The Effect of Electoral Geography on Pork Barreling in Bicameral Legislatures

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How does the electoral geography of legislative districts affect pork barreling? This article presents a formal model extending Mayhew's classic credit-claiming theory to account for the electoral geography of bicameralism. Under bicameralism, upper chamber (Senate) and lower chamber (Assembly) legislators who share overlapping constituencies must collaborate to bring home pork projects. Collaboration is easier between a Senator and an Assembly Member who share a large fraction of their constituents and thus have relatively aligned electoral incentives. But dividing a Senate district into a larger number of Assembly district fragments misaligns these electoral incentives for collaboration, thus reducing equilibrium pork spending. Hence, increased Senate district fragmentation causes a decrease in equilibrium spending. I exploit the 2002 New York Senate expansion as a natural experiment, examining how sudden changes in the geographic fragmentation of Senate districts account for differences in the distribution of pork earmarks immediately before and after the redrawing of district boundaries.

In 2002, two New York state legislators collaborated to convince the Virginia-based Veridian Corporation to build a new $7 million flight research facility at the Niagara Falls International Airport. Niagara Falls is represented in the Senate by George Maziarz (Republican) and in the Assembly by Francine DelMonte (Democrat). Both legislators secured pork earmark awards for Veridian from their respective chambers. Maziarz secured two Senate earmarks, totaling $1.43 million, while DelMonte directed a $500,000 Assembly earmark toward the construction of Veridian's new facility.[1] Collaborating to serve their overlapping Niagara Falls districts, the two legislators even coordinated their credit-claiming efforts, appearing together at Veridian's groundbreaking ceremony and issuing a joint, October 17, 2002, press release that announced:

> Senator George D. Maziarz and Assemblywoman Francine DelMonte today announced that Veridian Corporation will begin the development of its new flight research complex . . . bring[ing] new high paying jobs to Niagara County.

How does the electoral geography of bicameralism, highlighted by the shared credit claiming in the Veridian press release, affect legislators' incentives to pursue pork spending? The classic theory of Mayhew (1974) argues that all reelection-seeking legislators pursue the pork barrel in order to claim electoral credit with their constituents for bringing home particularistic spending projects. Countless theoretical models of distributive politics have assumed the validity of Mayhew's theory and have begun with the premise that legislators pursue

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[1]The three grants from Maziarz and DelMonte were earmarked for the same construction project at the Niagara Falls Airport. Maziarz's two earmarks were for the "construction of a 62' high bldg for hangar space and offices," while DelMonte's earmark was for the "design, engineering and equipping of a new hangar and office facility."

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pork projects to gain reelection votes (e.g., Ferejohn and Krehbiel 1987; Niou and Ordeshook 1985; Weingast, Shepsle, and Johnsen 1981). Yet subsequent empirical tests of Mayhew's hypothesis in multiple legislatures have produced mixed results and have raised important doubts about the theory's robustness.

For example, Stein and Bickers find that among members of Congress, credit claiming is rewarded only by voters who are highly attentive to politics or active within interest groups; hence, "not all legislators have the same incentives to utilize pork-barrel strategies . . ." (1994, 377). In fact, the authors find that most citizens remain unaware when their representatives bring home new federal spending projects. In Brazil's Chamber of Deputies, Samuels finds that many legislators do not pursue pork barreling as a credit-claiming strategy because the "identification of creditworthy politicians is relatively difficult . . . because voters may not perceive the benefits of the project and because voters may not credit the deputy for obtaining the project" (2002, 850). Many other studies have echoed these suspicions, showing that the credit-claiming hypothesis is conditional on various legislator and district characteristics (e.g., Alvarez and Saving 1997; Sellers 1997).

Collectively, these empirical studies raise important doubts about Mayhew's (1974) credit-claiming hypothesis and suggest a possible gap between empirics and theory, presenting a research puzzle: if voters are so inattentive and unable to credit the correct legislator responsible for obtaining each spending project, then what incentives drive most legislators' apparent motivation to bring home pork projects?

This article proposes a resolution to this puzzle based on the electoral geography of bicameralism, under which upper chamber (Senators) and lower chamber legislators (Assembly Members) have geographically overlapping districts. To analyze the consequences of this interchamber dynamic, this article's formal model revises and extends Mayhew's (1974) classic credit-claiming theory to account for bicameralism. The model preserves Mayhew's basic logic about credit claiming but accounts for the more recent finding that voters are unable to identify the precise legislator responsible for bringing home each project (Samuels 2002; Stein and Bickers 1994). Because of voters' ambiguity, a Senator and an Assembly Member with overlapping districts share both the responsibility and the credit for bringing home projects to their shared constituency.

The formal model shows that the mutual incentives that shape legislator collaboration on pork projects are determined by the degree of geographic overlap between Senate and Assembly districts, or k_s. Formally, k_s is the number of different Assembly districts that overlap with Senate district *s*. In New York, some Senate districts overlap with as few as three different Assembly districts ($k_S = 3$), while other Senate districts overlap with up to 12 ($k_S = 12$). The equilibrium results show that, ceteris paribus, an increase in k_s decreases the number of constituents shared between each Senator-Assembly Member pair, which decreases their shared payoff from collaborating on pork projects. Hence, equilibrium pork spending will be lower (higher) in Senate districts that overlap with more (fewer) different Assembly districts (k_S). This result can be stated more generally as follows:

> *The amount of pork-barrel spending a legislator brings home is a decreasing function of the geographic misalignment of lower and upper chamber electoral districts.*

The intuition behind this formal result is that collaboration on spending projects is more fruitful between a Senator and an Assembly Member who share a larger number of constituents, due to the close alignment of their electoral interests. By contrast, when k_s is high and two legislators share fewer overlapping constituents, a targeted pork project is less mutually beneficial to the two legislators, so equilibrium spending is lower.

This result represents a refinement of Mayhew (1974), building on and enhancing his classic credit-claiming theory to account for the electoral geography of bicameralism. This extension of Mayhew's original theory is important for both substantive and theoretical reasons. Substantively, bicameralism is an important institutional feature worldwide. Most OECD countries and all but one U.S. state employ bicameral legislatures; in most of these states, every citizen is represented by one or more geographically districted legislators in both chambers. Hence, as in the Veridian episode, legislators worldwide face the electoral complication of sharing their constituents with at least one other legislator from the opposite chamber. Theoretically, the varying geographic alignment of lower and upper chamber legislative districts, even within a single state, suggests that legislators may have differing incentives to collaborate with one another on pork projects.

Why is collaboration between legislators, as illustrated in the Veridian episode, such an important element of the pork-barreling process? One possibility is that legislators collaborate on spending projects to prevent free riding. Most voters cannot accurately identify the single legislator responsible for each pork project, so one legislator could free ride on the efforts of another legislator who shares the same constituency, unless they agree to collaborate. A second possibility is that legislators collaborate because a proposed pork project is more likely to be funded if it is jointly supported by both the upper and lower chamber legislators whose districts would benefit from the project.

To understand the nature of and motivations for legislator collaboration on projects, I interviewed 30 New York legislative staffers about the pork-barreling process. As detailed in the following section, the interviewees generally confirmed the second of these two explanations: while no interviewees expressed fears of free riding, many noted that projects with support in both chambers are more likely to be approved for funding by the chamber leaders.

To empirically test the formal prediction that Senate district fragmentation has a negative effect on pork spending, this article exploits the 2002 expansion of the New York Senate as a natural experiment. As explained later, Senate districts were redrawn in 2002 to expand the number of Senate seats, causing sudden and numerous changes in the electoral fragmentation of Senate districts across the state. Exploiting these exogenous changes, this article compares the distribution of earmark spending immediately before and after the 2002 Senate expansion. The findings suggest that a sudden increase in Senate district fragmentation causes a decrease in pork spending.

This article proceeds as follows. The first section describes interviews conducted to gain insight into New York's pork-barreling process and legislators' motivations for collaborating on pork projects. Next, a formal model of pork barreling in a bicameral legislature predicts a negative relationship between Senate district fragmentation and pork earmark spending in equilibrium. Finally, the article corroborates the formal model's predictions using line-item data on pork projects earmarked by New York Senators.

The New York Senate Pork-Barreling Process

The pork-barrel spending data in this article include thousands of spending projects that are funded by several state sources. The most prominent of these funding sources are the Community Capital Assistance Program (CCAP), the Strategic Investment Program (SIP), and the Community Enhancement Facilities Program (CEFAP). Each of these funding programs is allotted a fixed budget in the annual state budget, but the disbursement of individual grants from each program is at the discretion of the Senate and Assembly leaders and not subject to legislative or executive approval.

Individual legislators can request money from these funding programs to bring home pork project grants, formally called Member Items, to their constituents. The salient feature of this system is that legislators can request Member Item pork-barrel grants for any recipient of their choice and for any legal purpose. Individual Member Item spending projects never require approval by the entire legislative chamber or by the executive branch. Rather, Member Item requests need only the approval of either the Senate leader or the Assembly leader in order to secure funding. How do the chamber leaders decide which projects to approve?

To understand the details of this pork-barreling system in the New York legislature, I confidentially interviewed the legislative office staffs of New York Senators and Assemblymen by telephone during January and February of 2009. I specifically agreed not to identify interviewees and their legislative offices by name, by their staff titles, by party affiliations, or by names that would identify their geographic constituencies. I called legislative offices chosen at random until obtaining responses in 15 Senate offices and in 15 Assembly offices. From all of the interviewed legislative staffers, I requested information along three lines of questioning:[2]

1) to explain the entire process by which pork-barrel projects (which I referred to as "Member Items") are awarded from the funding programs (e.g., CCAP, SIP, etc.);
2) to explain the criteria used by Senate and Assembly leaders to decide which Member Item requests to approve; and
3) to list which other legislators, if any, they collaborate with when pursuing Member Item project grants, and to give anecdotes describing these collaborative efforts.

