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# The Law of 1/n Revisited: Distributive Politics, Legislature Size, and the Costs of Collective Action

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The foundational model of distributive politics predicts a positive relationship between the number of legislative districts and the level of inefficiency of projects approved by the legislature—Weingast, Shepsle, and Johnsen's "Law of 1/n." This relationship has been tested extensively in the empirical literature, with mixed results. This article presents a model wherein passing the omnibus legislation typical of distributive politics is a costly process. The model predicts a nonlinear relationship between legislature size and spending as increasing the size of the legislature also increases the costs of collective action. Results from an empirical exercise based on U.S. state legislatures (1962–2014) are consistent with the proposed model, showing a 1/n effect which diminishes at the margin as the legislature's size increases, especially in the lower chamber.

**JEL Classification: D72, H11, H77**

## 1. Introduction

The foundational model of distributive politics in the legislature is that of Weingast, Shepsle, and Johnsen (1981), and the best-known implication of the model is the "Law of 1/n", which describes a positive relationship between the number of legislative districts and the level of inefficiency in government spending. This straightforward hypothesis has been tested in an extensive empirical literature with some mixed results: Although the positive relationship tends to hold for upper houses and unicameral legislatures, lower legislative chambers do not typically exhibit a 1/n effect. Subsequent theoretical work also points out potential shortcomings in the original Weingast, Shepsle, and Johnsen (1981) model. This article adds to this growing literature critiquing and extending the Law of 1/n model. Specifically, the standard 1/n model is extended to include the costs related to the collective action required to pass the omnibus legislation typical of distributive politics. The extended model predicts a nonlinear relationship between legislature size and spending: Increasing the size of the legislature reduces per-district costs (the Law of 1/n) but also increases the costs of collective action. Results from an empirical test of the model are consistent with the proposed model, and also provide evidence of the Law of 1/n for the lower chamber—a relatively unique result in this literature. The results also raise questions about the consistency of findings for the upper chamber in the previous literature.

In its most basic form, the "Law of 1/n" stems from a fiscal common-pool model based on the idea that as the number of legislative districts increases the share of the cost of a given distributive

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policy (defined as projects with benefits concentrated to a specific area) borne by each district falls, ceteris paribus. As each legislator seeks projects for which the benefits to his/her district exceed its share of the costs at the margin, this encourages each representative to pursue projects which might otherwise fail a cost/benefit analysis if not for the sharing of costs across all districts. In the aggregate, government expenditure becomes inefficient as each district's representative ensures his/her preferred project is passed in the legislature. In the Weingast, Shepsle, and Johnsen (1981) model the extent of the inefficiency is linked directly to the number of districts via the decreasing share of the cost borne by each. For instance, under a simplified model where each one of "*n*" districts bears an equal share—that is "1/n"—of the total cost, individual legislators have a clear incentive to seek larger projects for their districts as the number of legislative districts splitting the bill increases. The model helps explain the near universal support for omnibus spending legislation: Each legislator secures their preferred project.

Recent work has taken a more critical look at the theoretical limitations of the original Weingast, Shepsle, and Johnsen (1981) model. For instance, Primo and Snyder Jr. (2008) note that in the original version of the model, increases in the number of legislative districts must necessarily decrease the population within each district, ceteris paribus. This has important implications for the benefits from a distributive project which accrue to members of a district. That article further expands on the original model to show that the Law of 1/n depends on factors including the publicness of the project and the cost-sharing arrangement between levels of government, and under certain conditions a "reverse Law of 1/n," where spending *decreases* as legislature size increases, is possible. More recently, Pecorino (2018) presents a model wherein increases in legislature size have ambiguous effects on expenditure, depending in part on the publicness and type of expenditure in question. That article argues that the original formulation of the Law of 1/n presumes a failure of the Coase theorem within the minimum winning coalition—if the Coase theorem held within the coalition, the members would agree to a spending regime which was jointly optimal for coalition members. Importantly for the present article, Pecorino (2018) also notes that transactions costs may rise with legislature size, causing difficulties in interpreting the effect of the number of districts on expenditure as being driven by changes in tax shares alone.[1] The standard model also lacks a participation constraint in that it simply presumes all legislators will engage in the cost-sharing arrangement.

Another aspect often overlooked in the Law of 1/n literature is that the passing of omnibus legislation—like all collective action—is a costly process (Raudla 2010). Although any individual legislator has a clear incentive to support large projects benefitting his or her constituency if the cost is spread across the entire legislature, he or she still requires support for the project from a majority of fellow legislators. Although certain processes such as logrolling as described by Buchanan and Tullock (1962) and Tullock (1981) may allow legislators to trade votes to ensure all get their preferred projects passed, there remain theoretical reasons to expect that the process of actually drafting and passing the resulting omnibus legislation is costly. Furthermore, we would expect the costs associated with the passage of such legislation to be increasing in legislature size as more effort is required to reach a consensus or form larger coalitions, especially if coordination across both legislative chambers is needed. Incorporating the rising costs associated with the collective

[1] Pecorino (2018) also notes this lack of a decreasing-tax-price explanation in some of the previous work (specifically Baqir 2002 and Egger and Koethenbuerger 2010), which finds evidence of a relationship between the number of districts and expenditure in councils which are represented by members elected at-large. Since the Weingast, Shepsle, and Johnsen (1981) hypothesis depends crucially on distributive spending which is geographically-targeted to specific districts, these findings cannot realistically be interpreted as supportive of the Law of 1/n.

action required for bill passage suggests a nonlinear relationship between legislature size and spending: Increasing the size of the legislature reduces per-district costs (the Law of 1/n) but also increases the costs of collective action. Furthermore, to the extent the benefits of cost-sharing decrease whereas the costs of collective action increase with legislature size, such an extended model may help to explain why the previous empirical literature has found mixed results between upper and (typically larger) lower legislative chambers.

The literature on group size and collective action follows important contributions in public choice. In considering a group attempting to provide some good or service in its common interest, Olson (1965) posits that the incentive to free-ride leads to collective action problems which are exacerbated for larger groups. Buchanan (1965) derives the optimality conditions for an exclusive group (i.e., a club) producing a collective consumption good. That contribution is based in part on the notion that the benefits of increased cost-sharing from additional group size are eventually offset by costs associated with congestion, meaning that even when exclusion is possible large groups become untenable. Looking at the voting process specifically, the influential work of Buchanan and Tullock (1962) builds its model of collective action in part on the concept of "decision costs," defined as the costs associated with reaching agreement, which rise as the number of individuals required to make a collective decision rises. In short, early work in the public choice tradition predicts collective action will be costlier and thus more difficult among larger groups.

Models specific to legislature behavior further illustrate the challenges of organizing collective action. Stigler (1976) offers one of the first thorough empirical analyses of legislature size. Crain and Tollison (1977) extend the Buchanan and Tullock (1962) model and shows that states with more restrictive voting rules mitigate potentially high decision costs by keeping legislatures relatively small in size. Crain (1979) argues that increases in legislature size may have an ambiguous effect on the production of legislation, as the higher costs of collective action may be partially offset by increases in specialization among legislators. Fiorino and Ricciuti (2007) offer empirical evidence in this vein, finding a positive relationship between legislature size and government spending for Italian regional governments. Hankins (2015) tests the effects of legislature size on state spending, particularly in response to shocks, and finds little evidence of a positive relationship—a result which is interpreted as supporting the idea that larger legislatures face higher costs associated with interest groups and lobbying. Foundational work by Weingast and Marshall (1988) argues that institutions within the legislature are developed to facilitate gains from trade among legislators.

One thread of this literature seeks to explain the apparent norms of universalism in the legislature whereby winning coalitions typically far exceed the minimal size (50% + 1 in simple majority rule) required to secure bill passage. Shepsle and Weingast (1981) demonstrate that legislator uncertainty and a propensity to count certain local costs as "political benefits" leads to favoring of very large coalitions where pork barrel legislation is concerned. Groseclose and Snyder Jr. (1996) show that in terms of securing passage of legislation, supermajorities are often lower-cost compared to minimal winning coalitions since in the latter case opposition would need to "buy" the vote of only a single legislator in order to defeat a bill. Stratmann (1992, 1995) provides empirical evidence of voting coalitions in the U.S. Congress.

A sizable empirical literature directly testing the Law of 1/n has developed. Most articles take U.S. state legislatures as their unit of analysis. Generally, the previous literature has found a positive, statistically significant relationship between the size of upper legislative chambers (i.e., senates) or unicameral legislatures/councils and measures of government expenditure, which is interpreted as consistent with the Law of 1/n. Results for lower chambers (i.e., houses), however, have been inconsistent. For example, in a pair of studies Gilligan and Matsusaka (1995, 2001) find consistent support for the positive relationship between upper chamber size and spending, but no significant evidence of a similar relationship between spending and lower chamber size. On the other hand, Primo (2006), Chen and Malhotra (2007), and Crowley (2015) all find the positive effect for upper chambers, but a statistically significant *negative* effect of lower chamber size on spending. Pettersson-Lidblom (2012) uses a regression-discontinuity design and data from Finland and Sweden to observe a negative relationship between legislature size and spending.

