Public Choice (2018) 176:507–528
https://doi.org/10.1007/s11127-018-0579-4

Court-ordered redistricting and the law of 1/*n*

Dongwon Lee[1] · **Sangwon Park**[2]

Received: 27 March 2018 / Accepted: 8 May 2018 / Published online: 4 July 2018

Abstract
This paper examines the effect of redistricting on the law of 1/*n*, which posits that government spending increases with the number of legislative districts. Our analysis suggests that court-ordered redistricting in the 1960s significantly influenced the 1/*n* effect, because dividing districts (increasing their number) and merging districts (reducing their number) both reduce public spending. After redistricting, the positive relationship between seats and spending holds for lower chambers in bicameral legislatures. The US experience informs those interested in the design of bicameral institutions about the fiscal implications of legislative apportionment.

Keywords Law of 1/*n* · Redistricting · Bicameral bargaining · Budget institutions

JEL Classification D72 · H72

1 Introduction

It is widely believed that public spending increases with the number of legislative districts—a relationship formalized as the law of 1/*n* (Buchanan and Tullock 1962; Weingast et al. 1981; Gilligan and Matsusaka 1995, 2001; Bradbury and Crain 2001). The intuition

✉ Dongwon Lee
danlee200@skku.edu

Sangwon Park
swonpark@hufs.ac.kr

1 Sungkyunkwan University, Seoul, Korea

2 Hankuk University of Foreign Studies, Seoul, Korea

behind the theory is that legislators logroll to deliver pork barrel projects to their districts because the costs are distributed across all districts.[1]

A number of empirical studies support the law of 1/*n* at the city, county, and national levels of government (Bradbury and Crain 2001; Baqir 2002; Perotti and Kontopoulos 2002; Bradbury and Stephenson 2003; Schaltegger and Feld 2009; Egger and Koethenbuerger 2010). However, studies of bicameral legislatures have suggested that the 1/*n* effect appears to hold only for one chamber in bicameral legislatures (Gilligan and Matsusaka 1995, 2001; Primo 2006; Chen and Malhotra 2007).[2] These latter studies found in a panel of US states that only upper-chamber size has a positive impact on government spending while lower-chamber size has either an insignificant or even a negative effect on spending.

The empirical literature contradicts a theoretical insight that it is possible to secure a minimal winning coalition within the lower chamber, without having to obtain votes in the upper chamber (Ansolabehere et al. 2003).[3] Intuitively, a senator will support a bill if her lower house colleagues (representing areas located within her district) are included in the coalition (Buchanan and Tullock 1962). The geographical embedding of lower chamber districts within upper chamber districts suggests that the positive relationship between seats and spending should also hold for lower chambers. Similarly, Bradbury and Crain (2001) suggested that the law of 1/*n* operates in lower chambers in most national legislatures because lower chambers wield more legislative power than upper chambers.

This paper fills the gap between theory and empirics by bringing the role of redistricting into the analysis of the law of 1/*n*. Existing studies of U.S. state legislatures have not taken into account the effect of court-ordered redistricting on the fiscal commons problem. Beginning with the 1962 "one-man, one-vote" decision in *Baker* v. *Carr*, many states redrew their district lines to eliminate unequal representation in the state legislatures. The adjustment involved a series of divisions and mergers of legislative districts (*Book of the States* 1972–1973).

Our central finding is that court-ordered redistricting in the 1960s significantly influenced the 1/*n* effect because dividing districts (increasing their number) and merging districts (reducing their number) both reduce public spending. Thus, the relationship between legislature size and spending is an empirical matter. Intuitively, prior to redistricting, when districts are malapportioned, it is possible to build a minimal winning coalition with less than a majority of the represented population. Redistricting (equalization of district populations), however, requires the extant coalition to include districts that were underrepresented previously. That requirement effectively reduces the incentive to pursue a large spending project.

After redistricting, the positive relationship between seats and spending is more likely to hold for lower chambers because geographical overlap between chambers makes the lower house chambers decisive in bicameral bargaining.

Only a few studies have examined the question of why the law of 1/*n* appears to hold for upper chambers but not for lower chambers in bicameral US state legislatures. Chen and

[1] More specifically, each of *n* legislative districts internalizes only a fraction (1/*n*) of the cost of all projects. See Lee (2015) for a more detailed discussion of the law of 1/*n*.

[2] Some recent studies also report inconsistent findings at the local government levels (e.g., MacDonald 2008; Jordahl and Liang 2010; Petterson-Lidbom 2012).

[3] Suppose that a winning coalition requires two-thirds of the lower house districts nested within half of the upper house districts. The share of the lower house districts needed to win the simple majority of the upper house is 1 / 3 (that is, 2 / 3 × 1 / 2). Thus, a simple majority of the lower house is sufficient to win the upper house.

Malhotra (2007) showed that public spending increases with the size of the upper chamber but declines with the ratio of lower-to-upper chamber seats—because dividing a Senate district into more House districts reduces each House member's payoffs from pursuing large projects. In a study of the 2002 New York Senate expansion, Chen (2010) found that dividing a Senate district into a larger number of Assembly district fragments reduces incentives for collaboration between a Senator and an Assembly member, thus reducing pork barrel spending. Our study demonstrates how the court-ordered redistricting in the 1960s complicates the relationship between seats and spending.

Using data from US states for the 1962–2008 period, we test the propositions suggested by our bicameral bargaining model, which incorporates redistricting into the fiscal commons problem. In the court-ordered redistricting period, upper-chamber size has a robust, positive impact on government spending, but lower-chamber size has a negative effect on spending. We attribute these results to the offsetting effects of district division and combination, not to the typical $1/n$ effect. Once the redistricting was completed, on the contrary, lower-chamber size had a robust, positive effect on public expenditures.

This paper is organized as follows. In Sect. 2, we use a Baron–Ferejohn bargaining model in order to demonstrate the effect of court-ordered redistricting on the fiscal commons problem. Section 3 presents an empirical test of the hypotheses suggested by the model. Section 4 discusses our findings and concludes.

2 Theory

Our theory builds on previous models of legislative bargaining (Baron and Ferejohn 1989; Primo 2006) and geographical setups in bicameral legislative structures (Ansolabehere et al. 2003; Chen and Malhotra 2007). We begin with a simple model of legislative bargaining in which district populations are equal. Extending the model, we then discuss budget outcomes in the *Baker* period (when court-ordered redistricting eliminated unequal representation in state legislatures) and the post-*Baker* period (once the one-man, one-vote principle was in place).

2.1 Basic model

Consider a (state) legislature with two chambers: Senate (S) and House (H) . There are m Senate districts with $m \geq 3$ odd, and each Senate district is divided into k (≥ 3) equally populated House districts.[4] The total number of House districts is denoted by $n = mk$. With single-member districts, Senate or House, the legislature consists of m senators and n representatives.[5] In the basic setup, each House district has a population of 1 voter, so that the total population of the state is n. Let $\widetilde{d}(n) = \frac{n}{2} + 1$ if n is even, and $\widetilde{d}(n) = \frac{n+1}{2}$ if n is odd.

Spending projects are targeted at the House district level (Ansolabahere et al. 2003).[6] A senator supports the spending bill if a majority of her House colleagues (located within

[4] The assumption about House districts embedded in Senate districts follows the previous literature (e.g., Ansolabehere et al. 2003; Chen and Malhotra 2007. In some states, House district lines cut across the Senate district lines, but that is not critical for the main results.

[5] Although many states had multi-member districts in the 1960s and 1970s, single-member districts became popular gradually as the courts ruled increasingly that multi-member districts hurt minority representation. See Crain (1977) for related discussions.