Question 1 (The Member Item Process). Nearly every interviewee willing to answer the first question gave an overall account of the pork-barreling process fairly consistent with media accounts: interviewees confirmed that Member Items are initiated by request from individual legislators, who may request project grants for any legally

[2]I also asked staff members how frequently their legislators' grant requests are approved or denied by the Senate leaders, but most interviewees either did not know or declined to give this information. Additionally, I attempted to speak with former Senate Majority Leader Joseph Bruno, who had already resigned in July 2008 and declined to be interviewed. The current chamber leaders' offices also did not grant requests for nonconfidential interviews.

eligible recipient and purpose.[3] The respective legislative chamber leaders have final discretion over whether to approve requests.

A few interviewees also noted that their legislative offices' Member Item requests are often motivated by specific funding requests by the constituents from their geographic districts. A typical anecdote was given by one interviewee who remarked: "[City Name's] YMCA asks for our support for [an annual program] . . . We're pleased to help them out every year because . . . [it] serves an important need in [City Name]" (Phone interview, February 9, 2009).

Question 2 (Selection Criteria). Interviewees gave a wide range of answers in response to the second question regarding the criteria used by chamber leaders to approve or deny Member Item requests.[4] Most interviewees either declined to speculate (by referring this question to the chamber leaders or to various state agency offices) or gave unspecific answers. For example, one interviewee stated that the "best-looking" projects that serve "great causes" are funded, while another interviewee stated: "No one really knows because there aren't a lot of rules they [the chamber leaders] have, so to speak" (Phone interviews, January 22 and January 13, 2009).

Among the interviewees who gave more specific answers, several agreed on the importance of having multiple supporters for a Member Item, either as formal sponsors or informal advocates. For example, one staffer noted, "It's definitely an advantage when an initiative [Member Item proposal] is being pushed by two of them [legislators]" (Phone interview, February 2, 2009). Another interviewee implied that a proposal with a supporter in both chambers is more likely to be funded. This interviewee, a staffer at an Assembly member's office, gave an example: "If Assemblywoman [redacted] is saying the fire department needs funds, and Senator [redacted] is agreeing by putting in the same request over there [in the Senate], then that's a pretty good indication that it does" (Phone interview, February 11, 2009).

When asked why the chamber leaders favor pork projects with sponsors in both chambers, the interviewee suggested that dual sponsorship is a sign of a more popular project, and a chamber leader "is going to fund initiatives that are popular . . . That's the bottom line" (Phone interview, January 22, 2009). A different interviewee offered a similar explanation: dual sponsorships help to identify the most worthy pork projects. The chamber leaders "aren't as familiar [as rank-and-file legislators] about which programs in [our region] are the best . . . we help them out by saying which ones are the most vital" (Phone interview, February 9, 2009).

Question 3 (Examples of Collaboration). In response to the third question regarding collaboration between different legislators, most interviewees who responded affirmed that their legislative offices communicate or coordinate with other legislators when preparing Member Item requests. When asked for specific names of other legislators with whom their offices had collaborated, many interviewees identified at least one legislator in the opposite chamber with a shared geographic constituency. That is, a Senator's legislative staffer would identify an Assembly Member with a geographically overlapping district as a collaborator, and vice versa. For example, one staffer from an Assembly Member's office remarked in an interview, "We'll check with Senator [redacted] about Member Items since both of us serve the [City Name] area" (Phone interview, January 22, 2009). Other interviewees emphasized that the nature of collaboration on Member Item requests is not always formal; rather, a legislator might verbally lobby for a Member Item that was formally requested by another legislator. As one interviewee from an Assembly office explained, "Even if [Assembly Member] isn't signing the initiative request, [he or she] might talk to [the Senate majority leader] and explain why the organization needs money. It helps to have that" (Phone interview, January 13, 2009).

Overall, the interviews revealed that while the Member Item approval process remains nebulous, many legislators believe that building a coalition of support for a proposed project creates an important advantage for obtaining a Member Item. However, an inherent problem in securing a second supporter for any pork project is that, because both New York chambers contain only single-member districts, natural coalition partners cannot be found within the same chamber. In other words, no two Senators share an overlapping constituency, so there are no natural opportunities for two Senators to cosponsor a single, mutually beneficial pork project. By contrast, Senators and Assembly Members *do* share overlapping constituencies, so a Senator seeking a pork project for her own district can naturally collaborate with the Assembly Member whose constituents would also benefit from the same project.

In fact, the interviewees cited similar logic in explaining why they communicate with members of the opposite chamber when pursuing Member Items. The

[3] For example, funds from Member Item initiatives may not be used for political activities or to purchase alcohol.

[4] For example, some interviewees noted that members of the majority party in each chamber are more likely to have their Member Item requests funded. Other interviewees stated they were unaware that partisanship plays a role.

interviewees agreed that a proposed project is significantly more likely to be funded when both a Senator and an Assembly Member collaborate in endorsing the proposal. As described later, this finding serves as the basis for this article's formal model, in which legislators must collaborate to pursue earmarks.

Why Do Some Legislators Not Collaborate?

The original round of interviews yielded interesting findings regarding the reasons a legislator might wish to collaborate with certain members of the opposite chamber when pursuing pork projects. However, the respondents did not explain why a Senator might decide *not* to collaborate with a certain Assembly Member (and vice versa), particularly one whose district overlaps with the Senator's own district. The original interviews did not ask this question.

To answer this question, I conducted a second round of follow-up interviews to ask why a particular legislator *does not* collaborate with a certain, randomly chosen legislator from the opposite chamber (randomly chosen from among the legislators *not* named during the first interview). Specifically, I used the following procedure for this second round of interviews:

Suppose that Senator *A*'s district overlaps with parts of four different Assembly districts, which are represented by Assembly Members *B*, *C*, *D*, and *E*. Further suppose that in the original round of interviews, Senator *A*'s staffer stated that Senator *A* often collaborates with Assembly Members *B* and *D*. This answer implies that *A* does not collaborate frequently with Assembly Members *C* and *E*. Among *C* and *E*, I chose the Assembly Member whose name appears first alphabetically. Suppose *C*'s name comes first alphabetically. Then I would interview the same staffer from Senator *A*'s office a second time and ask the following question:

> The last time we spoke, you mentioned that Senator *A* often works together with Assembly Members *B* and *D* to obtain Member Items. I'm wondering why Senator *A* hasn't collaborated with Assembly Member *C* quite as frequently on Member Items?

An analogous procedure was used for interviewees in Assembly Members' offices. I only interviewed legislative staff members who had already named one or more collaboration partners in response to Question 3 during the first round of interviews. However, in three cases, the original interviewee had already named every single overlapping legislator from the opposite chamber as a collaborator, so these interviewees were not called back a second time. In two other cases, the original interviewee declined or was unavailable to speak again.

Though the number of interviews conducted is too small to draw statistical inferences, the interviewees gave two types of responses. Interestingly, none of the interviewees cited partisan or ideological differences as a reason for not collaborating with a certain legislator. One group of interviewees either declined to answer the question or disagreed with the assumption that their legislator does not collaborate often with the second legislator named. For example, one interviewee responded to the question by rebutting, "I think they [the two legislators] do work together from time to time . . . ." Another interviewee noted that the two legislators named had collaborated on bills in the past (Phone interviews, February 25, 2009).

A second group of interviewees, however, answered the question by noting the geographic misalignment of electoral interests between their legislator and the opposite-chamber legislator I mentioned. Specifically, a number of interviewees cited the lack of geographic overlap in their constituencies as a reason for not collaborating. For example, one Senator's staffer was asked why the Senator has not collaborated frequently with a certain Assembly Member, even though the two legislators have slightly overlapping districts. The staffer explained that because the geographic overlap of their districts is relatively small, the two legislators' respective constituencies have divergent preferences on Member Item projects:

> Well, Senator [redacted] represents . . . the [redacted] areas, but Assemblyman [redacted] is from [redacted] . . . So they're getting [Member Item] initiative requests from different . . . organizations, you know? (Phone interview, February 23, 2009)

In other words, the businesses and nonprofits that lobby the Senator for earmarks are different from the groups that lobby the Assemblyman, whose district barely overlaps with the Senator's.

Another interviewee gave a similar explanation:

> The [Member Item] projects . . . are ones that programs in the community ask for . . . Lots of programs in [City X] are asking Senator [redacted] for help . . . And Assemblywoman [redacted], that's not really part of her district. (Phone interview, February 23, 2009)

In summary, two legislators might not collaborate with one another on pork projects due to coordination problems arising from misalignment of constituent interests. Among those interviewees who gave a specific reason for not collaborating with a certain legislator, the most commonly cited reason was the lack of geographic overlap in their districts' constituencies. If a Senator and an Assembly Member share very few or no constituents, then opportunities for collaboration on mutually beneficial pork projects are rare. I interpret this finding as evidence of the importance of geographic alignment of electoral interests between potential legislative collaborators, and, as described below, this intuition serves as the basis of the formal model.

Theoretical Issues

This section discusses and justifies three important assumptions of the formal model.

Collaboration on Pork Projects. As detailed in the previous section, the interviewees emphasized the importance of cross-chamber collaboration in pursuing Member Item grants. The formal model incorporates this finding as follows: I make the simplifying assumption that a pork project proposal needs at least one supporter in both the Senate and the Assembly in order to be funded. That is, if a Senator seeks to obtain a project for her own district, then she must find at least one member of the Assembly willing to endorse the project, and vice versa.

In addition to the interviewees' anecdotes, a review of legislators' press releases, media accounts, and official Member Item records suggests that collaborations often occur informally and are important for securing project funding. As one interviewee observed, an Assembly Member might speak to the Senate Majority Leader and verbally advocate on behalf of a Senator's Member Item proposal.