Studies using local-level data include Bradbury and Stephenson (2003) (which examines counties in the state of Georgia and finds a positive relationship between the number of county commissioners and government spending), Baqir (2002) (which looks at U.S. municipal governments and finds a positive relationship between city council size and spending), and Egger and Koethenbuerger (2010) (which finds a positive relationship between council size and spending using a data set of German municipalities). MacDonald (2008) also tests the Law of 1/n hypothesis on a sample of U.S. municipal governments and finds a positive relationship between council size and spending, although the result is not robust to the inclusion of fixed effects.

The inconsistent findings—specifically with regards to the lower chamber—in the empirical literature have motivated several articles in recent years which present extensions to the original Weingast, Shepsle, and Johnsen (1981) model. For instance, Crain (1999) argues that the Law of 1/n is conditional on the level of diversity within legislative districts. Bradbury and Crain (2001) present empirical evidence of differences in the strength of the Law of 1/n between unicameral and bicameral legislatures. Gilligan and Matsusaka (2006) argue that the relationship between legislature size and spending may in fact be due to gerrymandering. Ansolabehere, Snyder Jr., and Ting (2003) model bicameral legislatures in a bargaining framework and considers the possibility of forming minimum winning coalitions among house representatives alone; Chen and Malhotra (2007) use a similar game theoretic approach and shows that the ratio of chamber sizes is the more relevant variable (and is negatively related to spending), while Maldonado (2013) uses international data to find a linear relationship between chamber size and spending in countries with unicameral legislatures and a nonlinear relationship in those with bicameral legislatures. Crowley (2015) incorporates the relationship between substate governments and legislative districts to show that intergovernmental competition can partially mitigate the Law of 1/n, while Lee (2015) presents evidence that supermajority rules increase the 1/n effect.

The present article follows in this tradition by offering an extension to the typical model of distributive politics—specifically by including costs associated with collective action required to ensure a bill passes—in an effort to explore both the inconsistent empirical findings as well as the implications of some of the theoretical limitations outlined above. The following section presents this extended model: Its primary implication is a nonlinear relationship between legislature size and spending, as the Law of 1/n is offset by increasing transaction costs as the number of districts increases. Section 3 outlines an empirical exercise testing the model's implications and section 4 presents the primary results, which are consistent with the model's implications and offer evidence of a 1/n effect for the lower chamber and more inconsistent results for the upper chamber, unique findings relative to the previous literature. Section 5 presents results from a brief sensitivity analysis, while section 6 offers concluding remarks.

## 2. An Extended Model of Distributive Politics in the Legislature

Following the Primo and Snyder Jr. (2008) approach to the Weingast, Shepsle, and Johnsen (1981) model, let $X_i$ represent a publicly provided project of size $X$ in district $i$. Let $B(X_i)$ represent the total benefit derived by residents where the project is located and $C(X_i)$ represent the total costs of that project. As is typical in previous theoretical work in this area, assume $C'(X) > 0$, $C''(X) > 0$, $B'(X) > 0$, $B''(X) \leq 0$. All projects are funded from taxation spread equally across all legislative districts: that is, a district's share of a specific project $X_i$ is $\left(\frac{1}{n}\right)C(X_i)$, and its share of the total cost of financing all projects passed by the legislature is $\left(\frac{1}{n}\right)\sum_{j=1}^{n} C(X_j)$.

The legislator's objective function is

$$\text{Max } V_i(X_i, n) = B(X_i) - \left(\frac{1}{n}\right)\sum_{j=1}^{n} C(X_j), \tag{1}$$

with first order condition

$$B'(X_i^*) = \left(\frac{1}{n}\right)C'(X_i^*), \tag{2}$$

the standard equating of marginal benefit and marginal cost. From Equation 2 it is straightforward to show that an increase in the number of districts leads to a decrease in the marginal cost borne by any specific legislative district. It follows that optimal project size (as chosen by an individual legislator) is therefore increasing in legislature size.[2]

It is worth discussing the theoretical limitations of the model outlined above (and indeed most models following the traditional Law of 1/n framework). For instance, Primo and Snyder Jr. (2008) demonstrate that holding population constant, increases in the number of districts necessarily reduces the size of the population within each district, which may have implications for the optimal project size. That approach shows that in the case of pure public goods, the decreasing size of district populations means that while the number of projects increases with $n$, the size of each falls due to declining district size; the resulting "Law of 1/n" is driven by an increase in the number of projects and not necessarily optimal project size $X$. In terms of project sizes, the standard 1/n result described above is shown to hold in the presence of congestion effects and low costs of taxation, while for public goods or with larger costs of taxation, a "reverse" Law of 1/n can hold. Similar ambiguity applies to expenditure, the typical dependent variable in empirical tests of the Law of 1/n: The Primo and Snyder Jr. (2008) framework shows that expenditure is increasing in districts under regimes of cost-sharing, but absent that the relationship between legislature size and expenditure depends on factors including congestion.

As noted above, an additional limitation of the standard formulation is its lack of consideration of collective action costs. Unique to the present article's extended model, let $L(X_i)$ represent the costs required to capture a vote to help ensure passage of the project in the legislature.[3] These costs can be thought of as those associated with coalition-building or the decision costs a la Buchanan and Tullock (1962) associated with obtaining a sufficient number of votes in the legislature. Similarly, let $M(n)$ represent the size of the required winning coalition (i.e., the number of legislators

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[2] Specifically, Primo and Snyder Jr. (2008) differentiate the first order condition with respect to $n$, which yields the standard result of $\frac{\partial X_i^*}{\partial n} = \frac{B'(X_i^*)}{C''(X_i^*) - nB''(X_i^*)} > 0$.

[3] Consistent with traditional models of the Law of 1/n, the legislature here is unicameral, and the model therefore does not include any bargaining between houses. For an explicitly bicameral model with bargaining between chambers, see Chen and Malhotra (2007). In terms of the empirical analysis below, I consider specifications with upper and lower chamber sizes included, as well as a specification concerned with the total size of the legislature. In the sensitivity analysis, I also consider a specification with only those states with legislatures comprised of single-member districts.

required to ensure passage) in a legislature of size $n$. Thus, the product of these represents the total costs of ensuring project passage. Since the total costs (which are shared across districts) of a project increase with project size, let $L'(X_i) > 0$ and $L''(X_i) > 0$; that is, the cost required to secure a vote increases with project size. Finally, $M'(n) > 0$, as the size of the required coalition increases with legislature size.[4]

Allowing for the additional costs associated with securing passage of their project, each legislator chooses a project $X_i$, given all other projects $X$, so as to maximize the new objective function:

$$\text{Max}\, V_i(X_i,n) = B(X_i) - \left(\frac{1}{n}\right)\sum_{j=1}^{n} C(X_j) - L(X_i)M(n). \tag{3}$$

Stated less formally, legislators seek to maximize the benefits of a project less the total costs associated with its passage: Their district's share of the costs of financing all projects $X$ passed by the legislature and the costs of ensuring a project of size $X_i$ is passed in the legislature. Choosing $X_i$ to maximize the objective function yields the first order condition

$$B'\left(X_i^*\right) = \left(\frac{1}{n}\right)C'\left(X_i^*\right) + L'\left(X_i^*\right)M(n), \tag{4}$$

which equates marginal benefits and marginal costs.

To determine how legislature size affects optimal project size requires total differentiation of Equation 4 with respect to $n$, which following some algebraic manipulation yields

$$\frac{\partial X_i^*}{\partial n} = \frac{nM'(n)L'\left(X_i^*\right) - \left(\frac{1}{n}\right)C'\left(X_i^*\right)}{nB''\left(X_i^*\right) - C''\left(X_i^*\right) - nL''\left(X_i^*\right)M(n)}. \tag{5}$$

As $B''(X_i) \leq 0$, $C''(X_i) > 0$, and $L''(X_i) > 0$ the denominator of Equation 5 is negative. Thus the overall sign of $\frac{\partial X_i^*}{\partial n}$ hinges on the sign of the numerator, which can be interpreted as the rate of change of the total costs associated with increasing legislature size: Comparing the increasing collective action costs associated with ensuring passage of a project and the decreasing benefits derived from cost sharing. Stated formally,

$$\begin{cases} \dfrac{\partial X_i^*}{\partial n} > 0 & \textit{if } nM'(n)L'\left(X_i^*\right) < \left(\dfrac{1}{n}\right)C'\left(X_i^*\right) \\[2ex] \dfrac{\partial X_i^*}{\partial n} \leq 0 & \textit{if } n\mathrm{M}'(n)L'\left(X_i^*\right) \geq \left(\dfrac{1}{n}\right)C'\left(X_i^*\right) \end{cases}. \tag{6}$$

In other words, if the marginal benefits of cost-sharing $[\left(\frac{1}{n}\right)C'\left(X_i^*\right)]$ exceeds the marginal cost associated with passing the legislation $[nM'(n)L'\left(X_i^*\right)]$, then an increase in the size of the legislature will be associated with larger projects. On the other hand, if the marginal cost of passing the

[4] Groseclose and Snyder Jr. (1996) show that under many circumstances the low-cost coalition will be a supermajority exceeding the minimum winning coalition. For the purposes of this article, the specific composition of the winning coalition does not matter. We need only assume the size of a winning coalition necessarily increases with legislature size, which will be true for minimum winning coalitions, supermajorities, or a norm of universalism.

legislation is greater than the marginal benefit associated with cost-sharing among districts, then increases in legislature size will be associated with smaller projects. Importantly, the marginal cost associated with passing the legislation (and thus the overall sign of $\frac{\partial X_i^*}{\partial n}$) depends on the size of the legislature, both directly and indirectly through its impact on the size of the winning coalition. The larger (smaller) is $n$, the larger (smaller) will be these costs of ensuring passage in the legislature, ceteris paribus. At the same time, the larger (smaller) is $n$, the smaller (larger) will be the marginal benefit of additional districts sharing project costs. Thus, the sign of the relationship between an increase in the number of districts comprising a legislature and optimal project size is determined in part by the size of the legislature: Optimal project size is more likely to be an increasing function of legislature size for smaller legislatures, and more likely to be a decreasing function of legislature size for larger legislatures.

