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RESEARCH ARTICLE

How budgets change: punctuations, trends, and super-trends

Ehud Segal[1] · **Frank R. Baumgartner**[2]

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Abstract

Punctuated equilibrium theory (PET) describes policy change as occurring mostly through incremental movements with infrequent periods of dramatic change. An impressive body of empirical literature relating to budgeting supports this view, but virtually all empirical tests have focused on examining distributions of annual changes, thus nullifying chronology. In this article, we focus on the time element. Using the same databases as previously used in canonical PET studies, we explore multi-year trends, not only annual observations. For our analyses, we identify directional series of changes (while allowing for one-year changes in direction if these are immediately offset in the following year) on a U.S. budget distribution dataset covering the period of 1947 through 2014, with 60 categories of spending consistently defined over time and adjusted for inflation. We then assess the robustness of the PET findings when incorporating a longer time units of trending series of annual changes into the analysis. We find that almost 65% of changes occur in series of 4 years or more. Nonetheless, the signature PET literature pattern of high kurtosis is equally present in these series as well as in shorter series. Moreover, within growing and trending series, we find that 21% of these series generate 80% of positive budget change. Within these series, we identify a small group of "super-trends" that account for a large share of the overall change. We conclude that expanding methodologies for the study of budgetary change to incorporate longer-term dynamics helps to better understand policy change, but such findings remain consistent with the PET perspective.

Keywords Budgeting · Incrementalism · Gradual change · Punctuated equilibrium · Public policy

✉ Ehud Segal
ehud.segal@mail.huji.ac.il

Frank R. Baumgartner
Frankb@unc.edu

[1] Federmann School of Public Policy and Governance, Hebrew University of Jerusalem, 9190501 Jerusalem, Israel

[2] The Department of Political Science, UNC Chapel Hill, Chapel Hill, NC 27599-3265, USA

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Introduction

Dan Carpenter's magisterial treatment of the development of the institutional power of the US Food and Drug Administration (FDA) describes two major punctuations in the development of the Agency. First was its initial creation in 1938 in response to deaths from unregulated "patent medicines" (particularly the elixir sulfanilamide in 1937; see Carpenter, 2010, chapter 2). Second was the 1962 expansion of the Agency's powers following the thalidomide tragedy (chapter 4). In between these periods, however, was hardly a time of stasis. Rather, it was a long period of building up of the organizational capacity and, more importantly, the scientific rationale for a more effective regulatory model. Carpenter describes a slow build-up of institutional power based on changes in conceptual understanding of what the agency should be doing and what role it should play. These understandings were hotly contested and changed slowly over time. However, over a period of more than a decade they were at a very different place than where they had been before, helping to set the stage for the next major expansion of the Agency's power. Kingdon (1995) would describe such a thing as "softening-up" period. Baumgartner and Jones (1993) would describe it as the development of a new "policy image" that in turn would undergird the power of a new "institutional venue" of power.

Carpenter's description of the establishment and expansion of the powers of the FDA is consistent with punctuated equilibrium theory (PET). PET describes policy change as occurring mostly through incremental movements with infrequent periods of rapid and dramatic changes. Whereas early work in the PET tradition focused on the chronological development of policy changes in particular policy domains (e.g., Baumgartner & Jones, 2009), a new type of budgetary analysis introduced in subsequent writings used a method that ignored both chronology and the characteristics of individual policy domains (see, e.g., Jones et al., 1997, 1998, 2003; Jones & Baumgartner, 2005).

Jones and Baumgartner (2005) noted that one could look at changes in a single budget category over time; one could look at the distribution of changes across a series of categories in a particular year; or one could put all of these into a single distribution and assess the patterns of change across many budget categories and many years (see their Fig. 4.14, p. 111). This "budget change frequency distribution" has become a canonical demonstration of PET dynamics, with a signature high central peak, "weak shoulders" and "fat tails" reflecting an over-abundance of very small changes, an under-production of moderate changes, and an over-abundance of dramatic adjustments. The empirical evidence is impressive and has been reproduced in many countries (see for example the studies reviewed in Baumgartner, Jones and Mortensen 2023 or Kuhlmann & van der Heijden, 2018). Further, it can easily be assessed by a single statistical attribute: the kurtosis value of a distribution. If the value is near that of a normal distribution, then there is no evidence of PET.

We have no question about the value of this approach, particularly since it avoids over-generalizing from a short historical time period or a single year or from a single policy domain. However, like any approach, it has some merits and some drawbacks. Compared to Carpenter's approach or to the early PET literature, the newer literature is striking for its ahistorical nature, the elimination of the time element. In this article we therefore focus on the time element. Using the same databases as previously used in canonical PET studies, we explore multi-year trends, not only annual observations. We can therefore provide a useful robustness test and determine whether the literature's ahistorical approach is causing it to miss important insights.

Our interest in looking at more than just annual changes is driven by the fact that long-term trends matter. Some examples can illustrate this very easily. In the U.S. federal budget, the housing assistance budget function underwent a sharp and drastic change in 1974 and 1975, rising from 7.5 billion to 147 billion dollars; clearly a dramatic punctuation. In contrast, Medicare climbed from 19 billion to almost half a trillion dollars from 1967 to 2014 in a relatively gradual and stable pattern of growth. A glance at the two series over time would show one with great volatility, with some huge, but momentary, adjustments, and the other with a slow but steady rise accumulating to massive change. If some of the large adjustments in the short volatile series were immediately counter-balanced by adjustments in the opposite direction, then the series could show no net change over time, whereas the slowly building one could accumulate to a transformation of that policy domain. Moreover, the slowly growing or slowly declining series over time obviously differ from ones where the increases and decreases alternate: one trends, whereas the other is erratic around a mean of zero. Putting all of these in a single change distribution may hide important information. It seems plausible, then, that the standard tests of PET theory, impressive and revealing as they are, have been omitting an important question: how changes accumulate over long periods of time.

In light of these observations and findings, our central underlying question is simple: are the PET findings confirmed or contradicted when we use a different methodology, one which explicitly incorporates the possibility of multi-year trends? What else can we discover when we incorporate longer time periods into the analysis? To examine this, we develop a measure of a "trend" in budgeting: periods during which annual changes move consistently in the same direction. Utilizing this concept, we pose three more specific questions: (A) what share of budget changes occur in multi-year trends? (B) Are the temporal dynamics that characterize such trends consistent with PET or do they support a gradualist view of budgeting? and (C) When we incorporate trends, does this change our understanding of what series have the greatest degree of change?

Previous studies suggesting the need to look at trends

Several authors, a few within the PET perspective and some critical of it, have published findings that motivate our approach. These studies suggest that important insights may come from delving deeper into the dynamics of change than is possible with the analysis of a single aggregated distribution of all annual changes across every available budget category. For example, Breunig and Koski (2012) examined budgets at the state level and found that higher levels of punctuation in a state's budget function correspond to smaller long-term growth. This suggests that gradual changes may accumulate to more significant change in the long term than highly volatile or punctuated series. Robinson et al. (2014) found that budgetary punctuations occur in clusters. In other words, the probability of a budgetary punctuation is positively related to having had a recent punctuation. Flink and Robinson (2020) analyzed over 1000 Texas school districts over a nearly 20-year period and found that a significant number of punctuations were immediately counter-balanced by adjustments in the opposite direction. This points to the possibility that volatile budget series could actually be of little or no net change over time, whereas the slowly building ones may accumulate to much more significant change.

