The Effect of Legislature Size on Public Spending: A Meta-Analysis

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Abstract

In a seminal article, Weingast et al. (1981) argue that there is a positive relationship between legislature size and inefficiency in public expenditures. Their proposition is currently known as the "law of $1/n$" and has been widely debated in political science and public administration. However, recent studies have questioned the validity of the theory. In this letter, we conduct the first meta-analysis that assesses the generality of the "law of $1/n$". Based on a sample of 30 articles, we find no robust evidence for the effect of legislature size on government budgets. Yet the aggregate results show significant heterogeneity. We find moderate support for the "law of $1/n$" in unicameral legislatures and in the upper house, but panel/fixed-effects models and regression discontinuity designs reduce public spending estimates. Our results also indicate that proportional representation systems are no more likely to overspend than majoritarian ones.

Keywords: distributive politics; law of $1/n$; legislature size; meta-analysis; public spending

JEL Classification Codes: H21; H23; H50; H61

1 Introduction

Over the past decades, a large literature has examined the relationship between legislature size and public expenditure. Weingast et al. (1981) provided the general framework to analyse distributive politics. The authors argue that the larger the number of legislative districts (n), the smaller the share of tax burden each one will bear ($1/n$), thus legislators have an incentive to overspend in their districts and transfer the costs to the entire polity. Early studies that empirically tested the "law of $1/n$", as the theory is currently known, indeed found a positive correlation between the number of legislature seats and different measures of government spending, although these first results were mainly based on US state legislatures and the effect was often limited to one house (e.g., Baqir 2002; Gilligan and Matsusaka 1995, 2001).

Later research, however, has questioned the validity of the "law of $1/n$". Primo and Snyder (2008) affirm that, due to spatial spillovers, a collection of small districts can supply public goods more efficiently than the central government. The authors conclude that a "reverse law of $1/n$" may hold, wherein a higher number of legislators in small constituencies decrease the overall public spending. Similarly, Primo (2006) and Chen and Malhotra (2007) find that lower and upper chambers may have mixed effects on government spending, while Pettersson-Lidbom (2012) argues that the impact of larger chamber sizes is negative when using data from Finland and Sweden.

Since many empirical tests of the "law of $1/n$" have produced conflicting results, scholars have expanded this research agenda and closely investigated how institutional factors condition the original formulation of the theory. For instance, authors such as Crowley (2019) and Pecorino (2018) accurately point out that collective action problems have been overlooked in the literature, and recent findings indicate that bicameralism (Maldonado 2013), intergovernmental competition (Crowley 2015), redistricting (Lee and Park 2018), and party ideology (Bjedov et al. 2014) strongly influence the relationship between seats and spending. Moreover, the literature has increasingly applied causal inference methods to estimate the effect of the "law of $1/n$", and in contrast to previous studies using panel data, regression discontinuity designs generally indicate that more legislators decrease public expenditures (De Benedetto 2018; Höhmann 2017; Lewis 2019; Pettersson-Lidbom 2012). In this respect, scholars have long been aware of the theoretical and empirical limitations of the "law of $1/n$", and the proliferation of new studies reflect a conscious attempt to assess the robustness of the theory.

In this letter, we conduct the first meta-analysis that tests the generality of the "law of $1/n$". We select 30 articles that use quantitative methods to evaluate the impact of legislature size over government spending across several dimensions. Our study sample mirrors the diversity of the literature. Out of the 45 coefficients included in our main analysis, 40% of them are positive and statistically significant, 22.2% are positive and statistically insignificant, 17.8% are negative and statistically insignificant, and 20% are negative and statistically significant. Given the volume and the disparity of the studies, we employ meta-analysis to summarise the results.

Meta-analysis provides a rigorous approach to combine heterogeneous outcomes into a single estimation, and it allows scholars to gain valuable insights from the aggregated data (Cooper et al. 2019; Hedges and Olkin 1985). Meta-analysis can also identify potential sources of study variability, enabling researchers to assess threats to external validity and direct future efforts into more promising areas of academic inquiry (Doucouliagos and Ulubaşoğlu 2008). Research synthesis methods have been successfully applied in medicine and psychology since the 1970s (Glass 2015), and our work contributes to the burgeoning literature that uses meta-analytic methods to understand challenging questions in political science (Costa 2017; Doucouliagos and Ulubaşoğlu 2008; Green et al. 2013; Lau et al. 2007; Schwarz and Coppock 2020).

We run binomial tests and meta-regressions to further evaluate the relationship between legislature size and government expenditures. We use binomial tests to assess whether the proportions of positive and negative coefficients in our sample are statistically different from each other. In the meta-regressions, we measure the effect of five moderators that capture different sources of heterogeneity in the literature. We also construct a series of funnel plots to test for publication bias in existing research on the "law of $1/n$" (Easterbrook et al. 1991; Gerber et al. 2001).

Aggregate results indicate that legislature size has no significant impact on public spending. All of our main meta-analysis estimates show that the overall effect is not statistically different from zero, thus confirming the conflicting findings reported by the literature. However, when we look only at articles that employ regression discontinuity designs (RDDs), we see that all four papers included in our sample suggest that a higher number of legislators leads to lower public spending (De Benedetto 2018; Höhmann 2017; Lewis 2019; Pettersson-Lidbom 2012). In this regard, it is possible that methodological choices partially explain the divergent results observed in the literature, as articles that use RDDs consistently point to the same direction. One limitation of this finding is that these studies only test the impact of lower house size and its natural logarithm on the natural logarithm of expenditure per capita, thus it remains unclear whether the results hold with other variables.

