

Congressional Bargaining and the Distribution of Grants

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Abstract

In the United States, state and local governments receive over \$700 billion annually in federal grants, yet relatively little is known about how Congress designs these programs. I formalize a theory of congressional bargaining over grants and test the theory using an original dataset of Senate amendments. The results suggest that congressional rules and political considerations shape, and at times distort, federal grant programs. While grant programs may be intended to improve education or provide healthcare, I find that members of Congress treat these programs as opportunities to procure more funding for their constituents. Further, I show how coalitions are shaped by the status quo policy and the distribution of population, poverty, and other measures of need across states. These results have important implications for our understanding of the policymaking process and the effectiveness of federal programs.

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1 Introduction

“The rich get richer and the poor get poorer under the politically devised formula for the distribution of this aid.”

— Representative Ashbrook (111 Cong. Rec. 4236)

In the United States, the federal government allocates over \$700 billion annually in grants to state and local governments. This type of federal funding, known as grants-in-aid, encompasses major programs such as Medicaid, the Title I-A education program, Temporary Assistance for Needy Families (TANF), Section 8 Housing Choice Vouchers, and the Community Development Block Grant (CDBG). Grants-in-aid account for nearly a quarter of all federal domestic spending and over half of state government funding for health care and public assistance (Dilger and Cecire 2019). However, legislators have criticized these programs for allocating money based on political reasons as opposed to need.¹ And, in line with these criticisms, some programs are not responsive to changes in population (Larcinese, Rizzo, and Testa 2013a; Szymendera 2008) and provide more per capita funding to small states (Lee 2000) and to areas with lower economic need (Hall 2010).

How do political factors shape, and at times distort, the distribution of federal assistance? Existing theories highlight the role that congressional rules and political considerations play in the distribution of federal funding. The divide-the-dollar game by Baron and Ferejohn (1989) and its generalization by Banks and Duggan (2006) show that legislators with proposal or agenda setting power receive a disproportionate share of funding. Further, funds are only distributed to legislators that vote for the proposal (the winning coalition). And, when proposals are brought up under a closed rule, the size of the winning coalition is minimal (i.e., proposals pass by a bare majority). Others have expanded this model to examine the effect of endogenous status quo policies (Kalandrakis 2004), a unanimous voting rule and heterogeneous discount rates (Anesi and Seidmann

¹See, for example, the debates surrounding Title I-A of the Elementary and Secondary Education Act as summarized by Skinner and Rosenstiel (2017).

2015), persistent agenda setters (Diermeier and Fong 2011), endogenous procedural rules (Duggan and Kalandrakis 2012), and veto players (Nunnari 2018).²

However, the Baron and Ferejohn model and nearly all of its extensions allow for any distribution of the dollar, which does not reflect how a substantial portion of the federal budget is allocated. While grants-in-aid account for the majority of federal assistance, most theories about the allocation of funds focus on earmarks or “pork barrel” spending. Unlike earmarks, which allocate funding to specific places for one-off projects, grants-in-aid are primarily distributed based on statutory formulas that persist for many years. With one notable exception (Martin 2018), theories have not considered how this zero-sum bargaining process is altered when legislators must distribute funding via a formula based on observable state characteristics.

To address this gap in the literature, I formalize a theory of congressional bargaining over allocation formulas for grants-in-aid, and provide empirical evidence consistent with the theory. The model presented in this paper is most closely related to framework developed by Martin (2018). Martin extends the Baron and Ferejohn model to grant allocation formulas, focusing on how the number of formula dimensions structures legislative bargaining. Martin shows that when bargaining over a low-dimensional formula (i.e., a formula based on a small number of state characteristics), legislators have relatively little latitude in targeting funds to specific districts.³ This paper examines a fixed number of formula dimensions, exploring what it means for the specifics of coalitional composition and size and the direction of change. Unlike Martin, the paper also incorporates a status quo policy into the model.

Considering majoritarian rules, the status quo policy, and the structure of formulas together yields new predictions about how the congressional bargaining process influences policy and who benefits from federal programs. As in other bargaining models,

²For a more detailed discussion of extensions to the Baron and Ferejohn (1989) model, see Eraslan and Evdokimov (2019).

³Unlike the Baron and Ferejohn game, Martin’s theory predicts oversized winning coalitions, positive distributions outside of the winning coalition, and stable voting blocs.

the legislator with proposal power is able to direct additional benefits to her state and legislators whose states do poorly under the status quo policy are “cheaper” to include in coalitions. However, because formulas allocate funding based on state characteristics, states with similar characteristics fare similarly under the same program. Thus, states with similar characteristics to the proposer’s state also benefit. As a result, legislators representing states with similar characteristics to the proposer’s state are also cheaper to include in the winning coalition. Additionally, the theory provides a new explanation for two patterns in the distribution of grants: larger states and states with fast-growing populations receive less grant funding per capita (Lee 2000; Larcinese, Rizzo, and Testa 2013a, 2013b). The theory demonstrates how majoritarian rules, Senate representation, and the distribution of population, poverty, and other measures of need can result in these patterns. Finally, considering majority rule, the status quo policy, and the structure of formulas together yields new predictions about the size of coalitions. Specifically, I present a sufficient condition for non-minimal-winning coalitions based on a combination of state demographic characteristics and the status quo policy.

Using an original dataset of Senate amendments, I find strong support for the theory. I use a within-state design to examine which states are included in the winning coalition. Consistent with theoretical predictions, I find that states receiving less funding under the status quo and that have similar demographic characteristics to the proposer’s state are more likely to be included in the winning coalition when grant programs are amended.

These results have important implications for our understanding of the policymaking process and the effectiveness of federal programs. These findings demonstrate how majority and supermajority rules can distort the distribution of federal aid. Majoritarian rules require legislators to create coalitions to enact their proposals. I show how, in many cases, the legislators who get included in these coalitions are not those representing areas with high need. As a result, programs often do a poor job of distributing funding to areas with high need. These distortions in the distribution of federal funding can then create or exacerbate disparities in educational outcomes, access to healthcare, the availability of affordable housing, and the provision of other important services.

The remainder of the paper proceeds as follows. I begin by offering background on allocation formulas. I then present a theory of congressional bargaining over the distribution of grants. Next, I empirically test the theory by examining winning coalitions. Finally, I discuss the implications of the theory for how effectively grant programs allocate funding to areas with the highest need.

2 Grant Allocation Formulas

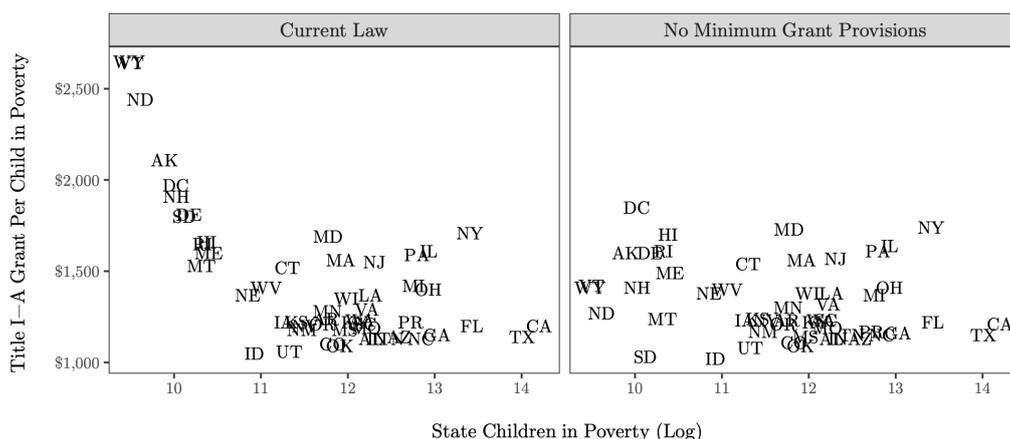
Legislators have the ability to direct grant funding to certain states and districts because, in many cases, Congress writes the grant allocation formula. These formulas generally allocate funds based on a set of observable attributes or formula factors. For example, a formula might specify that grants be allocated in proportion to population. A program targeting poverty might include a count of people living below the poverty line in a state. It may also include a factor related to a state's tax base to capture a state's fiscal capacity.

Consider, for example, the Title I-A program in the Elementary and Secondary Education Act. The purpose of the Title I-A program is to provide “financial assistance to local educational agencies (LEAs) and schools with high numbers or high percentages of children from low-income families” (“Title I, Part A Program” 2015). Grants under Title I-A are primarily allocated in proportion to the number of children in families living in poverty multiplied by state education expenditures. As a result, states with higher education spending receive more Title I-A funding. And, when reauthorizing the program, it is the relative weights on these factors that Congress bargains over. For example, while both factors have always been included in the Title I-A formula, legislators have reduced the weight placed on education expenditures over time (Skinner and Rosenstiel 2017).

Formulas often include minimum grant provisions, which provide each grantee with some minimum grant amount. These provisions can ensure that each grantee receives a specific dollar amount or percentage of available appropriations. Additionally, some minimum grant provisions (commonly referred to as “hold harmless provisions”) stipulate that each grantee receive a percentage of their grant amount from a prior year. Other

provisions, often referred to as “foundation grants” or “base guarantees,” allocate each grantee a set dollar amount and then distribute the remaining funds based on formula factors. The Title I-A program includes minimum grant provisions that guarantee each state a certain percentage of available appropriations and ensure no school district receives less than 85% of the funding it received in the prior year. One consequence of these minimum grant provisions is that smaller states receive more per capita funding than larger states. Figure 1 shows the Title I-A grant per child in poverty compared to the logged number of children in poverty in a given state under current law and if the formula contained no minimum grant provisions. Under current law, states with fewer children in poverty receive substantially more per child than states with higher numbers of children in poverty. When the minimum grant provisions are removed, this relationship goes away.

Figure 1: Title I-A Grant Amounts Per Child in Poverty (FY2016)



Source: Data from Skinner and Rosenstiel (2018)

Why does the Title I-A formula allocate funding based on poverty and education spending? And why does it include minimum grant provisions? While grants-in-aid account for a substantial portion of the federal budget and the majority of federal domestic assistance, they have received relatively little scholarly attention. Existing research suggests that legislators design grant programs to benefit their constituents (Martin 2018; Lee 2000). However, existing theories do not examine when and why certain factors are included in formulas.⁴ In this paper, I seek to answer these questions. In doing so, I also speak to the important question of when will Congress design formulas that target need?

⁴Lee (2000) argues that smaller states benefit from grants because the amount of

3 A Theory of Congressional Bargaining Over Grants

While grants-in-aid may be intended to improve education or provide healthcare, I argue that members of Congress treat these programs as opportunities to procure more funding for their constituents. I conceptualize grants-in-aid as a divide-the-dollar game where legislators bargain over the weights placed on state characteristics. That is, given a formula based on population and poverty, legislators decide the share of funding allocated based on population and the share of funding allocated based on poverty.

