

Supplementary Material:

Why we should use the Gini coefficient to assess punctuated equilibrium theory

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1 Relevance of L-Kurtosis in the Literature

We conducted a thorough literature review to gauge the relevance of the different measures used in PET research. We used a list of PET articles provided by Kuhlmann and van der Heijden (2018) as a starting point and added other relevant or newer research papers to it. The final list includes 66 papers with a quantitative assessment of PET published from 2005 until 2020. While the list gives a good overview, we do not claim it to be exhaustive. All papers were screened in regards to their measurement approach. Of the 66 identified articles 49 use the (L-)Kurtosis in some way. Of those, 31 mainly rely on the (L-)Kurtosis to support their findings, 19 combine or discuss it with other measures of punctuation. Table 1 gives an aggregated overview of all measures used. Table 2 lists all articles in detail.

Measurement approach	Number of Papers
(L-)Kurtosis	31
Multiple, including (L-)Kurtosis	19
Log-log & semi-log plots	1
Quantile regression	2
Split into categories, superimposed normal	8
Variance and degrees of freedom	1
Other	5
Total	67
Using (L-)Kurtosis	49

Table 1: Measurements used in PET research since 2005 counted by the number of papers

Thus, although there have been other measures (Breunig and Jones, 2011) and identification strategies (Fatke, 2020) proposed the dominating measure in PET research is still the (L-)Kurtosis. Another strand of the literature has moved to use multivariate analysis mostly by superimposing a normal distribution upon the change values and splitting the observations into different categories (e.g. Flink, 2017, Flink and Robinson, 2020). Instead of trying to identify general change patterns this strand of the literature is more interested in explaining what exactly leads to observed change events. Of the 67 papers identified, 30 at least once use a sample size below 250, where we identified significant divergence in the precision of G and τ_4 . Of this 30 at least 14 rely on sample sizes below 100.

	Title	Author(s)	Journal	Year	Measurement
1	A model of choice for public policy	Jones, Baumgartner	Journal of Public Administration Research and Theory	2005	(L-)Kurtosis
2	Policy Punctuations in Danish Local Budgeting	Mortensen	Public Administration	2005	Multiple, including (L-)Kurtosis
3	Comparative studies of policy agendas	Baumgartner, Green-Pedersen, Jones	Journal of European Public Policy	2006	(L-)Kurtosis ¹
4	Punctuated Equilibrium in French Budgeting Processes	Baumgartner, Foucault, Francois	Journal of European Public Policy	2006	(L-)Kurtosis
5	The more things change, the more they stay the same: A comparative analysis of budget punctuations	Breunig	Journal of European Public Policy	2006	(L-)Kurtosis
6	Explaining policy change: the impact of the media, public opinion and political violence on urban budgets in England	John	Journal of European Public Policy	2006	Multiple, including (L-)Kurtosis
7	Public Expenditures in the UK: How Measures Matter	Soroka, Wlezien, McLean	Journal of the Royal Statistical Society	2006	(L-)Kurtosis
8	Punctuated Equilibrium and Congressional Budgeting	Robinson, Caver	Political Research Quarterly	2006	(L-)Kurtosis
9	Patterns of Change in the Use of Imprisonment in the American States: An Integration of Path Dependence, Punctuated Equilibrium and Policy Design Approaches	Schneider	Political Research Quarterly	2006	Multiple, including (L-)Kurtosis
10	Punctuated equilibria and budgets in the American States	Breunig, Koski	Policy Studies Journal	2006	(L-)Kurtosis

¹Introduction article without empirical application but reference to (L-)Kurtosis (leptokurtic change patterns).

11	Explaining policy punctuations: Bureaucratization and budget change	Robinson, Caver, Meier, O'Toole	American Journal of Political Science	2007	Split into categories, superimposed normal
12	Noah and Joseph Effects in Government Budgets: Analyzing Long-Term Memory	Jones, Breunig	Policy Studies Journal	2007	Multiple, including (L-)Kurtosis
13	Political Attention in a coalition system: Analysing Queen's Speeches in the Netherlands 1945-2007	Breeman, Lowery, Poppleaars, Resodihardjo, Timmermans, de Vries	Acta Politica	2009	Multiple, including (L-)Kurtosis
14	Punctuated Equilibrium in Comparative Perspective	Baumgartner, Breunig, Green-Pedersen, Jones, Mortensen, Nuytemans, Walgrave	American Journal of Political Science	2009	Multiple, including (L-)Kurtosis
15	The dynamics of political attention: public opinion and the Queen's Speech in the United Kingdom	Jennings, John	American Journal of Political Science	2009	Multiple, including (L-)Kurtosis
16	A General Empirical Law of Public Budgets: A Comparative Analysis	Jones, Baumgartner, Breunig, Wlezien, Soroka, Foucault, François, Green-Pedersen, Koski, John, Mortensen, Varone, Walgrave	American Journal of Political Science	2009	Multiple, including (L-)Kurtosis