In other cases, such as the Veridian earmark described at the outset of this article, the collaboration between a Senator and an Assembly Member is more formal: the two legislators may jointly sponsor a project benefitting their shared constituents. In the Veridian episode, the collaboration between Senator Maziarz and Assemblywoman DelMonte was possible because their respective constituencies overlap in Niagara Falls: of the 127,936 constituents in DelMonte's Assembly district, 72,434 (57%) also reside in Maziarz's Senate district. Hence, even if most voters remained unaware of the specific Veridian earmarks, they would at least observe the positive economic effects of the new research facility and credit both legislators accordingly. Indeed, both legislators won reelection in 2004 by wide margins.

The formal model incorporates these different types of collaboration by allowing legislators to endorse a proposed pork project. The act of endorsement is costless for legislators, but a legislator will endorse a project only if it brings net positive benefits to her constituents. To incorporate the interviewees' emphasis on the importance of having multiple supporters, the formal model simplifies this requirement: a proposed pork project is funded only if at least one legislator from each of the two chambers endorses the proposal.

Hence, the formal model mimics the Weingast, Shepsle, and Johnsen (1981) norm of universalism, under which the rest of the chamber defers to an individual member to select the size of projects that are targeted to the member's own district. I adapt this model to a bicameral legislature, using the analogous assumption that in choosing the size of a pork project, each of the two chambers defers to the legislator in that chamber whose constituents would benefit from the project.

Ambiguity in Credit Assignment for Pork. An important theoretical advancement of the formal model is that it incorporates voters' confusion in deciding which of their elected officials to credit for local pork projects. Many scholars have concurred in suggesting that accurate credit assignment is a confusing task for all but the most attentive voters (e.g., Bednar 2007; Martin 2003).

To incorporate ambiguity in credit assignment, the model assumes that a legislator will be electorally rewarded for any pork project that brings net benefit to her district, regardless of whether or not the legislator was either the original proposer or an endorser of the project. Specifically, I assume that a legislator's payoff is the sum of all of her citizens' net payoffs from pork projects. Intuitively, this assumption means that citizens simply observe the project outputs and positive economic impacts of pork spending in their district. In turn, citizens reward all incumbent politicians for these positive outcomes, rather than investigating to determine which legislator was most responsible for bringing home the project.

Geographic Targeting of Pork Projects. Like the Veridian earmark grant, most pork projects that New York legislators bring home exhibit classic characteristics of pork-barrel spending: economic benefits are confined to a local area or county, while costs are borne from general statewide revenue sources. Hence, the formal model uses the simplifying assumption that pork-barrel projects are targeted to the Senate district level.

Specifically, the basic model assumes that citizens within a Senate district receive equal shares of project benefits directed to their district. Suppose that a Senate district with 25 citizens receives 100 units of pork. Then each individual within the district enjoys four units of benefits.

Afterwards, I relax this targeting assumption and consider the alternative assumption that projects are targeted to the Assembly district level. I show that altering this targeting assumption does not change the main comparative static results of the model.

The Bicameral Legislature Model

Players. A bicameral legislature consists of m Assembly Members (lower chamber), denoted $a \in \{1, \ldots, m\}$, and n Senators (upper chamber), denoted $s \in \{1, \ldots, n\}$, where $m \geq n \geq 1$. All districts are single member and equally apportioned within each chamber. There are P citizens, so each Senator represents exactly P/n constituents, and each Assemblyman has P/m constituents. For clarity, I use male pronouns for Assemblymen and female pronouns for Senators.

Strategies. Within each of the two chambers, one legislator is recognized at random to propose a pork-barrel project. The recognized legislator proposes a project of size $x \in [0, \infty)$ to be located in any single Senate district of his or her choice. Finally, the legislators in the opposite chamber individually decide whether or not to endorse this proposal.

As noted in the previous section, a pork earmark is shared equally among the citizens in the targeted Senate district. The cost of a project of size x is $C(x) = x^2$, and project costs are shared equally by all citizens. Hence, project benefits are first-order increasing but second-order decreasing on project costs. Therefore, when Senate district s receives x units of pork, each citizen in district s receives $\frac{x}{P/n}$ in benefits, while each citizen in all districts pays $\frac{x^2}{P}$ in costs.

The Norm of Universalism. As discussed in the *Theoretical Issues* section, this article follows the Weingast, Shepsle, and Johnsen (1981) model and its progeny in assuming that pork-barreling projects are funded under a norm of universalism, whereby the entire chamber defers to legislator i to determine the size of projects located within i's district. Adapting this norm to a bicameral legislature, I assume that a pork project is funded if it is either proposed or endorsed by at least one legislator in each of the two chambers. Hence, analogous to Weingast, Shepsle, and Johnsen (1981), a pork project needs only the support of one Senator and one Assemblyman to be funded.

Hence, this model adds complexity to Weingast, Shepsle, and Johnsen (1981) by allowing both chambers to initiate project proposals. I introduce this additional complexity to the model because bicameralism has a substantively important role in distributive politics. New York's pork-barrel records suggest, and anecdotal evidence from interviews confirms, that legislators from both chambers regularly initiate project proposals. This article seeks to illustrate that the credit-sharing result remains robust even after accounting for legislators' pork-barreling strategies in both chambers.

Sequence of Play. Formally, the sequence of play is as follows:

1(a). One Senator, $s \in \{1, \ldots, n\}$, is randomly recognized to make a proposal.
1(b). Senator s proposes a project of size $x_s \in [0, \infty)$ for any single Senate district.
1(c). Each Assemblyman chooses whether to endorse this proposed project of size x_s.
2(a). One Assemblyman, $a \in \{1, \ldots, m\}$, is randomly recognized to make a proposal.
2(b). Assemblyman a proposes a project of size $x_a \in [0, \infty)$ for any single Senate district.
2(c). Each Senator chooses whether to endorse this proposed project of size x_a.

Geographic Overlap of Districts. For notation, $\forall s \in \{1, \ldots, n\}$, let k_s represent the number of Assembly district fragments located within Senate district s. While different Senate districts may have varying values of k_s, the geographic limits on k_s are $\lceil m/n \rceil \leq k_s \leq m$, where $\lceil m/n \rceil$ denotes the smallest integer weakly greater than m/n. Hence, suppose a legislature contains 10 Senate districts and 15 Assembly districts. It would be geographically impossible for any Senate district to overlap with fewer than two or more than 15 Assembly district fragments.

For simplicity, assume that each of the k_s overlapping fragments within Senate district s contains an identical population. For example, suppose Senate district s contains 100 citizens and $k_s = 4$, while each Assembly district contains 50 citizens. Then each of the four overlapping Assembly districts shares exactly 25 citizens with Senator s's constituency, while the remaining 25 citizens lie outside of Senator s's district. Similarly, assume that when an Assembly district is fragmented into multiple Senate districts, each of the fragments contains an identical population.

Utility Payoffs. An individual citizen's utility payoff consists of her equal share of project benefits within her Senate district, minus her share of the total costs of all projects in all districts. For example, suppose that Senate district *s1* receives a project of size x_{s1}, while another Senate district, *s2*, receives a project of size x_{s2}. Then each citizen, *i*, residing within district *s1* receives the payoff:

$$u_i(x_{s1}, x_{s2}) = \frac{x_{s1}}{P/n} - \frac{x_{s1}^2}{P} - \frac{x_{s2}^2}{P}, \tag{1}$$

where the first term, $\frac{x_s}{P/n}$, represents *i*'s per capita share of the project benefits, and the second and third terms, $-\frac{x_{s1}^2}{P} - \frac{x_{s2}^2}{P}$, represent *i*'s equal share of the two projects' costs.

A legislator's utility payoff is the sum of the individual payoffs of all constituents who reside geographically within his or her district. Hence, under the previous example, Senate district *s1*'s Senator receives the payoff:

$$u_{s1}(x_{s1}, x_{s2}) = x_{s1} - \frac{x_{s1}^2}{n} - \frac{x_{s2}^2}{n}, \tag{2}$$

where x_{s1} represents the total project benefits enjoyed by *s1*'s citizens, and $-\frac{x_{s1}^2}{n} - \frac{x_{s2}^2}{n}$ represents the citizens' collective burden of total project costs.

Further, suppose that Assembly district *a1* overlaps with Senate district *s1* but not with *s2*. Then, continuing with the previous example, *a1*'s Assemblyman receives the payoff:

$$u_{a1}(x_{s1}, x_{s2}) = \frac{x_{s1}}{k_{s1}} - \frac{x_{s1}^2}{m} - \frac{x_{s2}^2}{m}, \tag{3}$$

where $\frac{x_{s1}}{k_{s1}}$ represents the amount of project benefits that flow into Assembly district *a1*, as $\frac{1}{k_{s1}}th$ of Senate district s1's residents are shared with *a1*. In other words, $\frac{x_{s1}}{k_{s1}}$ represents the shared project benefits enjoyed both by *s1*'s Senator and *a1*'s Assemblyman due to their geographically overlapping constituency. This quantity gives rise to the credit-sharing and coordination phenomenon that motivates this article.

Equilibrium Results. *Lemmas A* to *D* present only the necessary subgame perfect Nash equilibria (SPNE) results to determine the expected sum of pork projects within Senate districts. I assume that Senators and Assemblymen resolve indifference in favor of endorsing proposals and that Assemblymen randomly target project proposals when indifferent.

To calculate the amount of pork funded in equilibrium, I first describe the range of project sizes that Assemblymen (*Lemma A*) and Senators (*Lemma B*) are willing to endorse during stages *1 (c)* and *2 (c)*, respectively, in the sequence of play.

Lemma A (Assemblymen's Acceptance Set for Proposals). *Suppose a Senator proposes a project of size* $x_s > 0$ *to be located in Senate district s. Then* $\forall a \in \{1, \ldots, m\}$, *Assembly district a's Assemblyman endorses this project if and only if:*

(1) Assembly district *a* overlaps geographically with Senate district *s*; and:
(2) $x_s \leq \frac{m}{k_s}$.