The model's implications can be demonstrated more clearly by making a simplifying assumption concerning the winning coalition $M(n)$. Under a model of universalism, $M(n) = n$ and Equation 4 becomes

$$B'\left(X_i^*\right) = \left(\frac{1}{n}\right) C'\left(X_i^*\right) + nL'\left(X_i^*\right), \tag{7}$$

which with total differentiation with respect to $n$ yields

$$\frac{\partial X_i^*}{\partial n} = \frac{nL'\left(X_i^*\right) - \left(\frac{1}{n}\right) C'\left(X_i^*\right)}{nB''\left(X_i^*\right) - C''\left(X_i^*\right) - n^2 L''\left(X_i^*\right)}, \tag{8}$$

and now implies

$$\begin{cases} \dfrac{\partial X_i^*}{\partial n} > 0 & \textit{if } nL'\left(X_i^*\right) < \left(\dfrac{1}{n}\right) C'\left(X_i^*\right) \\[2ex] \dfrac{\partial X_i^*}{\partial n} \leq 0 & \textit{if } nL'\left(X_i^*\right) \geq \left(\dfrac{1}{n}\right) C'\left(X_i^*\right) \end{cases}. \tag{9}$$

The inequalities in (9) show that the overall effect of the number of legislative districts on optimal project size depends on the relationship between the marginal costs of passage and the marginal benefits associated with a cost-sharing of the project of size $X_i^*$. The size of the legislature, $n$, again matters critically for $\frac{\partial X_i^*}{\partial n}$: As $n$ increases, the marginal legislative costs on the left increase (ceteris paribus) while the marginal cost-sharing benefits on the right decrease, and the overall effect is that $\frac{\partial X_i^*}{\partial n}$ decreases (or becomes more negative) as the number of legislative districts increases. In short, as legislature size increases, the positive relationship between legislature and project sizes (i.e., the Law of 1/n) declines. This in turn implies that the 1/n effect will be more easily observed for smaller legislatures, ceteris paribus.

Figure 1 illustrates the simplified model. Panel A shows how the marginal costs on the right-hand side of Equation 7 are affected by different sizes of the legislature, $n$, for a given project of size $X_i^*$. Similar to the approach taken by Buchanan (1965) in deriving optimal club size, panel A shows that the addition of a district $n$ results in two effects at the margin: A decreasing share of costs and an increasing cost of collective action associated with securing passage of legislation. The

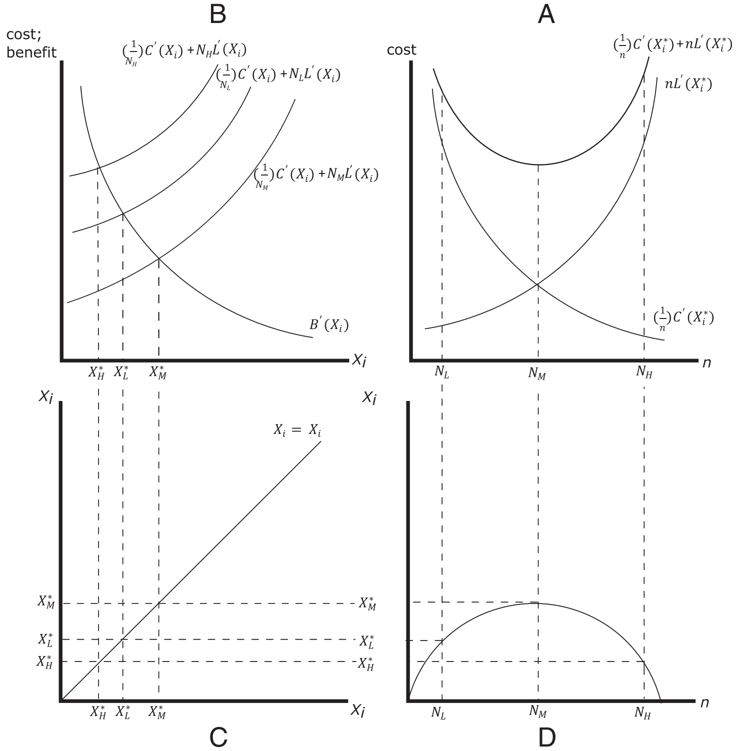


**Figure 1.** Extended Model of Distributive Politics.

sum of these costs decreases initially, reaches a minimum, and then begins increasing. Panel A shows that for a project of given size $X_i^*$, a mid-size legislature $N_M$ results in lower total costs at the margin than either a high-*n* ($N_H$) or low-*n* ($N_L$) legislature. Equation 7 is represented in panel B, where the optimal project size $X_i^*$ is determined by finding where the downward sloping marginal benefit curve crosses the upward sloping marginal cost curve associated with a legislature of given size. As panel A shows how the marginal cost changes with *n*, panel B shows different optimal project sizes ($X_M^*$, $X_H^*$, and $X_L^*$) associated with different legislature sizes ($N_M$, $N_H$, and $N_L$).

Panel C plots a 45° line so as to depict the optimal project size on the vertical axis of panel D, which illustrates the relationship between project and legislature size. The relationship defined by the inequalities in Expression 9 is now obvious: For low-*n* legislatures such as $N_L$ (those for which the marginal costs of passing legislation are smaller than the marginal benefit of increased cost-sharing), increases in legislature size results in larger optimal projects. Once the costs of expansion exceed those benefits (as is the case with high-*n* legislatures such as $N_H$) additional increases result in smaller-sized optimal projects. While the model implies some maximum optimal project size of $X_M^*$ associated with a legislature of size $N_M$ (where costs with respect to project size are minimized at the margin), the primary takeaway is that the Law of 1/n should be expected to hold only up to a point, after which the costs of collective action dominate and the relationship between chamber and project size turns negative.

At first glance, this model provides one possible explanation for the rather inconsistent findings in the empirical literature detailed above. Specifically, the literature finds the strongest evidence of Law of 1/n for upper legislative chambers (e.g., Gilligan and Matsusaka 1995, 2001; Primo

2006; Chen and Malhotra 2007; Crowley 2015) or other relatively small bodies, such as municipal or county councils (e.g., Bradbury and Stephenson 2003; Baqir 2002; Egger and Koethenbuerger 2010). This model implies that inconsistencies when looking at lower legislative chambers could be due, in part, to their relative size (for instance, across the U.S. state legislatures 1962–2014, the average lower chamber was nearly three-times the size of the average upper chamber). For these larger-sized legislatures, the Law of 1/n is no longer expected to hold due to increased costs of collective action. To the extent most of the pivotal collective action is taking place in the lower chamber as proposed by Ansolabehere, Snyder Jr., and Ting (2003), this effect is exacerbated. In fact, the model above predicts that at some point a negative relationship between chamber size and spending may exist, consistent with findings for lower chambers in some of the literature (e.g., Primo 2006; Chen and Malhotra 2007; Crowley 2015). The following section outlines an empirical approach to directly test these implications.

## 3. Empirical Approach

A baseline empirical model, consistent with the previous literature testing the Law of 1/n, takes the form

$$Y_{it} = \beta_1 n_{it}^U + \beta_2 n_{it}^L + \beta_3 \boldsymbol{X_{it}} + \gamma_i + \delta_t + \varepsilon_{it}, \tag{10}$$

where $Y_{it}$ represents government expenditure, $n_{it}^U$ and $n_{it}^L$ represent the number of seats in the upper and lower chambers of the state legislature respectively, $\boldsymbol{X_{it}}$ represents a vector of political and socioeconomic control variables, with $\gamma_i$ and $\delta_t$ denoting state and year fixed effects.[5] In the baseline model, the parameters of most interest are $\beta_1$ and $\beta_2$, representing the marginal effects of legislature size on expenditure, which the Law of 1/n predicts will both take positive signs. Previous empirical work, however, indicates an expected positive statistically significant estimate of $\beta_1$ with the sign and significance of $\beta_2$ less certain.[6]

The extended model presented above implies a nonlinear relationship between legislature size and government activity. Specifically, the marginal effect of legislature size on government spending is expected to decline as the number of legislative districts grows, ceteris paribus. Allowing for these additional effects yields

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[5] Notably, state legislature size is relatively stable even across the more than 50-year sample considered here: the correlation between the start of the sample (1962) and the end (2014) for both the senate and house size variables is roughly 0.9. This raises concerns about the ability to identify the effects of legislature size in the fixed effects model as the standard errors are likely to be inflated due to multicollinearity. At the same time, the use of the fixed effects model remains desirable due to the number of unobserved factors within states that help determine expenditure. Chen and Malhotra (2007) and others address this concern by estimating the model on a sample broken down into multiple-year intervals to allow for additional variation; I employ this approach as a robustness check in section 5 below. Additionally, estimation of the primary models on a sample comprised only of states which saw changes to the size of one or both houses returns qualitatively similar results to those reported in the following section.