The meta-regressions provide additional evidence that our study sample is highly heterogeneous and that effect sizes differ substantially according to study specifications. When using an extended sample of 162 coefficients, we find that unicameralism is associated with higher public spending, as predicted by the "law of $1/n$". Moreover, one of our meta-regressions indicates that larger upper chambers spend more in terms of per capita expenditure than lower chambers, a result that also appears in the binomial tests. Overall, non-majoritarian voting systems seem to decrease government spending, following the idea that the $1/n$ effect grows weaker as the empirical cases distance from the original definition of the law. Finally, meta-regression results confirm that regression discontinuity designs reduce public spending estimates.

2 Data and Methods

We compiled our study sample in three search rounds. In the first round, we gathered data from three large academic databases (Scopus, Microsoft Academic, and Google Scholar) and looked for studies that were written in English and cited Weingast et al. (1981), as it is the foundational work in the literature on the "law of $1/n$". To ensure that our sample was comparable, we only selected papers that used quantitative methods to analyse data[1]. After this stage, we identified six measurements that the literature often employs to quantify government expenditure and legislature size. For government expenditure, our study sample uses (i) public expenditure as a share of GDP; (ii) public expenditure per capita; and (iii) the natural logarithm of public expenditure per capita as its main variables of interest. In regards to legislature size, the variables are (i) lower chamber size; (ii) natural logarithm of lower chamber size; and (iii) upper chamber size[2].

In the second round, we did not require articles to cite Weingast et al. (1981) and used a keyword-based query on Google Scholar to broaden the scope of the first search. The search string contained terms strongly associated with the literature on the "law of $1/n$" and it was as follows: `("upper chamber size" OR "lower chamber size" OR "council size" OR "parliament size" OR "legislature size" OR "number of legislators" OR "legislative size") AND ("spending" OR "expenditure" OR "government size")`. We again restricted the search to articles written in English which employed quantitative methods. This search added two new results to our sample (Coate and Knight 2011; De Benedetto 2018), but neither of them included variables beyond the six measures we had previously identified. In the third search round, we looked into the personal webpages of every author whom we had already included in our sample. The purpose of this manual search was to assess whether there was any working paper or unpublished manuscript that we had missed in the two former queries. We did not find any new article that satisfied the inclusion criteria in this search. The full list of excluded records is available for online consultation in the replication materials. Combined, the three searches produced a dataset of 30 studies as of the 10th of March 2021. Table 1 contains the full list of articles we analyse in this paper.

[1]Since meta-analysis requires a single estimate per observation, we excluded articles that use interaction terms or quadratic specifications of our selected variables. Please refer to Section C in the Supplementary Material for a detailed description of the selection procedure. We also included two PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagrammes (Liberati et al. 2009) showing the number of resulting papers after each review step.

[2]There are a few important nuances concerning coding of these variables. Unicameralism, for example, is captured both by lower chamber size ($n = 7$) and by log lower chamber size ($n = 5$). Since much of the literature estimates how institutional designs affect this relationship, ours and many other articles use both lower and upper chamber sizes as main explanatory variables. We did not find any article that used the natural logarithm of upper chamber size in their models.

Table 1: Papers included in the meta-analysis, ordered by year of appearance

Author(s)	Journal	Country	Dependent Variable	Method	Institutional Design	Electoral System
Stein et al. (1998)	Unpub	Multiple (26)	PCTGDP	OLS	Mixed	NM
Baqir (1999)	Unpub	USA	logExpPC	OLS	Unicameral	M
Bradbury and Crain (2001)	JPubE	Multiple (37)	ExpPC, PCTGDP	PANEL	Mixed	NM
Gilligan and Matsusaka (2001)	NTJ	USA	ExpPC	PANEL	Bicameral	M
Baqir (2002)	PC	USA	logExpPC	OLS	Unicameral	M
Ricciuti (2003)	Unpub	Multiple (23)	ExpPC	PANEL	Mixed	NM
Mukherjee (2003)	CPS	Multiple (110)	PCTGDP	PANEL	Mixed	NM
Lledo (2003)	Unpub	BRA	PCTGDP	PANEL	Unicameral	NM
Ricciuti (2004)	RivPE	Multiple (75)	PCTGDP	OLS	Mixed	NM
Matsusaka (2005)	SPPQ	USA	ExpPC	IV	Bicameral	M
Primo (2006)	E&P	USA	ExpPC	PANEL	Bicameral	M
Erler (2007)	PC	USA	ExpPC, PCTGDP	PANEL	Bicameral	M
Chen and Malhotra (2007)	APSR	USA	ExpPC	PANEL	Bicameral	M
Fiorino and Ricciuti (2007)	PC	ITA	ExpPC	IV	Unicameral	NM
MacDonald (2008)	PC	USA	logExpPC	OLS	Unicameral	M
Schaltegger and Feld (2009)	JPubE	CHE	ExpPC	PANEL	Unicameral	NM
Coate and Knight (2011)	AEJ	USA	logExpPC	OLS	Unicameral	M
Pettersson-Lidbom (2012)	JPubE	FIN & SWE	logExpPC	RDD	Unicameral	NM
Baskaran (2013)	EJPE	DEU	ExpPC	IV	Unicameral	NM
Maldonado (2013)	SSQ	Multiple (92)	PCTGDP	OLS	Mixed	NM
Kessler (2014)	JPE	USA	ExpPC	PANEL	Unicameral	M
Bjedov et al. (2014)	PC	CHE	ExpPC, PCTGDP	PANEL	Unicameral	NM
Lee (2015)	PC	USA	ExpPC	IV	Bicameral	M
Lee (2016)	PC	USA	ExpPC	IV	Bicameral	M
Drew and Dollery (2017)	UAR	AUS	logExpPC	PANEL	Unicameral	NM
Höhmann (2017)	PC	DEU	logExpPC	RDD	Unicameral	NM
Lee and Park (2018)	PC	USA	ExpPC	PANEL	Bicameral	M
De Benedetto (2018)	Unpub	ITA	logExpPC	RDD	Unicameral	NM
Crowley (2019)	SEJ	USA	ExpPC	PANEL	Bicameral	M
Lewis (2019)	SCID	IDN	logExpPC	RDD	Unicameral	NM

