A General Empirical Law of Public Budgets: A Comparative Analysis

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Abstract

Political dynamics are likely to proceed according to more general laws of human dynamics and information processing, but the specifics have yet to be outlined. Here we begin this task by examining public budgeting in comparative perspective. Budgets quantify collective political decisions made in response to incoming information, the preferences of decision-makers, and the institutions that structure how decisions are made. Most models to date stress preferences (organized by political parties) almost exclusively. We suggest a quite different approach.

We begin by noting that input distributions for complex information-processing systems are Gaussian, providing a standard for comparing outputs against inputs. Next we examine public budget change distributions from a variety of countries and levels of government, finding that they are invariably distributed as double Paretians—two-tailed power functions. We find systematic differences in exponents for budgetary increases versus decreases (the latter are more punctuated) in most systems, and for levels of government (local governments are less punctuated).

Finally, we show that differences among countries in the coefficients of the general budget law are probably explained by differences in the formal institutional structures of the countries. That is, while the general form of the law is dictated by the fundamental operations of human and organizational information processing, differences in the magnitudes of the law's basic parameters are country and institution-specific.

A General Empirical Law of Public Budgets [1]

Political systems, like many social systems, are characterized by considerable friction. Standard operating procedures in organizations, cultural norms, and all sorts of facets of human cognitive architectures act to provide stability of behavior in a complex world. In politics, ideology and group identifications provide stable guides to behavior in complex circumstances. In politics, however, a second source of friction exists: institutional rules that constrain policy action. In the United States, policies can be enacted only when both houses of congress and the president reach agreement on a measure. In parliamentary democracies, action may be constrained by the necessity to put together multi-party governing coalitions. Institutional rules 'congeal' preferences (Riker 1980), making it difficult for new policies to enter the political arena.

In the past, scholars characterized these systems using *comparative statics*, a method of analysis that concentrated on equilibrium processes based on the preferences of decision-makers. (Shepsle and Weingast 1987, Krehbiel 1998). Change was admitted primarily though the replacement of governing parties through elections, which established a new preference-based equilibrium to which the policymaking system quickly adjusted. But comparative statics ignores the on-going information-processing needs of an adaptive system, and political systems are clearly adaptive systems. They dynamically respond to incoming information, not just the preferences of those making decisions.

Punctuated equilibrium has provided an alternate analytical frame (Baumgartner and Jones 1993; True, Jones, and Baumgartner 2007). The stability imposed by the two kinds of friction, cognitive/organizational friction and institutional friction, does not cause universal gridlock, with a system awaiting elections to point to change. But it is a retarding force that interferes with the smooth adjustment of a political system to changing information signals

[1] We appreciate comments from Didier Sornette on earlier versions of this paper.

from the policymaking environment. This force resembles the friction that occurs in the physical world, in that change occurs but only when the informational signal from the external world either is extraordinarily strong or when the signals accumulate to overcome the friction. These latter processes are described as *error accumulation models* (Larkey 1978), in that the deviation between the external world and the system response gets increasingly out of kilter until the system can no longer ignore the deviation.[2]

Systems characterized by friction remain stable until the signals from outside exceed a threshold, and then they lurch forward; they will continue moving only if the external signal continues at greater than threshold strength. Otherwise they resume 'equilibrium'. It is likely that political systems overcome friction when a sense of urgency about the external world drives decision-makers to re-prioritize their preferences. Urgency causes collective attention to focus on a very limited number of issues out of the panoply that are candidates for government action; these issues are rewarded by disproportionate attention, often leading to large changes in budget allocations. These dynamics lead to highly leptokurtic frequency distributions of policy change in the United States and elsewhere (Jones and Baumgartner 2005a; Breunig, Green-Pederson, and Mortensen 2005).

In this paper we report results from an analysis of ten separate budgetary datasets from six nations, using approaches common in natural sciences but only now being adopted in the social sciences. In particular, students of financial markets have used methods and concepts from physics (Matenga and Stanley 2000: Sornette 2003, Kotz and Nadarajah 2000; Sornette 2006), as we do here. We use these stochastic process methods to examine the full budgetary frequency distributions rather than the typical social science focus on moments (means and variances when Gaussian, or normal-curve, statistics are employed).

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[2] Error accumulation models are a special case of non-linear error correction models—they lead to much larger deviations before the 'error' is corrected than the more typical model (Escribano and Miar, 2002).

Our results illustrate the power of incorporating policy punctuations as part and parcel of the dynamics of policy change, rather than exceptions that must be explained by reference to special conditions. We show both that the dynamics are general, across a wide range of countries and levels of government, but that there remains a considerable role for differences in institutional structures.

Change Distributions

Histograms may roughly be characterized by three aspects: peak(s), tails, and shoulders. Here we study change phenomena; that is, the difference between behavior at two times. In such distributions, there is typically a single peak at the mode, centered at zero, which represents no change from the previous period.[3] The shoulders of the distribution indicate moderate changes from the status quo, while the tails indicate extreme changes. Much of the literature on fat-tailed dynamics has concentrated on the extremes, but shoulders are important as well, and it is possible that different dynamics account for the peaks, shoulders and tails.

Budgets set public priorities; they are the outcomes of complex policy processes involving the nature of the decision-making institutions, the preferences of decision-makers (organized by political parties), and informational signals from a changing environment. Institutions and political preferences generate friction; they are resistant to change. Punctuated equilibrium theory predicts that changes in governmental priorities will be abrupt and disjoint. Normally policies are at equilibrium; only under conditions of strong mobilization will extreme changes occur; moderate changes normally do not occur. These processes generate highly leptokurtic frequency distributions for changes in policy commitments – that is, distributions characterized by a high peak, weak shoulders, and heavy tails.(Jones and Baumgartner 2005a; True, Jones, and Baumgartner 2007).

[3] In a dynamic growth process such as characterizes budgets, the mode would be a positive increment.

One important class of leptokurtic frequency distributions are Paretian distributions, or power function distributions.[4] Such distributions are characteristic signatures for dynamical processes harboring critical regimes. There are a number of different processes that can lead to power functions, but generally change models involve systems occasionally getting into critical states in which large-scale punctuations are much more probable than in sub-critical states. Critical regimes are poised between 'order and chaos'—that is, between ordered incremental change and rapid, discontinuous change (Bak 1997; Sornette 2006, 2003; Mandelbrot 2004).

What does this mean for public budgeting (and, indeed, for policy change more generally)? It implies that it is possible for policymaking to be pushed into an area in which even small external disturbances can result in large, cascading changes. Major policy changes can be associated with electoral replacement, so that electoral changes can set the conditions for critical states in the policymaking process (Wlezien 1996; Peterson, Grossbeck, and Stimson 2003; Stimson 2004). But major changes also often occur in inter-election periods, at least in the US (Jones and Baumgartner 2005a: 84). Clearly major policy punctuations occur; the issue we raise here is whether political systems can be generally characterized as complex, evolving systems displaying punctuated dynamics that are not always associated with large-scale changes in the environment. In a nutshell, that is what is conveyed by the notion of critical regimes.[5]

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[4] Paretian or power function probability distributions are defined as $p(x) = x^{-\alpha}$, where p(x) is the probability that the variable takes the value x. The cumulative probability distribution function, which is often easier to work with empirically, is defined as $P(x) = x^{-(1+\alpha)}$, where P(x) is the probability that the value of the variable is greater than x. These formulas describe one-tailed distributions; for budget distributions, in which reductions are possible, we use a two-tailed version. They are called Paretian because Vilfredo Pareto noted that income distributions often have this shape.

[5] One particular mechanism of criticality that has gained considerable repute is Per Bak's self-organized criticality (SOC). In this model, evolving systems get themselves continually into critical states. It is a more difficult claim to sustain than the contention that we advance here, which is that political systems can get into these critical states. SOC requires both power law distributions of changes and long-run power law decay of autocorrelations (Sornette 2006: 396). For evidence of the latter for US budgetary series, see Jones 2006.