I first consider a one-period game in which a legislator proposes a formula and all legislators vote on the proposal. If the proposal is enacted, grants are allocated based on this new formula. If the proposal fails, grants are allocated based on the status quo policy. However, in practice, bargaining does not follow this take-it-or-leave-it structure. I therefore also consider an infinite horizon model where legislators bargain until agreement is reached and a new proposer is drawn in each period.

What formula gets enacted depends on which legislator has proposal power, the status quo formula, and the distribution of formula factors across states. The proposer is often able to modify formulas to bring additional funding to their states. However, due to the constraints imposed by bargaining over a formula, funding is distributed outside of the winning coalition. Which legislators are included in the winning coalition, and the size of that coalition, depends on the status quo policy and state characteristics. In particular, legislators are “cheaper” to include in the winning coalition when the states they represent are doing poorly under the status quo policy and have similar characteristics to the proposer’s state. And, in the repeated game, if the status quo is very favorable to the proposer then there are cases when delay can occur in equilibrium yet ultimately a new policy is passed.

funding needed, due to their population size, is small. However, I show that smaller states benefit because of the distribution of population across states. Moreover, my theory illustrates that minimum grant provisions are often the cheapest way to include smaller states in the winning coalition.

3.1 Model Setup

Let $N = \{1, \dots, n\}$ be a set of n legislators bargaining over how to allocate a budget. One of the legislators is endowed with proposal power. I denote this legislator with c .

Formula grants, unlike earmarks, are based on state characteristics. Additionally, formulas often include minimum grant provisions, which guarantee each grantee a minimum funding level. To incorporate this into the model, I allow legislators to bargain over weights placed on formula factors and the minimum grant amount. Each legislator i has two quantifiable attributes or formula factors, $x_i > 0$ and $z_i > 0$. For simplicity, x_i and z_i are measured in share. A legislator's allocation is a function of the weights placed on x and z , η and γ , as well as a fixed amount or minimum that each legislator receives, α :

$$y_i = \eta x_i + \gamma z_i + \alpha \frac{1}{n} \quad (1)$$

where $\eta, \gamma, \alpha \geq 0$.

For example, consider a formula based on population (x) and poverty (z) levels. If a state made up 10% of the total national population and had 25% of the national population living in poverty then $x_i = 0.1$ and $z_i = 0.25$. Further if $\eta = 0.5$, $\gamma = 0.5$, and $\alpha = 0$, then half of the funding would be based on population and the other half would be based on poverty. Under this formula, state i would receive 17.5% of the budget.⁵

What formula can be enacted is constrained by the funding level for the program. That is, legislators bargain over how to divide a budget among themselves but cannot increase the size of the budget. As in other zero-sum games, this budget constraint always binds in equilibrium. For simplicity, I fix the budget to 1. As a result, a legislator's grant amount y_i can be thought of as the share of available funding that her state receives. More formally, for an allocation $\mathbf{y} = (y_i)_{i=1}^n$ to be feasible, it must satisfy $\sum_{i=1}^n y_i \leq 1$. And because x_i and z_i are measured in share, then $\sum_{i=1}^n y_i \leq 1$ implies that $\eta + \gamma + \alpha \leq 1$.

⁵ $0.5 \times 0.10 + 0.5 \times 0.25 = 17.5\%$

I denote all feasible combinations of (η, γ, α) with χ where

$$\chi = \{\eta, \gamma, \alpha \in [0, 1] \mid \eta + \gamma + \alpha \leq 1\} \quad (2)$$

In practice, a formula typically remains in effect until it is amended. To incorporate this into the model, I include an exogenously determined status quo policy $(\eta_q, \gamma_q, \alpha_q) \in \chi$. This status quo remains in effect if no formula change is passed. During a program's initial enactment, the status quo formula is $(0, 0, 0)$. I denote legislator i 's grant allocated under the status quo policy with q_i .

The sequence of play is as follows. At the start of the game, one legislator makes a proposal $(\eta, \gamma, \alpha) \in \chi$ and the chamber floor then takes an up-or-down on the proposal. If a decisive coalition $W \subseteq N$ vote for the proposal, grants are allocated based on the new formula. If the proposal fails, the status quo policy remains in effect. Utilities are then realized and the game ends. A coalition is decisive if it contains at least m legislators where $1 < m < n$. This structure includes both majority and super-majority rules.

A player's utility is the allocation they receive from a formula. If a proposal (η, γ, α) is enacted, then the utility for legislator i is

$$u_i = \eta x_i + \gamma z_i + \alpha \frac{1}{n} \quad (3)$$

The largest grant amount a state can receive is equal to its largest formula factor. Let $f_i^1 > f_i^2 > f_i^3$ represent legislator i 's rank ordering of x_i , z_i , and $1/n$.⁶ When $f_i^1 = x_i$ (i.e., $x_i \geq z_i$ and $x_i \geq 1/n$) then the largest grant i can receive is x_i . And, this allocation occurs when $\eta = 1, \gamma = 0, \alpha = 0$. The intuition for this result is relatively straightforward: a legislator receives the largest grant when all of the weight is placed on her largest formula factor. I refer to legislators whose largest factor is x_i as legislators whose preferred weight is η . I refer to legislators whose largest factors are z_i and $1/n$ as legislators whose preferred weights are γ and α , respectively. Note that because x and

⁶For example, if $x_i > z_i > 1/n$ then $f_i^1 = x_i$, $f_i^2 = z_i$, and $f_i^3 = 1/n$.

z are measured as shares of the total, the mean of x is $1/n$ and the mean of z is $1/n$.⁷ Thus, when a formula is based on population (x) and poverty (z), a state with below average population and poverty levels prefers α . If a state has above average population and its population share is higher than its poverty share, the state prefers η . Otherwise, the state prefers γ .

3.2 Equilibrium Analysis

I focus on equilibria in which the proposer makes an acceptable allocation and no legislator uses a weakly dominated voting strategy. That is, the proposer proposes an allocation that defeats the status quo and legislators vote yes if and only if their utility from the proposal not passing is less than their utility from the proposal. These restrictions rule out uninteresting equilibria in which proposals are best responses solely because they would not pass and voting decisions are best responses solely because a single vote does not change the outcome.

The question for the proposer is which of the proposals that can pass the floor maximize her grant amount. A standard result of divide-the-dollar games is that the budget constraint always binds in equilibrium.⁸ Because of this, the proposer's grant is equal to the following:

$$y_c = 1 - \sum_{i \in N-c} y_i \quad (4)$$

Therefore, for the proposer to maximize her own grant she should minimize the grants to other legislators provided that a decisive coalition (at least $m - 1$ other legislators) would vote for the proposal. Let $A_i \subseteq \chi$ be the set of proposals that i would accept. As the alternative to a proposal is the status quo, all legislators accept any proposal that gives them at least their grant amount under the status quo. Thus the set of proposals

⁷ $\frac{\sum_{i=1}^n x_i}{n} = \frac{1}{n}$ because, by definition, $\sum_{i=1}^n x_i = 1$.

⁸I show this result for this model in Lemma 1 in the Appendix A.4.

acceptable to a given decisive coalition W is

$$A_W = \bigcap_{i \in W} A_i = \left\{ (\eta, \gamma, \alpha) \in \chi \mid \eta x_i + \gamma z_i + \frac{\alpha}{n} \geq q_i \ \forall i \in W \right\} \quad (5)$$

and the social acceptance set is the following set of all proposals that could pass:

$$A = \bigcup_{W \in \mathcal{D}} A_W \quad (6)$$

where \mathcal{D} is the set of all decisive coalitions. Thus, the proposer solves the following:

$$\begin{aligned} \min_{\eta, \gamma, \alpha} \sum_{j \in N-c} \eta x_j + \gamma z_j + \alpha \frac{1}{n} \\ \text{s.t. } (\eta, \gamma, \alpha) \in A \\ \text{s.t. } \eta + \gamma + \alpha = 1 \end{aligned} \quad (7)$$

In equilibrium, the proposer always weakly benefits when Congress considers revising a formula.⁹ If the proposer were to ever lose funding from a formula change, she would retain the status quo. And, in many cases the proposer is able to increase her grant amount. In particular, whenever the status quo policy does not allocate the entire budget, the proposer is always able to increase her grant amount. This is because, at the very least, the proposer can increase her most preferred weight, which strictly increases the grant amounts for all legislators. However, when the budget constraint does bind under the status quo, then, to increase her own grant amount, the proposer needs to decrease the grant amount for at least one other legislator. And, it is always possible for the proposer to do this when the proposer and $m-1$ other legislators are receiving less under the status quo than they would if all of the funding were allocated based on either their second-most preferred weight or the proposer's preferred weight. Proposition 1 summarizes this result.

Proposition 1. There exists a Nash equilibrium in which the proposer makes an acceptable proposal. Further, let g_i be the grant legislator i receives when the proposer sets her preferred weight to 1, G be the set of all legislators for whom $g_i \geq q_i$, and $|G|$ be the

⁹ $y_c \geq q_c$.

number of legislators in G . If (i) $\sum_{i \in N} q_i < 1$; (ii) $q_i < f_i^2$ for $m - 1$ legislators and the proposer; or (iii) $|G| \geq m$ and $q_i < g_c$ then there exists a Nash equilibrium in which a formula is enacted that increases the proposer's grant amount.

One implication of Proposition 1 is that when the status quo formula concentrates funding in just a few states, the proposer will generally be able to alter the formula to increase her grant amount. However, if the majority of states are doing well under the status quo, then the proposer may not be able to change the formula.

The underlying logic for this result is that when a legislator is not receiving her maximum grant amount then there is another formula in addition to the status quo formula that provides the legislator at least what she is receiving under the status quo. Thus, except in the case where the proposer is receiving her maximum grant under the status quo or when requirements (i), (ii), and (iii) are violated, it is always possible for the proposer to construct a formula that provides a $m - 1$ legislators at least what they were receiving under the status quo and increases her own grant.¹⁰

If possible the proposer sets her preferred weight to 1 as this provides her state its maximum grant amount. And, it is possible for the proposer to enact this formula when it provides $m - 1$ other states at least what they are receiving under the status quo formula. As a result, when the proposer sets her preferred weight to 1, there may be an oversized winning coalition. For example, if the proposer prefers η and at least $m - 1$ other legislators are receiving grants under the status quo less than or equal to x_i then the size of the winning coalition is equal to the number of states for which $q_i \leq x_i$. However, if the proposer is not able to set her preferred weight equal to 1 then any formula change has a winning coalition that is minimal sized. That is, under majority rule, the winning coalition is a bare majority. Corollary 1 states this result more formally.

Corollary 1. If $|G| \geq m$ then there exists a Nash equilibrium in which the winning coalition size is $|G|$. If $|G| < m$, then any formula change enacted in equilibrium has a minimal winning coalition.

¹⁰If the proposer is receiving her maximum grant under the status quo then she retains the status quo policy as this is already maximizing her utility.