Journal: Unpub = Unpublished, JPE = Journal of Political Economy, EJPE = European Journal of Political Economy, PC = Public Choice, JPubE = Journal of Public Economics, JPriE = Journal of Private Enterprise, APSR = American Political Science Review, SEJ = Southern Economic Journal, UAR = Urban Affairs Review, SCID = Studies in Comparative International Development, SSQ = Social Science Quarterly, SPPQ = State Politics and Policy Quarterly, CPS = Comparative Political Studies, RivPE = Rivista di Politica Economica, E&P = Economics and Politics, NTJ = National Tax Journal.

Country: Country codes follow the ISO 3166-1 alpha-3 international standard.

Dependent Variable: ExpPC = Per capita expenditure, logExpPC = Natural logarithm of per capita expenditure, PCTGDP = Expenditure as a percentage of GDP.

Method: OLS = Ordinary least squares, IV = Instrumental variables, Panel = Panel data/fixed effects, RDD = Regression discontinuity design.

Electoral System: M = Majoritarian, NM = Non-majoritarian (mixed or proportional representation).

Our study sample reflects the development of the literature. Although the “law of $1/n$” was first formulated in 1981, the empirical assessment of the theory only started a few years later, as dates of publishing range from 1998 to 2019. Most studies focus on the United States (14), but our sample also contains papers on Australia (1), Brazil (1), Germany (2), Indonesia (1), Italy (2), and Switzerland (2). Seven articles use cross-national data and analyse from 2 to 110 countries. Early studies used OLS and panel data methods to estimate the results, while studies from 2005 onward have also applied causal inference models such as instrumental variables and regression discontinuity designs to test the relationship between house size and public spending.

Regarding the dependent variables included in the sample, 16 studies employ public expenditure per capita, 9 papers use its natural logarithm, and 8 of them analyse the impact of legislature size on public expenditures as a percentage of GDP. This indicates that the area has refined the original definition of the "law of $1/n$" and tested the impact of larger legislatures on different measures of government spending. Our independent variables are lower chamber size (26), the natural logarithm of lower chamber size (7), and upper chamber size (12). These variables formed a 3×3 table, yet not all combinations were available in the data. We found no studies that correlate public expenditure per capita with either upper chamber size or the natural logarithm of lower house size. Thus, our meta-analysis contains seven of the nine possible variable combinations.

We also coded five moderators that may help us understand the heterogeneity in the reported results. We included them in our meta-regressions alongside an indicator for the type of independent variable used in the original study. The additional moderators are: 1) publication year; 2) paper publication in an academic journal; 3) estimation method; 4) institutional design; 5) electoral system. Since the literature on the "law of $1/n$" is notably diverse, we added only moderators that either refer to important theoretical questions, such as the effect of the electoral system on public spending, or to essential characteristics of the publications themselves. Although more moderators exist in the literature (e.g., data aggregation level), they do not appear as often as necessary for their inclusion in the meta-regressions. Table 2 shows the descriptive statistics of the moderator variables.

Table 2: Descriptive statistics of moderators

	[ALL] N=162	Other coefficients N=117	Main sample N=45
Independent Variables:			
Log of Lower Chamber Size	33 (20.4%)	26 (22.2%)	7 (15.6%)
Lower Chamber Size	82 (50.6%)	56 (47.9%)	26 (57.8%)
Upper Chamber Size	47 (29.0%)	35 (29.9%)	12 (26.7%)
Year	2008 (6.15)	2007 (5.96)	2009 (6.54)
Published work:			
No	17 (10.5%)	11 (9.40%)	6 (13.3%)
Yes	145 (89.5%)	106 (90.6%)	39 (86.7%)

Table 2: Descriptive statistics of moderators *(continued)*

	[ALL]	Other coefficients	Main sample
Estimation method:			
OLS	49 (30.2%)	40 (34.2%)	9 (20.0%)
PANEL	83 (51.2%)	58 (49.6%)	25 (55.6%)
IV	19 (11.7%)	12 (10.3%)	7 (15.6%)
RDD	11 (6.79%)	7 (5.98%)	4 (8.89%)
Institutional Design:			
Bicameral	49 (30.2%)	32 (27.4%)	17 (37.8%)
Mixed	50 (30.9%)	38 (32.5%)	12 (26.7%)
Unicameral	63 (38.9%)	47 (40.2%)	16 (35.6%)
Electoral system:			
Majoritarian	73 (45.1%)	51 (43.6%)	22 (48.9%)
Non-Majoritarian	89 (54.9%)	66 (56.4%)	23 (51.1%)