Frequency distributions of public budget changes are leptokurtic for all cases studied thus far (True, Jones, and Baumgartner 2007), but these studies are based on specific cases.[6] Can this invariance be extended to a truly comparative perspective? Does a common probability density function, the power function, characterize all political systems? Power function frequency distributions characterize many market-based transactions, and the exponents for these transactions are similar for different kinds of markets and transactions (Mandelbrot 2004; Gabalx, Goplkrishnan, Plerou, and Stanley 2003). Market transactions differ from political interchanges in one very important sense, however: in modern markets, there are limited formal decision costs in choosing to pursue a transaction. In politics, collective decision-rules limit the freedom of choice of any set of actors. Markets may be governed by cognitive friction that is overwhelmed occasionally by the sense of urgency (to buy or to sell), but the institutional friction so important in politics is much less a limitation on the behavior of market actors.

Friction is thus greater in politics than in markets. Friction additionally differs among institutional arrangements in democracies; separation of powers and federalism ought to lead to more friction, while parliamentary arrangements designed to make policymakers sensitive to public opinion ought to lead to less. If so, then do different institutional arrangements in nations lead to different distributions within the class of power functions?

In this paper we first note that input distributions for complex information-processing systems are Gaussian, providing a standard for comparing outputs against inputs. This implies that the political system transforms the inputs into leptokurtic outputs, such as budgets. Next we examine public budget change distributions from a variety of countries and levels of government, and find that they are invariably distributed as double Paretians—two-tailed

[6] Cases include US Budget Authority, US states, US municipalities, Texas school district budgets, Danish municipalities, UK national government, and the national budgets of France, Germany, Belgium, and Denmark.

power functions. That is, real outputs are both weak shouldered and fat-tailed. Both the budget increases and the cuts are power functions, though as we will see the increases tend to show a greater number of extreme values than the cuts. Real policymaking systems either move very little from equilibrium, or they lurch forward, and in some cases lurch forward in huge policymaking changes.

Finally we add a stringent test. If cognitive and institutional friction, alone or in combination, can account for budget change distributions, then we should be able to detect variations in the exponent estimates for the budget power functions. A ranking of these variations should correspond to a ranking of the institutional friction across institutions. For budgeting in the seven countries we studied, this is indeed the case.

A Gaussian Beginning

In many real-world information-processing situations, we do not have the luxury of observing the actual informational input, because we observe only whether the decision-maker attends to that information and what action he or she subsequently takes. Nevertheless we can make some inferences about the structure of the incoming information. The Central Limit Theorem (CLT) guarantees that in any situation where a decision-maker combines numerous sources of information in an implicit index, the limit of the distribution of that information will be Gaussian, so long as any one stream is not too disproportionately weighted and the streams are not highly correlated (Jones and Baumgartner, 2005b). In making budget decisions, when decision-makers incrementally adjust this year's budget from a starting-point of last year's budgets, annual changes will be Gaussian. This is but a special case of the index-construction model (Jones and Baumgartner 2005b), and leads to outputs that are proportionate to the strengths of input signals. Moreover, it can be shown that the incremental model, which Padgett (1980) showed must generate a Gaussian distribution of changes, is a special case of the proportionate updating model (Jones and Baumgartner 2005b).[7]

It is important to understand that we distinguish between information *signals*, detectable changes in the environment that are potentially relevant for policymaking, and the *news*, which is that part of the set of signals that decision-makers (including newspaper editors) attend to. The Central Limit Theorem can be sensibly assumed to apply to signals, but does not necessarily characterize the distribution of attention or news. There may be many social processes that come in between the signals being sent by the environment and how those are measured, translated into politically relevant understandings, and brought to the attention of decision-makers. But we know from the CLT that the distribution of changes in the underlying signals must be Gaussian because it is based on a large number of independent processes.

If priorities are changed moderately, in proportionate response to incoming signals, then budgetary outputs will approximate a Gaussian distribution. Changes in government policies will mimic the input distribution, which in a complex world will approximate the Gaussian. The Gaussian, unlike either the power or exponential family of distributions, has strong shoulders; moderate changes from the status quo are the norm.[8]

In real-world situations, decision-makers prioritize information in a manner than invariably leads to deviations from this proportionate processing of information (Jones and Baumgartner 2005a). They prioritize, and prioritization leads to non-Gaussian dynamics. Indeed, setting priorities causes bursts of activity characterized by fat-tailed distributions. Studying email communications, Barabasi (2005) shows that waiting-time models of processing information, which follow Poisson distributions if inputs are not weighted by their

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[7] Padgett further derived budget decisional models that are leptokurtic and in some cases Paretian.
[8] If decision-makers are able to adjust proportionately, output distributions will be Gaussian even if decision-makers are up-dating from past information. See Jones and Baumgartner 2005b.

importance (such FIFO inventory control systems or random processing), will follow power distributions if people prioritize the inputs based on the perceived urgencies of incoming messages. In more complex decision-making situations, decision-makers often do not update the set of indicators that guide their behavior—an example of friction. Then a sense of urgency will occasionally lead to overcoming the built-in friction that occurs in all human institutions. This implies that even if inputs are Gaussian, outputs from governments and other complex institutions will not be, but are likely to be characterized by fat-tailed dynamics.[9]

Many real distributions which involve combining diverse input streams are Gaussian. For example, quarterly change in real US GDP, assessed from the first of 1947 through the end of 2005 is Gaussian (see Figure 1), because there are enough independent components of GDP to meet the necessary Central Limit Theorem assumptions. Moreover, the state of the economy affects government budgets. If governments directly keyed expenditures to the economy, changes in expenditures would be Gaussian. That is, in this key situation linking a budget to an over-weighted indicator will still yield Gaussian budgets. Many state and local governments in the US are required constitutionally to balance their budgets, and hence are more likely to have less punctuated outputs—because a constitutional mandate chains the normally disproportionate policymaking process to a Gaussian input stream.

[Figure 1 about here]

Lots of physical systems, such as earthquakes and avalanches have frequency distributions characterized by power laws (Schroeder 1991; Sornette, 2006). As Per Bak's sandpile experiments have shown, physical systems with friction are capable of generating power functions, even when inputs (grains of sand) are incrementally added. His sandpiles

[9] In Barabasi's model, the tails of a distribution of response time represent delayed action whereas the peak indicates the urgency associated with short processing times. In the study of shifting policy priorities, the peaks of a budget distribution indicates the lack of urgency, while the tails, indicating big shifts in budgetary allocations, point to urgency.

generated either very small landslides or very large ones, but no moderate-sized slides (Bak 1997). Bak's systems resemble error accumulation models in that the sandpile has 'under-adjusted' to the accumulation of pressures with small landslides, and then must adjust in one fell swoop.

The Empirical Analysis of Budget Distributions

Several studies have shown that budget change distributions are highly leptokurtic, with strong central peaks and extended tails, and clearly not Gaussian (True, Jones, and Baumgartner 2007; Jones and Baumgartner 2005a; Jordan 2003; Robinson, 2003; Mortensen 2005; John and Margettts 2003; Breunig 2004; Soroka, Wlezien, and McLean 2006; Breunig and Koske 2006; Baumgartner, Foucault, and François 2006). Yet systematic comparisons across different political systems are lacking, and the particular probability distribution functions have only occasionally been studied.

To remedy this, we have assembled datasets on public budgets from seven national governments and three subnational governmental units. For two long series for France and the United States, we can analyze year-to-year inflation-adjusted percentage changes in Total or, in the US, Domestic and Defense spending; for the other datasets, where the series are considerably shorter, we have to pool across budget categories (and across the sub-units for subnational governments), again using percentage changes. This is necessary in the latter case to ensure that the distributions are not dominated by one or two really large budget categories; it is desirable in the former to enable comparison. Table 1 briefly describes these datasets.

[Table 1 about here]

Government expenditure data is notoriously unreliable at any but the most aggregate level, because categories are added and subtracted for accounting purposes but are not generally adjusted backwards to ensure comparability with earlier data. “Off the shelf” budget datasets should generally not be used for analysis across categories. Moreover, national governments do not usually maintain separate capital budgets, so budget decisions and the outlays generated by those decisions can occur in different fiscal years. As a consequence, it has been necessary for us to make certain that all series are internally comparable, which has involved a great deal of tedious adjustments for each series. This accounts for the fairly short time periods covered by some of the datasets.