Lemma B (Senators' Acceptance Set for Proposals). *Suppose an Assemblyman proposes a project of size* $x_a > 0$ *to be located in Senate district s. Then Senate district s's Senator endorses this project if and only if* $x_a \leq n$. *All other Senators decline to endorse.*

Proof: Appendix A.

Lemmas A and *B* describe the set of proposals that legislators endorse in SPNE. By assumption, all legislators are willing to endorse any project of size $x = 0$. For all nonzero project proposals, the driving intuition here is that a legislator endorses only if the project benefits some of his or her constituents, and the sum of the benefits outweighs the district's share of project costs. Project benefits are second-order decreasing on costs, so a legislator will reject an excessively large project even when benefits are targeted to her own district.

Lemma C (Senators' Proposal Strategy). *Suppose Senate district s's Senator is recognized. Then in SPNE, this Senator proposes a project of size* x_s *to be targeted to her own district, where the size of* x_s *is:*

$$x_s = \begin{cases} n/2, & \text{if } k_s < (2m)/n; \\ m/k_s, & \text{otherwise.} \end{cases} \tag{4}$$

Lemma D (Assemblymen's Proposal Strategy). *Suppose Assembly district a's Assemblyman is recognized. Then in SPNE, this Assemblyman proposes a project of size* $x_a = m/(2k_s)$, *to be targeted to any one of the Senate districts that overlap with Assembly district a.*

Lemmas C and *D* describe legislators' optimal proposal strategies when recognized to make a proposal. The intuition behind these results is that a proposer chooses a project that maximizes the utility enjoyed by his or her constituents while constrained by the need to secure an endorsement from a member of the opposite chamber.

Propositions 1 and *2* use the results from *Lemmas A* to *D* to derive comparative statics:

Proposition 1 (Comparative Statics). *Let χ_s represent the total size of all pork projects targeted to Senate district s,* $\forall s \in \{1, \ldots, n\}$. *In SPNE, the expected value of χ_s^* is:*

$$E\left(\chi_s^*\right) = \begin{cases} \frac{1}{2} + \frac{m}{2nk_s}, & \text{if } k_s < (2m)/n; \\ \frac{3m}{2nk_s}, & \text{otherwise} \end{cases} \tag{5}$$

This amount is:

1 ***(a):*** *First-order decreasing on* k_S.
1 ***(b):*** *Linearly increasing on* $(1/k_S)$.

Proof: Appendix A.

Proposition 1 states the expected amount of pork, $E(\chi_s^*)$, that Senate district *s* receives in SPNE. This amount (*equation 5*) is in *expectation* because in each play of the game, the distributive outcome depends on which legislators are recognized to make proposals. The first-order derivative of *equation (5)* with respect to k_S is strictly negative, indicating that pork spending decreases as the number of House district fragments within Senate district *S* increases (*Proposition 1a*).

The intuition behind this comparative static is that an increase in k_S decreases the number of constituents shared between *S*'s Senator and each overlapping Assembly Member. Hence, each Senator-Assembly Member pair shares less mutual benefit from a pork project targeted to their overlapping constituents, so they have less incentive to bring home large projects, as project costs are second-order increasing on size. In other words, this comparative static result is driven by the geographic misalignment of Senate and Assembly districts when k_S is high and by the fact that voters enjoy diminishing marginal returns from pork spending.

In *Proposition 1 (b)*, the inverse of the number of fragments, $1/k_S$, exhibits a positive linear relationship with $E(\chi_s^*)$, expected project size. I present this comparative static because the regression models in this article constrain the relationship between measures of spending and district fragmentation to be linear. Hence, *Proposition 1 (b)* allows for a more precise fit between the formal model predictions and empirical testing.

Definition 1 (Diversity Index). *Let D_s indicate the diversity of Assembly districts represented within Senate district S, where D_s is defined by the Gibbs and Martin (1962) index of diversity. This definition is:*

$$D_s = 1 - \sum_{a=1}^{m} (p_{sa})^2, \tag{6}$$

where p_{sa} is the proportion of Senate district s's population that also belongs to Assembly district a.

Intuitively, D_s represents the diversity of Assembly districts represented within the population of Senate district *s*. Therefore, Senate districts containing more Assembly district fragments (k_s) will also have a higher value of D_s. In the formal model, this positive relationship between k_s and D_s is trivial because all of the k_s Assembly district fragments within Senate district *s* are assumed to be equally populous.

However, in the empirical data presented in this article, New York Senate districts violate this assumption: in New York, the proportions of a Senate district belonging to the k_S overlapping Assembly districts are not always equal. Hence, in the empirical tests, D_s serves as a more precise measurement of the electoral fragmentation of each Senate district.

Proposition 1 (c) (Comparative Static on D_s). *In SPNE, the expected total size of pork projects targeted to Senate district s is:*

$$E\left(\chi_s^*\right) = \begin{cases} \frac{1}{2} + \frac{m}{2n}(1 - D_s), & \text{if } : D_s < 1 - \frac{n}{2m}; \\ \frac{3m}{2n}(1 - D_s), & \text{otherwise,} \end{cases} \tag{7}$$

which is linearly decreasing on D_s.

Proof: Appendix A.

Proposition 1 (c) presents the same relationship as *1 (a)* but expresses the comparative static in terms of the diversity index, D_S. Dividing a Senate district into more Assembly district fragments (high D_S) decreases its pork spending. Collectively, *Propositions 1 (a)* through *(c)* express the same relationship between Senate district fragmentation and pork spending but use three different measurements of electoral fragmentation. All three comparative static results are presented here because the empirical tests in this article use all three measurements of district fragmentation in order to demonstrate the robustness of this article's main finding.

In particular, the advantage of *Propositions 1 (b)* and *1 (c)* is that these two comparative statics both predict linear relationships; hence, the predictions lend more appropriately to linear regression models. *Proposition 1 (a)*, by contrast, does not predict a linear relationship between k_S and pork spending. Nevertheless, this comparative static presents the more intuitive interpretation that an increase in the number of Assembly districts overlapping a Senate district produces a decrease in pork spending.

Proposition 2 presents two results that replicate the findings of Weingast, Shepsle, and Johnsen (1981):

Proposition 2 (a) (Inefficiency). *In any multidistrict legislature, where $n \geq 2$, legislative spending in equilibrium is strictly greater than the socially optimal level.*

Proposition 2 (b) (The Law of 1/n). *Project inefficiency increases on legislative districts. The size of pork projects passed in SPNE is strictly increasing on m, the number of Assembly districts, and weakly increasing on n, the number of Senate districts.*

This article's formal model is an extension of Weingast, Shepsle, and Johnsen (1981), so Proposition 2 demonstrates that the model reproduces the two important results of their model: First, the geographically targeted benefits and dispersed costs associated with pork projects cause legislatures to inefficiently overspend (*Proposition 2a*). Second, the degree of inefficient overspending on pork increases with the number of legislative districts (*Proposition 2b*), a result known as the "Law of 1/n."

However, this result is qualified by Primo and Snyder's (2008) finding that the "Law of 1/n" is certain to hold only for distributive projects that have dispersed costs, geographically targeted benefits without spillovers, and low deadweight costs of taxation. Similarly, this article's formal model predictions apply only to pork-barrel projects with shared costs and locally confined benefits. Accordingly, the empirical data include only a unique category of New York state spending that closely resembles prototypical pork barreling. Though this article does not empirically test the "Law of 1/n" predictions, I prove them theoretically to emphasize that the formal model and its results are grounded in the original logic of the Weingast, Shepsle, and Johnsen model.

Extensions to the Basic Model

Weighted Recognition Probabilities. The basic model assumes that all Senators have an equal recognition probability of $1/n$. Yet most partisan legislatures violate this assumption in important ways: members of the majority party and legislators with seniority tend to enjoy greater access to committee powers and plenary time. Hence, majority party members bring home larger shares of the pork barrel, a result established both empirically (e.g., Balla et al. 2002; Bickers and Stein 2000; Lee 2003) and theoretically (e.g., Baron 1991).

How would accounting for majority party status and seniority affect the equilibrium results of the model? Consistent with Snyder, Ting, and Ansolabehere (2005), legislators with higher recognition probabilities would obtain larger shares of the pork barrel, ceteris paribus. Suppose that in the formal model, majority party Senators are recognized with probability p_H while other Senators have a p_L probability of recognition, where $p_H > p_L$. Then Senate districts with majority party senators would be more likely to receive pork projects, but the equilibrium size of these projects would remain the same as before. Hence, the amount of Senate pork in majority party districts would be greater than in minority party districts by a factor of p_H/p_L.

Geographic Targeting of Projects to the Assembly District Level. The basic model assumes that projects are targetable to the Senate district level. How would the equilibrium results change under the alternative assumption that projects are targeted to the Assembly district level, and project benefits are divided equally among the P/m citizens in the targeted district?

When the basic model is solved under this alternative assumption, the equilibrium project sizes are slightly different, but the main comparative statics continue to hold. Specifically, the expected sum of project benefits enjoyed by citizens of Senate district s becomes:

$$E(\chi_s^*) = \begin{cases} \dfrac{m}{2n} + \dfrac{m}{2nk_s}, & \text{if } k_s < 2; \\ \dfrac{3m}{2nk_s}, & \text{otherwise}, \end{cases} \tag{8}$$

which, as in *Proposition 1*, is first-order decreasing on k_S and linearly increasing on $(1/k_S)$.

Empirical Analysis of New York Pork Earmarks

The Empire State Development Corporation (ESDC), a New York state agency, administers legislative earmark projects statewide under six spending programs: the Community Capital Assistance Program (CCAP), Strategic Investment Program (SIP), Community Enhancement Facilities Program (CEFAP), Centers of Excellence (COE), Empire Opportunity Fund (EOF), and Strategic Investment Program (SIP). The ESDC has no discretion over which projects to fund. Rather, it merely administers funding for projects chosen by legislators under the pork-barreling earmark process described in the interviews.