A key methodological issue we had to address concerns the potential violation of an important assumption in a meta-analysis, that of effect size independence (Cheung 2014, 2019; Veroniki et al. 2016). In our study sample, authors frequently use the same datasets, and almost all papers fit more than one regression with similar variables, what suggests that the assumption above does not hold. We use two procedures to tackle this problem. First, we created two sets of study coefficients to reduce the impact of multicollinearity in our estimations. The first group includes only the most rigorous models from each paper, that is, those estimated with the largest n, most control variables, and fixed effects if the authors added them. If the article employed a regression discontinuity design, we chose the coefficient from the optimal bandwidth or from the intermediate one. This sample encompasses 45 estimates, as 13 articles analysed two dependent or independent variables of interest[3]. Our second sample, in contrast, contains all the 162 effect sizes reported in the 30 papers. Here we focus on the results for our restricted sample as we consider them more robust, but the findings are nearly identical when we use the extended set.

Our second procedure consists of employing multilevel random effect models (Cheung 2014; Matthes et al. 2019) in all of our estimations. We add two extra levels to the regular meta-analysis, one including a unique publication ID for each paper, and another indicating the data source used in the original study. By adding these two levels, we account for within- and between-study variation, thus removing these sources of effect size dependency and improving the accuracy of the results. More information about the multilevel models can be found in Section H.1 of the Supplementary Material.

[3]The papers that used more than one dependent or independent variable of interest are Bjedov et al. (2014); Bradbury and Crain (2001); Chen and Malhotra (2007); Crowley (2019); Erler (2007); Gilligan and Matsusaka (2001); Lee (2015, 2016); Lee and Park (2018); Maldonado (2013); Primo (2006); Ricciuti et al. (2003); Ricciuti (2004).

We use Hedges' g to calculate effect sizes in our meta-analysis (Hedges 1981). While there are other methods to standardise coefficients in meta-analytic studies, Hedges' g corrects for upward bias in small sample sizes and is considered more robust than measures such as Cohen's d (Lakens 2013). We estimate the Standardised Mean Difference (SMD), which represents the effect size in each study relative to the variability observed in that study, by extracting the coefficients and the standard errors from all articles included in our sample and converting them to Hedges' g. In cases where authors did not report the standard errors for their estimates, we computed them using the t-statistic presented in the original tables.

3 Results

The "law of $1/n$" states that more legislators increase government expenditure. In this paper, we employ three methods to test the empirical validity of that relationship. First, we run binomial z-tests to assess the frequency of positive and negative coefficients in our sample. Then, we fit nine multilevel meta-analyses using the `meta` (Balduzzi et al. 2019) and the `dmetar` (Harrer et al. 2019) packages for the `R` statistical language (R Core Team 2019). Lastly, we run four sets of meta-regressions to measure the effects of a group of moderators on the effect sizes of our study sample. To recapitulate, our independent variables of interest are lower chamber size, the natural logarithm of lower chamber size, and upper chamber size. The dependent variables are public expenditure per capita, the natural logarithm of public expenditure per capita, and government expenditure as a percentage of GDP. Since the outcomes have different scales, we treat them separately in our models.

3.1 Binomial Z-Tests

The binomial z-test evaluates whether the majority of the coefficients of our independent variables are positive or negative[4]. If increasing the number of legislators leads to higher public expending, we should expect most coefficients to be positive. Conversely, if the "reverse law of $1/n$" is true, our results should indicate that $p < 0.5$, that is, the proportion of positive coefficients is lower than 0.5. The null hypothesis here states that the sign of the coefficient is equally likely to be positive or negative.

We start with lower house size. Our results indicate that there is no correlation between the number of legislators in the lower house and public expenditure (successes = 13, trials = 26, $p_{success} = 0.5$, 95% CI = [0.299; 0.701], p-value = 1). Note that the "law of $1/n$" suggests that there is a positive association between both. The binomial test for the natural logarithm of lower chamber size also shows a non-statistically significant result (successes = 5, trials = 7, $p_{success} = 0.714$, 95% CI = [0.29; 0.963], p-value = 0.453). In contrast, we find a

[4] Since coefficients are either positive or negative, each of them can be considered a Bernoulli trial. Thus, the aggregate results for all papers follow a Binomial distribution where parameters n equals the number of papers and p is the chance of a positive coefficient. The "law of $1/n$" can be reformulated as the chance of $p > 0.5$, which facilitates the testing of the theory.

positive result for the number of legislators in the upper house, which is in line with the mainstream literature (successes = 10, trials = 12, $p_{success}$ = 0.833, 95% CI = [0.516; 0.979], p-value = 0.039).

3.2 Meta-Analysis

We then proceed to the meta-analysis. We matched the house size variables with our measures of government spending and created a theoretical 3×3 matrix. Out of the nine variable combinations, we found only seven the article pool. Our sample does not contain any papers that analyse the relationships between log lower chamber size and public expenditure per capita, or between upper chamber size and the logarithm of public expenditure per capita.