The somewhat shorter time series on disaggregated budget data is more than offset by the advantage this data offers: a direct assessment of changing priorities of government. “Off the shelf” budget data is not acceptable exactly because of this: the creation of new categories and the failure to up-date older series will cause the investigator to mistake accounting adjustments for shifts in priorities.

The varieties of budgets we have examined pose a strong test for any general pattern for distributions of budget changes. Economies are less volatile today than in the past as economic management in the developed world improves, so that volatility of budget series has damped down over time. This reduced budgetary volatility can be clearly seen in Figure 2, which shows inflation-adjusted expenditures for the US national government from 1800 to 2004.[10] In the past, political systems were more subject to external events; today national systems, especially large nations, have more control over their economic affairs. In addition, they may borrow to cover current expenditures, allowing more government growth than if a strict revenue requirement were enforced. For sub-national local governments things are different because generally must match their expenditures to incoming revenues, due to the

[10] Figure 5 also illustrates the ‘war ratchet’ of Peacock and Weisman (1967): when war occurs, both defense and domestic expenditures go up, and domestic expenditures tend to stay at the higher level)

demands of national governments or state constitutions. Can all of this variability be summarized by a single law of change?

[Figure 2 about here]

To test for the Paretian, we take the logarithm of both sides of the expression $y = ax^b$, where x represents the category midpoints of the variable of interest and y represents the frequencies associated with the midpoints. This yields $\ln(y) = \ln(a) + b\ln(x)$, which will plot as a straight line if the distribution is Paretian.[11] Figure 3 depicts frequency distributions and log-log plots for the long budget series. In the cases of both France and the US, inflation-adjusted outlays follow a power function distribution. For the US, both defense and domestic expenditures have signature power function frequency distributions. As Table 2 indicates, the exponents for both series center on -0.9 (with France slightly lower than the US) for the positive tail, but are higher for the negative tail. Higher positive (right) tail exponents but lower negative (left) tail exponents indicate fatter tails. These estimates indicate that it is easier to increase expenditures than to decrease them.[12] As we see, this is a general characteristic of all budget distributions.[13]

[Figure 3 and Table 2 about here]

Figure 4 shows both frequency distributions and log-log plots for US Budget Authority over Office of Management and Budget programmatic subfunctions, and Figure 5 shows German and French programmatic expenditures over several ministries. Because the data is

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[11] Researchers need to use considerable caution when using log-log plots to detect power function PDFs. Coefficients of determination are generally very high, because of accumulation in bins, and statistical tests are not reliable. See Sornette, 2006, and Clauset, Shalizi, and Newman, 2007. It is imperative to compare the log-log plot with a semi-log plot (which estimates an exponential distribution), and to use care when studying the tails of the distribution. Researchers usually use cumulative distribution functions (CDFs) because they are better behaved and bins may be cumulated.

[12] Both increases and decreases of expenditures occur relative to a long-run positive mean due to increasing economies.

[13] We may rule out this being an artifact of using percentages (proportions), as the right tail of these distributions terminates before reaching 100%. Moreover an examination of first differences for these series indicates no censored data issues.

pooled, the distributions represent shifts from one programmatic expenditure category to others—a direct estimate of shifting priorities of governments.

[Figures 4 and 5 about here]

The distributions of all three series follow power functions, and in all three cases growth punctuations are more probable than cutback punctuations. Indeed, the negative tail for the US is not discernibly distinct from an exponential fit. Modern governments find it more difficult to cut back programs significantly than to expand them dramatically. This is not surprising.

Figure 6 depicts log-log plots for the rest of the national governments. All show power function frequency distributions, and most (with the exception of Canada) show a tendency to have more difficulties in cutting programs in a very large fashion than in increasing them greatly. None of the national governments, however, show the strong difference between the tails that is evident in the US plot.

[Figure 6 about here]

We conclude that national governments shift priorities according to a power function, and in a manner generally consistent with punctuated equilibrium. This holds for both the United States, with its presidential system, and for parliamentary democracies. Moreover, the governments we studied generally experienced more resistance, or friction, in cutting programs than in expanding them. In particular, the shoulders of the negative tail for the national distributions are considerably stronger than those for the positive side, suggesting more resistance—to the point of approaching the exponential distribution for the US.

It is likely that the positive tails of these distributions are affected by both institutional friction and the general sense of urgency. The negative tail, however, may be mostly dominated by friction—it is normally less urgent to cut programs for national governments than to increase them. National governments can borrow money to fund operating expenses, and this allows a more mellow approach to cutting programs. Moreover, in harsh economic times, it is not a good economic idea to cut programs, contributing to declines in economic demand, and this adds a policy justification for the less extreme cuts in national budgets.

Turning to the sub-national governments, depicted in Figures 7 and 8, we detect considerable differences from the national governments. All may be classified as power functions and the US state governments unambiguously so. But for the local governments (Danish local governments and Texas school districts), the situation is not quite as clear. Examining the Danish local government case in more detail, we can see the distribution falls somewhere between an exponential and a power function—and even a log-normal characterization is not out of the question. But they are clearly not Gaussian; these governments do not make proportional decisions any more than national-level governments do. But they are much less subject to immoderate punctuations than national governments.

[Figures 7 and 8 about here]

In comparison to the national governments, the distributions of the sub-national governments we studied are remarkably symmetrical. Tables 2 and 3 show that the power function exponents are of similar magnitudes for each tail of the distribution. Both increasing budgets and cutting them must overcome friction; neither tail comes anywhere close to the expected Gaussian for fully proportionate decision-making. But sub-national governments are about as likely to cut budgets as to raise them; one gets a sense of on-going reprioritization that is far more moderate than happens at the national level. It is likely that this is a function of mandates imposed on these governments by their superior governmental units. States in the US can borrow only for capital needs, and hence cannot borrow to tide over required cuts. Generally local governments meet restrictions on the money they raise locally and the grants they receive from higher levels of government. The result is a far more balanced fiscal system than what occurs at the national level.

[Table 3 about here]

Comparative Institutional Friction

Past work argued that institutional friction increases as institutions add costs to the translation of inputs into outputs (Jones, Sulkin and Larsen 2003). The distribution for US Budget Authority consequently displays a greater degree of leptokurtosis than does one for Congressional hearings, which in turn is more punctuated than one for *New York Times* stories. Indeed, an analysis of fifteen different US series suggested a strong relationship between leptokutosis and a rough ranking of the “costs” in different political venues.

Our data allow for a similar comparison, this time across countries rather than political venues. Recall that we suggest that the non-normality of policy change distributions will be a function of both cognitive/organizational friction and institutional friction. Cognitive/organizational differences across countries are of course difficult to measure, though it is seems reasonable to assume that cognitive costs do not vary systematically across countries. Organizational costs will certainly vary, but it is not clear how to measure them – the efficiency of a bureaucracy is hard to get at.

Institutional differences are simpler to capture, however, and we provide an initial analysis here of the link between political institutions and the punctuated-ness of budgetary series – or, more broadly stated, an analysis of the way in which political institutions affect the way in which information is processed. This first cut relies in large part on a veto players approach: institutional friction should increase along with the number of veto players (Tsebelis 2002)

In particular, we expect friction to decrease along with (1) parliamentary government, (2) single-party governments, (3) unicameralism, and (4) a unitary state. More precisely, *ceteris paribus*:

(1) friction should be greater in presidential systems than in parliamentary systems, since policy change in the former is dependent on approval from several different bodies;

(2) friction should be greater in coalition or minority governments, since coalitions require more internal bargaining;

(3) friction should increase with bicameralism, since policy is vetted by two rather than one legislative chamber; and

(4) friction should be greater in federal systems, at least in those domains that are structured in a way that requires the agreement of multiple governments for single policy decisions.

Each of these institutional criteria has been very well-studied. There are several measures available of each; Table 4 shows some of the standard measures, across each of the countries for which we also have reliable budgetary data.

[Table 4 about here]

These institutional measures are drawn from Lijphart's *Patterns of Democracy*, and rely on data gathered for the 1971-1996 period. The first column of Table 4 shows the percentage of time during which the country was governed by a single–party (that is, non-coalition) majority government. The index of executive dominance is based on the average duration of cabinets, except for the US, where the duration of cabinets is fixed. Executive dominance over the legislature in the US is of course quite low, so the country is assigned a value of 1. The federalism measure is impressionistic – a 1 to 5 scale, where Lijphart assigns each country to one of five categories. The Belgian value represents an average of the pre- and post-1993 decentralization.[14] Bicameralism is a 1 to 4 scale, where 4 is two "symmetrical and incongruent chambers," and 1 is unicameralism. (Full details of each measure are available in Lijphart (1999).