Notice that if the proposer prefers the same weight as $m - 1$ other legislators then, in equilibrium, the proposer always sets her preferred weight to 1. Additionally, when the status quo formula is $(0, 0, 0)$, as would be the case when a program is initially enacted, then the proposer sets her preferred weight to 1.

There are, however, cases where there exists an equilibrium in which the proposer retains the status quo. For example, under majority rule, consider the case where a majority of legislators prefer α and the status quo policy is $(\eta_q, \gamma_q, \alpha_q) = (0, 0, 1)$. In this case all legislators are receiving grants equal to $1/n$, which is the maximum possible grant for the majority of legislators. Thus, any formula change would result in the majority of legislators losing funds. As a result, no matter which legislator is the proposer, no formula change is enacted in equilibrium.

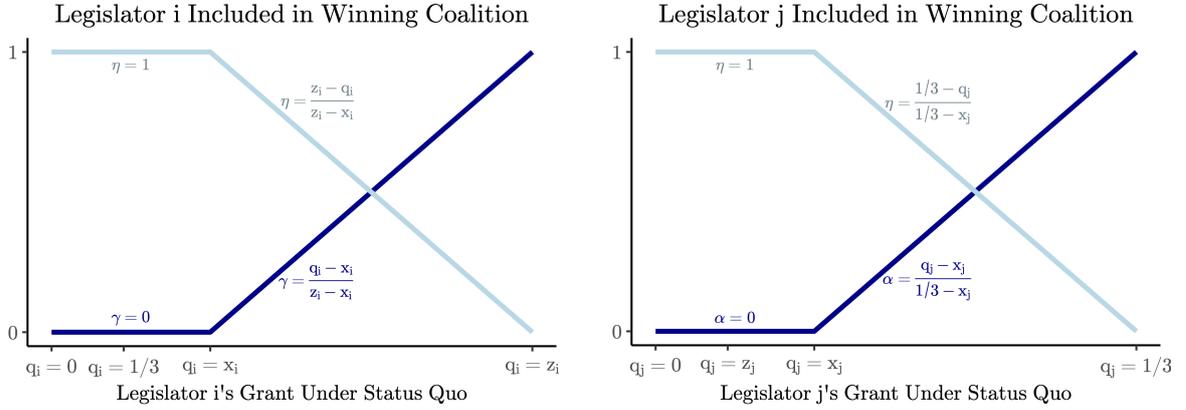
When proposing a formula, the proposer forms the cheapest winning coalition. As equation 7 indicates, the cheapest members of the winning coalition are those whose inclusion results in the smallest amount of funding being distributed to legislators other than the proposer. Specifically, legislators receiving smaller grants under the status quo policy and who share similar characteristics to the proposer are cheaper to include in the winning coalition. The intuition for the former is that the lower a legislator's grant under the status quo, the lower their reservation value. The intuition for the latter is that, because funding is allocated via formula, a legislator with similar x and z values to the proposer benefits from the same formulas as the proposer. For example, if the proposer and legislator i both have above average population but below average poverty, then they both benefit from a formula that puts all of the weight on population.

To illustrate what formula is enacted and which legislators are included in the winning coalition consider a case with three legislators c, i, j where $x_c > 1/3 > z_c$, $z_i > x_i > 1/3$, and $1/3 > x_j > z_j$. Thus, c prefers η , i prefer γ , and j prefers α . Further assume that $m = 2$ (i.e., majority rule). Thus, the proposer just needs one other legislator to weakly prefer the proposal to the status quo for it to pass.

Figure 2 shows what c would propose to include either i or j in the winning coalition, depending on the status quo policy. Notice that the smaller a legislator's grant is under

the status quo, the larger η is in proposer's proposed formula. And because the proposer prefers η , the smaller a legislator's grant is under the status quo, the larger the proposer's grant is under the proposal.

Figure 2: Proposals By Status Quo Grant



When deciding whether to include i or j in the winning coalition, c chooses whichever formula gives her state the larger grant amount. The solution to this is shown in Figure 3 below. Because η is smaller the larger a state's grant is under the status quo, when a state is receiving less under the status quo it is cheaper to include in the winning coalition.¹¹ Specifically, when $x_i \geq q_i$ then legislator i is included in the winning coalition. When $x_j \geq q_j$ then legislator j is included in the winning coalition. And, when both $q_i > x_i$ and $q_j > x_j$ then i is included in the winning coalition when the following is true:

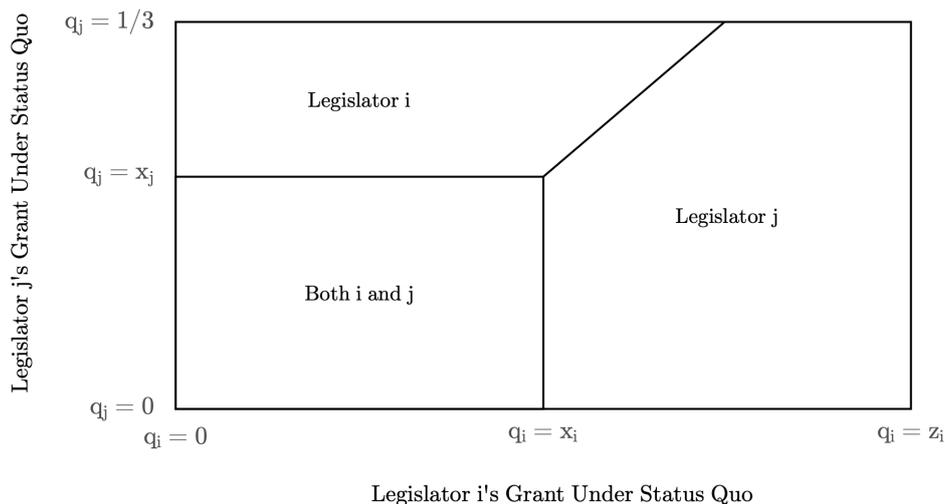
$$\frac{z_i - x_i}{x_c - z_c}(q_j - x_j) \geq \frac{1/3 - x_j}{x_c - 1/3}(q_i - x_i) \quad (8)$$

When equation 8 does not hold and $q_i > x_i$ then j is included in the winning coalition. Thus, as q_i increases, legislator i becomes more expensive to include in the winning coalition. However, when both i and j have large grants under the status quo policy then j is included in the winning coalition. The reason for this is that j has more similar

¹¹It is worth noting that evaluating how a state is doing under the status quo is relative. In this example, j 's grant under the status quo is always smaller than i 's grant. This is because $z_i > x_i > 1/3 > x_j > z_j$. However, there are times when the proposer is better off including i in the winning coalition than j .

characteristics to the proposer. That is, $1/3 > z_c$, so the proposer prefers a formula where α is larger to a formula where γ is larger. And, because $1/3 > z_j$, then including j in the winning coalition means increasing α not γ . Thus, because both z_j and z_c are below average, j is cheaper to include in the winning coalition.

Figure 3: Legislator Included in the Winning Coalition



Notice that the formula enacted in equilibrium distributes funding outside of the winning coalition. Unlike the Baron and Ferejohn (1989) model, any formula where at least one of the weights is non-zero provides some funding to every state. The reason for this is that $x_i > 0$ and $z_i > 0$. That is, for example, a formula that allocates funding based on population will provide some funding to every state as every state has a population greater than 0.

This example also illustrates how bargaining over a formula reduces the benefit for the proposer. In the Baron and Ferejohn (1989) game, the funds distributed outside of the winning coalition would go to the proposer. Further, in the case where either $q_i < x_i$ or $q_j < x_i$ then the proposer's benefit is further reduced. This is because the proposer sets $\eta = 1$, which increases the grant for i and/or j . However, in the Baron and Ferejohn game, the proposer would merely make i or j indifferent rather than increasing their grant amount. And, in equilibrium, the proposer would never include both i and j in the winning coalition.

3.3 Effect of Multiple Proposers

In practice, bargaining does not typically follow this take-it-or-leave-it structure. If the proposal is not accepted, other legislators can offer alternate proposals. To investigate the effect of this bargaining, I consider an infinite horizon game where a new proposer is randomly selected and payoffs are realized in each period. Specifically, the bargaining protocol is as follows. In the first period, a legislator makes a proposal $(\eta, \gamma, \alpha) \in \chi$ and the chamber floor then takes an up-or-down on the proposal. If m legislators vote for the proposal, then utilities based on the proposal are realized in the current period and in every subsequent period. Otherwise grants are allocated based on the status quo policy $(\eta_q, \gamma_q, \alpha_q) \in \chi$ for the current period, a new proposer is selected, and the game repeats. Legislator i is selected as the proposer with probability ρ_i . Legislators discount future payoffs with a common discount rate $\delta \in [0, 1)$. Note that when $\delta = 0$ this is the same as the one-period game.

Following Banks and Duggan (2006), I focus on no-delay stationary equilibria.¹² More formally, I require that legislators' proposals satisfy sequential rationality and that their acceptance sets satisfy weak dominance. In such equilibria, legislators have a continuation value

$$v_i = \sum_{j=1}^n \rho_j \int_{\chi} \frac{y_i(p)}{1 - \delta} \pi_j dp \quad (9)$$

where $y_i(p)$ is legislator i 's grant from proposal p and π_j puts probability one on socially acceptable proposals that maximize j 's utility and zero otherwise.

As in the one-period model, the question for the proposer is which of the proposals that can pass the floor maximize her grant amount. From equation 4 it follows that for the proposer to maximize her own grant she should minimize the grants to other legislators provided that legislators in the winning coalition W receive a grant at least equal to what they would if they rejected the proposal. If proposal $p = (\eta, \gamma, \alpha)$ is accepted, each player i receives a payoff in the current period equal to $y_i = \eta x_i + \gamma z_i + \alpha \frac{1}{n}$ and a dynamic

¹²No delay implies that a proposal p is in A .

payoff equal to $\frac{y_i}{1-\delta}$. Therefore, player i supports any proposal that provides her a grant y_i weakly greater than $(1-\delta)q_i + \delta v_i$ and the set of proposals acceptable to a given winning coalition is

$$A_W = \left\{ (\eta, \gamma, \alpha) \in \chi \mid \eta x_i + \gamma z_i + \frac{\alpha}{n} \geq (1-\delta)q_i + \delta v_i \quad \forall i \in W \right\} \quad (10)$$

The cheapest members of the winning coalition again are the legislators with the lowest grants under the status quo and that have similar characteristics to the proposer. However, in addition, a legislator's cheapness is also a function of her continuation value and thus the probability that she becomes the proposer in the future.

As with most divide-the-dollar games, this model can be formulated as a special case of Banks and Duggan (2006). From Theorem 1 of Banks and Duggan I get the following existence result:

Proposition 2. There exists a stationary equilibrium with immediate agreement.

And this result holds even though the status quo policy may be favorable to some legislators. However, for certain values of q_c and distributions of x and z there also exist stationary equilibria with delay. I provide an example of one such scenario in Appendix A.2.