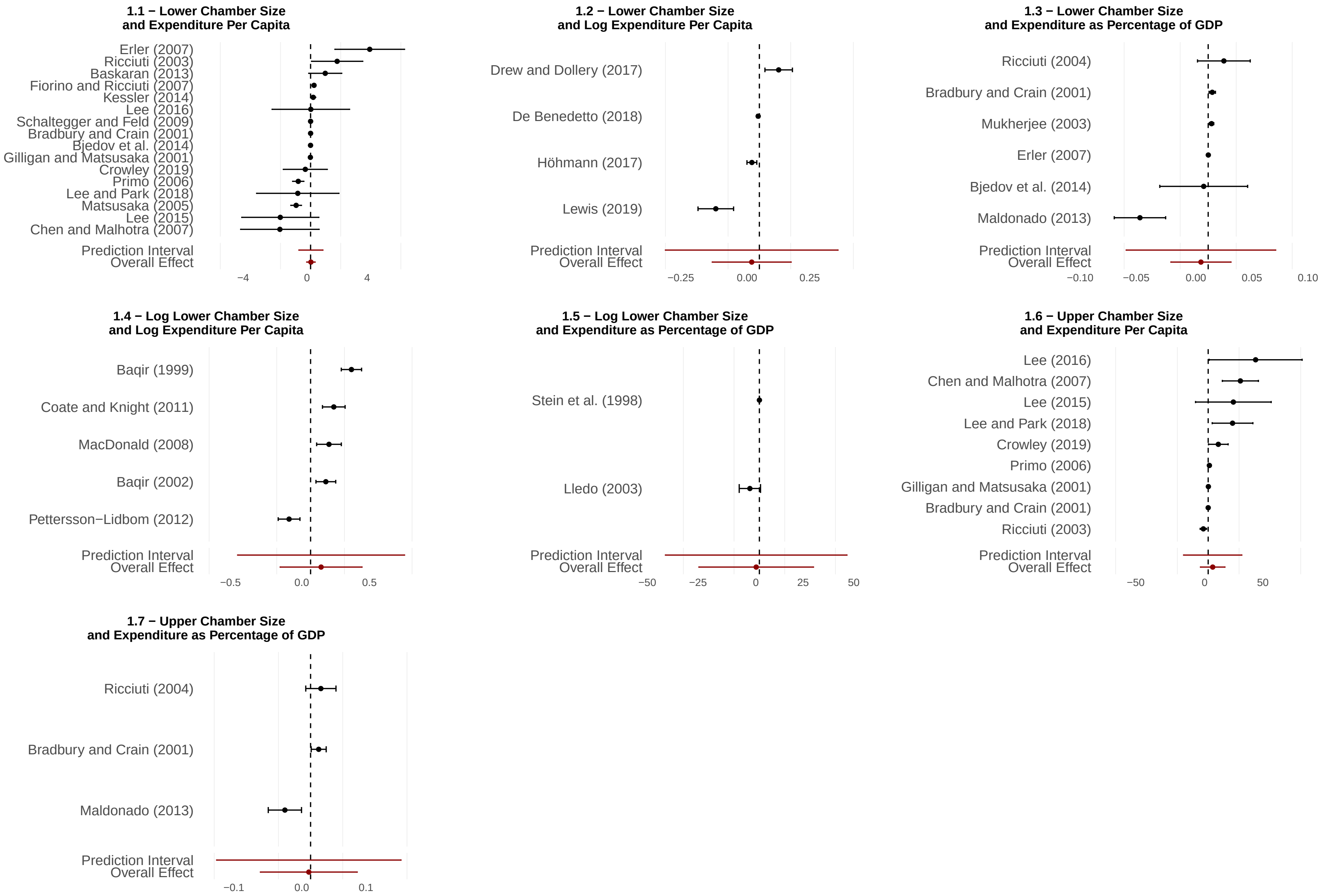
Figure 1 shows the forest plots for our restricted sample, which includes the 45 main coefficients of the 30 selected papers.[5] On the left side of the plots are the names of the study authors and paper publication year. For unpublished studies, we included the first year the paper was available online. The bars in the middle show the reported effect sizes and the vertical lines indicate their average, weighted by standard errors. The length of the lines represent the precision of the estimates. The red line at the bottom of the figures displays the overall effects plus their respective confidence intervals.

The uppermost row shows the results for lower chamber size in our restricted sample. In the first model, which correlates lower house and expenditure per capita, we find a standardised mean difference (SMD) of 0.022 and a standard error of 0.131 (figure 1.1, studies = 16, 95% CI = [-0.256; 0.299], p-value = 0.87), so we cannot rule out that the effect is zero. Indeed, the effect of lower chamber size on the other two dependent variables is also null in statistical terms. When we compare lower chamber size with log expenditure per capita, the overall effect size is -0.031 and the standard error is 0.049 (figure 1.2, studies = 4, 95% CI = [-0.188; 0.127], p-value = 0.58). The impact of larger lower houses on government spending as a percentage of GDP is also negligible (figure 1.3, studies = 6, SMD = - 0.006, 95% CI = [-0.0334; 0.021], p-value = 0.563). The results are virtually identical when we estimate the meta-analyses using our extended sample, and all three coefficients are again statistically indistinguishable from zero.