There are other measures of these criteria, to be sure, and as with any broad comparative institutional measure there are contestable values in each. We wish to stake no claim to the specific extent of federalism in one country versus another, however. For this preliminary work, we wish only to establish a general ranking the countries for which we have budgetary data, on each criteria, and then on all criteria combined. Ordinal rankings (1 through 7) are included in parentheses in Table 4. The final column then shows the sum of these rankings, where higher values suggest greater degrees of friction. The UK, with 93.3% single-party majority governments, strong executive dominance, a centralized state (for the period for which we have spending data), and only weak bicameralism, receives a total score of 6. We accordingly expect much less friction in the UK than in Germany, or particularly the US – decentralized and bicameral, with little to no executive dominance over the legislature.

Is there a systematic relationship between this rough approximation of institution constraints on information processing, and the distributional statistics for budgetary series across the seven countries? Figure 9 plots the l-kurtosis scores for each country alongside the institutional friction scores from Table 4. The correlation in the figure is striking (Pearson's r = .68). It suggests that leptokurtosis is systematically (and strongly) related to the arrangement of political institutions. Where the number of decision-making bodies is greater – where there are greater impediments to reactive policymaking – so too is there a greater degree of punctuated-ness in budgetary policy.[15]

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[14] Lijphart shows that the scale is highly correlated with central governments' tax shares, a more nuanced, though still incomplete, measure of decentralization.

[15] The correlation between l-kurtosis and the parameter estimate for the positive (budget increase) slope is .17 for all countries, but dropping Belgium, which is plagued with a short series and hence is dominated by its cross-section observations, the correlation is .71. Moreover, the scatterplot reveals

[Figure 9 about here]

There is a strong connection between the kurtosis of national budget distributions and our parameter estimates of the exponents for the power functions that characterize those distributions. Clearly the parameter estimates for the power exponents reflect in large measure institutional friction. While the power function is the general law of budgets, differences in exponents capture differences in institutional arrangements.

Conclusions

1) Friction is a characteristic of political systems; it holds in place the status quo through both formal means (such as supermajority requirements in the US, and the need to construct coalition governments in many parliamentary democracies) and informal means (such as the cognitive screen of political ideology). But stability will not allow a system to respond proportionally to changing external circumstances. Demands outside the political system build up, in an 'error accumulation' process; when these errors exceed a threshold, friction is overcome.

2) Budget changes follow power function distributions, and hence they display periods of quiescence interrupted by bursts of frenetic activity. Because budgets are reflections of priorities, and budget change distributions reflect changing priorities, the dynamics of budget changes indicate the occasional occurrence of bursts of urgency about the external world. Urgency is contagious. It is an internal facet of political systems, so that external events alone cannot account for the dynamical properties of policymaking. It is likely that these external signals cumulate and overcome political friction sporadically.

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that France and the US share a close affinity on both the kurtosis measure and the exponent measure, suggesting that our calculation based on Lijphart's measure may underestimate institutional friction in France.

3) Public budgets in modern democracies are invariably characterized by change distributions that follow power laws.

4) Exponents for national governments are variable, but a strong tendency exists for bursts of spending increases to dominate budget changes on the positive tail, while cuts are subject to less severe bursts. Orgies of spending are not fully offset by equally exuberant cutting.

5) Exponents for sub-national governments are both very similar (for the three disparate situations we studied) and quite symmetrical. Subnational government budgets are less punctuated—less subject to bursts of budgetary activity--than national government budgets. While orgies of spending and cutting both occur, they are more muted than in the case of national governments. Exponent comparisons are presented in Table 2 and 3, along with associated L-kurtosis measures. While national governments exhibit considerable country-to-country variation, they tend to display more dramatic dynamics than the sub-national governments.

6) Institutional friction across nations corresponds in general to the extent of punctuations in the budgetary data. Institutions act to keep in check system responses to strong external demands on the system.

7) A combination of internal re-prioritization and organizational friction seems best able to explain the patterns we have observed: strong budgetary conservatism represented by the peaks of the distribution of budget changes; weak shoulders, indicating the inability to respond to incoming information in a moderate, proportionate way; and fat tails, representing frenetic bursts of activity. The *contagion of urgency* overcomes the *friction of order* and leads to the dynamics of public budgeting.

Generally speaking, a distribution should approach Normal as a government increases its cognitive/organizational capacity, and reduces institutional impediments to reactive policymaking. More dramatic power function distributions should result from governments with poor cognitive/organization capacity, and many impediments to reactive policymaking. It's hard to assess cognitive/organizational capacity, but institutional impediments – veto players, in large part - are easier to think about.

Indeed, the effect of institutional design on friction in budgetary policy is evident in the results above. We expect friction to be greater in presidential systems than in parliamentary systems, for instance, since policy change in the former is dependent on approval from several different bodies. We also expect friction to increase with coalition government, low party discipline, and federalism, at least where federalism is structured in way that requires the agreement of multiple governments for single policy decisions. Our analyses bear out out these expectations, and the I-kurtosis scores for different countries correlates nicely with our measures of institutional difference. There seems little doubt that both cognitive/organizational and institutional variance matter in driving punctuations.

Table 1: Dataset Descriptions

Dataset	Type	Date	Units Pooled
National Governments (long series)			
United States	Outlays	1800-2005	years
US Domestic	Outlays	1800-2004	years
US Defense	Outlays	1800-2004	years
France	Outlays	1820-2002	years
National Governments (pooled)			
United States	Budget Authority	1947-2005	Years, 60 OMB programmatic subfunctions
France		1868-2004	Years, 7 ministries
Germany		1962-2000	Years, 26 functions
Great Britain		1981-1999	Years, 14 functions
Belgium		1991-2000	Years, 27 functions
Denmark		1974-2003	Years, 26 functions
Canada		1990-2004	Years, 12 functions
Sub-National Governments (pooled)			
US State	Operating Outlays	1984-2002	Years, 10 functions, 50 states
Danish Local	Operating Outlays	1991-2005	Years, 4 functions, 265 Municipalities
Texas School Districts	Operating Outlays	1989-2001	Years, 1130 districts

* Full descriptions available from the authors.

Table 2: Exponent Estimates for Power Functions of Tails of Distributions

Dataset	Positive Tail	R^2	Negative Tail	R^2	L-K
National Governments (long series)					
United States	-0.911	.982	1.396	.949	0.509
US Domestic	-1.094	.977	1.400	.933	
US Defense	-0.976	.976	1.602	.963	
France	-0.885	.973	1.091	.962	0.424
National Governments (pooled)					
United States	-1.024	.993	1.789	.916	0.512
France	-1.019	.983	1.353	.924	0.505
Germany	-1.387	.972	1.629	.960	0.456
Great Britain	-1.490	.981	1.797	.970	0.319
Belgium	-1.543	.970	1.293	.992	0.611
Denmark	-1.565	.982	2.179	.984	0.421
Canada	-1.245	.970	1.549	.915	0.379
Sub-National Governments (pooled)					
US State	-1.926	.992	2.007	.910	0.403
Danish Local	-1.810	.982	2.000	.965	0.363
Texas School Districts	-1.755	.983	2.575	.986	0.293

Table 3: Average Exponents [Range]

	Budget Increases (Positive Tail) $P(b > x) = x^{-\xi}$	Budget Cuts (Negative Tail) $P(b < x) = x^{-\xi}$	Average L-Kurtosis
National Governments (long series)	0.9 [.89 , 91]	1.2 [1.09 , 1.40]	.467
National Governments (pooled)	1.3 [1.02 , 1.57]	1.67 [1.29 , 2.18]	.458
Sub-National Governments (pooled)	1.8 [1.76 , 1.93]	2.2 [2.01 , 2.58]	.353

Table 4: Political Institutions and Friction

	Executive dominance	Single-party governments	Bicameralism	Decentralization	***Friction***
Belgium	1.95	28.8	3	2.8	
	(6)	(6)	(3)	(4)	***19***
Canada	4.17	95.2	3	1	
	(4)	(1)	(3)	(5)	***13***
Denmark	2.09	23.9	5	4	
	(5)	(7)	(1)	(3)	***16***
France	5.52	63.5	3	4.7	
	(1)	(4)	(3)	(2)	***10***
Germany	5.52	46.2	2	1	
	(1)	(5)	(6)	(5)	***17***
UK	5.52	93.3	3.5	5	
	(1)	(2)	(2)	(1)	***6***
US	1	80.1	2	1	
	(7)	(3)	(6)	(5)	***21***

Figure 1: Real US GDP Quarterly Change, 1947-2005.