4 Empirical Analysis

The theory predicts that a state is cheaper to include in the winning coalition when it is receiving a smaller grant under the status quo policy and has more similar characteristics to the proposer. In this section, I test these predictions. First, I examine the relationship between a state's grant amount under the status quo formula and whether that state is included in the winning coalition. Second, I look at the relationship between winning coalition membership and how similar a state's population is to that of the proposer's state. Consistent with the theory, I find that both groups of states are more likely to be included in the winning coalition when allocation formulas are changed.

4.1 Data and Methodology

I compile an original dataset of amendments to allocation formulas for grants-in-aid considered on the Senate floor. Specifically, when allocation formulas are amended, legislators have estimates produced of how each state will do under the proposal.¹³ In some cases, these estimates are printed in the Congressional Record. Figure 4 shows one such example (125 Cong. Rec. (1979) 29936). I collected estimates for these amendments from the Congressional Record for the 80th Congress to the 114th Congress (1947–2016). I also recorded each state’s grant under the status quo policy and which member proposed the amendment. I match these data to roll call votes from Lewis et al.’s (2017) Voteview database. Of the 117 amendments included in the dataset, 40% (47 amendments) received a roll call vote.¹⁴

Figure 4: Example of Amendment Data in the Congressional Record

FEDERAL FOSTER CARE FUNDING								
[In millions of dollars]								
	Fiscal year 1980				Fiscal year 1980			
	Fiscal year 1978	H.R. 3434	Bellmon amendment	Change	Fiscal year 1978	H.R. 3434	Bellmon amendment	Change
U.S. total.....	211.95	278.14	279.84	+1.70				
Alabama.....	1.30	1.80	2.21	+0.41	1.50	2.20	2.68	+1.43
Alaska.....	.70	.84	.80	-.04	.50	.60	.57	-.01
Arizona.....	(*)	1.10	1.57	+.47	.60	.72	.72	(*)
Arkansas.....	.40	1.00	1.27	+.27	.30	.36	.34	-.02
California.....	29.30	35.16	35.16	(*)	.50	.60	.57	-.03
Colorado.....	1.20	1.44	1.44	(*)	.30	3.30	4.65	+1.35
Connecticut.....	1.60	1.92	1.92	(*)	.08	.60	.85	+.25
Delaware.....	.40	.48	.49	+.01	109.20	131.04	125.09	-5.95
District of Columbia.....	.40	.48	.58	+.10	.70	2.60	3.01	+.41
Florida.....	1.10	3.50	4.15	+.65	.40	.48	.45	-.02
Georgia.....	2.20	2.64	2.99	+.35	2.50	5.00	6.22	+1.22
Hawaii.....	(*)	.40	.62	+.22	.60	1.30	1.58	+.28
Idaho.....	.30	.40	.40	(*)	3.70	4.44	4.24	-.20
Illinois.....	3.20	5.30	5.37	+.07	6.80	8.15	8.15	(*)
Indiana.....	1.20	2.60	3.31	+.71	.20	.40	.41	+.01
Iowa.....	1.10	1.32	1.32	(*)	.50	1.40	1.79	+.39
Kansas.....	2.40	2.88	2.75	-.13	.30	.36	.41	+.05
Kentucky.....	1.90	2.28	2.42	+.14	2.10	2.52	2.80	+.28
Louisiana.....	2.60	3.12	3.12	(*)	1.00	6.30	6.30	(*)
Maine.....	1.70	2.04	1.95	-.09	.40	.70	.73	+.03
Maryland.....	3.00	3.60	3.60	(*)	.50	.60	.57	-.03
Massachusetts.....	.60	2.50	2.50	(*)	2.60	3.12	2.98	-.14
Michigan.....	10.20	12.24	12.24	(*)	2.10	2.52	2.52	(*)
Minnesota.....	3.20	3.84	3.76	-.08	.80	.96	1.04	+.08
Mississippi.....	.80	1.30	1.50	+.20	2.90	3.48	3.48	(*)
Missouri.....					.07	.20	.20	(*)
Montana.....								
Nebraska.....								
Nevada.....								
New Hampshire.....								
New Jersey.....								
New Mexico.....								
New York.....								
North Carolina.....								
North Dakota.....								
Ohio.....								
Oklahoma.....								
Oregon.....								
Pennsylvania.....								
Rhode Island.....								
South Carolina.....								
South Dakota.....								
Tennessee.....								
Texas.....								
Utah.....								
Vermont.....								
Virginia.....								
Washington.....								
West Virginia.....								
Wisconsin.....								
Wyoming.....								

* Less than \$0.05 million.

† No change.

Notes: Amendment proposed by Senator Bellmon to a federal foster care grant program in 1979 (125 Cong. Rec. 29936).

¹³Grant estimates are generally produced by the government agency that administers the program or by the Congressional Research Service.

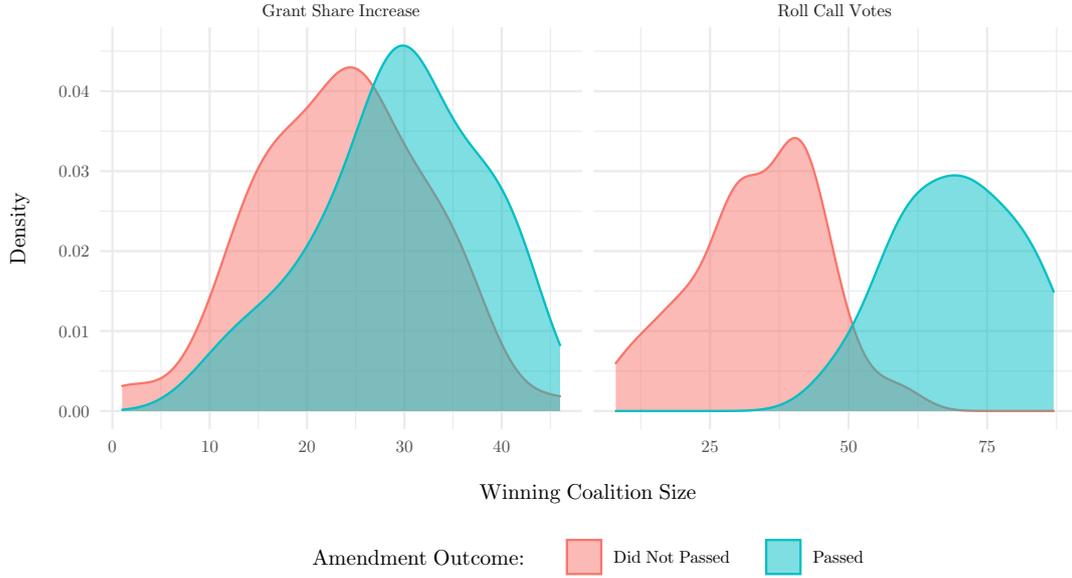
¹⁴In the analysis of roll call votes, only this subset is included. In the other analysis, all amendments are included. Both analyses include amendments that pass and those that do not. The roll call analysis includes votes to table amendments, which are reverse coded.

The analysis focuses on two key independent variables: how a state fares under the status quo policy and the state’s similarity to the proposer’s state. I consider the status quo policy to be the formula that would be in effect if the proposal did not pass. The status quo is usually the formula in current law, under the bill as reported by committee, or under changes passed by the House. In the example shown in Figure 4, grants under Senator Bellmon’s amendment were compared to grants under H.R. 3434. I then measure how a state is doing under the status quo policy using the state’s grant share under the status quo. To measure a state’s similarity to the proposer’s state, I use the Euclidean distance between their populations.¹⁵

I use two measures for whether a state is included in the winning coalition: (1) a binary indicator for whether the state’s grant share increased compared to the status quo policy and (2) whether the state’s Senators voted for the proposal. Figure 5 shows the distribution of the size of the winning coalition for each measure. Of the amendments that pass, many have a majority (and often supermajority) of states seeing an increase in their grant shares. Additionally, many of the amendments that pass do so by very large vote margins.

¹⁵State population data are from the U.S. Census (Manson et al. 2020).

Figure 5: Distribution of Winning Coalition Size



Notes: Winning coalition size measured as the number of states that see in an increase in their grant share under a proposal and the number of legislators voting for a proposal. Because each state is represented by two senators, 30 states seeing an increase in their grant amounts corresponds to 60 senators.

To examine the relationship between status quo grants, state characteristics, and winning coalition membership, I compare whether a state was included in the winning coalition under amendments proposed in the same congress. That is, I compare whether a state was included in the winning coalition when it was doing poorly under the status quo to when it was doing well under the status quo within a two-year span. Specifically, I estimate the following linear model using OLS regression:¹⁶

$$Pr(WC_{ipt} | q_{ipt}, \omega_{it}, x_{it}, x_{pt}^*) = \beta_1 q_{ipt} + \beta_2 |x_{it} - x_{pt}^*| + \omega_{it} + \epsilon_{ipt} \quad (11)$$

¹⁶The results are similar when state poverty is used instead of state population, log dollars are used instead of grant share, and a covariate for copartisanship is included. I include these analyses in Appendix C. I use a linear probability model as opposed to a logit model due to the inclusion of fixed effects. In Appendix Table A6, I estimate the probability using a conditional logistic regression and get similar results.

where WC_{ipt} is winning coalition membership; q_{ip} is state i 's grant share under the status quo for proposal p ; x_{it} is i 's population at time t ; x_{pt}^* is the population of the state represented by the proposer of proposal p ; ω_{it} is a state-congress fixed effect; and ϵ_{ipt} is an error term. As linear probability models suffer from heteroskedasticity, I use robust standard errors.¹⁷

As grant amounts vary by state, the analysis using grant amounts as the dependent variable is done at the state-amendment level. Similarly, as roll call votes are measured at the senator level, the analysis using roll call votes as the dependent variable is done at the legislator-amendment level.¹⁸ However, because the independent variables of interest vary at the state level, not the legislator level, the standard errors for the roll call analysis are clustered by state-amendment.

The advantage of using the Senate floor amendments data is that it allows me to isolate formula changes. That is, by looking at individual amendments rather than entire bills, I can examine how legislators voted when the only issue being considered is the allocation formula. Further, these data allow me to identify the proposer and easily quantify both the status quo policy and the proposal policy. However, it is worth noting that these data do not reflect the universe of all proposed amendments to formula grant programs. For example, during consideration of the Every Student Succeeds Act (ESSA) in 2016, 17 amendments to allocation formulas were proposed on the Senate floor. Of those amendments, 3 are included in the data I collected from the Congressional Record. The amendments included are those that make larger and more contentious formula changes. This is perhaps unsurprising given that the Congressional Record records what happens on the Senate floor and more contentious amendments result in more floor debate. To account for this sample selection issue, I reestimate the state characteristics analysis using a dataset of all amendments to allocation formulas considered during the three most recent reauthorizations of the Elementary and Secondary Education Act. This

¹⁷I calculate White (1980) heteroskedasticity-consistent standard errors using the `sandwich` package in R (Zeileis 2004).