In addition, two studies examine temporal dynamics of two macro budget categories in the US, domestic and defense spending. They do so over very long time periods, from the eighteenth century till nowadays, and they show the significance of gradual accumulation over time. Jones and Breunig (2007) found high levels of autocorrelation in both budget categories, a straightforward indication for trending periods. Jones et al. (2014) show that federal budgeting in the US is a "self-reinforcing, recursive incremental system whose solution is exponential growth, termed exponential incrementalism" (575). This pattern is interrupted by disjoint shifts, caused by critical events such as major wars or severe economic downturns. In addition, temporally localized policy dynamics are also in play, causing bends in the exponential path as well as punctuations. Hence, this analysis over longer periods of time exhibits a prominent role for gradual accumulation. Studies within the historical institutionalist approach portray similar patterns in gradual shifts of institutions, sometimes undetected, occurring over decades (Hacker, 2004; Mahoney & Thelen, 2010; Pierson, 2004; Thelen, 2004). Finally, Epp and Baumgartner (2017) find that budgetary instabilities are affected by institutional capacity, whether the policy area is strongly affected by slowly moving demographic trends, and external crises. All these studies motivate our attention to multi-year trends in budgets.

A number of scholars have argued for the significance of gradual changes slowly accumulating over time; these come from outside the PET perspective and are potentially more critical of it. A handful of case studies demonstrate cases in which gradual change accumulated to significant change and even paradigmatic change, external to the explanatory frameworks of PET. Such cases have been found to occur in various policy areas, such as: forestry (Cashore & Howlett, 2006, 2007), agriculture (Coleman et al., 1996; Daugbjerg, 1997, 2003; Skogstad, 1998), administrative reform (Capano, 2003) policy towards indigenous peoples (Howlett, 1994) and air pollution (Segal, 2018). Benjamin Cashore and Michael Howlett (2007) raise explicit concerns with regard to gradually accumulating incremental changes, and they argue that PET findings overlook this important mechanism of policy change. They note gradual movements in the same direction, none of which would constitute a punctuation when considered on an annual basis, but which might accumulate to substantial change this corresponds with Mahoney and Thelen's (2004) influential theory of gradual institutional change.

Charles Lindblom understood incrementalism as "political change by small steps" (1979, 517), he also explicitly recognized that "a fast-moving sequence of small changes can more speedily accomplish a drastic alteration of the status quo than can an only infrequent major policy-change" (Lindblom 1979, 520). Hence, the potential for significant gradual accumulation was recognized in the early years of the literature on budgetary change. Budgetary scholars including Wildavsky (1975), Padgett (1981), Larkey et al. (1981), Kamlet and Mowery (1987), and Su et al. (1993) have wrestled with issues of trends and annual changes, and we build on this work here. Summing up, previous research points to the possibility that gradual accumulation (or decline) may be a significant driver of change and that therefore any conclusions regarding patterns of policy outputs should also be sensitive to temporal dynamics. We provide that perspective here.

Gradually accumulating change and PET

In order to understand the theoretical disparity between gradual accumulating change and PET, we need to examine PET's behavioral foundation, which is Disproportionate Information Processing (DIP) theory (Jones & Baumgartner, 2005). At its core, DIP presents the cognitive overload model of decision-making. Simply put, policy makers suffer from an overload of signals and therefore process information disproportionately. For most issues, most of the time, they under-respond, because their attention is focused on a small number of other issues with the greatest urgent need for response. When an issue does capture their attention, they may over-respond because of the accumulated lag in policy response during the period when they were focused on other issues.

Within a DIP framework, gradual accumulation may occur if signals are pointing in a certain direction over extended periods of time (Segal, 2018). These may be demographic trends or program costs that can be predicted steadily to increase over time (Epp & Baumgartner, 2017). In Segal's (2018) study, it was steadily increasing environmental threats. For Epp and Baumgartner, it was slowly moving demographic trends. But just because policymakers respond steadily in the face of social indicators moving in a common direction year after year does not mean that they respond in a proportionate manner. Trending series, in other words, may still exhibit the distinctive pattern of under- and over-response, reflecting DIP theory.

Several of the studies reviewed above support a counter-argument, one that suggests that accumulated change over time may stem from a different behavioral model, one of relatively proportionate adjustment. Cashore and Howlett (2006, 2007) argue that a central mode of gradual changes is overlooked by PET. They suggest a "progressive incremental" dynamic of change consisting of incremental changes as an alternative model of policymaking. They demonstrate this through a case study of gradual policy response over time in forest policy in the Pacific Northwest, eventually generating paradigmatic changes in logging practices in response to growing demand to protect endangered species. The dynamic they describe suggests relatively efficient policymaking: pressure from the outside environment pushes policymakers progressively to adjust policy in response, eventually leading to a major policy change.

Other scholars have also identified cases of gradual rather than punctuated policy response. Skogstad (1998) described a gradual change in the European state-assisted agricultural paradigm in the 1990s increasing the paradigm's endurance, while the more stagnant paradigm in the United States was eventually overthrown. This is consistent with the emphasis on the "build-up" of pressure, or "error-accumulation" in DIP theory. During times when decision makers under-respond to signals, those signals accumulate. Either they dissipate, by random luck, or they accumulate over time if not incorporated into the decisions. This error-accumulation is then the source of punctuations, in the DIP model, as decision makers eventually have to respond to the accumulated crisis, since they did not respond sufficiently to it as it was building. If decision makers were to respond proportionately to signals as they accumulate, then there would be no build-up, and no need for punctuation; this is essentially the Skogstad (1998) example. Efficient processes can go on forever; inefficient ones eventually generate a break-down leading to a punctuation. But if policymakers can "get it right," as Skogstad suggests, then they can avoid policy punctuations altogether, something that is clearly inconsistent with PET and DIP.

Theory and hypotheses

We sum up the gradual change argument in the form of a rival hypothesis to DIP and PET: gradual accumulation is a central mechanism of change occurring in a more efficient and proportional response to incoming policy-relevant signals. We assess these changes by returning an important time-element into the study of budget changes, trends. If slowly accumulating changes are proportionate to shifting policy needs, then there will be no need for punctuations. In sum, we assess whether the overwhelming consensus in the budgetary literature in support of the "general punctuation hypothesis" (Jones et al., 2009) remains if we allow for trends. After all, that literature has been based on a common, but untested, methodological assumption, that ignoring the time element is inconsequential. Here we test this directly.

We test the following hypotheses. First are three hypotheses related to budgetary gradualism:

H1. Annual budget changes occurring in trends will show significantly less kurtosis than changes that are not part of trends.

H2. The longer the trend in a budget series, the lower the kurtosis.

H3. Analysis of the percent change in budget value from the start to the end of a trend will show lower kurtosis than analysis of the annual budget changes.

Analysis of trends rather than only annual values will generate new insights into the budgetary process. If H1 through H3 are disconfirmed, and series trending in the same direction for long periods are just as likely to be punctuated as series that do not trend (or do so for a shorter period), then a small share of series that are both punctuated and trending may generate extraordinary levels of change. This leads to these expectations:

H4. A small share of trending series will generate a large share of the overall budget change.

H5. These "super-trends" will incorporate both clear budget punctuations as well as sustained movement in the same direction.

Finally, as others have noted (Jones et al., 2009), growing and declining trends are mathematically distinct: Growing series are unbounded but declining series cannot decline by more than 100%. Therefore, the patterns we observe are sensitive to whether we are describing growing or declining series:

H6. The concentration of all change in just a few trending budgetary series will be greater for growing series than for declining ones.

Methodology

We begin by taking the U.S. budget distribution previously used in many published articles from the Comparative Agendas Project web site[1]; it covers the period of 1947 through 2014, with 60 categories[2] of spending consistently defined over time and adjusted for inflation. We use this dataset without updating it so that our results can most directly be compared with the previous literature. We use inflation-adjusted budget amounts as is

[1] https://www.comparativeagendas.net/.

[2] We included functions that represent policymaking and excluded financial functions, such as annual offsets (True 2009); we excluded annual changes in share for which the base year was smaller than 100 million 2009 adjusted dollars. These practices are standard in the literature.

common in most budget studies. In addition, we replicate our analysis using a complementary 'change-in-share' analysis that controls for budget drift and reach similar results; see Appendix B. For this, we convert all budget numbers into shares of the annual budget, summing to 100% for each year. We then analyze changes in this share. This means that we are analyzing changes in the share of the budget, understanding that the budget itself may be growing over time. Hence, the change-in-share method is also more reflective of prioritization on behalf of decision makers.