Next, we present the meta-analyses using the logarithm of lower house size as an independent variable. The relationship between this variable and the log of per capita expenditure is positive, but the coefficient is not significant (figure 1.4, studies = 5, SMD = 0.078, SE = 0.109, 95% CI = [-0.225; 0.381], p-value = 0.515). The effect of log lower house size on expenditure as a percentage of the GDP is negative, but it is again non-statistically significant (figure 1.5, studies = 2, SMD = -1.576, SE = 2.223, 95% CI = [-29.82; 26.668], p-value = 0.607). Results in the full sample are also null, and the coefficients for each dependent variable have the same sign as the restricted sample – positive and negative, respectively.

[5]Please refer to Sections H and I in the Supplementary Material for full results regarding both samples.

Figure 1: Forest plots of the relationship between legislature size and government spending (reduced sample)

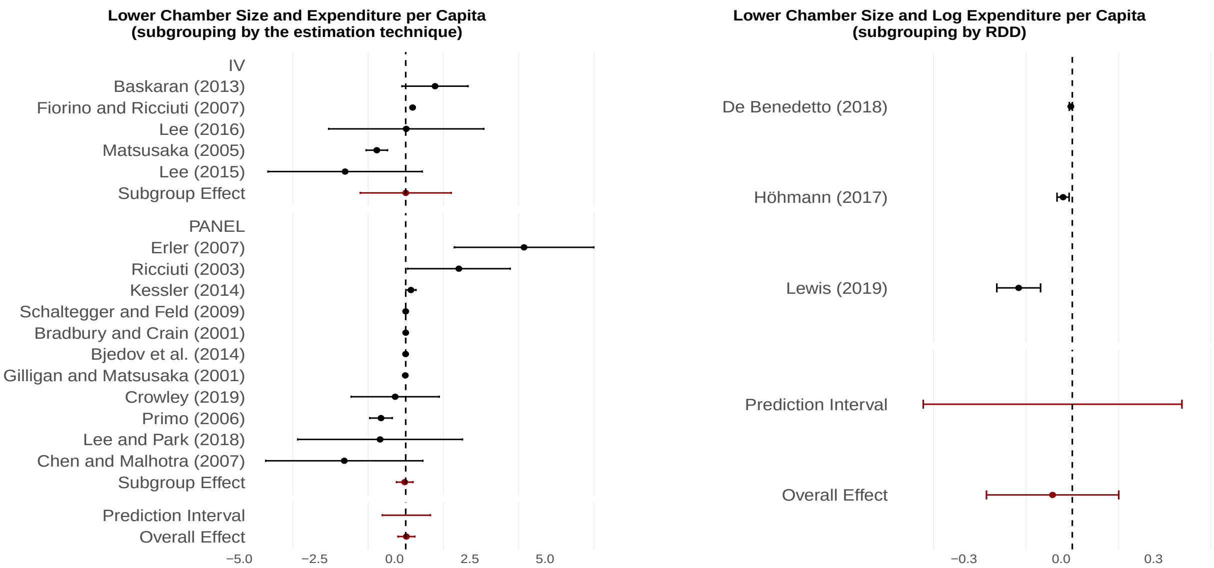


The third set of models uses upper house size as the main independent variable. We find a positive correlation between this variable and expenditure per capita (figure 1.6, studies = 9, SMD = 3.658, SE = 4.299, 95% CI = [-6.255; 13.572], p-value = 0.419), and a negative relationship with government spending as a percentage of GDP (figure 1.7, studies = 3, SMD = -0.003, SE = 0.018, 95% CI = [-0.079; 0.074], p-value = 0.891), yet neither coefficient is statistically significant. Results are the same in our extended sample.

Taken together, these results yield conservative interpretations. Besides all average effect sizes not reaching conventional levels of statistical significance, the studies are also notably heterogeneous. The I^2 statistic quantifies the degree of heterogeneity among studies. Higgins et al. (2019) consider any I^2 value above 75% to indicate high heterogeneity, and the lowest I^2 we find in the restricted sample is 80.7% (for the subset of upper chamber size and per capita expenditure). Additionally, all prediction intervals encompass zero. Therefore, we cannot reject the null hypothesis that the effect size is zero in any variable combination.

In a nutshell, we do not find evidence in favour of the "law of $1/n$". One reason for this may be the identification strategy authors use in their models. On the one hand, OLS and panel data models require too many controls to make units comparable, and they are vulnerable to omitted variable bias or post-treatment bias (Cinelli and Hazlett 2020; Pearl 2015). On the other hand, estimation methods such as instrumental variables (IV) and regression discontinuity designs (RDD) have become popular because of their high internal validity (Angrist and Pischke 2008). Figure 2 shows the disaggregated effects for two sets of models that employ causal estimation techniques. They measure the impact of lower house size on expenditure per capita (left) and on the natural logarithm of expenditure per capita (right).

Figure 2: Forest plots of the relationship between legislature size and government spending with regression method heterogeneity (restricted sample)



Papers that employ instrumental variables and panel/fixed-effects models show somewhat symmetrical distributions. Out of the five papers listed under IV, two are positive, two are negative, and one is null. In the plot for panel data, although more studies accumulate negative coefficients, the positive shifts are more pronounced, so the overall effect is also null. In contrast, all papers that use regression discontinuity designs show negative and statistically significant results. Since only three papers in this model use RDDs[6], we are cautious about predicting an overall negative relationship, but they do indicate that better identification strategies yield a zero-to-negative impact of legislature size on expenditure, in support of the "reverse law of $1/n$".