[6] This setup allows us to better identify the effect of redistricting in both chambers.

her Senate district) receive projects. That is, a spending project is valued by both the representative from that district and the senator in which the district is located (Ansolabehere et al. 2003; Lee 2016). A representative votes for the spending bill if indifferent. We also assume that spending projects do not benefit neighboring districts.

The legislature selects a set of spending projects using the following procedure: (1) Nature randomly selects a legislator from the House, (2) a recognized representative proposes a project for each of n House districts, (3a) if approved by both chambers by simple majority rule, the spending bill is implemented, and (3b) if not approved, the game ends with the default spending of 0 for every district.[7]

For simplicity, the game has a single proposal period (e.g., Chen and Malhotra 2007), but the results are similar for other game structures with infinite horizons (e.g., Baron and Ferejohn 1989). In addition, we assume that the proposer is selected from H, but that is not critical for the results.[8]

The payoff to a legislator in H is given by $u(x) - \tau = A\log(1 + x) - \tau$, where x is the size of project for his district, with A parameterizing the strength of the benefit, and τ is the tax burden.[9] The project is provided at a constant marginal cost of 1. With an equal distribution of the costs, each *voter-taxpayer* pays the same tax, τ. The government's budget constraint is then given by $Y = n\tau$, where Y is the total size of all projects (i.e., the sum of all projects across all districts).

One of the key assumptions of our model is that the budget constraint is a function of the number of voters, not necessarily the number of House districts. That is, we make a distinction between voters and House districts so that districts could have unequal numbers of voters. Existing studies of the law of $1/n$ typically assume an equal number of voters in districts (and thus equal distribution of the tax burden across districts) in order to focus on the common-pool problem. In practice, however, changes in legislature size often reflect changes in district populations. Our assumption about an unequal number of voters in districts allows us to identify the fiscal effect of redistricting that equalizes district populations. Thus, we are able to compare the $1/n$ effects in the *Baker* and the post-*Baker* periods. In Sects. 2.2 and 2.3, we allow districts to have unequal numbers of voters.

We focus on the subgame perfect equilibrium. Following the literature, we consider an equilibrium in which legislators do not vote against their true preferences.[10] In equilibrium, a proposer assembles the smallest possible coalition that secures majority support in both chambers.

Proposition 1 *The total size of all projects (in aggregate or per capita terms) rises with the size of the House, n.*

See "Appendix" for a formal proof

[7] We assume a closed rule in which legislators are not allowed to offer amendments once a proposal has been made.

[8] Alternatively, a proposer can be selected from S. The alternative setup yields qualitatively similar results.

[9] We assume that $A > 1$ to guarantee interior solutions.

[10] This assumption rules out weakly dominated strategies.

Proposition 1 implies that the law of $1/n$ applies to the lower chamber.[11] Intuitively, it is possible to build a winning coalition of $\widetilde{d}(n)$ House districts, which is large enough to secure majority support in the Senate (see Ansolabehere et al. 2003). For a House coalition of $\widetilde{d}(n)$ representatives, at least $\widetilde{d}(m)$ senators support the proposal, because more than half of their House colleagues are in the coalition.[12]

Thus, the total size of projects can be written as:

$$Y = G + (\widetilde{d}(n) - 1)g \tag{1}$$

where G and g denote the sizes of projects for the proposer and a coalition member, respectively, and $(\widetilde{d}(n) - 1)$ is the number of House coalition members. Because $\tau = Y/n$, the proposer's and a coalition member's payoffs are given respectively by[13]

$$u(G) - \frac{G + (\widetilde{d}(n) - 1)g}{n} \tag{2}$$

$$u(g) - \frac{G + (\widetilde{d}(n) - 1)g}{n} = 0. \tag{3}$$

Differentiating (2) with respect to G, the proposer's problem gives

$$u'(G) = \frac{1}{n} + \frac{\widetilde{d}(n) - 1}{n} \cdot \frac{dg}{dG} \tag{4}$$

In the first term on the right-hand side of (4), a larger number of districts (or voters) n reduces the cost borne by the proposer (common pool problem). In the second term, $dg/dG > 0$ because a coalition member must be compensated for the cost increase associated with a larger G (see (3)). Equation (3) also implies that dg / dG declines with n because a larger number of voters can share the increased cost of G.[14] Noting that $\frac{\widetilde{d}(n)-1}{n} \simeq 1/2$, Eq. (4) thus shows that G increases with n because both terms on the right-hand side fall with n.

In summary, the total size of projects $Y = G + (\widetilde{d}(n) - 1)g$ in (1) increases with n because G, g, and $(\widetilde{d}(n) - 1)$ are increasing in n. Notice that this basic model rules out redistricting. The bargaining outcome is more complicated, however, when legislative districts are divided and merged.

---

11 *Remark* The basic model assumes that each of m Senate districts is divided into an equal number of House districts. If that assumption is relaxed, the jth Senate district ($j \in \{1, \ldots, m\}$) would be divided into k_j House districts, where $k_1 \leq \cdots \leq k_m$. Then, $n = \sum_{j=1}^{m} k_j$ is the total number of House districts. In that case, we still obtain qualitatively similar results. Proofs are available upon request to the authors.

12 A winning coalition must include more than half of the House districts in more than half of the Senate districts. The number of House legislators required for a Senate majority is then $\frac{1}{4}n$ (i.e., $\frac{1}{2}m$ senators times $\frac{1}{2}k$ representatives). A simple majority of House districts is sufficient for winning the Senate.

13 In equilibrium, the proposer induces a coalition member to agree on the bill with the default payoff of 0.

14 By totally differentiating (3), we obtain $dg/dG = \frac{1}{n} \cdot \frac{1}{u'(g) - \frac{\widetilde{d}(n)-1}{n}}$, which is greater than 0 because $u'(g) > \frac{\widetilde{d}(n)-1}{n}$ (as the proposer selects g at less than the optimal level for coalition members). Noting that $\frac{\widetilde{d}(n)-1}{n} \simeq 1/2$, dg / dG also declines in n.

2.2 *Baker* period

The basic results in Sect. 2.1 contradict previous empirical findings that the law of $1/n$ does not hold for the lower chamber in US state legislatures (e.g., Gilligan and Matsusaka 1995; Primo 2006). One potential reason is the effect of court-ordered redistricting from 1962 to the 1970s. The 1962 "one-man, one-vote" decision in *Baker* v. *Carr* began the wave of reapportionment that transformed the pattern of political representation in state legislatures. Prior to *Baker*, for instance, the largest district in California's state senate had 400 times as many citizens as the smallest district (Ansolabehere et al. 2002). To eliminate unequal representation, states redrew district lines leading to a series of divisions and mergers of districts. Redistricting resulted in significant changes in the number of legislative districts.[15]

To impose structure on redistricting, we assume that House districts in one Senate district are more populous than those in other Senate districts. Specifically, the population of each House district located within the 1st through $(m-1)$th Senate districts is 1. In the mth Senate district, however, the population of each House district is 2.[16] Because each Senate district includes k House districts, the total population is $k(m-1)+2k=n+k$, and the budget constraint is given by $Y=(n+k)\tau$. We assume that congestion begins from a population of 2.[17]

To satisfy the criterion of "one man, one vote," either a division (Division) or mergers (Merger) of districts, Senate or House, are required.