The concept of a "trend" is fundamental to our analysis. For each observation, we simply note whether the change continues in the same direction (e.g., growing or declining) as the previous change, or if it reverses. If there is a reversal, we note if the reversal was itself immediately offset in the following year. In such a case, we call the reversal a single-year irregularity. We call a series a trend if it moves in the same direction for four years or longer, not counting single-year irregularities.[3] This methodology identified 1043 series from the total 3699 observations in the dataset. Note that our use of four years as a cutoff for defining a trend is arbitrary, but four years of continued growth or decline in a budget is substantively important. Further, whether we define the trend with a cutoff of, 3, 4, 5, or 6 years makes little difference with regard to the hypotheses tested; see Appendix Table 6. We assess levels of kurtosis in Table 3 below by the length of the series and show no particular break-points in the series. Therefore, we are confident that our results are robust with respect to the question of the use of a four-year cutoff to define a trend.

As aptly described by Johanna Kuhlmann and Jeroen van der Heijden (2018, 328–329), Baumgartner and Jones have repeatedly stressed that punctuations are identified by looking at entire distributions of changes, not by tracking a single series over time. The literature provides no objective definition for the cutoffs between small, medium and large changes within single budget series. In an entire distribution, on the other hand, punctuations are identified the presence of "fat tails" or a set of outlier values that would not be expected given the overall level of variability in the series. This means looking at the level of kurtosis in the series, which also implies looking at large numbers (several hundred) of observations rather than only a few. If the series of changes, taken together, is statistically similar to a bell curve (Normal distribution), then it is not punctuated even if there are some large changes. If, on the other hand, there is a high degree of kurtosis (e.g., a high central peak, weak shoulders, and fat tails, also known as leptokurtosis), then the distribution is punctuated (see also Eissler et al., 2016; Boydstun, 2013; Cavalieri, 2023). We follow these strategies here.

Results

Trending series

Breaking down the 3699 annual budget changes into series consistently moving in one direction or another generated 1043 series. Table 1 shows the length of each of the series we identified, separately for series that were growing and declining. It shows both the

[3] Consider this series of percent changes: +3, +2, +5, -2, +4, +2, − 1, −1. It is a trend of six years. This series: +3, +2, +5, -2, +1, +2, − 1, − 1 lasts only three years because the -2 in the fourth year is not completely offset by the +1 in the following period; the offset must be larger than the irregularity, otherwise it is not fully reversed.

Table 1 Growing and declining budget series, by number of years of consistent movement

Length	Distinct budget series				Annual budget observations			
	Declining		Growing		Declining		Growing	
	N	%	N	%	N	%	N	%
One year	182	17.45	121	11.60	182	4.92	121	3.27
2	135	12.94	117	11.22	270	7.30	234	6.33
3	92	8.82	73	7.00	276	7.46	219	5.92
4	65	6.23	55	5.27	260	7.03	220	5.95
5	12	1.15	30	2.88	60	1.62	150	4.06
6	10	0.96	28	2.68	60	1.62	168	4.54
7	12	1.15	23	2.21	84	2.27	161	4.35
8	1	0.10	12	1.15	8	0.22	96	2.60
9	4	0.38	9	0.86	36	0.97	81	2.19
10 years or more	9	0.86	53	5.08	98	2.65	915	24.74
		–		–		–		–
Total	522	50.05	521	49.45	1,334	36.06	2,365	63.94
Grand total		1043	100.00			3699	100.00	

See text above for more detail on how series are defined. The longest series lasted 61 years

Table 2 Characteristics of budget series, by trending or not

Trending for four years or more?	Growing or declining	Number of observations	Percent of observations (%)	Length (Median)	Annual change (Median) (%)	Cumulative change (Median) (%)
Yes	Growing	1791	48.42	6	6.8	111.9
Yes	Declining	606	16.38	4	−6.1	−39.8
Yes	Subtotal	2397	64.80			
No	Growing	574	15.52	2	12.1	30.6
No	Declining	728	19.68	2	−9.6	−21.4
No	Subtotal	1302	35.20			
Total		3699	100.0			

number of distinct budget series as well as the corresponding number of annual budget observations within each series. While there are relatively few very long trends, a much larger share of all budget observations are part of such trends, since by definition these longer trends have many annual observations. More precisely, just 31% of the series show a trend of four years or more, but 65% of all observations are part of such trends.

Table 1 makes clear that trending series are quite common, and that some data series trend, for many years in a row; 9 declining trends and 53 growing trends lasted for 10 years or more. These were fewer than 6% of all the series, but more than 25% of all budget observations. Table 2 shows summary statistics for growing and declining budget series according to whether they are part of a trend lasting at least four years.

Series trending for four or more years are more common than non-trending series. These findings provide a clear and definitive answer to our first question concerning the extent of accumulating changes: Trends have an important role in the logic of budgets. We can only gain by understanding whether annual budget shifts may be part of multi-year trends.

Looking into the size of budget changes in both types of series, trending and non-trending, we find that annual changes in non-trending series are larger than those in trending series. The medians of annual changes in non-trending series are 12.1% and −9.6%, as compared to 6.8% and −6.1% in the trending series. Of course, trending series see accumulation of these effects whereas non-trending series, by definition, experience less accumulation as well as a quicker offset by the following reversing series. This explains why the median of accumulated growth in growing trending series was 111.9%, as opposed to 30.6% in growing non-trending series. The median for accumulated decline in declining trending series was −39.8%, as opposed to −21.4% in declining non-trending series. At a minimum, we can say that attention to accumulated changes over many years provides insight into the nature of policy change. Some important policy changes take several years to accumulate.

Disproportionality in trending series

The previous short assessment should clearly answer the question of whether trending changes have a significant role in the budgetary process; they do. We now move on to examine trend dynamics. The fact that a series accumulates in the same direction for several years does not necessarily mean that it is gradual rather than punctuated. If, however, the distinctive characteristic of PET budgetary findings, high kurtosis, is limited only to non-trending series, then the methodological convention within the literature of ignoring time dynamics longer than one year would be problematic. Therefore, we want to know if evidence of proportionality in budgeting differs significantly in those series which are parts of significant trends compared to those which are not part of a trend.

Fortunately, we can devise a simple but robust test for this. Disproportionality is traditionally measured in the PET budgeting literature by using the kurtosis statistic, K, or its more robust analog, L-Kurtosis (LK). LK provides a single value, ranging from 0 to 1, indicating the degree of kurtosis in a distribution. Distributions with high kurtosis, compared to Normal, have a higher central peak, more slender shoulders, and longer tails. LK scores, compared to the more conventional K scores, are less sensitive to single cases in the tail, and therefore provide a more robust and reliable general test, more suitable for our analysis. LK values range from zero to one, with 0.123 the LK of a normal distribution. Table 2 breaks out each annual budget change observation by the length of a series to which it belongs and shows the LK scores for each set of observations.

As we saw in Table 2, 2397 changes are part of trends lasting four years or more, and 1,302 are part of series lasting less than four years. Table 3 shows that the distributions have almost identical LK values: 0.584 for trending series and 0.574 for non-trending series. Thus, we clearly reject H1, which posed that annual budget changes occurring in trends will show significantly less kurtosis than changes that are not part of trends.

