative aspect of the question motivating this paper, namely, when should we use an incentive rather than a disincentive to induce a desired behavior? A policy domain characterized by the goal of near elimination of a given market failure across the population is likely best served by a punishment policy, as this is the cheapest type of policy to administer for high levels of compliance. A policy domain characterized by the goal of inducing a small level of compliance, perhaps inducing a few firms or a small fraction of individuals to take a given action, is a strong candidate for a reward-based policy. The application to U.S. food policy below discusses this further, and the analysis of popular support for incentive and disincentive policies makes repeated use of this result as an analytical tool.

We turn now to consider the effect of changes in the distribution of valuations for, *ex ante*, choosing $a = 1$ rather than $a = 0$. In particular, the change we consider is an "upward shift" in the distribution of valuations for compliance, F. This is a stronger assumption than is strictly necessary here, but for the sake of continuity with the needs of later sections, we restrict attention to these upward shifts.[14]

Upward Shift in the Distribution of Valuations $\hat{F}$ represents an upward shift of F if for $v \sim F$ and $\hat{v} \sim \hat{F}$, $\hat{v} = \mu + v$ for some $\mu \geq 0$.

Proposition 1.1 (b)**.** *As the distribution of the population's valuations for choosing* $a = 1$ *rather than* $a = 0$ *shifts upwards: the level of compliance in the optimal policy intervention increases, and disincentives become less costly as the choice of policy with which to achieve the optimal level of compliance, while incentives become more costly.*

The optimal policy intervention and the status quo both provide the social planner greater utility, neither at an unambiguously higher rate than the other.

This part of the proposition asks how the social planner's optimal policy would change if the population were *ex ante* more compliant with the socially-desirable behavior, $a = 1$. In a more *ex ante* compliant a population, fewer individuals must change their behavior in order to achieve a desired level of compliance, so this element of social cost is less of a hindrance to achieving higher levels of compliance. The policy intervention will be less distortionary.

Similar to the analysis of W, an upward shift in F has no direct effect on the attractiveness of using punishments instead of rewards. Through its effect on the optimal level of compliance, however, an upward shift in F indirectly reduces the cost of disincentive policies while increasing the cost of incentive policies. As before, this promotes higher levels of compliance in policy interventions, which in turn makes using punishments increasingly attractive relative to using rewards.

An upward shift in F affects the status quo utility more intricately than the change considered in part (a). The positive valuations of those *ex ante* complying (i.e., $v_i \geq 0$)

14. For Proposition 1.1(b), the results hold for any first-order stochastic increase in the distribution of valuations.

increase, although there is also a corresponding decrease in the negative valuations required to achieve a given level of compliance, as just discussed. These effects work similarly on the social planner's evaluation of both the status quo and the optimal policy intervention. Additionally, however, $W(1 - F(0))$ increases, while $W(1 - F)$ need not increase for $1 - F > 1 - \hat{F}$. We cannot conclude, then, that if under an upward shift will always make a policy intervention increasingly attractive relative to the status quo.

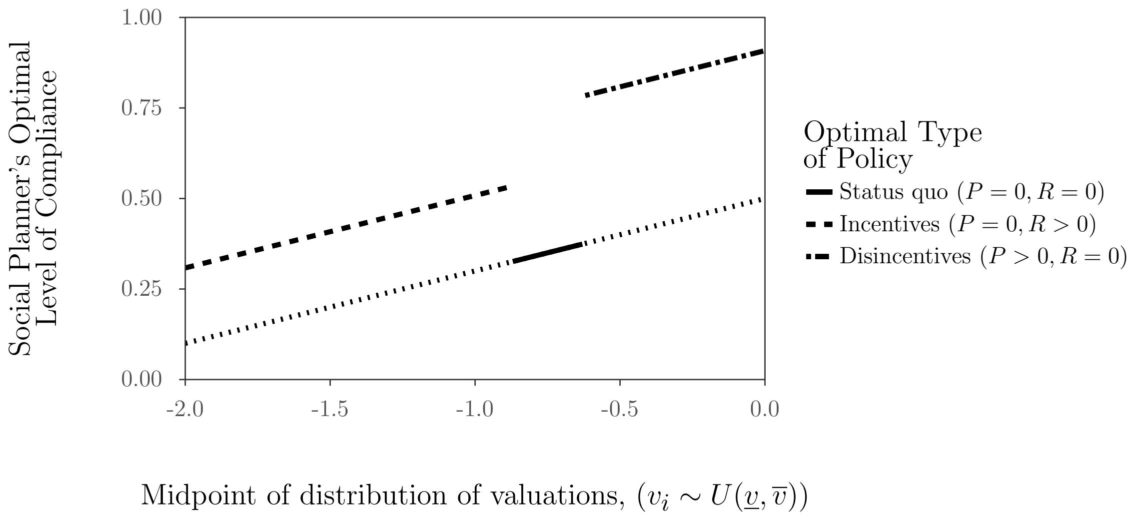
Figure 1.2 illustrates these results. Moving to the right along the horizontal axis, the distribution of valuations, F, shifts upwards. Our example entails a uniform distribution of valuations, and the running variable is the midpoint of the distribution. The optimal level of compliance is increasing when a policy intervention is optimal, and this ultimately favors the use of punishments instead of the use of rewards. As discussed, it may be that the optimal level of compliance and type of policy "regress" to the status quo even as F continues to shift upwards.

In the present analysis, F will play an important role below in modeling the presence of a subpopulation for which the policy intervention is not intended. The distribution of valuations would also be central to an analysis that incorporated behavioral phenomena. We turn next to analyze the role of the administrative costs of the different types of policy.

Proposition 1.1 (c)**.** *A decrease in the marginal cost of using disincentives to induce more of the population to choose $a = 1$ rather than $a = 0$ with no change in fixed costs has competing effects on the level of compliance and type of policy in the optimal policy intervention. The same holds for increases in the marginal cost of using incentives to induce more compliance with $a = 1$.*

The final result in Proposition 1.1 is surprising precisely because of the ambiguity it highlights. Adjusting the marginal costs of the types of policies would seem to be

Figure 1.2: The effect of increasing the *ex ante* valuations for choosing $a = 1$ rather than $a = 0$ on the optimal level of compliance and type of policy



Notes: The dotted line represents the status quo level of compliance, $1 - F(0)$. As per the functional forms from the example at the end of the previous section, $v_i \sim U(\underline{v}, \overline{v})$, and the horizontal axis represents $(\overline{v} + \underline{v})/2$. An increase in this quantity corresponds to an upward shift in the distribution of valuations ($F(\cdot)$ in the terminology of the model).

the most straightforward way to favor one type over the other, but this is not the case. The changes have direct effects on both the optimal level of compliance and the optimal type of policy, but in such ways that the indirect effects find themselves at odds. We are unable to state without invoking additional assumptions that reducing the per-unit administrative costs of a type of policy makes it more likely that type policy will be optimal.[15]

The direct effect of lowering the marginal cost of either type of policy on the optimal level of compliance is to encourage larger policy interventions. The other direct effect of lowering the marginal cost of rewards is to make rewards cheaper relative to punishments and thus their use more attractive at any level of compliance. Meanwhile,

15. Specifically, the additional assumptions – likely related to the fixed cost – would also need to ensure that the average cost of a given policy decreased at all levels of compliance.

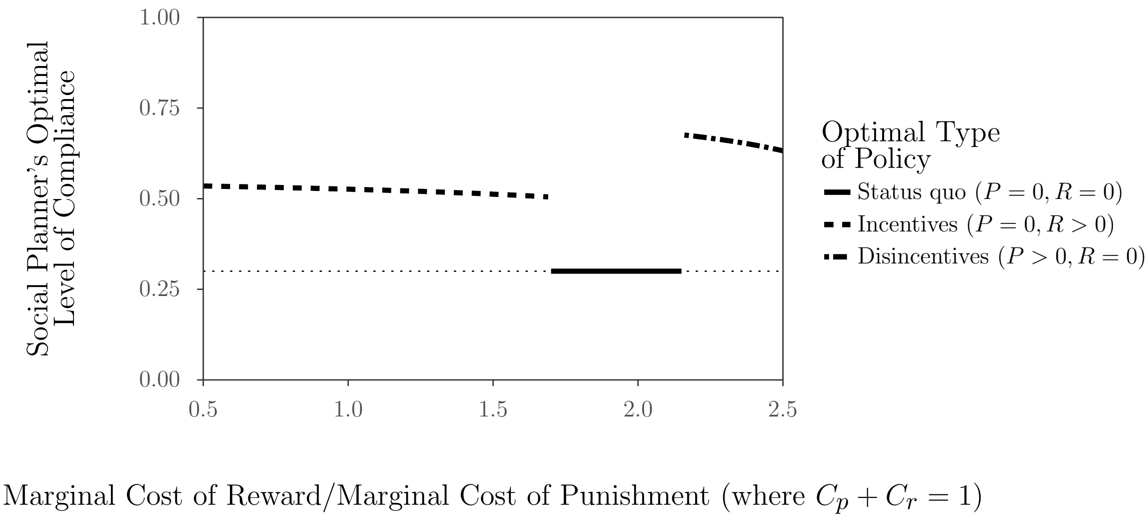
because the fixed cost of a punishment policy has not changed, the other direct effect effect of lowering the marginal cost of punishments is to increase the cost of using disincentives at any level of compliance, increasing the relative attractiveness of using incentives. The indirect effect of making higher levels of compliance cheaper to achieve is to favor the use of punishments, and the indirect effect of making rewards relatively more attractive is to favor lower levels of compliance.

Figure 1.3 shows exactly these effects. The running variable is the ratio of the coefficients on the cost terms (see the example functional forms given above), which represent the marginal costs. To demonstrate changes in both variables, we restrict the coefficients to sum to one, although note that this forces the marginal cost of rewards to increase as the marginal cost of punishment decreases. The optimal level of compliance decreases even as the marginal cost of a disincentive-based policy falls relative to the marginal cost of incentive-based policy. While the optimal type of policy does not switch back to rewards, as the proposition suggests could occur, this is likely because we have tied a decrease in C_p to an increase in C_r. Furthermore, the competing effects that occur when marginal costs change allow the status quo to be more attractive than either type of policy intervention at intermediate levels.

1.5 Modeling the Political Environment

In contrast to a social planner, an office-motivated politician seeks a policy that will garner the support of a majority of the population will support. Accordingly, we now undertake a characterization of the majority-preferred policy and its relationship to the social-planner's optimal policy. Part and parcel of this task will be engaging with the redistributive consequences of different types of policies. In this section, we establish a stylized depiction of redistribution with which we may engage the pressures of attaining popular support for policies. We also outline a similarly stylized model of elections that

Figure 1.3: The effect of decreasing the marginal cost of disincentives and increasing the marginal cost of incentives on the optimal level of compliance and type of policy



Notes: The dotted line represents the status quo level of compliance, Γ_0. The ratio of marginal cost coefficients, C_r/C_p, is increasing along the horizontal axis. For purposes of illustration, $C_p + C_r = 1$, though of course this need not be the case more generally.

motivates our focus on the majority preference.

The Redistributive Implications of Incentives and Disincentives

We suppose redistribution, the disbursement of revenues from fines as well as the financing of subsidies, is achieved via lump-sum transfers applied uniformly across the population, as in Meltzer & Richard (1981). All members of the population receive an equal share of revenues collected from fines and carry an equal burden in the financing of subsidies. We continue to assume that the policy applies to the population at large, not just a distinguishable subpopulation

Fines are still only administered to those who choose $a = 0$, while subsidies are only given to those who choose $a = 1$. Given a fine of size P and a subsidy of size R, revenues from fines available for redistribution are given by $P \cdot F(-P - R) - C_p(1 -$

$F(-P-R))$, while the required financing for a subsidy is given by $R \cdot [1-F(-P-R)] + C_r(1-F(-P-R))$. Every citizen receives/pays these quantities, which account for the deadweight administrative costs of the policies. Similarly, societal benefit from additional compliance with $a=1$ in the population, given by $W(1-F(-P-R))$, accrues to all individuals, regardless of whether they complied with the desired behavior.

It is helpful to clarify the utility a given member of the population, i, receives from a policy (P,R). The subscript "c" stands for complier (with $a=1$) and "nc" for non-complier. Fact 1 from above determines when an individual will and will not comply, for which the utility function below accounts. Recall $1-F(-P-R)$ is the proportion of the population that chooses the desired behavior, $a=1$, given punishment of size P and reward of size R.

$$U^i(P,R) = \begin{cases} U_c^i(P,R) = \\ W(1-F(-P-R)) + F(-P-R)(P+R) - C_p(1-F(-P-R)) - C_r(1-F(-P-R)) + v^i \\ \text{ if } v^i \geq -P-R \\ U_{nc}^i(P,R) = \\ W(1-F(-P-R)) - [1-F(-P-R)](P+R) - C_p(1-F(-P-R)) - C_r(1-F(-P-R)) \\ \text{ if } v^i < -P-R \end{cases} \tag{1.4}$$

Remark 1.1. *Suppose* $(P_c^{**}, R_c^{**}) = \arg\max_{(P,R)} U_c^i(P,R)$*. Then* (P_c^{**}, R_c^{**}) *is the policy that maximizes utility for all ex post compliers.*

Suppose $(P_{nc}^{**}, R_{nc}^{**}) = \arg\max_{(P,R)} U_{nc}^i(P,R)$*. Then* $(P_{nc}^{**}, R_{nc}^{**})$ *is the policy that maximizes utility for all ex post non-compliers.*

Compliance is endogenous, but holding fixed an individual's action choice, the policy that maximizes her utility will maximize the utility of all those who made the same choice.

Remark 1.2. *No restriction that $P, R \geq 0$ appears here, as it did above.*

Negative values of P correspond to a policy rewarding those that choose $a = 0$. Negative values of R correspond to a policy punishing those that choose $a = 1$. We return below to discuss the possibility of $P, R < 0$ – policies that encourage socially harmful actions or discourage socially beneficial behavior.

Preferences over Incentive and Disincentive Policies

The next result establishes that the preference of the individual with the median valuation for compliance is equivalent to the majority preference. The support of the individual with the median valuation, which we refer to henceforth as the "median voter" (MV), is necessary and sufficient for majority support. This would be the winning policy in an election between two office-motivated candidates in which all members of the population cast exactly one vote according to the weakly dominant strategy of voting for the candidate whose proposal offers them greatest utility. We denote this policy $(P^{**}, R^{**}) := \arg\max U^{MV}(P, R)$, where $v^{MV} = F^{-1}(1/2)$.

Lemma 1.3. *There does not exist a policy more preferred by a majority of individuals than (P^{**}, R^{**}).*

To prove the majority preference relation is equivalent to the preference relation of the individual with the median valuation, v^{MV}, we must show that preferences are monotonic in the valuations. We first note that the remark above implies that, for all i, $\arg\max_{(P,R)} U^i(P, R) \in \{(P_c^{**}, R_c^{**}), (P_{nc}^{**}, R_{nc}^{**})\}$. We then show that there exists a threshold valuation such that all members of the population with valuations above the threshold prefer (P_c^{**}, R_c^{**}), while those with valuations below the threshold prefer $(P_{nc}^{**}, R_{nc}^{**})$. This demonstrates the necessary monotonicity of preferences in the valuations, and we may then invoke the median voter theorem (Gans & Smart 1996).

This result establishes that if $(P^{**}, R^{**}) = (P_c^{**}, R_c^{**})$, then the median voter along with a majority of the population will choose $a = 1$. Conversely, if $(P^{**}, R^{**}) = (P_{nc}^{**}, R_{nc}^{**})$, then the median voter along with a majority of the population will choose $a = 0$. If the median voter complies (choosing $a = 1$) *ex post*, then so will a majority; if she does not comply with the desired behavior *ex post* (choosing $a = 0$), then neither will a majority.

1.6 The Majority-Preferred Policy

We now turn to characterizing the winning policy from Lemma 1.3, (P^{**}, R^{**}). As per the conclusions above, this entails characterizing (P_c^{**}, R_c^{**}) and $(P_{nc}^{**}, R_{nc}^{**})$ and the conditions under which (P^{**}, R^{**}) shifts from one to the other. The remark below clarifies that the winning policy will, as with the social planner's optimal policy, entail the use of only one type of policy.

Remark 1.3. *All individuals prefer the use of either an incentive or a disincentive policy – but not both – to achieve any given level of compliance.*

This insight follows from precisely the same logic as it did for the social planner in the previous section. Further, it allows us to adopt an approach to analyze the majority-preferred policy that closely mirrors the approach we took to analyze the optimal policy from the social planner's perspective. Indeed, Proposition 1.5 in Appendix Section 1.10.2 states that the comparative statics of the majority-preferred policy are highly similar to the comparative statics of the social planner's optimal policy (see Proposition 1.1). This is especially true when limiting consideration to the majority-preferred policy intervention, formally defined below, and the social planner's optimal policy intervention, as defined above. As with the social planner's optimal policy, characterizing the overall majority-preferred policy (vis-à-vis the majority-preferred policy intervention) requires some care. The possibility remains that for some exogenous change, the status quo (i.e., $P = 0, R = 0$) becomes increasingly attractive as incentive- or disincentive-based policies also become more attractive relative to the other.

Majority-Preferred Policy Intervention The most preferred policy intervention by the member of the population with the median valuation for choosing $a = 1$ rather than $a = 0$, characterized by a majority-preferred level of compliance and a majority-preferred type of policy that together specify $P^{**} \neq 0$ or $R^{**} \neq 0$.

For members of the population and social planner alike, increased compliance makes punishments increasingly attractive relative to rewards, and the use of punishments favors increasing compliance while the use of rewards favors decreasing compliance. As a result, and as Propositions 1.1 and 1.5 make explicit, the social planner's optimal policy intervention and the majority-preferred policy intervention respond similarly to increases in the marginal societal benefit from additional compliance, upward shifts in the distribution of valuations, and decreases (resp. increases) in the marginal cost of disincentives (resp. incentives).

The majority-preferred policy and the social planner's optimal policy are not the same. The more interesting characterization of the majority-preferred policy is in relation to the social planner's optimal policy, and this is the focus of the next proposition. It states that the median voter's preferred policy intervention "sandwiches" the social planner's optimal policy intervention, and the two only coincide when each prefers the status quo to their preferred policy intervention.

Proposition 1.2. *Comparing the majority-preferred policy intervention ($P^{**} \neq 0$ or $R^{**} \neq 0$) to the social planner's optimal policy intervention ($P^* > 0$ or $R^* > 0$):*

A majority will neither punish itself for choosing $a = 0$ nor reward a minority who choose $a = 1$ sufficiently to achieve the social planner's optimal level of compliance.

A majority will either reward itself for choosing $a = 1$ or punish a minority who choose $a = 0$ excessively, achieving a higher level of compliance than the social planner's optimal.

Increases in the marginal benefit of compliance with $a = 1$ or an upward shift in the distribution of valuations favor the outcomes in which a majority choosing $a = 1$ imposes a larger-than-efficient disincentive on the minority choosing $a = 0$, or in which a majority choosing $a = 0$ institutes a smaller-than-efficient incentive for the minority choosing $a = 1$.

The implications regarding majority compliance follow immediately from the fact that the median voter complies if and only if a majority of individuals are complying. As the choice to take $a = 1$ of the member of the population with the median valuation is a monotonically increasing step function of the level of *ex post* compliance, parameter changes that increase the level of compliance naturally make it more likely that the median will join the set of compliers.[16]

In effect, an *ex post* complier's marginal utility function is the same as the social planner's, but with a *greater* marginal net benefit at all levels of compliance. An *ex post* non-complier's marginal utility function is the same as the policymaker's, but with a *lower* marginal net benefit at all levels of compliance. Proposition 1.1 tells us that maximizing an *ex post* complier's utility will lead to greater levels of compliance than the social planner's optimal level and, indirectly, favor the use of punishments over rewards. Maximizing an *ex post* non-complier's utility will lead to lower levels of compliance than the social planner's optimal level and, indirectly, favor the use of reward-based policies over the use of punishment-based policies. An implication of this is that, relative to *ex post* non-compliers, *ex post* compliers will desire higher levels of

16. More accurately, the *ex post* action of the median voter, the overall level of compliance, and the type of policy are jointly determined in finding the majority-preferred policy, as the latter two were jointly determined in finding the social planner's optimal policy.

compliance and look more favorably upon the use of punishment-based policies.

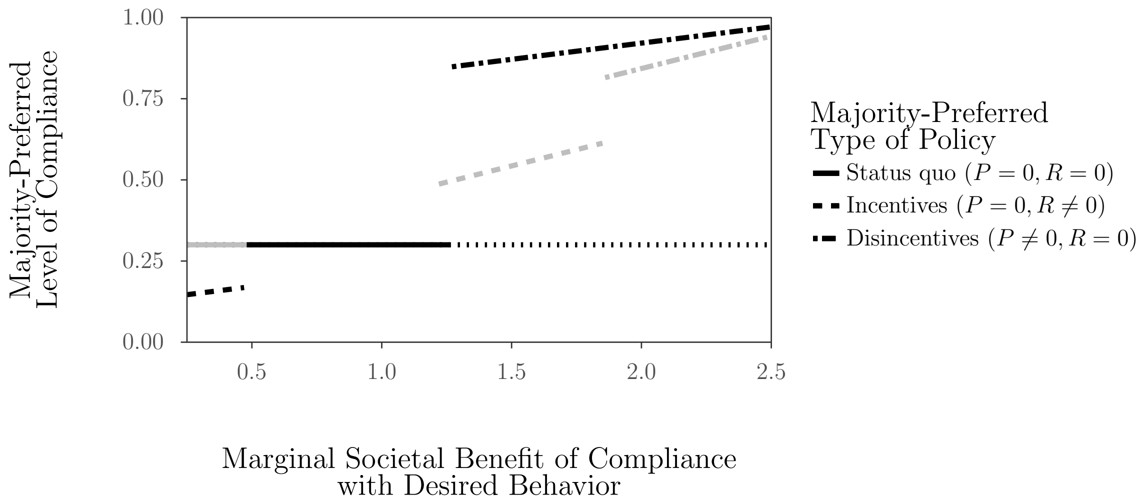
Proposition 1.2 codifies what likely would have been our intuition, namely, that a majority excessively rewards itself for complying or punishes a minority for not complying, and that a majority insufficiently rewards a minority of compliers or punishes itself for not complying. That a majority would ever choose to punish its own non-compliance or reward its own compliance might seem surprising, and again our intuition serves us well. These two outcomes are less likely in a sense. Exogenous changes that would lead a majority to comply (resp. not comply) increase the relative attractiveness of punishments (resp. rewards).

Figures 1.4-1.6 illustrate these results.[17] The black lines correspond to the majority-preferred level of compliance and type of policy. The gray lines correspond to the social planner's optimal level of compliance and type of policy (where line type indicates the type of policy according to the legend). The gray lines always lie inside of the black lines, demonstrating that the median voter's preferred policy will not achieve the social planner's preferred level of compliance, unless both prefer the absence of a policy intervention, the status quo. Further, for majority-preferred levels of compliance in which the member with the median valuation chooses $a = 1$ *ex post*, i.e., $1 - F \geq 1/2$, indirect effects seem to strongly favor the use of punishments rather than rewards.

A particularly surprising feature of the above results is the possibility that members of the population choosing $a = 1$ might be punished or that those choosing $a = 0$ might be rewarded. Negative punishments or rewards would never have been optimal from the social planner's perspective, as they would result in less social benefit and additional lost valuations. In the context of popular support, however, encouraging the socially desirable action garners support among the population only in as much as the social benefit contributes to their individual utility enough to outweigh redistributive

17. Figures 1.5-1.6 appear in the appendix.

Figure 1.4: The effect of increasing the marginal benefit to society of compliance on the median voter's most-preferred level of compliance and type of policy



Notes: The dotted line represents the status quo level of compliance, $1 - F(0)$. The gray lines correspond to the social planner's optimal level of compliance and type of policy. The horizontal axis represents increases in the marginal benefit to society of compliance, W', or g in the context of the example functional forms that underlie the figures.

concerns.

Encouraging the Socially Harmful Action

When seeking to maximize the utility of the median voter, and as was the case when seeking to maximize the social planner's utility, the status quo level of compliance, $1 - F(0)$ is privileged only because it is the sole level of compliance that may be achieved without any administrative costs. When the median voter prefers another level of compliance (even after taking into account the administrative costs incurred in achieving it), it need not be the case that this policy will entail encouraging $a = 1$, as it was in the case of the social planner. The median voter need not take into account any individuals' valuations other than her own, save for the role the valuations play in determining compliance.

Policies do exist which willingly encourage a harmful action or deter a beneficial action, and this outcome ought to be possible in any positive model of the politics of policymaking. A satisfying account would not require that some of the population believes $a = 0$ to be beneficial to society at large, but rather would suppose agreement on which is the desirable action and allow self interest alone to generate harmful policies. Since punishments turn into rewards and rewards into punishments, it is helpful to consider the following possibilities that may obtain in which the share of the population choosing $a = 1$ *ex post* is smaller than in the status quo:

1. Majority of population chooses $a = 0$, minority of population taxed for choosing $a = 1$ ("rewarded with negative subsidy")

2. Majority of population chooses $a = 0$, minority of population subsidized in choosing $a = 0$ ("punished with negative fine")

3. Minority of population chooses $a = 1$, majority of population taxed for choosing $a = 1$ ("rewarded with negative subsidy")

4. Minority of population chooses $a = 1$, majority of population subsidized in choosing $a = 0$ ("punished with negative fine")

The next section provides examples of such policies, as well as more standard public policies. The question we wish to answer here is when it is likely to be the case that $1 - F(-P^{**} - R^{**}) \leq 1 - F(0)$, and how this relates to majority compliance. Using the same comparative statics techniques we have employed throughout, we may reverse the logic of claims made to this point to generate insights into the conditions under which we would observe a policy actively induce less compliance with the desired behavior than under the status quo.

Corollary 1.3. *As the added value to society from additional compliance with $a = 1$ rather than $a = 0$ decreases at all levels of compliance or the distribution of the population's valuations for choosing $a = 1$ rather than $a = 0$ shifts downwards, the level of compliance in the majority-preferred policy decreases.*

This leads to an increase in the administrative cost of a policy that applies to those choosing $a = 0$ to achieve the majority-preferred level of compliance but a decrease in the cost of a policy that applies to those choosing $a = 1$, and the median voter's utility from choosing $a = 0$ increases, while her utility from choosing $a = 1$ decreases.

When characterizing the majority-preferred policy relative to the social planner's optimal policy, we found that the conditions favoring the use of reward policies (i.e., policies that apply to those choosing $a = 1$) favored smaller levels of compliance with $a = 1$ than the social planner would have preferred because such policies favor the median voter choosing $a = 0$. At the extreme, these "rewards" are so small as to become fines for those choosing $a = 1$. Among policies with the effect of encouraging the socially harmful/less beneficial $a = 0$, our analysis suggests that disincentives for $a = 1$ with a majority of the population choosing $a = 0$ are, in a sense, more likely than incentives for $a = 0$. An illustration of this appears in Figure 1.4.

It is also worth noting that with little difference in the welfare of the decisive voter, the majority-preferred policy may differ drastically. A small incentive for choosing $a = 1$ and a small disincentive for choosing $a = 1$ entails only modest changes in the redistributive implications of the policy for the decisive voter, provided her action choice does not change. Yet the policy produced is – substantively – highly different. In one case, the socially desirable action is encouraged, while in the other it is discouraged. While these are indeed rather different policies, we see that quite similar political conditions may have produced them both.

1.7 Accounting for Unaffected Subpopulations

To this point, we have ignored the modeling of a subpopulation not confronted with a choice between $a = 1$ and $a = 0$. We now engage this issue, considering two cases: 1) we are unable to identify subpopulations of interest, 2) we are able to differentiate between subpopulations, as we have assumed thus far. We take each in turn.

Many policies must apply to nearly the whole population. Even if a large segment of the population is already tacitly complying with a desired behavior or, conversely, effectively unable to comply with a desired behavior, often policy must nonetheless apply to this "unaffected" subpopulation, as well as the subpopulation of interest. In this case, the results regarding the first-order stochastic dominance of valuation distributions apply and provide an intuitive reconciliation.

The presence of an unaffected subpopulation that is effectively in compliance with desired policy (e.g., non-drivers not speeding) represents a more "compliant" distribution of valuations for the whole population than the distribution of valuations for the subpopulation of interest (drivers). From Proposition 1.1(b), we know that this favors the use of disincentives. In the example of discouraging speeding, this formalizes our intuition regarding the inefficiency of rewarding a substantial segment of the population (non-drivers) for not speeding when they were of no risk for doing so anyway. From the social planner's perspective, these conditions favor the use of fines and a large level of compliance when it comes to regulating the use of our roads.

Or consider the example of copyright for artistic works, or patents for inventions. While government wishes to encourage innovation, it is unable to target the subpopulation of possible innovators, artistic or otherwise. This constitutes the presence of a large subpopulation that will never "comply" with the behavior government wishes to encourage. The distribution of valuations of the population as a whole is less compliant than the distribution of valuations for compliance within the subpopulation of interest. Referencing Proposition 1.1(b) again, these conditions favor a social planner using rewards to spur innovation by a small share of the overall population.

In many circumstances, however, it is easy to differentiate those in a subpopulation of interest from those who are not. For instance, it is often the case that the subpopulation we wish to affect with policy is an industry. It is usually straightforward to identify firms from individuals and, further, firms in a certain industry from firms in other industries. We call the portion of the population that would not receive either a reward or a punishment under a given policy the "unaffected subpopulation" – e.g., those who do not own cars would not be penalized for failure to possess vehicle registration, those without cropland would be ineligible for farm subsides.

If enforcement is able to discriminate between the subpopulation of interest and the rest of the population, then the analyses of the social planner's optimal policy hold without further modification. We take the distribution of valuations in the subpopulation as the distribution of valuations for the population as a whole. The policymaker may ignore redistributive implications for subpopulations not directly affected by the policy, as she could with redistributive implications for individuals in the subpopulation affected by the policy.

In the analysis of the popular support for incentive and disincentive policies, however, the presence of an unaffected subpopulation may affect the analysis. This population certainly benefits from any additional compliance with the desired behavior from the population of interest. Furthermore, such individuals must also contribute to the financing of subsidies, but they may likewise benefit from the redistribution of fines or taxes collected.

Let the size of the subpopulation not directly affected by the policy, i.e., not eligible for a reward or punishment, be given by $\lambda \leq 1$. Denote an arbitrary individual in this group by ℓ. The entire population is still of mass 1, so the size of the subpopulation of interest is $1-\lambda$. The "subpopulation of interest" refers to the portion of the population to whom any incentive or disincentive would apply.

As a point of entry, consider the implications of incentive and disincentive policies for an individual, ℓ. Under a policy that involves the use of rewards (as well as potentially punishments), ℓ would have to contribute $(1-\lambda)R(1-F(-P-R)) + C_r((1-\lambda)(1-F(-P-R)))$ to finance the subsidy, but receive no compensation for her behavior. While she did "not not comply," she also did not comply – she is simply not a member of the subpopulation of interest. Under a punishment-based policy, ℓ will not receive any fine, but she will receive $(1-\lambda)PF(-P-R) - C_p((1-\lambda)(1-F(-P-R)))$.

With regards to policies applied to those choosing $a=1$, ℓ shares the same utility function as an *ex post* non-complier. With regards to policies applied to those choosing $a=0$, however, ℓ shares the same utility function as an *ex post* complier. Unlike a member of the subpopulation of interest, the relevant utility function does not hinge on the anticipated compliance of ℓ. Rather, appealing to ℓ will consist of comparing the most-preferred punishment-based policy for an *ex post* complier to the most-preferred reward-based policy for an *ex post* non-complier, and then comparing the best of those to the utility ℓ receives in the absence of any further policy intervention, namely $W((1-\lambda)(1-F(0)))$.

Our final result characterizes the preferences of a member of an unaffected subpopulation. We again suppose that the enforcement technologies do not depend on $P, R \gtreqless 0$, but rather depend smoothly on $1-F$. We also set aside the possibility that the status quo might be the majority-preferred policy and instead focus on the majority-preferred policy intervention.

Corollary 1.4. *Assume that the share of the population that is unaffected by the policy is given by $\lambda \geq \frac{1}{2}$, such that a majority of the population will receive neither incentive nor disincentive under a policy intervention. Denote a member of the unaffected* *subpopulation by ℓ.*

Let $P^{**} \neq 0$ denote the best disincentive policy intervention from the perspective of a member of the affected subpopulation with $v^i > -P^{**}$ (such that i chooses $a = 1$). Let $R^{**} \neq 0$ denote the best policy intervention from the perspective of a member of the affected subpopulation with $v^i < -R^{**}$ (such that i chooses $a = 0$).

An increase in the marginal benefit to society members of the affected subpopulation choosing $a = 1$ rather than $a = 0$ increases the utility ℓ receives from P^{**} and decreases the utility ℓ receives from R^{**}.

The same holds for an upwards shift in the distribution of valuations among the affected subpopulation for choosing $a = 1$ rather than $a = 0$.

A member of the population ineligible for any incentives or disincentives identifies with *ex post* compliers or non-compliers based on the particular policy used, rather than her valuation for compliance. The results above are merely reformulations of the results we have derived to this point. Indeed, the findings regarding policies encouraging $a = 0$ as well as the comparisons to the socially optimal policies apply in this context, as well.

When a subpopulation not directly affected by incentives or disincentives in a given policy domain is sufficiently large so as to effectively decide policy, it will always be the case that rewards will achieve smaller than the socially optimal level of compliance and punishments will achieve larger than the socially optimal level of compliance. As above, the downward pressure on rewards may drive them to become negative, constituting a disincentive for choosing $a = 1$. That such a policy would generate revenue to be redistributed among the population at large would only help to overcome the loss of social benefit for a member of the unaffected subpopulation.

1.8 Applications of the Model to Food Policy

We return now to discuss the food policy examples outlined in the introduction. The discussion will be brief but will aim nonetheless to provide a sense for how the results above might be used heuristically to think about the use of incentives and disincentives in public policy. A deeper analysis of any given policy domain would no doubt make more careful use of the ideas presented here and likely involve a wealth of other considerations.

Why might the Conservation Reserve Program utilize incentives? It is likely that the benefit to rotating cropland out of usage is quickly overtaken by the benefit of having cropland in use after a relatively small level of compliance. We certainly do not wish for all farmland to sit idle. This is precisely the sort of behavior for which an incentive is more appropriate than a disincentive. Compliance will and should be low, so rewards are the cheaper approach to achieving the desired ends.

The "sugary drink taxes" are another matter entirely. Recent research has found that even modest taxes do seem to result in decreases in consumption, so efficacy is not entirely in question,[18] although often the taxes – just a few cents per bottle – are seen more as a regressive tax than a deterrent.[19] Despite increasing adoption, however, these taxes remain incredibly unpopular. Such taxes may be an example of the case in which the winning policy punishes the majority of the population that nonetheless takes the less desirable action. As expected in such a circumstance, the punishment will achieve a lower level of compliance than would maximize social welfare.

Again with regards to individual consumption patterns, a number of incentive-based initiatives have been piloted of late. Among them are the Healthy Incentives

18. `http://www.wsj.com/articles/soda-consumption-falls-after-special-tax-in-california-city-1471982400`

19. To which it is often replied that the associated health risks are also regressive in their incidence.

Pilot in which recipients of Supplemental Nutrition Assistance Program (SNAP) money effectively receive cash back for purchases of fruits and vegetables. Other programs have used rewards to encourage children to make healthier eating choices in the context of school lunches (Just & Price 2013, List & Samek 2017). If compliance with these initiatives is desirable even as more and more take it up, and if the goal for these programs is to be rolled out on ever larger scales, then one implication of the model is that incentives may become more costly than disincentives at high levels of compliance. Should SNAP money spent on unhealthy foods be taxed? Should unhealthy lunch options be harder or more expensive to obtain? These are questions with which these programs will need to engage as they scale up. Incentives work in pilots, but high levels of compliance and the use of punishments are complementary.

Finally, an example of a socially beneficial policy being implicitly discouraged may be found in organic food certification (Wilde 2013, ch. 3). Certifying a farm as organic requires a costly certification process. While financial assistance may be procured through EQIP, farmers are often left to finance the process themselves. While most would agree that reduced use of pesticides and sub-therapeutic use of antibiotics imparts at least some benefit, farms are essentially being taxed for their compliance with this desirable behavior. That valuations for taking this action are such that compliance is likely to be low even in the presence of incentives, it may not be surprising that the outcome of the political process was the tax the small share of the population taking the desirable action, i.e., the use of a negative reward on compliers.

1.9 Conclusion

We have found that the higher the benefit of additional compliance with a desired behavior and the larger status quo compliance would be, the more we ought to observe the use of incentives rather than disincentives. By incorporating stylized accounts of redistribution and elections, we found that the those same conditions make it likely that a majority of compliers will punish non-compliers excessively or that a majority of non-compliers will reward compliers insufficiently (relative to the socially optimal level). The latter tendency may be so strong as to permit taxes on individuals taking the desired behavior, as in the case of organic farm certification. The mechanism driving the results throughout was the complementarity between using punishments rather than rewards and achieving higher levels of compliance. Introducing redistribution made this relationship even stronger.

As the model stands now, even if risk were introduced into the enforcement of incentives and disincentives and risk preferences introduced into the compliance decision taken by members of the population, it would have limited if any effect on the conclusions. Similarly, if costs were allowed to increase in the size of the policy (as well as in the measure of individuals to whom the policy is applied), the statement of results would change (as a result of employing the single-crossing property rather than the stronger increasing differences condition), but the findings would remain essentially unaltered. It is true that introducing both of these adjustments to the model together would result in upward pressure on costs by way of probabilistic enforcement of larger policy interventions.

While the findings presented herein are fairly robust to the addition of minor behavioral modifications or cost-function complexities, these two avenues seem to hold promise for additional inquiry on the use of incentives and disincentives. Specifically, incorporating population-based behavioral effects, such as crowding in/out, notions of norms and mores, or coordination in interactions among the population would offer a bridge between the rather institutionally focused account in this paper and the large extant behavioral literature that studies the ways in which people and groups respond to policy interventions. Would the complementarities highlighted above persist in such settings? This remains an open question.

Although our formal results could not offer firm predictions on the effect of changes in the rate at which costs accrue as a function of compliance, this seems to be an invitation for further research on this aspect. Based in specific applications, adding structure to the cost functions and they ways in which the administrative technology may change could allow more definitive insights to arise. This would likely entail changes in fixed costs along with changes marginal costs.