- Division
  - Each House district within the mth Senate district is divided into two House districts, each with a population of 1.
  - The mth Senate district is then divided into two Senate districts, each of which includes k House districts.
  - After division, there are $m+1$ Senate districts and $(m+1)k=n+k$ House districts.
- Merger
  - Every pair of House districts located within the 1st through $(m-1)$th Senate districts are merged into one House district with a population of 2.
  - The jth and the $(j+1)$th Senate districts merge $(j=1,3,\dots,m-2)$.
  - After the mergers, there are $\frac{m+1}{2}$ Senate districts and $\frac{(m+1)k}{2}=\frac{n+k}{2}(<n)$ House districts.

To abstract from the integer problem, we assume that k is even and m is odd, so that both n and $n+k$ are even. Note that the above redistricting pattern is in line with the redistricting

[15] The process was hectic, however. For instance, reapportionment activities were attended by litigation in most states, and state reapportionment plans often were challenged by courts. In addition, many states appealed those court decisions. For instance, in a 1972 Minnesota case, the Supreme Court established that equality of district populations did not extend so far that the lower courts could order radical changes in the size of a state legislature (*Book of the States* 1972–1973).

[16] Notice that malapportionment is an issue for both upper chambers (between the mth Senate district and other Senate districts) and lower chambers (between House districts located in the mth Senate district and other House districts).

[17] Specifically, the payoff for a representative located within the 1st through mth Senate district is given by $u(g)-\tau$. On the other hand, the payoff for a representative located within the mth Senate district is given by $\left[u(g')-\tau\right]+\left[u(g'')-\tau\right]$ where g' and g'' denote the amount of spending for each segment of population.

of the American state legislatures in the 1960–1970s.[18] The proposition below shows that during the redistricting process legislative size has two offsetting effects on spending.

Proposition 2 *Both after dividing and merging districts, the total size of all projects declines.*

See "Appendix" for a formal proof.

Before redistricting, the total size of projects is $Y = G + (\widetilde{d}(n) - 1)g$, where $(\widetilde{d}(n) - 1)$ does not include any House districts from the mth Senate district. Intuitively, prior to redistricting, when districts are malapportioned, it is possible to build a minimal winning coalition with less than a majority of the population because the proposer will not recruit districts with large populations (thus with higher project costs). Larger districts therefore are politically underrepresented (Ansolabehere et al. 2002).

The proposer's and a coalition member's payoffs are given respectively by[19]

$$u(G) - \frac{G + (\widetilde{d}(n) - 1)g}{n + k} \tag{5}$$

$$u(g) - \frac{G + (\widetilde{d}(n) - 1)g}{n + k} = 0. \tag{6}$$

From the proposer's payoff in (5), we obtain

$$u'(G) = \frac{1}{n + k} + \frac{\widetilde{d}(n) - 1}{n + k} \cdot \frac{dg}{dG} \tag{7}$$

During the redistricting process, the first term on the right-hand side of (7) remains the same because the number of voters $n + k$ does not change (i.e., no common pool effect). In the second term, however, $\widetilde{d}(n) - 1$ would increase to either $\widetilde{d}(n + k) - 1$ in case of division or $2(\widetilde{d}(\frac{n+k}{2}) - 1)$ in case of mergers.[20] Noting that $dg/dG > 0$ from (6), the right-hand side of (7) increases after redistricting, and G thus falls.

Intuitively, the winning coalition's voting share aligns with its population share. As a result, the extant coalition is required to include the areas that were underrepresented previously.[21] The inclusion of underrepresented districts effectively reduces the proposer's

[18] During the 1962–1972 period, for instance, the size of the lower chamber increased in 11 states and decreased in 14 states, and the size of the upper chamber increased in 16 states and decreased in 5 states.

[19] In (5) and (6), $(\widetilde{d}(n) - 1)$ refers to the number of House coalition districts, and $n + k$ refers to the number of voters (i.e., population).

[20] After mergers, each House district has a population of 2.

[21] The idea behind Proposition 2 can be illustrated with a simple example. Suppose that a state legislature consists of 10 districts: 9 districts with a population of 1 and the 10th district with a population of 3. The total population is then 12. Before redistricting, the 10th district is excluded from the coalition because that district has higher project costs. Thus, the winning coalition consists of five districts (assuming that 50% of a legislature will pass the bill), but less than half of the total population. More specifically, the coalition has a vote share of 0.5 with the population share of 0.42. In case of division, the 10th district is divided into 3 districts with populations of 1. With 12 districts of equal populations, the winning coalition needs to attract one additional district. In the case of mergers, 10 districts are combined into six districts each with a population of 2. The winning coalition now consists of three districts with a total population of 6. Although the number of districts declined because of mergers, the coalition must provide projects to one additional citizen. In both cases, the extant coalition faces higher costs of proposing spending projects owing to the inclusion of additional members.

incentive to propose a large spending project G because, for any given G, the proposer now must guarantee g to additional members. A reduction in G also leads to lower g because $dg/dG > 0$ from (6)—that is, a smaller G reduces a coalition member's costs.

In summary, as shown in the proof, the total size of projects Y falls after redistricting because declines in G and g dominate the increase in the number of coalition members.[22] Redistricting, both division (increasing the number of legislative districts) and mergers (reducing the number of legislative districts), reduces public spending.

Notice that we have assumed a very simple structure for analytical tractability, but the basic logic is similar for more general geographical setups of districts.[23] In addition, the basic logic is similar for alternative redistricting assumptions (e.g., House districts merge and Senate districts split).

Proposition 2 is in part driven by the assumption that the budget constraint is a function of the number of voters. If we instead assume that the budget constraint is a function of the number of House districts (regardless of district populations), then the first term on the right-hand side of (7) will change during the redistricting period. For instance, division increases the number of House districts from n to $n + k$, and we might observe the seats-to-spending relationship in Proposition 1. That is precisely the point of our analysis, however, because the empirical results do not seem to agree. That is, the $1/n$ effects differ between the *Baker* and the post-*Baker* periods.

We have assumed that spending projects do not benefit other districts (i.e., no spillovers). Such local public goods generally are consistent with the typical formulation of the fiscal commons problem. Our results are qualitatively similar as long as the spillover effect is not too large (see "Appendix" for intuition).

2.3 Post-*Baker* period

Redistricting also occurred in the post-*Baker* period to account for changes in district populations as population disparities grow between the decennial redistricting cycles. The disparities and redistricting took place in a more gradual, predictable manner relative to the *Baker* period, however (Elis et al. 2009). To illustrate budget outcomes in the post-*Baker* period, we consider the changes over time in district populations and legislative size as follows.

- $t = 1$: District populations are equal once the one-man, one-vote principle was in place (m Senate districts and n House districts).
- $t = 2$: The population of each House district within the mth Senate district doubles (population disparities).
- $t = 3$: District populations become equal again after division as in Sect. 2.2 ($m + 1$ Senate districts and $n + k$ House districts).

Note that the change in legislative size between $t = 1$ and $t = 3$ captures the $1 / n$ effect in Proposition 1 (public spending increases with the size of the House). On the other hand,

[22] To see this, note that $u(g) = \frac{Y}{n+k}$ both before and after redistricting (because a coalition member's payoff is 0), implying that if g falls, Y also must fall.

[23] More generally, the populations of more than $\widetilde{d}(n)$ House districts are 1, and other House districts may have populations greater than 1. In addition, more than half of the House districts located in more than $\widetilde{d}(m)$ Senate districts have populations of 1.

the change from $t = 2$ to $t = 3$ is associated with the redistricting outcome in Proposition 2 (public spending declines owing to division). These two effects are mixed during the post-*Baker* period.[24]

The "Appendix" shows that the 1 / n effect in Proposition 1 dominates the redistricting effect in Proposition 2. That is, public spending is positively associated with the size of the House in the post-*Baker* period. For an intuitive exposition, the total spending can be shown as coalition size × average spending per coalition member. The 1 / n effect (Proposition 1) reflects both a larger coalition size and the larger spending per member (i.e., common pool problem). In contrast, the redistricting effect (Proposition 2) consists of a larger coalition size but the smaller spending per each member. Thus, the 1 / n effect is more likely to dominate the redistricting effect.