[6] As noted above, Primo and Snyder Jr. (2008) raise concerns about the use of expenditure as the dependent variable in tests of the Law of 1/n since the theoretical argument is typically based instead on project size. That article shows that under different cost-sharing regimes and depending on the characteristics of the expenditure in question, legislature size can take a positive or negative sign. In the analysis that follows here, I consider expenditure to remain consistent with the vast majority of empirical work in this literature, while also noting that the predicted positive relationship between chamber size and spending may not hold for all types of expenditure. Importantly, the expected second order effect—that the 1/n effect is partially mitigated due to costs of collective action—should remain observable.

$$Y_{it} = \beta_1 n_{it}^U + \beta_4 \left(n_{it}^U\right)^2 + \beta_2 n_{it}^L + \beta_5 \left(n_{it}^L\right)^2 + \beta_3 \boldsymbol{X_{it}} + \gamma_i + \delta_t + \varepsilon_{it}, \tag{11}$$

which implies the marginal effects

$$\frac{\partial Y_{it}}{\partial n_{it}^U} = \beta_1 + 2\beta_4 n_{it}^U \tag{12}$$

and

$$\frac{\partial Y_{it}}{\partial n_{it}^L} = \beta_2 + 2\beta_5 n_{it}^L. \tag{13}$$

Importantly, the impact of a change in legislature size is now conditional on the number of districts, as predicted by the extended model above. Empirical results consistent with that model will be characterized by positive estimates for coefficients $\beta_1$ and $\beta_2$, and negative estimates for coefficients $\beta_4$ and $\beta_5$, implying that the positive 1/n relationship will be mitigated for larger-sized legislatures. The marginal effect can be calculated for different values of $n_{it}^U$ and $n_{it}^L$.

Previous work on this topic has noted the importance of acknowledging the interaction between chambers of the legislature. For instance, Chen and Malhotra (2007) presents anecdotal evidence that legislators in the lower chamber routinely coordinate with those representatives in the upper chamber with whom their districts overlap geographically. That model then assumes projects are targeted to upper chamber districts while an interaction between lower and upper chamber legislators is required for passage. Importantly, the present article is concerned with the costs of the collective action required to ensure passage of legislation: To the extent that collective action involves the entirety of the legislature then considering the number of seats in each house independently—while consistent with previous studies—is inconsistent with the model's implications. In other words, if a coalition of the entire legislature is required to ensure passage of a particular piece of legislation, then increases in the size of the legislature *in total* will increase those costs of collective action.

In consideration of this possibility, an alternative model specification is:

$$Y_{it} = \beta_1 n_{it}^U + \beta_2 n_{it}^L + \beta_4 (N_{it})^2 + \beta_3 \boldsymbol{X_{it}} + \gamma_i + \delta_t + \varepsilon_{it} \tag{14}$$

where $N_{it} = n_{it}^U + n_{it}^L$, representing the total number of legislative seats across both chambers. This model suggests a first-order relationship between each chamber's size and spending (consistent with the 1/n model of cost-sharing for projects targeting specific geographic areas), but that the second-order relationship of interest is dependent on the combined size of the legislature (based on a view that passage of omnibus legislation requires cooperation of both chambers). An additional specification considers only the total size of the legislature and takes the form

$$Y_{it} = \beta_1 N_{it} + \beta_2 (N_{it})^2 + \beta_3 \boldsymbol{X_{it}} + \gamma_i + \delta_t + \varepsilon_{it} \tag{15}$$

with the marginal effect of changes in total legislature size calculated in the same way as Equations 12 and 13 above, now in terms of total legislature size across both chambers. Collectively, these specifications allow for a variety of estimates of the interactions within the legislature.

**Table 1.** Summary Statistics

| | Mean | Standard Deviation |
|---|---|---|
| Upper chamber (senate) seats | 39.961 | 10.116 |
| Lower chamber (house) seats | 115.363 | 56.930 |
| Population (millions) | 5.232 | 5.574 |
| Population growth rate | 1.082 | 1.118 |
| Real per capita personal income | 13,792.330 | 3777.735 |
| Real per capita revenue from Federal Government | 465.119 | 242.277 |
| Proportion of population age 65+ | 0.117 | 0.022 |
| Proportion of population age 5–17 | 0.207 | 0.037 |
| Democrat governor | 0.534 | 0.499 |
| Proportion of upper chamber seats held by Democrats | 0.574 | 0.201 |
| Proportion of lower chamber seats held by Democrats | 0.573 | 0.192 |
| Average DW-NOMINATE score for state's U.S. senators | −0.015 | 0.306 |
| Real per capita total state expenditure | 1808.129 | 739.732 |
| Real per capita state construction expenditure | 138.012 | 63.064 |
| Real per capita state education expenditure | 265.389 | 108.108 |
| Real per capita state hospital direct expenditure | 66.557 | 41.174 |
| Real per capita state public welfare expenditure | 309.381 | 213.245 |
| Real per capita state highway expenditure | 154.795 | 73.027 |
| Real per capita state police and fire expenditure | 14.468 | 7.861 |
| Real per capita state sanitation expenditure | 6.696 | 11.211 |
| Real per capita state employee retirement benefits expenditure | 101.290 | 84.562 |

To test the relationship between legislature size and expenditure, and the nonlinear aspects predicted by the extended model, I gather annual state level data over the time period 1962–2014. Table 1 presents summary statistics. Consistent with previous studies in this area, Nebraska is excluded due to its unicameral legislature, and Alaska and Hawaii are dropped due to their unique characteristics.[7] The key variables of interest—the size of the upper and lower chambers in each state legislature—come from annual volumes of The Council of State Government's *Book of the States*, specifically the recurring table "The Legislators: Numbers, Terms, and Party Affiliations." Total state expenditure per capita serves as the dependent variable and comes from the U.S. Census Bureau's "Annual Survey of State and Local Government Finances" data, adjusted to real terms using the Bureau of Labor Statistics' Consumer Price Index.

As total per capita state expenditure may be an imperfect measure of "project size" described by the model, and consistent with the previous empirical literature, I also consider alternative categories of spending. Specifically, these alternative dependent variables include real per capita state construction expenditure, education expenditure, direct expenditure on hospitals, welfare expenditure, highway expenditure, police and fire expenditure, sanitation expenditure, and expenditure on employee retirement benefits.[8] All spending categories are state expenditure alone (as opposed to state and local expenditure) to ensure that the expenditures are being determined solely at the state level, consistent with the model of distributive politics in the state legislature. Importantly in the context of the Law of 1/n, only certain specific types of expenditures are consistent with distributive

[7] Additionally, Minnesota had a nonpartisan legislature for 12 years in the sample (1962–1973) and is excluded for those years.

[8] Data for some specific categories of spending are not available for several years in the sample. Regressions with those dependent variables contain only those years for which data is available. For a discussion of the potential limitations to using total expenditure, see Primo and Snyder Jr. (2008).

politics (Pecorino 2018). For instance, construction expenditure, by its very nature, is related to specific projects that must be located in defined geographic areas. Thus, such a measure perhaps coincides better with the distributive programs central to the original Weingast, Shepsle, and Johnsen (1981) argument. On the other hand, the positive relationship between chamber size and spending would not necessarily be expected with welfare expenditure, a category closer to a so-called entitlement and not "distributive" in the sense consistent with the Law of 1/n.

The vector $\boldsymbol{X_{it}}$ is made up of several control variables typical of this literature. Socioeconomic controls include the state's population, population growth rate, and real per capita personal income (from the U.S. Bureau of Economic Analysis), as well as real per capita revenue from the federal government (lagged one period to mitigate the possibility of simultaneity) and the proportions of the state's population which is aged 5–17 and over 65 (from the U.S. Census Bureau). Political control variables include an indicator variable, which takes a value of 1 if the state's governor is a Democrat, and proportions of the seats in the upper and lower chambers of the legislature held by Democrats (drawn from the *Book of the States*). Additionally, to control for overall ideology in the state, the average DW-NOMINATE score for the state's U.S. Senators is included as an additional control variable. Finally, to account for other potentially omitted factors, all models include both state and year fixed effects, and standard errors are clustered by state and year.

## 4. Results and Discussion

Table 2 presents results from the estimation of the various specifications outlined above using total state expenditure per capita as the dependent variable. The first column presents results from the baseline model: Consistent with the previous literature (and the Law of 1/n) the size of the upper chamber has a positive, statistically significant effect on spending. Also, consistent with a number of previous studies, the size of the lower chamber is not statistically significant, and the coefficient is negative. Among the control variables, personal income, federal revenue, and ideology are all statistically significant.

Columns 2–4 include the squared chamber size variables in various configurations. Column 2 presents results for the specification which includes both squared chamber terms. Here, the upper chamber size variable is no longer statistically significant upon controlling for the second-order effect. On the other hand, both the lower chamber and lower chamber squared terms are statistically significant, taking the expected signs: Lower chamber size is positively related to expenditure (a relatively unique result in this literature) but the quadratic term is negatively related, indicating that at the margin, as chamber size increases the 1/n effect is diminished. This diminishing effect is consistent with the theoretical model above, which predicts that as chamber size increases the increasing costs of collective action in the legislature will lead to a lessening of the positive relationship between chamber size and spending.