17	Punctuated budgets and governors' institutional powers	Breunig, Koski	American Politics Research	2009	(L-)Kurtosis
18	Friction and Party Manifesto Change in 25 countries (1945-1988)	Walgrave, Nuytemans	Journal of European Public Policy	2009	(L-)Kurtosis
19	Policy Punctuations in Mature Welfare States	Jensen	Journal of Public Policy	2009	(L-)Kurtosis
20	Political Attention and Public Spending in the United States	Mortensen	Policy Studies Journal	2009	Split into categories
21	Exploring the Factors for Budget Stability and Punctuations: A Preliminary Analysis of State Government Sub-Functional Expenditures	Ryu	Policy Studies Journal	2009	(L-)Kurtosis
22	Punctuations and Turning Points in British Politics? The Policy Agenda of the Queen's Speech, 1940-2005	John, Jennings	British Journal of Political Science	2010	Multiple, including (L-)Kurtosis
23	Why are policy agendas punctuated? Friction and cascading in parliament and mass media in Belgium	Walgrave, Vlieghe, thart	Journal of European Public Policy	2010	(L-)Kurtosis
24	Stability and Punctuations in Public Spending: A Comparative Study of Budget Functions	Breunig, Koski, Mortensen	Journal of Public Administration Research and Theory	2010	(L-)Kurtosis
25	Incrementalism in Appropriations: Small Aggregation, Big Changes	Anderson, Harbridge	Public Administration Review	2010	Other
26	Reduction, Stasis, and Expansion of Budgets in Advanced Democracies	Breunig	Comparative Political Studies	2011	Quantile regression
27	Stochastic Process Methods with an Application to Budgetary Data	Breunig, Jones	Political Analysis	2011	Multiple, including (L-)Kurtosis

28	Combining Incrementalism and Exogenous Factors in Analyzing National Budgeting: An Application to Spain	Caamano-Alegre, Lagos-Penas	Public Finance Review	2011	Multiple, including (L-)Kurtosis
29	From There to Here: Punctuated Equilibrium to the General Punctuation Thesis to a Theory of Government Information Processing	Jones, Baumgartner	Policy Studies Journal	2012	Discusses (L-)Kurtosis as one measures of punctuations.
30	When do new issues appear? Punctuations in the Belgian Executive Agenda	Van Assche	Acta Politica	2012	Multiple, including (L-)Kurtosis
31	Policy punctuations and issue diversity on the European Council agenda	Alexandrova, Carammia, Timmermans	Policy Studies Journal	2012	Multiple, including (L-)Kurtosis
32	The tortoise or the hare? Incrementalism, punctuations, and their consequences	Breunig, Koski	Policy Studies Journal	2012	(L-)Kurtosis
33	What are policy punctuations? Large changes in the Agenda of the UK Government	John, Bevan	Policy Studies Journal	2012	Other
34	Rural and regional policy: A case of punctuated incrementalism?	Cockfield, Botterill	Australian Journal of Public Administration	2013	Other
35	Representation, Agendas and Institutions	Bevan, Jennings	European Journal of Political Research	2013	(L-)Kurtosis
36	EU Budgetary Dynamics: Incremental or Punctuated Equilibrium?	Citi	Journal of European Public Policy	2013	Multiple, including (L-)Kurtosis
37	MP's Issue Attention in Parliament: Evidence of a Stick-Slip Process of Attention Allocation in the French National Assembly	Brouard	Journal of Legislative Studies	2013	(L-)Kurtosis
38	Newspaper attention and policy activities in Spain.	Chaqués-Bonafont, Baumgartner	Journal of Public Policy	2013	Other