In 2006, the ESDC complied with a series of Freedom of Information Law (FOIL) requests and turned over line-item data on Senators' earmarked pork projects from 1998 to 2004.[5] During this period, Senators earmarked 1,164 project grants, totaling $1.2 billion, to local governments, businesses, and nonprofit organizations throughout New York. The data identify the street addresses of earmark recipients as well as the Senators sponsoring the earmarks. In the vast majority of cases, Senators requested earmarks for grant recipients located within their own legislative districts, and this article analyzes only these earmarks.

I analyze the geographic variation of earmark spending across Senate districts and across New York zip codes. First, the results show that Senate districts that are fragmented into more (fewer) Assembly districts receive less (more) pork spending, consistent with the predictions of *Proposition 1*. Next, I use the November 2002 expansion and redistricting of the New York Senate as a natural experiment. The results show neighborhoods that switched into a Senate district with higher (lower) fragmentation experienced a decline (increase) in pork spending sponsored by their Senators, providing evidence of the district fragmentation's causal effect on spending.

Measuring Senate District Fragmentation. Propositions 1 (a), (b), and *(c)* derived comparative statics utilizing three different measures of Senate district fragmentation: k_S, $1/k_S$, and D_S. The purpose of presenting and analyzing all three variables is to illustrate the empirical robustness of this article's main result, that an increase in the number of Assembly districts that overlap with a Senate district causes a decrease in the Senate district's pork.

The empirical measurements of k_S, $1/k_S$, and D_S are as follows. For each New York Senate district, k_S denotes the number of Assembly districts that overlap geographically with the Senate district. For example, Senate District 24, covering Staten Island, overlaps with Assembly Districts (AD) 60, 61, 62, and 63; therefore, $k_{24} = 4$. Among New York's 62 Senate districts, k_S ranges in value from 3 to 12. The second measurement, $1/k_S$, is the inverse of k_S.

Finally, D_S is the Senate district's electoral diversity index, as described in *Definition 1*. Among New York Senate districts, the value of D_S ranges from 0.61 to 0.84. For example, Senate District 24 has a total population of 311,258, of whom 55,088 reside in AD 60; 34,500 reside in AD 61; 121,213 reside in AD 62; and 100,457 reside in AD 63. Therefore, applying *Definition 1*, the Gibbs-Martin diversity index for Senate District 24 is:

$$D_{24} = 1 - \left(\frac{55,088}{311,258}\right)^2 - \left(\frac{34,500}{311,258}\right)^2 - \left(\frac{121,213}{311,258}\right)^2 - \left(\frac{100,457}{311,258}\right)^2 = 0.700571.$$

Clearly, the electoral diversity index (D_S) is the most comprehensive measure of district fragmentation because D_S accounts for the distribution of a Senate district's population across the various Assembly districts. Nevertheless, this article presents empirical results using all three measurements of district fragmentation to demonstrate the robustness of the main finding.

Preliminary Empirical Tests. Proposition 1 predicts that more highly fragmented Senate districts should receive less pork spending. As a preliminary test of this prediction, Table 1 analyzes whether Senate districts that are more fragmented received less pork spending in 2003–2004. During this period, the median Senator brought home $462,500 in pork spending. However, the distribution of pork spending across the districts is right-skewed, and some districts received no earmarks. Therefore, the dependent variable is $\log(Y_S + 1)$, where Y_S is the total dollar amount of earmarks secured by district *S*'s Senator for her own constituents. I estimate the following three models, which are empirical tests of *Propositions 1 (a), (b),* and *(c)*, respectively:

$$\log(Y_S + 1) = \alpha + \beta_k \cdot k_S + \varepsilon_S, \tag{9}$$

$$\log(Y_S + 1) = \alpha + \beta_{1/k} \cdot (1/k_S) + \varepsilon_S, \tag{10}$$

$$\log(Y_S + 1) = \alpha + \beta_D \cdot D_S + \varepsilon_S, \tag{11}$$

where α is a constant and k_S, $1/k_S$, and D_S are the main independent variables corresponding to *Propositions 1 (a), (b),* and *(c)*, respectively.

The first three columns of Table 1 estimate *equations* (9–11). All three models demonstrate the significantly negative relationship between district fragmentation and pork spending predicted by the three comparative statics from *Proposition 1*. For example, Model 2 predicts that a one standard deviation increase in Senate district fragmentation is associated with a $54,000 decrease in pork spending to that district over 2003–2004.

The 2002 Senate Expansion as a Natural Experiment. The preliminary results in Table 1 support the predictions of *Proposition 1* by demonstrating the negative relationship between district fragmentation and spending. However, these preliminary results do not identify the causal direction of the relationship, nor do they rule

[5]Records of pork earmarks for Assembly members were released as well, but the records never identify the specific Assembly member responsible for each earmark. Hence, these earmarks are not analyzed as a dependent variable.

TABLE 1 Capital Pork Earmarks in New York's 62 Senate Districts, 2003–2004

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Proposition 1(a):	-1.08^{**}	—	—	-0.61^{*}	—	—
District Fragmentation (k_S)	(0.41)			(0.26)		
Proposition 1(b):	—	39.17^{**}	—	—	20.48^{*}	—
Inverse Fragmentation ($1/k_S$)		(14.15)			(9.13)	
Proposition 1(c):	—	—	-32.47^{*}	—	—	-25.37^{**}
Electoral Diversity Index (D_S)			(14.22)			(8.30)
Republican Senator	—	—	—	4.76^{**}	4.71^{**}	4.95^{**}
				(1.54)	(1.55)	(1.49)
Per Capita Income ($1,000s)	—	—	—	-0.21^{**}	-0.20^{**}	-0.20^{**}
				(0.070)	(0.069)	(0.067)
Poverty Rate	—	—	—	18.06	−16.38	−17.41
				(13.50)	(13.46)	(12.99)
Racial Minority	—	—	—	−6.77	−7.18	-7.26^{*}
				(3.40)	(3.37)	(3.23)
Senator's 2002 Electoral Margin	—	—	—	-7.36^{*}	-7.17^{*}	-6.18^{*}
				(3.09)	(3.09)	(3.00)
Population Density (1000s/Sq. Mi.)	—	—	—	−0.053	−0.054	−0.052
				(0.042)	(0.043)	(0.041)
Log Assembly Earmarks 2003	—	—	—	0.43^{**}	0.43^{**}	0.44^{***}
				(0.13)	(0.13)	(0.12)
Log Assembly Earmarks 2004	—	—	—	0.079	0.071	0.068
				(0.14)	(0.14)	(0.14)
Constant	15.37^{***}	1.65	32.74^{**}	16.95^{***}	9.31^{*}	31.19^{***}
	(2.71)	(2.66)	(10.59)	(4.60)	(4.55)	(7.26)
R^2	0.10	0.11	0.08	0.74	0.74	0.76
N	62	62	62	62	62	62

$^{***}p < .001$; $^{**}p < .01$; $^{*}p < .05$; (two-tailed); standard errors in parentheses.
Dependent Variable: Total logged dollars of Senator-sponsored capital pork spending, $\log(Y_S + 1)$, directed to each Senate district during 2003–2004.

out alternative theoretical explanations for this relationship. Hence, as a more robust identification strategy, I exploit the November 2002 expansion of the Senate as a source of sudden and exogenous variation in district fragmentation.

By constitutional formula, New York's Senate expanded from 61 to 62 single-member districts for the November 2002 election as a result of changes in state population. Due to the requirement of equal apportionment, Senate districts statewide were significantly redrawn to accommodate the newly created district. As a result, many towns were reassigned from one Senate district to another for the 2002 election. In fact, 891 of the 1,599 (56%) New York zip codes moved into a different Senate district. While a zip code's new Senate district may have an identical level of fragmentation (k_S) as the old district, the new district always has a different electoral diversity index (D_S), as the diversity index is a much more detailed measure of the district's electoral geography. Indeed, every zip code experienced a change in Senate district diversity index. Hence, for this natural experiment, I focus on the change in the diversity index (D_S) of the Senate district to which each zip code is assigned pre- and post-redistricting.

The basic intuition driving this natural experiment is that the 2002 Senate expansion caused sudden and statewide changes in the fragmentation of the Senate districts in which zip codes are located. Yet the main factors that influence a particular zip code's demand for pork-barrel projects—demographics, businesses, special interests, nonprofit organizations, voters' preferences and ideology, and local government needs—remain reasonably constant immediately before and after the November 2002 election. Hence, this article compares pork earmark awards at the zip code level immediately before and after the 2002 Senate expansion.

Of course, this natural experiment is not perfectly designed because the 2002 Senate expansion occurred simultaneously with (1) Senate elections that ushered in a new set of legislators and (2) a redistricting plan that introduces possible strategic gerrymandering of districts. In the following section, I later address these concerns about possible strategic drawing of the new districts and the effect of 2002 changes in legislative representation, and I show that these confounding events do not significantly alter the main results.

In this natural experiment, the main identification strategy is to regress pre- to post-redistricting changes in pork-barrel spending at the zip code level onto changes in the diversity index (D_S) of the Senate district in which each zip code is assigned before and after the Senate expansion. Formally, the basic model specification is:

$$\log\left(\frac{Y_Z^{POST}}{Population_Z}+1\right)-\log\left(\frac{Y_Z^{PRE}}{Population_Z}+1\right) = \alpha+\beta_{\Delta D}\left(D_Z^{POST}-D_Z^{PRE}\right)+\varepsilon_Z, \quad (12)$$

where Y_Z^{POST} represents per-year pork spending in zip code Z during 2003–2004, and Y_Z^{PRE} is the same measurement for years 1998–2002. Additionally, D_Z^{PRE} is the diversity index of the zip code's Senate district during 1998–2002, and D_Z^{POST} is the same measurement for 2003–2004. When a zip code spans more than one district, D_Z is the population-weighted mean of the diversity indices of all Senate districts in which the zip code lies. In all regression model estimates, I weight all observations by population.