Interestingly, while the coefficients on the upper chamber size variables also take the expected signs, they are not statistically significant. This result is somewhat surprising given the upper chamber's statistical significance in the baseline model, and the consistency with which the Law of 1/n has been observed in the upper chamber in the previous empirical literature.[9] This can perhaps be

[9] The point estimate on the upper chamber variable remains largely unchanged, although the associated standard error increased resulting in the lost statistical significance. One possible explanation for this is the presence of multicollinearity following the introduction of the squared chamber terms since the chamber size terms are quite highly correlated with the associated squared terms.

**Table 2.** Legislature Size and Total Expenditure

| Dependent Variable: Real Per Capita Total State Expenditure | | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Upper chamber (senate) seats | 8.210** | 8.423 | 9.594** | |
| | (4.051) | (18.17) | (3.804) | |
| Upper chamber (senate) seats, squared | | −0.0423 | | |
| | | (0.219) | | |
| Lower chamber (house) seats | −0.351 | 5.975** | 7.658* | |
| | (0.745) | (2.646) | (3.922) | |
| Lower chamber (house) seats, squared | | −0.0167** | | |
| | | (0.00690) | | |
| Total (upper + lower) seats | | | | 8.660*** |
| | | | | (2.924) |
| Total (upper + lower) seats, squared | | | −0.0173** | −0.0194*** |
| | | | (0.00829) | (0.00644) |
| Population | −7.729 | −8.321 | −8.275 | −8.427 |
| | (12.97) | (13.09) | (13.13) | (13.16) |
| Population growth rate | −20.52 | −19.10 | −19.64 | −19.84 |
| | (13.62) | (13.19) | (13.22) | (13.00) |
| Real per capita personal income | 0.0615*** | 0.0600*** | 0.0605*** | 0.0608*** |
| | (0.0142) | (0.0141) | (0.0140) | (0.0139) |
| Proportion of population age 65+ | 1014 | 922.9 | 907.3 | 922.2 |
| | (2136) | (2092) | (2108) | (2111) |
| Proportion of population age 5–17 | 139.2 | 190.0 | 136.1 | 153.0 |
| | (573.0) | (589.5) | (583.4) | (579.5) |
| Democrat governor | 15.23 | 14.90 | 14.90 | 14.96 |
| | (12.77) | (12.60) | (12.68) | (12.65) |
| Proportion of upper chamber seats held by Democrats | 131.9 | 137.1 | 132.5 | 133.4 |
| | (83.70) | (82.02) | (82.79) | (82.64) |
| Proportion of lower chamber seats held by Democrats | 83.78 | 79.42 | 86.6 | 186.50 |
| | (94.93) | (93.27) | (93.05) | (92.81) |
| Average DW-NOMINATE score for state's U.S. senators | −95.81*** | −101.1*** | −100.0*** | −100.6*** |
| | (33.40) | (32.72) | (32.50) | (32.71) |
| Real per capita Revenue from Federal Government ($t-1$) | 1.237*** | 1.243*** | 1.247*** | 1.248*** |
| | (0.113) | (0.112) | (0.114) | (0.115) |
| Observations | 2386 | 2386 | 2386 | 2386 |
| $R$-squared | 0.969 | 0.969 | 0.969 | 0.969 |

Notes: All models include state and year fixed effects, with standard errors clustered by state and year in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

interpreted as evidence that the lower chamber is indeed pivotal in distributive politics. Alternatively, to the extent the effects of collective action are only observed at relatively large chamber sizes, the typically smaller upper chamber may not exhibit the relationship in the same way the lower chamber does.

Column 3 includes results from Equation 14, where chamber sizes are included along with a squared total legislature size term. Here, the results are consistent with theoretical expectations: Coefficients on *both* upper and lower chamber sizes are positive and statistically significant, while the total legislature size variable is negative and statistically significant, supporting the theory that collective action costs across the entire legislature dampen the 1/n effect. The same can be said for column 4, which includes only the total legislature size and its squared term, with the coefficient on total legislature size positive and statistically significant while its square is negative and significant.

**Table 3.** Legislature Size and Expenditure by Category

| | Real Per Capital State Expenditure Category | | | |
|---|---|---|---|---|
| | Construction (1) | Education (2) | Hospitals (3) | Welfare (4) |
| Upper chamber (senate) seats | 1.192 | 4.912 | −5.264 | −13.72 |
| | (10.67) | (5.434) | (7.837) | (8.946) |
| Upper chamber (senate) seats, squared | −0.0254 | −0.0612 | 0.0820 | 0.169 |
| | (0.125) | (0.0653) | (0.0952) | (0.115) |
| Lower chamber (house) seats | 2.979** | 2.065*** | 1.879** | 0.417 |
| | (1.201) | (0.749) | (0.703) | (1.476) |
| Lower chamber (house) seats, squared | −0.00912*** | −0.00521*** | −0.00471** | −0.00113 |
| | (0.00323) | (0.00188) | (0.00201) | (0.00361) |
| Population | −1.849 | −4.915** | −1.381 | −5.059** |
| | (1.582) | (2.206) | (2.003) | (2.280) |
| Population growth rate | 3.553 | 3.679 | 0.470 | −8.891** |
| | (3.141) | (2.296) | (1.963) | (3.505) |
| Real per capita personal income | 0.0100*** | 0.00290 | −0.00326 | 0.0102** |
| | (0.00342) | (0.00289) | (0.00418) | (0.00484) |
| Proportion of population age 65+ | −576.6 | 349.1 | −335.2 | −247.1 |
| | (462.3) | (393.1) | (494.6) | (599.4) |
| Proportion of population age 5–17 | −194.6 | −248.3 | −134.9 | −248.2 |
| | (338.7) | (180.3) | (211.5) | (333.4) |
| Democrat governor | −2.631 | −0.841 | −0.113 | 3.874 |
| | (2.766) | (3.511) | (2.605) | (4.556) |
| Proportion of upper chamber seats held by Democrats | 6.803 | 39.42* | −41.48** | 59.27* |
| | (13.16) | (21.88) | (19.19) | (30.91) |
| Proportion of lower chamber seats held by Democrats | −22.33 | −55.60** | −16.37 | 57.23 |
| | (15.82) | (26.20) | (24.56) | (39.54) |
| Average DW-NOMINATE score for state's U.S. senators | −5.839 | −14.03 | −14.62 | −32.30* |
| | (9.054) | (10.25) | (9.528) | (18.02) |
| Real per capita revenue from Federal Government ($t-1$) | 0.0519 | 0.0429 | 0.00134 | 0.400*** |
| | (0.0353) | (0.0357) | (0.0267) | (0.0903) |
| Observations | 1831 | 2386 | 1830 | 2386 |
| $R$-squared | 0.754 | 0.919 | 0.703 | 0.938 |

Notes: All models include state and year fixed effects, with standard errors clustered by state and year in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Across specifications, then, the results are consistent with the theoretical relationship described above: The Law of 1/n holds with chamber size being positively related to spending, but at a decreasing rate.

Table 3 presents results analogous to those in column 2 of Table 2, although now using various expenditure categories as the dependent variable. As described above, some categories of expenditure (i.e., those bound to a specific geography) are more likely to be consistent with the Law of 1/n than others (i.e., more traditional entitlements). Results for per capita construction, education, and hospital expenditure in Table 3 are similar to those from the total per capita expenditure models. Specifically, columns 1–3 again present rare evidence of a 1/n effect for the lower chamber, with its coefficient being positive and statistically significant, and the square of lower chamber size exhibiting the predicted negative and significant coefficient estimate. Upper chamber size is once again curiously insignificant, although the coefficients do take the predicted signs in columns 1 and

2. In column 4, which considers per capita welfare expenditure, none of the chamber size coefficients are statistically significant providing evidence of a *lack* of a 1/n relationship. In sum, the Table 3 results provide evidence of the lower chamber size being positively related (at a decreasing rate) to construction, education, and hospital per capita spending. These results—for expenditure categories, which are likely to be more geographically based—are consistent with the model presented above. In contrast, the specification considering welfare expenditure per capita—a more traditional entitlement category to which the Law of 1/n need not apply—does not exhibit the same relationship.

Table 4 presents results from the same specifications using additional expenditure categories as dependent variables. Here, per capita sanitation expenditure (column 3) exhibits similar results to those described above—the lower chamber size is positive and statistically significant, while its squared term is negative and significant. Results from the police and fire expenditure per capita as well as retirement benefits specifications present no statistically significant relationship between chamber size and spending. Curiously, results for highway expenditure per capita are opposite of those predicted by the model: Lower chamber size is *negatively* related to expenditure in this category, and its squared term is positive, implying a reverse 1/n effect with diminishing returns to chamber size. At first glance, this result is surprising since highway expenditure would be expected to follow a pattern similar to construction and thus exhibit positive relationship to chamber size. One possible explanation for this discrepancy is that highways perhaps have larger spillovers than other forms of construction, leading to the reverse 1/n effect posited by some of the theoretical literature.