Finally, future work would do well to focus on inequality in this context. Characterizing the implications of incentives and disincentives for inequality would be a first step. A better understanding of policy choice based on the correlation of wealth and valuation for compliance, though, holds potential for an array of new insights about the use of incentives and disincentives in public policy.

1.10 Appendix

1.10.1 Proofs from Section 1.3-1.4: Social Planner

Reframing the social planner's problem

Lemma 1.1. *It is never optimal to use strictly positive levels of both punishments and rewards.*

Proof of Lemma 1.1. Recall that $C_p(\cdot)$ is decreasing and $C_r(\cdot)$ is increasing in the argument, $1-F$. Additionally, the cost of using punishments is zero at full compliance ($1-F=1$), and the cost of using rewards is zero at full non-compliance ($1-F=0$). As such, there must exist a level of compliance, denote it $1-\tilde{F}$, such that $C_p(1-\tilde{F}) = C_r(1-\tilde{F})$.

For all lower levels of compliance, $1-F < 1-\tilde{F}$, $C_r(1-F) < C_p(1-F)$, so rewards are the cheaper type of policy with which to attain a given level of compliance. Conversely, for higher levels of compliance, $1-F > 1-\tilde{F}$, $C_p(1-F) > C_r(1-F)$, so punishments are the cheaper type of policy with which to attain a given level of compliance. At $1-\tilde{F}$, either type of policy entails the same administrative cost, but only one should be used, so that costs are not incurred twice to achieve compliance of $1-\tilde{F}$. To achieve any level of compliance, then, only one type of policy should be employed. ■

Remark 1.4. *It is worth clarifying the generality with which this result holds. Given the model's somewhat simplistic assumptions, especially with regards to the accrual of costs, it emerges rather starkly that it is never optimal to employ strictly positive levels of punishment and reward to achieve precisely the same end. The finding, however, does not rely on such assumptions. The result and even the same approach are still valid even if both of the administrative cost terms increase in the size of the intervention (i.e., P, R)*

in addition to increasing in the measure of the population to which they are applied (i.e., $F, 1-F$). In that case, the marginal cost of administering punishment-based policies overtakes the marginal cost of administering reward-based policies. As such, there exists a level of compliance at which one would not only be indifferent between using incentive and disincentive policies, but at which one would be willing to use any mixture of the two policies to achieve that level of compliance. Yet this level of compliance will never be the level of compliance at which the marginal administrative costs are equal, and so it will still true that the optimal policy using only punishments or the optimal policy using on rewards achieves higher social welfare and entails a different level of compliance.

To reframe the social planner's problem as discussed in text, we denote a type of policy by $\theta \in \{p, r, \phi\}$, with p denoting the use of punishments, r denoting the use of rewards, and ϕ denoting the absence of a policy intervention. We adopt the ordering $p > r$ for the subset $\{p, r\}$. We leave ϕ out of the ordering, as the discussion in text would suggest. We denote the level of *ex post* compliance achieved by Γ.

Given a distribution of valuations, F, Γ uniquely defines the size of the policy intervention, which we refer to by X. We may define $X = P + R$, although recall that Lemma 1.1 establishes that at most one of P or R will be strictly greater than zero. The relationship is given by $X(\Gamma) = -F^{-1}(1-\Gamma)$. The choice forgo a policy intervention is given by (Γ_0, ϕ).

Lemma 1.4 establishes that the (Γ, θ) choice problem yields identical solutions to the original formulation in which the policymaker chose an optimal (P, R). Were $(P^*, 0)$ the optimal policy under the original formulation, then (Γ^*, θ^*) is the optimal policy under the reframing, where $\theta^* = p$ and $\Gamma^* = 1 - F(-P^*)$. The analogous statement holds for R. Lemma 1.1 plays a crucial role in the proof.

Lemma 1.4. $(\Gamma^*, \theta^*) := \max_{\Gamma \geq \Gamma_0, \theta \in \{\phi, r, p\}} W(\Gamma) - \int_0^{\Gamma} X(\tilde{\Gamma}) d\tilde{\Gamma} - C_\theta(\Gamma)$ *iff* $(\mathbb{I}_{\theta^*=p} \cdot X(\Gamma^*), \mathbb{I}_{\theta^*=r} \cdot X(\Gamma^*)) = (P^*, R^*) := \max_{P \geq 0, R \geq 0} W(1 - F(-P-R)) + \int_{-P-R}^{\overline{v}} v f(v) dv -$

$\mathbb{I}_{P>0}C_p(\Gamma) - \mathbb{I}_{R>0}C_r(\Gamma)$.

Proof of Lemma 1.4. By Lemma 1.1, we know that the optimal policy, (P^*, R^*) lies in the set $\{(P,0)|P \geq 0\} \cup \{(0,R)|R \geq 0\}$.

By the independence of irrelevant alternatives axiom, we know that eliminating the set of policies $\{(P,R)|P > 0, R > 0\}$ and maximizing over $(P,R) \in \{(P,0)|P \geq 0\} \cup \{(0,R)|R \geq 0\}$ instead of $(P,R) \in \mathbb{R}^2_+$ will yield the same solutions.

Then consider (P^*, R^*) and (Γ^*, θ^*). The one-to-one and onto transformation between the two pairs is sufficient. If $(\mathbb{I}_{\theta^*=p} \cdot X(\Gamma^*), \mathbb{I}_{\theta^*=r} \cdot X(\Gamma^*)) \neq (P^*, R^*)$, then it would suggest some other $(\tilde{P}, \tilde{R})$ were the solution to maximizing social welfare using the (P,R) formulation. This would contradict the supposition that (P^*, R^*) were the optimal choices of punishment and reward. The same argument in reverse (from (P^*, R^*) to (Γ^*, θ^*)) completes the proof. ∎

We rewrite the social planner's utility function in accordance with the above transformation:

$$U^{SP}(\Gamma, \theta) = \begin{cases} U_p^{SP}(\Gamma) = W(\Gamma) - \int_0^\Gamma X(\tilde{\Gamma})d\tilde{\Gamma} - C_p(\Gamma) & \text{if } \theta = p, \Gamma > \Gamma_0 \\ U_r^{SP}(\Gamma) = W(\Gamma) - \int_0^\Gamma X(\tilde{\Gamma})d\tilde{\Gamma} - C_r(\Gamma) & \text{if } \theta = r, \Gamma > \Gamma_0 \\ U_\phi^{SP}(\Gamma) = W(\Gamma) - \int_0^\Gamma X(\tilde{\Gamma})d\tilde{\Gamma} & \text{if } \theta = \phi, \Gamma = \Gamma_0 \end{cases}. \tag{1.5}$$

The restriction to $(P,R) \geq 0$ becomes $\Gamma \geq \Gamma_0 := 1 - F(0)$, which we impose on the social planner's transformed maximization problem.

Ashworth & Bueno de Mesquita (2006*b*) provide conditions of complementarity, formally supermodularity, under which such results are possible without further parameterization. Specifically, we seek to show each pair of arguments of the utility function has increasing differences. This amounts to demonstrating that the incremental return of each pair of arguments is increasing.

We derive these results in reference to U^{SP}, where $\theta \in \{p, r\}$. In effect, we treat the comparison to status quo utility under (Γ_0, ϕ) as a second step, after first choosing between p and r. In the context of Equation 1.5, we say U^{SP} has increasing differences in the level of compliance achieved, Γ, and the choice of policy type, $\theta \in \{p, r\}$, if for all $\hat{\Gamma} > \Gamma$ and $\hat{\theta} > \theta$ (i.e., $p > r$),

$$U^{SP}(\hat{\Gamma}, \hat{\theta}) - U^{SP}(\Gamma, \hat{\theta}) \geq U^{SP}(\hat{\Gamma}, \theta) - U^{SP}(\Gamma, \theta). \tag{1.6}$$

Indeed, this does hold for the social planner's objective function, reducing to

$$-C_p(\hat{\Gamma}) - C_p(\Gamma) \geq -C_r(\hat{\Gamma}) + C_r(\Gamma),^{20} \tag{1.7}$$

where the left-hand side is positive and the right-hand side is negative.

An increase in the level of compliance (Γ's incremental return) is more attractive under the use of disincentives than under to the use of incentives (an increase in θ). Equivalently, the use of punishments is more attractive relative to the use of rewards (θ's incremental return) as compliance (Γ) increases. This is a direct result of the asymmetric way in which costs accrue under each incentive and disincentive policies.

If it can then be shown that U^{SP} has increasing differences with respect to an exogenous parameter and each choice variable, then we may conclude that an increase in that parameter leads to an increase in the optimal choice of (Γ, θ), $\Gamma > 0, \theta \neq \phi$. We need not worry about indirect effects. The pairwise complementarity of parameters and choice variables (i.e., supermodularity) ensures that any indirect effects only enhance the direct effects. We then ask how the utility given by the optimal choice of a "non-zero" policy intervention changes relative to the status quo utility under (Γ_0, ϕ) in response to parameter changes.

20. This constitutes a proof of Lemma 1.2.

Comparative statics of social planner's optimal policy

Proposition 1.1' (a). *Let the optimal level of compliance,* $\Gamma \in [\Gamma_0, 1]$*, and type of policy,* $\theta \in \{p, r\}$*, under the function* W *be given by* (Γ^*, θ^*)*. Let* $(\hat{\Gamma}^*, \hat{\theta}^*)$ *be the optimal compliance and policy under* $\hat{W}$*.*

If $\hat{W}' \geq W'$*, such that the marginal benefit of compliance under* $\hat{W}$ *is weakly higher than under* W *for all levels of compliance, then* $\hat{\Gamma}^* \geq \Gamma^*$*. If* $\Gamma^* > \Gamma_0$*, then* $\hat{\theta}^* \geq \theta^*$*.*

Proposition 1.1' (b). *Let* (Γ^*, θ^*) *be the optimal level of compliance and type of policy under the distribution of valuations* F*. Let* $(\hat{\Gamma}^*, \hat{\theta}^*)$ *be the optimal compliance and policy under* $\hat{F}$*.*

If $\hat{F} \leq F$*, such that* $\hat{F}$ *first-order stochastically dominates* F*, and if* $\Gamma^*, \hat{\Gamma}^* > \Gamma_0$*, then* $\hat{\Gamma}^* \geq \Gamma^*, \hat{\theta}^* \geq \theta^*$*.*

Proposition 1.1' (c). *Let* (Γ^*, θ^*) *be the optimal level of compliance and type of policy under the function* C_p*. Let* $(\hat{\Gamma}^*, \hat{\theta}^*)$ *be the optimal compliance and policy under* $\hat{C}_p$*. Further, suppose* $\hat{C}_p' \leq C_p'$*, such that the marginal cost of punishing non-compliers is weakly less under* $\hat{C}_p$ *than under* C_p *for all levels of compliance.*

A change from C_p *to* $\hat{C}_p$ *increases the incremental return of* U^{PM} *from an increase in* Γ *but decreases the incremental return of* U^{PM} *with respect to a change from* $\theta = r$ *to* $\theta = p$*. As such, the relationships of* $\hat{\Gamma}^*$ *to* Γ^* *and* $\hat{\theta}^*$ *to* θ^* *are ambiguous, even if* $\Gamma^*, \hat{\Gamma}^* > 0$*.*

The same is true for C_r *and* $\hat{C}_r$*, where* $\hat{C}_r' \leq C_r'$ *such that the marginal cost of rewarding compliers is weakly greater under* $\hat{C}_r$ *than under* C_r *for all levels of compliance.*

***Proof of Proposition 1.1'*.** We seek to apply Theorem 5 from Milgrom & Shannon (1994). We have already shown in text that U^{PM} is supermodular in (Γ, θ). Additionally, $\{[\Gamma_0, 1] \times \{p, r\}\}$ is a lattice satisfying the necessary condition on the set from which the choice variables (Γ, θ) are drawn. It remains to be shown whether U^{PM} has increasing differences in $(\Gamma, \theta; W(\cdot), F(\cdot), C_p(\cdot), C_r(\cdot))$, with partial orderings for the latter four arguments supplied in the Proposition and further clarified below. To do so, we must demonstrate increasing differences in each choice variable-parameter pair.

For Propositions 1.1'(a)-(b), our aim is to show U^{PM} does have increasing differences in $(\Gamma, \theta; W(\cdot), F(\cdot))$. As such, $(\Gamma^*, \theta^*) = \underset{(\Gamma,\theta)\in\{[\Gamma_0,1]\times\{p,r\}\}}{\arg\max} U^{PM}(\Gamma, \theta; W(\cdot), F(\cdot))$ is monotone nondecreasing in $(W(\cdot), F(\cdot), \Gamma_0)$.[21] For Proposition 1.1(c), we wish to demonstrate that $U^{PM}(\Gamma, \theta; C_p, C_r)$ has increasing differences in $(\Gamma; C_p)$ and $(\Gamma; C_r)$ but decreasing differences in $(\theta; C_p)$ and $(\theta; C_r)$. Thus, we cannot infer that (Γ^*, θ^*) is monotone nondecreasing in (C_p, C_r).

For each parameter, we adopt a mix of techniques. To show increasing differences in θ and the parameter, we compare the incremental return of a discrete increase in the parameter at $\theta = r$ and $\theta = p$. This follows the approach taken to show the increasing differences of (Γ, θ) in text.

We proceed differently to show increasing differences in Γ and the parameter. For example, for $W(\cdot)$, we examine $\frac{\partial}{\partial\Gamma}(U^{PM}(\Gamma, \theta; \hat{W}) - U^{PM}(\Gamma, \theta; W))$. If that quantity is weakly positive, increasing differences may be inferred. Note that

$$\frac{\partial}{\partial\Gamma}U^{PM}(\Gamma, \theta; W(\cdot), F(\cdot), C_p(\cdot), C_r(\cdot)) = W'(\Gamma) + F^{-1}(1-\Gamma) - C_\theta(\Gamma).$$

We clarify partial orderings using $\succ$ to avoid ambiguity with numerical statements about the parameters, although nothing regarding preferences should be inferred.

1. Partially order the set of functions $\{W(\cdot)|W' \geq 0\}$ with the rule:

$$\hat{W} \succ W \Leftrightarrow \hat{W}' > W', \forall\Gamma.$$

21. We address the matter of Γ_0 after item 2 below.

$(\Gamma, W):\ \frac{\partial}{\partial \Gamma}(U^{PM}(\Gamma, \theta; \hat{W}) - U^{PM}(\Gamma, \theta; W)) = \hat{W}'(\Gamma) - W'(\Gamma) \geq 0$, ($>$ for $\Gamma < 1$)

$(\theta, W):\ U^{PM}(\Gamma, \hat{\theta}; \hat{W}) - U^{PM}(\Gamma, \theta; \hat{W}) - [U^{PM}(\Gamma, \hat{\theta}; W) - U^{PM}(\Gamma, \theta; W)] = 0$

2. Employ the partial ordering given by first-order stochastic dominance to order the set of distributions over valuations, $F(v)$, such that:

$$\hat{F} \succ F \Leftrightarrow \hat{F} < F, \forall v \in \text{int}(\text{supp}(F)).$$

$(\Gamma, F):\ \frac{\partial}{\partial \Gamma}(U^{PM}(\Gamma, \theta; \hat{F}) - U^{PM}(\Gamma, \theta; F)) = \hat{F}^{-1}(1-\Gamma) - F^{-1}(1-\Gamma) \geq 0$, ($>$ for $\Gamma < 1$)

$(\theta, F):\ U^{PM}(\Gamma, \hat{\theta}; \hat{F}) - U^{PM}(\Gamma, \theta; \hat{F}) - [U^{PM}(\Gamma, \hat{\theta}; F) - U^{PM}(\Gamma, \theta; F)] = 0$

Should a change in a parameter affect the constraint set for the the maximization problem, Theorem 4 from Milgrom & Shannon (1994) provides the condition under which we may still infer monotone comparative statics. Specifically, as long as the constraint set is increasing (in the strong set order) and the strict single crossing property is satisfied in the parameter, we may proceed as before. In this case, the constraint set is $[\Gamma_0, 1] = (1 - F(0), 1)$, which is strictly smaller than $[1 - \hat{F}(0), 1]$ in the strong set ordering.

To show that the strict single crossing property is satisfied, the incremental return must be strictly larger than zero for parameter values strictly larger than the value at which the incremental return equals zero. The strict increasing differences in $(\Gamma; F)$ suffice. For $(\theta; F)$, we cannot establish the strict single-crossing property. Whether the combination of strictly increasing differences in (Γ, θ) and $(\Gamma; F)$ suffices is for the moment an open question. I think so, as $(\hat{\Gamma}, \theta) > (\Gamma, \theta)$, and the theorem just states $x > \hat{x}$.

3. Partially order the set of functions $\{C_p(\cdot)|C_p' \leq 0, C_p(1) = 0\}$ with the rule:

$$\hat{C}_p \succ C_p \Leftrightarrow \hat{C}_p' < C_p', \forall \Gamma < 1.$$

   Note this implies $\hat{C}_p(\Gamma) > \hat{C}_p(\Gamma), \forall \Gamma < 1.$

(Γ, C_p) : $\frac{\partial}{\partial \Gamma}(U^{PM}(\Gamma, \theta; \hat{C}_p) - U^{PM}(\Gamma, \theta; C_p)) = C_p'(\Gamma) - \hat{C}_p'(\Gamma) \geq 0$

(θ, C_p) : $U^{PM}(\Gamma, \hat{\theta}; \hat{C}_p) - U^{PM}(\Gamma, \theta; \hat{C}_p) - [U^{PM}(\Gamma, \hat{\theta}; C_p) - U^{PM}(\Gamma, \theta; C_p)] = -\hat{C}_p(\Gamma) + C_p(\Gamma) \leq 0$

4. Partially order the set of functions $\{C_r(\cdot)|C_r' \geq 0, C_r(0) = 0\}$ with the rule:

$$\hat{C}_r \succ C_r \Leftrightarrow \hat{C}_r' < C_r', \forall \Gamma > 0.$$

   Note this implies $\hat{C}_r(\Gamma) < C_r(\Gamma), \forall \Gamma > 0.$

(Γ, C_r) : $\frac{\partial}{\partial \Gamma}(U^{PM}(\Gamma, \theta; \hat{C}_r) - U^{PM}(\Gamma, \theta; C_r)) = -C_r'(\Gamma) - \hat{C}_r'(\Gamma) \geq 0$

(θ, C_r) : $U^{PM}(\Gamma, \hat{\theta}; \hat{C}_r) - U^{PM}(\Gamma, \theta; \hat{C}_r) - [U^{PM}(\Gamma, \hat{\theta}; C_r) - U^{PM}(\Gamma, \theta; C_r)] = -\hat{C}_r(\Gamma) + C_r(\Gamma) \leq 0$

This concludes the proof, from which Proposition 1.1 follows directly. ■

1.10.2 Proofs from Sections 1.5-1.6: Majority Preference

Reframing the politician's problem

Lemma 1.3. *Let* $(P^{**}, R^{**}) := \arg\max_{(P,R)} U^{MV}(P, R)$. *There does not exist a policy more preferred by a majority of individuals than* (P^{**}, R^{**}).

Proof of Lemma 1.3. $U^i(P_c^*, R_c^*) - U^i(P_{nc}^*, R_{nc}^*)$ is strictly increasing in v_i. Set $v^{\tilde{i}}$ s.t. $U^{\tilde{i}}(P_c^*, R_c^*) = U^{\tilde{i}}(P_{nc}^*, R_{nc}^*)$. It must be that $\forall i$ s.t. $v^i > v^{\tilde{i}}$, $U^{\tilde{i}}(P_c^*, R_c^*) >$

$U^{\tilde{i}}(P^*_{nc}, R^*_{nc})$.

From the monotonicity of the preference relation with respect to v^i and an application of the median voter theorem, we conclude that the majority preference relation is equivalent to the preference relation of the individual with the median valuation. ■

Comparative statics of majority-preferred policy

The office-motivated politician, seeks to maximize the decisive voter's utility by choosing a level of compliance among the population (Γ) and a type of policy (θ). The politician must, however, take into account whether the decisive voter will herself choose $a = 1$ *ex post*. As such, it is useful to rewrite the utility function of the decisive voter in terms of the (Γ, θ) formulation, recalling that $-X = F^{-1}(1-\Gamma)$, where $X = P + R$, and that the decisive voter will choose $a = 1$ when $v^{MV} \geq -X \Leftrightarrow \Gamma > \frac{1}{2}$.

$$U^{MV}(\Gamma,\theta) = \begin{cases} U^{MV}_{c,\theta}(\Gamma) = W(\Gamma) - (1-\Gamma)F^{-1}(1-\Gamma) - C_\theta(\Gamma) + v^{MV} & \text{if } \Gamma \geq \frac{1}{2} \\ U^{MV}_{nc,\theta}(\Gamma) = W(\Gamma) + \Gamma F^{-1}(1-\Gamma) - C_\theta(\Gamma) & \text{if } \Gamma < \frac{1}{2} \end{cases} \quad (1.8)$$

As above, we wish to demonstrate that U^{MV} has increasing differences in (Γ, θ). If this can be shown, then if U^{MV} has increasing differences in an exogenous variable and each choice variable, we may draw conclusions to the effect that an increase in the exogenous parameter makes higher compliance and the use of punishments more favorable. From there, we may derive results about the compliance of the decisive voter and the circumstances in which $a = 0$ might be encouraged. Because the pairwise complementarity ensures that indirect effects only enhance direct effects, we may be satisfied that the conclusions drawn from such analysis are particularly robust.

Demonstrating increasing differences in $(\Gamma, \theta), \theta \in \{p, r\}$[22] proceeds exactly as did the inequality in 1.6, although showing increasing differences in the choice variables

22. Recall that we adopt the ordering $p > r$.

and the parameters of interest presents a small hurdle. As above, we seek increasing differences with respect to pointwise increases in the marginal benefit, W, and first-order stochastic increases of the distribution of valuations for compliance, F. The latter, however, is no longer straightforward without additional structure. As such, we limit consideration to "shifts" in a distribution, a particular type of first-order stochastic increases. Specifically, we say $\hat{F}$ represents a shift of F if for $v \sim F, \hat{v} \sim \hat{F}$, $\hat{v} = \mu + v, \mu \geq 0$. Ultimately, the results of Proposition 1.1 apply to the Condorcet winning policy as they did to the social-welfare maximizing policy, with an additional implication regarding the majority's *ex post* decision to comply.

Proposition 1.5. *Let the Condorcet winning policy, consisting of a level of compliance,* $\Gamma \in [0, 1]$*, and type of policy,* $\theta \in \{p, r\}$*, under the functions* W*,* F*,* C_p*, and* C_r *be given by* $(\Gamma^{**}, \theta^{**})$*. Further, let the decisive voter's decision to comply or not under* $(\Gamma^{**}, \theta^{**})$*,* $a^{MV}(\Gamma^{**}, \theta^{**}) \in \{0, 1\}$*, be given by* α^{**}*.*

(a) Let $(\hat{\Gamma}^{**}, \hat{\theta}^{**})$ *be the Condorcet winning policy under* $\hat{W}$ *(holding the other functions at the values above) and* $\hat{\alpha}^{**}$ *be the action choice of a majority of the population.*

If $\hat{W} \geq W'$*, such that the marginal benefit of compliance under* $\hat{W}$ *is weakly higher than under* W *for all levels of compliance, then* $\hat{\Gamma}^{**} \geq \Gamma^{**}$ *and* $\hat{\alpha}^{**} \geq \alpha^{**}$*. If* $\Gamma^{**} > \Gamma_0$*, then* $\hat{\theta}^{**} \geq \theta^{**}$*.*

(b) Let $(\hat{\Gamma}^{**}, \hat{\theta}^{**})$ *be the Condorcet winning policy under* $\hat{F}$ *and* $\hat{\alpha}^{**}$ *be the action choice of a majority of the population.*

If $\hat{F} \leq F$*, such that the distribution of valuations under* $\hat{F}$ *is a shift of the distribution under* F*, then if* $\theta^{**}, \hat{\theta}^{**} \neq \phi$*, then* $\hat{\Gamma}^{**} \geq \Gamma^{**}$*,* $\hat{\theta}^{**} \geq \theta^{**}$*, and* $\hat{\alpha}^{**} \geq \alpha^{**}$*.*

(c) *Let* $(\hat{\Gamma}^{**}, \hat{\theta}^{**})$ *be the Condorcet winning policy under* $\hat{C}_p$ *and/or* $\hat{C}_r$*, where* $\hat{C}_p' \leq C_p'$ *and* $\hat{C}_r' \leq C_r'$*.*

The relationships of $\hat{\Gamma}^{**}$ *to* Γ^{**}*,* $\hat{\theta}^{**}$ *to* θ^{**}*, and* $\hat{\alpha}^{**}$ *to* α^{**} *are ambiguous.*

Proof of Proposition 1.5. We need only show increasing differences or the single-crossing property in $\{\Gamma, \theta\} \times \{W, F\}$, with W ordered by pointwise larger first derivatives and F ordered by first-order stochastic dominance. Recall that α denotes the *ex post* compliance of the decisive voter, and thus a majority of the population.

1. $\hat{W} \succ W \Rightarrow \hat{W}' > W', \forall \Gamma \in [0, 1]$

$$(\Gamma, W): \ \frac{\partial}{\partial \Gamma}[U^{MV}(\Gamma, \theta; \hat{W}) - U^{MV}(\Gamma, \theta; W)] = \hat{W}' - W' \geq 0$$

$$(\theta, W): \ U^{MV}(\Gamma, \hat{\theta}; \hat{W}) - U^{MV}(\Gamma, \theta; \hat{W}) - [U^{MV}(\Gamma, \hat{\theta}; W) - U^{MV}(\Gamma, \theta; W)] = 0$$

2. $\hat{F}(\hat{v}) \succ F(v) \Rightarrow \hat{v} = \mu + v, \ \mu \geq 0.$

$$(\Gamma, F): \ \frac{\partial^2}{\partial \Gamma \partial \mu} = \frac{\partial}{\partial \mu} F^{-1}(\Gamma, \mu) > 0, \forall \Gamma \in [0, 1]$$

$$(\theta, F): \ U^{MV}(\Gamma, \hat{\theta}; \hat{F}) - U^{MV}(\Gamma, \theta; \hat{F}) - [U^{MV}(\Gamma, \hat{\theta}; F) - U^{MV}(\Gamma, \theta; F)] = 0$$

3. We cannot definitively sign the change in the Condorcet winning policy given the partial ordering on the costs for the same reason as in Proposition 1.1.

Finally, α is an increasing function of Γ^{**}, and the effects of compliance/non-compliance were accounted for in the analysis of U^{MV}. ■

Proposition 1.2'. *Let* (Γ^*, θ^*) *be the social-welfare maximizing level of compliance and type of policy, and let* $(\Gamma^{**}, \theta^{**})$ *be the policy (inducing* $a = 1$*) that maximizes the decisive voter's utility, i.e., the Condorcet winning policy if limited to* $\Gamma \in [\Gamma_0, 1] \Leftrightarrow P, R > 0$*. Suppose both policies entail active interventions, such that* $\theta^*, \theta^{**} \neq \phi$*.*

A majority neither punishes itself for non-compliance nor rewards a minority of compliers sufficiently to achieve the optimal level of compliance. Formally, if $\Gamma < 1/2 \Leftrightarrow \alpha = 0$*, such that a majority of the population chooses* $a = 0$*, and* $\theta \neq \phi$*, then* $\Gamma^{**} < \Gamma^*$*.*

A majority either rewards itself or punishes the minority excessively, so as to achieve greater than the optimal level of compliance. Formally, if $\Gamma > 1/2 \Leftrightarrow \alpha = 0$*, such that a majority of the population chooses* $a = 0$*, and* $\theta \neq \phi$*, then* $\Gamma^{**} > \Gamma^*$*.*

Increases in the marginal benefit of compliance or an upward shift in the distribution of valuations favor the outcomes in which a majority of compliers imposes a larger-than-efficient disincentive on the minority of non-compliers, or in which a majority of non-compliers institutes a smaller-than-efficient incentive for the minority of compliers.

Proof of Proposition 1.2'*.* Consider the following series of inequalities:

$$\begin{array}{rcll} \frac{\partial U^{MV}_{c,\theta}}{\partial \Gamma} & = & W' + \frac{1-\Gamma}{f(F^{-1}(1-\Gamma))} + F^{-1}(1-\Gamma) - C'_\theta & \\ & \geq & & \\ \frac{\partial U^{PM}_{\theta}}{\partial \Gamma} & = & W' + F^{-1}(1-\Gamma) - C'_\theta & , \forall \Gamma \in [\Gamma_0, 1]. \\ & \geq & & \\ \frac{\partial U^{MV}_{nc,\theta}}{\partial \Gamma} & = & W' - \frac{\Gamma}{f(F^{-1}(1-\Gamma))} + F^{-1}(1-\Gamma) - C'_\theta & \end{array}$$

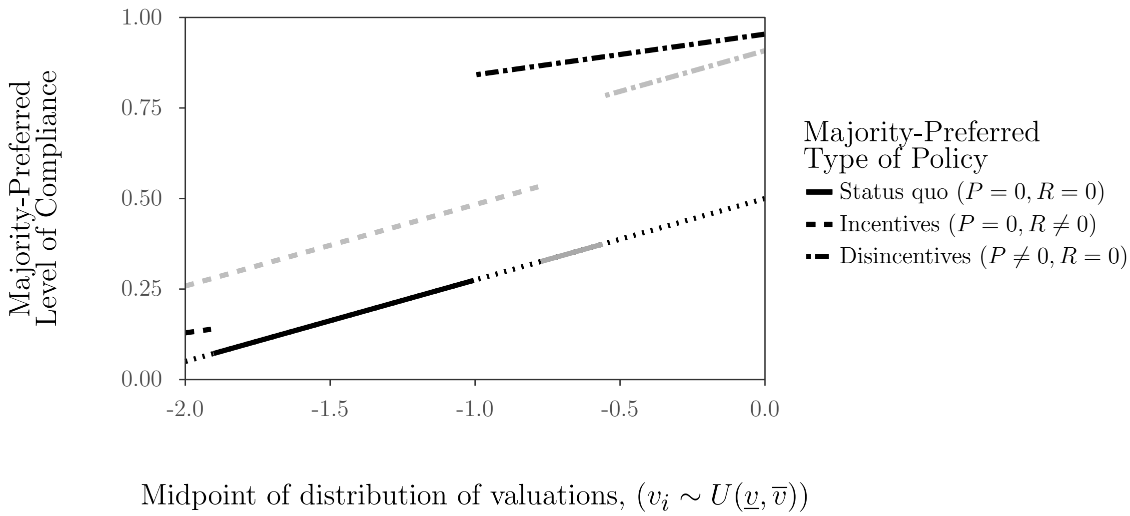
Viewed in the context of Proposition 1.1(a), were we to define $\hat{W}' = W' + \frac{1-\Gamma}{f(1-\Gamma)}$ and $\hat{\hat{W}}' = W' - \frac{\Gamma}{f(1-\Gamma)}$, we would find $\hat{W}' \geq W'$ and $W' \geq \hat{\hat{W}}'$ pointwise and could draw the same conclusion regarding increasing differences in (Γ, α).

Applying Proposition 1.1 to $U^{MV}_{nc,\theta}$ and $U^{MV}_{c,\theta}$, the results regarding $\Gamma^{**} \gtrless \Gamma^*$ follow immediately. The indirect effect of increasing Γ is that $\theta^{**} \geq \theta^*$.

The comparative statics stem from an application of Proposition 1.1', and Proposition 1.2 follows immediately from Proposition 1.2'. ■

As noted in text, further illustration of the preceding result may be found in these figures:

Figure 1.5: The effect of shifting upwards the distribution of valuations for compliance with $a = 1$ rather than $a = 0$ on the median voter's most-preferred level of compliance and type of policy



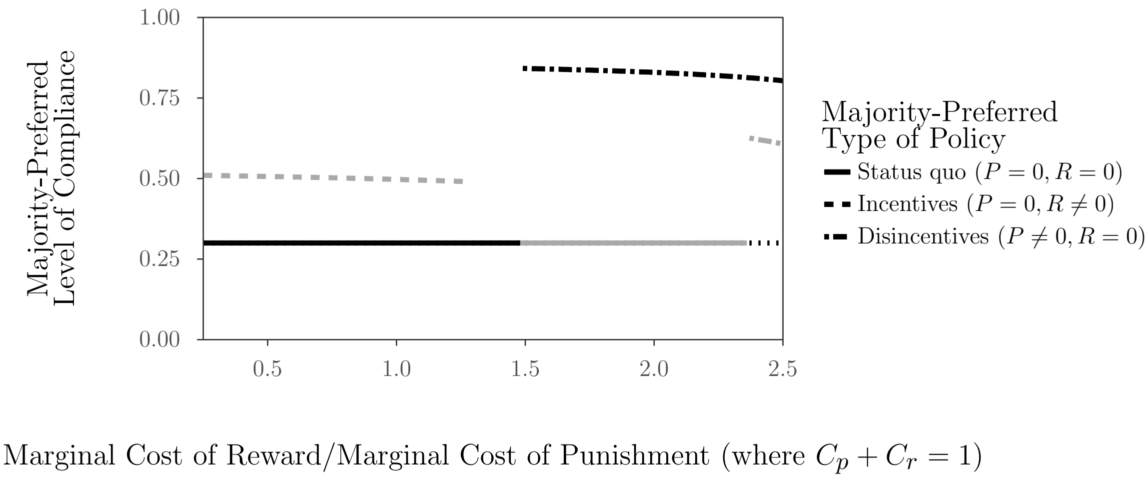
Notes: The dotted line represents the status quo level of compliance, $1 - F(0)$. The gray lines correspond to the social planner's optimal level of compliance and type of policy. The horizontal axis measures $(\overline{v} + \underline{v})/2$, which corresponds to the decisive voter's valuation for compliance. An increase in this quantity also signifies an upward shift in the distribution of valuations, $F(\cdot)$.

Corollary 1.3'. *Let the Condorcet winning policy, consisting of a level of compliance,* $\Gamma \in [0, 1]$, *and type of policy,* $\theta \in \{\phi, p, r\}$, *under the functions* W, F, C_p, *and* C_r *be given by* $(\Gamma^{**}, \theta^{**})$.

(a) Let $(\hat{\Gamma}^{**}, \hat{\theta}^{**})$ *be the Condorcet winning policy under* $\hat{W}$ *(holding the other functions at the values above).*

If $\hat{W} \geq W'$, *such that the marginal benefit of compliance under* $\hat{W}$ *is weakly higher than under* W *for all levels of compliance, and if* $\hat{\Gamma}^{**} < \Gamma_0$, *then* $\Gamma^{**} < \hat{\Gamma}^{**} < \Gamma_0$, *and* $\theta^{**} \leq \hat{\theta}^{**}$.

Figure 1.6: The effect of decreasing the marginal cost of disincentives relative to the marginal cost of incentives on the median voter's most-preferred level of compliance and type of policy



Notes: The dotted line represents the status quo level of compliance, Γ_0. The gray lines correspond to the social planner's optimal level of compliance and type of policy. The ratio of marginal cost coefficients, C_r/C_p, is increasing along the horizontal axis. The restriction that $C_p + C_r = 1$ facilitates visual comparison but is not a restriction that applies more broadly.

(b) *Let* $(\hat{\Gamma}^{**}, \hat{\theta}^{**})$ *be the Condorcet winning policy under* $\hat{F}$.

If $\hat{F} \leq F$, *such that the distribution of valuations under* $\hat{F}$ *is an upwards shift of the distribution under* F, *then if* $\Gamma^{**}, \hat{\Gamma}^{**} < \Gamma_0$, *then* $\hat{\Gamma}^{**} \geq \Gamma^{**}$ *and* $\hat{\theta}^{**} \geq \theta^{**}$.

Proof of Corollary 1.3'. Follows directly from Propositions 1.1-1.2 ■

1.10.3 Proof from Section 1.7: Introducing Unaffected Subpopulations

Corollary 1.4' *Assume that* $\lambda \geq \frac{1}{2}$, *such that a majority of the population will receive neither incentive nor disincentive under a policy intervention.*

Let $(\Gamma^{\ell *}_{c,p}, p)$ *be the policy that maximizes* $W((1-\lambda)\Gamma) - (1-\lambda)(1-\Gamma)F^{-1}(1-\Gamma) - C_p((1-\lambda)\Gamma)$ *and* $(\Gamma^{\ell *}_{nc,r}, r)$ *be the policy that maximizes* $W((1-\lambda)\Gamma) + (1-\lambda)\Gamma F^{-1}(1-\Gamma) - C_r((1-\lambda)\Gamma)$. *It is the case that* $\Gamma^{\ell *}_{c,p} > \Gamma^{\ell *}_{nc,r}$.

Let the Condorcet winning policy under the functions W, F, C_p, and C_r be given by $(\Gamma^{\ell*}, \theta^{\ell*})$. It is the case that $(\Gamma^{\ell*}, \theta^{\ell*}) \in \{(\Gamma^{\ell*}_{c,p}, p), (\Gamma_0, \phi), (\Gamma^{\ell*}_{nc,r}, r)\}$.

(a) *Let $(\hat{\Gamma}^{\ell*}, \hat{\theta}^{\ell*})$ be the Condorcet winning policy under $\hat{W}$.*

It must be that $(\hat{\Gamma}^{\ell*}, \hat{\theta}^{\ell*}) \in \{(\Gamma^{\ell*}_{c,p}, p), (\Gamma_0, \phi), (\Gamma^{\ell*}_{nc,r}, r)\}$.

If $\hat{W} \geq W'$, such that the marginal benefit of compliance under $\hat{W}$ is weakly higher than under W for all levels of compliance, and if $\hat{\theta}^{\ell*}, \theta^{\ell*} \neq \phi$, then $\hat{\Gamma}^{\ell*} \geq \Gamma^{\ell*}$.

(b) *Let $(\hat{\Gamma}^{\ell*}, \hat{\theta}^{\ell*})$ be the Condorcet winning policy under $\hat{F}$.*

It must be that $(\Gamma^{\ell*}, \theta^{\ell*}) \in \{(\Gamma^{\ell*}_{c,p}, p), (\Gamma_0, \phi), (\Gamma^{\ell*}_{nc,r}, r)\}$.

If $\hat{F} \leq F$, such that the distribution of valuations under $\hat{F}$ is an upwards shift of the distribution under F, and if $\hat{\theta}^{\ell*}, \theta^{\ell*} \neq \phi$, then $\hat{\Gamma}^{\ell*} \geq \Gamma^{\ell*}$.