Looking at the individual series (clustered by trend length so that the N's are roughly comparable and over 400 in each case), values are high. These range from 0.511 to 0.634, very high in comparison to the LK of a normal distribution (0.123). We therefore reject H2, which posed that the longer the trend in a budget series, the lower the kurtosis, since there is no tendency for kurtosis to decline as the series grows longer. (And in addition, none of the groups comes close to the value expected in a normal distribution.) Overall, Table 3 shows that consistency in the direction of change is not correlated with a less

Table 3 LK values for series of different lengths

Series length (in years)	N	LK
1–2	807	0.555
3	495	0.588
4	480	0.528
5–6	438	0.634
7–9	466	0.629
10+	1013	0.511
Non-trending	1302	0.574
Trending for four years or more	2397	0.584
All changes	3699	0.586

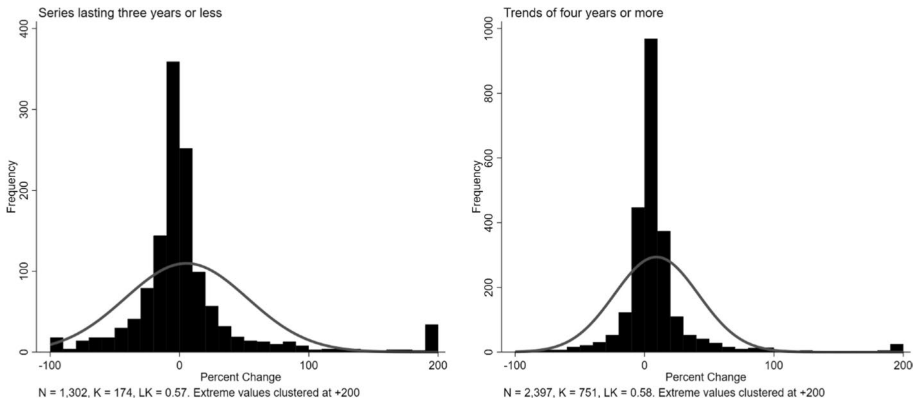

Fig. 1 Annual percent changes in budget value, trending and non-trending series compared

erratic pattern of budgeting. Decision-making processes within trending series of changes also evolve in a disproportionate dynamic consistent with PET and DIP expectations. The results reject the hypothesis that gradual accumulation is evidence of a more efficient and proportionate pattern of policy adjustment than what has been shown in the PET literature. They also present a strong indication that governmental decision-making processes beyond budgets occur in PET patterns even if change is advancing in a certain direction over an extended period.

Figure 1 shows the distribution of changes at the core of the main result in Table 3: The left panel shows those changes not part of a trending series, and the right panel shows those observations which are part of a trend of four years or longer. The figure shows the number of observations showing various percentages of change from the previous year. A large peak of observations is around zero percent, and there are a number of outliers. A normal curve with similar variance is overlaid on the figure, showing that the observed values: (a) over-produce cases in the central peak; (b) under-produce cases in the moderate "shoulders" of the distribution; and (c) over-produce outliers. This is consistent with dozens of articles in the previous literature (see Baumgartner et al., 2023).

Figure 1 confirms the results from Table 3. No matter if we look at shorter or longer trends, we see the signature of a punctuated equilibrium process: a high-kurtosis distribution.

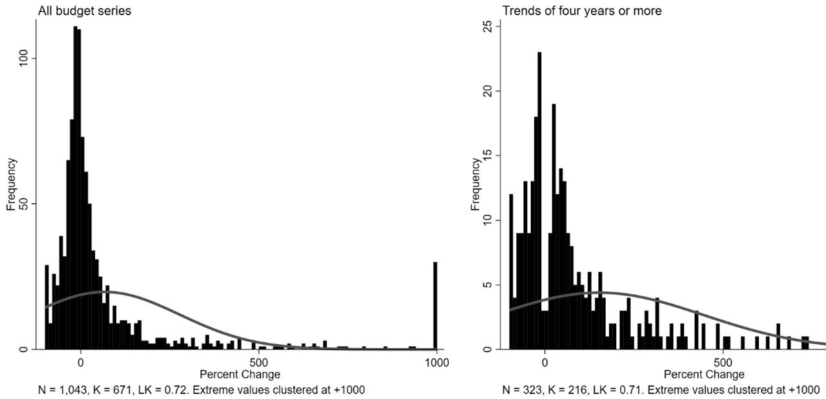

Fig. 2 Cumulative percent changes in budget value, all series and series trending for four years or more

Finally, we performed another series of tests on the accumulated change across the length of each trend, from its beginning to its end. If trends have a central role in budgeting then perhaps we should widen our perspective from snapshots of annual changes to assess the cumulative change over an entire trend, however long it may be. For example, budgeting may be tied through a "mandatory spending" formula for many years, automatically changing in response to demographic trends, numbers in poverty, or other social indicators. Or, general budgeting policy may be set in the first year of a new administration, continuing for four or eight years until the next one. In such cases, a cumulative change would be a better representation of decision-making dynamics than analysis only of annual changes without respect to how these accumulate. For example, if a series moved up by 5% each year for five years before reversing, we would call this a trend accumulating to 26.5% total change. In contrast, in Fig. 1 and in Table 2 it would be recorded as five values of five. The left panel in Fig. 2 shows the distribution of cumulative changes of all 1,043 trends that we identified, and the right panel shows the same values for all trends lasting four years or longer (N = 323). (Note that the N's are lower here than in Table 1 because the unit of analysis here is the series, not the number of annual observations within each series.)

When we look at the cumulative change from the beginning to the end of a budgeting trend, of course the degree of change is greater than if we look at just one year at a time. We cluster the values at + 1000% change because many of them go beyond that level. But in looking at all the trends our algorithm identified, or in looking only at the trends lasting at least four years, the LK value is nearly identical: 0.72 or 0.71. Still the general shape of change that we showed in Fig. 1, and which is common in the literature, remains. Trending series show the same kind of PET distribution of changes as non-trending series and shifting our analysis from annual changes to the endpoints of trends of various lengths does not change this finding. Thus, we reject H3, which posed that analysis of the percent change in budget value from the start to the end of a trend will show lower kurtosis than analysis of the annual budget changes, as we rejected H1 and H2.

Isolating super-trends

Our final analysis concerns the largest trends, i.e. those that accumulate over long periods of time to generate the greatest degree of percent change in budget value. The motivation

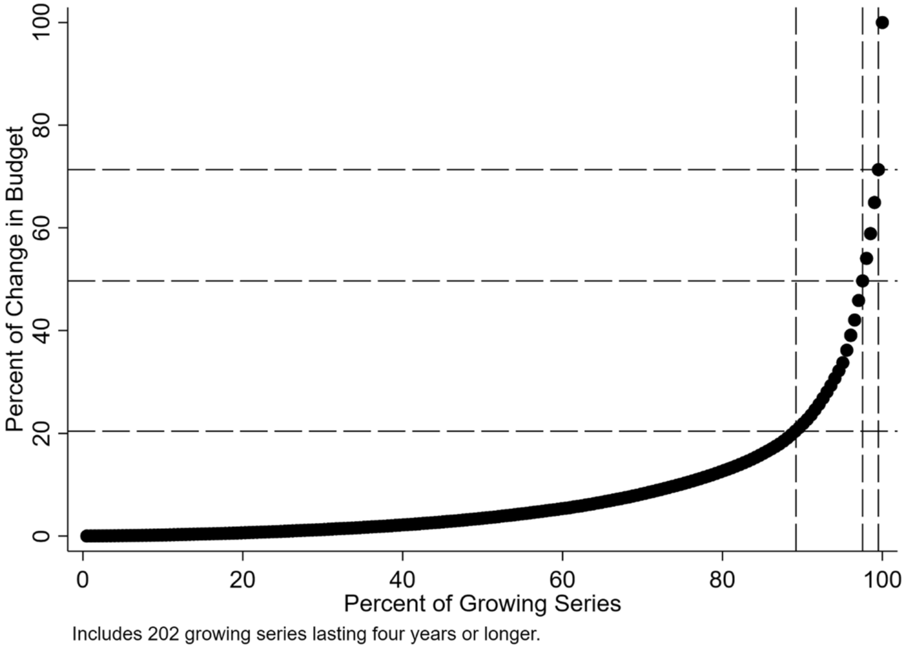

Fig. 3 Cumulative budget change in growing budget series trending for 4 years or longer

for this is double. First, it is of obvious substantive interest to examine the dynamics of the most significant policy changes. Second, our analysis of whole distributions in the previous part provided a strong indication of PET temporal dynamics though still it did not examine them directly.