¹⁸This analysis excludes the majority leader due to votes to recommit.

analysis, included in Appendix Table A4, produces similar results.

4.2 Results

Table 1 examines which states and legislators are included in the winning coalition when an allocation formula is amended. In line with theoretical predictions, when a state is doing worse under the status quo it is more likely to be included in the winning coalition.¹⁹ Specifically, a 1 percentage point increase in a state's grant under the status quo reduces the probability that their Senator votes for an amendment by 1.9 percentage points. Additionally, states that have a similar population level to the proposer are also more likely to be included in the winning coalition. And, these results hold when measuring winning coalition membership using roll call votes as well as a binary indicator for whether a state's grant share increased.

¹⁹It could be the case that states receiving less funding under the status quo see an increase in their grant amounts due to mean reversion. To test this, I simulate how much states would receive if grant shares were determined randomly. I find that the effect size is significantly smaller than what I observe in the data, suggesting that the results are not just due to mean reversion. I include this analysis in Appendix Figure A2.

Table 1: Winning Coalition Membership

	<i>Dependent variable:</i>	
	Vote for Amendment	Grant Share Increase
Status Quo Grant Share	-0.019* (0.008)	-0.041*** (0.008)
Difference from Proposer	-3.585*** (0.408)	-2.117*** (0.313)
State-Congress Fixed Effects	✓	✓
Count of Amendments	47	117
Observations	4,144	5,604
Adjusted R ²	0.356	0.095

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Robust standard errors in parentheses, clustered by state-amendment for analysis of roll call votes. The unit of analysis in the first column is legislator-amendment. The unit of analysis in the second column is state-amendment. Grant share is measured on a scale of 0 to 100. Difference from the proposer is measured using the Euclidean distance in state population. Models using log dollars instead of share, poverty instead of population, and including a covariate for copartisanship are presented in Appendix C.

These results suggest that legislators are trying to alter allocation formulas to increase their states' grant amounts and that bargaining over a formula imposes additional constraints on legislators. If legislators are attempting to allocate funding based solely on need, then a state's grant under the status quo and its similarity to the proposer should have no relationship to whether it is included in the winning coalition. Thus, these results are more consistent with legislators trying to maximize grants for their states by forming the cheapest winning coalitions. Further, state characteristics only influence how cheap a legislator is when grants are allocated based on state characteristics (i.e., via formula). Thus, these findings suggest that not only are legislators trying to procure more funding for their states, but that they are constrained by the structure of formulas. However, this is not to say that other political and institutional factors do not play a role in the distribution of grants. Rather, these results should be taken to mean that at least some of the patterns in grant allocations can be explained by legislators trying to increase their grant amounts and the structure of formulas.

5 When Will Grant Programs Target Need

Grants-in-aid are often designed with the explicit goal of providing extra financial assistance to people or places in need (Morgan and Shih 1991). Some programs are intended to alleviate fiscal disparities among states and localities, while others target assistance to specific populations. However, not all programs do this effectively. Funding for the federal highway program is not correlated with larger highway systems, more highway use, or lower median incomes—all of which could be considered measures of need for additional highway funding (Zhu and Brown 2013). Similarly, the Airport Improvement Program is intended to “help in developing a nationwide system of public-use airports that meets the current needs and the projected growth of civil aviation” (*Airport Improvement Program Handbook* 2019). However, airport funding does not reflect current needs, or the projected growth of civil aviation (Atkinson 2020).

When will grants-in-aid target need effectively? The theory and empirical results illustrate how what formula gets enacted, and thus which states benefit, depends on the proposer, the status quo policy, and the distribution of population, poverty, and other measures of need across states. Because funding is allocated based on state characteristics, proposers representing a constituency with high need must allocate funding to other places with high need in order for their own states to benefit. Thus, when proposers represent areas with high need, they should improve formulas with poor targeting of need and protect formulas that target need effectively.

However, majority rule and the status quo policy may limit a proposer’s ability to target funding to areas with the greatest need. For a legislator to improve the targeting of a formula, she needs to find a majority, or supermajority, of legislators who support her proposal. Thus, if the majority of legislators have relatively low need then, depending on the status quo, it may not be possible to enact a formula that improves targeting. Further, when amending a formula that is already well targeted, states with low need are more likely to be included in the winning coalition as they are doing poorly under the status quo. As a result, for the proposer to maximize her grant under a program that is well targeted, she may need to make the program less targeted.

Majority rule makes targeting need particularly challenging in the Senate because need is often concentrated in a minority of states. In the Senate, each state is represented by two senators, regardless of population. However, there are a few states with very high populations (e.g., New York, California, Texas) but the majority of states have population levels below the national average. Thus the majority of senators do not want allocation formulas that distribute funding solely based on population, or any measure of need correlated with population such as poverty levels. Instead, the majority of senators want allocation formulas that favor smaller states. Further, Senate representation coupled with majority and supermajority rules means that winning coalitions must include small states. And, as the theory illustrates, the formula that maximizes the proposer's grant while also including a state with low population levels often includes minimum grant provisions.

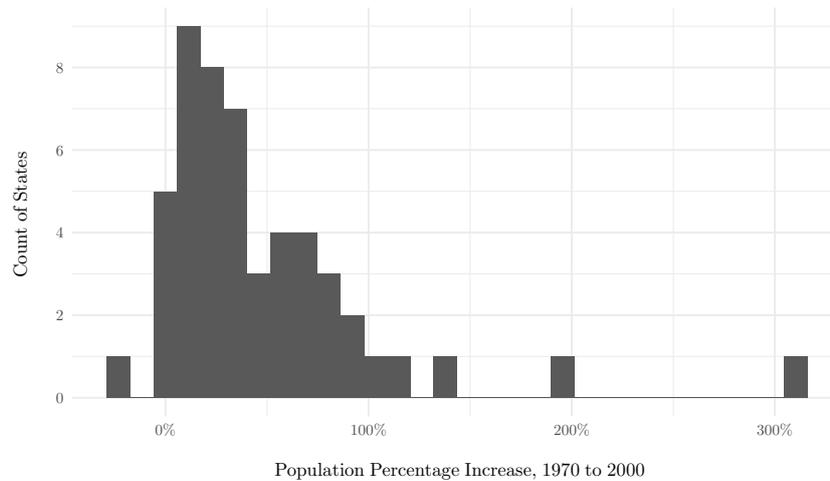
Consistent with the theory, a recurring pattern in the distribution of grants is that small states tend to receive more per capita grant funding than larger states (Larcinese, Rizzo, and Testa 2013b; Lee 2000; Lee and Oppenheimer 1999).²⁰ Because a large number of formulas do include some measure of population, many formulas should end up with generous minimum grant amounts. And, since minimum grants distribute an equal amount of funding to each state, these provisions provide smaller states more per capita funding.

Increases in state population have the same issue as state population levels. While nearly all states have seen their populations increase over the past several decades, some states have seen substantially larger increases than others. Figure 6 shows the distribution of percentage increases in population across states from 1970 to 2000. The skewed distribution of population increases across states means that the majority of states—and thus the majority of Senators—do not want a formula that is responsive to changes in

²⁰Lee (2000) argues that smaller states are cheaper coalition partners because the total amount of funding needed, due to their small population size, is low. By contrast, I show that smaller states are not necessarily cheaper to include in the coalition, but the distribution of population across states means that they must be included.

population.

Figure 6: Increases in Population Across States, 1970 to 2000



Notes: Population data from the U.S. Census Bureau.

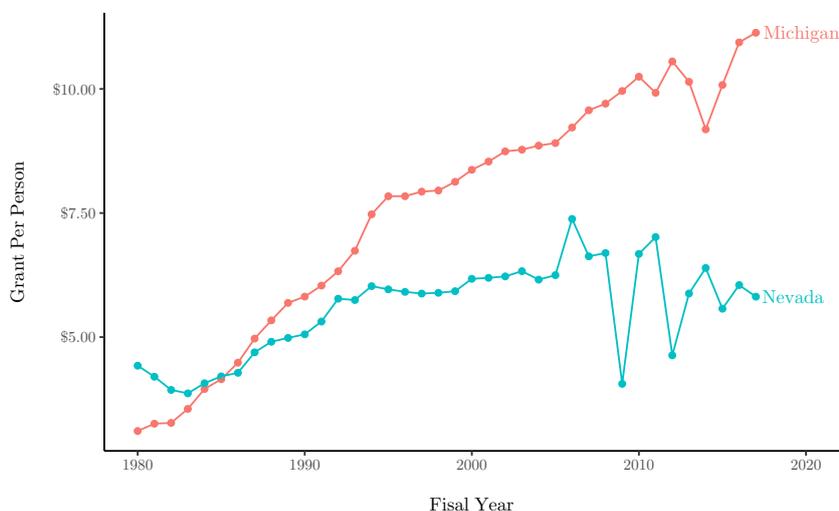
The distribution of population increases and the majority and supermajority rules in the Senate may explain the use of old data in allocation formulas. As previously discussed, some allocation formulas include foundation grants or base guarantees, which allocate each grantee a set dollar amount based on a previous year’s grant amount and then distribute the remaining funds based on formula factors. By guaranteeing each state their grant amount from a previous year, these provisions are essentially allocating funding based on the state characteristics from that previous year. In other words, a FY1978 foundation grant means that at least part of the funding for a program is being allocated based on data from 1978.

Foundation grants benefit states that have seen their population shares decline over time and hurt states that have seen their population shares increase.²¹ Moreover, these provisions mean that the grant amounts will be less correlated with the current population of each state and thus with need. Consider, for example, the Vocational Rehabilitation

²¹Larcinese, Rizzo, and Testa (2013b) also note that states with fast-growing populations receive less federal funding. However, they attribute this pattern to budget incrementalism.

Program. Under the program, each state first receives an allocation equal to its grant in FY1978. The remaining funds are then allocated based on state population and per capita income. Figure 7 shows the grant per person in Nevada and Michigan under the Vocational Rehabilitation program. Nevada and Michigan have similar per capita income levels but Nevada has seen a much larger increase in its population than Michigan since 1976. Figure 7 illustrates that the grant per person in Michigan has become much larger than that of Nevada as the differences between states' current population and 1976 population increase.