This expanded empirical model allows for additional exploration of the marginal effect of legislature size on spending. Specifically, given the included squared term, the true marginal effect of legislature size becomes a function of the legislature size itself in the manner expressed in Equations 12 and 13 above. Using the primary specification (i.e., Eqn. 11 above) estimates from Tables 2–4, marginal effects can be evaluated at specific values of chamber sizes to identify any differences in the relationship between chamber size and spending as chamber size changes. Table 5 presents the calculated marginal effects at three chosen values for upper and lower chamber sizes: The sample mean (approximately 40 for the upper chamber, and approximately 115 for the lower chamber), the sample minimum (17 for upper chamber, 35 for lower chamber), and the sample maximum (67 for upper chamber, and 400 for lower chamber). Results consistent with the model above would be characterized by a stronger positive marginal effect at lower chamber sizes, which diminishes (perhaps eventually becoming negative) at larger chamber sizes.

Consistent with the model's implication, the positive 1/n effect is most observable when the models are evaluated at the sample minimum. For the total expenditure models, there is evidence of a positive relationship between lower chamber size and total legislature size and spending. The construction, education, hospital, and sanitation per capita expenditure models return similar results. Also consistent with theory, the effect appears to diminish as chamber size increases: When evaluated at the sample mean, for instance, the magnitudes of the estimated marginal effects are considerably smaller. At the sample maximum, the marginal effects of lower chamber size are all negative in these specifications, and statistically significant, indicating that for very large legislatures additional increases in size result in decreases in spending.[10] Once again, the results for the upper

[10] Using the coefficient point estimates reported in Tables 3 and 4, a back-of-the-envelope calculation of Equation 13 can be used to estimate the specific legislature size at which the marginal effect is equal to zero (before turning negative). Specifically, for total per capita expenditure, this point is roughly 178.89 seats in the lower chamber. For construction, it is 163.32, for education 198.18, for hospitals 199.47, and for sanitation it is 162.50.

**Table 4.** Legislature Size and Expenditure by Category

| | Real Per Capita State Expenditure Category | | | |
|---|---|---|---|---|
| | Highways (1) | Police and Fire (2) | Sanitation (3) | Retirement Benefits (4) |
| Upper chamber (senate) seats | −4.388 | 0.797 | −2.986 | 1.535 |
| | (7.698) | (0.761) | (2.540) | (2.965) |
| Upper chamber (senate) seats, squared | 0.0645 | −0.00943 | 0.0161 | −0.00776 |
| | (0.0891) | (0.00937) | (0.0248) | (0.0380) |
| Lower chamber (house) seats | −1.060** | 0.0881 | 1.495** | −0.846 |
| | (0.524) | (0.0921) | (0.561) | (0.672) |
| Lower chamber (house) seats, squared | 0.00247* | −0.000292 | −0.00460*** | 0.00213 |
| | (0.00146) | (0.000254) | (0.00165) | (0.00171) |
| Population | 0.503 | −0.370** | 0.541 | −1.614 |
| | (0.981) | (0.153) | (0.353) | (1.913) |
| Population growth rate | 2.055 | −0.0195 | −0.766 | −1.276 |
| | (3.407) | (0.203) | (0.731) | (1.879) |
| Real per capita personal income | 0.00675** | 0.00137*** | −0.000940 | 0.00151 |
| | (0.00268) | (0.000330) | (0.000898) | (0.00388) |
| Proportion of population age 65+ | −49.48 | 57.12 | −25.56 | 81.13 |
| | (407.9) | (47.19) | (120.1) | (327.1) |
| Proportion of population age 5–17 | −243.6 | 3.297 | 20.38 | 274.3 |
| | (224.8) | (19.95) | (83.40) | (203.5) |
| Democrat governor | −4.613 | 0.196 | −1.241 | 2.212 |
| | (2.788) | (0.353) | (1.106) | (3.088) |
| Proportion of upper chamber seats held by Democrats | 17.98 | 4.006 | −1.199 | −18.28 |
| | (13.62) | (2.807) | (5.333) | (22.80) |
| Proportion of lower chamber seats held by Democrats | −35.87** | −2.685 | −0.906 | 22.38 |
| | (17.41) | (2.272) | (5.180) | (25.26) |
| Average DW-NOMINATE score for state's U.S. senators | −6.889 | −2.548** | −2.774 | −9.442 |
| | (8.055) | (1.169) | (1.654) | (8.313) |
| Real per capita Revenue from Federal Government ($t-1$) | 0.0427 | 0.00889*** | 0.00152 | 0.0498** |
| | (0.0355) | (0.00313) | (0.00746) | (0.0223) |
| Observations | 2386 | 2386 | 1270 | 2385 |
| $R$-squared | 0.815 | 0.834 | 0.695 | 0.904 |

Notes: All models include state and year fixed effects, with standard errors clustered by state and year in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

chamber are insignificant (with a single exception), providing evidence that the extended model is better able to explain the larger lower chamber. Furthermore, no statistical significance is observed in the marginal effects for the welfare, police and fire, and retirement benefits expenditure specifications (consistent with previous estimates above) indicating these categories of spending are not explicable by the Law of 1/n. Highway expenditure remains unique in that a statistically significant negative marginal effect of lower chamber size is observed, which decreases in magnitude (and become indistinguishable from zero) as chamber size increases.

Figure 2 further illustrates this point by plotting the estimated marginal effects (and associated 95% confidence intervals) for the lower chamber size variable evaluated over a range of values on both total expenditure and one of the selected spending categories, construction. From the figure, it is clear that for smaller-size legislatures, the marginal effect of an increase in legislature size is positive,

**Table 5.** Legislature Size and Expenditure, Marginal Effects

| | Total (1) | Construction (2) | Education (3) | Hospitals (4) | Welfare (5) | Highways (6) | Police and Fire (7) | Sanitation (8) | Retirement Benefits (9) |
|---|---|---|---|---|---|---|---|---|---|
| **Evaluated at Sample Minimum for Chamber Sizes (Upper: 17, Lower: 35)** | | | | | | | | | |
| | Real Per Capita State Expenditure Category | | | | | | | | |
| Upper chamber (senate) seats | 6.984 | 0.328 | 2.831 | −2.478 | −7.961 | −2.194 | 0.476 | −2.437 | 1.271 |
| | (11.06) | (6.589) | (3.266) | (4.629) | (5.215) | (4.713) | (0.448) | (1.705) | (1.770) |
| Lower chamber (house) seats | 4.807** | 2.341** | 1.700*** | 1.550*** | 0.338 | −0.888** | 0.0677 | 1.173*** | −0.697 |
| | (2.182) | (0.982) | (0.621) | (0.564) | (1.228) | (0.425) | (0.0746) | (0.448) | (0.555) |
| Observations | 2386 | 1831 | 2386 | 1830 | 2386 | 2386 | 2386 | 1270 | 2385 |
| **Evaluated at Sample Mean for Chamber Sizes (Upper: 39,96, Lower 115.36)** | | | | | | | | | |
| | Real Per Capita State Expenditure Category | | | | | | | | |
| | Total (1) | Construction (2) | Education (3) | Hospitals (4) | Welfare (5) | Highways (6) | Police and Fire (7) | Sanitation (8) | Retirement Benefits (9) |
| Upper chamber (senate) seats | 5.040 | −0.848 | 0.0202 | 1.316 | −0.184 | 0.769 | 0.0434 | −1.686*** | 0.914 |
| | (4.061) | (2.406) | (0.915) | (0.824) | (2.038) | (1.128) | (0.111) | (0.597) | (0.891) |
| Lower chamber (house) seats | 2.125* | 0.895* | 0.862** | 0.804*** | 0.156 | −0.491** | 0.0208 | 0.404** | –0.355 |
| | (1.176) | (0.507) | (0.338) | (0.256) | (0.671) | (0.208) | (0.0352) | (0.192) | (0.293) |
| Observations | 2386 | 1831 | 2386 | 1830 | 2386 | 2386 | 2386 | 1270 | 2385 |
| **Evaluated at Sample Maximum for Chamber Sizes (Upper: 67, Lower: 400)** | | | | | | | | | |
| | Real Per capita Sate Expenditure Category | | | | | | | | |
| | Total (1) | Construction (2) | Education (3) | Hospitals (4) | Welfare (5) | Highways (6) | Police and Fire (7) | Sanitation (8) | Retirement Benefits (9) |
| Upper chamber (senate) seats | 2.750 | −2.213 | −3.290 | 5.719 | 8.974 | 4.259 | −0.466 | −0.824 | 0.495 |
| | (12.26) | (6.805) | (3.511) | (5.028) | (6.944) | (4.416) | (0.515) | (0.849) | (2.419) |
| Lower chamber (house) seats | −7.372** | −4.320*** | −2.107*** | −1.886** | −0.489 | 0.912 | −0.145 | −2.183*** | 0.856 |
| | (3.030) | (1.434) | (0.787) | (0.913) | (1.459) | (0.668) | (0.113) | (0.775) | (0.719) |
| Observations | 2386 | 1831 | 2386 | 1830 | 2386 | 2386 | 2386 | 1270 | 2385 |