We use the case of division for illustrative purposes. In the case of mergers, the results are qualitatively similar in that the 1 / n effect dominates the redistricting effect.[25]

3 Empirical evidence

This section provides an empirical analysis of our hypotheses: (1) during the redistricting period (i.e., *Baker* period), the size of a legislature has two offsetting effects on spending, the outcome of which is an empirical matter, and (2) once redistricting is completed (i.e., post-*Baker* period), the 1/n effect holds for lower chambers. Notice that our theory does not predict the relation between legislative size and spending during the *Baker* period, but rather forms expectation based on district mergers and divisions. Unfortunately, we are unable to separate mergers and divisions because the changes in legislature size are the combined outcomes of the two. Our empirical strategy instead focuses on the differences in the seats-to-spending relationship between the *Baker* and the post-*Baker* periods, and the presence of the 1/n effect in the lower chamber in the post-*Baker* period.

This paper employs data from 47 US states from 1962 to 2008, excluding Alaska, Hawaii, and Nebraska.[26] We divide our sample into two periods: *Baker* (1962–1977) and post-*Baker* (1978–2008).[27] Court-ordered redistricting occurred mainly from 1962 to 1972; by 1972, state legislative districts had nearly equal populations (*Book of the States* 1972–1973). Because of lags in budgeting and legislative organization, however, it is difficult to pinpoint when redistricting (merger and division) should have stopped influencing budget outcomes or when equal district populations began to govern the policy arena

[24] In the *Baker* period, only the redistricting effect occurs because the population disparities were a pre-existing condition.

[25] Proofs are available upon request to the authors. Note that if mergers of districts follow population growth in those districts, the 1 / n effect could be negative—that is, between $t = 1$ and $t = 3$, total spending increases whereas the number of legislative districts declines. The relationship between seats and spending is then negative. If mergers of districts follow population declines, on the contrary, both total spending and the number of legislative districts fall. Because mergers of districts typically take place when those districts experience outflows of residents, we expect that the relationship between seats and spending is positive in the post-*Baker* period.

[26] Alaska and Hawaii's expenditures per capita are considered outliers, and Nebraska's legislature is unicameral.

[27] It would be interesting to see if the theory also holds in the pre-*Baker* period (i.e., before 1962). We did not examine the pre-*Baker* period, however, because disaggregated data on state governments before 1962 are rare and available mainly for abnormal years, such as the Great Depression and World War II.

associated with the fiscal common problem (Ansolabehere et al. 2002). Following Ansolabehere et al. (2002), the years from 1962 to 1977 refer to the *Baker* period during which the wave of reapportionment equalized district populations. Thus, the post-*Baker* period, from 1978 to 2008, depicts expenditures once one-man, one-vote was in place. As robustness check, we also use different cutoff years between the *Baker* and the post-*Baker* period.

The dependent variables include total expenditure and four types of spending: capital outlays, current expenditures, current operations, and wage expenditures. Examining different types of spending is important because (1) pork barrel spending does not apply to all types of spending, and (2) legislators may prefer specific types of expenditures to others. For instance, the law of $1/n$ may not hold for prisons and landfills (Bradbury and Stephenson 2003), and legislators may prefer current expenditures that can be adjusted in the short term (Egger and Koethenbuerger 2010).

The control variables include income per capita (in \$1000), population in natural logs, share of residents with a bachelor's degree, the Citizen Ideology Index (which measures voters' ideological preferences for government services), and intergovernmental revenue from the federal government (per capita).[28] These variables are similar to those used in previous research (Chen and Malhotra 2007; Lee 2016).

Table 1 reports descriptive statistics of the variables used in this study. Note that the average size of the House changed from 119 seats in the *Baker* period (1962–1977) to 114 seats in the post-*Baker* period (1978–2008). The average size of the Senate is 40 seats in both periods, but that comparison masks changes in the number of Senate districts in individual states.

The basic estimation equation at the state level is

$$G_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 U_{it} + \Phi X_{it} + \theta_i + \lambda_t + u_{it} \tag{8}$$

where G_{it} is government expenditures in state i at time t, L_{it} is the size of the House, U_{it} is the size of the Senate, X is a vector of control variables, θ_i is the state-specific effect, λ_t is the time effect, and u_{it} is the error term.

In Eq. (8), β_1 and β_2 show the effects of the sizes of the lower and upper chamber on public spending, respectively. The theoretical model implies that $\beta_1 > 0$ and $\beta_2 = 0$ in the post-*Baker* period, while the signs of the two coefficients are an empirical matter in the *Baker* period.

Notice that the sizes of the legislature are treated as exogenous.[29] A potential issue of endogeneity arises if voters' preferences explain both legislature size and the level of public spending (Egger and Koethenbuerger 2010) or if larger expenditures require more legislators to participate in the budget process (Petterson-Lidbom 2012). Those two studies have examined local government councils in Sweden, Finland and Germany. In the context of US state legislatures, however, the endogeneity concern is significantly reduced because the sizes of state legislatures are determined by each state's original constitutional links between legislative seats and population, and legislative seats and spending (Gilligan and

[28] The Citizen Ideology Index was obtained from the revised 1960–2008 Citizen Ideology Series calculated according to Berry et al. (1998).

[29] We ignore the potential multicollinearity between L_{it} and U_{it} as the correlation between the two is not high (0.19 for the total sample period; 0.21 for the *Baker* period; 0.19 for the post-*Baker* period).

Matsusaka 1995).[30] In addition, more government spending leads to more government employees rather than to more legislators (Baqir 2002).[31]

Our analysis suggests that legislature size did have different impacts on spending in different periods. Table 2 presents the results of estimating total expenditure per person for three periods: the full sample period, the *Baker* period (1962–1977), and the post-*Baker* period (1978–2008). In the full and *Baker* period samples, upper-chamber size has a robust, positive effect on spending, while the coefficients on lower-chamber size are either statistically insignificant or even negative. These results are similar to previous empirical findings, but are likely to be influenced by the court-ordered redistricting. Our interpretation is that, during the *Baker* period, the relationship between seats and spending does not reflect the traditional law of $1/n$. The relationship rather depends on two opposing forces: merger (reducing both legislature size and spending) and division (increasing legislature size and reducing spending).

During the post-*Baker* period, on the contrary, only the number of lower-chamber seats has a robust, positive impact on spending.[32] In terms of magnitude, a one-seat increase in the lower chamber raises per capita spending by about \$8. For a median state of 3.6 million people, expanding the lower house by 10% (about 11 seats) would be associated with an increase of \$300 million in total public spending—about 2% of the median state expenditure.[33] The coefficients on the upper-chamber size also are positive, but statistically insignificant.[34]

The results in Table 2 are consistent with our theoretical finding that redistricting complicates the effects of legislature size on spending during the *Baker* period, and that the $1/n$ effect is likely to hold for lower chambers once redistricting is completed.

As robustness check, Table 3 reports the estimates for total expenditure per person using alternative cutoff years for the *Baker* and post-*Baker* periods. In columns 1 through 4, four alternative *Baker* periods end in 1972, 1974, 1976, and 1978. In columns 5 through 8, four alternative post-*Baker* periods begin in 1973, 1975, 1977, and 1979.