Four control variables are also included: The *Per Capita Income* of each zip code is expressed in thousands of dollars. *Poverty Rate* is the proportion of the zip code's population living below the poverty level. *Racial Minority* is the proportion of the district that is either African American or Hispanic. *Population Density* is expressed in millions of people per square mile. Table 2 reports summary statistics of all variables.

Table 3 estimates *equation (12)* and finds significant evidence that an increase in a zip code's district fragmentation causes a decrease in pork spending to the zip code. In Model 1, a one standard deviation increase in its district's diversity index causes a \$0.092 annual per capita decrease in pork-barrel spending, which amounts to a decrease of \$28,000 per year for a mean-sized Senate district. This estimate is comparable in size to the preliminary results in Table 1.

To demonstrate the robustness of these results, I expand the empirical analysis in two directions. First, in Appendices B and C, I reestimate all models from Table 3 using two alternative specifications of the dependent variable: a lagged dependent variable (Appendix B) and a cubic root transformation rather than a log transformation (Appendix C). Results under the alternative specifications significantly confirm the main results from Table 3. Second, in the following section, I consider several alternative explanations for the main empirical findings.

Alternative Causal Explanations

Although this article's natural experiment isolates the impact of sudden changes in Senate district fragmentation, there are two vulnerabilities to this identification strategy, as noted earlier: First, the 2002 Senate expansion occurred simultaneously with the November 2002 election, which ushered in a new set of Senators who may have had different pork-obtaining abilities than their predecessors. Second, the fact that Senate districts are drawn by a partisan redistricting commission introduces the possibility of strategic behavior if the commission members are aware of district fragmentation's negative effect on pork barreling. I consider the possibility of these various alternative explanations for the main empirical results in this section.

1. *Majority Party Status.* Some of the interviewees noted that the Senate leader favors members of his own majority party in approving earmark requests. Throughout 1998–2004, the Senate remained under Republican control, so a town that switched from Democratic to Republican Senate representation (or vice versa) in the November 2002 election may have experienced a resulting increase (or decrease) in pork-barrel earmarks.

   To measure these effects, I expand *equation (12)* by adding indicator variables for zip codes that switched from Democratic (pre-November 2002) to Republican (post-November 2002) Senate representation, and vice versa.[6] I estimate this expanded model in column 2 of Table 3 (and column 2 of Appendices B and C).

   Consistent with the findings of previous empirical studies (e.g., Balla et al. 2002; Bickers and Stein 2000; Lee 2003), the Table 3 estimates suggest that a Senator's majority party status has a positive impact on pork spending. A zip code that switches from Democratic to Republican Senate

[6]When a zip code spans more than one Senate district, I count only the Senate district that contains the highest fraction of the zip code's population.

Table 2 Summary Statistics

Descriptive Statistics by Senate District

	Mean	Std. Dev.	Min	Max
Senate Pork Earmarks, 2003–2004 (logged)	8.63	7.01	0	18.67
District Fragmentation (k_S)	6.26	2.09	3	12
Inverse Fragmentation ($1/k_S$)	0.18	0.06	0.08	0.33
Electoral Diversity Index (D_S)	0.74	0.06	0.61	0.84
Republican Senator (2003–2004)	0.65	0.48	0	1
Per Capita Income ($1,000)	23.35	11.25	11.77	83.53
Senator's 2002 Electoral Margin	0.47	0.17	0.08	0.74
Poverty Rate	0.14	0.09	0.04	0.38
Racial Minority (Blacks and Hispanics)	0.30	0.29	0.04	0.94
Population Density (1000s/Sq. Mi.)	14.32	20.66	0.03	79.56
Logged Assembly Pork Earmarks, 2004	11.74	3.69	0	16.69
Logged Assembly Pork Earmarks, 2003	11.99	4.27	0	17.51

Note: $N = 62$ for all variables.

Descriptive Statistics by Zip Code

	Mean	Std. Dev.	Min	Max
Change in logged spending per capita, per year: $\log(Y_Z^{POST}/Population_Z + 1) - \log(Y_Z^{PRE}/Population_Z + 1)$	−0.071	1.04	−6.54	10.1
District Diversity Index, Pre-November 2002 (D_{PRE})	0.72	0.05	0.64	0.85
District Diversity Index, Post-November 2002 (D_{POST})	0.72	0.06	0.61	0.84
Δ District Diversity Index ($D_{POST} - D_{PRE}$)	0.00	0.05	−0.15	0.20
Per Capita Income ($1,000s)	22.53	11.71	0.00	155.50
Poverty Rate	0.11	0.09	0.00	1.00
Racial Minority (Blacks and Hispanics)	0.12	0.21	0.00	0.98
Population Density (1,000s/Sq. Mi.)	5.25	15.22	0.00	153.87
Democrat (Pre-Redist.) to Republican (Post-Redist.) Senator	0.03	0.16	0	1
Republican (Pre-Redist.) to Democrat (Post-Redist.) Senator	0.01	0.10	0	1
Population (1,000s)	11.9	17.8	0	106

Note: $N = 1{,}599$ for all variables, as New York has 1,599 populated zip codes. Several more zip codes are unpopulated and excluded from this analysis.

representation enjoys a significant, annual $0.64 per capita increase in pork spending. Switching from a Republican to a Democratic Senator produces a smaller and statistically insignificant decrease in a zip code's pork spending; this negative effect is statistically significant under alternate specifications of the dependent variable (Appendix C). Additionally, I add a Republican Senator indicator to *equation (11)*, finding that Republicans bring home significantly more pork (Table 1). Nevertheless, in all specifications, accounting for the impact of Senators' majority party status does not alter the main finding of electoral fragmentation's negative effect on pork barreling. In fact, accounting for this factor slightly enlarges the estimate of the effect of changes in the district diversity index in Table 3 and in Appendices B and C.

2. *Legislator Seniority.* Although only one of the interviewees mentioned this factor, I consider the possibility that the pork-barreling process favors more senior Senators. A possible confounding factor in the natural experiment is that a zip code may have been served during 2003–2004 by a more tenured or a less tenured Senator than the one who served during 1998–2002. To estimate this possible effect, I reestimate *equation (12)* after including an indicator for zip codes that switched to a more

TABLE 3 Change in Pork Earmark Spending by Zip Code from Pre- to Post-Redistricting Years

	Dependent Variable: Change in Logged Earmark Spending per Capita, per Year				
	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**
Proposition 1(c): Δ District Diversity Index ($D_{POST} - D_{PRE}$)	−1.23* (0.55)	−1.50** (0.55)	−1.50** (0.55)	−1.46** (0.55)	−1.61** (0.57)
Per Capita Income ($1,000s)	−0.0072** (0.0027)	−0.0063* (0.0028)	−0.0057* (0.0029)	−0.0056* (0.0029)	−0.0056 (0.0029)
Poverty Rate	−0.73 (0.42)	−0.78 (0.42)	−0.74 (0.42)	−0.73 (0.42)	−0.66 (0.43)
Racial Minority	0.36** (0.12)	0.34** (0.12)	0.46* (0.19)	0.52** (0.18)	0.49** (0.19)
Population Density (1,000,000s/Sq. Mi.)	0.0073 (1.38)	0.21 (1.38)	0.54 (1.44)	0.66 (1.43)	0.62 (1.43)
Democrat (Pre-Redistricting) to Republican (Post-Redistricting) Senator	—	0.39*** (0.099)	0.40*** (0.10)	0.40*** (0.099)	0.49*** (0.11)
Republican (Pre-Redistricting) to Democrat (Post-Redistricting) Senator	—	−0.24 (0.18)	−0.25 (0.18)	−0.25 (0.18)	−0.27 (0.18)
2000 Gore Vote Share	—	—	−0.30 (0.36)	—	—
|2000 Gore Vote Share −0.50|	—	—	—	−0.57 (0.44)	−0.41 (0.44)
Post-Redistricting Senator is More Junior	—	—	—	—	−0.039 (0.079)
Post-Redistricting Senator is More Senior	—	—	—	—	−0.17 (0.087)
Constant	0.078 (0.098)	0.046 (0.099)	0.16 (0.18)	0.047 (0.099)	0.090 (0.11)
N	1,599	1,599	1,599	1,599	1,599

***p < .001; **p < .01; *p < .05; (two-tailed); standard errors in parentheses.
The dependent variable is measured as $\log(Y_Z^{POST}/Population_Z + 1) - \log(Y_Z^{PRE}/Population_Z + 1)$, where Y_Z^{POST} represents per-year pork spending in zip code Z during 2003–2004, and Y_Z^{PRE} is the same measurement for years 1998–2002.

senior Senator after the November 2002 election (382 zip codes experienced such a switch). I also add a second indicator for zip codes that switched to a more junior Senator (987 zip codes). The remaining 230 zip codes retained the same Senator, so seniority was unchanged. Model 5 of Table 3 and Appendices B and C report the reestimated regression results. Overall, the results show little consistent evidence that an increase in Senator seniority causes a significant increase in pork-barrel spending. Nor does accounting for changes in seniority affect the main result concerning district fragmentation.

3. *Targeting Core or Moderate Voters.* I consider the possibility that the 2003–2004 Republican Senate may have been more aggressive in targeting pork to either core Republican neighborhoods or moderate voters than in previous years. In Table 3, I reestimate *equation (12)*, controlling for each zip code's *2000 Gore Vote Share*[7] (Model 2) and the distance of the *Gore Vote Share* from 50% (Model 3). In general, there is no evidence that

[7]I calculate a zip code's *Gore Vote Share* by taking the population-weighted mean of Gore's vote share of all precincts lying within the zip code.

the 2003–2004 Senate was unusually aggressive in targeting pork to core Republican zip codes. There is limited evidence that more pork is targeted to moderate zip codes (Appendix B) and Senate districts with closer electoral margins (Table 1), but these effects do not alter the main district fragmentation result.