Figure 7: Vocational Rehabilitation Grants



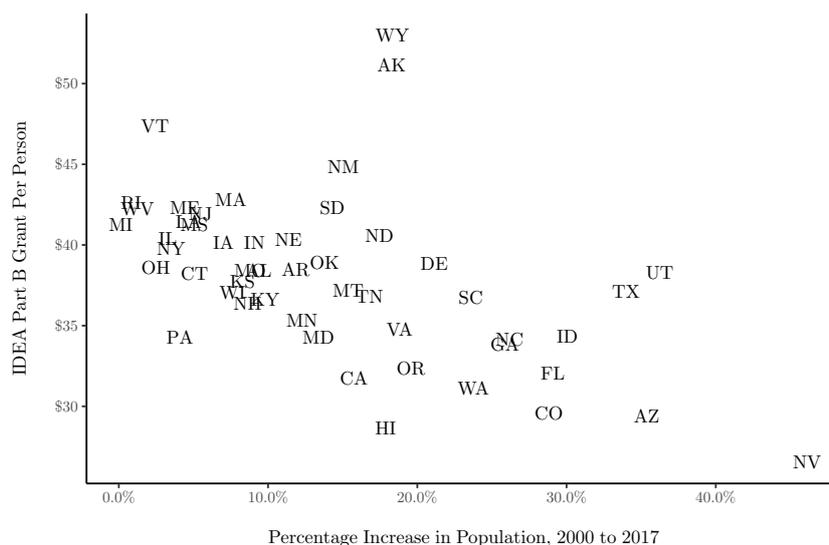
Notes: Data on Vocational Rehabilitation grants are from the U.S. Department of Education and population data are from the U.S. Census Bureau.

Similar to the Vocational Rehabilitation program, funding for the education of children with disabilities is based, in part, on decades-old population data. The Individuals with Disabilities Education Act (IDEA) Part B program is the primary source of federal funding for the education of children with disabilities. Under this program, each state first receives a grant equal to what it received in FY1999. Then, any remaining funds are allocated in proportion to state population and poverty, subject to minimum and maximum grant provisions.²² As with the Vocational Rehabilitation program, this formula

²²Additionally, the formula includes hold harmless provisions that stipulate that each state must receive at least as much funding as it did in the preceding year.

provides less per capita funding to states with large increases in population. To illustrate this point, Figure 8 shows the relationship between population growth and IDEA Part B grants per child. States with large increases in population, such as Nevada and Arizona, receive substantially less per person than places with less growth, such as Michigan.

Figure 8: IDEA Part B Grants by Population Increase (FY2017)



Notes: Data on IDEA Part B grants are from the U.S. Department of Education and population data are from the U.S. Census Bureau.

While minimum grant provisions and foundation grants may reduce the targeting of federal funding to areas with the highest need, there are good reasons to include these provisions in allocation formulas. Minimum grant provisions can ensure that each state receives enough funding to run a program. Foundation grants and hold harmless provisions can make funding more predictable, which is important for planning state and local government budgets. However, the more generous these provisions are, the less funding is allocated based on population, poverty, and other measures of need. Additionally, the longer the foundation grants remain in place, the greater the mismatch between the current target population the program is intended to serve and the data being used to allocate a portion of the funding.

6 Conclusion

In this paper I show how federal grants-in-aid are shaped by majority and super-majority rules, legislators attempting to maximize the funding their states receive, the status quo policy, and the structure of allocation formulas. As in many bargaining models, legislators with proposal power receive more grant funding. However, allocating grants using a formula imposes additional constraints. The advantage to the proposer is reduced because funding is distributed outside of the winning coalition, winning coalitions may be oversized, and members of the winning coalition may receive a larger share of funding than is required to make them support a proposal. Further, states doing worse under the status quo and that are similar to proposers benefit more from formulas because they are cheaper to include in the winning coalition. And, consistent with these predictions, I find that states receiving smaller grants under the status quo policy and that have similar population levels to the proposer are more likely to be included in the winning coalition.

Together, the theoretical and empirical analyses contained in this paper produce several important contributions. First, while grants-in-aid make up a substantial portion of the federal budget and account for the majority of federal assistance, they have received much less scholarly attention than other types of federal spending. This paper joins a small literature that argues that federal grant programs are influenced by political considerations and congressional rules (Curry and Donnelly 2020; Lee 2000; Levitt and Snyder 1995; Martin 2018). I add to this literature by developing and testing new predictions about how the status quo policy shapes grants-in-aid and who benefits from these programs. Moreover, I provide a new explanation for two recurring patterns in the distribution of grants: larger states and states with fast-growing populations receive less federal funding per capita (Lee 2000; Larcinese, Rizzo, and Testa 2013b). I demonstrate how both of these patterns can result from the combination of majoritarian rules, Senate representation, and the distribution of population, poverty, and other measures of need across states.

Second, I extend the scope of divide-the-dollar models generally. With one notable exception (Martin 2018), existing theories do not take into account the constraints that

bargaining over a formula impose. Unlike existing work, I incorporate the constraints of a formula and the status quo policy into a divide-the-dollar model. The interaction of these features yields new predictions about how legislators form coalitions and, thus, who benefits from federal programs. Additionally, considering majority rule, the status quo policy, and the structure of formulas together yields new predictions about the size of coalitions.

Finally, this paper speaks to the important question of whether Congress is well designed to enact effective programs. The results demonstrate how majority and supermajority rules coupled with representation in the Senate can result in programs that do a poor job of targeting need. In particular, because of the distribution of population and population increases across states, it is challenging to enact programs that target need. Additionally, it is easy for programs that start out targeting need to become less targeted over time.

One avenue for future research is how the politics of grants-in-aid differs in the House compared to the Senate. All of the analyses in this paper focus on the Senate, not the House of Representatives. While there is nothing particular to the theory that applies to the Senate but not the House, Senators may be more likely to try and alter grant programs to bring more funding to their states than House members. Specifically, because formulas do not allocate grants to congressional districts it is difficult for House members to claim credit for formula changes and know how a formula change will affect funding for their district (Lee 2003, 2004). However, the population-based representation, lack of supermajoritarian rules, and strong control over policymaking by the Speaker suggest there may be interesting differences between the House and Senate.

Appendix

A Theory

A.1 Maximum Grant Amounts

It is first useful to consider the maximum possible amount each state could receive under a formula. In a typical divide-the-dollar game (e.g., Baron and Ferejohn 1989), the maximum possible allocation for a legislator is 1 (i.e., they take the entire dollar). However, when allocations are constrained by a formula, each type of legislator has a different maximum allocation, which is less than 1 and determined by x_i and z_i . A legislator's "type" is pair $\{x_i, z_i\}$. Thus, legislators with the same values for x_i and z_i are of the same type. Based on these types, legislators fall into the following three categories, which describe their maximum possible allocation and the formula factor from which they most benefit:

1. When $x_i \geq z_i$ and $x_i \geq 1/n$ then $y_i^{\max} = x_i$ and this allocation occurs when $\eta = 1, \gamma = 0, \alpha = 0$. I refer to these legislators as legislators whose preferred weight is η .
2. When $z_i \geq x_i$ and $z_i \geq 1/n$ then $y_i^{\max} = z_i$ and this allocation occurs when $\gamma = 1, \eta = 0, \alpha = 0$. I refer to these legislators as legislators whose preferred weight is γ .
3. When $x_i \leq 1/n$ and $z_i \leq 1/n$ then $y_i^{\max} = 1/n$ and this allocation occurs when $\alpha = 1, \eta = 0, \gamma = 0$. I refer to these legislators as legislators whose preferred weight is α .²³

The intuition for this result is relatively straightforward: a legislator receives the largest grant when all of the weight is placed on their largest formula factor. More formally,

²³If $x_i = z_i = 1/n$ then that legislator receive their maximum allocation ($1/n$) under any combination of weights so long as $\eta + \gamma + \alpha = 1$.

$$\max_{\eta, \gamma, \alpha} \eta x_i + \gamma z_i + \alpha \frac{1}{n} \quad (12)$$

when $\eta, \gamma, \alpha \geq 0$ and the budget constraint is $\eta + \gamma + \alpha \leq 1$.

In the case where $z_i = x_i = 1/n$, any combination of η, γ, α provides i her maximum grant of $1/n$ so long as $\eta + \gamma + \alpha = 1$. In this case, η, γ , and α are essentially perfect substitutes. However, in all other cases we must consider corner solutions. When $(1, 0, 0)$ is the formula, i receives a grant of x_i . When $(0, 1, 0)$ is the formula, i receives a grant of z_i . When $(0, 0, 1)$ is the formula, i receives a grant of $1/n$. Thus, $(1, 0, 0)$ provides i her maximum grant (equal to x_i) when $x_i > z_i$ and $x_i > 1/n$. That is, when i prefers η . Similarly, $(0, 1, 0)$ and $(0, 0, 1)$ provides i her maximum grant when she prefers γ and α , respectively.

A.2 Example of Delay

Proposition 2 shows that there always exists a stationary equilibrium without delay. However, for certain values of q_c and distributions of x and z there also exist stationary equilibria with delay.²⁴ In such an equilibrium, legislators have the following continuation value:

$$v_i = \frac{\sum_{j \in N} \rho_j \left(\int_A \frac{y_i(p)}{1-\delta} \pi_j dp + (1-\delta) q_i \pi_j (\chi - A) \right)}{1 - \delta \sum_{j \in N} \rho_j \pi_j (\chi - A)} \quad (13)$$

where $\pi_j(\chi - A)$ is the probability that legislator j makes a proposal that is not accepted.

Consider a case where $1/3 > x_c > z_c$, $x_i > z_i > 1/3$, $x_j > z_j > 1/3$, and $(\eta_q, \gamma_q, \alpha_q) = (0, 0, 1)$. That is, legislator c prefers α , legislators i and j both prefer η , and the status quo formula places all of the weight on α , providing each legislator with a status quo grant of $1/3$. Further assume $m = 2$ (i.e., majority rule). I look for stationary equilibria of the following form: $p_c = (0, 0, 1)$, $A_c = \{(\eta, \gamma, \alpha) \in \chi | y_c \geq (1 - \delta)1/3 + \delta v_c\}$, $p_i =$

²⁴Model 6 of Banks and Duggan (2006) provides a similar example of a stationary equilibrium with delay.

$p_j = (1, 0, 0)$, $A_i = \{(\eta, \gamma, \alpha) \in \chi | y_i \geq (1 - \delta)1/3 + \delta v_i\}$, and $A_j = \{(\eta, \gamma, \alpha) \in \chi | y_j \geq (1 - \delta)1/3 + \delta v_j\}$. In such equilibria,

$$\begin{aligned} v_c &= \frac{(\rho_i + \rho_j) \frac{x_c}{1-\delta} + \rho_c \frac{1}{3}(1-\delta)}{1 - \delta \rho_c} \\ v_i &= \frac{(\rho_i + \rho_j) \frac{x_i}{1-\delta} + \rho_c \frac{1}{3}(1-\delta)}{1 - \delta \rho_c} \\ v_j &= \frac{(\rho_i + \rho_j) \frac{x_j}{1-\delta} + \rho_c \frac{1}{3}(1-\delta)}{1 - \delta \rho_c} \end{aligned} \tag{14}$$

Therefore c accepts a proposal when

$$y_c \geq \frac{1}{3} + \frac{\delta(1 - \rho_c) \left(\frac{x_c}{1-\delta} - 1/3 \right)}{1 - \delta \rho_c} \tag{15}$$

i accepts a proposal when

$$y_i \geq \frac{1}{3} + \frac{\delta(1 - \rho_c) \left(\frac{x_i}{1-\delta} - 1/3 \right)}{1 - \delta \rho_c} \tag{16}$$

and j accepts a proposal when

$$y_j \geq \frac{1}{3} + \frac{\delta(1 - \rho_c) \left(\frac{x_j}{1-\delta} - 1/3 \right)}{1 - \delta \rho_c} \tag{17}$$

In this case, i and j always vote to reject c 's proposal. And, by construction, all three legislators' acceptance sets satisfy weak dominance. Further, the proposer weakly prefers proposing $(0, 0, 1)$ to any other proposal that would get rejected and weakly prefers proposing $(0, 0, 1)$ to making a proposal that either i or j would accept immediately. Thus, c 's proposal strategy satisfies sequential rationality. Additionally, as i and j 's proposals would both pass and provide them their maximum grant amounts, these strategies also satisfy sequential rationality. Therefore, there exists a stationary equilibrium where delay occurs with probability 1 but after a finite number of periods a proposal other than the status quo is enacted.²⁵

²⁵If c were not fixed as the proposer in the first period then delay would occur with probability $\rho_c > 0$.