Our focus here is on trends that grow for at least four years. Table 2 showed that 48% of the federal budget consists of such cases. This group consists of 202 trending series with 1,571 annual observations. (Appendix B shows the parallel analyses for all series as well as other robustness tests.) Fig. 3 focuses on those 202 series and compares them with respect to the total accumulated change that each generates. Similar to a plot that might show what share of wealth is controlled by what share of the population, the presentation allows a simple graphical demonstration of how important a small number of series is in the overall accumulation of all budget change. Note that if all the budget series contributed equally to the budget changes, the result would be a straight line along the 45-degree line from bottom-left to top-right of the Figure.[4]

Figure 3 is annotated with horizontal and vertical lines indicating the percent of the series generating 20, 50, and 80% of the change in budget value; the corresponding shares of series are 0.5, 2.5, and 21% In fact, just six series out of 202 (3.8%) generate half of all the change described here; these are visible as individual dots in the upper-right of the

[4] Jones et al. (2009) presented a series of distributions similar to Fig. 3, though they referred to annual observations, not trends, and were presented in a log–log presentation rather than as we do in Fig. 3. Results were similar.

Table 4 Six super-trends

Budget category	Year		Millions of 2009 Dollars			Percent of the budget		
	Start	End	Start	End	Growth	Start	End	Growth
Housing assistance	1954	1975	$326	$146,746	448	0.071	10.732	149
Medicare	1966	2014	$4,818	$486,911	100	0.571	13.189	22
Community Development	1964	1973	$131	$12,576	95	0.018	1.114	61
Space Flight, Research, and Supporting Activities	1955	1965	$370	$28,246	75	0.089	3.850	42
Social Services	1951	1967	$161	$11,186	68	0.027	1.192	43
Social Security	1947	2008	$13,347	$812,247	60	4.326	22.310	4

The Table shows the starting and ending years of each series, their starting and ending values in constant dollars as well as in terms of the percent of the budget they constitute in each year, and the growth from beginning to end. For ease of presentation, Growth here is defined as (Ending Value – Starting Value)/Starting Value. In the text, we generally refer to "percentage growth," which is the same number times 100. See Table 5 for annual values for each of the six "super-trends" described here

Figure. We confirm H4, which posed that a small share of trending series will generate a large share of the overall budget change.

Table 4 describes these six "super-trends" in greater detail, and Appendix Table 5 provides the annual values for each of the series, allowing a more detailed assessment of the combination of gradual and punctuated changes that make up each.

Table 4 shows the most remarkable positive changes in the US budget over the entire period. Housing Assistance, for example, increased from 1954 to 1975 from approximately $326 million to almost $150 billion, more than 400 times the earlier value. Expressed in terms of the percent of the federal budget, it grew from less than 0.07% to almost 11%, clearly a remarkable change. While this is the largest change in the entire federal budget, the six other series documented here also show very large changes.

The six "super-trends" we document here combine punctuations with continuing trends (see Table 5). That is, taken as a group, the trending series we study here are not stories of simple proportionate growth in response to a trending social problem such as demographic growth; each is subject to an important single punctuation, or several of them. However, neither are these series characterized by a flat series, a single interruption, and then a flat line at a new value. They are just as punctuated as the other series in the budget (as we showed in Table 2), but they combine this common characteristic with another one: they trend in the same direction for many years. Appendix Table 5 shows no case without a major annual budgetary shift, and most of the series have several extremely large changes. Combined with the previous analysis, these results clearly indicate that the super-trends combine punctuations with continued change; many show multiple large changes in a short time period. We confirm H5, which posed that "super-trends" will incorporate both clear budget punctuations as well as sustained movement in the same direction.[5]

[5] Note that punctuations should be identified with respect to being outliers in a large distribution of values. When we refer to punctuations in Table A-1 in this section, we are referring to observations that are extreme outliers with respect to the others. This, however, is not a formal test but rather an illustration using limited data.

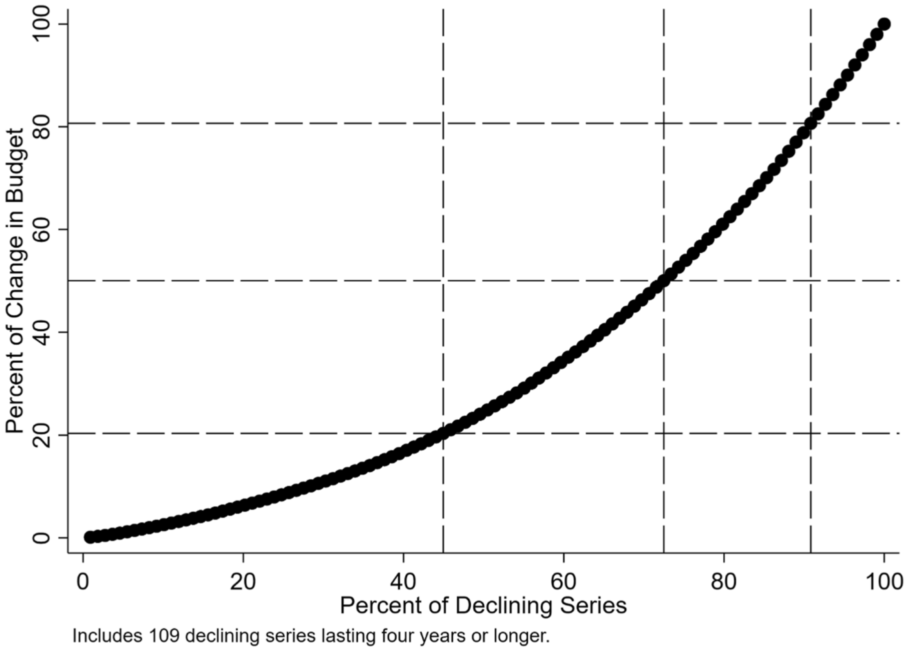

Fig. 4 Cumulative budget change in declining budget series trending for 4 years or longer

Figure 4 shows the equivalent to Fig. 3 for declining series. The level of disproportionality is significantly lower, though it remains.

Declining series do appear to show some significant differences from growing series, as Fig. 4 differs markedly from Fig. 3. Most obviously, the largest changes are not concentrated to the same extent in just a few series but are spread more evenly across all the categories. Thus, we confirm H6, which posed that the concentration of all change in just a few trending budgetary series will be greater for growing series than for declining ones. This is for several reasons: First, of course a series cannot decline by more than 100%. And once it does, it must, by definition, reverse in the following period. Growing trends, with no upper limit, can continue to grow even after they have seen rapid growth in the past. Second, many of the largest declines come in single years, often in such series as farm stabilization programs, emergency preparedness, and other series explicitly designed to respond to temporary crises but not to remain at high levels year after year. There are a few long-term declines that accumulate to very large percentages, almost eliminating the spending program altogether; these have come in various veterans' education programs as wars have faded into history (for example Veterans Education, Training, and Rehabilitation declined by 96% from 1957 to 1966 and again by 98% from 1977 to 1990). Other examples include Space Flight (−66% from 1966 to 1975); Veterans Benefits (1951 to 1960; − 50%; Community Development (−53% between 1984 and 1989 and −79% between 2009- and 2014).

Even though Fig. 4 shows significant differences from Fig. 3, it remains the case that reductions are not evenly spread across budget series. As the lines in the Figure illustrate, 55% of the series account for 80% of the total accumulated budget declines; 27.5% account for half of the decline, and 9.2% of the series account for 20% of the total decline. This concentration is much lower than in the positive series, but it remains substantively important.