3.3 Meta-Regressions

In this section, we run a series of meta-regressions with six moderators to account for the heterogeneity across the selected papers. The first variable indicates whether the study uses lower chamber size, log lower chamber size, or upper chamber size as a main explanatory variable. We include separate effect sizes for upper and lower chamber sizes when papers analysed both. The second variable shows the study publication year, which we included to capture temporal variation in the study coefficients. We also add a dummy variable to assess whether published articles report effect sizes that are higher or lower than those from working papers. The fourth variable measures whether studies focusing on non-majoritarian electoral systems report coefficients that are smaller or larger than those from majoritarian countries. The fifth covariate is a categorical variable indicating the statistical procedure used in the original models (panel data, instrumental variables, OLS, or regression discontinuity design). In our last variable, we separate coefficients produced from samples of unicameral or bicameral systems, and code papers that analyse multiple polities with different institutional designs as "mixed".

Table 3 presents the meta-regression results for our restricted and extended samples. Each column represents one of the three measures of public spending we discuss in this paper, and the last one uses all coefficients. To reduce the risk of false positives in our analyses, we use permutation tests to calculate significance levels for the meta-regressions (Higgins and Thompson 2004). To interpret these results, the sign of coefficients matters the most. These meta-regression coefficients can be viewed as representing "the effect of the moderator on the $1/n$ effect". This means positive coefficients predict a strengthening of the $1/n$ effect, and negative ones predict it will get weaker under that moderator category, when compared to its reference category. Since we aggregate different types of independent variables under the same models, the size of the effects does not accurately translate the scale of variations.

[6] Pettersson-Lidbom (2012) also uses RDDs but the study is not included in this model as it employs log lower chamber size as the independent variable.

Table 3: Meta-regression results

	Expenditure Per Capita		Log Expenditure Per Capita		Gov. Spending % GDP		All Coefficients	
	Restricted	Extended	Restricted	Extended	Restricted	Extended	Restricted	Extended
Log of Lower Chamber Size			-0.035	-0.128	-0.047	-0.033	-0.222	-0.148
			(0.134)	(0.124)	(0.028)	(0.024)	(0.144)	(0.090)
Lower Chamber Size	-0.779	-2.590***			-0.009	0.002	-0.055	-0.012
	(1.045)	(0.643)			(0.006)	(0.005)	(0.067)	(0.013)
Year	0.033	0.142**	0.000	-0.005	-0.007**	-0.006***	-0.013	-0.001
	(0.081)	(0.060)	(0.012)	(0.010)	(0.002)	(0.002)	(0.009)	(0.006)
Published: Yes	0.712	0.946	-0.167*	0.009			-0.084	-0.009
	(1.725)	(1.149)	(0.058)	(0.045)			(0.093)	(0.035)
Non-Majoritarian	0.455	0.818	-0.300	0.006	0.043	0.038*	-0.082	-0.190**
	(1.814)	(1.181)	(0.134)	(0.134)	(0.028)	(0.020)	(0.142)	(0.086)
Method: Panel	0.491	-0.361	0.200	-0.354***	-0.018	-0.010	-0.027	-0.137***
	(0.975)	(0.977)	(0.104)	(0.050)	(0.017)	(0.013)	(0.114)	(0.032)
Method: IV		-0.564		-0.052			-0.160	-0.069**
		(0.894)		(0.050)			(0.190)	(0.034)
Method: RDD				-0.308***			-0.168	-0.200***
				(0.041)			(0.147)	(0.036)
Inst. Design: Mixed	-0.739	-1.262			-0.074*	-0.058***	0.123	0.192
	(2.233)	(1.388)			(0.033)	(0.015)	(0.196)	(0.119)
Inst. Design: Unicameral	-0.155	-0.945					0.396**	0.277**
	(1.718)	(1.000)					(0.162)	(0.115)
Intercept	-67.291	-282.761**	-0.030	10.432	13.621**	12.496***	26.032	2.505
	(163.078)	(120.473)	(23.652)	(20.215)	(3.884)	(3.396)	(18.812)	(11.485)

Note: The restricted and extended samples include 45 and 162 study coefficients, respectively. We report the results from the permutation tests. Reference categories: Independent Variable = Upper House Size; Published = No; Method = OLS, Inst. Design = Bicameral. Significance codes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$. Blank cells mean that there is no sufficient data to estimate the parameter.

The first two models show the results for public expenditure per capita. No variable reaches conventional levels of statistical significance in the restricted sample. In the extended sample, we find that models that use lower chamber size as an independent variable have lower effects when compared to upper chamber size. This suggests that an additional member in the lower house has a smaller impact on public spending than a member in the upper house. Moreover, the results for the extended sample point out that recent studies find larger effects than older ones.

The third and fourth columns use the natural logarithm of expenditure per capita as the dependent variable. Among the coefficients in the restricted sample, those in published studies tend to be smaller than those in working papers[7]. Another two moderators are negatively associated with the outcome in our larger coefficient pool. They both refer to estimation methods. Studies that employ panel/fixed effects or regression discontinuity designs (RDDs) have lower coefficients for log expenditure per capita if we take OLS as the reference category.