4. *Assembly Pork as a Substitute for Senate Pork.* The main empirical finding is that Senators from highly fragmented districts bring home less pork. One possible explanation for this result is that a Senator has less electoral pressure to obtain pork when an Assembly Member who shares her district has already brought home many spending projects. In other words, if Senate and Assembly pork serve as substitutes, and if Assembly Members in highly fragmented districts bring home the most pork, then Senators in such fragmented districts may have less pressure to bring home spending projects of their own, thus accounting for the main findings.

   To test this possibility, I expand *equations (9–11)* to account for the amount of Assembly-sponsored pork that each Senate district enjoys in 2003 and 2004.[8] If the substitution effect is empirically valid, then districts with more Assembly pork should receive less Senate pork. However, the estimation results in the final three columns of Table 1 reveal the opposite finding. Senate and Assembly pork appear to be complements, rather than substitutes: a Senate district that receives more Assembly-sponsored pork projects receives significantly more pork from its Senator as well. While the data do not identify the specific legislator responsible for each Assembly-sponsored pork project, these findings suggest that highly fragmented Senate districts receive more pork from both their Senators and Assembly Members.

5. *Strategic Drawing of Districts.* Because of their control of the New York Senate in 2001–2002, Republicans controlled the redrawing of Senate districts for the November 2002 election. The partisan nature of the redistricting process introduces the possibility that the natural experiment results are confounded by strategic districting. The Republicans controlled only the redrawing of Senate districts, while Democrats controlled the Assembly redistricting. However, with foresight and coordination with the Democrats, the Republicans could have manipulated the electoral fragmentation of Senate districts if they perceived that doing so would be advantageous.

   For example, if members of the redistricting commission believed that less fragmented districts are electorally advantageous, then Republican members might have strategically drawn less fragmented districts in right-wing regions of the state. Additionally, to promote partisan electoral interests, Republicans might have directed even more pork to right-wing areas in 2003–2004 than in previous years, thereby producing a negative correlation between district fragmentation and pork spending, even if the former did not cause the latter.

   To determine if Republican redistricters may have manipulated Senate district boundaries in such a manner, I test whether the November 2002 changes in Senate district fragmentation exhibited a systematically partisan pattern statewide. Specifically, I regress the electoral diversity index of each zip code's post-2002 Senate district onto measures of partisan control and voter ideology. The full model specification is:

$$D_Z^{POST} = \alpha + \beta_D\left(D_Z^{PRE}\right) + \beta_G(\textit{Republican Senator}_Z) + \beta_G(\textit{Gore Vote}_Z) + \varepsilon_Z, \quad (13)$$

   where D_Z^{POST} is the diversity index of zip code Z's Senate district during 2003–2004, and D_Z^{PRE} is the same measurement for 1998–2002. I include an indicator for zip codes represented by a *Republican Senator* in 2001–2002, and I account for zip codes' *Gore Vote* share in 2000.

   Appendix D presents estimates of *equation (13)* and its reduced versions. In all estimated models, there is no significant evidence that the redistricting commission strategically designed the geographic overlap of Senate and Assembly districts for partisan advantage. Changes in district fragmentation do not appear to be intentionally targeted to either Democratic or Republican Senate seats, nor are they targeted to more Republican or Democratic areas. The most likely explanation for this nonfinding is that the Senate redistricters were primarily interested in gerrymandering districts to protect incumbent Republican Senate seats; they did not appear to strategically manipulate the geographic fragmentation of these Senate districts.

Discussion

A substantial volume of work in political economics has built upon Mayhew's (1974) classic argument that all

[8]Complete Assembly pork data is not available for 1998–2002.

legislators have a fundamentally similar electoral motive to pursue pork barreling. For example, the Baron and Ferejohn (1989) model and its progeny presume that all legislators wish to maximize their respective districts' shares of distributive benefits. This article demonstrates that Mayhew's theoretical argument is empirically sound and is enhanced by accounting for the electoral geography of bicameralism. I extend Mayhew's theory to consider the distributive consequences that arise when a Senator and an Assembly Member share the responsibility and the credit for delivering pork projects to their shared constituency. The formal model predicts that Senators who share their geographic districts with fewer Assembly members have greater incentives to collaborate on pork-barrel projects. These Senate districts therefore receive more pork spending from their legislators in equilibrium.

The main result from the formal model is that dividing a Senate district into more Assembly districts, or greater electoral fragmentation, has a negative effect on pork barreling. Yet this theoretical result has applications beyond bicameralism. This article's theoretical model predicts that having to share electoral credit with more elected officials decreases one's incentive to pursue pork barreling. This result has applications to mutlimember districts, federalism, and other multitiered institutions, as suggested by existing work. For example, Bueno de Mesquita (2002) and Ashworth and Bueno de Mesquita (2006) present formal models showing that the potential for free riding among legislators in multimember districts decreases their incentives to serve constituents.[9] For the case of federalism, Bednar's (2007) formal model shows that voters' uncertainty in assigning credit for policies creates credit-seeking opportunities for national governments to encroach on state policy domains. This article's evidence from the New York earmarks data suggests that the underlying logic behind the credit-sharing theory—that having to share credit among more officials decreases particularistic spending—has empirical validity.

Moreover, recent work has begun to recognize the importance of electoral geography on government spending. Chen and Malhotra (2007) examine U.S. state legislatures, finding that an increase in the ratio of lower chamber to upper chamber districts causes a decrease in total legislative spending. This article improves upon Chen and Malhotra (2007) by providing a more precise formal explanation and a more direct empirical test of their hypothesis: an increase in lower to upper chamber district ratio decreases the constituents shared by a Senator and any single Assembly Member. Sharing a smaller constituency makes collaboration between the two legislators less fruitful, so equilibrium pork spending decreases.

Virtually every voter in the democratic world is represented by more than one elected official at the various levels of government. Hence, two ubiquitous themes in the study of politics are the problem of voter uncertainty in crediting the correct politicians for their respective actions and the importance of collaboration among elected officials to serve their shared constituents. The theoretical intuition behind this article, supported by its empirical findings, demonstrates that these themes have important consequences for the geographic distribution of government spending: electoral institutions that exacerbate the geographic misalignment of electoral interests among politicians have a negative impact on officials' incentives to deliver particularistic benefits to their constituents.

[9]However, Snyder and Ueda (2007) find that in U.S. state legislatures, any free riding that occurs among legislators is outweighed by the effect of multimember districts' larger geographic sizes.

Appendix A: Proofs

Proof of Lemmas A and B. Let $\{d\}$ represent the set of citizens residing within district d.

A legislator endorses a proposal only if the sum of his or her constituents' net payoffs is non-negative; that is, some project benefits must flow to the legislator's constituents and equal or outweigh their share of project costs. For an Assemblyman, this condition is $\sum_{i\in\{a\}}[\frac{x_s}{P/n}-\frac{x_s^2}{P}]\geq 0 \Rightarrow \frac{x_s}{k_s}-\frac{x_s^2}{m}\geq 0 \Rightarrow x_s\leq \frac{m}{k_s}$, where s is one of the Senate districts that overlaps with the Assemblyman's district. For a Senator, s, this condition is $\sum_{i\in\{s\}}[\frac{x_a}{P/n}-\frac{x_a^2}{P}]\geq 0 \Rightarrow x_a-\frac{x_a^2}{n}\geq 0 \Rightarrow x_a\leq n$, where the project of size x_a is targeted to the Senator's district.

Proof of Lemmas C and D. Legislators are assured of a payoff of zero by proposing a project of size $x_s = 0$ to any district; hence, they will propose a project only if passage of the project will bring them a non-negative payoff. Further, proposers are constrained by the need for at least one endorsement in the opposite chamber, which requires satisfying the conditions in *Lemmas A* and *B*. Within these constrains, proposers maximize their own constituents' net payoff from the project. Senators who are recognized as proposers therefore optimize their utility as follows:

$$\underset{x_s\in[0,\infty)}{\mathbf{argmax}}: x_s-\frac{x_s^2}{n} \tag{14}$$

$$s.t.: x_s\leq n, \tag{15}$$

$$x_s \leq \frac{m}{k_s} \tag{16}$$

where the first constraint (Eq. 15) guarantees the proposing Senator a non-negative payoff, while the second constraint (Eq. 16) ensures that Assemblymen whose districts overlap with the proposer's district will endorse the project. This optimization problem has the solution $x_s = \{ \begin{matrix} n/2, & \text{if } k_s < (2m)//n; \\ m/k_s, & \text{otherwise,} \end{matrix}$ where the Senator proposes a project of size x_s for her own district.

Assemblymen who are recognized as proposers select x_a and face the optimization problem:

$$\underset{x_a \in [0,\infty)}{\textbf{argmax}} : \frac{x_a}{k_s} - \frac{x_a^2}{n} \tag{17}$$

$$s.t. : x_s \leq n, \tag{18}$$

$$x_s \leq \frac{m}{k_s}, \tag{19}$$

where the first constraint (Eq. 18) guarantees the proposing Assemblyman a non-negative payoff, while the second constraint (Eq. 19) ensures that Senators whose districts overlap with the proposer's district will endorse the project. The optimization solution is $x_a = m/(2k_s)$.