A.3 Proof of Proposition 1

Proposition 1. There exists a Nash equilibrium in which the proposer makes an acceptable proposal. Further, let g_i be the grant legislator i receives when the proposer sets her preferred weight to 1, G be the set of all legislators for whom $g_i \geq q_i$, and $|G|$ be the number of legislators in G . If either (i) $\sum_{i \in N} q_i < 1$; (ii) $q_i < f_i^2$ for $m - 1$ legislators and the proposer; or (iii) $|G| \geq m$ and $q_i < g_c$ then there exists a Nash equilibrium in which the proposer enacts a formula that increases her grant amount.

Proof. By construction, the voting strategy $A_i = \{(\eta, \gamma, \alpha) \in \chi | \eta x_i + \gamma z_i + \alpha/n\}$ satisfies weak dominance. Notice that legislator i 's acceptance set A_i contains the status quo formula for all $i \in N$. Thus, A is always nonempty as it will contain the status quo formula. As a result, the proposer can always make an acceptable proposal. And, because a non-acceptable proposal results in grants based on the status quo formula, there is always an acceptable proposal that the proposer weakly prefers to a non-acceptable proposal. As a result, selecting the proposal in A that maximizes her grant amount, is a best response for the proposer. Thus, there exists a Nash equilibrium in which the proposer makes an acceptable proposal. \square

Define w_i^1, w_i^2, w_i^3 as the value of legislator i 's most, second-most, and least preferred weights, respectively, under the status quo.²⁶

- (i) When $\sum_{i \in N} q_i < 1$ this implies $\eta_q + \gamma_q + \alpha_q < 1$. Thus, the proposer can always strictly increase her grant amount and the grant amount for all other legislators by increasing her preferred weight by $1 - \alpha_q - \gamma_q - \eta_q$. \square
- (ii) Note that when $\eta + \gamma + \alpha = 1$ but legislator i 's least preferred weight is 0 then it must be the case that $y_i \geq f_i^2$. Thus, when $q_c < f_c^2$ this implies that $w_c^1 + w_c^2 < 1$. Further, when $q_i < f_i^2$ for $m - 1$ legislators then $w_i^1 + w_i^2 < 1$ for $m - 1$ legislators. Thus the grant for the proposer and $m - 1$ legislators can be increased by decreasing w_c^3 . \square

²⁶For example, if $f_i^2 = x_i$ then $w_i^2 = \eta_q$

(iii) When $|G| \geq m$ then the formula that sets the proposer's preferred weight to 1 is socially acceptable. This is because it provides every legislator with $y_i = g_i$, which weakly increases grants for m legislators. Further, this provides the proposer her maximum grant amount ($y_i = y_i^{\max}$), which strictly increases the proposer's grant amount provided the proposer is not already receiving her maximum. \square

A.4 Proof of Corollary 1

Let g_i be the grant legislator i receives when the proposer sets her preferred weight to 1, G be the set of all legislators for whom $g_i > q_i$, and $|G|$ be the number of legislators in G . Further, let A_W^* be the formula in A_W that maximizes the proposer's grant amount and $y_i(A_W^*)$ be legislator i 's grant amount from this formula.

It is first useful to consider some lemmas to prove the main result. Lemma 1 shows that in equilibrium the budget constraint always binds.

Lemma 1. $\sum_{i \in N} y_i = 1$

Proof. Suppose not and $\sum_{i \in N} y_i < 1$. Note that because $\sum_{i \in N} x_i = 1$ and $\sum_{i \in N} z_i = 1$, then Lemma 1 implies $\eta + \gamma + \alpha = 1$. If it were not to bind then the proposer could always strictly increase her grant amount by increasing her preferred weight by $1 - \alpha - \gamma - \eta$. \square

Lemma 2 shows that if the formula proposed in equilibrium does not provide the proposer her maximum grant amount then at least one legislator in the winning coalition is indifferent between the proposal and the status quo.

Lemma 2. If $y_c(A_W^*) < y_c^{\max}$ then there exists $i \in W$ such that $y_i(A_W^*) = q_i$.

Proof. From weak dominance,

$$A_i = \left\{ (\eta, \gamma, \alpha) \in \chi \mid \eta x_i + \gamma z_i + \frac{\alpha}{n} \geq q_i \right\} \quad (18)$$

If possible, the proposer would set her preferred weight to one as it provides her y_c^{\max} . Thus, when $y_c(A_W^*) < y_c^{\max}$, it must be the case that $q_i > g_i$ for $m - 1$ legislators. This implies that $m - 1$ legislators do not prefer the same weight as the proposer and some of

these legislators need to be included in the winning coalition. Further, from Lemma 1, it immediately follows that if the proposer cannot set her preferred weight to 1 the formula proposed in equilibrium will put weight on at least one other factor. If $y_i(A_W^*) > q_i$ for all $i \in W$ such that $g_i > q_i$ then the proposer can increase her preferred weight and decrease the other weight in the formula, which decreases the grants for these legislators. Further, the proposer will continue to do this until $y_i(A_W^*) = q_i$ for at least one legislator. \square

Lemma 3 shows that in equilibrium the sum of grants distributed to legislators other than the proposer weakly decreases if members are removed from the winning coalition. Further, if the formula proposed in equilibrium does not provide the proposer her maximum grant amount then this inequality is strict.

Lemma 3. When $W' \in \mathcal{D}$ and $W' \subset W$ then

1. $\sum_{i \in N-c} y_i(A_{W'}^*) \leq \sum_{i \in N-c} y_i(A_W^*)$
2. If $y_c(A_W^*) < y_c^{\max}$ then $\sum_{i \in N-c} y_i(A_{W'}^*) < \sum_{i \in N-c} y_i(A_W^*)$

Proof. Because the budget constraint binds in equilibrium, the proposer's grant is equal to the following:

$$y_c = 1 - \sum_{i \in N-c} y_i \quad (19)$$

Thus for the proposer to maximize her grant, she must minimize grants to all other legislators. As a result,

$$\sum_{i \in N-c} y_i(A_{W'}^*) = \min_{(\eta, \gamma, \alpha) \in A_{W'}} \sum_{i \in N-c} \eta x_i + \gamma z_i + \alpha/n \quad (20)$$

$$\sum_{i \in N-c} y_i(A_W^*) = \min_{(\eta, \gamma, \alpha) \in A_W} \sum_{i \in N-c} \eta x_i + \gamma z_i + \alpha/n \quad (21)$$

Because $W' \subset W$, it immediately follows that $A_W \subseteq A_{W'}$. As a result, $\sum_{i \in N-c} y_i(A_{W'}^*) \leq \sum_{i \in N-c} y_i(A_W^*)$. As for part 2, note that, from Lemma 2, there exists $j \in W$ such that $y_j(A_W^*) = q_j$. If legislator j is removed from the winning coalition then c can increase her preferred weight and decrease at least one of the other weights. This strictly increases

the proposer's grant amount, therefore strictly decreasing the sum of grants distributed to other legislators. \square

With this, I can now prove the main result.

Corollary 1. If $|G| \geq (n+1)/2$ then the winning coalition size is $|G|$. If $|G| < (n+1)/2$, then any formula change enacted in equilibrium has a minimal winning coalition.

Proof. If possible the proposer sets her preferred weight to 1 as this results in her maximum grant amount. It is possible for the proposer to enact this formula when $m - 1$ other states receive at least what they are receiving under the status quo formula. Thus, the winning coalition size is $|G|$. In all other cases, the winning coalition is minimal sized. Suppose not and c proposes $(\eta, \gamma, \alpha) \in A$ where $y_i > q_i$ for $\hat{n} > m$ legislators. Because, $|G| < m$ the proposer cannot set her preferred weight to 1. From Lemma 1 it follows that if the proposer cannot set her preferred weight to 1 then in equilibrium at least two weights are non-zero. From Lemma 3, the proposer strictly prefers increasing her preferred weight and decreasing at least one of the other weights such that fewer legislators are included in the winning coalition. This results in a minimal winning coalition because if it did not and the other weights could not be decreased any further then this would imply that the proposer's preferred weight is 1, which is not possible.²⁷ And, the proposer strictly prefers this formula to (η, γ, α) because it increases the weight on her most preferred factor and weakly decreases the weight on the other two factors. \square

A.5 Proof of Proposition 2

To apply Theorem 1 of Banks and Duggan (2006) I must verify six technical conditions:

1. Impose the requirement that $\delta \in [0, 1)$ and $\delta_i = \delta \forall i$.

²⁷There are some knives edge conditions in which two legislators are equally "cheap" to include in the winning coalition and thus, in equilibrium, the proposer could have an oversized coalition.

2. The set of possible formulas χ is nonempty, compact, and convex where $\chi = \{\eta, \gamma, \alpha \in [0, 1] \mid \sum_{i \in N} \eta x_i + \gamma z_i + \alpha 1/n \leq 1\}$. $(0, 0, 0) \in \chi$ so χ is nonempty. Convexity and compactness follow immediately from the linear budget constraint and the non-negativity constraints used to define χ .
3. The status quo policy $(\eta_q, \gamma_q, \alpha_q) \in \chi$. This is true by assumption.
4. Impose the requirement that the recognition probabilities ρ_1, \dots, ρ_n are fixed throughout the game. Note that fixing the proposer as the proposer in the first period does not conflict with this requirement as we can consider the proposer to be the legislator who is chosen as the proposer in the first period.
5. Each legislator's utility u_i is continuous and concave. This is ensured by the linearity of the utility function.
6. Each legislator's utility u_i is strictly quasi-concave and strictly monotonic in the consumption of i 's district. Strict quasi-concavity and strict monotonicity follow from the fact that i 's utility is strictly increasing in her own district's grant amount.²⁸

B Senate Floor Amendments

Figure A1 shows the number of amendments in the dataset in each congress by amendment status.