Proof of Corollary 1.4'. This follows directly from Proposition 1.5 and the discussion in Section 1.7. ■

CHAPTER 2

SIGNALING THROUGH ENTRY? INCUMBENT LEARNING ABOUT CHALLENGER STRENGTH

Abstract

What does an incumbent know about the strength of a challenger? Traditional arguments and analyses implicitly assume that strong and weak potential challengers enter in different circumstances. Such logic implies that an incumbent has perfect knowledge of the strength of a candidate challenging her. This paper develops a model of entry and policy competition that reveals this account to be incomplete. It does so by highlighting an important and under-appreciated difference between electoral competition and other signaling environments. Because a strong candidate benefits from being underestimated while a weak candidate benefits from being overestimated, obfuscation – rather than signaling – characterizes electoral competition. As a result, the incumbent never fully learns the strength of the challenger she faces. Equilibrium predictions emerge regarding uncontested elections, upset victories, and the extremism of the winning policy. Implications for empirical work follow from the dependence between uncontested elections and candidate behavior in contested elections.

2.1 Introduction

In the 2016 Congressional elections, 97% of House incumbents won reelection, with upwards of 50 of them running unopposed. This rate of incumbent retention is on the high end but certainly within the range of reelection rates in recent decades, and dozens of incumbents go unchallenged in every election cycle. The seemingly assured, and not infrequently unfettered, path to victory for sitting officials has long been a subject of scholarly attention and even popular concern. It is particularly striking that rates of incumbent reelection and uncontested elections remained at their usual levels even in a year in which over 75% of the United States disapproved of the performance of Congress on election day[1] and in which media accounts suggested that many congressional seats might be up for grabs.[2] Taken together, this renews the call for understanding the motivations for would-be candidates to challenge incumbents, the mechanisms by which upset victories remain the exception that proves the rule of incumbent retention, and the implications for voter welfare.

Political scientists have consistently returned to two questions about the decision to challenge an incumbent up for reelection in analyses of the significance of upset victories and uncontested elections for voter welfare. First, to what extent and to what effect do strong challengers wait for an open seat to run for office, the so-called "scare-off" effect of incumbency (Abramowitz 1991, Cox & Katz 1996, Jacobson 1989, Krasno & Green 1988, Stone, Maisel & Maestas 2004)? Second, why would weak candidates ever challenge a sitting office-holder (Banks & Kiewiet 1989, Canon 1993)?

The reasoning implicit in these questions has a degree of intuitive appeal, and goes something as follows: given the well-documented incumbency advantage, strong chal-

1. `http://www.realclearpolitics.com/epolls/other/congressional_job_approval-903.html`

2. `http://www.nytimes.com/2016/10/06/us/politics/donald-trump-campaign.html`

lengers ought to increase their comparatively better chances at winning by competing on a more level playing field, i.e., entering an open-seat race; meanwhile, weak challengers only decrease their already low chances of winning by taking on a sitting official.[3] This line of reasoning tacitly makes the strong assumption that an incumbent knows the strength of a challenger she faces.

This paper asks what an incumbent can learn about the strength of a challenger she faces, simply from the fact that the challenger entered the election. Does an incumbent, in fact, know the strength of the candidate challenging her? If not, what are the implications of this uncertainty for accountability and the competitiveness of elections?

We pursue the question of incumbent learning about challenger strength using a model in which a potential challenger who is better informed about his quality first decides whether to enter the election or not. If the challenger enters, the incumbent and challenger then engage in policy competition. The incumbent, while possessing an advantage over any strength challenger, is uncertain as to the strength of the challenger, and so is uncertain as to the extent of this advantage.

The model suggests the logic underlying common arguments about strategic entry may be incomplete. If potential challengers care about the winning policy even if they lose, and if incumbents must adopt different policies to retain their seats when challenged than if running uncontested, then a central result is that the incumbent never knows with certainty the strength of a challenger. It is never the case, then, that only strong or weak challengers enter, because each would prefer to be mistaken for the other.

The intuition for this result is straightforward. If an incumbent believes she will only face strong challengers, a weak challenger will induce significantly more moderation in policy from an incumbent simply by entering than the policy moderation such

3. Hall & Snyder (2015) provide a thorough summary of the development of this received wisdom.

a challenger might expect based strictly on her viability as a candidate. If, however, an incumbent is quite sure she will only be challenged by weak candidates, a strong candidate becomes a wolf in sheep's clothing, able to capitalize on an incumbent's complacency and potentially achieve an upset victory. In the presence of some uncertainty over how strong a potential challenger may prove to be as a candidate, the benefit to a weak challenger of being overestimated and the benefit to a strong challenger of being underestimated effectively preclude separating equilibria. Rather than signaling, the challenger achieves obfuscation through entry.

Compared to a setting with full information, a much richer, and more realistic, set of outcomes occur in this model. The model generates predictions about the frequency with which we observe contested elections and, conditional on an election being contested, the position of the winning policy and the frequency with which the incumbent retains office. This leads to a range of new insights regarding the evaluation of voter welfare.

Specifically, the discussion following the derivation of the equilibrium strategies highlights that the probability of contested elections and the probability of an upset victory given that the election has been contested are not independent events. It also characterizes the relationship between these outcomes, as well as their exact relationship to voter welfare. Taken together, the results suggest that – other than a better pool of challengers – no other changes to parameters of the model are assured to increase voter welfare. Changes to the non-policy benefit of holding office, the cost of entry, or the distribution of ideal points in the district all entail tradeoffs in the voter's expected utility. Interpretations of and implications for empirical studies of elections follow these results.

This paper proceeds as follows. After placing the model in the context of related literature, the next section presents the details of the model and derives the equilibrium cases. The discussion includes sections on challengers' motivation to obfuscate their type and several additional results regarding uncontested elections, safe seats, and policy divergence, followed by a brief conclusion.

2.2 Related Literature

Prior work has demonstrated the pitfalls of performing empirical analyses that ignore the strategic interaction and learning that occurs between challengers and incumbents (Carson 2005). While a spate of recent scholarship examines the strategic interaction and learning that occurs between candidates and voters (Ashworth 2005, Ashworth & Bueno de Mesquita 2006*a*, Ashworth & Bueno de Mesquita 2008, Banks & Sundaram 1998), Epstein & Zemsky (1995) appear to be among the few scholars to address learning between challengers and incumbents. They model fundraising as a means for incumbents to signal strength to challengers, setting aside incumbents' inferences about challengers. In the model presented below, it is challengers, not incumbents, who possess private information, and thus incumbents who stand to learn about the strength of challengers.

The empirical work on strategic challengers discussed at the outset of this paper has traditionally, and out of necessity, focused on observable measures of candidate quality, such as previous office-holding or campaign experience. From the theoretical standpoint of this article, this focus errs in two ways: it ignores the effects of potentially unobservable (or at least less readily observable) determinants of candidate quality that may correlate imperfectly with observable measures, and it ignores the difference in quality within the population of untested candidates. Although some papers recognize the former possibility (e.g. Canon (1993)), none engage seriously with the uncertainty surrounding untested candidates and the implications of the potentially large differences in quality among this group. This receives further attention in the discussion following the exposition of the model.

Methodologically, the two features animating the model are the potential for entry and the differences among (and uncertainty over) candidates' valences. Strategic entry by challengers appears as a feature in a significant body of electoral models (e.g., Feddersen, Sened & Wright (1990), Osborne (1993), Osborne (2000)), but Gordon, Huber & Landa (2007, 2009) are the first to study, theoretically and then empirically, voter learning as it relates to challenger entry. Gordon & Landa (2009) examine the effects on the electoral fortunes of incumbents of different strengths in a model in which challengers as well as incumbents are allowed to leave a seat uncontested, although it is again voters doing the strategic learning in this model. These papers set aside learning between challengers and incumbents. It is noteworthy, however, that Gordon and Landa as well as Epstein and Zemsky uncover a tendency for incumbents of different types to pool in the equilibria of their models, as is found for challengers of different strengths in this paper.

Several papers model simultaneous spatial competition in which candidates possess differing levels of valence as well as some element of uncertainty (Groseclose 2001, Aragones & Palfrey 2002, Aragones & Palfrey 2005, Hummel 2010). A key result derived by Groseclose and reinforced in subsequent work suggests that disadvantaged challengers may adopt more divergent policy positions than their incumbent opponents. This may occur in the model presented here, as well, although incorporating entry and asymmetric information into the model seem to attenuate this tendency somewhat. While this paper draws on the literature that uses valence in elections, it strives to employ a more natural characterization of the policy space than some of the above, which like this paper also embrace a mixed-strategy equilibrium.

Simply introducing dynamics into such models can have a significant impact on candidate behavior in equilibrium (e.g., Bernhardt, Camara & Squintani (2011)), although our findings prove robust to the introduction of dynamic policy proposals. Carter & Patty (2015) model dynamic policy competition where candidates possess different valences and make an effort decision akin to entry. While this model shares several features with the model in this paper, the authors assume candidates to be vote-maximizing, rather than some combination of office- and/or policy-motivated, a significant point of difference (see Patty (2002)). In the context of a model with entry, this distinction is crucial.

2.3 The Model

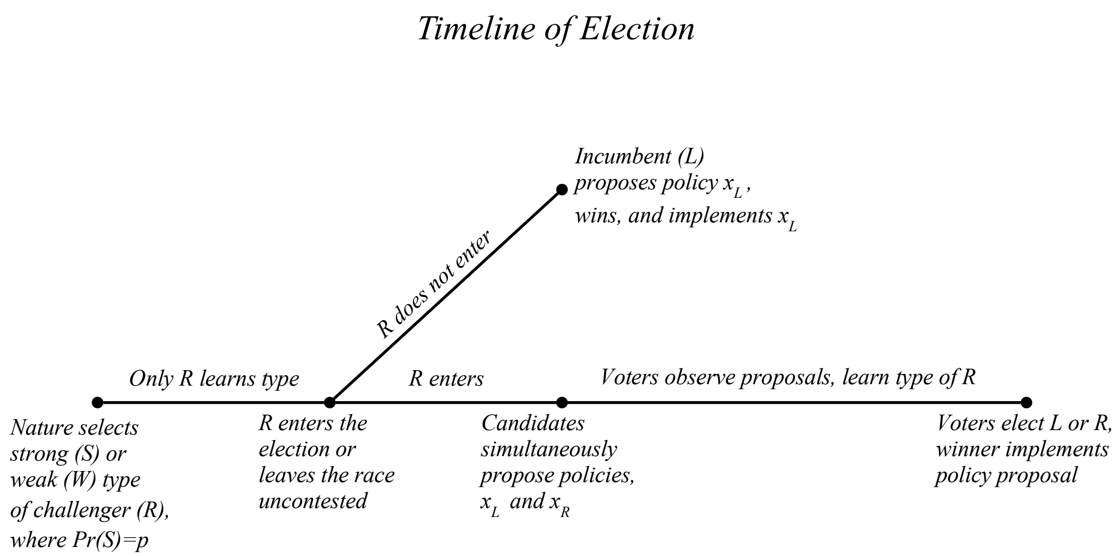
2.3.1 Preliminaries

The set of players consists of an incumbent, L, a (potential) challenger R, and a continuum of voters whose ideal points are strictly ordered in $\mathbb{R}$. Let $c \in \{L, R\}$ denote an arbitrary candidate, v denote an arbitrary voter, and V denote the median voter. The Challenger ("he") is either a strong type (S) or a weak type (W). The Incumbent ("she") takes only one type.

Nature first selects a type of challenger, $t \in \{S, W\}$, choosing a strong type ($t = S$) with probability $p \in [0, 1]$, where p reflects the strength of the pool of potential candidates. The challenger learns his type and then decides to enter the race or leave the seat uncontested. The entry decision of the challenger is immediately observable to all players, but the incumbent does not know the challenger's type. The incumbent and the challenger (if contesting the election) simultaneously propose a policy, $x_c \in \mathbb{R}$. Finally, all voters observe the policy proposals, learn the challenger's type, and cast a vote for one of the candidates that entered the election. The candidate that garners a majority of votes wins the election and implements his/her platform.

Each player's utility from an implemented policy is strictly decreasing in the distance

Figure 2.1: Order of Play



of the policy from the player's ideal point, $M_v, \forall v$, and $M_c, c = L, R$. Specifically, the disutility individual i receives from a winning policy x is given by $-|M_i - x|$. We assume that $M_L < M_V < M_R$. Both types of challenger share the same ideal point. For convenience, we set $M_V = 0$, hence $M_L < 0 < M_R$.

We allow candidates to be office motivated as well as policy motivated, where winning the election confers a benefit of $B \geq 0$, representing the salary, professionalization, or prestige of holding office. Candidates incur a strictly positive cost upon entering the election, $C > 0$. Many interpretations are compatible with this quantity, including the signatures required to appear on a ballot, prices in the relevant media market, and the geographic span or population of the constituency.[4] The benefit to holding office and

4. All (types of) candidates face the same cost of entry. Including some costs to entry are necessary if we want to see strategic entry (and strategic "non-entry"), as discussed in Callander (2008). Introducing different costs, especially between the types of challengers, might be a realistic nuance to add to the model, but the model embeds the varying levels of incumbent advantage entirely in the candidates' valences. More to the point, any separation that resulted from assuming greater costs on weaker challengers would not be strategic but rather an artifact of the different costs each type of R

the cost to running in the race enter additively into the candidates' utility. Payoffs to the candidates are then as follows:

$$U_L = \begin{cases} -|M_L - x_L| + B - C & \textit{if } L \textit{ wins} \\ -|M_L - x_R| - C & \textit{if } R \textit{ wins} \end{cases} \tag{2.1}$$

$$U_R = \begin{cases} -|M_R - x_R| + B - C & \textit{if } R \textit{ wins} \\ -|M_R - x_L| - C & \textit{if } L \textit{ wins and } R \textit{ enters} \\ -|M_R - x_L| & \textit{if } L \textit{ wins and } R \textit{ does not enter} \end{cases} \tag{2.2}$$

Voters derive non-policy utility specific to each (type of) candidate, in addition to disutility from the implementation of winning policies not at their ideal point. Some degree of valence is associated with each (type of) candidate and accrues to the voter if that candidate is elected, entering additively into each voter's utility function. Denote the incumbent's valence by A_L, the strong type of challenger's valence by $A_{R|S}$, and the weak type of challenger's valence by $A_{R|W}$. A voter's payoffs are specified below:

$$U_v = \begin{cases} -|M_v - x_L| + A_L & \textit{if } L \textit{ wins} \\ -|M_v - x_R| + A_{R|t} & \textit{if } R \textit{ wins and is of type } t \in \{S, W\} \end{cases} \tag{2.3}$$

Granting voters full information when deciding whom to vote for captures the idea that the challenger's type is revealed over the course of the campaign but after the candidates stake policy positions.

Imposing the ordering $A_L > A_{R|S} > A_{R|W}$ embodies the assumption that the incumbent possesses an advantage over either type of challenger, but a bigger advantage

faced. We do not include the possibility for the incumbent not to run, and thus forgo C, assuming instead that she has already announced her intention to seek reelection.

over the weaker type, W, than over the stronger type, S. Defining $\underline{a} := A_L - A_{R|S}$ and $\overline{a} := A_L - A_{R|W}$, the incumbent then possesses a valence advantage of $\underline{a}$ over the stronger type of challenger and a valence advantage of $\overline{a}$ over the weaker type of challenger, such that $\underline{a} < \overline{a}$. We refer to an arbitrary such valence advantage as $a \in \{\underline{a}, \overline{a}\}$.

Given the conception of challenger strength as equivalent to the extent of the valence advantage on the part of the incumbent, nature is effectively choosing the size of L's net valence advantage, a, over R in the game's first move. The assumption that the incumbent knows only the distribution of challenger strengths evokes a challenger, perhaps untested, whose viability as a candidate the incumbent can only guess. That the challenger possesses greater information over the extent of his strength captures the private information the challenger may have about the support he will receive from the party organization, his viability as a candidate from appraisals by party officials or campaign consultants, or simply knowledge of his personal aspirations in contesting the election (i.e., genuinely trying to win or just "keeping the incumbent honest"). The range of outcomes that emerge in equilibrium of the model with asymmetric information more closely mirrors reality than the full information baseline, in which incumbents always win.

Throughout, we assume that the incumbent cannot win – against either type of challenger – by simply proposing her ideal point, M_L. This supposes that incumbents must propose a different platform to win the election if challenged than they would if they ran uncontested. It requires that the incumbent's ideal point not be too moderate (close to the median voter's) and/or that the incumbent's valence advantage not be too large adding a realistic source of interest to the model. Specifically, $M_L < A_{R|W} - A_L$.

2.3.2 Characterizing Equilibrium Strategies and Cases

The solution concept for this sequential-move game with uncertainty is weak perfect Bayesian equilibrium. Only equilibrium strategies that do not include weakly dominated actions receive consideration. This implies that voters will vote sincerely, which permits restricting attention to the median voter's decision (see Lemma 2.1 in Appendix 2.6.1).[5] Henceforth, "the voter" will refer to the median voter, V.

Given the assumed ordering of ideal points, it is also weakly dominated for candidates to propose any policies that do not lie between their own ideal point and the ideal point of the median voter (see Lemma 2.2 in Appendix 2.6.1). Neither type of R will take a position to the left of the median voter's ideal point ($x_R < M_V = 0$) or to the right of his own ideal point ($x_R > M_R$), nor will L propose a policy to the left of her ideal point ($x_L < M_L$) or to the right of the median voter's ideal point ($x_L > M_V = 0$). As such, it will always be the case that $x_L \in [M_L, 0]$ and $x_R \in [0, M_R]$.

The voter's decision rule if R does challenge L is straightforward, except in cases of indifference. Recall that the incumbent possesses a valence advantage of a over her challenger, and that while the valence advantage is known to R but not to L when each proposes a policy, it is revealed over the course of the election, so V will take the size of L's valence advantage over R into account when casting a vote. Given the payoffs specified above, V votes for L if

$$x_L + a > -x_R \tag{2.4}$$

and for R if the inequality were reversed.

The only cases of voter indifference that will occur with positive probability in

5. The addition of valence to the model does nothing to affect the standard result that, in unidimensional policy settings, the support of the median voter is necessary and sufficient to achieve the support of a majority of voters.

equilibrium involve the challenger converging entirely to the median voter's ideal point, 0. If R of type t proposes $x_R = 0$ and L proposes $x_L = A_{R|t} - A_L$ such that V is indifferent, equilibrium existence requires that V vote for L (see Lemma 2.3 in Appendix 2.6.1). Such tie-breaking rules arise endogenously, in the sense of "endogenous sharing rules" (Simon & Zame 1990).[6]

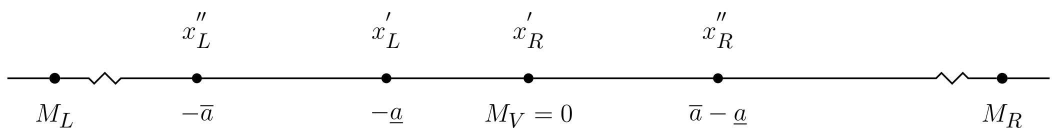
Remark 2.1. *Recalling the assumption that voters must vote for exactly one of the candidates that entered the election, if the Incumbent is not challenged, she will propose her ideal point, M_L, and receive V's vote.*

The incumbent must converge farther when facing a strong type of challenger than when facing a weak type. If the incumbent guesses incorrectly which type she faces, she runs the risk of converging more than she needed to in order to win against a weak challenger (incurring disutility from a policy farther from her ideal point) or losing the election to a strong type by not converging enough. If she knew which type she faced, she would only converge as much necessary to win, but she lacks this knowledge unless the two types of challenger fully separate with respect to entry.

Proposition 2.1 states that, in fact, the incumbent will never know exactly which type of challenger she faces. The two types at least partially pool on the entry decision, either both entering with strictly positive probability or neither entering at all. As such, the central tension in the model is that the incumbent is uncertain how much she must converge in policy towards the median to win the election. In and of itself, the impossibility that the two types of challenger ever fully separate with respect to entry is also an important implication of the model.

6. These tie-breaking rules may depend both on the policies leading to voter indifference and the type of challenger. For instance, while the result above indicates that V must vote for L if $x_L = A_{R|W} - A_L$ and a weak challenger proposes $x_R = 0$, V need not vote for L if, against the same policy $x_L = A_{R|W} - A_L$, a strong challenger proposes $x_R = A_{R|S} - A_{R|W}$, a pair of policies at which, given the valence of the strong type, V is again indifferent between the two candidates. Indeed, this is the only other case of indifference for which we need specify a voting rule to establish equilibrium existence, and V must vote for R in this case.

Figure 2.2: Illustrating the Logic of Proposition 2.1



Notes: The incumbent, if challenged, wishes to moderate her policy proposal only as far as necessary to defeat the challenger, i.e., x'_L against a strong type proposing x'_R and x''_L against a weak type proposing x'_R. If only weak types entered, the incumbent would propose x''_L, giving strong challengers and incentive to enter. If the only entrants were strong types, the incumbent would propose x'_L, and either the weak type would also wish to enter or both types would rather avoid C and accept $x_L = M_L$ rather than incur C to force convergence to x'_L.

Proposition 2.1. *The incumbent is never certain of the strength of a challenger who contests the election.*

The logic underlying this result is that weak challengers benefit from being overestimated as the incumbent adopts a more moderate policy than she needs to in order to win, and strong challengers benefit from being underestimated as they will upset an incumbent that did not converge enough in policy to defeat a strong challenger. Essential to this line of argument is the principle that, in equilibrium, the incumbent must possess correct beliefs about the type of challenger she faces. If one type of candidate would be willing to enter, both would, so separation cannot occur on entry. Further illustration of this result appears in Figure 2.2.

If the incumbent believed only weak candidates enter in equilibrium, she would converge just enough when challenged to defeat a weak type proposing x'_R, namely x''_L in Figure 2.1. Given this policy-proposal strategy of the incumbent, however, the strong challenger would not remain out of the election. If a strong type enters and proposes x'_R, he will win the election, defeating an incumbent that has adopted too divergent a policy proposal.[7]

7. In fact, any $x_R \in [x'_R, x''_R]$ would win against an incumbent proposing x''_L.

If the incumbent believed only strong candidates enter in equilibrium, she would converge far enough when challenged to defeat a strong type proposing x'_R, specifically x'_L. If a strong challenger finds it worthwhile to incur the cost of entry only to lose to an incumbent proposing x'_L, so will a weak challenger. If the strong type would profitably deviate by not entering, then the weak type would also prefer to leave the race uncontested. The proof, found in Appendix 2.6.2, follows this same line of argument.

The fact that, in equilibrium, the two types of challengers cannot fully separate with respect to entry follows from a feature of electoral settings not present in standard signaling models. Namely, in classic signaling models, one type wishes to reveal itself truthfully, while the other type wishes to be mistaken. In the context of challengers weighing entry against an incumbent, both strong and weak types wish to be mistaken for each other, and so obfuscation of types ensues rather than revelation of types.

Under uncertainty, the incumbent must weigh moderating too much with not moderating enough, i.e., x'_L against a weak challenger proposing x'_R or x''_L against a strong challenger proposing $x_R \leq x''_R$. In the latter case, the strong challenger defeats the incumbent. The race for Florida's 2$^{\text{nd}}$ Congressional district in 2014 provides an example of an incumbent underestimating a challenger who turned out to be strong. Two-term incumbent Steve Southerland faced a challenge from Gwen Graham. Southerland, believing he did not face a serious threat, did little to distance himself from Congressional deadlock and the Republican obstinacy that contributed to it. Furthermore, he allowed himself a late start campaigning, leaving Graham's campaign, which had wide, moderate appeal, as the only voice for the first part of the race. When asked about his slow start and Graham's early surge in the polls, Southerland leaned against his pickup truck and replied, "It's easy to score touchdowns when the defense isn't on the field."[8]

8. Sherman, Jake. 2014. "How to blow an easy GOP win." *Politico*: `http://www.politico.com/story/2014/10/2014-florida-elections-steve-southerland-gwen-graham-112020`.

Having underestimated a strong challenger, Southerland went on to lose to Graham.

Lemmas 2.4 – 2.5 (see Appendix 2.6.3), in conjunction with the results thus far, establish that four types of equilibria may obtain. Either both types of challenger will enter with some strictly positive probability (cases 1-3) or neither type will enter (case 4). In cases where the challenger enters, the incumbent will either randomize over policies when challenged (cases 1-2) or propose a single policy (case 3).[9] In cases where the Incumbent randomizes over policy proposals, strong challengers will always enter, and weak challengers will either strictly randomize between entering and leaving the race uncontested (case 1) or enter with certainty (case 2).

Proposition 2.2 outlines the equilibrium behavior observed in each of the cases as depicted graphically in Figure 2.3. The proposition follows immediately from Proposition 2.2', which may be found in Appendix 2.6.4 and which specifies the exact parameter values, the distributions of policy proposals over which the candidates randomize, and the voter strategies that characterize the equilibrium cases. The distributions of proposals take a somewhat complex form and as such are relegated to the appendix. The intuition behind these policy-proposal distributions follows the statement of equilibrium.

Proposition 2.2. *Threshold values $\hat{C}$ and $\hat{p}$ exist such that the following cases (corresponding to Figure 2.3) obtain in equilibrium:*

In all cases, if unchallenged, the incumbent proposes $x_L = M_L$, and V votes for L.

1. *The incumbent randomizes over an interval of proposals when challenged,*[10] *a strong type of challenger always enters and randomizes over an interval of pro-*

9. Specifically, and as is established in the proof of Lemma 2.4, if the incumbent is not randomizing, she will converge enough to defeat a strong type ($x_L = -\underline{a} = A_{R|S} - A_L$).

10. Where $x_L = -\overline{a} = A_{R|W} - A_L$ is the most divergent policy in the support of the distribution according to which L randomizes. Her most convergent policy is a function of $A_L, A_{R|S}, A_{R|W}, B, C, M_L, p$ (see the proof of Proposition 2.2 in the appendix), but it is such that $x_L \leq -\underline{a}$, $\forall x_L$.

posals,[11] *and a weak challenger enters with probability $\sigma_{R|W}$, always proposing $x_R = 0$ if contesting the election.*

2. *Strategies are as in case 1, except a weak challenger enters with probability $\sigma_{R|W} = 1$.*

3. *The incumbent always proposes $x_L = A_{R|S} - A_L$ when challenged, both types of challenger always enter, a strong challenger randomizes among policies $x_R \in [0, A_{R|S} - A_{R|W}]$, and a weak challenger proposes $x_R = 0$.*

4. *Neither type of challenger enters, with the incumbent holding the belief that any off-the-equilibrium-path entrant is of strong type and proposing $x_L = A_{R|S} - A_L$ if challenged.*

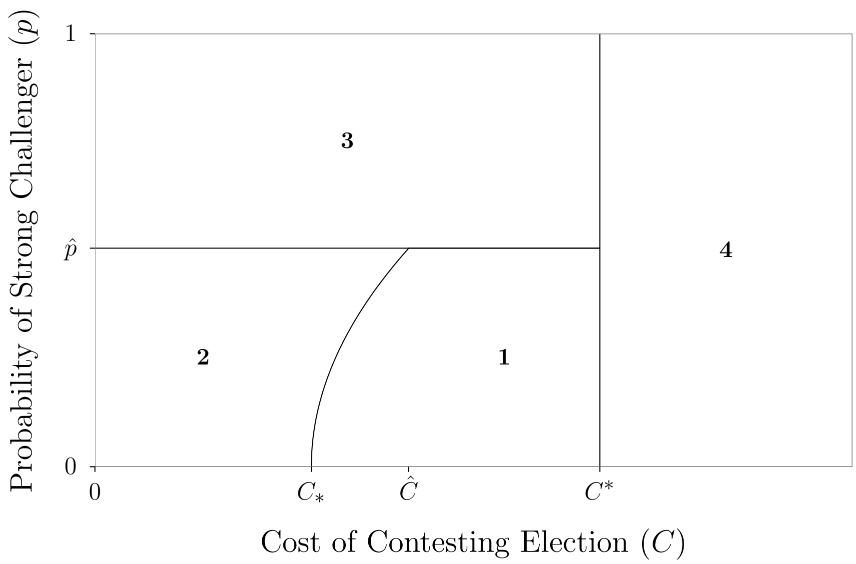
When a challenger of type t has proposed $x_R = 0$ and $x_L = A_{R|t} - A_L$ such that V is indifferent between the candidates, V votes for L. If $x_L = A_{R|W} - A_L$ and a strong challenger proposes $x_R = A_{R|S} - A_{R|W}$, V votes for R. In any other case in which V would be indifferent between the two candidates, V may break the tie in favor of L with any probability.

If costs are not too large, as in cases 1-3, then elections are contested at least some of the time. If costs are too high, then neither type of challenger would wish to enter, even if the incumbent were to converge enough to defeat even a strong challenger, i.e., $x_L = -\underline{a}$. This characterizes case 4, where the incumbent would believe that any entrant was a strong type, and so would propose $x_L = -\underline{a}$ if challenged.

Equilibrium cases 1 and 2 are of greatest interest. Their most notable feature is that the incumbent, if challenged, and the strong challenger randomize over an interval of

11. Where $x_R = \overline{a} - \underline{a} = A_{R|S} - A_{R|W}$ is the most divergent policy in the support of the distribution according to which type S of R randomizes. His most convergent policy offers the voter the same utility as L's most convergent policy.

Figure 2.3: Equilibrium Cases



Notes: The regions of the figure correspond to the cases in Proposition 2.2. In cases 1 and 2, both the incumbent (when challenged) and the strong type of challenger randomize over intervals of policy proposals.

In case 1, the weak type of challenger does not always enter the election, and in case 4, neither type of challenger enters the election, resulting in uncontested elections in these cases; in cases 2 and 3, both types of challenger always enter the election.

Upset victories, in which a strong challenger defeats the incumbent, are possible in cases 1 and 2. The extent of the incumbent's and the strong challenger's convergence is increasing along the curved line separating cases 1 and 2, and the extent of the incumbent's convergence increases throughout case 1 as C rises from $\hat{C}$ to C^*, making upsets less likely. In case 3, the incumbent converges with certainty to a proposal moderate enough to defeat even a strong challenger, and so no upsets are possible, and in case 4 the incumbent is never challenged, and so never defeated.

policies. The most divergent policies in the support of their respective distributions of policy proposals are fixed, and they offer the voter the same level of utility (after taking their respective valences into account). Specifically, these most-divergent proposals are $x_L = -\overline{a}$ and $x_R = \overline{a} - \underline{a}$. While the strong challenger's strategy does not put strictly positive mass on proposing $\overline{a} - \underline{a}$, the incumbent may propose $-\overline{a}$ with strictly positive probability.

The supports of the equilibrium distributions of policy proposals in cases 1 and 2 are intervals. The "extent of convergence" of these distributions of policy proposals will be said to have increased if, for each policy in the support, the probability of proposing a policy at least that far from the median voter's ideal point is weakly decreasing.[12] This may occur if the intervals over which a challenged incumbent and a strong challenger randomize include more convergent policies, the incumbent places less mass on her most divergent policy, and/or the distributions of proposals skew towards M_V. The extent of convergence is the primary degree of freedom by which the indifference conditions supporting the mixed strategies in cases 1 and 2 are satisfied. In case 1, it is joined by the probability that a weak challenger enters.

At equilibrium within case 1, the strategies of the incumbent (when challenged) and the strong challenger (who will always enter) are to randomize over an interval of policy proposals, while the strategy for the weak type of challenger entails randomizing between entering (and proposing $x_R = M_V$) and leaving the election uncontested. What would be the effect of an increase in the cost of entry from C to C', where $C' < C^*$ (i.e., still in case 1)? Given the proposal strategy of the Incumbent, weak challengers would no longer have an incentive to enter the election. In turn, this would lead to an increase in the extent of convergence by the incumbent, who is sure she faces a strong

12. The distribution of proposals may be thought of as a distribution of utility offers to the voter, or platform-valence offers. The extent of convergence may be said to have increased if and only if this distribution of platform-valence offers is increasing in the sense of first-order stochastic dominance.

type, which would lead to entry by weak types again. Only through an increase in the extent of convergence and a reduction in the frequency with which the weak challenger enters can equilibrium be maintained.

What would be the effect within case 1 of an increase in the probability nature chose a strong type from p to p'? The incumbent would increase the extent of her convergence, as she believes she more likely faces a stronger type. This would induce weak challengers to enter more frequently, however, which would mitigate the incumbent's incentive to converge. To maintain equilibrium, the weak challenger must enter somewhat more frequently, and within case 1, all other strategies may remain the same.

Within case 2, proposal strategies are similar to those in case 1, but the weak challenger will always enter the election. As the weak challenger strictly prefers to enter the election, an increase in the cost, C, has no effect within case 2. An increase in the probability that the challenger is strong, p, leads the incumbent to increase the extent of her convergence, which in turn induces a strong challengers to increase the extent of their convergence.

As p approaches $\hat{p}$, the distributions of proposals become increasingly convergent, until in case 3, the incumbent proposes $x_L = -\underline{a}$ with full probability. As p goes from $\hat{p}$ to 1, the strong challenger increases the extent of his convergence, until he places full mass on $x_R = M_V$. Throughout case 3, the weak challenger always enter, proposing the median voter's ideal point.

In the discussion that follows, the next sections briefly discuss the obfuscation of strength that challengers achieve through the entry decision as well as the incentives for challengers to contest even races they know they will lose. The focus then shifts to several implications of the model for the study of voter welfare. Part and parcel of this latter endeavor is the relationship among upset victories and uncontested elections.

2.4 Discussion

2.4.1 Signaling through Entry?

As Proposition 2.1 states, in none of the equilibrium cases do the strong and weak types of challengers fully separate with respect to entry. This result highlights the complexities of electoral politics vis-à-vis other signaling environments. In canonical signaling models, e.g., Rothschild & Stiglitz (1976), a lower (weaker, riskier) type wishes to be mistaken for a higher type, and the higher type is potentially willing to incur some cost to accurately reveal its type. In the model presented here, the weak challenger wishes to be "treated" as though he is a strong type as this will induce the incumbent to adopt a more convergent policy position than she would if she believed she faced the strong type. The strong challenger, however, does not wish to accurately reveal his type either. The strong type wishes to be mistaken for the weaker type as this will induce the incumbent to adopt a more divergent policy position than she would if she believed she faced a weak type, allowing for the possibility of an upset victory.

That candidates of different strengths tend to pool in equilibrium may emerge as a more general phenomenon. Epstein & Zemsky (1995) find that incumbents of two potential strengths will fully signal their type through campaign fundraising only over a relatively small subset of the parameter space. The set of parameters of which separation occurs grows even smaller as the authors restrict attention to what they call "strategic separation" rather than simple separation. Gordon & Landa (2009) also find incumbents of different strengths tend to pool. They find that weak types dilute the benefits of incumbency for stronger incumbents.

This is not to downplay the importance of the entry decision in supporting the equilibria of the model. It is only because the weak type of challenger tempers the frequency with which he enters that the incumbent is made indifferent between more convergent and less convergent policy proposals. This in turn leads to the rich set of outcomes in equilibrium, as in case 1. It is the partial separation with respect to entry that allows for the possibility of uncontested elections, varying levels of policy convergence, and even upset victories by the disadvantaged candidate.

2.4.2 Incentives to Enter

The motivations of the two types of challengers to enter the election differ markedly. The strong type of challenger has the prospect of winning the election and thus two-fold incentives for entering the election. If he upsets the advantaged candidate, he accrues B as the benefit from holding office. He will also receive less policy disutility, as he will be able to implement a policy much closer to his ideal point. The weak type of challenger, however, will never hold office in equilibrium. He will receive neither the benefit from holding office, B, nor the chance to implement a policy on his side of the median voter after ascending to office.

What then induces the weak type of challenger to enter? If the weak type stays out of the race, he receives the policy disutility associated with the incumbent's ideal policy. Simply by entering, he is able to induce convergence to at least the incumbent's optimal response if she knew she faced a weak type, $x_L = A_{R|W} - A_L$. Furthermore, because of the incumbent's uncertainty about which type she faces, the weak type may achieve a higher level of policy convergence from the incumbent. If the incumbent believes she faces a strong type, the winning policy will be more convergent than $x_L = A_{R|W} - A_L$.

It is rational for the incumbent to risk losing to a strong challenger, balancing this against the expected benefit of winning at a policy closer to her ideal point. This rational complacency, which at times results in the incumbent being upset by a strong challenger but at other times allows the incumbent to avoid converging unnecessarily against a weak challenger, emerges as a particularly interesting implication of the lack of full separation on the entry decision. Both types of challenger are able to leverage the uncertainty facing the incumbent of which type she actually faces. The strong type occasionally scores an upset victory, while the weak type occasionally achieves even greater policy convergence than he otherwise would, and does so merely by entering the election. Through the obfuscation of types in equilibrium, each type of challenger benefits from the uncertainty facing the advantaged candidate.

2.4.3 Contested Elections and Upset Victories

Normative theorists of democratic accountability have stressed the importance of both contested elections as well as the demonstrated potential for incumbents to be upset (e.g., Alvarez, Cheibub, Limongi & Przeworski (1996) and **?**). Because contested elections are a necessary condition for the possibility of turnover, the two goals are thought to be complementary, and each is thought to be positively related to voter welfare. The main result below suggests this account is too simplistic.

Changes leading to more contested elections may lead to more upset victories, but this may be despite the fact that the probability of an upset victory conditional on the election being contested has fallen. This is because contested elections and upset victories are not independently determined in equilibrium. The probability that the election is contested and the probability of an upset *conditional on a contested election* are co-dependent. Because the probability of an upset conditional on a contested election is an important indication of voter welfare, the results below highlight this outcome, as well. The following section delves more deeply into the implications for voter welfare.

Proposition 2.3. *Let the probability that nature selects a strong type not be too high ($p < \hat{p}$) and the cost of entry not be too large ($C < \hat{C}$).*

An increase in B or a decrease in C or M_L leads the probability that the election is contested and the probability that the challenger upsets the incumbent to increase, but *the probability of an upset conditional on a contested election to decrease.*

Only increases in p lead to more frequent contested elections or upsets without decreasing the probability of an upset conditional on a contested election.

The proof of Proposition 2.3, which appears in appendix section 2.6.6 makes use of the two corollaries to Proposition 2.2 that appear below. The proofs of these corollaries may be found in appendix section 2.6.5.