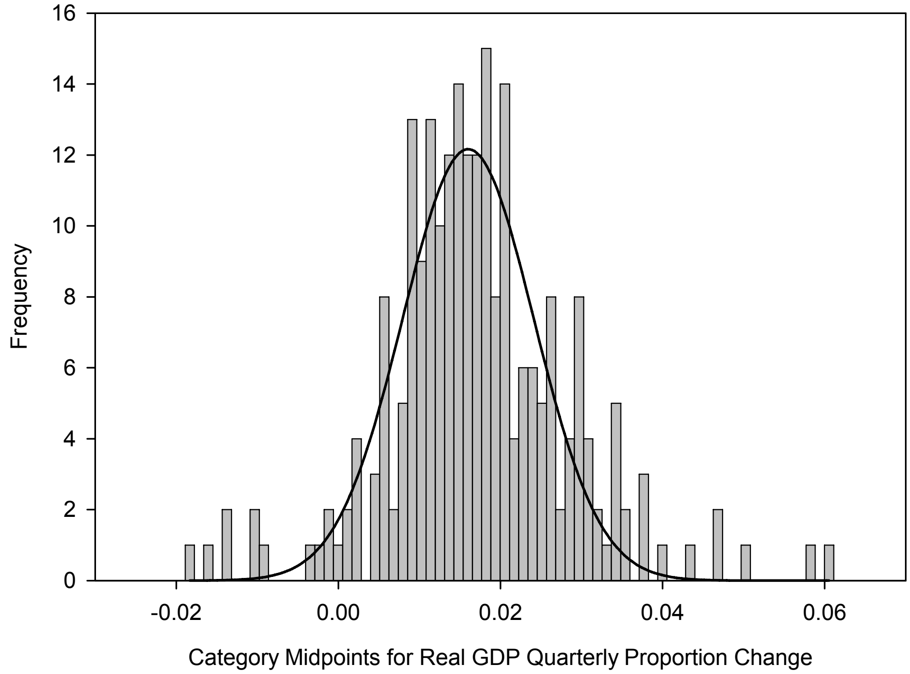
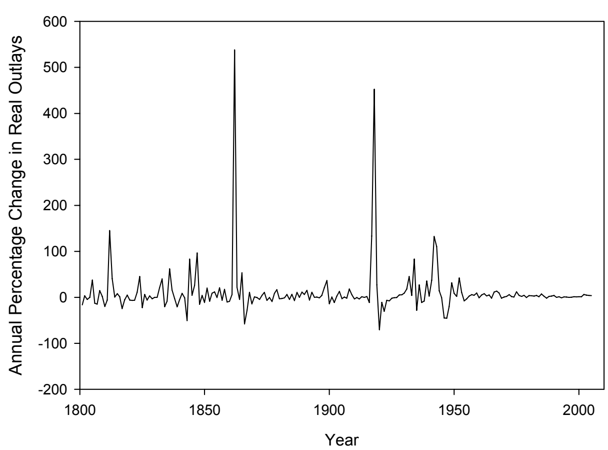


Figure 2: US Real Outlays, 1800-2004

a) Percentage Change



b) Total

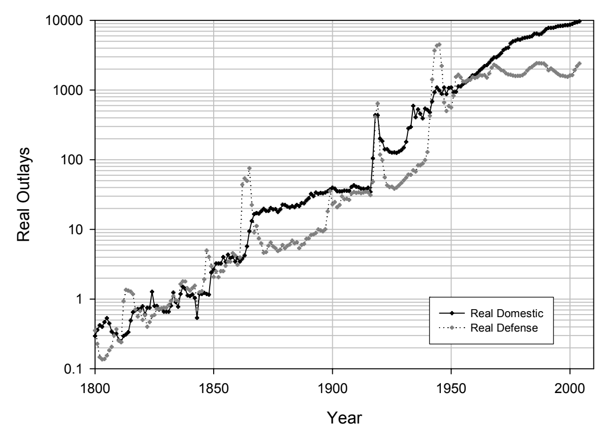
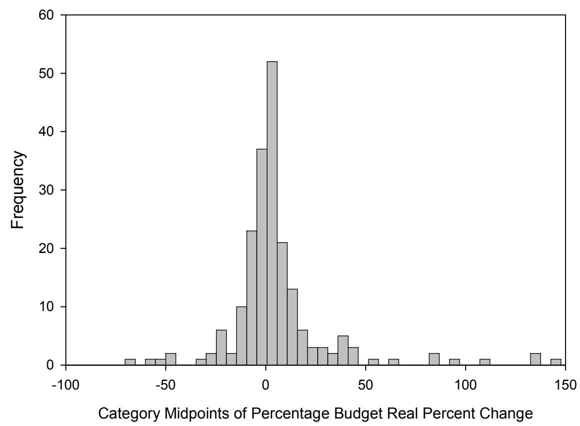
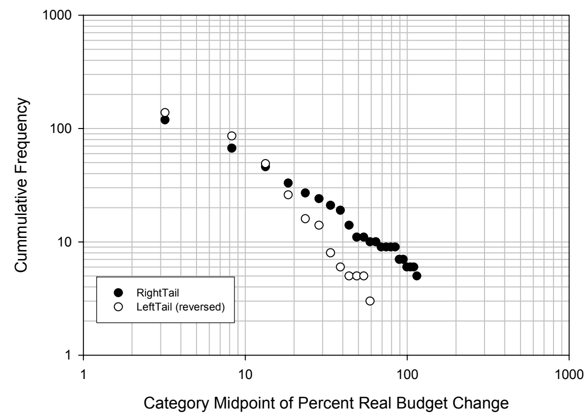


Figure 3: Frequency Distribution and Log-Log Plots for the Long Budget Series: Total Outlays in the US and France

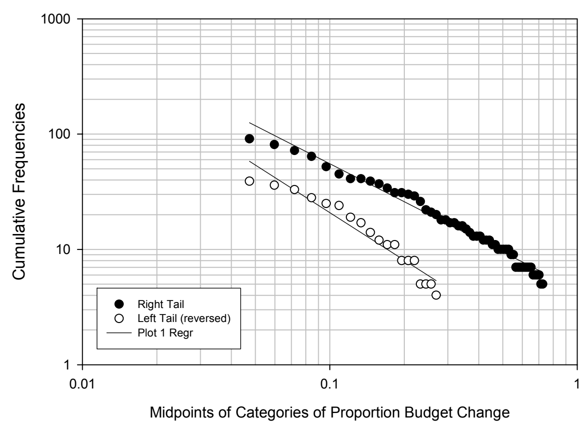
a) US Total Outlays, Frequency Distribution