Proof of Proposition 1. Each Senator has a $1/n$ probability of recognition and, if recognized, successfully proposes a project for her own district and of a size described in *Eq. 4* of *Lemma C*. Because Assemblymen each have a $1/m$ probability of recognition and, by assumption, randomly target project proposals to Senate districts when indifferent, each Senate district has exactly a $1/n$ probability of being the target of an Assemblyman-proposed project. Per *Lemma D*, such a project has size: $x_a = m/(2k_s)$. Hence, a Senate district receives projects totaling, in expectation:

$$E(\chi_s^*) = \begin{cases} \frac{1}{n}\left(\frac{n}{2}\right) + \frac{1}{n}\left(\frac{m}{2k_s}\right), & \text{if } k_s < (2m)/n; \\ \frac{1}{n}\left(\frac{m}{k_s}\right) + \frac{1}{n}\left(\frac{m}{2k_s}\right), & \text{otherwise} \end{cases} \tag{20}$$

which is equivalent to *Eq. 5*. The first-order derivatives with respect to k_s and $(1/k_S)$ are:

$$\frac{\partial E(\chi_s^*)}{\partial k_s} = \begin{cases} n - \frac{m}{2nk_s^2}, & \text{if } k_s < (2m)/n; \\ -\frac{3m}{2nk_s^2}, & \text{otherwise.} \end{cases} \tag{21}$$

$$\frac{\partial E(\chi_s^*)}{\partial (1/k_s)} = \begin{cases} \frac{m}{2n}, & \text{if } k_s < (2m)/n; \\ \frac{3m}{2n}, & \text{otherwise.} \end{cases} \tag{22}$$

Hence, $E(\chi_s^*)$ is first-order decreasing on k_s and linearly increasing on $(1/k_S)$.
From *Definition 1*, we have $D_S = 1 - k_S(1/k_S)^2 \Rightarrow k_S = 1/(1 - D_S)$, so applying to Eq. 5, we have:

$$E(\chi_s^*) = \begin{cases} \frac{1}{2} + \frac{m}{2n}(1 - D_s), & \text{if} : D_s < 1 - \frac{n}{2m}; \\ \frac{3m}{2n}(1 - D_s), & \text{otherwise,} \end{cases}$$

which is linearly decreasing on D_S.

Proof of Proposition 2(a). A project of size x, regardless of where it is targeted, produces x total units of benefits and incurs x^2 in costs. Hence, the socially optimal policy must satisfy $\underset{x \in [0,\infty)}{\textbf{argmax}} : [x - x^2]$, which is optimized at $x^* = 1/2$. This socially optimal project size is strictly smaller than the equilibrium project sizes in *Lemmas C* and *D*: $x^* = 1/2 < \begin{cases} n/2, & \text{if } k_s < (2m)/n; \\ m/k_s, & \text{otherwise.} \end{cases}$

Proof of Proposition 2(b). For any Senate district s, Proposition 1 describes the expected total of project sizes directed to s. Summing over all Senate districts, the expected sum of all projects is:

$$E\left(\sum_{s=1}^{n} \chi_s^*\right) = \sum_{s=1}^{n} \left\{ \begin{matrix} \frac{1}{2} + \frac{m}{2nk_s}, & \text{if } k_s < (2m)/n; \\ \frac{3m}{2nk_s}, & \text{otherwise.} \end{matrix} \right\}$$

$$= \begin{cases} \frac{n}{2} + \frac{m}{2} \cdot \sum_{s=1}^{n} \frac{1}{k_s}, & \text{if } k_s < (2m)/n \\ \frac{3m}{2} \cdot \sum_{s=1}^{n} \frac{1}{k_s}, & \text{otherwise.} \end{cases}$$

The first-order derivatives with respect to m and n are, respectively:

$$\frac{\partial E\left(\sum_{s=1}^{n} \chi_s^*\right)}{\partial m} = \left\{ \begin{matrix} \frac{1}{2} \cdot \sum_{s=1}^{n} \frac{1}{k_s}, & \text{if } k_s < (2m)/n; \\ \frac{3}{2} \cdot \sum_{s=1}^{n} \frac{1}{k_s}, & \text{otherwise.} \end{matrix} \right\} > 0;$$

and:

$$\frac{\partial E\left(\sum_{s=1}^{n} \chi_s^*\right)}{\partial n} \geq \left\{ \begin{matrix} \frac{1}{2}, & \text{if } k_s < (2m)/n; \\ 0, & \text{otherwise.} \end{matrix} \right\} \geq 0.$$

Hence, the sum of total project sizes is strictly increasing on m and weakly increasing on n.

Appendix B: Change in Pork Earmark Spending by Zip Code from Pre- to Post-Redistricting Years (Lagged Dependent Variable)

	Dependent Variable: **Post-Redistricting Earmark Spending (Logged, per Capita, per Year)**				
	Model (1)	**Model (2)**	**Model (3)**	**Model (4)**	**Model (5)**
Pre-Redistricting Earmark Spending (Logged, per Capita, per Year)	0.47*** (0.025)	0.48*** (0.026)	0.48*** (0.026)	0.47*** (0.026)	0.47*** (0.025)
Proposition 1(c): Δ District Diversity Index ($D_{POST} - D_{PRE}$)	−1.02* (0.49)	−1.15* (0.49)	−1.16* (0.49)	−1.05* (0.49)	−1.22** (0.51)
Per Capita Income ($1,000s)	−0.0029 (0.0024)	−0.0036 (0.0025)	−0.0041 (0.0026)	−0.0055* (0.0026)	−0.0056* (0.0026)
Poverty Rate	0.84* (0.38)	0.81* (0.38)	0.84* (0.38)	0.97* (0.38)	1.03** (0.39)
Racial Minority	0.027 (0.11)	0.022 (0.11)	0.11 (0.17)	0.44** (0.16)	0.41* (0.16)
Population Density (1,000,000s/Sq. Mi.)	−4.01** (1.24)	−3.75** (1.24)	−3.52** (1.29)	−2.75* (1.27)	−2.82* (1.28)
Democrat (Pre-Redistricting) to Republican (Post-Redistricting) Senator	—	0.18* (0.088)	0.19* (0.089)	0.20* (0.088)	0.29** (0.11)
Republican (Pre-Redistricting) to Democrat (Post-Redistricting) Senator	—	−0.24 (0.16)	−0.25 (0.16)	−0.27 (0.16)	−0.30 (0.16)
2000 Gore Vote Share	—	—	−0.21 (0.32)	—	—
|2000 Gore Vote Share −0.50|	—	—	—	−1.34*** (0.39)	−1.18** (0.39)
Post-Redistricting Senator is More Junior	—	—	—	—	−0.030 (0.070)
Post-Redistricting Senator is More Senior	—	—	—	—	−0.17* (0.077)
Constant	0.074 (0.087)	0.047 (0.088)	0.13 (0.16)	0.049 (0.088)	0.085 (0.10)
N	1,599	1,599	1,599	1,599	1,599

***p < .001; **p < .01; *p < .05; (two-tailed); standard errors in parentheses.
The dependent variable is measured as $\log(Y_Z^{POST}/Population_Z + 1) - \log(Y_Z^{PRE}/Population_Z + 1)$, where Y_Z^{POST} represents per-year pork spending in zip code Z during 2003–2004, and Y_Z^{PRE} is the same measurement for years 1998–2002.

Appendix C: Change in Pork Earmark Spending by Zip Code from Pre- to Post-Redistricting Years (Cubic Root Transformation)

	Dependent Variable: Cubic Root of Change in Earmark Spending per Capita, per Year				
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Proposition 1(c):	−2.06**	−2.34**	−2.33**	−2.29**	−2.60**
Δ District Diversity Index	(0.77)	(0.78)	(0.78)	(0.78)	(0.80)
($D_{POST} - D_{PRE}$)					
Per Capita Income ($1,000s)	−0.0070	−0.0051	−0.0051*	−0.0043	−0.0040
	(0.0038)	(0.0039)	(0.0041)	(0.0040)	(0.0040)
Poverty Rate	−0.15	0.12	−0.11	0.18	0.21
	(0.59)	(0.59)	(0.59)	(0.59)	(0.60)
Racial Minority	0.22	0.20	0.18	0.38	0.37
	(0.17)	(0.17)	(0.27)	(0.26)	(0.26)
Population Density	−2.19	−1.74	−1.78	−1.27	−1.47
(1,000,000s/Sq. Mi.)	(1.94)	(1.94)	(2.02)	(2.00)	(2.02)
Democrat (Pre-Redistricting) to Republican (Post-Redistricting) Senator	—	0.39**	0.39**	0.40**	0.53***
		(0.14)	(0.14)	(0.14)	(0.15)
Republican (Pre-Redistricting) to Democrat (Post-Redistricting) Senator	—	−0.51*	−0.51*	−0.53*	−0.57*
		(0.25)	(0.25)	(0.25)	(0.25)
2000 Gore Vote Share	—	—	−0.034	—	—
			(0.51)		
|2000 Gore Vote Share −0.50|	—	—	—	−0.60	−0.40
				(0.61)	(0.62)
Post-Redistricting Senator is More Junior	—	—	—	—	0.016
					(0.11)
Post-Redistricting Senator is More Senior	—	—	—	—	−0.18
					(0.12)
Constant	0.085	0.027	0.013	0.047	0.035
	(0.14)	(0.14)	(0.25)	(0.099)	(0.16)
N	1,599	1,599	1,599	1,599	1,599

***$p < .001$; **$p < .01$; *$p < .05$; (two-tailed); standard errors in parentheses.

The dependent variable is measured as $\sqrt[3]{Y_Z^{POST}/Population_Z - Y_Z^{PRE}/Population_Z}$, where Y_Z^{POST} represents per-year pork spending in zip code Z during 2003–2004, and Y_Z^{PRE} is the same measurement for years 1998–2002.

Appendix D: Predicting Changes in Senate District Fragmentation

	Dependent Variable: Senate District's Electoral Diversity Index, Post–November 2002 Redistricting (D_{POST})		
	Model (1)	**Model (2)**	**Model (3)**
Senate District's Electoral Diversity Index, Pre–November 2002 Redistricting (D_{PRE})	0.78*** (0.022)	0.78*** (0.023)	0.78*** (0.023)
Republican Senator (Pre-Redistricting)	−0.0017 (0.0024)	—	−0.00024 (0.00300)
2000 Gore Vote Share	—	0.0081 (0.0073)	0.0077 (0.0090)
Constant	0.16*** (0.017)	0.16*** (0.016)	0.16*** (0.017)
R^2	0.46	0.46	0.46
N	1,599	1,599	1,599

***p < .001; **p < .01; *p < .05; (two-tailed); standard errors in parentheses.
The unit of analysis is the zip code. The dependent variable is the electoral diversity index of the Senate district in which each zip code lies, post November 2002.

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