Animating this result is the role the incumbent's equilibrium belief that a challenger is strong, μ, plays in determining the frequency of the two outcomes in equilibrium. While this is an endogenous quantity, itself a function of parameters such as B, C, and M_L, it connects contested elections, upset victories, and the extent of convergence. Consider the following decomposition of the probability that the Incumbent is upset.

$$\Pr(R \text{ upsets } L) = \Pr(\text{contested}) \cdot \Pr(t = S|\text{contested}) \cdot \Pr(R \text{ wins}|t = S) \qquad (2.5)$$

A contested election is of course a necessary condition for an upset to occur. When the election is contested, only strong challengers defeat incumbents in the model, and then only when the Incumbent underestimates a strong challenger, believing him to be of weak type.

This decomposition holds in all of the equilibrium cases, although different elements of the right-hand side of equation (2.5) drive the outcomes across cases. The middle term – the probability that a challenger contesting the election is of strong type – is simply μ, as the Incumbent's belief must be correct in equilibrium. In case 1, when weak challengers mix between entering and leaving the race uncontested, $\mu > p$. Under full entry, in cases 2 and 3, $\mu = p$. In case 4, incumbent would belief an off-the-equilibrium-path challenger to be of strong type, so $\mu = 1$.

When entry occurs on the equilibrium path (as in cases 1-3), such that μ may be derived by Bayes' Rule, the probability that the election is contested – the first term on the right-hand side of equation (2.5) – is given by p/μ. Proposition 2.1 establishes that if the weak challenger enters with positive probability, the strong challenger will always enter. As such, the probability that the election is contested is (weakly) inversely related to the Incumbent's belief that a challenger contesting the race is of strong type. In case 1, with weak challengers mixing between entering and not, $\mu \in [p, \hat{p}]$. In cases 2 and 3, both types of challengers always enter, so $\mu = p$. When no entry occurs on the equilibrium path (as in case 4), Pr(contested) = 0.

Corollary 2.4 (to Proposition 2.2)**.** *For $C < \hat{C}$ and $p < \hat{p}$, the probability that the election is contested is (weakly) increasing in p and B, while the probability of an upset is (weakly) decreasing in C and M_L.*

Less immediately apparent is the fact that the probability a given strong challenger wins – the third term on the right-hand side of equation (2.5) – is also inversely related to the Incumbent's belief that a challenger is of strong type. Upon reflection, however, this is also quite intuitive. The greater the likelihood that the Incumbent is facing a strong challenger, the less likely she will be to underestimate her opponent.

Although a higher equilibrium probability that a challenger is of strong type leads to a lower the probability that a given strong challenger wins, the first effect outweighs the second as long as the Incumbent's strategy does not include converging all the way to $x_L = A_{R|S} - A_L = -\underline{a}$ with strictly positive probability. This requires $C < \hat{C}, p < \hat{p}$. When $\Pr(x_L = -\underline{a}) = 0$, the probability of an upset conditional on entry is increasing in μ. If $C > \hat{C}$ and/or $p > \hat{p}$, however, increases in μ lead to greater (or full) probability of $x_L = -\underline{a}$, thereby reducing the probability of an upset conditional on entry. When $\mu \neq p$, the inverse relationship between the probability of entry and μ makes it such that even if the probability of an upset conditional on entry is increasing in μ, the unconditional probability of an upset is decreasing in μ.

Corollary 2.5 (to Proposition 2.2). *Suppose* $C < \hat{C}$ *and* $p < \hat{p}$.

The probability that the challenger upsets the incumbent is (weakly) decreasing in C *and* M_L, *while the probability of an upset is (weakly) increasing in* p *and* B.

The probability that the challenger upsets the incumbent conditional on a contested election is (weakly) increasing in C, M_L, *and* p, *while the probability of an upset conditional on entry is (weakly) decreasing in* B.

The empirical literature on challenger performance generally bears out that high quality challengers outperform low quality challengers, where quality is measured using experience. Yet the result above states that the higher the probability that nature chooses a strong type, the lower the probability that a given strong challenger wins. In what ways, if any, is this at odds with the empirical consensus?

Empirical work focuses out of necessity on observable measures of challenger quality, while the model is predicated on challenger strength being unobservable. Suppose, however, that observable signs of strength (e.g., experience) are positively correlated with unobservable qualities. A challenger with experience might then be drawn from a distribution of challenger types with a higher p than the distribution from which a challenger without experience was drawn. Either may be strong or weak types on unobserved factors, but it is more likely the experienced candidate is a strong type.

If p is too high, no challengers will defeat incumbents. If p is not too high, within case 2, a higher probability of nature choosing a strong type, say $p' \in (p, \hat{p})$, would increase the frequency of upset victories. This is true despite the fact that a given strong challenger is less likely to defeat an incumbent. The increase in the probability that nature has chosen a strong challenger offsets the probability that the incumbent treats a challenger as though strong. If unobservable aspects of strength are correlated with observable measures, then studies would find (as they have) that experienced challengers more frequently defeat incumbents. Yet this finding may miss that an individual strong challenger could have worse prospects, as the expected strength of the pool of experienced candidates causes the incumbent to be more cautious about diverging from the median's preferences.

Other empirical findings seem to foot with the predictions of the model more straightforwardly, although the proposition above suggests a dose of caution even in these cases. For example, Squire (2000) examines uncontested elections at the level of state legislatures. He hypothesizes that increased professionalization within a legislature encourages entry by challengers, and he uncovers exactly this relationship. This pattern is consistent with a lower frequency of uncontested seats at the national level, where the prestige of holding office is even greater (Wrighton & Squire 1997). Indeed, within the model, an increase in the benefit of holding office leads to greater entry.

As has been noted, though, the increase in entry is not a result of challengers finding the prospect of holding office more valuable. The increase in entry is driven by the weak challenger contesting the election with greater frequency. The weak type will never win, however, and the increase in entry serves to temper the incumbent's desire to converge enough to defend her seat and secure the benefit B with certainty.

A fall in uncontested congressional elections leading to their research prompts Wrighton and Squire to conclude that according to this metric, "American democracy is healthier than at any other time [in the 20^{th} century]" (p. 452). Does the logic by which an increase in B actually leads to more contested elections subvert this conclusion? To understand what inference may be drawn from observed changes in outcomes associated with changes in the various parameters of interest, the relationship of the outcomes just discussed to voter welfare must be interrogated more fully.

2.4.4 Implications for Evaluating Voter Welfare

The probabilities with which various outcomes obtain are of interest in their own right, but they are also essential for understanding voter welfare. Contested elections are always better for voters than uncontested elections. The previous section establishes, however, that increases in the frequency of contested elections may be associated with tradeoffs in other outcomes, such as upsets. Conditional on an election being contested, voters benefit as the extent of convergence of the candidates' strategies increases.[13] When $C < \hat{C}$ and $p < \hat{p}$, the frequency of upsets conditional on a contested election is indicative of greater convergence in policy proposals in contested elections. As such, increases in contested elections may be associated with reductions in expected voter welfare in contested elections.

With changes in which parameters, then, is there a positive association with both the frequency of contested elections and expected policy convergence in contested elections? The result below states that only increases in p contribute positively to expected voter welfare without tradeoffs that push downwards on voter welfare. For analyst and strategic actor alike, the following implication emerges: changing any parameter other than p (perhaps in service of another objective, such as increasing incumbent retention) has both positive and negative consequences for voter welfare.

Proposition 2.6. *Voter welfare is (weakly) increasing in p.*

Changes in B, C, and M_L have both positive and negative effects on voter welfare.

Behind this proposition are two forces. The first is the frequency of contested elections. The second is the extent of convergence conditional on entry. When $C < \hat{C}$ and $p < \hat{p}$, the incumbent's belief that she faces a strong challenger when contested

13. Recall that the "extent of convergence" of a distribution of policy proposals is said to be increasing if the distribution of utilities offered to the voter as a function of the policy and the valence of the candidate is increasing in the sense of first-order stochastic dominance.

is positively related to the extent of convergence. When $C > \hat{C}$ or $p > \hat{p}$, μ remains constant and greater convergence in a contested election reduces the frequency of upset victories; whether or not voter welfare is increasing in that part of the parameter space depends more on the frequency of entry.

Increases in the quality of the pool of potential challengers, p, and the non-policy benefit to holding office, B, both lead to more contested elections. Only p, however, increases the extent of convergence of the candidates' proposal strategies.[14] Because B increases the frequency of contested elections by decreasing the incumbent's belief that she faces a strong challenger, however, increases in B also lead to fewer upset victories. It neither strictly increases nor strictly decreases the extent of convergence, but due to greater entry by weak challengers, a greater share of elections result in a policy offering the voter $A_{R|W}$, the lowest utility V will receive in any contested election in equilibrium.

When C and M_L increase, the weak challenger requires greater convergence to be willing to enter the election, so in equilibrium the incumbent proposes policies according to a more convergent distribution, and the strong challenger follows suit. Accompanying this positive contribution to voter welfare, however, is an increase in the frequency of uncontested elections, which result in a winning policy much worse from the voter's perspective than any policy that would result from a contested election. Should C and M_L increase so much that $C > \overline{C}$, the latter effect ultimately dominates. In case 4, there are no contested elections. Even though an incumbent would converge to $-\underline{a}$ if challenged, this never occurs, and the winning policy is always M_L. A third effect, further muddying the waters, is that changes to the incumbent's ideal point, M_L, not only affect the likelihood of various outcomes, but the utility the voter derives from an

14. In fact, at most one of these consequences of increasing p obtains at any generic point in the parameter space, but it is never the case that increasing p applies downward pressure to voter welfare in any way.

uncontested election. Increases in M_L reflect a more moderate incumbent relative to the voter's preferences as M_L approaches M_V.

This raises another important important point with regards to empirical work. If an analysis excluded any uncontested elections, then the effects on voter welfare of an increase in the cost of contesting an election or the incumbent's ideal point would be unambiguously positive, but this would ignore the negative effects on voter welfare of having more uncontested elections. The exclusion of uncontested races may materially bias inference.

Suppose, for instance, that one wished to understand the effect on the distance of the winning policy from the median voter's ideal point as a function of the distance of the incumbent's ideal point from the median voter's. To simplify the thought experiment greatly, the analyst might run the following model:

$$|x - M_V| = \alpha + \beta \cdot |M_L - M_V| + \epsilon. \tag{2.6}$$

This analysis would be in the spirit of studies such as McCarty, Poole & Rosenthal (2006), which investigate the effect of gerrymandering on polarization, i.e., the effect of changes in the distribution of ideologies within a district on the extremism of the policies espoused by the representative of that district.

Were the sample used to test the model given in equation 2.6 only to include contested elections, the estimate of β would be negative. This would be a somewhat surprising conclusion, suggesting greater district-level polarization leads to less extreme policies. Of course, the model would provide an explanation, namely that a more homogenous district would lead to less entry. This in turn gives the incumbent a higher belief that she faces a strong type and thus leads to more convergent policy proposals (and safer seats, a plausible intention of gerrymandering). However, this inference would be somewhat incorrect, as it excludes the relatively extreme winning policies that occur in uncontested elections, a crucial part of the mechanism by which greater convergence came about.

A number of papers in recent years have used a regression discontinuity design in which small population shifts trigger discontinuous increases in the salary awarded to politicians, the quantity B in our model (Eggers, Freier, Grembi & Nannicini 2016). Many of these papers attempt to draw inference about electoral accountability and the incumbency advantage. As in the preceding example, whether or not these analyses included only contested elections could have stark affects on inferences about the effect of B on outcomes such as incumbent retention.

The decision to exclude uncontested elections from analyses is not without consequence. The model presented herein offers predictions for analyses that condition on an election being contested when constructing their sample. It also demonstrates, however, that when analyzing the effect of changes in the cost of entry or the incumbent's ideal point, excluding uncontested elections may bias results or even fail to sign estimates correctly.

2.5 Conclusion

This paper presented a model of challenger entry followed by electoral competition. Under the plausible assumptions that strong challengers have something to gain if underestimated and that weak challengers have something to gain if overestimated, the model revealed that the incumbent will never know with certainty whether she faces a strong or a weak opponent until after she has laid down a policy stake. In the equilibrium cases of greatest interest, uncontested elections, upset victories, and varying levels of convergence in the winning policy all occur.

The rich set of outcomes occurring in equilibrium stem from what might be termed the incumbent's "rational complacency." The incumbent, valence-advantaged as she is, could moderate enough in policy to ensure victory. She is willing, though, to adopt less moderate positions, weighing the chance of winning at policies she finds more attractive against the possibility of losing to a strong challenger. The weak challenger will never win an upset victory. Yet the prospect of being mistaken for a strong challenger and inducing moderation from the incumbent over and above what would be necessary for the incumbent to defeat a weak challenger incentivizes weak challengers to enter.

A key set of relationships emerges from the equilibrium strategies, namely, the connection between the probability that the election is contested at all and the behavior of candidates in contested elections. This is most clearly demonstrated by the probability of an upset victory conditional on the election being contested. Because the frequency of entry is driven by weak types of challengers, a higher probability of a contested election lowers the incumbent's belief that she faces a strong type. In turn, this leads to the rational complacency just discussed, which increases the probability that a given strong challenger will upset the incumbent. The probability of an upset conditional on entry (but not conditional on the type of challenger) will fall as a result of the influx of weak challengers, but the unconditional, ex ante probability of an upset will rise.

This complex web of effects becomes particularly salient when considering voter welfare. Changes in parameter values such as the non-policy benefit to holding office, the cost of entry, or the distribution of preferences may lead the probability of a contested election to increase (a benefit to voters) while causing the expected policy proposals in contested elections to be distributed less favorably. Together, these results make the case that the exclusion of uncontested races from analyses of elections may bias results. Not only is the decision to contest the race not randomly assigned, but behavior in contested races is not independent of the probability that the race is contested. Comparative statics may change in magnitude or even in sign depending on the decision to consider all elections or only contested elections.

Increases in the prior probability that the challenger is strong are the only parameter change that does not entail tradeoffs in voter welfare. Contested elections increase, and proposals in contested elections become increasingly moderate. As such, recruiting stronger pools of potential candidates emerges as a recommendation of the model for those seeking to improve election outcomes not from the perspective of a particular side, but rather broadly for the population as a whole.

2.6 Appendix

2.6.1 Preliminary Results: Lemmas 2.1-2.3

In the context described in-text, the elimination of weakly dominated strategies implies that voters will vote sincerely, which in turn allows us to invoke the median voter theorem and restrict attention to the median voter's decision. The first result formalizes this, establishing that it is as though the incumbent and the challenger, L and R, compete only for the support of the median voter, V. The elimination of weakly dominated strategies will also help narrow the range of policy proposals we need to consider as we develop the players' equilibrium strategies below, which the second lemma makes explicit.

Lemma 2.1. *The majority preference relation is equivalent to the median voter's preference relation.*

Proof of Lemma 2.1. The assumption that players, including voters, do not play weakly dominated actions implies that If L is challenged by R, no voter votes for a candidate whose policy proposal, if implemented, and valence, if elected, would provide the voter strictly lower utility than the opposing candidate. Voting is sincere, with voters only voting for their most preferred candidate.

Voter preferences are supermodular in ideal points and the winning policy proposal, and this property is preserved with valence entering additively into voter utility. This is a sufficient condition to apply the results from Gans & Smart (1996), and the result follows immediately. ■

Lemma 2.2. *In any equilibrium, $x_L \in [M_L, 0]$ and $x_R \in [0, M_R]$.*

Proof of Lemma 2.2. We show that for any policy $x_L \notin [M_L, 0]$ or $x_R \notin [0, M_R]$, the candidates could weakly improve their chances of winning and/or the utility they would derive from winning by proposing a policy within those intervals.

Consider $x_L < M_L$. $\hat{x}_L = M_L$ increases the utility the incumbent offers the voter, thus weakly increasing L's chance of winning, and provides L more utility from the winning policy should she win. $\hat{\hat{x}}_L = 0$ similarly weakly dominates any proposal $x_L > 0$. A symmetric argument applies to R.

As such, the assumption to eliminate weakly dominated strategies narrows the domain of proposals available to L and R to the intervals given above. ■

A strategy for the incumbent is a policy to propose when unchallenged as well as a (possibly degenerate) distribution of policies according to which to propose when challenged, where in this latter case x_L is distributed according to the cumulative distribution function ξ_L. The support of this distribution will be a subset of the interval $[M_L, 0]$. A strategy for the challenger is a pair for each type consisting of a probability of entry, $\sigma_{R|t} = \Pr(enter|t)$, and a distribution of policy proposals, $x_{R|t}$, with distribution function $\xi_{R|t}$. The support of this distribution will be a subset of the interval $[0, M_R]$.[15] Let the incumbent's belief that she faces a strong type be denoted by μ, which by consistency of beliefs must equal $\frac{p\sigma_{R|S}}{p\sigma_{R|S}+(1-p)\sigma_{R|W}}$ when at least one of the types of challenger enters with strictly positive probability.

The possibility of voter indifference affects a candidate's expected utility from proposing x_c only to the extent that, given ξ_{-c}, there is a strictly positive probability that V will be indifferent the two candidates. However, two cases of voter indifference will be of particular importance going forward, and the next result concerns these cases. Specifically, in the event that a challenger of type t converges in policy entirely to the median voter's ideal point, 0, and the incumbent proposes $x_L = A_{R|t} - A_L$ (converging just enough to leave V indifferent), the next lemma says V must vote for L.

15. We do not assume the distributions are continuously differentiable, but results below establish that the interiors of non-degenerate strategy distributions lack mass points and gaps and so are, in fact, in C^1.

Lemma 2.3. *No equilibrium can exist in which a challenger of type t proposes $x_R = 0$ with strictly positive probability and the support of ξ_L includes $x_L = A_{R|t} - A_L$, but in which V does not vote for L in the event that the incumbent proposes $x_L = A_{R|t} - A_L$ and a challenger of type t proposes $x_R = 0$.*

Proof of Lemma 2.3. For $\xi_{R|t}$ such that $\Pr(x_R = 0|t) = \alpha > 0$, suppose that V votes for type t of R with probability $\beta > 0$ when $x_L = A_{R|t} - A_L$ and type t of R has proposed $x_R = 0$.

Consider $\hat{x}_L = A_{R|S} - A_L + \epsilon$, where $\epsilon > 0$. Then $\mathbb{E}U_L(\hat{x}_L) > \mathbb{E}U_L(A_{R|S} - A_L)$ if $-M_L + A_L - A_{R|S} + B - \epsilon > -M_L + (1 - \mu\alpha\beta)(A_L - A_{R|S} + B) + \mu\alpha\beta(0) \Rightarrow \epsilon < A_L - A_{R|S} + B$. Such an ϵ clearly exists, so it cannot be the case that $x_L = A_{R|S} - A_L$ was in the support of ξ_L in any equilibrium in which ties are not broken entirely in L's favor when $x_L = -\underline{a}$ and a strong challenger has proposed $x_R = 0$.

This same logic applies to $\xi_{R|W}$ s.t. $\Pr(x_R = 0|W) > 0$, except that we must account for the fact that it is possible that the strong type could be proposing $A_{R|S} - A_{R|W}$. This only makes the argument above stronger, however, as $\hat{\hat{x}}_L = A_{R|W} - A_L + \epsilon$ also reduces the likelihood of the strong challenger winning. Setting this added benefit aside, we have $\mathbb{E}U_L(\hat{\hat{x}}_L) > \mathbb{E}U_L(A_{R|W} - A_L)$ if $\epsilon < A_L - A_{R|W} + B$. As it is possible to find such an ϵ, so $x_L = -\overline{a}$ cannot be in L's equilibrium distribution of proposals if she loses at that proposal to a weak type proposing $x_R = 0$ with any positive probability. ■

2.6.2 No Entry Separation: Proposition 2.1

Proposition 2.1. *The two types of challengers never fully separate with respect to entry in equilibrium.*

The proof merely provides extra detail around the argument in text.

Proof of Proposition 2.1. If the incumbent believes that only weak types of challengers enter in equilibrium, she would propose $x_L = A_{R|W} - A_L$, converging enough so that there is no policy available to the weak type such that voting for R offers the voter more utility than would voting for L would provide.[16] However, it would not be sequentially rational for the strong type to remain out of the election. Any $x_R < A_{R|S} - A_{R|W}$, which makes voting for S more attractive for V than voting for L, would win with certainty. Further, according to our assumption that $-M_L + A_{R|W} - A_L < C$, the weak type's preference would be to leave the seat uncontested.

If the incumbent believes she faces only a strong type, then she would converge to $x_L = A_{R|S} - A_L$. As established V must break ties in favor of L for an equilibrium to exist, so R would be losing with certainty. If the strong type remains willing to contest the race, i.e., $C < -M_L + A_{R|S} - A_L$, the weak type would also prefer to enter (getting more convergence from the incumbent than his low valence "deserves"). If the strong type is not willing to incur the cost of entry only to lose to an incumbent converged to $x_L = A_{R|S} - A_L$, then neither would the weak type. ■

2.6.3 Constructing Equilibria in Randomized Strategies: Lemmas 2.4-2.6

In developing the policy proposal strategies in this model, it is useful to consider the utility that a candidate offers to the voter with the candidate's policy proposal and associated valence. For instance, if L proposes x_L, the voter's utility from voting for L would be $x_L + A_L$. As such, let $z_L : [M_L, 0] \to \mathbb{R}$ simply be an affine transformation given by $z_L(x_L) = x_L + A_L$, the utility the voter would receive from electing L. Similarly, we characterize the utility offered to the median voter by the strong type with

16. Per Lemma 2.3, even if the weak type proposes $x_R = 0$, V must break the tie in favor of L in any equilibrium.

the function $z_{R|t} : [0, M_R] \to \mathbb{R}$ where $z_{R|t}(x_R) = -x_R + A_{R|t}$.

Since $x_L \sim \xi_L$, we write $z_L \sim \zeta_L$, where $\zeta_L(z) = \xi_L(z - A_L)$. Similarly, write $z_{R|t} \sim \zeta_{R|t}$, where $\zeta_{R|t}(z) = 1 - \xi_{R|t}(A_{R|t} - z)$. Denoting L's belief (correct on the equilibrium path) that the probability she faces a strong challenger is $\mu \in [0, 1]$, we may write $z_R \sim \zeta_R$ with $\zeta_R = \mu \cdot \zeta_{R|S} + (1 - \mu) \cdot \zeta_{R|W}$.

Definition We refer to z_c as comprising candidate c's *policy-valence offer* (PVO), and ζ_c as c's *distribution of PVOs.*[17]

If c offers a PVO of $z_c > z_{-c}$, then the voter (voting sincerely by Lemma 2.1) will vote for candidate c. Note that conditional on winning, each candidate would prefer to do so at a PVO that offers the voter a lower level of utility, thus winning at a more divergent policy (i.e., a policy closer to the candidate's ideal point). Candidate c's utility, then, is decreasing in z_c. As a first step in characterizing the equilibrium distributions of PVOs, the next lemma establishes that L and R's maximum PVO must be the same.

Lemma 2.4. *The support of both candidates' equilibrium distribution of PVOs must have the same maximum,* $\overline{z}$.

Recall that "candidate" here refers to L or R without drawing distinction between the possible types of challenger, i.e., both types' strategies need not include $\overline{z}$. Conditional on R winning, the type of challenger behind a given winning PVO certainly has implications for L's utility. For the sake of this result, however, it only matters to L whether or not some type of R is offering a higher PVO (i.e., more utility to the voter) than she is.

17. Tthe strategies and their derivation hold much in common with those from the theory of asymmetric auctions (see Maskin & Riley (2000)). The context of electoral politics, however, features a complexity absent from auctions: namely, if a candidate loses, he/she cares about the policy at which his/her opponent wins. In auctions, if a bidder does not win, she does not care about her opponent's bid.

Proof of Lemma 2.4. Suppose that the candidates' maximum PVOs are such that $\overline{z}_c > \overline{z}_{-c}$. Then $\hat{z}_c = \frac{\overline{z}_c + \overline{z}_{-c}}{2}$ would yield c as high a probability of winning as z_c but at a policy closer to M_c. As such, it cannot be that $\overline{z}_c$ is part of c's distribution of PVOs in equilibrium, and so $\overline{z}_c = \overline{z}_{-c}$. ■

The challenger's highest possible PVO is $z_R = A_{R|S}$, if the challenger is of strong type and has converged in his policy proposal all the way to the voter's ideal point. As both candidates' distributions of PVOs must share the same maximum, $A_{R|S}$ is clearly an upper bound on $\overline{z}$.

Indeed, if L's equilibrium strategy entails a degenerate distribution of PVOs, her pure strategy must consist of offering $z_L = A_{R|S}$. For any $\hat{z}_L < A_{R|S}$ offered with full mass, any candidate in whose favor V does not break ties at $\hat{z}_L$ would benefit from proposing a slightly more moderate policy and offering $z_c > \hat{z}_L$. Such a beneficial deviation exists for L or (at least the strong type of) R if L plays a pure strategy unless $z_L = A_{R|S}$ and V awards L the vote in the event of indifference.

Remark 2.2. *Given Lemma 2.2, there must also exist finite minimum bids for office, $\underline{z}_c$. L's minimum offer cannot be less than $z_L = M_L - A_L$, while R's cannot be less than $z_R = -M_R - A_{R|S}$.*

A related result is that if L is not converging to $x_L = A_{R|S} - A_L$ ($z_L = A_{R|S}$) with probability one, then the minimum of the support of both candidates' distributions of bids for office is equal to $\underline{z} = A_{R|W}$. Before proceeding to this lemma, consider that if L plays a mixed strategy, she must win with certainty at the maximum offer of utility, $\overline{z}$, that the candidates share. Either $\overline{z} = A_{R|S}$, and so L must win by Lemma 2.3, or $\overline{z} < A_{R|S}$ and $\Pr(z_R < \overline{z}) = 1$, by Lemma 2.4. Further, if L is randomizing in equilibrium, the strong type of R must win with at least some strictly positive probability at all policies (bids) over which she randomizes. For the candidates to be willing to randomize over lower PVOs, they trade off a lower probability of winning and a smaller policy loss if they do win with winning more often at $\overline{z}$, a less attractive policy.[18]

Lemma 2.5. *If both candidate's equilibrium strategies entail non-degenerate distributions of bids for office, z_c, then the minimum of the supports of these distributions, $\underline{z}_c$, must be the same, namely $\underline{z} = A_{R|W}$.*

Proof of Lemma 2.5. Any (type of) candidate whose equilibrium strategy entails a non-degenerate distribution of bids for office must either win with some strictly positive probability at the minimum of the distribution's support, or lose at all points in the support of the distribution. If $\overline{z} < A_{R|S}$, then both candidates win with certainty if they offer $z_c = A_{R|S}$. Even if $\overline{z} = A_{R|S}$ and L offers this bid with positive mass, if she does not place full mass on it (i.e., $\Pr(z_L < \overline{z}) \in (0, 1)$), then R must clearly win with some probability if he bids $z_{R|S} = \overline{z} = A_{R|S}$, by the fact that the support of $\zeta_{R|S}$ must include $\overline{z}$ and because $\zeta_L(\overline{z}) > 0$.

As candidates randomize over less divergent policy proposals, they are trading off some probability of winning for the prospect of winning at a more appealing policy. In fact, they not only trade-off the probability of winning, though, but also incur greater expected disutility in expectation from the winning policy if they lose as they diverge. Nonetheless, for both of the candidates' equilibrium distributions to be non-degenerate, the candidates must be indifferent among all policies (or bids, z_c) over which they randomize, and so they must be winning with at least some strictly positive probability at the lowest bid in their distributions. It must be, then, that $\underline{z}_L = \underline{z}_R$. If not, e.g., $\underline{z}_c < \underline{z}_{-c}$, then candidate c would lose with certainty at all $z \in [\underline{z}_c, \underline{z}_{-c})$, which we have argued cannot occur if ζ_c, ζ_{-c} are non-degenerate. ■

18. Complicating this trade-off is that, the more divergent the policy position at which a candidate loses, the greater the expected disutility from the winning policy, i.e., the more divergent the opposing candidate's policy could have been while still offering the voter the greater level of utility, $z_{-c} > z_c$.

For candidate L and at least one type of R to be randomizing in equilibrium, it must be true that $\zeta_R(\underline{z}) = \mu\zeta_{R|S}(\underline{z}) + (1-\mu)\zeta_{R|W}(\underline{z}) > 0$ and $\zeta_L(\underline{z}) > 0$. This implies that $\Pr(z_L = \underline{z}) > 0$. Suppose L and at least one type t of R both place positive mass on $\underline{z}$ and both win with some strictly positive probability against the other. One or both of L and R of type t would find it worthwhile to bid slightly above $\underline{z}$ instead of ever offering $\underline{z}$. So it must be the case that whichever type of R is placing mass on $\underline{z}$ is losing with certainty, but this means that it cannot be the type of R that is randomizing. It must be that S randomizes, does not place positive mass on $\underline{z}$, and W loses with certainty, but the only $\underline{z}$ for which there could be no deviation is $\underline{z} = A_{R|W}$, where by Lemma 2.3, we know V must vote for L if indifferent between L and type W of R. Finally, note that it must be true that V would vote for type S of R if the strong challenger proposes $x_R = A_{R|S} - A_{R|W}$ and the incumbent $x_L = A_{R|W} - A_L$, but the strong challenger will not offer $\underline{z}$ with positive probability, and so from L's perspective, she need only take into account the probability with which she will face a weak type of challenger, degenerately offering $\underline{z}$.

The final lemma asserts that the PVO distributions when the candidates are mixing are continuously differentiable over their interiors. The proof establishes that, if L is mixing, R must be as well, and that each will randomize over an interval of PVOs, $[A_{R|W}, \overline{z}]$. Furthermore, when mixing, neither candidate will place any positive mass on any offer except $A_{R|W}$ and, for L, the maximum, $\overline{z}$, but only if $\overline{z} = A_{R|S}$.

Lemma 2.6. *In any equilibrium, the incumbent does not put strictly positive mass on any PVO $z_L \in (\underline{z}, A_{R|S})$ with strictly positive probability. If ζ_L is a non-degenerate distribution, $\zeta_{R|S}$ will not place strictly positive mass on any PVO $z_R \in (A_{R|S}, A_{R|S}]$.*

If the candidates' equilibrium distributions of PVOs, $\zeta_c, c = L, R$, are both non-degenerate, the distributions will also have no gaps, i.e., $\forall a, b \in [\underline{z}, \overline{z}]$ s.t. $b > a, \zeta_c(b) - \zeta_c(a) > 0$.

Proof of Lemma 2.6. Note that if $\overline{z} < A_{R|S}$, which we know by the discussion above cannot occur unless L's strategy is non-degenerate, then neither candidate will offer the voter utility of $\overline{z}$ with strictly positive probability in equilibrium. Only if $\overline{z} = A_{R|S}$ may L place positive mass on $\overline{z}$ in an equilibrium involving non-degenerate distributions of bids for office.

Suppose by way of contradiction that candidate c has placed positive mass on $\hat{z} \in (\underline{z}, \overline{z})$ (i.e., either L placing strictly positive mass on some $\hat{z} \in (\underline{z}, \overline{z})$ or R placing strictly positive mass on some $\hat{z} \in (\underline{z}, \overline{z})$ if ζ_L is a non-degenerate distribution). By the definition of mass point, $\Pr(z_c \in (z^-, z^+)) > 0$, where $z^- < \hat{z} < z^+$, and so regardless of how V breaks a tie at $\hat{z}$, there exists a discontinuous increase in the probability of $-c$ winning by increasing her PVO from z^- to z^+. As such, $\exists \gamma$ s.t. $\mathbb{E}U_{-c}(z^-) < \mathbb{E}U_{-c}(z^+), \forall z^- \in (\hat{z} - \gamma, \hat{z}), z^+ \in (\hat{z}, \hat{z} + \gamma)$. It cannot be a best response if $\exists z_{-c} \in (\hat{z} - \gamma, \hat{z})$, implying that c should instead offer $\hat{z} - \alpha\gamma, \alpha \in (0, 1)$, so $\hat{z}$ cannot be part of c's best response. This proves the first part of the lemma.

To prove that there will not be gaps in the distributions of PVOs when they are both non-degenerate, suppose by way of contradiction that c's distribution lacks support over $(a, b) \in [\underline{z}, \overline{z}]$, but where a, b are in the support of ζ_c. Note that $b \leq \overline{z}$. Also note that if both candidates propose according to non-degenerate distributions, each trades winning more often at higher PVOs with losing more often at lower PVOs, which are more attractive to the candidate.

Because $z_{-c} = a$ offers $-c$ a strictly higher expected payoff than any $z_{-c} \in (a, b)$ (the same winning probability but at a PVO that is more attractive to $-c$), $\nexists z_{-c} \in (a, b)$. As we established that the offer distributions share the same minimum if both are non-degenerate, then the two distributions must share the same gaps, if any exist. However, $z_c = a$ offers a strictly higher payoff than $z_c = b$, so it cannot be that b is in the support of either candidate's distribution, a contradiction of the assumption that there exists a gap in the distributions. ■

2.6.4 Characterizing the Equilibrium Cases: Proposition 2.2

Before proceeding to fully characterize the equilibrium cases, we recall and establish some notation: $C_* := -M_L + A_{R|W} - A_L$, $C^* := -M_L + A_{R|S} - A_L$, $\sigma_{R|t}$ denotes the probability that a challenger of type t enters the election, μ denotes L's belief that she faces a strong challenger,[19] and $\overline{z}$ is the maximum of the distribution of platform-valence offers (PVO) made by the candidates in equilibrium.

Consider a function of the cost of entry that specifies what the maximum of the distribution of PVOs must be, $Z : [C_*, \hat{C}] \longrightarrow [A_{R|W}, A_{R|S}]$, to support the indifference conditions necessary for a mixed-strategy equilibrium, i.e., one involving non-degenerate distributions of policy proposals. As is verified below, this is a strictly increasing function in C, so we may define $\hat{C} := Z^{-1}(A_{R|S})$ to be the value of C at which $Z(C)$ is equal to $A_{R|S}$, the upper bound of $\overline{z}$.

Further, let $\tilde{P} : [A_{R|W}, A_{R|S}] \longrightarrow [0, 1]$ give the highest proportion of strong potential challengers in the population for which, given $\overline{z} \in [A_{R|W}, A_{R|S}]$, there exists some level of entry by weak types, $\sigma_{R|W} \in [0, 1]$, that could support beliefs held by L that would sustain a mixed-strategy equilibrium. Entry by weak challengers decreases μ so that L remains willing to randomize. Note that P is a strictly increasing function in $\overline{z}$, and set $\hat{p} := P(A_{R|S})$.

Then let $P : [C_*, \hat{C}] \longrightarrow [0, \hat{p}]$ be a function given by $\tilde{P}(Z(C))$ and represented by the curve in Figure 2.3 separating cases 1 and 2.[20] We refer to this function below

19. From Lemma 2.3, we know that $\sigma_{R|W} > 0 \Rightarrow \sigma_{R|S} = 1$, so know $\mu = \frac{p}{p+(1-p)\sigma_{R|W}}$ when the election is contested.

20. With regards to uniqueness, the cases indicated below must obtain, but R's strategy in case 3 need not be as stated in the proposition. Up to this element, the equilibrium is unique. R's strategy in case 3 is chosen because it works throughout the entire case, has intuitive appeal, and holds even as $A_L \to A_{R|S}$ and $B \to 0$.

simply by $P(C)$.

Proposition 2.2'. *The following strategies, by case, constitute an equilibrium of the model:*[21]

In all cases, if unchallenged, the incumbent offers $z_L = M_L + A_L$ *(i.e., proposes* $x_L = M_L$*).*

1. $(C,p) \in \{(C,p) | C \in (C_*, \hat{C}], p \in (0, P(C)]\} \cup \{(C,p) | C \in (\hat{C}, C^*], p \in (0, \hat{p}]\}$:

$$\overline{z} = \begin{cases} Z(C) & C \in [C_*, \hat{C}] \\ A_{R|S} & C \in (\hat{C}, C^*] \end{cases}$$

$$Z(C) = A_{R|W} + \sqrt{A_L - A_{R|W} + C + M_L}\left(\sqrt{2(A_L + A_{R|S} - 2A_{R|W} + B)} - \sqrt{A_L - A_{R|W} + C + M_L}\right)$$

$$\mu = 1 - \frac{\sqrt{A_L + A_{R|S} - 2\overline{z} + B}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}} = \begin{cases} \frac{\sqrt{2(A_L - A_{R|W} + C + M_L)}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}} & C \in [C_*, \hat{C}] \\ 1 - \frac{\sqrt{A_L - A_{R|S} + B}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}} & C \in (\hat{C}, C^*] \end{cases}$$

$$z_L \sim \begin{cases} \zeta_L(z_L) = \begin{cases} 0 & z_L < A_{R|W} \\ (1-\mu)\frac{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}}{\sqrt{A_L + A_{R|S} - 2z_L + B}} & z_L \in [A_{R|W}, \overline{z}] \end{cases} & \forall C \in [C_*, \hat{C}] \\ \hat{\zeta}_L(z_L) = \begin{cases} 0 & z_L < A_{R|W} \\ \frac{(A_{R|S} - A_L - C - M_L)/\sqrt{A_L + A_{R|S} - 2z + B}}{\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L - A_{R|S} + B}\right)} & z_L \in [A_{R|W}, A_{R|S}) \\ 1 & z_L \geq A_{R|S} \end{cases} & \forall C \in (\hat{C}, C^*] \end{cases}$$ [22]

$$z_{R|S} \sim \frac{(1-\mu)\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L + A_{R|S} - 2z + B}\right)}{\mu\sqrt{A_L + A_{R|S} - 2z + B}},\ z_{R|S} \in [A_{R|W}, \overline{z}]$$ [23]

$$\sigma_{R|S} = 1$$

$$z_{R|W} = A_{R|W}$$

$$\sigma_{R|W} = \frac{p(1-\mu)}{(1-p)\mu} = \begin{cases} \frac{p\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{2(A_L - A_{R|W} + C + M_L)}\right)}{(1-p)\sqrt{2(A_L - A_{R|W} + C + M_L)}} & C \in [C_*, \hat{C}] \\ \frac{p\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}}{(1-p)\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L - A_{R|S} + B}\right)} & C \in (\hat{C}, C^*] \end{cases}$$

2. $(C,p) \in \{(C,p) | C \in (0, C_*], p \in (0, \hat{p}]\} \cup \{(C,p) | C \in (C_*, \hat{C}], p \in (P(C), \hat{p}]\}$:

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21. Corresponding to Figure 2.3 in the text.