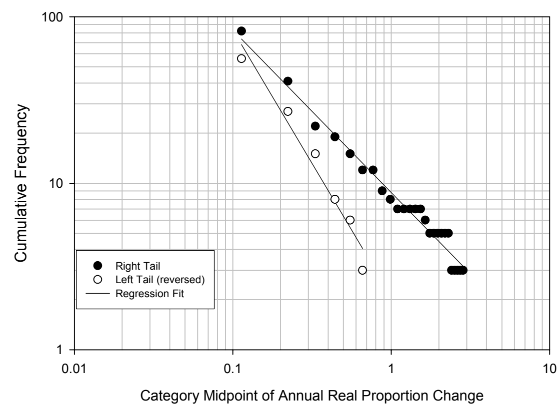
b) US Total Outlays, Log-Log Plot



c) US Domestic Outlays, Log-Log Plot



d) US Defense Outlays, Log-Log Plot



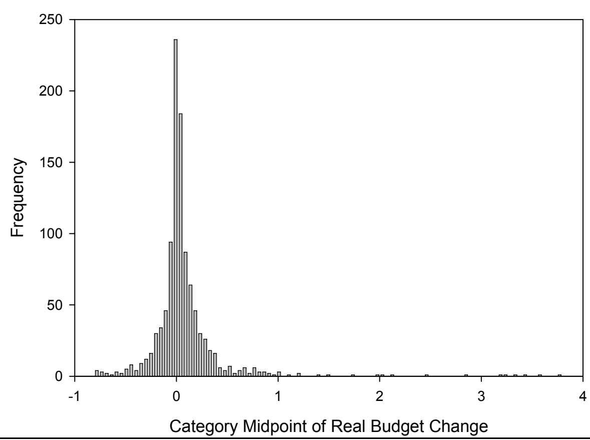
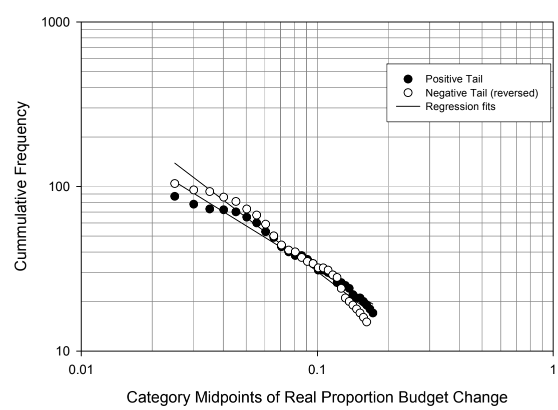
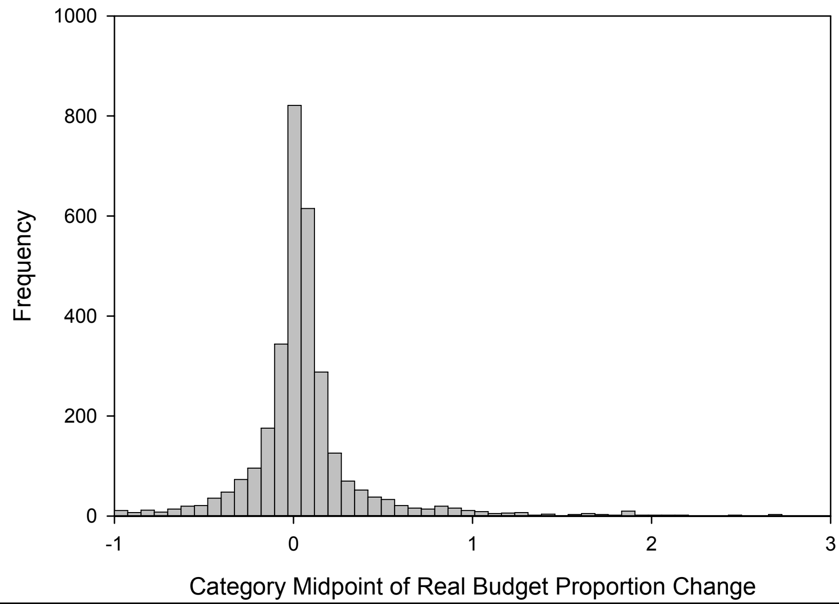
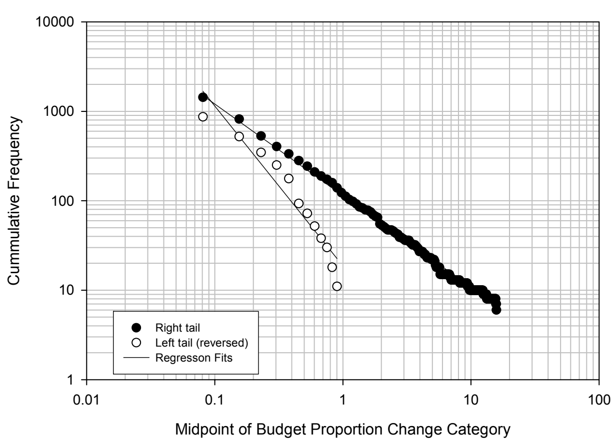
e) French Total Expenditures, Frequency Distribution	**f) French Total Expenditures, Log-Log Plot**
	

Figure 4: Frequency Distribution for Annual Proportion Change for US Budget Authority, 1947-2005

a) Frequency Distribution



b) Log-Log Plot



c) Log-Linear Plot

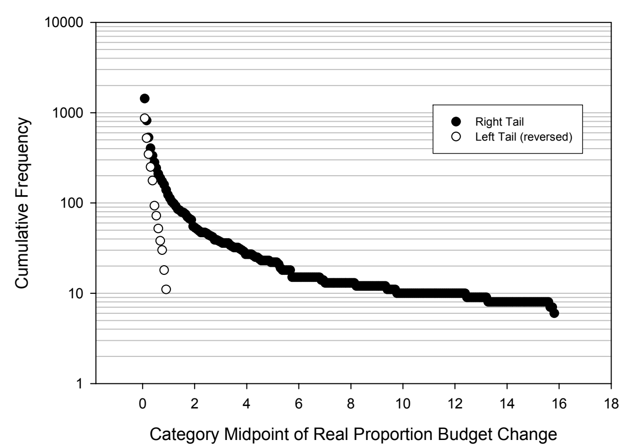
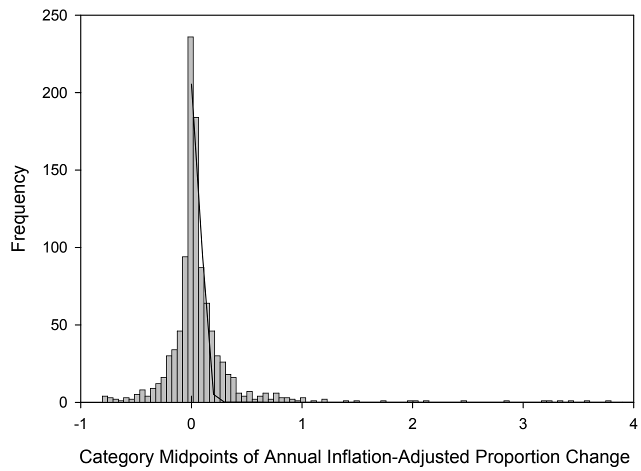
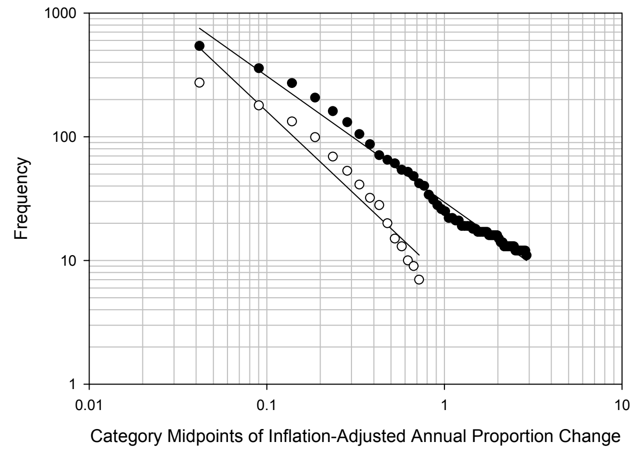


Figure 5: Frequency Distribution (a) and Log-Log Plot (b) for French and German Programmatic Spending