²⁸This condition is needed to ensure that Banks and Duggan's requirement of limited shared weak preferences (LSWP) holds. LSWP is similar to, but weaker than, single-peakedness.

Figure A1: Amendments to Formula Grant Programs Over Time

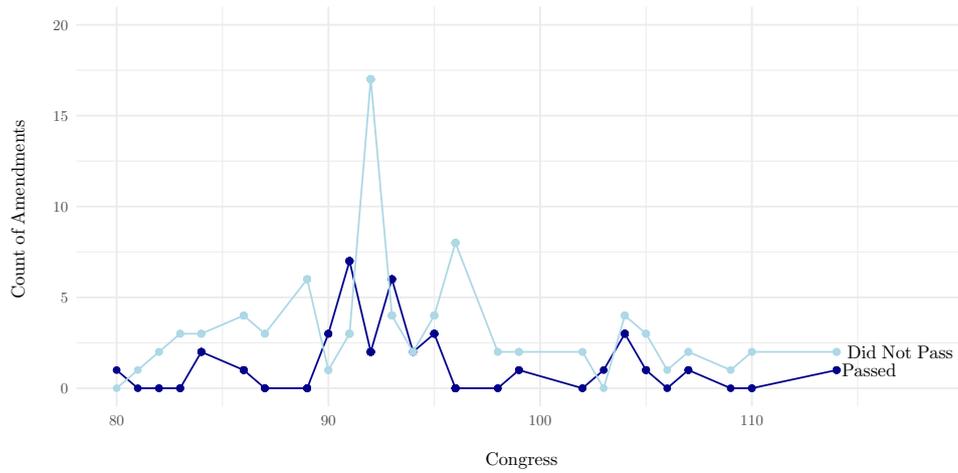


Table A1 provides some descriptive statistics on Senate amendments to formula grant programs. Winning coalition size is measured as the number of states whose grant amount would increase under the proposal.

Table A1: Summary of Formula Grants Amendment Data

	All Amendments	Passed Amendments
Grant Under Proposal		
Mean	\$116,373,836	\$56,887,163
St. Dev.	\$560,444,629	\$185,588,104
Status Quo Grant		
Mean	\$103,861,793	\$55,393,051
St. Dev.	\$497,156,091	\$193,021,005
Change in Grant Amt.		
Mean	\$12,512,042	\$1,494,113
St. Dev.	\$102,585,375	\$50,567,361
Proposal Funding Level		
Mean	\$5,741,109,230	\$2,831,355,390
St. Dev.	\$20,118,608,406	\$5,566,692,195
Status Quo Funding Level		
Mean	\$5,123,848,472	\$2,756,991,257
St. Dev.	\$17,856,464,769	\$5,563,743,261
Winning Coalition Size		
Mean	35.35	37.83
St. Dev.	13.85	11.62

C Robustness Checks

Table A2 reexamines winning coalition membership, but also includes a covariate for co-partisanship. Specifically, I include an indicator for whether an amendment was proposed by a copartisan.²⁹ I find that, even when accounting for partisanship, legislators are more likely to be included in the winning coalition when their state is doing worse under the status quo or has similar characteristics to the proposer’s state.

Table A2: Winning Coalition Membership

	<i>Dependent variable:</i>	
	Vote for Amendment	Grant Share Increase
Status Quo Grant Share	−0.019* (0.008)	−0.041*** (0.008)
Difference from Proposer	−3.179*** (0.392)	−2.130*** (0.314)
Proposer Is a Copartisan	0.247*** (0.019)	−0.028 (0.025)
State-Congress Fixed Effects	✓	✓
Count of Amendments	47	117
Observations	4,144	5,604
Adjusted R ²	0.405	0.095

Note: *p<0.05; **p<0.01; ***p<0.001. Robust standard errors in parentheses, clustered by state-amendment for analysis of roll call votes. The analyses in the first column is at the legislator level. The analyses in the second column is at the state level. Grant share is measured on a scale of 0 to 100.

Table A3 reexamines which states are included in the winning coalition using a state’s grant amount (measured in log dollars) as opposed to its grant share to measure its grant under the status quo. I also include a covariate for the funding level of the program to account for the fact that a state may have a lower grant under the status quo because that program is smaller. Similar to using grant share, I find that states doing worse under the status quo are more likely to be included in the winning coalition.

²⁹When performing analyses at the state level, I consider an amendment to be proposed by a copartisan if the proposer is a copartisan of either of a state’s Senators.

Table A3: Winning Coalition Membership

	<i>Dependent variable:</i>	
	Vote for Amendment	Grant Share Increase
Status Quo Grant (Log)	-0.040*** (0.012)	-0.046*** (0.003)
Difference from Proposer	-3.108*** (0.412)	-1.719*** (0.322)
Program Funding Level (Log)	0.007 (0.014)	0.043*** (0.005)
State-Congress Fixed Effects	✓	✓
Count of Amendments	47	117
Observations	4,144	5,604
Adjusted R ²	0.363	0.106

Note: *p<0.05; **p<0.01; ***p<0.001; robust standard errors in parentheses, clustered by state-amendment for analysis of roll call votes

The analysis of winning coalition membership uses a dataset that includes only a subset of amendments to grant programs. Table A4 reexamines whether states more similar to the proposer are more likely to be included in the winning coalition using a dataset that does not suffer from this selection issue. Specifically, I regress whether a state's Senators voted for an amendment on the distance between a state's population and the proposer's population. In this analysis I examine all amendments to allocation formulas introduced on the Senate floor during consideration of the three most recent reauthorizations of the Elementary and Secondary Education Act (ESEA): the Every Student Succeeds Act, No Child Left Behind Act, and Improving America's Schools Act.³⁰ I again find that states with similar characteristics to the proposer's state are more likely to vote for the amendment when I examine the subset of amendments that passed on the Senate floor. As I do not have estimates of how a state does under the

³⁰Data on the amendments to these bills comes from Congress.gov. I classified each amendment as amending a formula or not using the available text of the amendment. As a result, only amendments for which the text was available were included.

amendment, I cannot measure winning coalition membership by whether or not a state's grant amount increased.

Table A4: Winning Coalition Membership, ESEA Reauthorizations

	<i>DV: Vote for Amendment</i>	
	All Amendments	Passed Amendments
Difference from Proposer	-0.251 (0.348)	-1.295*** (0.343)
State-Congress Fixed Effects	✓	✓
Count of Amendments	55	28
Observations	5,573	2,734
Adjusted R ²	0.023	0.093

Note: *p<0.05; **p<0.01; ***p<0.001
Standard errors clustered by state-amendment

Table A5 reestimates the winning coalition analysis using state poverty instead of state population to estimate the similarity to the proposer's state. Again, I find that states with similar characteristics to the proposer are more likely to be included in the winning coalition.³¹

³¹The state poverty data only go back to 1970. As a result, this analysis includes fewer observations than the analysis using population data.

Table A5: Winning Coalition Membership

	<i>Dependent variable:</i>	
	Vote for Amendment	Grant Share Increase
Status Quo Grant Share	−0.025* (0.011)	−0.043*** (0.013)
Difference from Proposer (Poverty)	−3.280*** (0.639)	−2.079*** (0.446)
State-Congress Fixed Effects	✓	✓
Count of Amendments	23	58
Observations	2,113	2,813
Adjusted R ²	0.258	0.072

Note: *p<0.05; **p<0.01; ***p<0.001. Robust standard errors in parentheses, clustered by state-amendment for analysis of roll call votes. Grant share is measured on a scale of 0 to 100.

Table A6 reestimates the winning coalition analysis using a conditional logistic regression.³² As with the other analyses, I find that states doing worse under the status quo and that are more similar to the proposer are more likely to be included in the winning coalition.

Table A6: Winning Coalition Membership (Conditional Logit)

	<i>Dependent variable:</i>	
	Vote for Amendment	Grant Share Increase
Status Quo Grant Share	−0.142** (0.045)	−0.436*** (0.040)
Difference from Proposer	−18.573*** (1.932)	−9.251*** (1.273)
State-Congress Fixed Effects	✓	✓
Count of Amendments	47	117
Observations	4,144	5,604
Log Likelihood	−1,001.034	−1,993.629

Note: *p<0.05; **p<0.01; ***p<0.001

The analysis of winning coalition membership shows that legislators receiving smaller

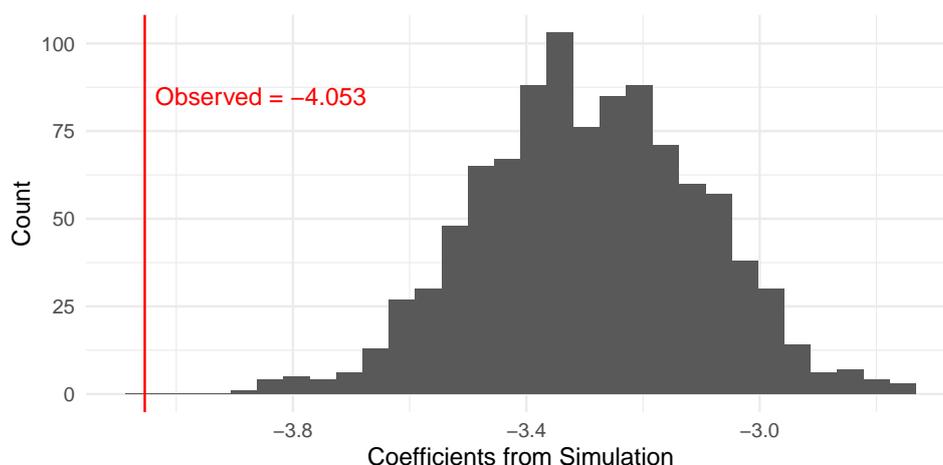
³²Note, table reflects raw logit coefficients.

grants under the status quo policy are more likely to be included in the winning coalition. However, this could be do to reversion to the mean. That is, if legislators were randomly choosing proposals (and thus who is included in the coalition) then states doing worse under the status quo may be more likely to benefit from the proposal due to mean reversion. To test this, I simulate how much a state would receive under a proposal if grants were determined randomly. Specifically, I run 1,000 simulations where I draw a state's grant share for each amendment from a beta distribution. I estimate the parameters for the beta distribution from the observed data using the method of moments. For each simulation I estimate the following:

$$\Pr(GrantFromSim_{ip} > StatusQuoGrant_{ip}) = \beta_1 StatusQuoGrant_{ip} + \delta_{ic} + \epsilon_{ip}$$

where δ_{ic} is a state-congress fixed effect. Figure A2 compares the coefficients (β_1) from the simulation to the coefficient from the observed data calculated using the same specification. The effect sizes from the simulation are all smaller than the observed effect size (-4.053). This suggests that the probability of observing an effect as extreme as -4.053 if grants are randomly determined using the data generating process described above is zero. That is, the observed effect is not solely due to mean reversion.

Figure A2: Simulated Reversion to the Mean



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