22. At $\hat{C}$, $\hat{\zeta}_L = \zeta_L$, and for higher values of C, $\hat{\zeta}_L$ is just a mix of ζ_L and (increasingly) a distribution placing all mass on $A_{R|S}$.

23. The truncated distribution of z_L over $(A_{R|W}, \overline{z})$ is $\frac{\mu}{1-\mu}\zeta_L(z) = \zeta_{R|S}(z)$, which is to say that the truncated distribution of z_L over $[A_{R|W}, \overline{z})$ is $\zeta_L(z) = \zeta_R(z)$, even when $C \in (\hat{C}, C^*]$ (see the previous footnote).

$\overline{z} = P^{-1}(p) = A_{R|W} + p(1 - \frac{p}{2})(A_L + A_{R|S} - 2A_{R|W} + B)$

$\mu = p$

$$z_L \sim \zeta_L(z_L) = \begin{cases} 0 & z_L < A_{R|W} \\ (1-\mu)\frac{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}}{\sqrt{A_L + A_{R|S} - 2z_L + B}} = (1-p)\frac{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}}{\sqrt{A_L + A_{R|S} - 2z_L + B}} & A_{R|W} \in [A_{R|W}, \overline{z}] \end{cases}$$

$z_{R|S} \sim \frac{(1-\mu)(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L + A_{R|S} - 2z + B})}{\mu\sqrt{A_L + A_{R|S} - 2z + B}} = \frac{(1-p)(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L + A_{R|S} - 2z + B})}{p\sqrt{A_L + A_{R|S} - 2z + B}},$

$z_{R|S} \in [A_{R|W}, \overline{z}]$

$\sigma_{R|S} = 1$

$z_{R|W} = A_{R|W}$

$\sigma_{R|W} = 1$

3. $(C,p) \in \{(C,p)|C \in (0, C^*], p \in (\hat{p}, 1)\}$:

$\overline{z} = A_{R|S}$

$\mu = p$

$z_L = A_{R|S}$

$$z_{R|S} \sim \zeta_{R|S}(z_{R|S}) = \begin{cases} \frac{(1-p)(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L + A_{R|S} - 2z + B})}{p\sqrt{A_L + A_{R|S} - 2z + B}} & z_{R|S} \in [A_{R|W}, A_{R|S}) \\ 1 & z_{R|S} \geq A_{R|S} \end{cases}$$

$\sigma_{R|S} = 1$

$z_{R|W} = A_{R|W}$

$\sigma_{R|W} = 1$

4. $(C,p) \in \{(C,p)|C > C^*, p \in (0,1)\}$:

$\mu = 1$ *(such that off-path challengers are believed to be strong types)*

$z_L = A_{R|S}$ *(when challenged, which would only occur off-path)*

$z_{R|S} = A_{R|S}$

$\sigma_{R|S} = 0$

$z_{R|W} = A_{R|W}$

$\sigma_{R|W} = 0$

If the incumbent is unchallenged, V votes for L.

If a challenger of type t has proposed $x_R = 0$ and $x_L = A_{R|t} - A_L$ such that V is indifferent between the candidates, V votes for L.

If $x_L = A_{R|W} - A_L$ and a strong challenger proposes $x_R = A_{R|S} - A_{R|W}$, V votes *for R. In any other case in which V would be indifferent between the two candidates, V may break the tie in favor of L with any probability.*

Proof of Proposition 2.2'. Given Lemma 2.5, four cases may obtain: 1) L and R could both propose policies according to non-degenerate distributions and the weak type of challenger could leave the election uncontested with some strictly positive probability, 2) L and R could both propose policies according to non-degenerate distributions and the weak type of challenger could always enter, 3) L could propose a degenerate distribution in which $x_L = A_{R|S} - A_L$, or 4) neither type of R could enter the election.

To preclude entry by both types, costs must be sufficiently high, $C \geq -M_L - A_L + A_{R|S} =: C^*$, such that even if L converges as though she is certain she faces the strong type, a challenger would not find it worthwhile to incur the cost of entry. The beliefs which support equilibrium case 4 are $\mu = 1$, such that L is certain she faces a strong type of challenger off the equilibrium path and would respond to entry with a policy convergent enough to dissuade entry.

Lemma 2.6 guarantees that $\zeta_c, c = L, R$ will be either degenerate or continuously differentiable with pdf ζ_c'. If the latter is true, we may write the probability that any candidate wins at a bid for office $z_c \in (A_{R|W}, \overline{z})$ as $\zeta_{-c}(z_c)$. Recall that if $\overline{z} < A_{R|S}$, $\zeta_c(\overline{z}) = 1$ and $\Pr(z_c = \overline{z} | \overline{z} \neq A_{R|S}) = 0$.

Next, we consider the possibility that the two candidates' distributions of PVOs are both non-degenerate (cases 1 and 2). Arguments above establish it could either be the case that $\overline{z} < A_{R|S}$ and so neither puts positive mass on $\overline{z}$, or that $\overline{z} = A_{R|S}$ with L offering $\overline{z}$ with potentially strictly positive (but not full) probability and still randomizing (with the challenger randomizing, as well).

We first suppose that $\overline{z} < A_{R|S}$. Indifference conditions are as follows, using $V(\cdot)$ to denote utility in terms of the bids for office, z, such that $V_c(z_c(x_c)) = U_c(x_c)$.

$$\begin{aligned}
\mathbb{E}V_L(z_L) &= M_L + [1-\mu+\mu\zeta_{R|S}(z_L)]\cdot[A_L - z_L + B] + \mu\int_{z_L}^{\overline{z}}(z_{R|S}-A_{R|S})\zeta'_{R|S}(z_R)dz_{R|S} - C \\
&= M_L + A_L - \overline{z} + B - C, \ \ \forall z_L \in [A_{R|W}, \overline{z}] \\
\mathbb{E}V_{R|S}(z_{R|S}) &= -M_R + \zeta_L(z_{R|S})\cdot[A_{R|S} - z_{R|S} + B] + \int_{z_{R|S}}^{\overline{z}}(z_L - A_L)\zeta'_L(z_L)dz_L - C \\
&= -M_R + A_{R|S} - \overline{z} + B - C, \ \ \forall z_{R|S} \in [A_{R|W}, \overline{z}] \\
\mathbb{E}V_{R|W}(A_{R|W}) &= -M_R + \zeta_L(A_{R|W})[A_{R|W} - A_L] + \int_{A_{R|W}}^{\overline{z}}(z_L - A_L)\zeta'_L(z_L)dz_L - C \\
&= -M_R + M_L
\end{aligned}$$

We have three degrees of freedom, in a manner of speaking, namely: μ, $\overline{z}$, and $\zeta_L(A_{R|W})$.[24] These may be adjusted to satisfy the three equalities, where it must also be the case that ζ_{-c} must leave c's expected utility constant for all $z_c \in [A_{R|W}, \overline{z}]$, $\zeta_c(\overline{z}) = 1$, and $\zeta_{R|S}(A_{R|W}) = 0$.

Examining the second equality (evaluated at $z_{R|S} = A_{R|W}$) and the third equality, we see it must be the case that $M_L + C - \zeta_L(A_{R|W})[A_{R|W} - A_L] = A_{R|S} - \overline{z} + B - \zeta_L(A_{R|W})[A_{R|S} - A_{R|W} + B] \Rightarrow \zeta_L(A_{R|W}) = \frac{(A_{R|S}-\overline{z}+B)-(M_L+C)}{A_L+A_{R|S}-2A_{R|W}+B}$.

The conditions on the distributions then yield the following:

$\zeta_L(z) = \frac{A_{R|S}-\overline{z}+B-C-M_L}{\sqrt{A_L+A_{R|S}-2A_{R|W}+B}\sqrt{A_L+A_{R|S}-2z+B}}$,

$\zeta_{R|S}(z) = \frac{(1-\mu)\left(\sqrt{A_L+A_{R|S}-2A_{R|W}+B}-\sqrt{A_L+A_{R|S}-2z+B}\right)}{\mu\sqrt{A_L+A_{R|S}-2z+B}}$.

The imposition that $\zeta_L(\overline{z}) = 1 = \zeta_{R|S}(\overline{z})$ and $\zeta_{R|S}(A_{R|W}) = 0$ yields relationships between μ and $\overline{z}$ as well as $\overline{z}$ and C:

Let the function specifying the highest value of p for which the belief μ could be achieved by modulating entry by the weak type is given by:

$P(\overline{z}) = 1 - \frac{\sqrt{A_L+A_{R|S}-2\overline{z}+B}}{\sqrt{A_L+A_{R|S}-2A_{R|W}+B}}$.

24. $\zeta_L(A_{R|W}) \geq 0$

Let the function specifying the value of $\overline{z}$ for which randomization by the incumbent could leave the weak type of challenger indifferent between entering and staying out of the election is given by:

$Z(C) = -A_L + 2A_{R|W} - C - M_L + \sqrt{2(A_L + A_{R|S} - 2A_{R|W} + B)(A_L - A_{R|W} + C + M_L)}$.[25]

These conditions suggest a few natural limits on case 1. First, if $C < C_*$ and $p \in (0, \hat{p}]$, or $C \in (C_*, \hat{C}]$ and $p \in (P(Z(C)), \hat{p}]$, then the cost is too low for the weak challenger to remain out of the election given the extent to which the incumbent is willing to converge in light of the (relatively high) probability of facing a strong challenger. Second, $p \in (0, \hat{p}]$ and $C > B - M_L - \sqrt{(A_L - A_{R|S} + B)(A_L + A_{R|S} - 2A_{R|W} + B)} =: \hat{C} =: Z^{-1}(A_{R|S}) \Rightarrow \overline{z} > A_{R|S}$, which cannot occur.[26] The second scenario is easily grouped within case 1; the first will comprise case 2.

Returning to the parameter values for which the indifference conditions can all simultaneously hold, namely $C \in (C_*, \hat{C}], p \in (0, P(C)]$ (such that $Z(C) \leq A_{R|S}$),[27] then we may write the probability with which the weak type enters as $\sigma_{R|W} = \frac{p(1-\mu)}{(1-p)\mu}$, where L's belief that she faces a strong type is given by

$$\mu = \frac{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{2(A_L - A_{R|W} + C + M_L)}\right)^2}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}}.$$[28]

If $C > \hat{C}$ while $p \in (0, \hat{p}]$, then the upper bound of the PVOs over which the candidates randomize is too low to simultaneously keep S indifferent among $z_R \in$

25. Note that at $C = -M_L - A_L + A_{R|W}$, $Z(C) = A_{R|W}$, and $P(A_{R|W}) = 0$, such that only if the incumbent believes she faces a weak challenger with certainty would she be willing to adopt this "randomization," which involves playing as though only weak types exist.

26. Note that $\hat{C} \in (-M_L - A_L + A_{R|W}, -M_L - A_L + A_{R|S})$, so C s.t. $\overline{z} > A_{R|S}$, does not imply that neither type of challenger would be willing to enter even against L converging to $x_L = A_{R|S} - A_L$, as though only facing strong types.

27. i.e., $C \leq \hat{C} := B - M_L - \sqrt{(A_L + A_{R|S} - 2A_{R|W} + B)(A_L - A_{R|S} + B)}$

28. $C < \hat{C} \Rightarrow \sqrt{A_L + A_{R|S} - 2A_{R|W} + B} > \sqrt{2(A_L - A_{R|W} + C + M_L)} \Rightarrow$
$\mu = \frac{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{2(A_L - A_{R|W} + C + M_L)}\right)^2}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}} = \frac{\sqrt{2(A_L - A_{R|W} + C + M_L)}}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}} \Rightarrow$
$\sigma_{R|W} = \frac{p(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{2(A_L - A_{R|W} + C + M_L)})}{(1-p)\sqrt{2(A_L - A_{R|W} + C + M_L)}}$

$[A_{R|W}, A_{R|S}]$ while also keeping W indifferent among staying out of the election and entering and making a PVO of $z_{R|W} = A_{R|W}$. However, by placing positive mass on $A_{R|S}$, L can satisfy these conditions. Specifically, modifying the indifference conditions accordingly yields the distribution

$$\hat{\zeta}_L(z) = \frac{A_{R|S}-A_L-C-M_L}{\sqrt{A_L+A_{R|S}-2z+B}\left(\sqrt{A_L+A_{R|S}-2A_{R|W}+B}-\sqrt{A_L-A_{R|S}+B}\right)}, \forall z \in [A_{R|W}, A_{R|S}],$$

where L proposes a PVO of $z_L = A_{R|W}$ with probability $\hat{\zeta}_L(A_{R|W})$ and a bid for office of $z_L = A_{R|S}$ with probability $1 - \hat{\zeta}_L(A_{R|S})$.[29] This covers the remainder of case 1.

Turning to case 2, consider $C \in (0, C_*]$ and $p \in (0, \hat{p}]$, or $C \in (C_*, \hat{C}]$ and $p \in (P(C), \hat{p}]$. Due to the low likelihood of facing a strong type, the incumbent is not willing to increase the extent of her convergence enough that the weak type would be willing to randomize. In this case, the weak type enters will full probability (so no uncontested elections occur), and the incumbent and strong challenger still randomize (so upset victories still occur). The strategies arise from the same indifference conditions for L and the strong type of R that led to case 1, and indeed their proposal strategies are as in case 1. We have lost a degree of freedom in setting $\mu = p$, but the weak type of R does not need to be indifferent. As such, $\overline{z} = \tilde{P}^{-1}(p) = A_{R|W} + p\left(1 - \frac{p}{2}\right)(A_L + A_{R|S} - 2A_{R|W} + B)$ is the highest PVO in the candidates' distributions.

Finally, we consider the scenario in which $C \in (0, C^*]$ and $p \in (\hat{p}, 1)$, which constitutes case 3. Here the probability of facing a strong type is so large that it is impossible to sustain any set of strategies in which the incumbent is randomizing in equilibrium. While the incumbent must then converge to offer a PVO of $z_L = A_{R|S}$ with full mass, the strong type of challenger's strategy must be such that she is willing to do so. Unless $p > \frac{A_{R|S}-A_{R|W}}{A_L-A_{R|W}+B} > 1 - \frac{\sqrt{A_L-A_{R|S}+B}}{\sqrt{A_L+A_{R|S}-2A_{R|W}+B}} = \hat{p}$, the incumbent is not willing to offer a PVO of $A_{R|S}$ if the strong challenger is also doing so with full probability. Finding a

29. $\hat{\zeta}_L(A_{R|S}) \to 0$ (i.e., $\Pr(z_L = A_{R|S}) \to 1$) as $C \to -M_L - A_L + A_{R|S}$, the level of cost at which neither type of challenger would want to enter if L were to offer $z_L = A_{R|S}$ with probability 1.

strategy for S that does not entail full convergence to $x_{R|S} = A_{R|S}$ but still leaves the incumbent willing to propose $x_L = A_{R|S} - A_L$ is both necessary and desirable.[30]

We propose a strategy similar to L's as C grows large in case 1. S offers PVOs $z_{R|S} \in [A_{R|W}, A_{R|S})$ according to the same $\zeta_{R|S}$, where $\mu = p$, and offers $z_{R|S} = A_{R|S}$, i.e., $x_R = 0$, with probability $1 - \zeta(A_{R|S})$. This strategy is thus a continuation of case 2. This new distribution is given by $\hat{\zeta}_{R|S}(z) = \frac{\hat{p}(1-p)}{p(1-\hat{p})} \cdot \zeta_{R|S}(z) \oplus \frac{p-\hat{p}}{p(1-\hat{p})} \cdot A_{R|S}$.[31]

We must verify that this leaves L indifferent among any $z_L \in [A_{R|W}, A_{R|S})$, but with a strictly higher payoff from $z_L = A_{R|S}$. From the indifference condtions when $p = \hat{p}$, we have that $\mathbb{E}(z_{R|S} - A_{R|S}; \zeta_{R|S}) = \frac{A_L - A_{R|S} + B - (1-\hat{p})(A_L - A_{R|S} + B)}{\hat{p}}$. L's expected utility at $z_L = A_{R|W}$ is equal to her expected utility at all $z_L \in (A_{R|W}, A_{R|S})$ by the construction of S's strategy. So $\mathbb{E}V_L(A_{R|W}) = (1-p)(A_L - A_{R|W} + B) + p\frac{A_L - A_{R|S} + B - (1-\hat{p})(A_L - A_{R|S} + B)}{\hat{p}} + \frac{p-\hat{p}}{p(1-\hat{p})} \cdot (A_{R|S} - A_{R|S}), \forall z \in [A_{R|W}, A_{R|S})$ given p. It is easy to verify this yields lower utility for L than $z_L = A_L - A_{R|S} + B$ if $\hat{p} < p$, which defines the present equilibrium case. Having derived strategies for case 3, this completes the proof.[32] ■

Proposition 2.2 follows directly from Proposition 2.2'.

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30. While the equilibrium strategies proposed for case 3 are not unique, the outcome is the same across all such cases: L wins with certainty.

31. As $p \to 1$, $\Pr(x_R = 0|S) \to 1$.

32. We may back out the distributions of policy proposals from the distributions of PVOs given $\xi_L(x_L) = \zeta_L(x_L + A_L)$, and $\xi_{R|S}(x_R) = 1 - \zeta_{R|S}(A_{R|S} - x_R)$, although the distributions of PVOs are in fact all that is necessary to ascertain the frequency of various outcomes and determine voter welfare in equilibrium.
When $p < \hat{p}$, if $C \leq \hat{C}$, then $\xi_L(x_L) = \frac{A_{R|S} - \overline{z} + B - C - M_L}{\sqrt{A_L + A_{R|S} - 2A_{R|W} + B}\sqrt{A_{R|S} - 2x_L - A_L + B}}$, and if $C > \hat{C}$, then $\hat{\xi}_L(x) = \frac{A_L - A_{R|S} + C + M_L}{\sqrt{A_{R|S} - 2x_L - A_L + B}(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L - A_{R|S} + B})}$.
For $C < C^*$, when $p < \hat{p}$, $\xi_{R|S}(x_R) = 1 - \frac{(1-\mu)\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L - A_{R|S} + 2x_R + B}\right)}{\mu\sqrt{A_L - A_{R|S} + 2x_R + B}}$, with μ defined as above. When $p > \hat{p}$, $\hat{\xi}_{R|S}(x_R) = 1 - \frac{(1-p)}{p}\frac{\left(\sqrt{A_L + A_{R|S} - 2A_{R|W} + B} - \sqrt{A_L - A_{R|S} + 2x_R + B}\right)}{\sqrt{A_L - A_{R|S} + 2x_R + B}}$, such that additional mass is placed on $x_{R|S} = 0$.

2.6.5 Comparative Statics: Corollaries 2.4-2.5 to Proposition 2.2

Proof of Corollary 2.4. In cases 1-3, the probability that the election is contested is given by $\frac{p}{\mu}$. In case 1, μ depends on B, C, and M_L; it is decreasing in B and increasing in C, M_L. In cases 2-3, $\mu = p$. Thus, $\frac{p}{\mu}$ is (weakly) increasing in p and B, and (weakly) decreasing in C and M_L across cases 1-3. ■

Proof of Corollary 2.5. In case 1, when $C < \hat{C}$, the probability of an upset is given by $\frac{p}{\mu}\mu(1 - \frac{\mu}{2})$.

In case 2, where $\mu = p$, the probability of an upset (conditional on entry and unconditionally) is given by $p(1 - \frac{p}{2})$.

In case 1, p only affects the probability that the election is contested. In case 2, p only affects the probability of an upset conditional on entry, so the probability of an upset is increasing in p both conditional on entry and unconditionally.

For B, C, M_L, which work through μ, the probability of an upset conditional on entry responds in the opposite direction as the overall probability of an upset, unconditional on entry. In case 1, an increase in μ, which decreases the probability that the election is contested, decreases the probability of an upset conditional on entry but increases the probability of an upset unconditional on entry. ■

2.6.6 Contested Elections, Upsets, and Voter Welfare: Propositions 2.3 & 2.6

Proposition 2.3. *Let the probability that nature selects a strong type not be too high ($p < \hat{p}$) and the cost of entry not be too large ($C < \hat{C}$).*

An increase in B or a decrease in C or M_L leads the probability that the election is contested and the probability that the challenger upsets the incumbent to increase, but the probability of an upset conditional on a contested election to decrease.

Only increases in p lead to more frequent contested elections or upsets without decreasing the probability of an upset conditional on a contested election.

Proof of Proposition 2.3. The proposition follows immediately from Corollaries 2.4-2.5. ■

Proposition 2.6. *Voter welfare is (weakly) increasing in p.*

Changes in B, C, and M_L have both positive and negative effects on voter welfare.

Proof of Proposition 2.6. Conditional on the election being contested, the extent of convergence is increasing in μ, yet the probability that the election is contested is decreasing in μ, so changes in B, C, M_L – which affect μ – involve competing effects on voter welfare. (There are additional competing effects associated with these parameters, as discussed in text.)

Increases in p, however, lead to more contested elections and, conditional on contested elections, greater convergence in policy proposals. Each of these contributes positively to voter welfare, with no countervailing effects. ■

CHAPTER 3

DISTRIBUTIVE POLITICS AND LEGISLATOR IDEOLOGY

Abstract

This paper examines the relationship between legislative centrism (or conversely, extremism) and the distribution of federal outlays. A substantial body of theoretical work suggests that legislators closer to the chamber median are more attractive and willing candidates to engage in vote buying and hence should receive a disproportionate share of distributive benefits. We investigate this prediction empirically with panel data covering 27 years of federal outlays, using a research design that exploits elections in other districts to identify changes in the relative ideological position of individual legislators. We find a seven-percent decrease in outlays associated with a one-standard-deviation increase in a member's ideological distance from the median voter. We find the effect of exogenous increases in legislative extremism on outlays to be robust across a wide variety of specifications, and we take special care to distinguish this effect from those induced by potentially confounding covariates, most notably majority party status.

Replication files available at `http://d-alexander.com/s/Replication-files.zip`.

3.1 Introduction

As scholars going back at least to Ferejohn (1974) have recognized, distributive politics amounts to more than just a contest among legislators for scarce federal resources. It also involves the deliberate use of these monies to, as Evans (2004) puts it, "grease the wheels" of the legislative process. Whether to buttress pre-existing support for a bill against the lobbying of an opposing party or faction, or to purchase the support of a member who, absent the side payment, would vote against a particular bill, policy entrepreneurs routinely make use of outlays to cultivate support for their legislative initiatives (Evans 1994, Evans 2004, Wiseman 2004, Cann & Sidman 2011).

Who within Congress is most likely to benefit from vote buying, an activity that, as Richard Neustadt once quipped, is "as traditional as apple pie"?[1] Who, that is, stands to reap a greater share of federal outlays from successive efforts to build legislative coalitions through side payments? From Snyder (1991) to Dekel, Jackson, and Wolinsky (2008, 2009), a substantial body of theoretical work sheds light on the matter, suggesting that it is ideological moderates who represent the most likely candidates to be engaged by vote buyers. Because they are more likely to be ideologically indifferent (or close to indifferent) between policy alternatives, moderate members should be more frequent targets of congressional vote-buying activities. It is this theoretical prediction that we test in this paper.

In order to study the effect of legislative centrism on the geographic distribution of federal outlays, we use a member-by-county fixed-effects research design to analyze distributive outlays over a 27-year period. This research design uses only movements in the ideological position of an individual legislator that are generated by elections of new members from other districts. That is, we hold fixed the ideology of each given leg-

1. As cited in Evans (2004).

islator and ask how her proximity to the median voter changes after elections that alter the composition of the chamber. We find a statistically and economically significant positive effect of increased legislative centrism on county-level outlays. Specifically, a one-standard-deviation increase in a representative's ideological proximity to the House median leads to a seven-percent increase in outlays received by her constituents. These findings, we show, are robust to a wide variety of alternative specifications and do not appear to be an artifact of majority party status.

The paper proceeds as follows. We first review the relevant theoretical literature on vote buying as well as existing empirical studies of distributive politics. After discussing our identification strategy, model specification, and data, we then present our main results. We subsequently scrutinize the role of majority party status in distributive politics and subject our core analyses to a variety of robustness checks and placebo tests. We conclude by placing our findings in the context of related, ongoing questions in the study of U.S. legislative and electoral politics.

3.2 Theoretical Motivation

Vote-buying models typically posit a legislative environment in which one or more lobbyists compete over two possible legislative outcomes.[2] Such lobbyists might be conceived of as either traditional interest groups and thus unable to cast votes themselves, non-voting elected officials such as the president, or as actual voting members or blocs in a collective decision-making body. In any case, these lobbyists offer side payments to legislators in exchange for their votes, with payments usually being conditional on support. What constitutes the payments in these models is generally left

2. This stands in contrast to alternative formulations of legislative bargaining games, such as Baron & Ferejohn (1989) and Baron (1991), which do not include a role for parties or other organizations within or outside of Congress, instead focusing on individual legislators' proposal power.

unspecified, though Baron (2006, p. 607) writes that "lobbying consists of providing politically-valuable resources to legislators," a criterion that budgetary outlays certainly satisfy. The payments compensate legislators for voting against their or their constituents' beliefs, thereby justifying the ideological or electoral compromise.

Snyder (1991) initiates the modern literature on vote buying with a model of a single, price-discriminating lobbyist. The model predicts that a lobbyist will make payments to those initially opposed to her favored position until majority support is procured (see his Proposition 1). As Snyder puts it, "the lobbyist pays the highest bribes to legislators whose ideal points are closest to the median of the legislature, but on the side of the median closer to the lobbyist's proposal. That is, a lobbyist does not bribe his close supporters...but rather his marginal opponents" (p. 97). Snyder goes on to comment that most empirical work on money in politics neglects this result. Having ignored the ability of vote buyers to price discriminate among legislators, Snyder speculates, previous researchers had mischaracterized the distributive consequences of vote buying.

While much congressional vote-buying may occur in a legislative environment populated by just one lobbyist, as Snyder (1991) recognizes and as Wiseman (2004) reiterates, multiple lobbyists may compete over opposing legislative outcomes. Recognizing this possibility, a subsequent stream of political economists develop extensive-form vote-buying models with competing lobbyists, the first being Groseclose & Snyder (1996). This two-stage bargaining model, further explored in settings with finite numbers of legislators by Banks (2000) and Groseclose & Snyder (2000), characterizes equilibria in which supermajorities are assembled in order to block threats from an opposing interest. While the Groseclose and Snyder model has had a profound impact on political scientists' thinking about vote-buying activities, its power lies in demonstrating a strong second-mover advantage in a bargaining setting with an exogenously finite time horizon. Its utility in assessing the distributive consequences of vote buying, however, is more limited. Depending upon which equilibrium case is under consideration,[3] Groseclose and Snyder's model generates different predictions about the distribution of payments. Without a clear equilibrium selection mechanism, it is virtually impossible to distill clear, testable predictions.

More recently, Dekel, Jackson, and Wolinsky (hereafter Dekel et al.) take up the tradition of competitive vote-buying models with a pair of companion papers that make important theoretical advances and generate clearer predictions. Dekel et al. (2008) examine vote buying in general elections, while Dekel et al. (2009), most relevant for our purposes, model vote buying within a legislature. In Dekel et al. (2009), the use of a per-round bidding cost allows the games to be endogenously finite, capturing the dynamic nature of legislative negotiation without undue impositions on the number of bidding rounds. Additionally, careful use of a smallest unit of payment and a reasonable assumption about the irreversibility of bidding (a rule against undercutting one's previous offer to a given legislator) enable the authors to avoid the issues with ties and shifting strategies encountered in Blotto-like allocation games (see Roberson (2006)).

The central prediction of the Dekel et al. (2009) model on legislative vote buying is essentially identical to that of Snyder (1991). When payments are made in equilibrium, they are directed to what the authors refer to as "near-median legislators," *and payments are again decreasing in amount with distance from the median* (see their Proposition 3). Such legislators, after all, are the "cheapest" that could be bought to secure majority support, and minimum payments are made to secure the requisite support needed for a bill's passage. To further illustrate the logic underlying this result, we present an adaptation of this model in section 3.10.1 of the online appendix.

Due to its theoretical robustness across single- and multiple-vote buyer settings, the

3. Where equilibrium cases in the presence of competing vote buyers are determined by the relative and absolute valuations of the two lobbyists.

prediction that legislators receive more "payments" from interested parties the nearer the median they are ideologically serves as our main hypothesis. Yet these theories leave open a number of practical questions. Who does the vote buying? How is it done? At what levels of aggregation should we expect to observe such an effect? These questions, it turns out, are both closely related and highly pertinent when moving from theory to empirics.

3.3 Moving from Theoretical to Empirical Predictions

In seeking to better understand the distribution of federal outlays using vote-buying theory, we must clarify and defend the real-world interpretation we apply to these models. As federal outlays constitute the "payments," we take the "lobbyists" to be the party organizations, broadly defined, as it is these groups that have the ability and incentive to manipulate the distribution of federal funds. This could include the president, outside interest groups, or individual legislators – any actor who might work through or with party leadership to deploy distributive outlays in order to garner support for a legislative endeavor.

The claim that party organizations within Congress, and those working on their behalf, can control the more manipulable distributive funds appears well-founded observationally.[4] It certainly is borne out by the following story from a House Appropriations Committee staffer as taken from Shepsle et al. (2009, p. 348):

4. Furthermore, this view is entirely in line with the vote-buying models we take as theoretical motivation. Rather than imposing a balanced-budget requirement or considering lobbyist-specific budgets that are likely to bind on each iteration of the game, the valuation-based version of the Dekel et al. (2009) model conceives of the groups seeking to influence legislators as having significant discretionary funds from which they may allocate as much as they wish to a given legislative effort, distributing such funds as they see fit. Dekel et al. also investigate a version of the model that assigns constraints on each vote buyer's coffers, but the distribution of payments in the equilibrium of a single round of the budget-constrained game is identical to that of the unconstrained, valuation-based version, under the conditions relevant to the budget-constrained version in which payments are made.

> One House [of Representatives] Appropriations [Committee] staff member ... described a budget account that was explicitly divided into four with each partisan delegation in each chamber having authority over its share. Other interviews suggested this was the implicit norm for many of the most heavily earmarked accounts, although it was typically not explicitly codified.

The models that generate our main hypothesis (Snyder 1991, Dekel et al. 2009) do not elucidate which party organizations might be more or less prominent vote buyers. While they agree on the prediction that payments to legislators will rise up until the median legislator, for any given bill-specific iteration of the game these payments will be made on one side of the median. Which side of the median will this be? Because they do not put any constraints on the identity of the bill proposer, the models are largely agnostic about the matter. The models show that payments will only be made by the side that lacks the ex ante support of a majority of members, and to members that fall on that side of the median. If this more often characterizes the minority party, then payments may load on its side of the median member. However, the majority party likely wields greater control over the agenda, and given that some of its bills may lack the ex ante support of a majority of members, payments could load on that side of the median as well.

The "procedural cartel model" first forwarded in Cox & McCubbins (1993) and developed further in Cox & McCubbins (2005) takes a strong stand on this latter possibility. The authors argue for a theory of negative agenda control in which the majority party colludes to prevent unwanted bills from reaching the floor. Those bills that do see the light of day tend to move policy toward majority-party centrists. While negative agenda control should mostly ensure passage of such bills, Cox & McCubbins (2005, pp. 45-47, 159, ch. 10) stipulate that distributive benefits may be needed on the margins to compensate majority members suffering a "policy loss."[5] The implication is that, in effect, the majority party must from time to time partake in vote-buying, and that majority party members would be the exclusive beneficiaries.

A couple of previous empirical analyses, discussed below, have already provided support for this implication of the procedural cartel model of party government. In our primary analysis, we look for payments to decrease (i.e., benefit moderates) on both sides of the median. In extensions, we investigate whether vote-buying benefits moderate members of both the majority and minority parties, or whether it is applied to one group differentially; and whether vote-buying with outlays benefits moderate members of the majority party in the same way on either side of the median.

Finally, we must confront the level of aggregation at which our analysis takes place. As a practical matter, we are unable to observe the side-payments associated with any single bill. Rather, our outcome of interest is the aggregate outlays distributed to a specific geographic unit in a given year. While the predictions of the single- or competing-vote buyer models reflect payments made in a single iteration of the game, it is straightforward to see why we might expect the sum of payments to monotonically decrease as one moves further away from the median even when aggregating across bills, as we do in the empirical analysis. Because payments, when made, always decrease in magnitude with distance from the median, the prediction of a single iteration of vote buying scales up to considering multiple independent iterations.[6]

5. Centrists, if the model assumes an open rule, but potentially members on either extreme of the majority party if the model assumes a closed rule.

6. This feature of aggregation stands in contrast to some of the other vote-buying models, notably Groseclose & Snyder (1996). When considering multiple independent iterations of that game, the aggregate distribution of payments relies heavily upon the assumed distribution of proposals and its implications for the size of ex ante legislator valuations and thus ex ante majority support. One could derive the result that payments decrease monotonically with distance from the median given certain assumptions and yet derive differing results given other assumptions. Such sensitivity to varying assumptions provides yet another reason to focus on the Dekel et al. model, which requires no further assumptions besides independence of iterations to derive predictions testable with aggregate data. Whether this prediction is as accurate as it is straightforward remains an empirical matter.

From an empirical standpoint, the validity of aggregating payments requires more thought. For instance, vote-buying models predict minimal winning coalitions, yet we know that "[d]ivisions on legislative roll calls are seldom near 50-50" (Groseclose & Snyder 1996, p. 303). As previously discussed, the models also predict that payments on any single bill will occur on one side of the median. Unfortunately, though, there is not a straightforward way to account for either of these facts. Data do not currently exist that would allow us to tie specific federal outlays to voting behavior across a significant number of bills. While such data might provide a more direct test of some of the claims of vote-buying theories, we see the individual-bill and aggregating approaches as complementary. An aggregate analysis enables us to ascertain whether, as theory suggests, legislators closer to the median receive a disproportionate share of federal outlays over the course of a budgetary cycle in Congress, and it allows us to do so without imposing additional and potentially ad hoc assumptions on a bill-by-bill basis.

3.4 Previous Empirical Work on Distributive Politics and Legislator Ideology

Over the last couple of decades empirical studies on distributive politics have proliferated, but only a small portion of this work specifically examines vote buying.[7] Joining distributive politics and vote-buying theories, Evans (1994, 2004) offers the most sustained empirical examination of the use of distributive side payments to achieve

7. Instead, previous studies have scrutinized the importance of committee membership (Alvarez & Saving 1997*a*), majority party status (Balla, Lawrence, Maltzman & Spigelman 2002, Cox & McCubbins 1993, Levitt & Snyder 1995), electoral competition (Alvarez & Saving 1997*b*, Stein & Bickers 1994), state size (Knight 2008, Lee 2000), majoritarian rules and universalism (Bickers & Stein 1997, Groseclose 1996, Shepsle & Weingast 1981), party alignment with various members of the executive branch or the president (Berry, Burden & Howell 2010, Bertelli & Grose 2009, Gordon 2011, McCarty 2000), partisan contributions (Cann & Sidman 2011), and the roles of local governments (Bickers & Stein 2004, Rich 1989).

legislative objectives.[8] As support for her argument that federal monies (earmarks in her case, rather than the categorical grants that are our dependent variable) are used to purchase votes, Evans presents interview data as well as in-depth case studies on legislation for the Federal Highway Program and the North American Free Trade Agreement. In these empirical investigations, Evans shows that legislators' promises of votes in exchange for particularized benefits are in fact binding, as demonstrated by bill- and even vote-specific changes in voting behavior.

To our knowledge, only Herron & Theodos (2004), Carroll & Kim (2010), and Jenkins & Monroe (2012) investigate the implications of vote buying (and in the latter two cases, the particular the predictions of Cox & McCubbins's (2005) theory) with explicit regard to ideological moderation and extremism. Herron & Theodos (2004) find evidence from a discretionary grant program in Illinois that extremists received less money than predicted given district need and other political variables. Not looking to test vote-buying theory, however, the finding is characterized as potentially contradictory to theories in which majority parties reward their most loyal members rather than as possible evidence in support of vote-buying theories.

The latter two papers focus on Congress. Carroll & Kim (2010) find that members of the majority party with higher individual roll rates – votes against bills that ultimately passed – tend to receive greater shares of outlays (both in the number of projects and dollar amounts). They explicitly do not examine the distributive consequences of

8. A burgeoning body of empirical work also investigates features of vote-buying models that do not (directly) concern matters of distributive politics. Wiseman (2004), for instance, classifies bills as likely to have been attractive to multiple vote buyers rather than a single interested group, and then looks for voting patterns that conform to the predictions of single and competitive vote-buying models. Herron & Wiseman (2008) consider the implications for redistricting consistent with conditional party government, cartel, and vote-buying theories, uncover evidence that appears at least consistent with vote-buying theories. Taylor (2014) builds on Wiseman (2004) to examine evidence of vote buying in the amount of time it takes bills to pass. In order to bridge theory and data, it bears recognizing, all of these studies adopt auxiliary assumptions about various actors' preferences and their ability to manipulate outcomes.

ideology (as distinct from roll rates) for members of the minority party.

Along similar lines, Jenkins & Monroe (2012) present evidence that the majority party "buys its negative agenda control with side payments to its centrist members" (p. 910). The majority party leadership, they show, directs a greater share of their campaign contributions to centrist co-partisans than to extremists within their party. Consistent with the cartel theory, no such effects are observed within the minority party. They do not explore, however, whether budgetary outlays are deployed in a similar manner.

Lastly, Cann & Sidman (2011) present evidence that parties reward their members with distributive benefits in exchange for raising money for and consistently voting with their party. Members with higher party unity scores and who raise more money for their party tend to receive higher direct outlays, direct awards, and contingent liability rewards. To the extent that party unity varies inversely with ideological centrism, the "exchange theory" on which this study is based produces predictions opposite to that of the vote-buying models discussed above. We investigate whether both mechanisms may be at play in a supplementary analysis below.

Our study builds upon and contributes to this literature. It does so, first, by focusing squarely on the core claims about the distributive consequences of ideological extremism and moderation that come out of a variety of important formal models of vote-buying. Moreover, the quasi-experimental research design we offer, which is described in further detail below, supports causal claims where much of the previous literature does not. Finally, in the empirical analyses that follow, we speak to variants of and alternatives to vote-buying theory. Our results, as such, represent the most comprehensive and unified analysis yet of the effects of legislator ideology on distributive politics.