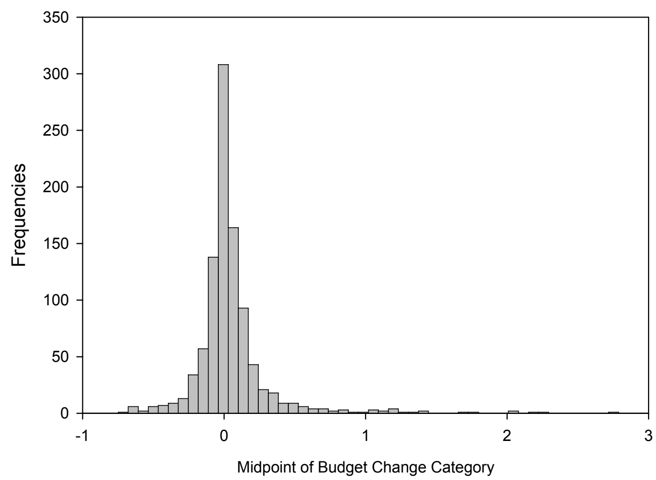
a) French Programs, Frequency Distribution



b) French Programs, Log-Log Plot



a) German Central Government, Frequency Dist



b) Germany, Log-Log Plot

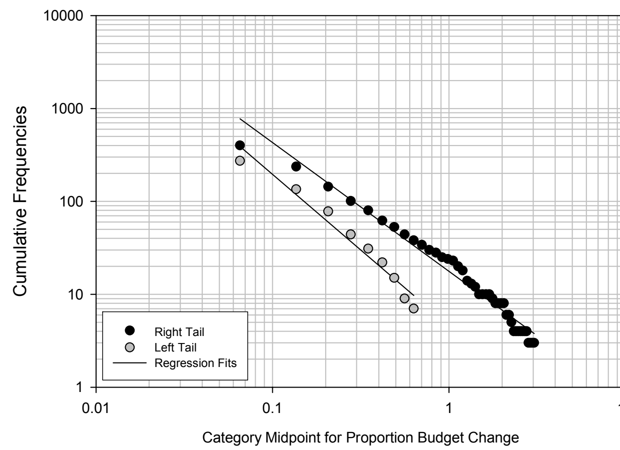


Figure 6: Log-Log Plots for the Central Governments of (a) United Kingdom, (b) Denmark, (c) Canada and (d) Belgium

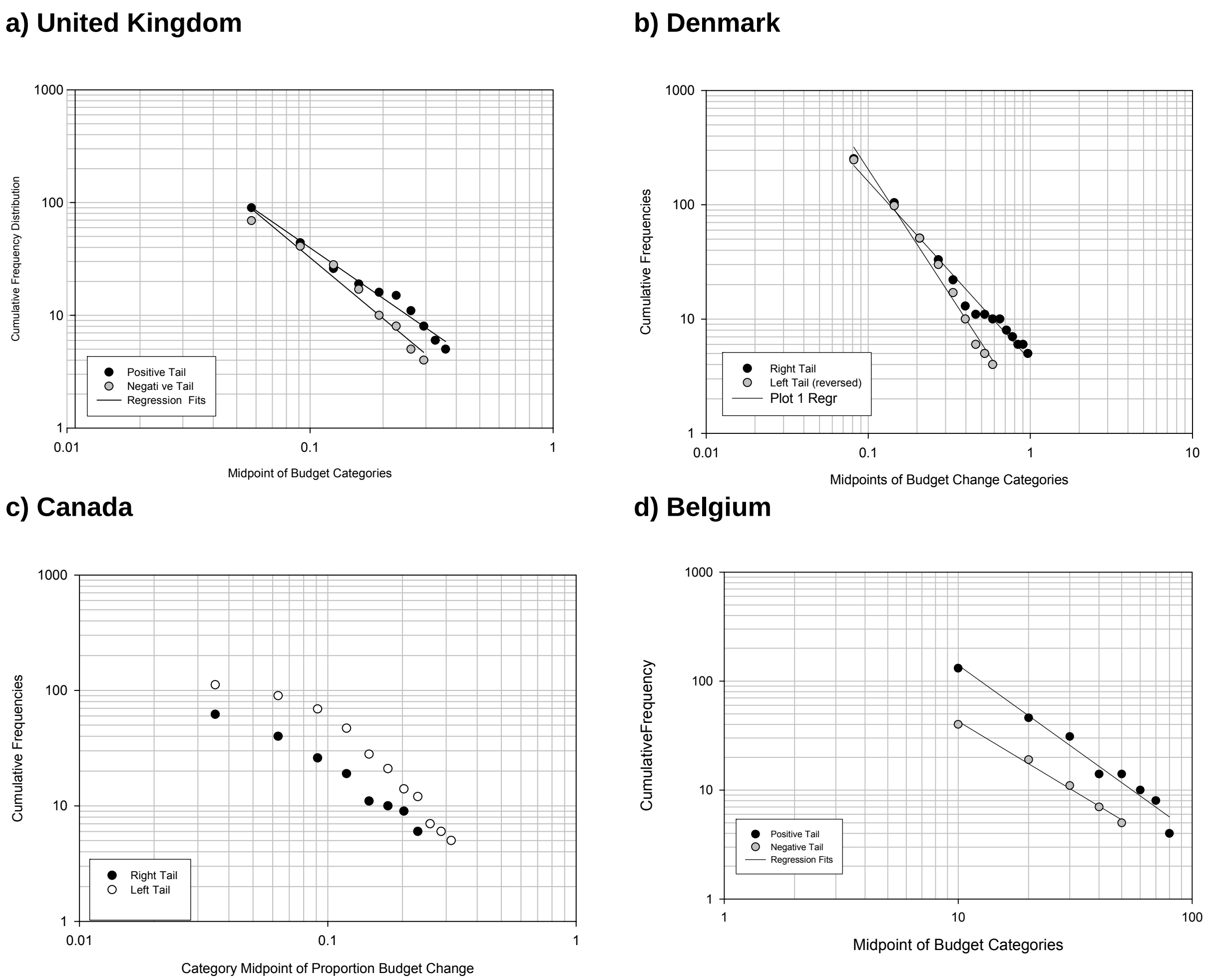
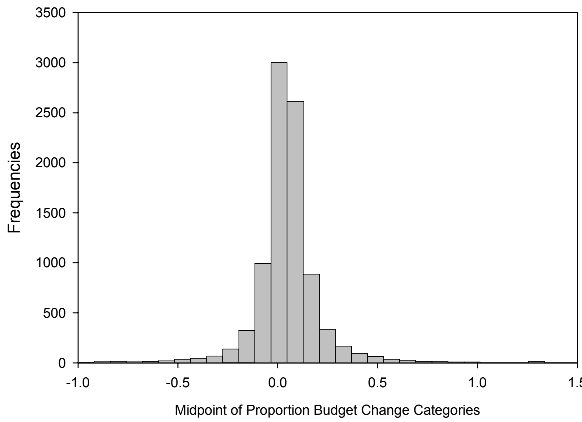
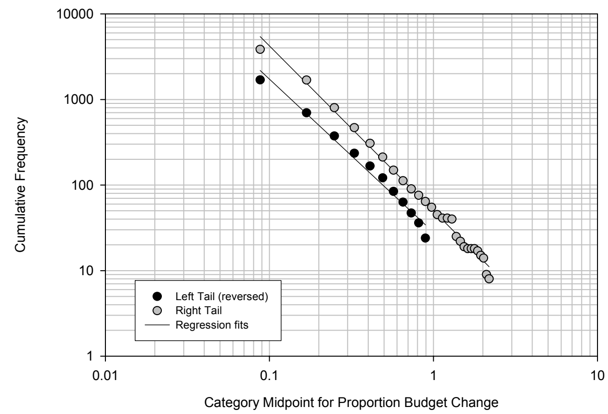


Figure 7: Frequency Distributions and Transformed Plots (Tails of Distribution) for US State Outlays and Texas School Districts