Note in columns 1 through 4 that the size of the upper chamber has a robust, positive effect on spending, but the coefficients on the size of the lower chamber are negative. In contrast, columns 5 through 8 show that, during the post-*Baker* period, coefficients on the lower-chamber seats are positive and significant in most columns. The coefficients on the size of the upper chambers also are positive, but again insignificant.

Our results are consistent across different types of spending. Table 4 shows the regression estimates for four different types of per capita expenditure: capital outlays, current expenditures, operation expenditures, and wage expenditures. Panels *A* and *B* refer to the *Baker* and post-*Baker* periods, respectively. In panel *A*, upper-chamber seats have a robust, positive effect on current and operation expenditures, but lower-chamber

[30] Some states amended their constitutions to alter the sizes of their legislatures, but for reasons encompassing all legislative matters, not just those related to budget allocation (Lee 2015).

[31] On a similar note, Malhotra (2006) showed that larger government size can lead to an increase in legislative professionalism while legislature size remains fixed.

[32] The Chow test ($p$value < 0.005) indicates a structural break between the *Baker* and post-*Baker* periods—that is, the coefficients on *Lower* and *Upper* are statistically different between the two periods at the 1% level.

[33] Data refer to the average of 1978 and 2008.

[34] It is possible that the insignificance can be explained by the lack of changes in upper-chamber sizes in the post-*Baker* period (and thus large standard errors).

Table 1 Descriptive statistics

	Total		*Baker*		Post-*Baker*	
	Mean	SD	Mean	SD	Mean	SD
Total expenditure	3249	1300	2087	653	3848	1135
Capital outlay	332	134	361	148	317	124
Current expenditure	2917	1272	1726	614	3532	1072
Current operation	1537	762	837	333	1899	663
Wage expenditure	595	268	452	153	669	284
Legislature size (house)	116	57	119	61	114	55
Legislature size (senate)	40	10	40	11	40	10
Income per capita (in 1000)	25.4	7.0	18.9	3.8	28.7	5.9
Ln(population)	15.0	1.0	14.8	1.0	15.0	1.0
Education attainment	0.11	0.05	0.06	0.02	0.14	0.04
Ideology	47	16	44	18	48	15
Federal aid	815	405	527	221	964	398

The *Baker* period refers to 1962–1977, and the post-*Baker* period refers to 1978–2008

Table 2 Effects of legislature size on total expenditures

	Total 1962–2008	*Baker* period 1962–1977	Post-*Baker* period 1978–2008
Lower	– 0.851	– 1.689**	7.632***
	(1.395)	(0.697)	(2.309)
Upper	19.74**	10.06**	9.062
	(8.406)	(3.965)	(20.38)
Income	33.72**	– 1.745	48.66***
	(15.82)	(13.84)	(15.56)
ln(POP)	– 371.3**	– 310.3	– 483.8 *
	(147.2)	(247.2)	(269.3)
BA	3923**	– 572.3	4789**
	(1461)	(1616)	(1792)
Ideology	– 0.706	0.503	2.016
	(2.155)	(1.240)	(2.966)
fedaid	1.184***	1.635***	0.986***
	(0.0963)	(0.143)	(0.113)
No. Obs.	2209	752	1,457
R^2	0.957	0.945	0.936

Dependent variable: total expenditures per capita. The *Baker* period refers to 1962–1977, and the post-*Baker* period refers to 1978–2008. All dollar figures are in constant 2005 US dollars. All columns include fixed effects and time dummies. Robust standard errors are reported in parentheses

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 3 Robustness: alternative *Baker* and post-*Baker* periods

	1	2	3	4	5	6	7	8
	Baker				Post-*Baker*			
	1962–1972	1962–1974	1962–1976	1962–1978	1973–2008	1975–2008	1977–2008	1979–2008
Lower	– 2.018**	– 2.073**	– 1.861 **	– 0.839	3.526	4.249*	5.310**	7.662***
	(0.951)	(0.910)	(0.758)	(0.685)	(2.279)	(2.517)	(2.517)	(2.799)
Upper	5.280*	7.183**	9.428**	17.23***	11.52	13.56	13.13	9.449
	(3.120)	(3.243)	(3.816)	(5.311)	(18.54)	(19.22)	(20.01)	(21.06)
No. Obs.	517	611	705	1269	1692	1598	1504	1410
R^2	0.930	0.932	0.942	0.916	0.938	0.936	0.936	0.935

Dependent variable: total expenditures per capita. Other control variables (not shown) include Income, ln(POP), BA, Ideology, and Fedaid. All columns include fixed effects and time dummies. All dollar figures are in constant 2005 US dollars. Cluster-robust standard errors are reported in parentheses

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 4 Effects of legislature size on expenditure types

	1	2	3	4
Dependent variable	Capital	Current	Operation	Wage
Panel A: *Baker* period				
Lower	0.106	– 1.795**	– 0.607	– 0.150
	(0.153)	(0.719)	(0.900)	(0.232)
Upper	– 0.913	10.97***	4.324*	1.338
	(1.932)	(3.079)	(2.264)	(1.417)
No. Obs.	752	752	752	752
R^2	0.408	0.945	0.936	0.896
Panel B: post-*Baker* period				
Lower	0.720	6.913***	2.806**	1.890**
	y(0.434)	(1.973)	(1.188)	(0.825)
Upper	3.204	5.859	– 2.162	– 15.77**
	(1.972)	(21.06)	(12.21)	(6.084)
No. Obs.	1,457	1,457	1,457	1,457
R^2	0.374	0.938	0.933	0.125

Dependent variable: expenditures per capita. The *Baker* period refers to 1962–1977, and the post-*Baker* period refers to 1978–2008. Only the coefficients on *Lower* and *Upper* are reported from the full equation. All columns include fixed effects and time dummies. All dollar figures are in constant 2005 US dollars. Cluster-robust standard errors are reported in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

seats have either statistically insignificant or negative impact on expenditures. In panel *B* (post-*Baker* period), lower-chamber seats have a robust, positive effect on current, operation, and wage expenditures, while the effect is smaller in magnitude and statistically insignificant for capital outlays. That is consistent with Egger and Koethenbuerger (2010), who found the $1/n$ effect to be larger in magnitude for current expenditures

Table 5 Budget rules and the effects of legislature size on expenditures (post-*Baker* period)

Dependent variable	1 Total	2 Capital	3 Current	4 Operation	5 Wage
Panel A: line item veto present					
Lower	7.224***	0.665*	6.558***	3.032**	1.913**
	(2.232)	(0.389)	(1.930)	(1.318)	(0.755)
Upper	34.10	2.008	32.09	13.41	– 23.49**
	(43.17)	(3.920)	(45.54)	(19.09)	(11.62)
No. Obs.	1253	1253	1253	1253	1253
R^2	0.938	0.377	0.941	0.932	0.120
No. id	41	41	41	41	41
Panel B: no-carryover rule present					
Lower	82.60	21.63**	60.98	18.22	40.75**
	(71.01)	(8.224)	(64.05)	(55.32)	(15.69)
Upper	– 151.2	– 39.29**	– 111.9	– 38.93	– 93.08***
	(146.3)	(16.86)	(131.9)	(114.7)	(33.42)
No. Obs.	1054	1054	1054	1054	1054
R^2	0.938	0.337	0.940	0.930	0.113
No. id	34	34	34	34	34
Panel C: spending limit present					
Lower	50.36*	0.438	49.92*	47.82***	119.1
	(23.65)	(4.674)	(23.58)	(10.43)	(127.3)
Upper	– 54.97	2.547	– 57.51*	– 78.67***	-252.7
	(34.29)	(8.124)	(32.38)	(16.47)	(253.8)
No. Obs.	465	465	465	465	465
R^2	0.961	0.365	0.959	0.967	0.124
No.id	15	15	15	15	15

Dependent variable: expenditures per capita. The post-*Baker* period refers to 1980–2008. Only the coefficients on *Lower* and *Upper* are reported from the full equation. All columns include fixed effects and time dummies. All dollar figures are in constant 2005 US dollars. Cluster-robust standard errors are reported in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

(e.g., materials and personnel) relative to infrastructure spending—perhaps because legislators, being impatient, prefer expenditure categories that can be implemented and adjusted in the short run. The coefficients on the size of the upper chamber are either statistically insignificant (columns 1 through 3) or negative (column 4). These results are again consistent with our theoretical model, but contrast with previous findings that the law of $1/n$ tends to operate only in the upper chamber in the US state legislatures.