39	Punctuated Equilibrium and the Supreme Court	Robinson	Policy Studies Journal	2013	Multiple, including (L-)Kurtosis
40	Effects of political institutions on punctuated-equilibrium in local emergency management policy processes: Examination of county governments in Florida	Kwon, Choi, Bai	U.S. Lex Localis	2013	(L-)Kurtosis
41	Stability and change in US city policymaking: evidence and a path forward	Sapotichne, Johnson, Park	Joshua Sapotichne, Megan Johnson & Young-Shin Park	2013	(L-)Kurtosis
42	Organizational History and Budgetary Punctuation	Robinson, Flink, King	Journal of Public Administration Research and Theory	2014	Split into categories, superimposed normal
43	How Authoritarianism Intensifies Punctuated Equilibrium: The Dynamics of Policy Attention in Hong Kong	Lam, Chan	Governance	2014	(L-)Kurtosis
44	Two faces of media attention: media storms vs. general coverage	Boydston, Hardy, Walgrave	Political Communication	2014	(L-)Kurtosis
45	Point Predictions and the Punctuated Equilibrium Theory: A Data Mining Approach—U.S. Nuclear Policy as Proof of Concept	Hegelich, Fraune, Knollmann	Policy Studies Journal	2015	Other
46	Punctuated Equilibrium Theory: An Empirical Investigation of Its Relevance for Global Health Expenditure	Martin, Streams	Public Budgeting and Finance	2015	(L-)Kurtosis
47	Punctuated Equilibrium and the Information Disadvantage of Authoritarianism: Evidence from the People's Republic of China	Chan, Zhao	Policy Studies Journal	2016	(L-)Kurtosis
48	Agenda instability in Pennsylvania politics: Lessons for future replication	Mallinson	Research & Politics	2016	(L-)Kurtosis

49	Is Morality Policy Different? Testing Sectoral and Institutional Explanations of Policy Change	Hurka, Adam, Knill	Policy Studies Journal	2017	log-log and semi-log plots
50	Budgetary change in authoritarian and democratic regimes	Baumgartner, Carammia, Epp, Noble, Rey, Yildirim	Journal of European Public Policy	2017	(L-)Kurtosis
51	Complexity, Capacity, and Budget Punctuations	Epp, Baumgartner	Policy Studies Journal	2017	Multiple, including (L-)Kurtosis
52	Representative systems and policy punctuations	Fagan, Jones, Wlezien	Journal of European Policy	2017	(L-)Kurtosis
53	Rethinking Punctuated Equilibrium Theory: A Public Administration Approach to Budgetary Changes	Flink	Policy Studies Journal	2017	Split into categories, superimposed normal
54	Ordering Chaos: The Performance Consequences of Budgetary Changes	Flink	Journal of Public Administration Research and Theory	2017	Split into categories, superimposed normal
55	Punctuated equilibrium in democracy and autocracy: an analysis of Hungarian budgeting between 1868 and 2013	Sebök, Berki	European Political Science Review	2018	(L-)Kurtosis
56	Stability and change in international policy-making: A punctuated equilibrium approach	Lundgren, Squatrito, Tallberg	Review of International Organizations	2018	(L-)Kurtosis
57	Copping Off and Bottoming Out: Setting Budget Priorities Through Executive Power	Breunig	Policy Studies Journal	2018	Quantile regression
58	Wars, presidents, and punctuated equilibriums in US defense spending	Sharp	Policy Sciences	2019	(L-)Kurtosis

59	Punctuated equilibrium or incrementalism in policymaking: What we can and cannot learn from the distribution of policy changes	Desmarais	Research & Politics	2019	(L-)Kurtosis
60	Nepalese Budgetary Dynamics: Following Incrementalism or Punctuated Equilibrium	Guragain, Lim	Public Organization Review	2019	Multiple, including (L-)Kurtosis
61	A Comparative Test of the Punctuated Equilibrium Theory: Policy Punctuations in Tobacco Control	Vannoni	Journal of Comparative Policy Analysis: Research and Practice	2019	Multiple, including (L-)Kurtosis
62	Talk is not cheap: Policy agendas, information processing, and the unusually proportional nature of European Central Bank communications policy responses	Cross, Greene	Governance	2019	(L-)Kurtosis
63	Predicting budgetary change: The effect of performance gaps	Flink	Journal of Public Administration Research and Theory	2019	Split into categories, superimposed normal
64	Budgetary Punctuations: A Fiscal Management Perspective	Xiao, Wang, Liu	Policy Studies Journal	2020	(L-)Kurtosis
65	Punctuated Equilibrium and Bureaucratic Autonomy in American City Governments	Park, Sapotichne	Policy Studies Journal	2020	Split into categories, superimposed normal
66	Systemic Dynamics of Policy Change: Overcoming Some Blind Spots of Punctuated Equilibrium Theory	Fernández-i-Marín, Hurka, Knill, Steinebach	Policy Studies Journal	2020	Variance and degrees of freedom
67	Corrective policy reactions: positive and negative budgetary punctuations	Flink, Robinson	Journal of Public Policy	2020	Split into categories, superimposed normal

Table 2: List of quantitative PET articles identified

2 L-Kurtosis and Gini: Empirical data

2.1 Bootstrap on US Budget Outlays

Additional to the simulated results, we also tested the measures on empirical data. For this we relied on the data on US budget outlays collected by the Comparative Agendas Project (Jones et al., 2009). We use the version provided by (Fatke et al., 2019). Instead of simulating different draws from the same underlying distribution, we rely on a bootstrap procedure to estimate the precision of the G and τ_4 . We drew 10,000 samples with replacement from the data and calculated G and τ_4 for each sample. The resulting density distributions of the measures can be seen in Figure A1. The lines mark the values for the full distribution which are $G = 0.82$ and $\tau_4 = 0.57$.