***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

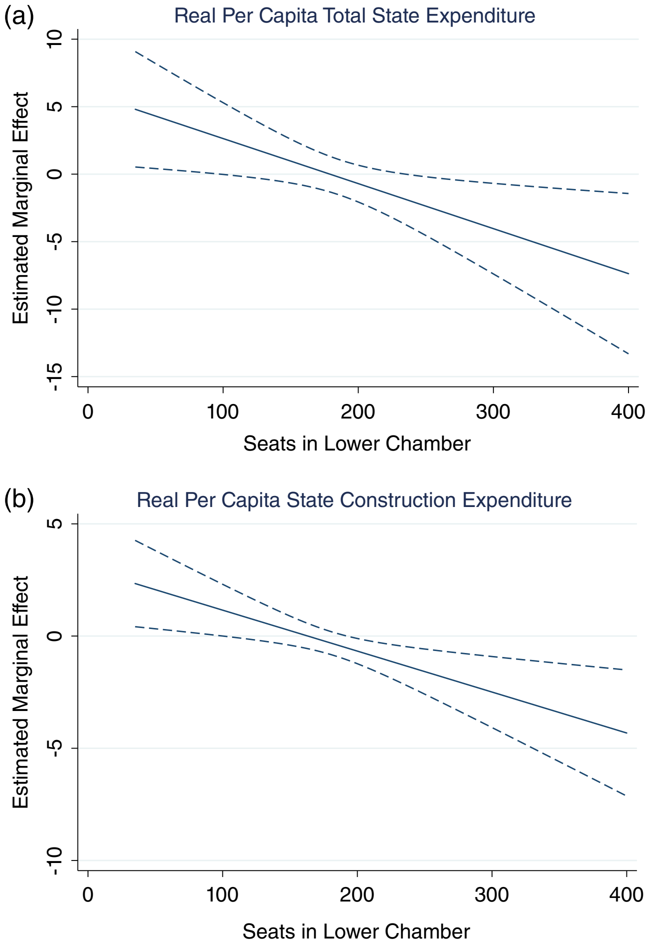


**Figure 2.** Estimated Marginal Effects of Legislature Size on Expenditure.
Notes: Dashed lines indicate 95% confidence interval.

consistent with the Law of 1/n. As legislature size increases, however, the effect diminishes, eventually becoming indistinguishable from zero, and finally negative for very large legislatures. It is at this point that the theory described above would suggest the costs of collective action have become prohibitively high.

The empirical results summarized in Table 5 are not only consistent with the theoretical model above, they may shed light on the inconsistent findings—particularly for lower legislative chambers—in the previous empirical literature. By controlling for the second-order effect of chamber size, a consistent positive 1/n effect for lower chamber sizes is observable when evaluated at the sample mean and minimum values—a novel result in this literature. At larger values, however, the lower chamber effect becomes negative and statistically significant. This result is consistent with the above model's prediction that for large legislatures the increasing costs associated with ensuring project passage may overwhelm the decreasing tax share driving the typical 1/n effect. To the extent this phenomenon is more pronounced in lower chambers (which tend to be larger relative to upper chambers), a failure to account for the second order effect of chamber size may be driving the results in the previous empirical literature which find statistically insignificant—or even significantly negative—effects of lower chamber size on spending.

In contrast, the results in Table 5 are insignificant for the upper chamber. This suggests that while the previous literature has been consistent in its findings of a 1/n effect for the upper chamber, once we control for the nonlinear aspects, that result becomes less robust, especially when considering the marginal effects over a relevant range of values. This, coupled with the comparatively strong results for the lower chamber, may suggest that these second-order effects associated with collective action are predominately exhibited in the larger lower chambers of legislatures, either due to its size, or perhaps because of its pivotal role in developing the minimum winning coalition required to pass the omnibus legislation representative of distributive politics.

## 5. Sensitivity Analysis

Previous studies in the literature have employed alternative data sets when exploring the relationship between chamber size and expenditure. For instance, given that state legislature size changes very infrequently even over a relatively long period of time (1962–2014 here), Chen and Malhotra (2007) employ an alternative panel specification comprised of multiple-year intervals instead of annual data. As a test for sensitivity to this alternative, Table 6 presents results of the primary model specification (each chamber size variable and its squared term) across all nine dependent variables this time using data from five-year intervals.[11] The results are largely the same as presented above: Upper chamber size is statistically insignificant across all specifications, with the sole exception of hospital expenditure, where it curiously takes a negative sign. The effect of lower chamber size is positive and statistically significant across the total expenditure, construction, education, and sanitation expenditure specifications, and its squared term takes the predicted negative sign in each—consistent with previous results. Also consistent with the above results, no statistical significance is observed in the welfare, police and fire, or retirement benefits models, and the unusual negative result for highway spending remains as well. In short—the vast majority of the results presented above for the lower chamber remain intact when the longer time interval is considered. Hospital expenditure remains the only real difference, with results for lower chamber size no longer statistically significant.

Chen and Malhotra (2007) also include additional specifications, which consider only those states with districts comprised of a single member. Table 7 is analogous to Table 6 but is now based on only those states with single-member districts.[12] The results here are a bit more varied. For one, chamber size is no longer statistically significant in the total expenditure, education, or hospital specifications. The lower chamber size variables remain statistically significant with the predicted signs in the construction and sanitation models, and now also take statistically significant and expected signs in the highways and police and fire models. The lower chamber size variables are now statistically significant in the retirement benefits spending specification, although the sign is opposite that consistent with the Law of 1/n. Education and police and fire expenditure also exhibit positive, statistically significant results for the *upper* chamber size variables, and expected negative signs on the squared term—results unique to this specification. In sum, the results are still mostly consistent with both the theoretical model and previous empirical findings

[11] Specifically, the previous sample was truncated to include observations from 1965, 1970, 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010.

[12] The Chen and Malhotra (2007) data identify states with multiple-member legislative districts for the years 1964, 1974, 1984, 1994, and 1992–2004. Across these years, Arizona, Idaho, Maryland, New Hampshire, New Jersey, North Dakota, South Dakota, Vermont, Washington, and West Virginia are identified as having multiple-member districts and are therefore dropped from this analysis. Additionally, a number of other states had multiple-member districts in at least one of the selected years (before changing to single-member districts for the remainder of the sample); these state observations are dropped for those years only: Connecticut, Florida, Illinois, Maine, Montana, New Mexico, North Carolina, Pennsylvania, Rhode Island, South Carolina, Virginia, and Wyoming.

**Table 6.** Legislature Size and Expenditure, 5-Year Intervals

| | Real Per Capital State Expenditure Category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total (1) | Construction (2) | Education (3) | Hospitals (4) | Welfare (5) | Highways (6) | Police and Fire (7) | Sanitation (8) | Retirement Benefits (9) |
| Upper chamber (senate) seats | 4.335 | −34.87 | 2.194 | −41.64** | −7.614 | −11.15 | 0.818 | −17.03 | 2.044 |
| | (15.61) | (28.40) | (3.787) | (16.50) | (7.561) | (7.323) | (0.501) | (17.03) | (2.762) |
| Upper chamber (senate) seats, squared | 0.0232 | 0.228 | −0.0304 | 0.428*** | 0.0952 | 0.145 | −0.0100 | 0.0779 | −0.0155 |
| | (0.185) | (0.334) | (0.0522) | (0.112) | (0.0965) | (0.0913) | (0.00636) | (0.155) | (0.0383) |
| Lower chamber (house) seats | 4.484** | 22.25* | 1.918* | 11.59 | −0.190 | −1.117** | 0.0651 | 12.50* | −1.141 |
| | (1.567) | (9.466) | (0.969) | (8.769) | (1.185) | (0.399) | (0.0924) | (5.572) | (0.626) |
| Lower chamber (house) seats, squared | −0.0118** | −0.0742* | −0.00503* | −0.0386 | 0.000814 | 0.00294** | −0.000223 | −0.0420* | 0.00294 |
| | (0.00412) | (0.0323) | (0.00227) | (0.0295) | (0.00279) | (0.00113) | (0.000247) | (0.0188) | (0.00161) |
| Population | −10.70 | −1.588 | −4.830* | −2.349 | −5.390* | 0.242 | −0.393** | 0.478 | −2.372 |
| | (10.61) | (2.156) | (2.352) | (2.467) | (2.930) | (1.001) | (0.173) | (0.439) | (2.047) |
| Population growth rate | −24.55 | 6.293 | 4.051 | −0.918 | −8.006 | −3.560 | −0.257 | −0.0499 | -2.141 |
| | (18.44) | (4.770) | (4.304) | (2.912) | (4.612) | (6.477) | (0.221) | (0.417) | (2.317) |
| Real per capita personal income | 0.0635** | 0.00966** | 0.000143 | −0.00177 | 0.0156** | 0.00619 | 0.00143** | −0.000615 | 0.00292 |
| | (0.0239) | (0.00380) | (0.00380) | (0.00407) | (0.00568) | (0.00731) | (0.000452) | (0.00133) | (0.00408) |
| Proportion of population age 65+ | 1095 | −693.2 | 302.5 | −351.5 | −71.53 | −168.4 | 44.99 | −98.99 | 212.5 |
| | (2274) | (522.2) | (437.2) | (494.5) | (721.0) | (498.1) | (45.59) | (152.4) | (333.8) |
| Proportion of population age 5–17 | −362.9 | −611.9 | −417.6 | −128.4 | −100.7 | −521.3 | −6.824 | 11.46 | 527.2 |
| | (1013) | (612.3) | (341.8) | (240.2) | (758.6) | (424.4) | (37.77) | (86.02) | (290.8) |
| Democrat governor | 18.91 | 0.809 | −2.967 | 1.553 | 7.262 | −3.441 | 0.0887 | −2.681 | 2.765 |
| | (18.44) | (5.515) | (4.073) | (2.676) | (6.025) | (4.197) | (0.501) | (1.677) | (3.556) |
| Proportion of upper chamber | 55.79 | 8.572 | 58.82** | −44.21* | 17.83 | 20.44 | 4.054 | −2.745 | −18.63 |
| seats held by Democrats | (142.7) | (27.72) | (21.41) | (22.04) | (41.07) | (28.10) | (4.319) | (5.815) | (26.74) |
| Proportion of lower chamber | 93.58 | −28.41 | −86.33** | −40.77 | 71.38 | −45.97 | −3.511 | −0.200 | 5.851 |
| seats held by Democrats | (159.6) | (31.65) | (27.72) | (25.03) | (46.87) | (29.33) | (3.509) | (11.60) | (33.93) |
| Average DW-NOMINATE | −124.6** | −16.75 | −20.37* | −19.07 | −33.82* | −15.76* | −2.673** | −3.517 | −10.39 |
| score for state's U.S. senators | (43.23) | (10.28) | (9.886) | (13.58) | (17.92) | (8.220) | (1.054) | (2.034) | (8.936) |
| Real per capita Revenue from | 1.345*** | 0.0786* | 0.0512 | 0.0171 | 0.464*** | 0.0583 | 0.00990** | 0.0137* | 0.0511* |
| Federal Government (t−1) | (0.201) | (0.0386) | (0.0409) | (0.0296) | (0.101) | (0.0409) | (0.00382) | (0.00648) | (0.0266) |
| Observations | 468 | 329 | 468 | 329 | 468 | 468 | 468 | 249 | 468 |
| R-squared | 0.972 | 0.777 | 0.930 | 0.769 | 0.945 | 0.816 | 0.851 | 0.717 | 0.911 |