Many US states have adopted budget institutions that act as checks on the fiscal commons problems. In Table 5, we consider three such institutions for the post-*Baker* period: line-item veto power by governors, no-carryover rule, and spending limits (defined by Primo (2006) as no-carryover rule plus elected high courts). Line-item veto authority can weaken the effect of legislature size on spending by transferring budgetary power from the legislators to the governor (Dearden and Husted 1993). Some states also employ a no-carryover rule, which prohibits carrying public budget deficits over to the next fiscal year and requires spending cuts or collecting more revenue. The no-carryover rule is more effective in states with elected, not appointed, state high courts (Bohn and Inman 1996; Primo 2006).

Since all three institutions are (nearly) time invariant, Panels *A* through *C* of Table 5 include only the states with gubernatorial line-item vetos, no-carryover rules, and spending limits, respectively. Note in Panel *A* that the presence of line-time veto does not weaken the relationship between legislature size and government expenditures. The coefficients on *Lower* are positive and statistically significant in all columns. In Panels *B* and *C*, the presences of no-carryover rules and spending limits appear to constrain the effects of legislature size on several types of expenditures. The coefficients on *Lower* are statistically insignificant for total, current, and operation expenditures (in Panel *B*) and capital and wage expenditures (in Panel *C*). Although some of those coefficients are larger in magnitude than those in Panel *A*, they are offset by a larger, negative coefficients on *Upper*. In sum, these results are consistent with Primo (2006), who found that both the no-carryover rule and spending limits constrain U.S. state government spending.

4 Concluding remarks

The law of $1/n$ has become a central idea in the fiscal commons literature because of its powerful intuition: that representatives logroll to bring inefficiently large projects to their districts because the costs are distributed evenly across all districts (Buchanan and Tullock 1962). Empirical studies of bicameral legislatures found that the $1/n$ effect appears to hold only for upper chambers in American state legislatures. Recent theoretical insights, however, suggest that the law of $1/n$ should hold for lower chambers because geographic linkages make the lower chambers decisive in inter-chamber bargaining.

We have investigated this puzzle by taking into account the role of the court-ordered redistricting in the 1960s. Our analysis suggests that redistricting modified the fiscal commons problem by changing the political (voting) power of the logrolling coalitions. Intuitively, equalization of legislative district populations required the extant coalition to logroll across the regions that had been underrepresented previously because of large population sizes. That requirement weakened legislators' incentives to pursue large spending projects. Thus, both dividing (increasing legislature size) and merging (reducing legislature size) districts should have reduced the total size of spending projects. That is, legislature size had two offsetting effects on public spending. Once the one-man, one-vote standard was in place, however, the $1/n$ effect is likely to hold for the lower chambers.

Empirical evidence confirms that court-ordered redistricting of US state legislatures significantly affected the relationship between seats and spending. During the redistricting period, only upper chamber size had a positive impact on public spending. After reapportionment was completed, legislature size in the lower chamber positively influenced the size of government.

For politicians or civil servants interested in constitutional design, our paper helps in understanding the potential benefits and costs of introducing bicameral legislative structures. While bicameral structures could be a means to curtail fiscal excesses, the apportionment of legislative seats critically influences the fiscal commons problem in bicameral legislatures.

Our study has several limitations that point to directions for future research. First, our theoretical model assumes that representatives have the same preferences for spending projects. Crain (1999) noted, however, that the diversity of constituents' preferences within and across districts matters for the $1/n$ effect. Future studies could expand our model to account for constituent diversity.

Second, in most US states, legislators themselves redraw district lines when redistricting is required, implying that our empirical results in the post-*Baker* period are potentially affected by gerrymandering of legislative districts. For instance, new districts could be drawn in a way to protect the power of the incumbent members of the House. Future research can investigate the potential effect of gerrymandering on the law of $1/n$.

Finally, our theoretical model does not account for no-carryover rules or spending limits, although the empirical results indicate that those institutions constrain the impact of legislative sizes on some types of expenditures. Accounting for no-carryover rules or spending limits in our model would require a dynamic setup and randomness. Although we believe that our main theoretical results would hold, it would be fruitful for future research to model the effects of those budget institutions.

Acknowledgements We wish to thank an anonymous reviewer, editors William F. Shughart II and Pete Leeson, and participants at the meetings of the Korean Association of Public Finance and the 2016 Western Economic Association International conference for valuable comments and suggestions. This work was supported by the Hankuk University of Foreign Studies Research Fund.

Appendix

Proof of Proposition 1 Denote by ji the ith House district in the jth Senate territory. Without loss of generality, let 11 be the proposer. At any equilibrium, the proposer can assemble the cheapest possible coalition of $\widetilde{d}(n)$ House districts such that at least $\widetilde{d}(m)$ Senate districts include $\widetilde{d}(k)$ coalition members in their territories. For example, the coalition consists of $11, 12, \dots, 1\widetilde{d}(k), 21, \dots, 2\widetilde{d}(k), \dots, \widetilde{d}(m)1, \widetilde{d}(m)2, \dots \widetilde{d}(m)\widetilde{d}(k), \dots$ until the size of coalition is exactly $\widetilde{d}(n)$.[35] Thus the proposed bill will pass both H and S.

In equilibrium, the proposer will maximize her payoff while inducing a coalition member to agree on the bill.[36] To do so, she guarantees the coalition member the default payoff of 0. The proposed project size for non-coalition districts will be 0. Let G and g denote the size of projects for the proposer and a coalition member, respectively. Then the total size of projects is $Y = G + (\widetilde{d}(n) - 1)g$, and the budget constraint can be written as $t = \frac{G}{n} + \frac{\widetilde{d}(n)-1}{n} g$ (because $Y = nt$). A coalition member will agree if $A \log(1 + g) - t = A \log(1 + g) - \frac{G}{n} - \frac{\widetilde{d}(n)-1}{n} g \geq 0$. Thus, the proposer's problem is given as follows.

[35] Note that $\widetilde{d}(m)\widetilde{d}(k) \leq \widetilde{d}(n)$ as long as $m \geq 3$ and $k \geq 3$.