Trends and proportionality

Because a series is gradually trending upwards or downwards over time does not imply that policymakers are "getting it right" or adjusting proportionately to a steadily growing (or disappearing) problem. Rather, whether a series is trending up or down, policymakers may still be under-responding to the change in social need. Therefore, we can see errors continue to accumulate even as budgets are continually adjusted in the same direction over many years (see Jones & Baumgartner, 2005 in general for a discussion of error-accumulation, friction, and the occasional need to make radical adjustments). Punctuations and trends can go together. When they do, we can see even greater accumulated changes than would be suggested by a focus only on annual budget changes. Of course, as Skogstad (1998) described, occasionally, policymakers may very well get it right. Our results suggest that this is the exception rather than the rule, even when series trend in a common direction over many years.

Conclusion

We set forth in this study with two central questions in mind: do PET findings hold when we use a methodology which explicitly incorporates the possibility of multi-year trends?; and what else can we discover when we incorporate longer time periods into the analysis with focus on the trends characteristics and impact on change? For this, we re-examined patterns of change in budgetary data, assessing whether the consistent findings in the PET literature could be due to a methodological quirk, that of focusing only on cumulative distributions of annual changes. We also gained insights by directly examining temporal dynamics and looking at trends rather than only annual changes. Our results were quite straightforward. A large proportion of changes in budgets occur within trending series, almost 65% when using a four-year cutoff but still significant proportions when five- and six-year cutoffs are used. However, the signature pattern of change previously repeated across the literature in analyses of annual budget changes is repeated when we look at accumulated changes from the beginning to the end of multi-year trends. This suggests that the DIP theory of cognition that is at the core of PET remains valid even while budgets may be shifting steadily in one direction over many years. The fact that a budget may trend in a common direction does not mean policymakers are responding proportionately to the severity of the underlying problem. We find the same tendency for punctuations and high kurtosis within trending and non-trending series.

We also found that a small group of punctuated and long trends, that we label "super-trends," are responsible for exceptional shares of the total accumulated change in the entire system. In fact, within growing and trending series, 21% of the budget series generate about 80% of the total budgetary change. Overall, we validate the central findings of the PET approach, but we also point to reasons to expand our empirical focus beyond only annual assessments of "the shape of change." A more complete understanding of budgets requires attention to dynamics over time, and particularly to a small set of "super-trends" that generate a large share of the universe of budgetary reallocations. Understanding these dynamics is both of theoretical and substantive interest.

Future research could possibly focus on identifying patterns of accumulation and decrease over time within trends, as well as the factors that influence such accumulation and decrease patterns. Analyzing change patterns within super-trends could be an interesting place to start.

Appendix A: Further details on the six super-trends

Table 5 presents the annual data associated with the summary laid out in Table 4 in the main text.

The details presented in Table 5 allow a detailed understanding of the concept of a trend. Looking at the Percent Change of Budget Value column, these generally increase, but sometimes have negative values. Recall from the text that our definition of a trend is one that is not reversed for two years in a row. Also, note that the percent of budget values, and the changes calculated from these, sometimes show different patterns.

Substantively, a review of the last column of the table allows an assessment of whether these series are subject to stability followed by a single punctuation followed by a new stable value, or if there is a more complicated pattern. Clearly, the pattern is more complicated than a single stable—change—stable pattern would suggest. Some of the very large adjustments are preceded by very substantial build-ups, and some very large changes are then quickly followed by even more change in the same direction. In sum, Table 5 makes clear that the six Super-Trends generally involve a number of dramatic adjustments, not just a single one. It also shows that these dramatic long-term shifts are not examples of gradualism, either. They show punctuations as well as trends.

Appendix B: Robustness tests

Alternative cutoffs to define a "Trending Series"

We define a "trend" as a series that moves in the same direction for four years or more. Our findings robust to different cutoff points, however. Table 6 replicates the findings in Table 2 in the main text using different cutoff points, three, five, and six years in Parts A, B, and C respectively.

Defining a "trending" series in different ways of course alters the number of them that are observed in the same data. Table 2 in the main text showed 65% of all budget observations being part of a trend of at least four years; this number is 78% if we define a trend with a cutoff of three years (Part A, above); 52% if defined as five years or longer (Part B); and 46% with a cutoff of six years (Part C). Also, by construction, the median lengths of the trending and non-trending series change.

The annual and cumulative change values, however, do not change enough to merit any revisions in our substantive conclusions. This, combined with the more important test in Table 3 of the main text (LK scores for series of different lengths) shows that the findings are robust to the question of what is the cutoff for a "trending series." We would reach the same substantive and theoretical conclusions no matter which particular cutoff we were to use.

Table 5 Annual values for the six super-trends described in Table 4 in the main text

Budget category	Year	Constant dollars		Percent of budget	
		Value	Annual percent change	Value	Annual percent change
Housing Assistance	1954	$326		0.071	
	1955	$492	51	0.118	65
	1956	$619	26	0.136	15
	1957	$633	2	0.130	−4
	1958	$656	4	0.129	−1
	1959	$745	14	0.138	7
	1960	$815	9	0.146	6
	1961	$900	10	0.147	1
	1975	$146,746	571	10.732	487
Medicare	1966	$4,818		0.571	
	1967	$19,039	295	2.028	255
	1968	$22,514	18	2.379	17
	1969	$30,004	33	3.130	32
	1970	$29,377	−2	3.037	−3
	1971	$31,062	6	3.154	4
	1972	$30,232	−3	2.887	−8
	1973	$38,356	27	3.398	18
	1974	$49,981	30	4.183	23
	1975	$49,563	−1	3.625	−13
	1976	$51,241	3	4.038	11
	1977	$59,262	16	4.312	7
	1978	$67,918	15	4.905	14
	1979	$72,766	7	5.061	3
	1980	$75,314	4	5.048	0
	1981	$87,922	17	5.566	10
	1982	$100,739	15	6.077	9
	1983	$110,490	10	6.186	2
	1984	$114,850	4	6.310	2
	1985	$122,793	7	6.150	−3
	1986	$129,918	6	6.580	7
	1987	$141,051	9	7.117	8
	1988	$153,219	9	7.474	5
	1989	$167,888	10	7.909	6
	1990	$171,509	2	7.905	0
	1991	$176,886	3	8.097	2
	1992	$189,273	7	8.338	3
	1993	$196,462	4	8.633	4
	1994	$199,411	2	8.757	1
	1995	$204,730	3	8.896	2
	1996	$243,881	19	10.439	17
	1997	$244,301	0	10.097	−3
	1998	$254,671	4	10.211	1

Table 5 (continued)

Budget category	Year	Constant dollars		Percent of budget	
		Value	Annual percent change	Value	Annual percent change
	1999	$273,281	7	10.539	3
	2000	$280,356	3	10.472	– 1
	2001	$293,947	5	10.465	0
	2002	$307,846	5	10.541	1
	2003	$299,971	– 3	9.791	– 7
	2004	$313,167	4	9.952	2
	2005	$346,070	11	10.553	6
	2006	$400,437	16	11.692	11
	2007	$421,807	5	12.301	5
	2008	$427,141	1	11.732	– 5
	2009	$435,497	2	10.300	– 12
	2010	$439,589	1	11.430	11
	2011	$453,701	3	12.106	6
	2012	$449,157	– 1	12.225	1
	2013	$463,525	3	12.858	5
	2014	$486,911	5	13.189	3
Community Development	1964	$131		0.018	
	1965	$4,761	3524	0.649	3446
	1966	$6,451	36	0.765	18
	1967	$5,355	– 17	0.571	– 25
	1968	$10,203	91	1.078	89
	1969	$6,117	– 40	0.638	– 41
	1970	$12,394	103	1.281	101
	1971	$10,606	– 14	1.077	– 16
	1972	$12,545	18	1.198	11
	1973	$12,576	0.2	1.114	– 7
Space Flight, Research, and Supporting Activities	1955	$370		0.089	
	1956	$461	29	0.101	15
	1957	$475	11	0.098	– 4
	1958	$692	14	0.136	39
	1959	$1,776	5	0.330	142
	1960	$3,010	24	0.539	64
	1961	$5,462	– 1	0.891	65
	1962	$10,236	81	1.576	77
	1963	$20,349	– 10	2.908	84
	1964	$27,915	55	3.897	34
	1965	$28,246	17	3.850	– 1
Social Services	1951	$161		0.027	
	1952	$162	0.3	0.025	– 7
	1953	$165	2	0.029	18
	1954	\$163	– 1	0.036	21