3.5 Empirical Strategy and Data

Our explanatory variable of interest is a legislator's ideological distance to the median, and our outcome of interest is the total of discretionary outlays received by a given legislator for her constituency. Our primary analysis matches county-level data on federal outlays with corresponding political and demographic variables at the county, district, and state level. The advantage of county-level data is that we can observe the same units over a long period of time, whereas the boundaries of most districts are redrawn decennially. However, we must exclude from our analysis counties that are divided into multiple congressional districts because we cannot cleanly match such counties to a single member of congress.[9] These excluded counties disproportionately represent urban centers around the country, and thus encompass a significant proportion of the total U.S. population. Still, after culling out these counties, our main analyses include data on 43% of the total U.S. population from 87% of the nation's counties,[10] varying slightly by year. Several supplementary analyses, including one using district-level data, help to allay concerns that our results are somehow being biased by the exclusion of multi-member counties. These are presented under "Robustness Checks and Placebo Tests" below.

A more substantive reason exists for only considering those counties represented by a single legislator. Representation of a single geographic or population unit by a group of legislators is innately a team-production problem. While it is likely that the ideological moderation/extremism of the various members plays a role, the vote-buying theories we draw from provide no insight into how such a collection of ideologies would

9. County-to-district population correspondence data from `http://mcdc.missouri.edu/websas/geocorr90.shtml`, `http://mcdc.missouri.edu/websas/geocorr2k.shtml`, and `http://mcdc.missouri.edu/websas/geocorr12.shtml`.

10. With the average population by county dropping from 84,271 individuals (across 81,555 total county-year observations) to 41,347 individuals (across 71,199 county-year observations).

affect receipt of outlays. The same is true with regard to the role that senators play in the distribution of outlays. Accounting for the Senate, however, does not present the same difficulties for identifying the effect of the ideology of a single member of the House that we face with multi-member counties. We conduct an analysis that controls for "Senate-effects" below, discussed among extensions of our main results.

To explain patterns in federal outlays in fiscal year t, which runs from October of year $t-1$ to September of year t, we use political and demographic characteristics of year $t-1$. The money spent in year t is the result of the budget passed by congress in year $t-1$. As such, the distributive effects of vote buying should be observed during the fiscal year after a budget passes Congress.

The data on county-level outlays comes from the Consolidated Federal Funds Report (CFFR) over the years in which it was published (fiscal years 1983-2010),[11] excluding FY1983 as we lack a county-to-district correspondence for 1982. A strength of using CFFR is that it enables us to distinguish the set of programs most likely to be subject to political manipulation, nonformula grants, from those that are not, such as entitlements and formula-based grants, which we use for placebo tests. The most relevant summary statistics for this cut of federal funds appear in Table 3.1, and more information on our culling of outlays may be found in Subsection B.5 of the Online Appendix. Honing in on nonformula grants makes our analysis more transparent than prior work that relied on a fairly ad-hoc distinction between "low-variation" and "high-variation" programs, which was based on an arbitrary threshold in a program's coefficient of variation across districts to determine a cut-point for exclusion from the analysis (e.g., Levitt and Snyder (1995) or Berry, Burden & Howell (2010)).

11. Although information on federal outlays by county is available through the present from other sources, for the sake of consistency we construct our dataset using only outlays as reported in CFFR, of which publication ceased after fiscal year 2010 with the termination of the Federal Financial Statistics program. Data accessed Summer 2013 at `http://www.census.gov/govs/cffr/`.

In estimating the effect of a representative's ideological distance to the median on her receipt of federal outlays, we confront three potential sources of endogeneity. The first includes the many other determinants of outlays that also correlate with a member's ideology. For instance, poorer districts may elect more liberal representatives and also receive more aid from federal programs targeting poverty alleviation, generating a spurious correlation between distance from the chamber median and outlays.[12] Second, voters desiring more federal aid may intentionally choose more centrist representatives. Similarly, extremists may not only possess strong preferences over policies but also value position-taking over securing federal monies for their districts. The election of an extremist (or a moderate) may then lead to a decrease (increase) in outlays not because of the ideology of the representative but rather because of the legislator's preferences over position-taking relative to procuring pork barrel spending for her district. Third, individual members seeking to procure more aid for their districts may vote in a more centrist fashion in order to make themselves attractive candidates for vote trading. With regard to the second and third concerns, we would be worried that greater centrism might be associated with other, possibly unobservable, efforts taken by the district or member to obtain more federal spending.

Our research design and measurement strategies offer solutions to each of these concerns. To address the first and second sources of endogeneity, we use a county-by-member fixed-effects model, in which each county-member pair receives its own constant in estimation. The analysis then relies exclusively on within county-by-member changes in distance to the chamber median voter over time. Time-invariant attributes of the county-member pairing are purged by the fixed effects, obviating concerns that, for instance, members representing extremely liberal districts receive more outlays due to

12. Indeed if this particular example held true, it would bias us against finding evidence of the vote-buying mechanism we seek to identify, in which more moderate members fare better in terms of distribution.

the fixed characteristics of their constituents. A range of covariates serve as controls for time-varying characteristics of both members and counties. Further, using county-by-member fixed effects helps us avoid concerns that we are leveraging cross-county variation in the case of members who represent more than one county[13] or that redistricting could introduce an unwanted source of variation if a member's district comprises different counties over time.

Pursuant to the third endogeneity concern, one might still worry that individual members moderate their own voting behavior during years in which they wish to bring home more federal spending – and that they also take other actions to obtain more funding at the same time. To remove this potential source of endogeneity, we rely upon a feature of Poole and Rosenthal's Common Space DW-NOMINATE scores (Poole 2005), from which we use the first-dimension to derive our measure of ideological distance from the median. In the Common Space scores, each legislator's score is fixed over the course of her tenure.[14] Because we use scores that are constant across a member's career in Congress, along with county-by-member fixed effects, we only exploit variation in ideological distance caused by shifts in the location of the median voter. Put another way, changes in a member's distance from the median come only from changes in the composition of the chamber, which are almost surely exogenous with respect to the ideological position of any single representative.

For example, consider a member with an ideal point of -0.50 who served in two congressional terms, one in which the median voter's ideal point was -0.25 and one in which the median voter's ideal point was 0.25. We then ask whether the member

13. A stark example of this is single-member states, where all counties in the state fall under a single representative, though the phenomenon is hardly limited to such cases.

14. More precisely, when a legislator switches parties, they are assigned a new ICPSR ID number and thus allowed a new fixed ideological estimate in the calculation of Poole and Rosenthal's data. As a result, scores are fixed over the course of a legislator's tenure in a given party affiliation. This affects only a few cases.

Table 3.1: Key County-Level Descriptive Statistics

Statistic	Absolute distance from median	Outlays (in 2010 $1,000's)
Overall Mean	0.319	9,265
Majority Party Mean	0.190	9,038
Minority Party Mean	0.503	9,590
W/in-Group Std Dev	0.118	38,900

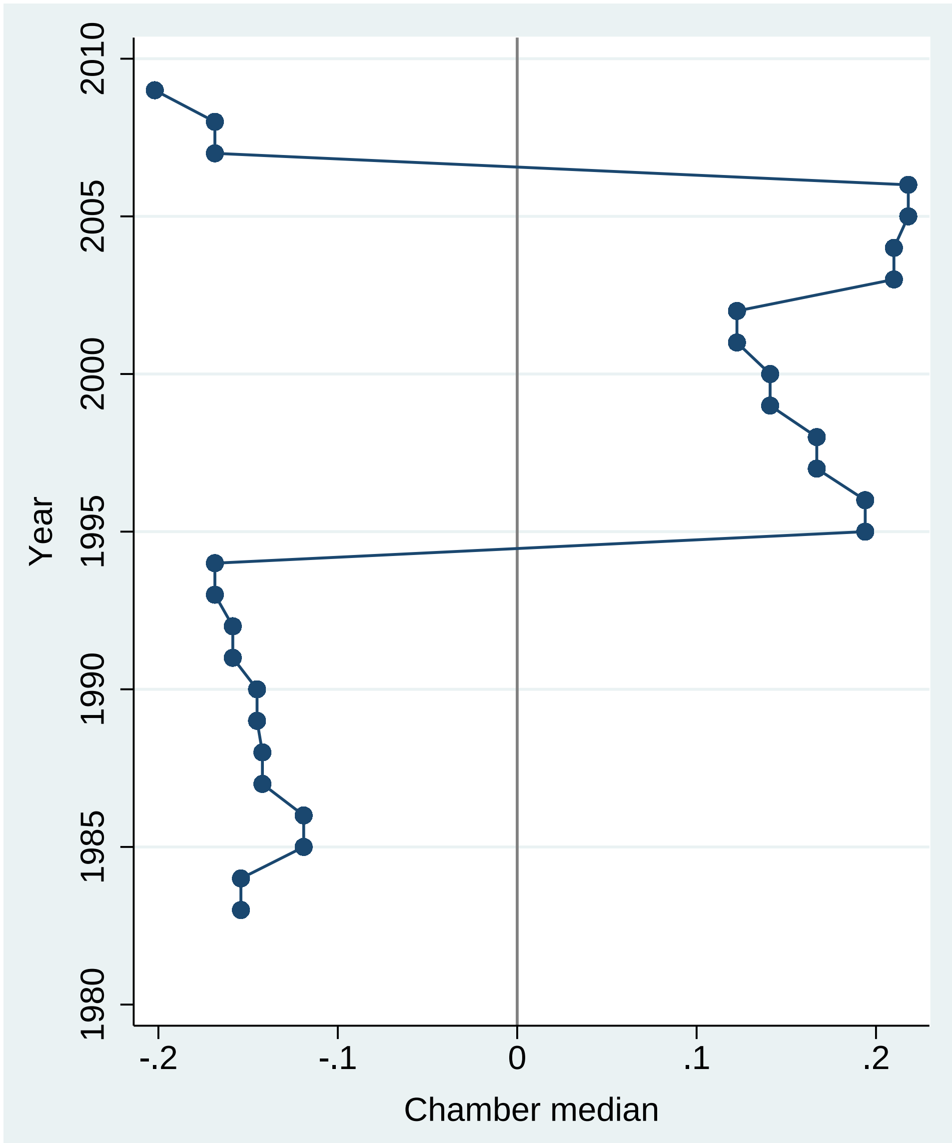
Notes: Absolute distance from median is the absolute value of median-centered DW-NOMINATE Common Space scores for the calendar years 1983-2009. *Outlays* are county-level grants (excluding formula grants), inflation adjusted to 2010 dollars, for fiscal years 1984-2010. Means are presented for the entire House as well as just the House majority and minority parties. *W/in-Group Std Dev* is the within county-by-member standard deviation of each variable. The sample is restricted to only those counties represented by a single congressperson and that are present in our baseline analysis (model 2 of Table 3.2), for a total of 71,199 county-year observations. Of those, 41,872 were represented by a member of the majority and 29,327 by a member of the minority party. Additional summary statistics may be found in Table 3.5 in the online appendix.

received more outlays in the first congress, when her absolute distance from the median was 0.25, than in the second, when her absolute distance was 0.75. The relative ideological location of the member changed between the two congresses *only* because of changes in composition of the chamber arising from elections in *other* districts across the nation, making the comparison across terms a valid causal estimate of the effect of distance from the median voter on outlays. Any additional effects of national electoral swings will be accounted for with year fixed effects. Furthermore, even if an individual member's roll call voting record did appear artificially moderate due to vote-selling, this artificial moderation could not generate fluctuations in ideological distance due to changes in the median voter's location. Artificial moderation, if it existed, would only bias us against finding any results using our research design.[15]

Our source of identifying variation is displayed in Figure 1, which shows the location of the House median voter, measured via DW-NOMINATE Common Space scores, from 1983 through 2009. Key descriptive statistics related to this measure of ideology appear

15. Moreover, it is likely that the number of votes a given legislator trades for outlays is small relative to the total number of votes she casts, and that the Common Space score is based on a largely ideologically consistent body of decisions, with the few aberrations contributing little to the estimation of the score.

Figure 3.1: Movement in the House Median by Year



Notes: The horizontal axis represents the location of the median member of the House of Representatives as measured in DW-NOMINATE Common Space scores.

in Table 3.1. There are two major swings in the median voter's location, which are associated with changes in majority party control in 1995 and 2007, as well as smaller year-to-year changes throughout our study period. Given the importance of changes in majority control in determining changes in the location of the median voter, it will be important to control for majority status, as well as the interaction of majority status and ideological distance, in our analysis. These issues receive sustained attention below.

Formally, we estimate the following general model:

$$\ln(outlays_{it}) = \beta_0 + \alpha_i + \delta_{t-1} + \beta_1 |Distance_{i,t-1}| + \mathbf{X}_{i,t-1}\Phi + \varepsilon_{i,t-1}, \qquad (3.1)$$

where the dependent variable is the log value of county-level outlays in a given fiscal year t.[16] The fixed effects, α_i, are generally county-by-member-specific, though we examine the robustness to using just county and just member fixed effects instead. All models also include year fixed effects, δ_{t-1}, for the preceding calendar year and a constant, β_0. Our variable of interest is the absolute value of the ideological distance to the floor median for the representative of a given county as calculated with DW-NOMINATE Common Space scores. The coefficient for this variable is β_1. A vector of covariates $\mathbf{X}_{i,t-1}$ has corresponding coefficients given by Φ. Political covariates take on member-year specific values, where the member is the representative associated with a given county, and the demographic characteristics are county-year measurements.

When selecting time-varying political covariates, we take our cues from the existing empirical literature on the determinants of federal distribution. We use dummy variables for membership in the party of the president, majority status, party affiliation (if using just county rather than county-member fixed effects), committee membership, and being a party leader, committee chair, or ranking minority committee member (Nelson N.d., Stewart, III & Woon N.d.).[17] A tenure variable tracks the number of

16. We add one to the value of all outlays so that observations in which a county received zero of some type or cut of outlays remain in the analysis and are given a value of zero when log-transformed. Substantively, this amounts to assuming that receiving one dollar in outlays is effectively the same as receiving nothing, and the addition of one has an even less discernible effect on those counties receiving strictly positive amounts. All analyses were run without these observations, and the results change minimally across the board.

17. Committee datasets accessed Summer 2013 at `http://web.mit.edu/17.251/www/data_page.html`.

terms served by a given representative, and we include an additional indicator for a representative's first term.[18] A measure of party competitiveness, *Close election*, identifies those instances when a member receives less than five percent of the two-party vote share in the last election. The last of the political variables, also electoral in nature, is the absolute value of the state-wide difference in vote shares between the sitting president and the other major party candidate in the previous election.[19] This value decreases in the competitiveness of the previous presidential election in a given area, while the close congressional election dummy identifies more competitive elections.

Among the factors recognized by the existing empirical literature, majority party membership is most likely to confound the effect on the distribution of outlays of our variable of interest, absolute distance to the median. The median voter will almost certainly be a member of the majority party, and other members of the majority will tend to be found closer to the median voter on an ideological continuum than will their peers in the minority. As such, a representative with low ideological distance to the median will more likely be drawn from the majority party than the minority party. One might be concerned, then, that results indicating the importance of ideological distance reflect majority party influences rather than the vote-buying mechanisms posited in our theory. Moreover, the implication of the majority party cartel theory put forward by Cox & McCubbins (1993) that Jenkins & Monroe (2012) test (using campaign contributions, rather than distributive outlays) represents yet another complication in considering the role of majority party status vis-à-vis ideological distance from the median. To disentangle their theoretical claims from those that emerge from the vote-buying literature, therefore, in the empirical tests that follow we include majority party status as both a control and, later, as an interaction with our variable of interest.

18. Information on individual legislators' ideology, political affiliation, and tenure accessed Summer 2013 from `http://voteview.com/dwnomin_joint_house_and_senate.htm`.

19. Both electoral variables accessed Summer 2013 at `http://library.cqpress.com/elections/`.

With the increase in polarization over our sample period, documented at length in McCarty, Poole & Rosenthal (2006), it is possible that new members entering the chamber tended to make their senior colleagues relatively more moderate. We might worry about conflating seniority (and the distributive benefits it may confer) with moderation. By controlling for a member's number of terms in office with the *Tenure* variable, we are able to account for the effect of seniority. While this accounts for the most likely way in which increasing polarization would confound our analysis, we more directly explore the interaction of legislator ideology and increasing polarization in a supplementary analysis below.

Given our nearly 30-year sample, the lengthy tenure of many representatives, and the fact that some members in our sample represent multiple counties in our data, it is important to account for intra-county demographic changes over time. We therefore include the log values of county population and income as controls.[20] To account for correlation of the error term, ε_{it}, both across and within counties over time, we cluster standard errors at the state level. While our primary concern is that the error terms for counties represented by the same legislator (i.e., in the same district) would be correlated, we recognize that counties across a state may also share common effects we have not captured.[21] As such, clustering at the state level, which subsumes clustering at lower levels, represents a rather conservative treatment of the standard errors. Further information about the data and the decisions we made in compiling it may be found in Section 3.10.2 of the online appendix.

Table 3.2: Absolute Distance & Rank from Median

	(1)	(2)	(3)	(4)	(5)	(6)
Absolute distance from median	-0.147*	-0.608**	-0.591**			
	(0.081)	(0.300)	(0.274)			
Absolute rank from median (/100)				-0.026*	-0.120**	-0.116**
				(0.014)	(0.045)	(0.044)
Majority party		-0.162*	-0.158*		-0.184**	-0.178**
		(0.091)	(0.083)		(0.073)	(0.072)
President's party		0.029	0.031		0.039	0.040
		(0.036)	(0.033)		(0.040)	(0.036)
Committee chair		0.042	0.011		0.041	0.011
		(0.088)	(0.087)		(0.087)	(0.088)
Ranking minority member		-0.018	-0.034		-0.020	-0.036
		(0.068)	(0.062)		(0.069)	(0.063)
Party leader		0.088	0.008		0.082	0.003
		(0.089)	(0.083)		(0.088)	(0.082)
First term		0.010	-0.004		0.010	-0.004
		(0.028)	(0.024)		(0.028)	(0.024)
Tenure (# terms)		-0.178	-0.214		-0.179	-0.213
		(0.124)	(0.139)		(0.127)	(0.140)
Close election		0.135***	0.136***		0.135***	0.136***
		(0.036)	(0.033)		(0.036)	(0.033)
State presidential margin		0.004*	0.004*		0.004*	0.004*
		(0.002)	(0.002)		(0.002)	(0.002)
Log income	-0.092	-0.123	-0.125	-0.090	-0.114	-0.118
	(0.173)	(0.189)	(0.178)	(0.173)	(0.188)	(0.178)
Log population	-0.064	-0.046	-0.029	-0.065	-0.048	-0.031
	(0.277)	(0.279)	(0.266)	(0.276)	(0.279)	(0.267)
Constant	14.602***	14.724***	14.586***	14.593***	14.724***	14.602***
	(1.646)	(1.694)	(1.553)	(1.640)	(1.654)	(1.523)
Committee dummies	No	No	Yes	No	No	Yes
Adj. R^2	0.218	0.220	0.221	0.218	0.220	0.221
N	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Absolute rank from median (/100)* is the rank ordering of the *Absolute distance from median* variable divided by 100 for scaling purposes; the higher the rank, the farther a legislator is ideologically from the median.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

3.6 Main Results

Table 3.2 presents our primary estimates of the effect of absolute distance from the chamber median on the distribution of federal outlays. All models include county-by-

20. Data accessed Summer 2013 at `http://bea.gov/iTable/index_regional.cfm`.

21. For example, due to Senate-effects, an issue we address in the next section as an extension of our baseline analysis.

member fixed effects, and as a result only take advantage of exogenous changes in each individual member's distance to the median that are generated by elections in other districts. Models 1-3 regress log outlays at the county-level on our measure of absolute distance from the median in NOMINATE space. As a robustness exercise, models 4-6 regress log outlays on the legislators' rank-ordered absolute distance from the median – that is, the number of other representatives between the member and the median voter – per 100 legislators.

Models 1 and 4 regress the log value of county-level outlays on our main variable of interest, as well as the county-level demographic covariates, log values of population and income. As the dependent variable is in logs, the appropriate interpretation for a one unit change in the regressor would be, in the case of model 1, an approximately 15% decrease in the amount of outlays a district receives.

In models 2 and 5, we add all of the political covariates except for the dummy variables representing membership on specific committees. In doing so, we see the effect sizes of both *Absolute distance from median* and *Absolute rank from median (/100)* increase markedly to -0.608 and -0.120, respectively, and gain statistical significance.

The positive and significant effect of being in a highly contested district, the *Close election* variable, on outlays reflects the importance of electoral objectives in determining the distribution of outlays, but it also helps allay concerns that the significant negative effect of *Absolute distance* on outlays stems from electoral considerations rather than our proposed legislative mechanism. If electorally close districts are more likely to be represented by moderates, then absolute distance would have covaried inversely with our close congressional election measure. As such, it might have been the case that *Absolute distance* reflected safer districts, less in need of targeted federal funds, and we would see a negative coefficient that in fact had nothing to do with our proposed vote-buying mechanism. By including the measure of the electoral competitiveness of a district, we would then expect the effect of *Absolute distance* to fall. In fact, the effect size increases, lending further credence to our core theoretical claims.[22]

Lastly, in models 3 and 6, we add indicator variables for membership on all of the standing committees (variables not shown). Membership on committees, especially those thought to be most influential in distributive politics (Appropriations, Ways and Means), could interfere with the stylistic representation of Congress in vote-buying theory, primarily if such posts provided easier access to procurement processes or project-making opportunities. However, memberships on any of the standing committees appear to make little difference to both the effect sizes and significance levels of our variables of interest. While the committee membership indicators are jointly significant, the F-statistic is remarkably small given the number of variables we are testing.[23] We omit the committee dummies in subsequent analyses, although our results are robust to their inclusion.[24]

When interpreting the magnitude of the estimates, it is important to remember that the location of a legislator relative to the median simply never changes by as much as one unit in NOMINATE space. As a result, it makes more sense to consider a standard deviation's worth of change in *Absolute distance*. For model 2, the within-

22. While the estimate of the coefficient for the variable *President's party* is not a statistically significant, we refer readers to Berry, Burden & Howell (2010) for a complete analysis of this effect. The effect we estimate is close in magnitude to theirs, but less precisely estimated. This may be as expected given that we use only single-member counties and impose more fixed effects. Berry, Burden & Howell (2010) explain that estimating the effect of *President's party* requires only the use of county-level fixed effects, rather than the county-by-member fixed effects used here.

23. Only a couple of these variables display statistical significance, which is an expected result given the number of tests being performed, even if all of the null hypotheses of zero effect held true.

24. Given the lack of significance of most of our control variables, one might worry that their inclusion, while theoretically justified, distorts the true effect of *Absolute distance*. In Table 3.6 of the online appendix, we sequentially add the control variables, showing that the jump in significance, both substantive and economic, comes from the inclusion of *Majority party* and, to a lesser extent, *Close election*. These two variables display consistent statistical significance and, more importantly, most plausibly confound the effect of *Absolute distance*. We address the important interaction between *Absolute distance* and *Majority party* in the next section.

member standard deviation for the sample used in estimation is 0.118.[25] We would then associate a 7.2% decrease in outlays with a one standard deviation increase in distance from the median. Put differently, a one-standard deviation increase in distance from the median leads to an approximately $670,000 decrease in outlays (at the county level, in 2010 dollars), or a loss of a little more than $16 per capita for the average county in our sample. For *Absolute rank*, the within-group standard deviation is 0.681, implying an 8.2% decrease in outlays associated with a one-standard deviation increase in ranked distance from the median in model 5. In subsequent analyses, we continue with only the *Absolute distance* variable, noting that highly similar results are recovered from both measurement strategies. Model 2 in Table 3.2 serves as our baseline model for comparisons in the foregoing analyses.

Numerous auxiliary analyses were performed, all of which may be found in section 3.10.3 of the online appendix. Several bear mentioning here. First, we explored different fixed effects strategies, including the use of no fixed effects, county fixed effects, and county-member fixed effects.[26] Comparing the different fixed effects strategies, we see that using member fixed effects produces estimates largely identical to the even more stringent county-by-member fixed effects that we use. To preserve our identification strategy, we continue to employ county-by-member fixed effects.[27]

Given that vote-buying theory makes no clear predictions about the specific functional form of equilibrium payments, a variety of other characterizations of the *Absolute distance* variable were tried, including the addition of higher and lower order terms as well as the

25. See Table 3.1 above.

26. See Table 3.7 in the online appendix.

27. It is worth noting that although county-level fixed effects, as in model 2, allow us to employ more variation than models 3 and 4, a good deal more than just a county's representative's distance to the median changes when a county's representative changes. This may lie behind the perhaps surprising finding that the estimated effect of *Absolute distance* is smaller when using only county-level fixed effects.

natural log of *Absolute distance*.[28] Only the specification in levels proved to be robust across models and across specifications of the dependent variable. We also carried out an analysis using splines, in which *Absolute distance* was segmented and allowed to take on different slopes on either side of a knot point placed at gradually increasing distances from the median.[29] We found that the effect of absolute distance from the floor median tended to be concentrated around, but not limited to, near-median legislators, as vote-buying theory would suggest. Finally, we estimate a separate effect for members of the majority on the far side of the median relative to most of their copartisans; this analysis is discussed in the next section, following the discussion of majority party status.

The House, of course, does not distribute federal outlays alone. The Senate also is involved. For the contributions of senators to confound our main results, however, a decrease (increase) in a House member's distance from the median would need to coincide with an increase (decrease) in the amount of federal outlays driven by a senator to counties represented by that House member. Though unlikely, we cannot dismiss this possibility out hand. Hence, we add several additional controls to our baseline model that are explicitly intended to account for possible Senate confounders.

In Table 3.10 of the online appendix, model 1, we add a variable counting the number of senators from the state of a given county who share the same party as that county's representative, a dummy variable if a county's representative comes from the same party as the senate majority party, and a variable counting the number of senators from the state of a given county who share the same party as the president. All of these variables could positively correlate with the allocation of funds to a given county for reasons that primarily relate to Senate activities. While the estimated coefficients for the first two of these variables display the expected positive sign, none achieve statistical significance at

28. See Table 3.8 in the online appendix.

29. See Table 3.9 in the online appendix.

conventional levels. Moreover, including these potential confounders does not notably alter our estimates of the main variable of interest, distance from the house median legislator.

In model 2 of online Table 3.10, we include the natural log of per capita nonformula grants awarded to all other counties in a given county's state. This variable captures the success of the state's entire congressional delegation at procuring pork barrel spending. Without including the county's specific allotment, this variable reflects the aptitude of a state's senators, albeit not exclusively, at obtaining funds for their state. Not surprisingly, this variable is positively signed and highly significant. Importantly, though, the estimate for the effect of *Absolute distance* is similar in magnitude and statistical significance to our baseline model, suggesting that our effect of interest persists even after including the state's level of per capita spending. Model 3 simply includes all variables from models 1 and 2, and results are consistent with those models.

One might be concerned that distance from a member's own party median also influences rewards flowing to the district (e.g., see Cox & McCubbins (2005)), a confounding effect that could inflate and/or deflate our estimates of interest. Running our baseline model with a variable measuring absolute distance from *party* mean, we observe a positive and statistically significant estimate of the coefficient for this new variable.[30] One standard deviation's worth of within-member variation in absolute distance from party mean is so small, however, that we are reluctant to conclude from our analysis that intra-party extremists receive more in distributive outlays.

To examine whether tendencies to vote with or against one's party reflect general extremism or moderation and to explore the possibility that Cann & Sidman's (2011) exchange theory is at work alongside vote buying, we used party unity scores in lieu of

30. See Table 3.11 in the online appendix.

absolute distance from the median as well as alongside the distance variable.[31] In the models including both *Absolute distance* and *Party unity*, we, too, find evidence that (especially majority) members who vote with their party receive greater outlays than peers who vote with the opposition. However, the coefficient on *Party unity* is considerably smaller than the coefficient for *Absolute distance*, which retains its significance and anticipated sign. While party loyalists appear to be rewarded for toeing the line, their support may be taken relatively for granted compared with their more centrist peers.

Lastly, using CVP scores (Fowler & Hall 2012),[32] an alternate roll call-based measure of legislator ideology, yielded similar magnitude of effect size and consistently negative coefficients on the estimates of the effect of absolute distance from the median on log outlays.[33] We take the similarity of the results as encouraging, and also point out that CVP scores feature an ease of interpretation that NOMINATE scores lack. The estimates from regressions using CVP scores may be read as the percent increase in outlays associated with a given increase in the probability of voting conservatively relative to the median member of the chamber.

3.7 Majority Party Status

Majority status merits a deeper discussion than most of the other controls and covariates. From a purely empirical standpoint, majority party status plays a key role with regard to *Absolute distance*. Distance from the floor median will be inversely correlated with majority party status for the simple reason that the chamber median lies within the majority party (given that the parties have ceased to overlap in NOMINATE

31. See Table 3.12 in the online appendix.

32. CVP scores available at `http://www.andrewbenjaminhall.com/papers/`.

33. See Table 3.13 in the online appendix.

space). More generally, Wiseman & Wright (2008) document that majority members will be on average closer to the chamber median. They emphasize that partisan and floor/median sources of legislative influence are thus often complementary, as the median moves strongly in the direction of the majority party. As a result, empirical tests that seek to find evidence for one influence could simultaneously represent evidence for the other. Accounting for this correlation is essential for identifying the effect of each variable individually.

The relationship between majority status and outlays, however, is theoretically ambiguous. Theories in which the majority party extracts rents for itself would suggest that majority status leads an individual representative to receive more in federal outlays. If the majority party used its control over distributive funds to quiet the opposition, the effect of majority status on outlays could even be negative. Theories of negative agenda control, meanwhile, predict that the majority moves the agenda to the center of its party's distribution and pays off moderate members of its own party to compensate them for policy losses. If indeed this theory only applies to the majority party, with its dominant ability to set the House agenda, then we might expect to find a discernible relationship between legislator ideology and federal outlays only among members of the majority party.

Given these various sources of ambiguity, we explore the separate and joint contributions of legislative extremism and majority status in Table 3.3. Model 1 includes *Absolute distance* without the variable for majority status but with the remainder of the controls. The coefficient is negative, as expected, but imprecisely estimated. Model 2 includes only majority status along with the controls, leaving out our measure of absolute distance to the median. Although insignificant, the positive coefficient estimated here supports either a rent-seeking theory or, to the extent that majority party covaries inversely with *Absolute distance*, accounts of vote buying. Model 3 includes both

Table 3.3: Interacting *Absolute Distance* and *Majority Party*

	(1)	(2)	(3)	(4)
Absolute distance from median	-0.168*		-0.608**	-0.660*
	(0.090)		(0.300)	(0.334)
Majority party		0.043*	-0.162*	-0.221
		(0.024)	(0.091)	(0.140)
Absolute distance x majority				0.238
				(0.246)
President's party	0.039	0.041	0.029	0.028
	(0.041)	(0.041)	(0.036)	(0.036)
Committee chair	0.037	0.043	0.042	0.040
	(0.086)	(0.090)	(0.088)	(0.087)
Ranking minority member	0.002	-0.001	-0.018	-0.018
	(0.083)	(0.083)	(0.068)	(0.067)
Party leader	0.089	0.091	0.088	0.086
	(0.086)	(0.086)	(0.089)	(0.088)
First term	0.012	0.015	0.010	0.011
	(0.027)	(0.027)	(0.028)	(0.027)
Tenure (# terms)	-0.168	-0.167	-0.178	-0.185
	(0.119)	(0.119)	(0.124)	(0.125)
Close election	0.136***	0.134***	0.135***	0.135***
	(0.037)	(0.036)	(0.036)	(0.035)
State presidential margin	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.127	-0.128	-0.123	-0.124
	(0.184)	(0.183)	(0.189)	(0.189)
Log population	-0.050	-0.049	-0.046	-0.055
	(0.276)	(0.275)	(0.279)	(0.283)
Constant	14.588***	14.512***	14.724***	14.839***
	(1.669)	(1.659)	(1.694)	(1.732)
Adj. R^2	0.220	0.220	0.220	0.220
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. This variable is interacted with the dummy variable for majority party status in model 4.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

absolute ideological distance to the median and majority status, along with the other controls we have employed throughout. The coefficient estimate for *Absolute distance* is statistically significant and approximately four times larger than that in a comparable model that did not include majority party status. Here, the coefficient for majority status is now both significant and negative.

Model 4 adds an interaction term between *Majority party* and *Absolute distance*. The effect of *Absolute distance* appears to be stronger within the minority party, but we cannot reject that there is no difference in the effect of absolute distance from the chamber median between the majority and minority parties. Most importantly, however, we see no evidence that our results for the effect of ideological distance to the median are an artifact of majority status. Moreover, the fact that *Absolute distance* remains significant in the presence of an interaction variable suggests that moderate minority members are also beneficiaries of vote buying (whether from their own party or the majority party cobbling together coalitions). Outlays emerge as a broad instrument of coalition building, extending beyond negative agenda control's stricter conception of being used by the majority party on majority party members.

While the interaction term lacks significance in its own right, it does provide traction on the following question: How can the average majority party member obtain more outlays than the average minority member, as implied by model 2, while bringing home less than a minority member located at the same ideological distance from the chamber median, as implied by model 4? The answer is that the average majority party member is much closer to the chamber median than is the average minority party member. Specifically, the average absolute distance from the median for members of the majority party is 0.190, while the average absolute distance from the median for members of the minority party is 0.503.[34] Figure 3.2 presents a visual representation of the estimates from model 4. The negative relationship between ideological distance and outlays holds within both the majority (solid lines) and minority (dashed lines), which

34. See Table 3.1 above.

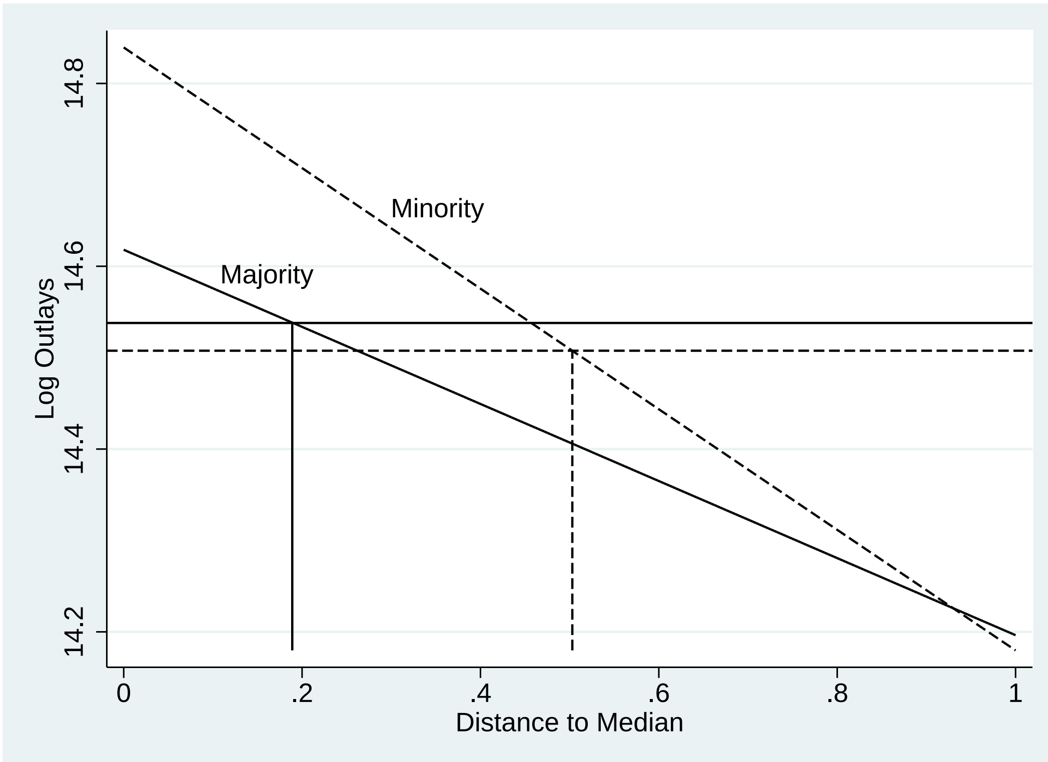
is our main point of interest here. In addition, at any given distance from the median that both minority and majority members might obtain, a minority party member is predicted to garner more outlays than a majority party member at the same location. However, given their generally closer proximity to the median, the "average" member of the majority party (vertical solid line) acquires slightly more overall outlays (horizontal solid line) than the "average" member of the minority party (vertical dashed line) receives in outlays (horizontal dashed line). Still, the graph emphasizes one crucial point: minority party members located closest to the median have the highest expected outlays. This pattern is consistent with a model in which marginal members of the opposition are often targets of vote buying.

As additional tests, we interact an indicator variable for periods of unified government (defined as instances when the Senate and House majorities as well as the president are all of the same party) with the *Absolute distance* and *Majority party* variables.[35] If legislation is more difficult to pass during periods of divided government, as some have found (Howell et al. 2000), we may observe a greater reliance on vote buying and/or agenda setting using federal outlays as the instrument. While the *Unified government*, *Absolute distance*, and *Majority party* variables remain significant as the regressions progress towards full saturation, the interaction terms do not retain significance throughout this process. As such, although model 3 of that analysis would actually suggest vote buying is more active during times of unified government, we hesitate to draw firm conclusions.

We may similarly wonder whether increased polarization makes vote buying a more essential feature of the legislative process. To investigate this, we interact McCarty, Poole & Rosenthal's (2006) polarization index, measured as the difference between the mean Republican and mean Democrat DW-NOMINATE score, with our *Majority* and

35. See Table 3.14 in the online appendix.

Figure 3.2: Understanding the Interaction between *Distance from Median* and *Majority Party*



Notes: The solid lines correspond to the majority party, while the dashed lines correspond to the minority party. The downward-sloping lines are the outlays awarded to members of each party as a function of the members' absolute distance to the median in DW-NOMINATE Common Space scores. These are based on the estimates from model 4 of Table 3.3. The vertical lines represent the average absolute distance from the median for each party, as in Table 3.1. The horizontal lines pass through the intersection of each pair of diagonal and vertical lines. The horizontal line for the majority party (14.538) lies just above the horizontal line for the minority party (14.508), indicating the average member of the majority party receives more than the average member of the minority party, as found in model 2 of Table 3.3.