Three estimates are statistically significant in the third set of meta-regressions, which include public expenditure as a percentage of GDP as the dependent variable. Both in our restricted and in our extended samples, recent studies have smaller coefficients than older papers, which stands in contrast with the first model. Moreover, institutional design also affects outcomes. Papers that use mixed samples of bicameral and unicameral systems report significantly lower coefficients than those that analyse bicameral legislatures

[7]We find no evidence of publication bias in our models. The funnel plots for all estimations are available Sections H and I of the Supplementary Material.

exclusively. Non-majoritarian electoral systems, a category that encompasses proportional representation and mixed systems, may have a positive effect on the "law of $1/n$", but the estimate only borders on statistical significance.

The last two columns report meta-regressions that aggregate all selected studies. In the restricted sample of coefficients, unicameralism has a positive effect. This result holds for the extended sample as well. When we regress all 162 coefficients, the effects of estimation methods become stronger once again. Panel/fixed-effects models and regression discontinuity designs both significantly decrease the $1/n$ effect. Instrumental variable models follow along these lines. Non-majoritarian electoral systems are also significantly associated with lower levels of public spending, which may be justified since the "law of $1/n$" was conceived for majoritarian voting. These latter results, however, do not replicate in the other sets of estimations.

The evidence seems to be sensitive to the methodological design. Our results suggest that the same study samples may produce different outcomes depending on the response variables scholars decide to analyse. The broadest aggregation level presented the most insightful results in dialogue with the literature. The additional legislator in non-majoritarian legislatures does not increase expenditure as much as she would if the system were majoritarian. We are also more likely to witness legislative expenditure growing along with the amount of representatives in unicameral legislatures rather than in bicameral systems. This indicates that while the "law of $1/n$" is not generalisable, its predicted effects are stronger when the institutional features of a polity come closer to its original theoretical framework.

4 Discussion

In this letter, we use meta-analytic methods to assess the generality of the "law of $1/n$". Based on a sample of 30 publications, our meta-analyses show that there is no strong evidence that an increase in the number of legislators has a significant effect on public expenditures. The meta-regressions indicate that study characteristics have a considerable influence on reported results. Electoral system affects the relationship between legislature size and public expenditure, but the results are not replicable in all estimations. In our extended sample, we find that unicameralism favours the $1/n$ effect. Publication year generates conflicting findings in our models, but recent papers tend to present smaller coefficients than older ones. The meta-regressions confirm that modern estimation methods such as RDDs and panel/fixed-effects models decrease effects more frequently than OLS regressions. In a nutshell, we only find moderate support for the "law of $1/n$" in unicameral governments and in the upper house, mostly when authors used OLS estimators.

While the vast literature covering the "law of $1/n$" builds important empirical knowledge, we hypothesise that some of the null findings that we present here are due to difficulties in testing important assumptions behind the theory itself. For instance, the theory assumes three types of costs for legislative public good provision, namely expenses for the constituency, expenses outside the constituency, and externalities. The main issue in assessing their actual impact is that externalities such as shifts in prices of local firms, for example, are extremely hard to measure. Thus, it is very difficult to properly translate the mechanism to empirical data, making it is easy to accidentally distort results. Therefore, it should not come as a surprise that slight differences in political features generate highly heterogeneous results.

In this sense, the empirical cases in the literature may not always be the most fortunate testing ground for the "law of $1/n$". While we believe that moving beyond the majoritarian districts framework could produce valuable insights, institutional features that are central to the theory cannot be overrun. For example, proportional representation (PR) electoral systems allow candidates whose constituents are spread across large territories to provide diffused public goods and win elections. However, geographically-targeted service provision is at the very core of the legislative behaviour that produces the "law of $1/n$". Thus, scholars should consider the possible implications of these micro-level dynamics when applying the "law of $1/n$" logic to different settings.

Another plausible reason why there is no clear-cut evidence in favour or against the "law of $1/n$" may be that there are few incentives for the pure accumulation of knowledge in the social sciences, at least when compared to the benefits scholars may accrue when they challenge or add features to existing theories (Geddes 2003). This leads to a reduced number of replication studies and research syntheses in the field, although we have seen some positive changes in this respect, such as EGAP's *Metaketa Initiative*[8]. Here we show that continuously producing and consuming meta-analyses is a viable path towards knowledge-building in our discipline. Although aggregating observational – instead of experimental – data can be especially challenging, we believe that research synthesis methods play an essential role in advancing our understanding of complex political phenomena.

Our analyses suggest other avenues for further research. First, our study sample did not include articles that evaluate the association between the natural logarithm of lower chamber size and public expenditure per capita, or between upper house size and log expenditure per capita. New work on that area might clarify some of the inconsistencies we find here. Second, despite the inclusion of several moderators in our models, aggregate results still show considerable heterogeneity. Domestic factors such as party dynamics or gerrymandering (Lee 2015; Mukherjee 2003; Gilligan and Matsusaka 2006) may prove useful in explaining those divergent results. Third, authors should leverage natural and quasi-experiments to assess whether the current results hold when systematically tested. Fortunately, this may also be a trend under way, as all four studies using regression discontinuity designs in our sample were published within less than 10 years prior to this meta-analysis. These suggestions may help scholars to validate the robustness of their findings and policy-makers to reach an

[8] See https://egap.org/our-work/the-metaketa-initiative for further information.

optimal balance between sound fiscal policy and the demands for increased political representation.

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