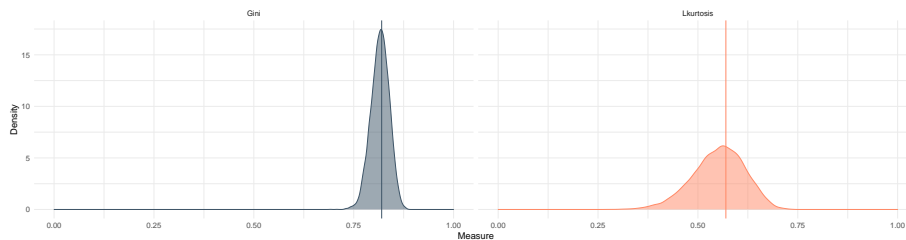


Figure A1: Density distributions of Gini coefficient (G) and L-kurtosis (τ_4) retrieved from bootstrap procedure ($n=10,000$) on US budget outlays.

The results show that G is superior when it comes to precision in this empirical example. With a standard deviation of $SD_G = 0.02$ versus a $SD_{\tau_4} = 0.07$ and coefficients of variation of $CV_G = 0.03$ and $CV_{\tau_4} = 0.12^2$. Thus, in this example, the difference in precision between the two values is more severe than in our simulated example in the main text. We fixed the seeds between both simulations so we can calculate the correlation between the two measures which is roughly $p = 0.9$. One concern when using G is that it is calculated based on absolute values. We tested if this affects the results retrieved by splitting

²When taking the log outlays for calculating the change values the difference is slightly smaller, with G still being twice as precise.

the data into positive and negative values and calculating G separately. We included the zeros in the calculation of the negative values. This resulted in $G_{positive} = 0.75$ and $G_{negative} = 0.92$. When calculating the weighted average, and rounding it to two digits $G = 0.82$, which is identical to the result retrieved when taking the absolute values and calculating G directly.

2.2 Example for possible Type I error caused by imprecision

As shown in the main text, the imprecision of τ_4 can be detrimental when assessing hypotheses. This is also true for empirical data. We show it for a comparative case by replicating the results from Lundgren, Squarito, and Tallberg (2018). Lundgren and colleagues assess the hypotheses that higher levels of institutional friction result in higher degrees of punctuation by comparing five different IOs with varying levels of friction. They calculate τ_4 for the change rate values of policy attention to assess their hypothesis. The calculated values of τ_4 vary from 0.26 to 0.31.

Figure A2 shows the corresponding density distribution of the change rate values, the corresponding Lorenz curves, and the calculation for G and τ_4 against the level of friction as identified by Lundgren et al. (2018). While Lundgren and colleagues conclude that there is a connection between friction and punctuation, the results from G show a different picture. This has two reasons. First off, the underlying distributions of the five different IOs are all rather similar. This can be seen in the density distributions and especially in the Lorenz curves. The difference between the lowest and the highest value of τ_4 is only 0.05. Given the imprecision we identified, we would argue that differences of this magnitude in τ_4 are not suited to make statements about the degrees of punctuation between these distributions. Second, looking at the density distribution τ_4 may underestimate the punctuation of the EU. The density distribution shows a clear bump between 1 and 2, therefore, in change events in the magnitude of 100% to 200% difference to the previous observation period. This is not captured by τ_4 . Fur-