Table 5 (continued)

Budget category	Year	Constant dollars		Percent of budget	
		Value	Annual percent change	Value	Annual percent change
	1955	$220	35	0.053	48
	1956	$284	29	0.063	18
	1957	$317	11	0.065	4
	1958	$361	14	0.071	9
	1959	$379	5	0.070	−1
	1960	$471	24	0.084	20
	1961	$465	−1	0.076	−10
	1962	$841	81	0.130	71
	1963	$759	−10	0.109	−16
	1964	$1,177	55	0.164	51
	1965	$5,083	332	0.693	322
	1966	$9,547	88	1.132	63
	1967	$11,186	17	1.192	5
Social Security	1947	$13,347		4.326	
	1948	$13,576	2	5.247	21
	1949	$13,993	3	4.705	−10
	1950	$17,469	25	4.442	−6
	1951	$23,887	37	3.957	−11
	1952	$26,478	11	4.084	3
	1953	$29,650	12	5.279	29
	1954	$32,941	11	7.183	36
	1955	$35,895	9	8.594	20
	1956	$43,856	22	9.636	12
	1957	$45,338	3	9.309	−3
	1958	$51,845	14	10.189	9
	1959	452,633	2	9.766	−4
	1960	$65,600	25	11.754	20
	1961	$73,128	11	11.935	2
	1962	$73,489	0.5	11.316	−5
	1963	$83,108	13	11.876	5
	1964	$94,439	14	13.183	11
	1965	$94,987	1	12.947	−2
	1966	$105,698	11	12.528	−3
	1967	$131,339	24	13.992	12
	1968	$130,637	−1	13.804	−1
	1969	$146,684	12	15.303	11
	1970	$161,927	10	16.740	9
	1971	$165,922	2	16.850	1
	1972	$175,924	6	16.801	−0.3
	1973	$193,540	10	17.145	2
	1974	$210,288	9	17.599	3
	1975	$220,271	5	16.109	−8

Table 5 (continued)

Budget category	Year	Constant dollars		Percent of budget	
		Value	Annual percent change	Value	Annual percent change
	1976	$218,356	− 1	17.209	7
	1977	$233,916	7	17.018	− 1
	1978	$241,887	3	17.469	3
	1979	$255,159	5	17.746	2
	1980	$269,975	6	18.094	2
	1981	$281,809	4	17.840	− 1
	1982	$290,078	3	17.498	− 2
	1983	$323,748	12	18.125	4
	1984	$328,367	1	18.041	− 0.5
	1985	$351,551	7	17.608	− 2
	1986	$371,496	6	18.815	7
	1987	$382,010	3	19.275	2
	1988	$421,161	10	20.545	7
	1989	$447,267	6	21.071	3
	1990	$464,576	4	21.414	2
	1991	$474,839	2	21.737	2
	1992	$481,199	1	21.197	− 2
	1993	$488,177	1	21.453	1
	1994	$511,661	5	22.468	5
	1995	$527,626	3	22.926	2
	1996	$544,278	3	23.296	2
	1997	$573,574	5	23.706	2
	1998	$607,257	6	24.347	3
	1999	$644,911	6	24.870	2
	2000	$688,991	7	25.735	3
	2001	$715,306	4	25.465	− 1
	2002	$725,487	1	24.842	− 2
	2003	$729,567	1	23.812	− 4
	2004	$730,440	0.1	23.212	− 3
	2005	$763,067	4	23.269	0.2
	2006	$784,638	3	22.911	− 2
	2007	$798,003	2	23.273	2
	2008	$812,247	2	22.310	− 4
International Development and Humanitarian Assistance	1949	$211		0.071	
	1950	$1,926	813	0.490	591
	1951	$2,801	45	0.464	− 5
	1952	$6,687	139	1.031	122
	1953	$12,712	90	2.263	119
	1954	$6,876	− 46	1.499	− 34
	1955	$10,344	50	2.476	65
	1956	$11,688	13	2.568	4

Table 6 Replication of Table 2 with alternative cutoff values for trending series

Trending for three years or more?	Growing or declining	Number of observations	Percent of observations (%)	Length (median)	Annual change (median) (%)	Cumulative change (median) (%)
Part A. Three-year trends						
Yes	Growing	2,010	54.34	5	6.98	82.50
Yes	Declining	882	23.84	4	−6.28	−31.70
Yes	Subtotal	2,892	78.18			
No	Growing	355	9.60	1	14.61	27.60
No	Declining	452	12.22	1	−11.91	−19.70
No	Subtotal	807	21.82			
Total		3699	100.00			
Part B. Five-year trends						
Yes	Growing	1571	42.47	7	6.51	120.70
Yes	Declining	346	9.35	7	−6.08	−48.95
Yes	Subtotal	1917	51.82			
No	Growing	794	21.47	2	11.57	36.70
No	Declining	988	26.71	2	−8.65	−22.65
No	Subtotal	1782	48.18			
Total		3699	100.00			
Part C. Six-year trends						
Yes	Growing	1421	38.42	8	6.50	149.00
Yes	Declining	286	7.73	7	−5.89	−50.15
Yes	Subtotal	1707	46.15			
No	Growing	944	25.52	2	10.42	37.55
No	Declining	1048	28.33	2	−8.65	−23.45
No	Subtotal	1992	53.85			
Total		3699	100.00			

Changes in annual values vs. changes in annual budget shares

We use percent changes in value rather than changes in "share" in the main text of the paper. This can be an important distinction because if the entire budget increases by a large percent in any particular year, then an increase by a smaller amount can lead to a reduction in the share of the annual budget. Similarly in a year of decline, a smaller decline than average would be an increase in share. Our complementary analysis of changes in share is for theoretical reasons (we believe it has merit in reflecting budgetary choices and priorities made by policymakers by normalizing for policy drift or changes in the overall size of government), but our results are robust to either methodology.

Table 7 replicates Table 2 in the main text using percent changes in values rather than percent changes in shares.

Similar to the results showed in Table 5, changing the definition of a trend makes some small differences in the results. We see 61% of all series appearing as part of a trend, rather than 65% as in the main text. However, the differences are small.

Figure 5 is perhaps a more important test, replicating Fig. 1 in the text using changes in values rather than changes in shares.

Figure 5 shows very similar results to Fig. 1 in the main text, indicating no substantive differences in interpretation from using shares or values of annual budgets in calculating percentage change values. Note that the N’s are slightly different in this presentation, as some series continue as “trends” when calculated as percent change in values, but not when calculated as percent change in series as in the main text. However, these differences are small.

Figure 6 replicates Fig. 2 in the same manner.

As in the previous figure, differences here suggest no change in the substantive interpretation of the results compared to the data presented in the main text. In this presentation, there are more series, because many series continue in the same direction when considered by values, but not when considered as shares. Because of this difference, a larger number of trends last much less. The maximum length when considered by shares is 21 years, with just 10 series lasting 15 years or longer. When looking at values, the longest trend lasts 61 years, and 24 trends last 15 years or longer. The overall cumulative change from beginning to end of these series is therefore greater. However, the signature finding of high kurtosis remains no matter if we look at values or shares of the budget, and the overall shape of the distributions are very similar.

Extensions of Figs. 3 and 4

Figure 3 in the main text included only growing trends (lasting 4 years or more), and Fig. 4 included declining trends, with the same format. Figures 7 and 8 replicate these Figures but show all series, including series not lasting long enough to be called part of a trend.