[36] Technically there are many equilibria but all have the same outcomes in terms of project sizes.

$$\max_{G,\,g}\left[A\log(1+G)-\frac{G}{n}-\frac{\widetilde{d}(n)-1}{n}g\right]$$
$$\text{s.t. } A\log(1+g)-\frac{G}{n}-\frac{\widetilde{d}(n)-1}{n}g=0$$
$$\Rightarrow \max_{g}\left[A\log\left(1+n\left[A\log(1+g)-\frac{\widetilde{d}(n)-1}{n}g\right]\right)-A\log(1+g)\right]$$

From the first-order condition, we obtain:

$$\begin{aligned}&\frac{n\left(\frac{A}{1+g}-\frac{\widetilde{d}(n)-1}{n}\right)}{1+n\left[A\log(1+g)-\frac{\widetilde{d}(n)-1}{n}g\right]}=\frac{1}{1+g}\\&\Rightarrow A\log(1+g)=A-\frac{\widetilde{d}(n)}{n}\end{aligned}\tag{9}$$

In summary,

$$\begin{aligned}Y&=G+(\widetilde{d}(n)-1)g\\&=n\left[A\log(1+g)-\frac{\widetilde{d}(n)-1}{n}q\right]+(\widetilde{d}(n)-1)g\\&=nA\log(1+g)\end{aligned}\tag{10}$$

where g satisfies (9). It is straightforward that g increases with n from (9). Thus, $Y=nA\log(1+g)$ increases with n too.

Proof of Proposition 2 This proof shows that the total size of projects declines both after dividing and merging districts. We focus on coalition formation in H because a minimal winning coalition in H can guarantee a minimal winning coalition in S (as shown in the proof of Proposition 1). Specifically, we compare the total size of projects before redistricting, after division, and after mergers.

1. Before redistricting

Let G_b and g_b be the expected size of projects for the proposer and a coalition member, respectively. Define the total size of projects Y_b accordingly. Note that no coalition member will be chosen from the mth district. To see this, suppose that g is offered to any House district located outside the mth Senate district's territory. In addition, assume that (g, Y) makes the House district just agree on the bill, where Y is the size of the total public projects. If the same g is offered to any House district located within the m th Senate district, the payoff will be $\left[A\log\left(1+(g-y)\right)+A\log(1+y)-\frac{Y}{n+k}-\frac{Y}{n+k}\right]$, where $g-y$ and y are spending for each of the two citizens of the House district. Note that for any g and Y,

$$\begin{aligned} &A\log(1+g)-t=0\\ &\quad\Rightarrow \max_{y}\ \left[A\log\left(1+g-y\right)+A\log(1+y)-t-t\right]<0 \end{aligned}$$

where $t=\frac{Y}{n+k}$. Thus any legislator located within the mth Senate district will reject the bill that offers g.

We need to consider two cases:

(*) The proposer is from the 1st through $(m-1)$th Senate district with probability $\frac{m-1}{m}$. Define G_1, g_1 and Y_1 accordingly. The proposer maximizes her payoff subject to the default payoff of 0 for coalition members.

$$\begin{aligned} &\max_{(G_1,g_1)}\left[A\log\left(1+G_1\right)-\frac{G_1+\frac{n}{2}g_1}{n+k}\right]\\ &\text{s.t. } A\log\left(1+g_1\right)-\frac{G_1+\frac{n}{2}g_1}{n+k}=0\\ &\quad\Rightarrow \max_{g_1}\ \left[A\log\left(1+(n+k)\left[A\log\left(1+g_1\right)-\frac{n}{n+k}\frac{g_1}{2}\right]\right)-A\log(1+g_1)\right] \end{aligned}$$

The first-order condition is

$$A\log(1+g_1)=A-\frac{n}{n+k}\frac{1}{2}-\frac{1}{n+k}. \tag{11}$$

Then,

$$\begin{aligned} Y_1&=G_1+\frac{n}{2}g_1\\ &=(n+k)\left[A\log\left(1+g_1\right)-\frac{n}{n+k}\frac{g_1}{2}\right]+\frac{n}{2}g_1\\ &=(n+k)A\log(1+g_1) \end{aligned}$$

where g_1 satisfies (11).

(**) The proposer is from the mth Senate district with probability $\frac{1}{m}$. The proposer's (House) district has a population of 2, and each resident receives the same amount of projects (because u is concave). Let G_2 and g_2 denote the size of project for each person in the proposer's district and for a coalition member, respectively. Define Y_2 accordingly. The total size of projects for the proposer's district is $2G_2$, and the proposer's payoff is $2\left[A\log(1+G_2)-t\right]$.

$$\begin{aligned} &\max_{(G_2,g_2)} 2\left[A\log\left(1+G_2\right)-\frac{2G_2+\frac{n}{2}g_2}{n+k}\right]\\ &\text{s.t. } A\log\left(1+g_2\right)-\frac{2G_2+\frac{n}{2}g_2}{n+k}=0\\ &\quad\Rightarrow \max_{g_2}\ \left[A\log\left(1+\frac{n+k}{2}\left[A\log\left(1+g_2\right)-\frac{n}{n+k}\frac{g_2}{2}\right]\right)-A\log(1+g_2)\right] \end{aligned}$$

The first-order condition is

$$A\log(1+g_2) = A - \frac{n}{n+k}\frac{1}{2} - \frac{2}{n+k}. \tag{12}$$

Then,

$$\begin{aligned} Y_2 &= 2G_2 + \frac{n}{2}g_2 \\ &= (n+k)\Big[A\log\big(1+g_2\big) - \frac{n}{n+k}\frac{g_2}{2}\Big] + \frac{n}{2}g_2 \\ &= (n+k)A\log(1+g_2). \end{aligned}$$

where g_2 satisfies (12).

In summary, from (*) and (**), the expected total size of projects is given by

$$Y_b = (n+k)\Big[\frac{m-1}{m}A\log(1+g_1) + \frac{1}{m}A\log(1+g_2)\Big]. \tag{13}$$

2. After division

Let G_s and g_s be the size of projects for the proposer and a coalition member after division, respectively. Define Y_s accordingly. All the derivations are the same as in Proposition 1, except that $n+k$ is the total number of House districts. Therefore, we obtain

$$Y_s = G_s + \frac{n+k}{2}g_s = (n+k)A\log(1+g_s) \tag{14}$$

where g_s satisfies

$$A\log(1+g_s) = A - \frac{1}{2} - \frac{1}{n+k}. \tag{15}$$

Comparing Eqs. (11), (12), and (15), we conclude that $g_s < g_2 < g_1$. Therefore $Y_s < Y_b$.

3. After merger

Let G_r and g_r be the size of projects for each resident in the proposer's district and a coalition member, respectively. Define Y_r accordingly. The proposer's problem is given by

$$\begin{aligned} &\max_{(G_r, g_r)} 2\left[A\log\big(1+G_r\big) - \frac{2G_r + (\widetilde{d}(\frac{n+k}{2}) - 1)2g_r}{n+k}\right] \\ &\text{s.t. } A\log\big(1+g_r\big) - \frac{2G_r + (\widetilde{d}(\frac{n+k}{2}) - 1)2g_r}{n+k} = 0 \\ &\Rightarrow \max_{g_r} \left[A\log\left(1 + \frac{n+k}{2}\left[A\log\big(1+g_r\big) - \frac{\widetilde{d}\big(\frac{n+k}{2}\big)-1}{n+k}2g_r\right]\right) - A\log(1+g_r)\right] \end{aligned}$$

The first-order condition is

$$A\log(1+g_r) = A - 2\frac{\tilde{d}\left(\frac{n+k}{2}\right)-1}{n+k} - \frac{2}{n+k} \tag{16}$$

Then,

$$\begin{aligned} Y_r &= 2G_r + \left(\tilde{d}\left(\frac{n+k}{2}\right)-1\right)2g_r \\ &= (n+k)\left[A\log\left(1+g_r\right) - \frac{\tilde{d}\left(\frac{n+k}{2}\right)-1}{n+k}2g_r\right] + \left(\tilde{d}\left(\frac{n+k}{2}\right)-1\right)2g_r \\ &= (n+k)A\log\left(1+g_r\right). \end{aligned}$$

where g_r satisfies (16).