Absolute distance variables.[36] *Absolute distance* remains significant when we reintroduce it to the models, with an almost identical coefficient as in our baseline model, leaving us with confidence that our results are not an artifact of polarization. Beyond this, the analysis provides only weak evidence that vote buying may have become more active over this period of increasing polarization.

In a final analysis related to the majority party, we again relax the implicit assump-

36. See Table 3.15 of the online appendix.

tion of a single linear effect of distance from the median across the entire chamber and focus on majority members on the far side of the floor median from the majority of their party.[37] We find that evidence of vote buying is at least as strong with these moderate majority members as with the moderate majority members closer to their party median. This is further support that vote buying is not limited to negative agenda control, but takes place on both sides of the median, and possibly with both parties doing the buying.

3.8 Robustness Checks and Placebo Tests

We perform two sets of checks against our baseline model.

3.8.1 Alternative Characterizations of Outlays

In Table 3.4, we present the results of additional robustness tests and a "placebo" test for which we expect to find no effects. The first three models consider alternative segmentations of federal grants. The first column is our baseline model, culling out formula-based spending from the grants category of outlays (as in the models in Table 3.2) – the spending that should be most susceptible to political manipulation.[38] The second column utilizes the entire grants category, and the third column looks at only formula-based grants, where we would expect to see the smallest, if any, effects of vote buying. We see that the significance of the negative coefficient for absolute distance to the floor median is robust to all of these specifications, but as expected, the effect size and significance attenuate as the focus moves to what we would presume would be less

37. See Table 3.16 in the online appendix.

38. See Table 3.17 in the online appendix for models which use all grants as the dependent variable. Patterns of significance are largely similar across models and variables, though as seen in Table 3.4, results attenuate vis-à-vis nonformula-based grants.

Table 3.4: Robustness & Placebo Tests

	Robustness			Placebo
	(1) No Formula	(2) All Grants	(3) Formula Only	(4) Dis. & Ret.
Absolute distance from median	-0.608**	-0.321**	-0.188	0.058*
	(0.300)	(0.133)	(0.115)	(0.029)
Majority party	-0.162*	-0.085*	-0.046	0.022**
	(0.091)	(0.044)	(0.040)	(0.011)
President's party	0.029	0.004	-0.007	0.001
	(0.036)	(0.008)	(0.007)	(0.003)
Committee chair	0.042	0.038*	0.053**	0.007
	(0.088)	(0.020)	(0.024)	(0.011)
Ranking minority member	-0.018	0.003	-0.023	-0.025*
	(0.068)	(0.023)	(0.028)	(0.015)
Party leader	0.088	0.073*	0.068	0.022
	(0.089)	(0.043)	(0.042)	(0.016)
First term	0.010	-0.011	-0.020	0.005
	(0.028)	(0.012)	(0.014)	(0.003)
Tenure (# terms)	-0.178	-0.039	-0.015	-0.015*
	(0.124)	(0.030)	(0.025)	(0.008)
Close election	0.135***	0.042***	0.021*	-0.003
	(0.036)	(0.010)	(0.012)	(0.003)
State presidential margin	0.004*	0.003***	0.003**	-0.000*
	(0.002)	(0.001)	(0.001)	(0.000)
Log income	-0.123	0.008	0.071	0.005
	(0.189)	(0.059)	(0.050)	(0.047)
Log population	-0.046	0.209**	0.296***	0.719***
	(0.279)	(0.086)	(0.061)	(0.051)
Constant	14.724***	12.481***	10.555***	8.822***
	(1.694)	(0.649)	(0.575)	(0.348)
Adj. R^2	0.220	0.674	0.808	0.926
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of outlays received by a given county in a given year. Outlays are defined as all nonformula grants in model 1, all grants in model 2, only formula grants in model 3, and disability and retirement payments to individuals in model 4. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. Models 1-3 are marked "Robustness" as we expect to observe some, perhaps attenuated, effect of *Absolute distance* on outlays even across different cuts of the grants category. Model 4 is labeled "Placebo" as we do not expect to observe any effect of *Absolute distance* on outlays for disability and retirement payments to individuals.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

manipulable, formula-based grants.

We see the same pattern in the *Close election* variable. Again, it is commonly held that marginal seats are targeted with funds to bolster the incumbent's strength in the coming election. The ideal funds for such purposes would presumably be the more manipulable, nonformula based grants. Indeed we see that as we introduce formula-based spending and then consider only formula-based spending across models 1-3, the positive coefficient on the *Close election* variable steadily attenuates, as expected.

Model 4 uses an altogether different CFFR category, namely direct disability and retirement payments, which are the major categories of entitlements. Because they should not be subject to vote-buying activities, these payments provide a useful placebo test. While the estimated coefficient for *Absolute distance* is statistically significant, it switches sign and is an order of magnitude smaller than our baseline estimate. Not seeing a negative coefficient and losing all economic significance, this last, placebo model serves as encouragement that the results of our baseline model reflect the vote-buying mechanism as predicted by theory.

3.8.2 Were Our Baseline Results Driven By the Exclusion of Multi-Member Counties?

As discussed above, counties with multiple representatives present difficulties for identifying the effect of a single legislator's ideology on the outlays allotted to her constituency. These counties include, at a minimum, the most populous regions, as well as any smaller counties through which district lines happen to be drawn. While the results from our culled sample of single-member counties have proven robust to a wide variety of analyses, there remains the possibility that these results are not representative of the entire population and are being somehow biased by the exclusion of the most populous counties. We therefore perform four additional analyses that, taken together, suggest that our findings are not an artifact of our specific sample.

First, we adopt several strategies to expand our sample. We begin by simply including each county-representative pair as an observation, matching this pair to the overall spending of the county. This constitutes model 1 of Table 3.18. This approach is of course imperfect, as it attributes all nonformula grants of a county to each of the representatives sharing the county and, perhaps more troubling, uses this same level of spending as the outcome variable over multiple observations. That said, our results on *Absolute distance* prove robust to the inclusion of these additional observations. The effect size attenuates only slightly and retains statistical significance.

In models 2-4 of Table 3.18, we choose a single representative of the multi-member county, resulting in a single observation for each county. In selecting a representative, we choose the member with the smallest absolute distance from the median in model 2 and the member with the largest absolute distance from the median in model 4. The estimated effect size in model 2 is almost identical to that in the culled sample of our baseline model, and with a similarly high level of statistical significance. Only in model 3 when choosing the member farthest from the median to represent multi-member counties do we see the estimated effect size (slightly) attenuate and fall (just) below statistical significance, as might be expected. Model 4 chooses the member whose district contains the largest share of a county's population as the representative for that county in the sample. The results in this model are again nearly identical to our baseline results. These models, then, not only mollify concerns that our results were biased by the exclusion of urban counties, but also yield additional evidence in line with the predictions of vote-buying theory.

Second, we divide the culled sample into four quartiles based on population. We do so in order to investigate whether there exist differential effects by population among those counties for which we have a clean county-to-representative match, suggesting that it would be wrong to extrapolate the results from our culled sample to the excluded counties with larger populations. The results of this analysis are presented in Table 3.19 of the online appendix. The estimated effects of *Absolute distance* across the four quartiles of population are remarkably similar to the findings for the sample as a whole.

All retain statistical significance, none are statistically distinguishable from the others, and no evidence of a monotonic trend emerges. As such, there is no reason to expect that the effect would be different for the more dense counties which are excluded from our main analysis.

To further assess the robustness of our core findings, we employ an altogether different dataset: the Federal Assistance Award Data System (FAADS) data on district-level outlays.[39] The FAADS maps federal outlays into congressional districts, and thereby avoids the challenges associated with ensuring a clear correspondence between a county and a single congressperson. This feature of the data allows us to use all districts, without excluding the most urban areas as we had to do in the county-level analysis. As with the CFFR data, it is reasonably straightforward to identify and cull out formula-based spending. When using FAADS, however, new complications arise. We must remove redistricting years, which introduce a mismatch between districts in which outlays are distributed and the political and demographic variables associated with their authorization. Additionally, when using district-member fixed effects, we must employ redistricting-specific member fixed effects for each period in which different district boundaries apply in order to account for the fact that members may represent substantively different geographies following decennial redistricting. As such, we significantly reduce the temporal variation present in this model vis-à-vis the county-level analysis that spanned nearly thirty years within units.

Using only nonformula grants as the dependent variable and district-member fixed effects, the coefficient of the absolute distance variable does not appear significantly different from zero and displays a sign contrary to our expectation. Models employing all grants as the dependent variable or CVP scores as the basis for *Absolute distance* more

39. Our data utilize and extend district-level outlays data as documented in Bickers & Stein (1991). See Berry, Burden & Howell (2010) for a previous use and extension of the FAADS data.

consistently retain the expected negative sign.[40] In other words, the district-level results are uneven and inconclusive when using district-by-member fixed effects. Notable, however, in none of these analyses do the results become stronger when restricting the sample to only those districts represented in the county-level analysis. This suggests that our county-level results were not driven by the exclusion of the most populous counties (i.e., those containing more than one district).

The district-level results could fail to hold for two main reasons: the inclusion of the urban areas we had to exclude in the county-level analyses, or the fact that district boundaries change, forcing us to reset the district-by-member fixed effects every ten years and thus limiting the variation available for estimation. The two sets of analyses that include the most populous counties and split up the sample by population quartiles weigh in favor of the second explanation. In the fourth and final analysis related to the representativeness of the culled sample, we impose artificial redistricting on our county-level sample by resetting the county-by-member fixed effects in 1993 and 2003.[41] If the results are similarly inconclusive, it suggests that the mixed results of the district-level analysis stemmed not from including the urban centers excluded from the county-level analysis, but rather from the need to observe our units of observation over smaller, disjointed periods of time.

In Table 3.24 in the online appendix, we find that indeed our estimated effect sizes attenuate relative to our baseline estimates, and statistical significance vanishes in a couple of cases. In conjunction with the three preceding sets of analyses, this indicates that the inconclusiveness of the district-level analysis stems from our accounting for redistricting rather than the systematic exclusion of the most populous areas.

40. We omit results here and refer the reader to Tables 3.20-3.23 in the online appendix.

41. In fact, not all redistrictings occurred in exactly the years preceding these races, and the district-level analysis reflects this fact.

3.9 Conclusion

This paper presents the most comprehensive and compelling evidence to date that ideological moderates receive more distributive outlays than do ideological extremists within Congress. The estimated seven-percent decrease in outlays associated with an exogenously derived one-standard-deviation increase in ideological distance from the median remains significant both statistically and substantively, resistant to false positives in placebo tests, and robust to various specifications and measures of both absolute distance to the median and outlays.

The vote-buying models with which we motivate our study offer both theoretical justification for the study as well as an explanation of the results. While a representative may forgo some distributive benefits for her district, if she or the voters she represents value taking an ideological stance enough, the benefits of position-taking outweigh any distributive costs. Conversely, if a representative or her voters are more moderate, then the opportunity to tender one's vote in order to bring outlays back to the district may carry the day.

Due to the inherent unobservability of side payments, we cannot be completely sure that we have captured the unique effects of vote buying on the distribution of outlays. Our research design rules out objections related to the taste of legislators for pork barrel relative to legislative activities and other similarly first-order threats to our causal claim. Past and future work that ties vote-buying efforts on specific bills directly to earmarks and outlays is mutually complementary with our analysis in providing evidence that vote buying takes place and does so in line with theoretical predictions. Future data collection efforts that link payments and specific bills may better illuminate the particular conditions under which vote buying actually occurs. The existing theoretical literature scrutinizes who will be paid for voting for a single bill. Empirically, however, payments may be offered on the basis of continued support across multiple bills. Further, the propensity of any payments to be made may depend, in turn, upon substantive features of the policies for which existing theory does not account. To move beyond the average effects of ideological extremism on overall federal outlays, which we have documented here, new and substantial investments in data collection are required.

The findings in this paper also suggest that the effect of majority party status is more difficult to track empirically than to predict theoretically, where it is widely held to be an important determinant in legislative bargaining and distributive politics. The analysis performed herein suggests that this may be due to the covariation and interaction of majority status with ideological distance to the median, as well as a result of the possible concurrence of negative and positive agenda control. A deeper understanding of these forces may help subsequent research better account for majority party influence in distributive politics.

Finally, the team production issues that prevented a straightforward application of vote-buying theory to the ideology of senators and to counties served by multiple representatives deserve attention in their own right. How might theories of vote-buying and agenda setting be modified or adapted to consider such cases? While the findings in this paper provide compelling evidence for the role of ideology in outlays received by a single representative for a given area, its applicability to cases of overlapping political jurisdictions remains unanswered.

3.10 Appendix

3.10.1 Adaptation of Dekel, Jackson & Wolinsky's (2009) Vote-Buying Model

While Dekel, Jackson & Wolinsky (2009) explore a range of political variables and outcomes, our interest is limited to the equilibrium distribution of payments across the ideological spectrum of voters. To elucidate this as quickly as possible, we present just the key features of the model necessary to motivate an understanding of the equilibrium solution and the distribution of payments. We adapt the notation with trivial modifications when convenient, and we adjust the variables to the setting of the distribution of federal projects as manipulated by political parties in Congress. We refer the interested reader to the presentation in Dekel et al. (2009) for the full details.

We suppose an odd number of legislators, $i \in N$, and two parties, R and L. At the start of the game, the party that lacks ex ante support for its preferred outcome has the opportunity to make the first bid (in the example below, this would be party R), where a bid consists of a promise of outlays to one or more legislators, and payments to different legislators need not be the same size. The parties then alternate bids, while incurring a non-zero cost to bidding each round.

Offers by a party to a legislator cannot be less than previous offers made by the same party to the same legislator, an assumption that offers are "irreversible." While offers are binding, if party L makes a higher offer to a particular legislator than party R, that legislator will now be voting for party L, so party R is free to reallot the funds it had previously promised to the legislator. This feature becomes important in motivating what Dekel et al. refer to as the "shadow price" of buying a legislator's vote: the legislator's support itself costs money, but there is an additional cost of having freed up the promises of the opposing party.

A legislator i receives utility $p_i^k + V_i^k$, where p_i^k is the payment she receives from party k and V_i^k is the utility she receives from voting for the outcome preferred by party k. These ex ante valuations, V_i^k, are assumed to be exogenously fixed throughout. We arrange the legislators such that $v(i) = V_i^L - V_i^R$ is a non-increasing function in i, as in Figure 3.3.[42] Legislator i follows her dominant strategy and votes for the outcome proposed by party L iff $p_i^L + V_i^L > p_i^R + V_i^R$.

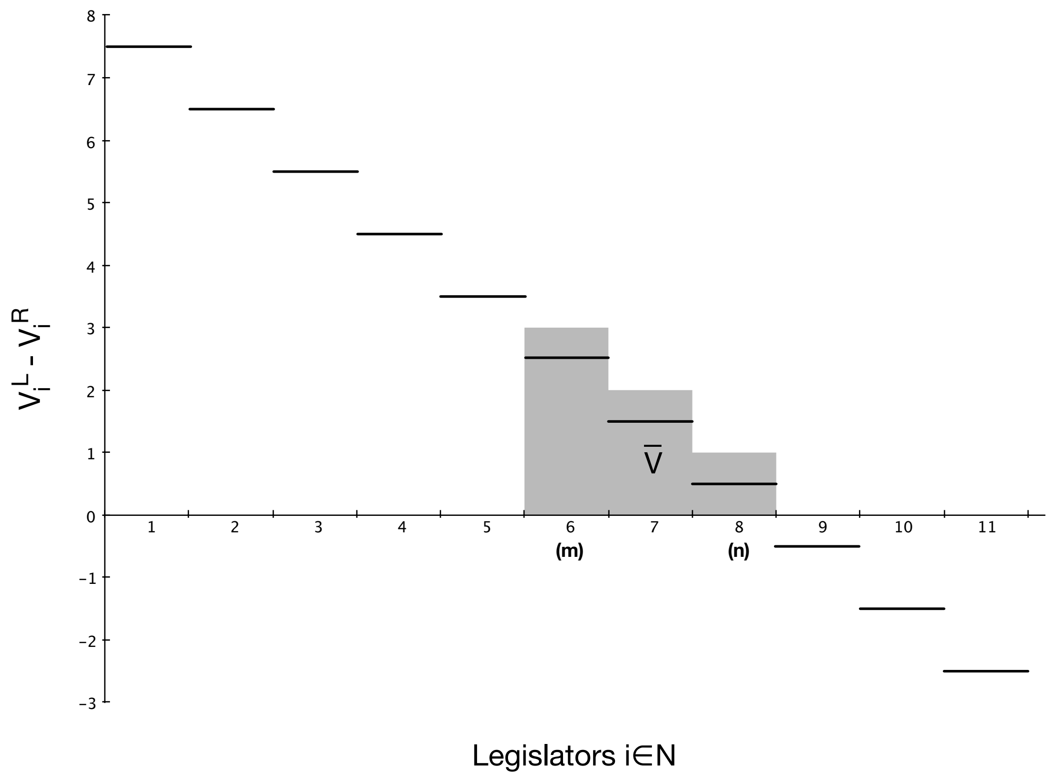
Denote the median legislator by $m = (N + 1)/2$. We asssume without loss of generality that party L has ex ante majority support, such that $v(m) > 0$. Let the rightmost legislator that supports ex ante the proposal that party L prefers be denoted by $n = \arg\max\{i : v_i > 0\}$. Then we may define $\bar{V} = \sum_{i=m}^{n} v_i$, admittedly omitting non-trivial nuances regarding the smallest units of payment.[43] It is this quantity $\bar{V}$ that will be particularly important in characterizing the payments in equilibrium. Note that, as depicted visually in Figure 3.3 (as well as Figure 1 of Dekel et al. (2009)), $\bar{V}$ represents an area that is a right triangle of sorts, with its hypotenuse sloping (by steps) downwards away from the median (to the right, if we assume L has ex ante majority support). Lastly, let the valuations of the parties for the passage of their preferred proposal be denoted as W^L and W^R.

Suppose that the party with ex ante minority support for its preferred proposal begins the bidding; there is no need for the party with ex ante majority support to preempt in a potentially infinite game as there will always be an opportunity to respond if necessary. Proposition 3 in Dekel et al. (2009) then states that, for sufficiently small per-round bidding costs and given our additional assumption that party R always makes the first move, one of two cases obtains in any equilibrium:

42. Based on Figure 1 in Dekel et al. (2009).

43. In fact, the existence of a smallest unit of payment (equal to one in the figure) is the reason that the shaded area extends above the valuation lines in Figure 3.3. Our omission of this detail in the exposition in no way drives the core result regarding equilibrium payments.

Figure 3.3: Visualizing the Equilibrium Distribution of Payments



1. If $W^R > W^L$, party R wins at cost $\bar{V}$ paid to the legislators m (median) through n (almost-indifferent).

2. If $W^R \leq W^L$, party L wins at no cost, as party R will not initiate bidding.

In equilibrium, we either observe party L win and make no payments, or we observe party R win and make payments that correspond to the region $\bar{V}$. These payments are approximately the sum of the valuations of each legislator from the median to the farthest-right legislator that ex ante preferred party L's preferred outcome. Party R must procure the support of the median and all legislators to the right of the median, a winning coalition in a simple majority-rule setting.

The non-zero cost to bidding discourages parties from bidding for legislators' votes when they know they will not have to deliver on their promises. Given the setting of complete and perfect information, each party applies backwards induction, bidding only if they must in order to win. Recall that in this example party L has ex ante support for its preferred outcome (i.e., has the support of the median voter), so party R has the choice of making the first bid. Intuitively, then, if party L values winning its preferred outcome more than party R values winning its preferred outcome, then party R will realize that party L is willing to bid higher and will thus stay out of the bidding entirely. If, however, party R values the bill more, it will procure the necessary votes to obtain a majority and party L, realizing party R's willingness to outbid, will make no promises to any legislators.

The legislators whose valuations are represented by the area $\bar{V}$ are the "cheapest" legislators that party R could have bought to form this winning coalition. When payments occur, therefore, they are directly exclusively to near-median legislators. Moreover, past a certain point, more extreme legislators receive no payments whatsoever.

3.10.2 Data: Sources & Constructed Variables

The data sources are introduced more less in the order in which they are invoked in the .do file. Data and .do file are available upon request, as is the regression replication .do file.

General Data on Federal Government

Using the sources below, a file was created with facts about the broad political landscape. Variables include year and congress (e.g., 98th, 111th) identifiers as well as the size of each party in each chamber, the party with the majority in each chamber, the party of the president, whether it was a period of unified government (Senate and House majorities of the same party as the president), and an inflation multiplier (with 2010 set as the base year).

`http://history.house.gov/Institution/Party-Divisions/Party-Divisions/`

`http://www.senate.gov/pagelayout/history/one_item_and_teasers/partydiv.htm`

`http://www.bls.gov/data/inflation_calculator.htm`

To this was merged a file with state names, FIPS and ICPSR codes, and years, such that the resulting file had year-state observations from 1983-2009.

Ideology Data

NOMINATE Poole & Rosenthal's NOMINATE data (Poole 2005) are used not only for our ideology variables but for the information they provide on a number of other legislator characteristics. As explained in the paper, DW-NOMINATE Common Space scores were used.

`http://voteview.com/dwnomin_joint_house_and_senate.htm`

First a variable tracking the tenure of legislators is created, simply counting the number of terms the legislator has served in Congress. Note that a legislator's ICPSR ID number follows her between chambers, but not if she switches party. Observations for seats that were split by two representatives in a single Congress were dropped. This covers retirements and deaths, in which a special election or appointment was made to fill the seat (assuming the replacement cast enough votes to receive a NOMINATE score for that congress) as well as representatives switching parties, receiving a different ID number mid-congress. In the nearly 30 years of our sample, around 100 cases fell into one of those categories. Two primary alternatives to dealing with split seats were both tried, with effectively identical results: 1) The entire congress could have been assigned to the member who cast the greatest number of votes, as in Berry, Burden & Howell (2010); or 2) Each year could be assigned to the member that served the majority of that year, favoring slightly those members that served the earlier part of the year in which the budget was under construction. To reiterate, though, all methods were tried and results never varied significantly.

CVP For an additional measure of ideology, Fowler & Hall's (2012) Conservative Vote Probabilities (CVP) were used.

`http://www.andrewbenjaminhall.com/papers/`

Party Unity Party Unity scores were also used, where "a party unity vote is defined as one where at least 50 percent of Democrats vote against at least 50 percent of Republicans."

`http://pooleandrosenthal.com/party_unity.htm`

Derived Ideology Measures From the three basic measures of ideology discussed above, a number of derivative variables were created. For NOMINATE and CVP scores, the central variable was absolute distance from the House median in ideology scores. *Absolute rank from the median* was created similarly. Using these distance measures and the party unity scores, a number of interaction variables (e.g., with majority/minority and Democratic/Republican parties) and other functional forms (e.g., log, square, square root) were tested. Lastly, we used the Commonspace DW-NOMINATE scores to calculate a polarization index as in (McCarty, Poole & Rosenthal 2006): the mean Republican minus the mean Democrat NOMINATE scores in a given congress.

Electoral Margins

From vote shares for the two major parties in congressional elections, a dummy variable was created equal to 1 if the margin of victory was within five percent. For all years, the most recent past electoral outcomes were utilized.

`http://library.cqpress.com/elections/`

From these data and the availability of the geographic correspondences described below, a variable denoting whether there exists a geographic correspondence for a district since its last redistricting was created. In practice, however, Congressional Quarterly appears to designate a district as having been redistricted if any district in the state was redistricted. Excluding all districts for which there was not an updated geographic correspondence since the last redistricting date seemed overly conservative and created a significant amount of unevenness in our sample, so the most current geographic correspondence data were employed, catching all major redistrictings and most if not all of the minor redistrictings.

Presidential election results at the state level mark the last of the electoral data. The key variable created is, for each year and each state, the absolute value of the state-wide vote margin in the previous presidential election.

Committee Membership Data

From Nelson (N.d.) and Stewart and Woon (Stewart, III & Woon N.d.) come data on committee membership. The key variables were dummies for being a party leader (though in practice many Speakers of the House lack enough votes to be given NOMINATE scores and are thus *de facto* excluded from our dataset), being a committee chair, or being the ranking minority member. Additionally, dummy variables for membership on all of the individual standing committees were generated, although these were left out of the baseline model in the paper. (The member fixed effects strategy leaves little variation for detecting the effect of a representative's tenure on a given committees.)

`http://web.mit.edu/17.251/www/data_page.html`

Poole and Rosenthal continually update their ID numbers, but the committee data reflects what appear to be "un-updated" ID numbers. As a result, corrections in ICPSR ID numbers in the committee file were required, and appear in an auxiliary .do file.

County-Level Outlays

Data on county-level outlays come from the Consolidated Federal Funds Report (CFFR), and as discussed in the paper, data from fiscal year t are matched with data from calendar year $t-1$. CFFR data span from 1983-2010, when the Federal Financial Statistics program remained in operation. The year 1983 is dropped, as there does not exist geographic correspondence data for 1982, the last year of a previous redistricting period. The corresponding calendar years for the explanatory variables is then 1983-2009. Outlays are inflation adjusted, putting all amounts in 2010 dollars.

`http://www.census.gov/govs/cffr/`

The outlays are then split into different types of transfers and are summed by county, state, year, and the type of transfer.

From the FAADS data (discussed below), a correspondence was created between program ID numbers and all of the types of transfers (or types of grants) funds were issued under for a given program ID number. After merging this file into the outlays data, formula grants could be culled out of the grants category, leaving block grants, project grants, and cooperative agreements. The entire grants category as well as only formula grants were also separately analyzed. For all characterizations of outlays, funds were summed, leaving one county-state-year observation for each of the characterizations.

County-year observations with zero value for a given type or cut of outlays were rare (only a couple hundred for nonformula grants, say), but in order to deal with this issue, we added one to all values of outlays. The log-transformed values were then zero and were included in the analysis as such. Substantively, this amounts to assuming that receiving nothing and receiving a single dollar are the same, and the effect that adding one has on higher levels of outlays is even smaller. Previous versions of the paper dropped zero observations from all analyses, and results were nearly identical, if not somewhat stronger.

Geographic Correspondences (County-to-District & District-to-District)

A county-to-district crosswalk was created, containing all of the relevant population correspondences among counties and congressional districts, using each raw correspondence file repeatedly for all of the years until a new file is available. As mentioned above, this seems to cover all of the major redistrictings and most if not all of the minor redistrictings. Even for the occasional district that might have been redistricted and that lacks an updated file for a couple years, the correspondence is still likely quite accurate. The files may be found at the links below.

`http://mcdc.missouri.edu/websas/geocorr12.html`; `http://mcdc.missouri.edu/websas/geocorr2k.html`; `http://mcdc.missouri.edu/websas/geocorr90.html`

These data identify counties that were represented by only one district. Additionally, with these data one can determine what proportion of a district's population remains in the district across redistricting. Using varying thresholds of population carryover, it is possible to look at within-member variation that spans redistrictings. Further explanation of the use of this method appears in the footnotes for Tables 3.21, 3.22, and 3.23.

County-Level Demographics

Income and population at the county level come from the Bureau of Economic Analysis (BEA).

`http://bea.gov/iTable/index_regional.cfm`

CFFR does not parse apart New York City, which is not a problem for this study as it would be dropped anyway under the restriction that counties be contained in only one district. Additionally, several Alaskan boroughs and Virgina cities (Virginia has a number of cities not within counties) appear in BEA but not in CFFR, or at least not using the same codes. These instances do not ultimately, then, appear in the analysis.

District-Level Outlays

The FAADS data on district-level outlays are compiled as per Bickers & Stein (1991) and extended in the same manner as outlined in Berry, Burden & Howell (2010), and the reader is referred to both of those papers for more detail. The only real departure in this study is the breakout of grants by type, rather than coefficient of variation. The no-formula category is constructed to mirror the CFFR no-formula category, as it excludes only formula-based spending and includes block grants, project grants, and cooperative agreements. The all-grants measure includes formula-based spending. A dollar was added to all values, to account for any observations of zero outlays.

3.10.3 Supplementary Analyses

Table 3.5: Additional Summary Statistics at the County Level

Variable	Obs	Mean	Std. Dev.	Min	Max
Absolute distance from median	71199	.319	.209	0	1.172
Absolute rank from median (/100)	71199	1.861	1.224	.01	4.32
Absolute distance x majority	71199	.112	.139	0	.848
Distance from median (sq)	71199	.145	.16	0	1.374
Distance from median (sqrt)	71199	.526	.205	0	1.083
Distance from median (ln)	71001	-1.494	1.054	-7.601	.159
Distance x Republican	71199	.214	.242	0	1.172
Distance x Democrat	71199	.105	.173	0	.9
Distance from within party mean	71199	.124	.097	0	.642
Party unity score	71199	84.463	12.952	22.418	100
Unified government	71199	.253	.435	0	1
Polarization index	71199	.755	.077	.646	.844
Distance (CVP) from median	71167	.199	.159	0	.609
Rank (CVP) from median (/100)	71167	1.914	1.233	.01	4.32
Maj on far side of median	71199	.095	.294	0	1
Majority party	71199	.588	.492	0	1
President's party	71199	.496	.5	0	1
Committee chair	71199	.041	.199	0	1
Ranking minority member	71199	.053	.224	0	1
Party leader	71199	.003	.053	0	1
First term	71199	.146	.353	0	1
Tenure (# terms)	71199	4.989	3.785	1	28
Close election	71199	.078	.269	0	1
State presidential margin	71199	14.249	10.103	0	55.94
Log income	71199	12.831	1.311	7.555	17.406
Log population	71199	9.923	1.194	4.111	13.345
Log grants (no formula)	71199	14.371	1.938	0	22.558
Log grants (all)	71199	16.111	1.554	4.094	23.277
Log grants (formula only)	71199	15.705	1.688	0	22.609
Log retirement and disability (all)	71199	17.098	1.347	0	21.558

Notes: Absolute distance from median is the absolute value of median-centered ideal point estimates in DW-NOMINATE Common Space scores. All variations of this variable are explained in the footnotes of the results tables in which they are used. Further explanations here are given mostly for control variables. *Majority party* is a dummy variable equal to 1 if a legislator is in the majority party. *President's party* is a dummy variable equal to 1 if a legislator shares the same party as the sitting president. *Committee chair* is a dummy variable equal to 1 if a legislator is the chair of any standing House committee. *Ranking minority member* is a dummy variable equal to 1 if a legislator is the ranking minority member on any standing House committee. *Party leader* is a dummy variable equal to 1 if a legislator has a party leadership role. *First term* is a dummy variable equal to 1 for a legislator's first term in Congress. *Tenure (# terms)* counts the number of Congresses in which a legislator has served. *Close election* is a dummy variable equal to 1 if the margin of victory in the previous congressional election was 5% or less. *State presidential margin* is absolute value of the state-wide vote margin in the previous presidential election. *Log income* is the natural log of county-level income. *Log population* is the natural log of county-level population. *Log grants (no formula)* is the log value of nonformula grants received by a given county in a given year, as measured in the Consolidated Federal Funds Report. The other measures of outlays are explained in the footnotes of the results tables in which they are used. A dollar was added to all values of outlays to account for zeros in the dataset (see Subsection B.5 of this document). The sample is restricted to only those observations included in the baseline model (Table 2 of the paper, model 2).

Table 3.6: Sequential Addition of Control Variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Absolute distance from median	-0.147*	-0.685*	-0.604	-0.611*	-0.603*	-0.617*	-0.608**
	(0.080)	(0.390)	(0.362)	(0.339)	(0.332)	(0.308)	(0.300)
Majority party		-0.192	-0.161	-0.170	-0.169	-0.165*	-0.162*
		(0.123)	(0.111)	(0.105)	(0.102)	(0.094)	(0.091)
President's party			0.035	0.034	0.035	0.029	0.029
			(0.036)	(0.037)	(0.037)	(0.037)	(0.036)
Committee chair				0.051	0.040	0.045	0.042
				(0.090)	(0.088)	(0.086)	(0.088)
Ranking minority member				-0.005	-0.012	-0.019	-0.018
				(0.074)	(0.074)	(0.069)	(0.068)
Party leader				0.088	0.085	0.080	0.088
				(0.088)	(0.087)	(0.086)	(0.089)
First term					0.037	0.012	0.010
					(0.027)	(0.027)	(0.028)
Tenure (# terms)					-0.194	-0.178	-0.178
					(0.138)	(0.124)	(0.124)
Close election						0.133***	0.135***
						(0.036)	(0.036)
State presidential margin						0.004*	0.004*
						(0.002)	(0.002)
Log income							-0.123
							(0.189)
Log population							-0.046
							(0.279)
Constant	12.850***	13.141***	13.080***	13.091***	12.835***	12.791***	14.724***
	(0.057)	(0.193)	(0.166)	(0.159)	(0.235)	(0.213)	(1.694)
Adj. R^2	0.218	0.219	0.219	0.219	0.219	0.220	0.220
N	71199	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. The first model includes only distance from the median, the second model brings in majority party status, the third model controls for log income and log population, the fourth model adds covariates related to parties and committees, the fifth model adds in first-term and tenure variables, and the sixth model considers electoral margins in the county for the most recent congressional and presidential elections.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.7: Experimenting with Fixed Effects

	(1)	(2)	(3)	(4)
Absolute distance from median	-0.087	-0.199*	-0.701**	-0.608**
	(0.218)	(0.105)	(0.274)	(0.300)
Majority party	-0.020	-0.002	-0.197**	-0.162*
	(0.094)	(0.051)	(0.087)	(0.091)
President's party	0.051	0.045	0.014	0.029
	(0.039)	(0.036)	(0.041)	(0.036)
Committee chair	0.191	-0.047	-0.014	0.042
	(0.180)	(0.048)	(0.085)	(0.088)
Ranking minority member	0.148	0.019	-0.029	-0.018
	(0.146)	(0.068)	(0.063)	(0.068)
Party leader	-0.389*	0.227***	-0.052	0.088
	(0.204)	(0.079)	(0.054)	(0.089)
Party	-0.168*	-0.001		
	(0.091)	(0.041)		
First term	0.025	0.018	0.007	0.010
	(0.040)	(0.027)	(0.029)	(0.028)
Tenure (# terms)	-0.002	0.002	-0.197	-0.178
	(0.009)	(0.005)	(0.134)	(0.124)
Close election	0.052	0.059	0.127***	0.135***
	(0.057)	(0.038)	(0.038)	(0.036)
State presidential margin	0.011**	0.002	0.004*	0.004*
	(0.004)	(0.002)	(0.002)	(0.002)
Log income	-0.035	0.142	-0.490***	-0.123
	(0.205)	(0.174)	(0.177)	(0.189)
Log population	1.134***	-0.398	1.702***	-0.046
	(0.231)	(0.266)	(0.174)	(0.279)
Constant	1.962***	15.029***	1.981***	14.724***
	(0.537)	(1.623)	(0.633)	(1.694)
Fixed Effects	None	County	Member	Cnty-Member
Adj. R^2	0.555	0.286	0.504	0.220
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. Year fixed effects used in all models. In model 1, no additional fixed effects are used. In model 2, county-level fixed effects are used. Model 3 is our baseline model (model 2 from Table 2 of the paper), in which we use member fixed effects. Model 4 uses county-by-member fixed effects. Models 3-4, which condition on each member, do not admit *Party* as an additional control, as party is constant within all legislator ICPSR ID numbers; legislators who switch parties receive a new ID number. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.8: Variations on Absolute Distance

	(1)	(2)	(3)	(4)	(5)	(6)
Absolute distance from median	-0.585**	-0.736*		-0.659**	-1.098**	
	(0.268)	(0.430)		(0.328)	(0.431)	
Distance from median (sq)	-0.032					
	(0.246)					
Distance from median (sqrt)		0.129				
		(0.200)				
Distance from median (ln)			-0.016	0.007		
			(0.017)	(0.014)		
Distance x Republican					1.745	0.647
					(1.046)	(0.676)
Distance x Democrat						-1.098**
						(0.431)
Majority party	-0.162*	-0.164*	0.023	-0.168*	-0.024	-0.024
	(0.091)	(0.093)	(0.026)	(0.091)	(0.091)	(0.091)
President's party	0.029	0.029	0.042	0.031	0.037	0.037
	(0.036)	(0.036)	(0.041)	(0.037)	(0.041)	(0.041)
Committee chair	0.042	0.042	0.041	0.041	0.043	0.043
	(0.087)	(0.088)	(0.089)	(0.088)	(0.085)	(0.085)
Ranking minority member	-0.017	-0.017	-0.002	-0.017	-0.022	-0.022
	(0.069)	(0.068)	(0.081)	(0.068)	(0.064)	(0.064)
Party leader	0.088	0.086	0.091	0.086	0.089	0.089
	(0.089)	(0.089)	(0.086)	(0.089)	(0.087)	(0.087)
First term	0.010	0.011	0.014	0.011	0.009	0.009
	(0.028)	(0.028)	(0.027)	(0.028)	(0.028)	(0.028)
Tenure (# terms)	-0.179	-0.180	-0.166	-0.180	-0.189	-0.189
	(0.124)	(0.125)	(0.120)	(0.125)	(0.129)	(0.129)
Close election	0.135***	0.135***	0.135***	0.135***	0.129***	0.129***
	(0.036)	(0.035)	(0.036)	(0.036)	(0.035)	(0.035)
State presidential margin	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.123	-0.123	-0.133	-0.129	-0.107	-0.107
	(0.188)	(0.188)	(0.185)	(0.190)	(0.195)	(0.195)
Log population	-0.046	-0.047	-0.040	-0.038	-0.059	-0.059
	(0.280)	(0.279)	(0.277)	(0.280)	(0.283)	(0.283)
Constant	14.728***	14.718***	14.470***	14.757***	14.241***	14.241***
	(1.704)	(1.689)	(1.643)	(1.701)	(1.556)	(1.556)
Adj. R^2	0.220	0.220	0.220	0.220	0.220	0.220
N	71199	71199	71001	71001	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Distance from median (sq)* is *Absolute distance from median* squared. *Distance from median (sqrt)* is the square root of *Absolute distance from median. Distance from median (ln)* is the natural log of *Absolute distance from median*; the counties represented by the median legislator in each year are dropped from these analyses as their value for *Absolute distance* is zero. *Distance × Republican/Democrat* is *Absolute distance from median* interacted with a dummy variable for membership in each party.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.9: Spline Analysis