Figure 3 was limited to 202 growing trends of four years or more. Expanding the analysis to all growing series, Fig. 7 shows little difference. Whereas Fig. 3 showed a high concentration of change coming from just a few series (21% of the series generating 80% of the change; 2.5% generating 50% of the change; and 0.5% generating 20% of the change), the corresponding values for Fig. 7 are 9.1, 0.7, and 0.2% of the series generating 80, 50, and 20% of the

Table 7 Replication of Table 2 with Percent Changes in Share rather than Percent Changes in Value

Trending for four years or more?	Growing or declining	Number of observations	Percent of observations (%)	Length (median)	Annual change (median) (%)	Cumulative change (median) (%)
Yes	Growing	1,044	28.2	5	6.9	78.5
Yes	Declining	1,225	33.1	5	−6.1	−42.4
Yes	Subtotal	2,269	61.3			
No	Growing	718	19.4	2	10.9	22.3
No	Declining	712	19.3	2	−8.8	−19.90
No	Subtotal	1,430	38.7			
Total		3,699	100.0			

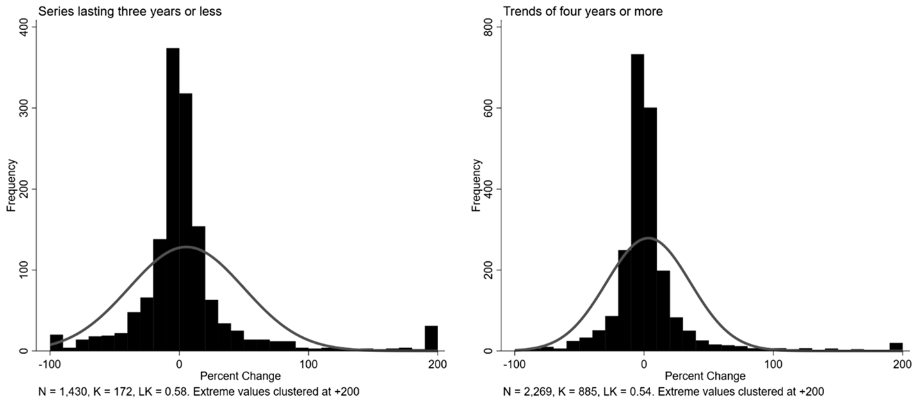

Fig. 5 Replication of Fig. 1 using percent changes in shares rather than percent changes in values

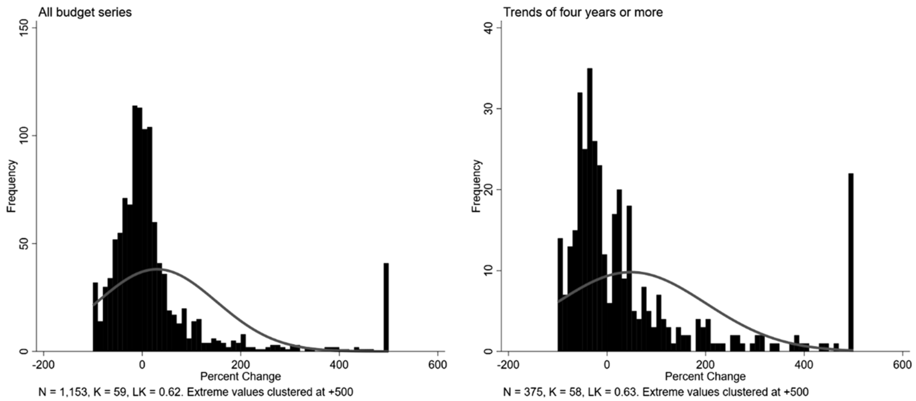

Fig. 6 Replication of Fig. 2 using percent changes in shares rather than percent changes in values

change. This suggests that addition of more than 200 additional observations only adds to the remarkable concentration in overall changes coming from a small share of the series.

Figure 4 was limited to 109 declining series lasting four years or more. Figure 8 shows all declining series, no matter the length, and shows little difference from Fig. 4; as with Fig. 7, the revised data in Fig. 8 show a slightly higher degree of concentration than what was shown in the main text.

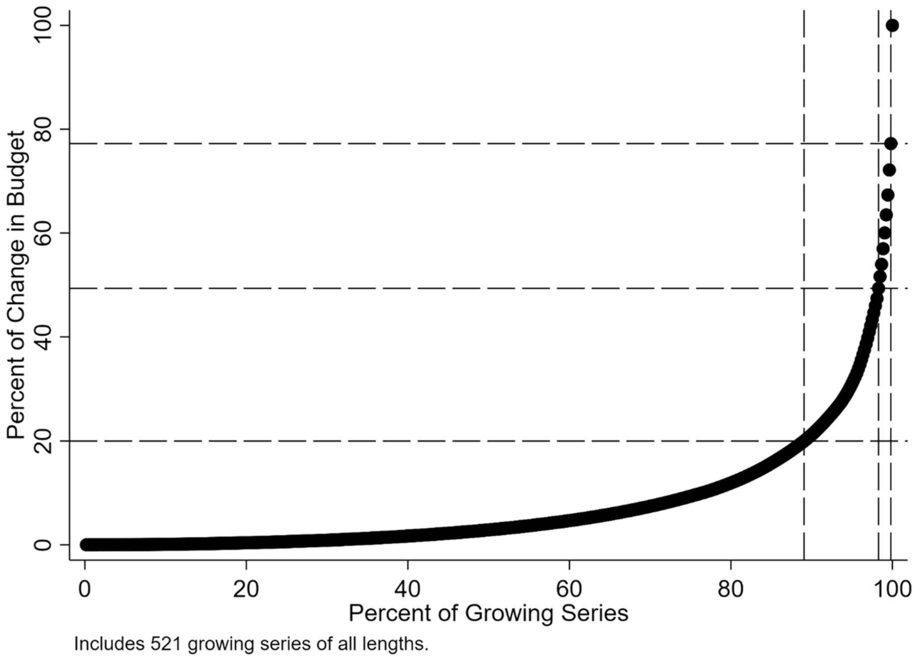

Fig. 7 Replication of Fig. 3 for all growing series

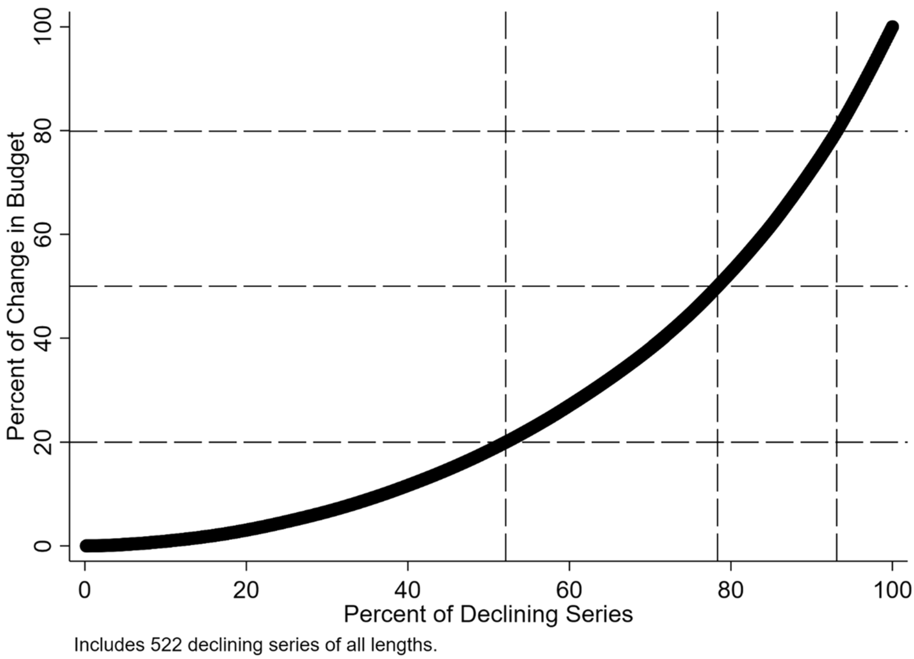

Fig. 8 Replication of Fig. 4 for all declining series

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Declarations

Competing interests The authors declare none.

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