Comparing Eqs. (12) and (16), we conclude that $g_r \leq g_2$. Thus $Y_r < Y_b$ holds.

Remark Spillovers

Suppose that spending projects benefit other districts. Specifically, when the pth district receives x_p, all other districts obtain $\alpha A\log(1+x_p)$, where $\alpha \in [0,1]$ denotes the degree of spillover. If α is larger, a coalition member receives larger spillover benefits from G and thus requires a smaller g to compensate for the cost increase associated with a larger G. In the extreme case of $\alpha = 1$, the proposer's problem simply becomes $u'(G) = \frac{1}{n}$ because the proposer does not need to compensate coalition members (i.e., $g = 0$ in (2a)). If α is not large, the results are similar to the no-spillover case in the basic model (although the proposer will distribute less g than would be the case with no spillover). Thus, the $1/n$ effect in Proposition 1 will hold regardless of spillovers.

The restructuring effect in Proposition 2 also holds as long as α is not too large. Recall that restructuring reduces spending because the proposer is required to add the districts that were previously underrepresented (reducing the incentive to propose a large G). If α is very large, however, redistricting may not affect spending. In the case of $\alpha = 1$, for instance, the proposer does not have to guarantee g to additional districts because spillover benefits guarantee majority support in both chambers. If α is not large, on the contrary, the results would be similar to the no-spillover case in the *Baker* period.

Post-Baker period

Consider the following changes in population and legislatures.

- At $t = 1$, there are m Senate districts, and each Senate district includes k House districts. The population of each House district is 1.
- At $t = 2$, population of each House districts located within the 1st through $(m-1)$th Senate districts is 1. In the mth Senate district, however, the population of each House district is 2.
- At $t = 3$, division as in Sect. 2.2 occurs. After division, there are $m + 1$ Senate districts and $n + k$ House districts.

For simplicity, n, k and $\frac{n+k}{2}$ are even. We assume that $A > 1$ so that the socially optimal spending for each district is positive.[37] Let Y^t denote the total government spending at time t.

Using (9) and (10),

$$Y^1 = nA - \frac{n}{2} - 1.$$

Using (11) through (13),

$$Y^2 = (n+k)A - \frac{n}{2} - \frac{m+1}{m}.$$

Using (14) and (15),

$$Y^3 = (n+k)A - \frac{n+k}{2} - 1.$$

Comparing $Y^3 - Y^1$ (the $1/n$ effect) and $Y^2 - Y^3$ (the redistricting effect), we obtain

$$\begin{aligned}&[Y^3 - Y^1] - [Y^2 - Y^3]\\ &= \left[kA - \frac{k}{2}\right] - \left[\frac{k}{2} - \frac{1}{m}\right] = kA - k + \frac{1}{m} > 0(\because A > 1).\end{aligned}$$

References

Ansolabehere, S., Gerber, A., & Snyder, J. (2002). Equal votes, equal money: Court-ordered redistricting and public expenditures in the American states. *American Political Science Review*, *96*(4), 767–777.

Ansolabehere, S., Snyder, J. M, Jr., & Ting, M. M. (2003). Bargaining in bicameral legislatures: When and why does malapportionment matter? *American Political Science Review*, *97*(3), 471–481.

Baqir, R. (2002). Districting and government overspending. *Journal of Political Economy*, *110*, 1318–1354.

Baron, D. P., & Ferejohn, J. A. (1989). Bargaining in legislatures. *American Political Science Review*, *83*(4), 1181–1206.

Berry, W. D., Ringquist, E. J., Fording, R. C., & Hanson, R. L. (1998). Measuring citizen and government ideology in the American States, 1960–93. *American Journal of Political Science*, *42*(1), 327–348.

Bohn, H., & Inman, R. P. (1996). Balanced budget rules and public deficits: Evidence from the U.S. states. *Carnegie-Rochester Conference Series on Public Policy*, *45*, 13–76.

Bradbury, J. C., & Crain, W. M. (2001). Legislative organization and government spending: cross-country evidence. *Journal of Public Economics*, *82*, 309–325.

Bradbury, J. C., & Stephenson, E. R. (2003). Local government structure and public expenditures. *Public Choice*, *115*, 185–198.

Buchanan, J. M., & Tullock, G. (1962). *The calculus of consent*. Ann Arbor: The University of Michigan Press.

Chen, J. (2010). The effect of electoral geography on pork barreling in bicameral legislatures. *American Journal of Political Science*, *54*(2), 301–322.

Chen, J., & Malhotra, N. (2007). The law of k/n: The effect of chamber size on government spending in bicameral legislatures. *American Political Science Review*, *101*(4), 657–676.

Council of State Governments. (1962–2008). *The book of the states*. Lexington: Council of State Governments.

[37] $\text{argmax}\left[A\log(1+g) - g\right] > 0 \Leftrightarrow A > 1.$

Crain, W. M. (1999). Districts, diversity, and fiscal biases: Evidence from the American states. *The Journal of Law & Economics*, *42*(2), 675–698.
Dearden, J. A., & Husted, T. A. (1993). Do governors get what they want? An alternative examination of the line-item veto. *Public Choice*, *77*, 707–723.
Egger, P., & Koethenbuerger, M. (2010). Government spending and legislative organization: Quasi-experimental evidence from Germany. *American Economic Journal: Applied Economics*, *2*(4), 200–212.
Elis, R., Malhotra, N., & Meredith, M. (2009). Apportionment cycles as natural experiments. *Political Analysis*, *17*(4), 358–376.
Gilligan, T. W., & Matsusaka, J. G. (1995). Deviations from constituent interests: The role of legislative structure and political parties in the states. *Economic Inquiry*, *33*(3), 383–401.
Gilligan, T. W., & Matsusaka, J. G. (2001). Fiscal policy, legislative size, and political parties: Evidence from state and local governments in the first half of the 20th century. *National Tax Journal*, *54*(1), 57–82.
Jordahl, H., & Liang, C.-Y. (2010). Merged municipalities, higehr debt: On free-riding and the common pool problem in politics. *Public Choice*, *143*, 157–172.
Lee, D. (2015). Supermajority rule and the law of 1/*n*. *Public Choice*, *164*, 251–274.
Lee, D. (2016). Supermajority rule and bicameral bargaining. *Public Choice*, *169*, 53–75.
MacDonald, L. (2008). The impact of government structure on local public expenditures. *Public Choice*, *136*, 457–473.
Malhotra, N. (2006). Government growth and professionalism in U.S. State Legislatures. *Legislative Studies Quarterly*, *31*(4), 563–584.
Perotti, R., & Kontopoulos, Y. (2002). Fragmented fiscal policy. *Journal of Public Economics*, *86*, 191–222.
Petterson-Lidbom, P. (2012). Does the size of the legislature affect the size of government? Evidence from two natural experiments. *Journal of Public Economics*, *96*, 269–278.
Primo, D. M. (2006). Stop us before we spending again: Institutional constraints on government spending. *Economics & Politics*, *18*, 269–297.
Primo, D. M., & Snyder, J. M. (2008). Distributive politics and the law of 1/n. *Journal of Politics*, *70*(2), 477–486.
Riker, W. H. (1962). *The theory of political coalitions*. New Haven: Yale University Press.
Schaltegger, C. A., & Feld, L. P. (2009). Do large cabinets favor large governments? Evidence on the fiscal commons problem for Swiss Contons. *Journal of Public Economics*, *93*, 35–47.
Weingast, B., Shepsle, K., & Johnson, C. (1981). The political economy of benefits and costs: A neoclassical approach to distributive politics. *Journal of Political Economy*, *89*, 642–664.