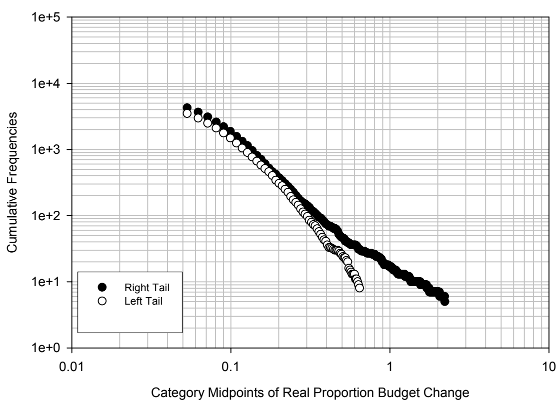
a) US States: Frequency Distribution



b) US States: Log-Log Plot



c) Texas School Districts, Log-Log Plot



d) Texas School Districts, Log-Linear Plot

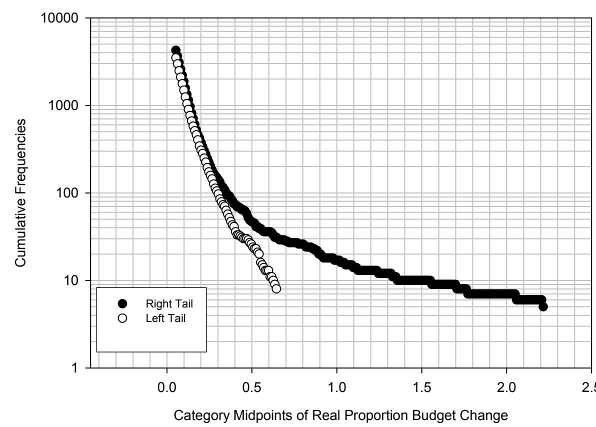
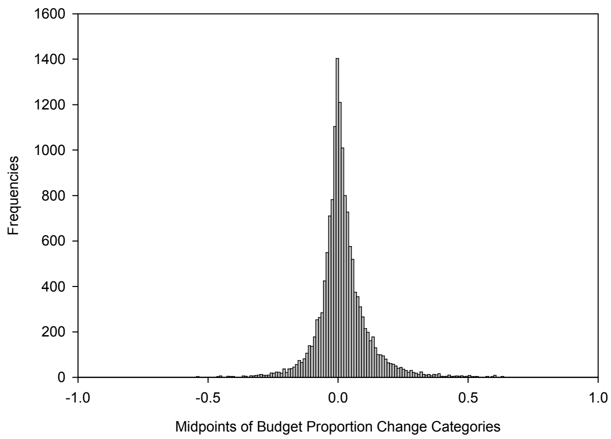
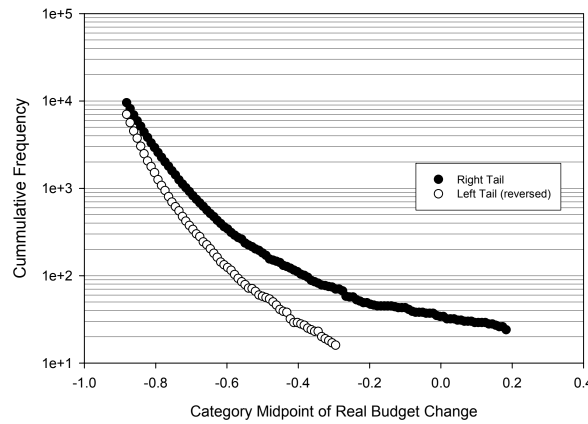


Figure 8: Plots of Log-Linear (a), Probit of Log-Linear (b), Log-Log (c), and Frequency Distribution for Danish Local Government

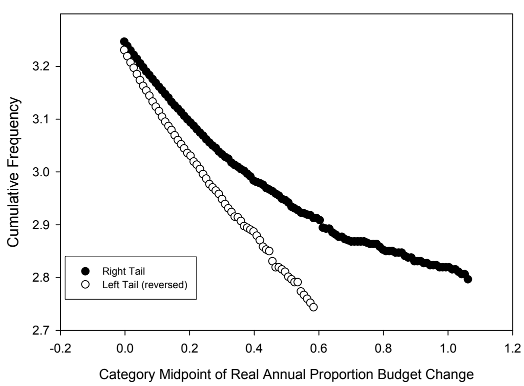
a) Frequency Distribution



b) Log-Linear Plot



c) Probit of Log-Linear



d) Log-Log Plot

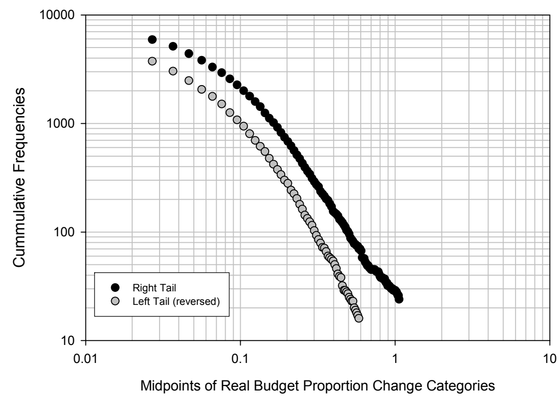


Figure 9: Institutional Friction and L-Kurtosis

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Appendix
Budget Data Source Descriptions

All of the series we studied were corrected for category consistency, or the issue was not relevant to the dataset (as in the case of fully aggregated data).

UK budgetary data consist of data for 14 major functions, consistently defined from fiscal years 1980 to 1999. Data are from Stuart Soroka and Christopher Wlezien, Total Expenditure on Government Services in the United Kingdom, 1980-2000, UK Data Archive (SN 4980). Details are available at http://www.data-archive.ac.uk/. Fiscal years in the UK run from April of one year to March of the following year.

Canadian budgetary data are for the 12 major functions for Federal General Government Expenditure, consistently defined from fiscal years 1989 to 2002. Data are available from CANSIM (Matrix 3950002). Details are available at http://cansim2.statcan.ca/. Note that the dataset used here excludes a few very minor expenditure categories as well as some unspecified intergovernmental transfers (mainly to provincial governments) which cannot be allocated by function. Fiscal years in Canada run from April of one year to March of the following year.

Belgian budget data are for 27 categories of spending over the period of 1991 to 2000, and originate from the Belgian Political Agenda-setting Project. The project (2001-2004) was funded by the "Federale Diensten voor Wetenschappelijke, Technische en Culturele Aangelegenheden" (DWTC). It was conducted by Stefaan Walgrave (coordinator, UA), Lieven De Winter, André Frognier, Frédéric Varone and Benoît Rihoux (UCL), Patrick

Stouthuysen (VUB), and Marc Swyngedouw (KUL). Details are available at: http://www.ua.ac.be/main.aspx?c=m2p.

Danish local spending data consist of inflation-adjusted local spending figures using four consistently defined categories of spending from 1991 to 2005 pooled across 271 Danish municipalities. The data originally come from Tables "BUD32" and "BUD32X", available online from Statistics Denmark (http://www.statistikbanken.dk). See Mortensen (2005) and "the link to the comparative budget projects website" for further documentation.

The dataset on Danish national spending consist of inflation-adjusted public spending figures using 26 consistently defined categories of spending from 1971 to 2003, using data originally made available by Statistics Denmark, Section of Public Finances (www.dst.dk). Further documentation is available at "the link to the website of the comparative budget project."

The sources for national-level French budgetary data are the INSEE (*Institut National de la Statistique et des Etudes Economiques*) Statistical Handbook (annual). The historical data (1868 through 1939) are gathered through a retrospective series published in the 1951 French Statistical Handbook. All other data have been computed from the annual INSEE Statistical Handbooks. For data after the Second World War, we have used the Statistical Handbook 1947–1987 published by the INSEE. From 1988 onwards, we have used the annual publication of INSEE called *Tableaux de l'Economie Française* which provides a complete presentation of public spending adopted by the Parliament through the Finance Law. Total expenditure is made up of separate series for Defense and Civilian public spending. Each statistical series is originally produced and delivered by the Direction of National Public Accounts (a division of the Ministry of Finance). Data are expressed in current francs and were then adjusted into constant francs using the Consumer Price Index (CPI) as supplied in the INSEE publications.

Texas school budgets data include "instructional spending per pupil" for all public school districts in Texas from 1989 to 2001. All data are available from http://www.tea.state.tx.us/. School years run from August through May (with the year based on the year in which school year ends). Enrollment data is included to allow researchers to drop cases for smaller districts, as is done in many uses of the data in political science. The budgetary data is corrected for inflation using the "Cost of Living Index for the American States, 1960-2003" (ICPSR-1275).

US Budget Authority Data are derived from Office of Management and Budget Sources, which adjust categories for consistency after 1976. The Policy Agendas Project (www.policyagendas.org) applied consistent adjustments back to 1947. Data are adjusted for inflation using GDP deflators, with 2005 as the base year.

US Government Outlays are from *Historical Statistics of the United States*, compiled by the US Census Bureau, updated from the Office of Management and Budget website, Historical Statistics, Table 1.1. The Consumer Price Index was used to adjust for inflation due to the absence of GDP deflators for the early part of the series, with June 1984 = 100.