Notes: All models include state and year fixed effects, with standard errors clustered by state and year in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

**Table 7.** Legislature Size and Expenditure, Single-member Districts

| | Real Per Capita State Expenditure Category | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total (1) | Construction (2) | Education (3) | Hospitals (4) | Welfare (5) | Highways (6) | Police and Fire (7) | Sanitation (8) | Retirement Benefits (9) |
| Upper chamber (senate) seats | −39.03 | −19.81* | 17.35* | −8.662 | 4.799 | −44.94*** | 2.609*** | −7.645 | −0.190 |
| | (47.49) | (10.00) | (9.497) | (7.051) | (27.12) | (6.828) | (0.813) | (5.114) | (9.341) |
| Upper chamber (senate) seats, squared | 0.601 | 0.260** | −0.194* | −0.0508 | −0.109 | 0.514*** | −0.0335*** | 0.0786 | 0.0425 |
| | (0.535) | (0.116) | (0.108) | (0.0841) | (0.314) | (0.0723) | (0.00913) | (0.0475) | (0.104) |
| Lower chamber (house) seats | −2.367 | 81.07*** | −0.171 | 4.452 | −2.123 | 1.972* | 0.208** | 20.65*** | −4.550** |
| | (3.883) | (7.979) | (1.226) | (7.216) | (4.074) | (1.057) | (0.0732) | (3.102) | (1.605) |
| Lower chamber (house) seats, squared | 0.00217 | −0.455*** | 0.00128 | 0.0111 | 0.00547 | −0.00698** | −0.000694*** | −0.114*** | 0.0123*** |
| | (0.0113) | (0.0500) | (0.00243) | (0.0454) | (0.0128) | (0.00307) | (0.000229) | (0.0174) | (0.00387) |
| Population | −1.756 | −2.852 | −6.049*** | −0.0539 | −7.412** | −0.842 | −0.285 | 0.911 | −1.944 |
| | (10.72) | (2.379) | (1.074) | (3.105) | (3.071) | (1.044) | (0.201) | (0.936) | (1.658) |
| Population growth rate | −41.49** | −8.419 | 0.201 | −2.203 | −10.25 | 2.476 | 0.0869 | −1.769 | −2.850 |
| | (18.49) | (7.392) | (3.890) | (2.602) | (6.072) | (4.946) | (0.418) | (2.320) | (4.453) |
| Real per capita personal income | 0.0520 | 0.0151* | 0.000617 | −0.00445 | 0.0160 | 0.00277 | 0.00113 | −0.00332 | 0.000734 |
| | (0.0479) | (0.00707) | (0.00424) | (0.00554) | (0.0132) | (0.00751) | (0.000885) | (0.00343) | (0.00431) |
| Proportion of population age 65+ | −585.6 | −1004 | −361.5 | 262.2 | −1771 | −668.0 | 125.3* | −245.0 | −249.4 |
| | (2737) | (651.5) | (505.9) | (630.0) | (1182) | (469.9) | (65.44) | (229.1) | (613.2) |
| Proportion of population age 5−17 | −1268 | −440.6 | −467.1 | −107.6 | −535.2 | −687.2** | −11.46 | 52.77 | 22.07 |
| | (1383) | (409.6) | (460.7) | (325.9) | (691.2) | (288.1) | (37.42) | (125.9) | (280.3) |
| Democrat governor | 40.16* | −0.380 | 4.440 | 2.674 | 5.697 | −2.450 | 0.325 | −0.320 | −0.803 |
| | (22.25) | (3.466) | (4.048) | (2.799) | (7.481) | (2.863) | (0.383) | (1.088) | (3.903) |
| Proportion of upper chamber seats held by | 227.1 | −30.76 | 15.61 | −49.72** | −10.57 | 28.91 | 2.014 | −6.793 | 1.266 |
| Democrats | (156.4) | (28.75) | (22.78) | (20.59) | (35.34) | (30.01) | (2.719) | (4.095) | (35.86) |
| Proportion of lower chamber seats held by | 29.18 | −44.04* | −62.94* | 26.35 | 34.05 | −13.81 | −0.768 | −9.447 | −5.286 |
| Democrats | (180.6) | (22.98) | (34.62) | (21.71) | (65.59) | (22.41) | (3.648) | (6.060) | (48.56) |
| Average DW-NOMINATE score for state's U.S. | −61.75 | 5.057 | 4.144 | −3.658 | −24.06 | 0.162 | −1.902* | 2.269 | −11.91 |
| senators | (41.18) | (8.636) | (8.828) | (8.251) | (20.07) | (7.670) | (0.981) | (2.155) | (7.868) |
| Real per capita Revenue from Federal | 0.918** | 0.0366 | −0.0151 | 0.0258 | 0.427* | −0.00144 | 0.00583 | 0.0199 | 0.0409 |
| Government ($t-1$) | (0.313) | (0.0460) | (0.0703) | (0.0316) | (0.225) | (0.0235) | (0.00359) | (0.0163) | (0.0316) |
| Observations | 573 | 517 | 573 | 517 | 573 | 573 | 573 | 460 | 573 |
| $R$-squared | 0.969 | 0.842 | 0.946 | 0.873 | 0.917 | 0.889 | 0.890 | 0.853 | 0.910 |

Notes: All models include state and year fixed effects, with standard errors clustered by state and year in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

discussed above; however, these findings do seem to provide evidence of differences between single- and multi-member district states in terms of the relationship between chamber size and expenditure.

## 6. Conclusion

The foundational model of distributive politics, Weingast, Shepsle, and Johnsen (1981), predicts a positive relationship between the number of legislative districts and inefficiency of government spending: the Law of 1/n. A voluminous empirical literature has tested this straightforward hypothesis, with mixed results: The relationship is generally observable for upper legislative chambers and unicameral bodies, but not for lower houses. A related theoretical literature has followed noting the limitations of the original Law of 1/n model. This article adds to that growing literature by proposing an extended model of distributive politics which includes the costs associated with collective action. The extended model predicts a nonlinear relationship between legislature size and spending: Increases in the number of districts leads to reductions in per-district project costs (the 1/n effect) but also causes increases in costs of collective action required to pass omnibus legislation.

Results of an empirical exercise using U.S. state data 1962–2014 are consistent with the predictions of the proposed extended model. Specifically, controlling for the second-order effects of chamber size yields positive, significant 1/n effects for the lower chamber, a unique result in this literature. The observed second-order effects are negative and significant, indicating that as chamber size increases, the 1/n effect is partially diminished. Similar empirical evidence is found when considering various categories of expenditure. Furthermore, the empirical results presented here raise questions about the previously consistent findings on the upper chamber: Specifically, those results do not appear to be robust to the inclusion of a second-order effect of chamber size.

The model presented here and its empirical results come with some important caveats. As with most models following the Weingast, Shepsle, and Johnsen (1981) approach, the model presented here is unicameral in nature and does not explicitly model bargaining between legislature chambers, although some specifications do include total measures of legislature size. Furthermore, the typical disconnect identified by Primo and Snyder Jr. (2008) between project size in the theoretical framework and expenditure in the empirical model is present here—although the predicted mitigating marginal effects of the increasing costs of collective action can be expected whether the typical positive relationship between chamber size and spending or the potential "reverse Law of 1/n" is observed.

The model presented here yields additional testable implications. For instance, characteristics beyond size likely influence the costs of collective action within the legislature and variations in these characteristics should yield predictable effects on the size of projects supported by member legislators. Furthermore, the model implies the existence of a legislature size associated with a maximum optimal project size, before which increases in the number of districts lead to increases in spending and beyond which additional increases lead to less expenditure. Depending on the normative position one takes with respect to so-called pork barrel legislation, or the size of government in general, the model yields policy implications regarding the "optimal" legislature size.

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