	0.1	0.3	0.5	0.7	0.9	1.1
	(1)	(2)	(3)	(4)	(5)	(6)
Distance from median - spline 1	-0.604	-0.556**	-0.606**	-0.613**	-0.607**	-0.607**
	(0.424)	(0.270)	(0.279)	(0.292)	(0.300)	(0.300)
Distance from median - spline 2	-0.608*	-0.644*	-0.618	-0.477	-2.247***	-7.407***
	(0.309)	(0.353)	(0.435)	(0.755)	(0.483)	(1.138)
Majority party	-0.162*	-0.162*	-0.162*	-0.162*	-0.162*	-0.162*
	(0.092)	(0.093)	(0.090)	(0.089)	(0.091)	(0.091)
President's party	0.029	0.029	0.029	0.029	0.029	0.029
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Committee chair	0.042	0.042	0.042	0.042	0.042	0.042
	(0.088)	(0.087)	(0.087)	(0.087)	(0.088)	(0.088)
Ranking minority member	-0.018	-0.017	-0.018	-0.018	-0.018	-0.018
	(0.068)	(0.069)	(0.069)	(0.068)	(0.068)	(0.068)
Party leader	0.088	0.087	0.088	0.087	0.087	0.087
	(0.089)	(0.089)	(0.089)	(0.089)	(0.089)	(0.089)
First term	0.010	0.011	0.010	0.011	0.011	0.011
	(0.028)	(0.028)	(0.028)	(0.028)	(0.027)	(0.027)
Tenure (# terms)	-0.178	-0.180	-0.179	-0.179	-0.178	-0.178
	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)	(0.124)
Close election	0.135***	0.135***	0.135***	0.135***	0.134***	0.134***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.035)	(0.035)
State presidential margin	0.004*	0.004*	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.123	-0.123	-0.123	-0.122	-0.122	-0.122
	(0.189)	(0.188)	(0.189)	(0.188)	(0.189)	(0.189)
Log population	-0.046	-0.047	-0.046	-0.045	-0.047	-0.046
	(0.279)	(0.280)	(0.280)	(0.279)	(0.279)	(0.279)
Constant	14.723***	14.740***	14.725***	14.718***	14.724***	14.721***
	(1.694)	(1.701)	(1.707)	(1.703)	(1.693)	(1.694)
Adj. R^2	0.220	0.220	0.220	0.220	0.220	0.220
N	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores and is allowed to take two slopes, one on either side of a knot point. The number above each model denotes the knot connecting spline 1 to spline 2. Spline 1 estimates the effect of *Distance from median* from zero to the knot point, while spline 2 estimates the effect of *Distance from median* from the knot point and higher. The knot point is allowed to increase across the models, such that spline 1 covers an increasingly large share of the estimation, while spline 2 covers less.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.10: Accounting for the Senate

	(1)	(2)	(3)
Absolute distance from median	-0.437	-0.345**	-0.208
	(0.508)	(0.162)	(0.363)
Senators from state in own party (0,1,2)	0.015		0.006
	(0.034)		(0.032)
Same party as Senate majority (0,1)	0.042		0.035
	(0.053)		(0.047)
Senators from state in president's party (0,1,2)	-0.012		-0.009
	(0.026)		(0.019)
Log per capita spending in state's other counties		0.733***	0.724***
		(0.055)	(0.057)
Majority party	-0.149	-0.079*	-0.071
	(0.151)	(0.047)	(0.102)
President's party	0.033	0.016	0.017
	(0.034)	(0.032)	(0.029)
Committee chair	0.077	0.033	0.074
	(0.091)	(0.072)	(0.069)
Ranking minority member	-0.020	0.029	0.029
	(0.064)	(0.048)	(0.044)
Party leader	0.066	0.085	0.065
	(0.096)	(0.097)	(0.099)
First term	0.017	0.022	0.028
	(0.026)	(0.022)	(0.024)
Tenure (# terms)	-0.179	-0.172	-0.171
	(0.126)	(0.115)	(0.114)
Close election	0.137***	0.091***	0.092***
	(0.035)	(0.028)	(0.026)
State presidential margin	0.004	0.004**	0.003*
	(0.003)	(0.002)	(0.002)
Log income	-0.089	-0.088	-0.060
	(0.223)	(0.175)	(0.210)
Log population	-0.073	0.089	0.066
	(0.270)	(0.279)	(0.264)
Constant	14.500***	7.052***	6.965***
	(1.590)	(1.643)	(1.436)
Adj. R^2	0.225	0.243	0.247
N	69553	71199	69553

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores.
The first model includes a variable counting the number of senators sharing the same party as a county's representative in the House (taking on a value of 0, 1, or 2), a dummy variable equal to one if a county's representative is in the same party as the Senate majority party, and a variable counting the number of senators from a county's state that share the same party as the president (again taking on a value of 0, 1, or 2). These variables are all intended to capture the effects of team production between representatives and the senators from their state.
The second model adds to the baseline model the log per capita spending in all other counties in a county's state. This variable is intended capture the effectiveness of a state's senators at procuring distributive spending for their state, without including a county's own spending. When a representative covers more than one county, however, this variable does include funds procured by a county's representative for the other counties she represents.
The third model includes the three variables from model 1 and the spending variable from model 2.
$^*p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.11: Distance from Party Mean

	(1)	(2)	(3)	(4)	(5)	(6)
Absolute distance from median				-0.180**	-0.578**	-0.562**
				(0.079)	(0.283)	(0.257)
Distance from within party mean	0.695	0.952**	0.986**	0.976**	0.878**	0.916**
	(0.453)	(0.425)	(0.400)	(0.426)	(0.435)	(0.414)
Majority party		0.056**	0.054**		-0.140	-0.137*
		(0.025)	(0.023)		(0.087)	(0.079)
President's party		0.040	0.042		0.029	0.031
		(0.040)	(0.037)		(0.036)	(0.033)
Committee chair		0.058	0.028		0.056	0.026
		(0.089)	(0.088)		(0.085)	(0.085)
Ranking minority member		0.017	-0.001		-0.001	-0.017
		(0.079)	(0.070)		(0.063)	(0.058)
Party leader		0.122	0.041		0.117	0.037
		(0.086)	(0.082)		(0.089)	(0.084)
First term		0.008	-0.006		0.004	-0.010
		(0.028)	(0.025)		(0.028)	(0.025)
Tenure (# terms)		-0.185	-0.223		-0.194	-0.231
		(0.118)	(0.136)		(0.123)	(0.139)
Close election		0.133***	0.133***		0.134***	0.134***
		(0.036)	(0.032)		(0.035)	(0.032)
State presidential margin		0.004*	0.004*		0.004*	0.004*
		(0.002)	(0.002)		(0.002)	(0.002)
Log income	-0.098	-0.124	-0.129	-0.087	-0.119	-0.123
	(0.176)	(0.183)	(0.173)	(0.173)	(0.189)	(0.179)
Log population	-0.027	-0.020	0.001	-0.034	-0.019	-0.001
	(0.281)	(0.276)	(0.261)	(0.279)	(0.282)	(0.269)
Constant	14.183***	14.056***	13.914***	14.151***	14.293***	14.153***
	(1.658)	(1.634)	(1.493)	(1.640)	(1.703)	(1.563)
Committee dummies	No	No	Yes	No	No	Yes
Adj. R^2	0.218	0.220	0.221	0.219	0.220	0.221
N	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Distance from within party mean* is the absolute value of the mean-centered first dimension of the DW-NOMINATE Common Space scores, *by party*, thus measuring each legislator's ideological distance from her party's mean.

$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.12: Party Unity

	(1)	(2)	(3)	(4)
Party unity score	0.004*	0.001	0.004*	0.001
	(0.002)	(0.003)	(0.002)	(0.003)
Party unity x majority		0.008**		0.007*
		(0.004)		(0.004)
Absolute distance from median			-0.603**	-0.192
			(0.261)	(0.147)
Majority party	0.014	-0.679**	-0.189**	-0.671**
	(0.022)	(0.306)	(0.081)	(0.290)
President's party	0.047	0.032	0.035	0.030
	(0.043)	(0.036)	(0.038)	(0.036)
Committee chair	0.038	0.030	0.036	0.031
	(0.086)	(0.083)	(0.084)	(0.083)
Ranking minority member	-0.002	-0.020	-0.019	-0.023
	(0.079)	(0.063)	(0.065)	(0.062)
Party leader	0.092	0.090	0.089	0.089
	(0.085)	(0.082)	(0.089)	(0.083)
First term	0.009	0.006	0.005	0.005
	(0.028)	(0.027)	(0.028)	(0.027)
Tenure (# terms)	-0.182	-0.202	-0.193	-0.203
	(0.127)	(0.129)	(0.133)	(0.130)
Close election	0.137***	0.136***	0.138***	0.136***
	(0.036)	(0.034)	(0.035)	(0.034)
State presidential margin	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.121	-0.116	-0.116	-0.115
	(0.185)	(0.195)	(0.191)	(0.196)
Log population	-0.047	-0.058	-0.043	-0.056
	(0.271)	(0.278)	(0.275)	(0.279)
Constant	14.079***	14.427***	14.294***	14.459***
	(1.572)	(1.619)	(1.617)	(1.621)
Adj. R^2	0.220	0.221	0.220	0.221
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Party unity score* is the percentage of votes in which at least 50% of Democrats vote against at least 50% of Republicans that a legislator voted with her party. This variable is also interacted with the dummy variable for a member's being in the majority party.
$^*p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.13: Absolute Distance & Rank from Median - CVP

	(1)	(2)	(3)	(4)	(5)	(6)
Distance (CVP) from median	-0.164*	-0.352	-0.347			
	(0.087)	(0.260)	(0.239)			
Rank (CVP) from median (/100)				-0.025*	-0.054	-0.050
				(0.013)	(0.035)	(0.033)
Majority party		-0.062	-0.062		-0.068	-0.062
		(0.072)	(0.067)		(0.065)	(0.061)
President's party		0.032	0.034		0.038	0.040
		(0.036)	(0.033)		(0.039)	(0.035)
Committee chair		0.039	0.006		0.038	0.006
		(0.089)	(0.088)		(0.086)	(0.086)
Ranking minority member		-0.013	-0.030		-0.016	-0.032
		(0.074)	(0.066)		(0.071)	(0.065)
Party leader		0.094	0.012		0.102	0.020
		(0.091)	(0.085)		(0.091)	(0.084)
First term		0.013	-0.002		0.014	-0.000
		(0.027)	(0.024)		(0.027)	(0.024)
Tenure (# terms)		-0.169	-0.205		-0.171	-0.208
		(0.119)	(0.136)		(0.122)	(0.138)
Close election		0.133***	0.133***		0.129***	0.129***
		(0.035)	(0.032)		(0.035)	(0.033)
State presidential margin		0.004*	0.004*		0.004*	0.004*
		(0.002)	(0.002)		(0.002)	(0.002)
Log income	-0.093	-0.128	-0.130	-0.091	-0.122	-0.126
	(0.174)	(0.187)	(0.176)	(0.173)	(0.187)	(0.176)
Log population	-0.063	-0.045	-0.027	-0.065	-0.049	-0.030
	(0.277)	(0.277)	(0.263)	(0.277)	(0.277)	(0.264)
Constant	14.588***	14.597***	14.448***	14.597***	14.617***	14.474***
	(1.640)	(1.673)	(1.528)	(1.639)	(1.662)	(1.519)
Committee dummies	No	No	Yes	No	No	Yes
Adj. R^2	0.218	0.220	0.221	0.218	0.220	0.221
N	71167	71167	71167	71167	71167	71167

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Distance (CVP) from median* is the absolute value of legislators' Conservative Vote Probabilities (CVP scores), which are already median-centered. *Rank (CVP) from median (/100)* is the rank ordering of the *Distance (CVP) from median* variable, divided by 100 for scaling purposes; the higher the rank, the farther a legislator is ideologically from the median.

$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.14: Unified Government

	(1)	(2)	(3)	(4)
Unified government	4.538***	4.786***	4.936***	4.900***
	(1.593)	(1.659)	(1.676)	(1.650)
Unif. gov't x majority	0.015	-0.129	-0.214**	-0.024
	(0.047)	(0.096)	(0.099)	(0.152)
Absolute distance from median		-0.844**	-0.843**	-0.948**
		(0.392)	(0.385)	(0.389)
Unif. gov't x distance			-0.240	0.010
			(0.143)	(0.179)
Absolute distance x majority				0.418*
				(0.249)
Unif. gov't x maj'ty x distance				-0.508*
				(0.285)
Majority party	0.037	-0.187**	-0.189**	-0.303**
	(0.033)	(0.087)	(0.087)	(0.133)
President's party	0.035	0.073	0.070	0.063
	(0.045)	(0.059)	(0.059)	(0.055)
Committee chair	0.044	0.038	0.039	0.039
	(0.090)	(0.085)	(0.084)	(0.085)
Ranking minority member	-0.000	-0.027	-0.029	-0.027
	(0.083)	(0.064)	(0.063)	(0.062)
Party leader	0.091	0.088	0.094	0.095
	(0.086)	(0.088)	(0.087)	(0.084)
First term	0.015	0.008	0.009	0.012
	(0.027)	(0.028)	(0.027)	(0.027)
Tenure (# terms)	-0.167	-0.182	-0.183	-0.191
	(0.119)	(0.125)	(0.125)	(0.123)
Close election	0.135***	0.133***	0.129***	0.130***
	(0.036)	(0.034)	(0.034)	(0.034)
State presidential margin	0.004*	0.004*	0.004*	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.129	-0.117	-0.116	-0.119
	(0.183)	(0.191)	(0.191)	(0.192)
Log population	-0.049	-0.048	-0.044	-0.052
	(0.275)	(0.280)	(0.279)	(0.284)
Constant	14.517***	14.757***	14.698***	14.863***
	(1.660)	(1.676)	(1.670)	(1.721)
Adj. R^2	0.220	0.220	0.220	0.221
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Unified government* denotes years in which the House and Senate majorities were both of the same party as the president. All models include a variable interacting *Unified government* with the dummy variable for majority status. Model 2 reintroduces *Absolute distance*, model 3 interacts *Unified government Absolute distance*, and model 4 fully saturates the regression by interacting all terms with the dummy variable for majority status.

$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.15: Polarization

	(1)	(2)	(3)	(4)
Polar index x majority	-0.037	-0.386	-0.962	-0.277
	(0.511)	(0.596)	(0.769)	(1.408)
Absolute distance from median		-0.659*	0.536	-0.338
		(0.334)	(1.263)	(1.442)
Polar index x distance			-1.511	-0.499
			(1.534)	(1.869)
Absolute distance x majority				2.033
				(2.241)
Polar index x maj'ty x distance				-2.253
				(2.921)
Majority party	0.073	0.127	0.583	-0.027
	(0.406)	(0.423)	(0.575)	(1.048)
President's party	0.042	0.036	0.037	0.036
	(0.044)	(0.042)	(0.043)	(0.043)
Committee chair	0.044	0.044	0.048	0.047
	(0.090)	(0.089)	(0.088)	(0.088)
Ranking minority member	-0.000	-0.016	-0.010	-0.009
	(0.084)	(0.069)	(0.068)	(0.067)
Party leader	0.091	0.089	0.097	0.098
	(0.086)	(0.090)	(0.090)	(0.086)
First term	0.015	0.010	0.008	0.011
	(0.027)	(0.028)	(0.028)	(0.028)
Tenure (# terms)	-0.167	-0.181	-0.183	-0.188
	(0.119)	(0.126)	(0.125)	(0.126)
Close election	0.134***	0.135***	0.135***	0.135***
	(0.036)	(0.036)	(0.035)	(0.035)
State presidential margin	0.004*	0.004*	0.004*	0.005*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.128	-0.116	-0.113	-0.116
	(0.184)	(0.191)	(0.190)	(0.191)
Log population	-0.050	-0.058	-0.049	-0.063
	(0.274)	(0.283)	(0.283)	(0.288)
Constant	14.513***	14.756***	14.519***	14.797***
	(1.654)	(1.683)	(1.645)	(1.660)
Adj. R^2	0.220	0.220	0.220	0.220
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Polar index* denotes the Polarization Index for the U.S. House as defined by McCarty, Poole & Rosenthal (2006): the difference between the mean of Republicans' NOMINATE scores and the mean of Democrats' NOMINATE scores in a given congress. We cannot separately identify the effect of this variable from the year fixed effects, so we omit it in the models. However, all models include a variable interacting *Polar index* with the dummy variable for majority status. Model 2 reintroduces *Absolute distance*, model 3 interacts *Polar index* and *Absolute distance*, and model 4 fully saturates the regression by interacting all terms with the dummy variable for majority status.
$^*p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.16: Majority Members on Far Side of Median

	(1)	(2)	(3)	(4)
Maj on far side of median	-0.134	-0.089	-0.003	0.009
	(0.094)	(0.067)	(0.049)	(0.048)
Maj far side of med X abs dist			-2.654**	-2.613**
			(1.037)	(1.010)
Absolute distance from median		-0.466**	0.083	0.015
		(0.225)	(0.248)	(0.231)
Absolute distance x majority				0.172
				(0.228)
Majority party	0.057*	-0.105	0.089	0.035
	(0.031)	(0.068)	(0.105)	(0.100)
President's party	0.043	0.033	0.042	0.041
	(0.041)	(0.038)	(0.042)	(0.041)
Committee chair	0.044	0.043	0.039	0.038
	(0.091)	(0.089)	(0.084)	(0.083)
Ranking minority member	-0.008	-0.019	-0.031	-0.031
	(0.074)	(0.067)	(0.062)	(0.061)
Party leader	0.086	0.085	0.087	0.086
	(0.085)	(0.088)	(0.084)	(0.084)
First term	0.015	0.012	0.011	0.011
	(0.027)	(0.027)	(0.028)	(0.028)
Tenure (# terms)	-0.188	-0.189	-0.188	-0.191
	(0.129)	(0.130)	(0.129)	(0.129)
Close election	0.132***	0.133***	0.126***	0.127***
	(0.035)	(0.035)	(0.035)	(0.034)
State presidential margin	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.121	-0.119	-0.106	-0.107
	(0.186)	(0.190)	(0.193)	(0.193)
Log population	-0.053	-0.049	-0.069	-0.075
	(0.277)	(0.279)	(0.283)	(0.287)
Constant	14.452***	14.635***	14.395***	14.496***
	(1.597)	(1.651)	(1.571)	(1.612)
Adj. R^2	0.220	0.220	0.221	0.221
N	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Maj on far side of median* is a dummy variable equal to one if a legislator is a member of the majority party but has an estimated ideal point in the first dimension of DW-NOMINATE Common Space scores that is on the far side of the median ideal point from the majority of the majority party. This variable is interacted in models 3 and 4 with *Absolute distance.*
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.17: Absolute Distance & Rank from Median - All Grants

	(1)	(2)	(3)	(4)	(5)	(6)
Absolute distance from median	-0.084***	-0.321**	-0.322**			
	(0.030)	(0.133)	(0.122)			
Absolute rank from median (/100)				-0.014**	-0.050*	-0.054**
				(0.005)	(0.028)	(0.026)
Majority party		-0.085*	-0.085**		-0.071	-0.079
		(0.044)	(0.040)		(0.052)	(0.047)
President's party		0.004	0.000		0.010	0.006
		(0.008)	(0.008)		(0.009)	(0.009)
Committee chair		0.038*	0.031		0.037*	0.031
		(0.020)	(0.020)		(0.019)	(0.019)
Ranking minority member		0.003	-0.003		0.004	-0.003
		(0.023)	(0.022)		(0.023)	(0.023)
Party leader		0.073*	0.055		0.071	0.053
		(0.043)	(0.042)		(0.043)	(0.042)
First term		-0.011	-0.013		-0.011	-0.012
		(0.012)	(0.011)		(0.012)	(0.010)
Tenure (# terms)		-0.039	-0.046*		-0.038	-0.045*
		(0.030)	(0.027)		(0.030)	(0.026)
Close election		0.042***	0.047***		0.042***	0.047***
		(0.010)	(0.012)		(0.010)	(0.011)
State presidential margin		0.003***	0.003***		0.003***	0.003***
		(0.001)	(0.001)		(0.001)	(0.001)
Log income	0.028	0.008	0.012	0.028	0.011	0.015
	(0.059)	(0.059)	(0.060)	(0.059)	(0.059)	(0.059)
Log population	0.193**	0.209**	0.194**	0.193**	0.208**	0.193**
	(0.091)	(0.086)	(0.082)	(0.091)	(0.085)	(0.082)
Constant	12.361***	12.481***	12.580***	12.354***	12.457***	12.571***
	(0.671)	(0.649)	(0.571)	(0.672)	(0.654)	(0.572)
Committee dummies	No	No	Yes	No	No	Yes
Adj. R^2	0.672	0.674	0.674	0.672	0.673	0.674
N	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of *all* grants in the Consolidated Federal Funds Reports' grants category received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. *Absolute rank from median (/100)* is the rank ordering of the *Absolute distance from median* variable divided by 100 for scaling purposes; the higher the rank, the farther a legislator is ideologically from the median.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.18: Including Multi-Member Counties

	(1) All	(2) Min dist	(3) Max dist	(4) Max share
Absolute distance from median	-0.478*	-0.605**	-0.496	-0.589**
	(0.257)	(0.259)	(0.319)	(0.272)
Majority party	-0.127	-0.161**	-0.129	-0.160*
	(0.079)	(0.076)	(0.100)	(0.083)
President's party	0.009	0.026	0.016	0.013
	(0.027)	(0.033)	(0.031)	(0.031)
Committee chair	0.024	0.032	0.029	0.027
	(0.064)	(0.074)	(0.080)	(0.077)
Ranking minority member	-0.022	-0.016	-0.022	-0.023
	(0.057)	(0.063)	(0.064)	(0.062)
Party leader	0.116	0.101	0.097	0.117
	(0.071)	(0.079)	(0.086)	(0.098)
First term	0.004	0.007	0.002	0.004
	(0.022)	(0.026)	(0.025)	(0.025)
Tenure (# terms)	-0.127*	-0.187	-0.110	-0.152
	(0.073)	(0.117)	(0.080)	(0.098)
Close election	0.110***	0.125***	0.120***	0.124***
	(0.029)	(0.033)	(0.034)	(0.032)
State presidential margin	0.003*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)
Log income	-0.074	-0.105	-0.107	-0.099
	(0.159)	(0.178)	(0.174)	(0.177)
Log population	-0.013	-0.059	-0.033	-0.032
	(0.235)	(0.262)	(0.250)	(0.260)
Constant	14.610***	14.979***	14.797***	14.709***
	(1.643)	(1.625)	(1.653)	(1.661)
Adj. R^2	0.244	0.229	0.227	0.230
N	96399	81587	81546	81835

Notes: Standard errors clustered by state. Year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores.
The first model includes all representatives of a county as an observation, multiply counting counties when necessary (highly-populated counties). This model still utilizes county-by-member fixed effects.
The second and third models take the representative of each county with the minimum and maximum distance to the median, respectively, as the unique entry for that county. The fourth model takes the representative of each county whose district covered the greatest share of the county's population. These models also utilize county-by-member fixed effects. Small differences in the sample size across these latter three models reflect occasional missing data among control variables for the different representatives assigned to counties across these models.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.19: Splitting up the Sample by Quartiles of Population

	(1)	(2)
Absolute distance from median x first population quartile	-0.718*	-0.773*
	(0.387)	(0.394)
Absolute distance from median x second population quartile	-0.522*	-0.476
	(0.300)	(0.295)
Absolute distance from median x third population quartile	-0.592**	-0.583**
	(0.274)	(0.266)
Absolute distance from median x fourth population quartile	-0.571**	-0.541**
	(0.241)	(0.247)
Second Quartile		-0.195**
		(0.081)
Third Quartile		-0.231*
		(0.124)
Fourth Quartile		-0.296**
		(0.131)
Majority party	-0.161*	-0.159*
	(0.091)	(0.091)
President's party	0.029	0.029
	(0.037)	(0.037)
Committee chair	0.040	0.038
	(0.087)	(0.087)
Ranking minority member	-0.019	-0.021
	(0.067)	(0.066)
Party leader	0.088	0.085
	(0.090)	(0.090)
First term	0.010	0.010
	(0.028)	(0.028)
Tenure (# terms)	-0.177	-0.175
	(0.125)	(0.124)
Close election	0.135***	0.135***
	(0.036)	(0.036)
State presidential margin	0.004*	0.004*
	(0.002)	(0.002)
Log income	-0.120	-0.115
	(0.188)	(0.189)
Log population	-0.053	-0.002
	(0.284)	(0.284)
Constant	14.770***	14.370***
	(1.739)	(1.741)
Adj. R^2	0.220	0.220
N	71199	71199

Notes: Standard errors clustered by state. County-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores.
The first model includes interactions between *Absolute distance* and dummy variables for each quartile of population in our baseline sample. The second model adds memberships in given quartiles as standalone variables.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.20: Additional Summary Statistics at the District Level

Variable	Obs	Mean	Std. Dev.	Min	Max
Absolute distance from median	10184	.369	.222	0	1.19
Majority party	10184	.56	.496	0	1
President's party	10184	.471	.499	0	1
Committee chair	10184	.049	.215	0	1
Ranking minority member	10184	.047	.212	0	1
Party leader	10184	.007	.086	0	1
First term	10184	.136	.343	0	1
Tenure (# terms)	10184	5.422	4.014	1	28
Close election	10184	.066	.249	0	1
State presidential margin	10184	12.932	8.932	0	55.94
FAADS Grants (no formula - B,P,CA) (ln)	10184	17.842	1.475	9.411	22.535
FAADS Grants (all - B,P,CA,F) (ln)	10184	19.428	1.21	16.217	23.644

Notes: Absolute distance from median is the absolute value of median-centered ideal point estimates in DW-NOMINATE Common Space scores. *Majority party* is a dummy variable equal to 1 if a legislator is in the majority party. *President's party* is a dummy variable equal to 1 if a legislator shares the same party as the sitting president. *Committee chair* is a dummy variable equal to 1 if a legislator is the chair of any standing House committee. *Ranking minority member* is a dummy variable equal to 1 if a legislator is the ranking minority member on any standing House committee. *Party leader* is a dummy variable equal to 1 if a legislator has a party leadership role. *First term* is a dummy variable equal to 1 for a legislator's first term in Congress. *Tenure (# terms)* counts the number of Congresses in which a legislator has served. *Close election* is a dummy variable equal to 1 if the margin of victory in the previous congressional election was 5% or less. *State presidential margin* is absolute value of the state-wide vote margin in the previous presidential election. *FAADS Grants (no formula - B,P,CA)(ln)* is the log value of nonformula grants (block grants (B), project grants (P), and cooperative agreements (CA)) received by a given district in a given year, as measured in the Federal Assistance Award Data System. *FAADS Grants (all - B,P,CA,F)(ln)* adds formula grants (F) to the preceding measure of outlays. The sample is restricted to include only those observations present in the estimation of model 1 of Table 3.21.

Table 3.21: District-Level Analysis - No Formula

	Full Sample			County-Analysis Sample Only		
	(1) CQ	(2) 100%	(3) 80%	(4) CQ	(5) 100%	(6) 80%
Absolute distance from median	0.017	0.153	0.207	0.028	0.196	0.263
	(0.251)	(0.271)	(0.270)	(0.363)	(0.436)	(0.425)
Majority party	0.019	0.066	0.085	0.030	0.082	0.106
	(0.104)	(0.109)	(0.110)	(0.148)	(0.170)	(0.167)
President's party	-0.008	-0.002	0.002	-0.034*	-0.026	-0.022
	(0.010)	(0.015)	(0.017)	(0.018)	(0.027)	(0.029)
Committee chair	-0.058	-0.047	-0.041	-0.055	-0.031	-0.004
	(0.054)	(0.056)	(0.056)	(0.090)	(0.100)	(0.102)
Ranking minority member	-0.019	-0.019	-0.018	-0.050	-0.056	-0.043
	(0.050)	(0.045)	(0.044)	(0.053)	(0.051)	(0.049)
Party leader	0.047	0.128	0.126	-0.093	-0.088	-0.053
	(0.141)	(0.157)	(0.151)	(0.118)	(0.117)	(0.129)
First term	-0.039	-0.031	-0.033	0.022	0.044	0.045
	(0.030)	(0.030)	(0.028)	(0.033)	(0.036)	(0.035)
Tenure (# terms)	-0.080	-0.080	-0.080	-0.203	-0.208	-0.200
	(0.128)	(0.124)	(0.124)	(0.143)	(0.144)	(0.147)
Close election	0.042	0.037	0.029	0.057	0.044	0.035
	(0.033)	(0.037)	(0.038)	(0.036)	(0.049)	(0.050)
State presidential margin	0.000	0.000	0.000	0.003**	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	16.482***	16.379***	16.328***	16.263***	16.188***	16.120***
	(0.221)	(0.216)	(0.211)	(0.263)	(0.285)	(0.276)
Adj. R^2	0.511	0.450	0.467	0.553	0.468	0.490
N	10184	10759	11090	5204	5456	5651

Notes: Standard errors clustered by state. District-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given district in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. The column heads speak to redistricting, where the district-by-member fixed effects must be reset in each new redistricting period and the data on outlays from the first year after redistricting goes into effect must be excluded from the analysis. *CQ* takes Congressional Quarterly's designation of redistricting, where redistricting of any districts in a state is counted as redistricting of all districts in that state. *100* uses a requirement that 100% of a district's population be carried over for a district to be considered comparable across the redistricting. *80* uses a requirement that 80% of a district's population be carried over across the redistricting to be considered the same district. Models 1-3 consider the full remaining sample (i.e., all years other than those after redistricting), while models 4-6 analyze only those districts that appeared in the county-level analysis after counties represented by more than one congressperson were dropped. The second three columns serve to verify that the county-level results were not driven by the exclusion of densely populated areas from the sample.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.22: District-Level Analysis - All Grants

	Full Sample			County-Analysis Sample Only		
	(1) CQ	(2) 100%	(3) 80%	(4) CQ	(5) 100%	(6) 80%
Absolute distance from median	-0.089	-0.004	-0.009	-0.020	0.119	0.084
	(0.151)	(0.181)	(0.170)	(0.195)	(0.267)	(0.242)
Majority party	-0.009	0.021	0.019	0.016	0.063	0.050
	(0.058)	(0.066)	(0.062)	(0.080)	(0.101)	(0.093)
President's party	0.006	0.006	0.000	-0.003	-0.004	-0.010
	(0.007)	(0.010)	(0.009)	(0.009)	(0.015)	(0.013)
Committee chair	-0.019	-0.023	-0.018	-0.021	-0.021	-0.012
	(0.022)	(0.023)	(0.023)	(0.026)	(0.042)	(0.043)
Ranking minority member	-0.007	-0.007	-0.009	-0.008	-0.014	-0.014
	(0.022)	(0.020)	(0.020)	(0.027)	(0.026)	(0.026)
Party leader	-0.069	-0.026	-0.036	-0.121*	-0.121*	-0.108
	(0.062)	(0.065)	(0.061)	(0.065)	(0.064)	(0.068)
First term	-0.028**	-0.020	-0.021	-0.010	0.011	0.008
	(0.011)	(0.014)	(0.014)	(0.019)	(0.025)	(0.024)
Tenure (# terms)	-0.049	-0.040	-0.039	-0.130***	-0.138***	-0.135***
	(0.039)	(0.036)	(0.038)	(0.040)	(0.041)	(0.044)
Close election	0.027	0.012	0.007	0.022	-0.001	-0.007
	(0.017)	(0.029)	(0.029)	(0.019)	(0.044)	(0.045)
State presidential margin	-0.001	-0.001	-0.001	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	17.996***	17.980***	17.945***	17.810***	17.756***	17.723***
	(0.118)	(0.131)	(0.124)	(0.143)	(0.174)	(0.160)
Adj. R^2	0.734	0.561	0.586	0.765	0.598	0.624
N	10189	10767	11099	5206	5458	5654

Notes: Standard errors clustered by state. District-by-member and year fixed effects used in all models. The dependent variable is the log value of *all* grants in the Consolidated Federal Funds Reports' grants category received by a given district in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Absolute distance from median* is the absolute value of the median-centered first dimension of the DW-NOMINATE Common Space scores. The column heads speak to redistricting, where the district-by-member fixed effects must be reset in each new redistricting period and the data on outlays from the first year after redistricting goes into effect must be excluded from the analysis. *CQ* takes Congressional Quarterly's designation of redistricting, where redistricting of any districts in a state is counted as redistricting of all districts in that state. *100* uses a requirement that 100% of a district's population be carried over for a district to be considered comparable across the redistricting. *80* uses a requirement that 80% of a district's population be carried over across the redistricting to be considered the same district. Models 1-3 consider the full remaining sample (i.e., all years other than those after redistricting), while models 4-6 analyze only those districts that appeared in the county-level analysis after counties represented by more than one congressperson were dropped. The second three columns serve to verify that the county-level results were not driven by the exclusion of densely populated areas from the sample.

$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.23: District-Level Analysis - No Formula - CVP

	Full Sample			County-Analysis Sample Only		
	(1) CQ	(2) 100%	(3) 80%	(4) CQ	(5) 100%	(6) 80%
Distance (CVP) from median	-0.263*	-0.206	-0.201	-0.207	-0.170	-0.166
	(0.142)	(0.149)	(0.139)	(0.197)	(0.204)	(0.185)
Majority party	-0.079	-0.061	-0.060	-0.050	-0.046	-0.045
	(0.055)	(0.058)	(0.054)	(0.073)	(0.076)	(0.070)
President's party	-0.005	0.001	0.007	-0.031*	-0.023	-0.018
	(0.010)	(0.015)	(0.016)	(0.018)	(0.028)	(0.029)
Committee chair	-0.058	-0.046	-0.039	-0.056	-0.029	-0.001
	(0.056)	(0.057)	(0.057)	(0.091)	(0.102)	(0.103)
Ranking minority member	-0.019	-0.020	-0.018	-0.053	-0.059	-0.046
	(0.050)	(0.045)	(0.044)	(0.054)	(0.051)	(0.049)
Party leader	0.057	0.134	0.135	-0.080	-0.076	-0.039
	(0.141)	(0.154)	(0.150)	(0.125)	(0.124)	(0.137)
First term	-0.042	-0.035	-0.037	0.019	0.040	0.041
	(0.030)	(0.030)	(0.029)	(0.033)	(0.036)	(0.035)
Tenure (# terms)	-0.074	-0.073	-0.074	-0.197	-0.203	-0.196
	(0.132)	(0.129)	(0.130)	(0.146)	(0.148)	(0.151)
Close election	0.041	0.037	0.030	0.056	0.044	0.036
	(0.033)	(0.037)	(0.038)	(0.036)	(0.048)	(0.050)
State presidential margin	0.000	0.000	0.000	0.003**	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	16.601***	16.550***	16.527***	16.359***	16.357***	16.322***
	(0.142)	(0.140)	(0.138)	(0.168)	(0.175)	(0.166)
Adj. R^2	0.512	0.450	0.467	0.553	0.468	0.490
N	10182	10757	11088	5202	5454	5649

Notes: Standard errors clustered by state. District-by-member and year fixed effects used in all models. The dependent variable is the log value of nonformula grants received by a given district in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year. *Distance (CVP) from median* is the absolute value of legislators' Conservative Vote Probabilities (CVP scores), which are already median-centered. The column heads speak to redistricting, where the district-by-member fixed effects must be reset in each new redistricting period and the data on outlays from the first year after redistricting goes into effect must be excluded from the analysis. *CQ* takes Congressional Quarterly's designation of redistricting, where redistricting of any districts in a state is counted as redistricting of all districts in that state. *100* uses a requirement that 100% of a district's population be carried over for a district to be considered comparable across the redistricting. *80* uses a requirement that 80% of a district's population be carried over across the redistricting to be considered the same district. Models 1-3 consider the full remaining sample (i.e., all years other than those after redistricting), while models 4-6 analyze only those districts that appeared in the county-level analysis after counties represented by more than one congressperson were dropped. The second three columns serve to verify that the county-level results were not driven by the exclusion of densely populated areas from the sample.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

Table 3.24: Imposing Redistricting on Counties

	(1)	(2)	(3)	(4)	(5)	(6)
Absolute distance from median	-0.143*	-0.000	-0.051			
	(0.075)	(0.222)	(0.202)			
Absolute rank from median (/100)				-0.029**	-0.076**	-0.083**
				(0.013)	(0.035)	(0.033)
Majority party		0.048	0.025		-0.103	-0.121*
		(0.082)	(0.071)		(0.079)	(0.072)
President's party		0.029	0.029		0.038	0.037
		(0.042)	(0.040)		(0.040)	(0.038)
Committee chair		0.135	0.116		0.132	0.113
		(0.107)	(0.105)		(0.105)	(0.103)
Ranking minority member		0.113	0.099		0.103	0.090
		(0.084)	(0.083)		(0.081)	(0.081)
Party leader		-0.052	-0.092		-0.051	-0.089
		(0.112)	(0.105)		(0.113)	(0.106)
First term		0.034	0.019		0.032	0.016
		(0.030)	(0.028)		(0.030)	(0.028)
Tenure (# terms)		-0.135**	-0.158**		-0.146***	-0.166**
		(0.051)	(0.071)		(0.053)	(0.072)
Close election		0.122***	0.119***		0.123***	0.121***
		(0.030)	(0.030)		(0.030)	(0.030)
State presidential margin		0.007***	0.007***		0.007***	0.007***
		(0.003)	(0.002)		(0.002)	(0.002)
Log income	-0.209	-0.241	-0.247	-0.208	-0.240	-0.247
	(0.213)	(0.217)	(0.207)	(0.213)	(0.218)	(0.207)
Log population	-0.063	-0.145	-0.149	-0.065	-0.138	-0.142
	(0.480)	(0.464)	(0.463)	(0.481)	(0.468)	(0.467)
Constant	17.303***	18.839***	19.141***	17.310***	18.956***	19.329***
	(2.944)	(2.746)	(2.821)	(2.942)	(2.694)	(2.787)
Committee dummies	No	No	Yes	No	No	Yes
Adj. R^2	0.209	0.211	0.211	0.209	0.211	0.212
N	71199	71199	71199	71199	71199	71199

Notes: Standard errors clustered by state. Year fixed effects used in all models. We impose "redistricting" on the estimation by interacting county-by-member fixed effects with dummy variables representing the periods 1983-1992, 1993-2002, and 2002-2009. The county-by-member fixed effects are then "redistricting-specific." The dependent variable is the log value of nonformula grants received by a given county in a given year. The outlays data span fiscal years 1984-2010 and are matched with explanatory variables from the previous calendar year.
$^{*}p \leq 0.10$ $^{**}p \leq 0.05$ $^{***}p \leq 0.01$

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