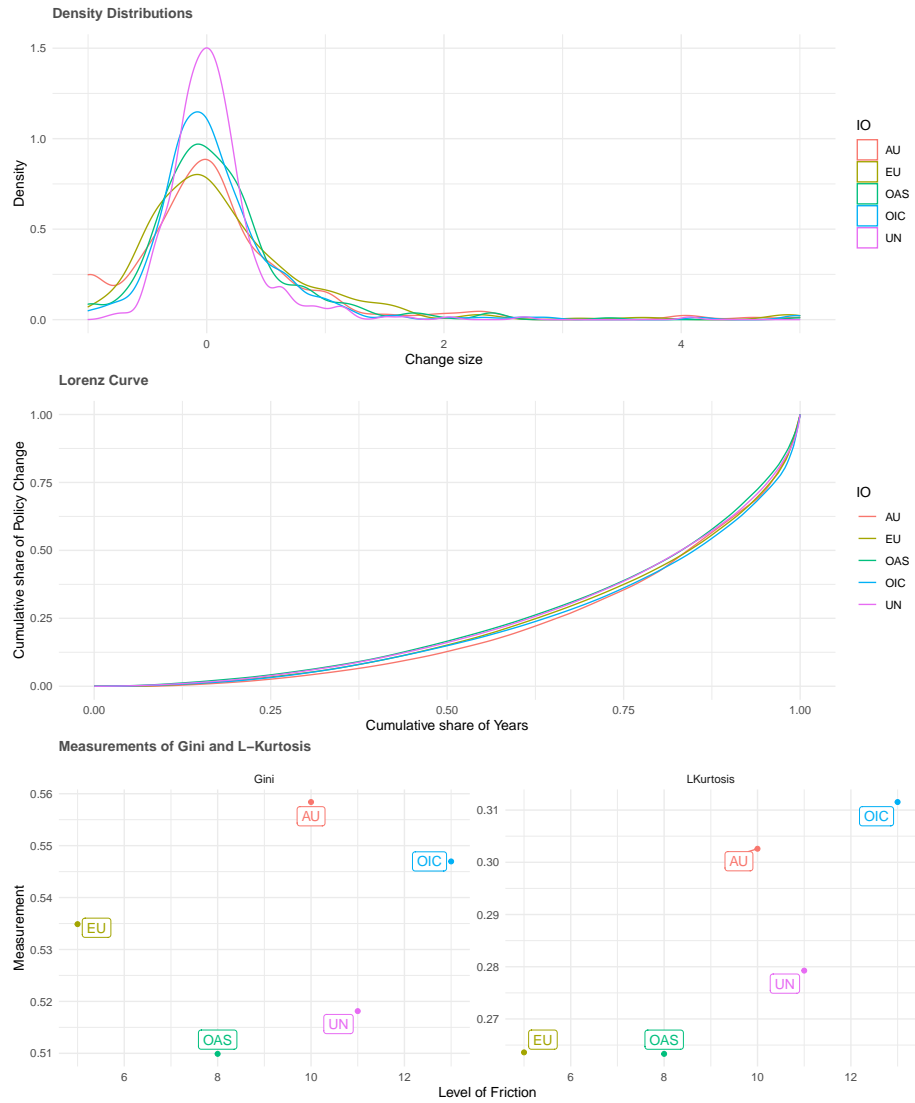


Figure A2: Top: Density distribution of policy attention change rates of 5 IOs based on data from Lundgren et al. (2018). Middle: Lorenz Curve of cumulative share of Policy Change events against cumulative share of years. Bottom: Gini coefficient (G) and L-Kurtosis (τ_4) against levels of friction

thermore, we can see that the Lorenz curve of the EU is more concave than the one of the OAS and the UN. Given the higher precision we identified when comparing G to τ_4 , we would argue that the finding presented by Lundgren et al. could be a result of a Type I error caused by the lack of precision of τ_4 .

3 L-Kurtosis and Gini: Type II errors

Type II errors are hard to define in PET research since there is no defined bound when a distribution is *not* punctuated or how different distributions have to be to possess different levels of punctuation. Again we turn to the t-distribution to give an approximation of how prone the measures are to Type II errors. The t-distribution creates a density distribution similar to a normal distribution, but with more observations in the tails and thinner shoulders. How *punctuated* the t-distribution is, depends on the degrees of freedom (DF) of the distribution (Fernández-i-Marín et al., 2019). Lower DF form a more punctuated shape, with rising DF the t-distribution converges towards a normal distribution. A threshold of 30 is often implied as the point, where the distributions become practically identical. Therefore, to give an approximation of Type II error we employ a similar simulation strategy as before. Instead of varying the sample size, we vary the DF of a t-distribution. Again, we use the same rejection criterion as before – we would reject H_0 if the value of a distribution is 0.05 higher than the *true* value. We simulate 1,000 draws with a sample size of 250 from a t-distribution for each degree of freedom between 2 and 30 and calculate both measures. Figure A3 shows how often in percent a researcher would reject H_0 under the given rejection criterion.

Unsurprisingly the rejection rate of τ_4 is higher than for the G . This shows, that the decision between G and τ_4 is also dependent on what kind of error is worse given the research context. Although there are certain scenarios where Type II errors are preferred to Type I errors, for example in certain medical tests, we would argue that in a social science context it is advisable trying to reduce Type I errors.

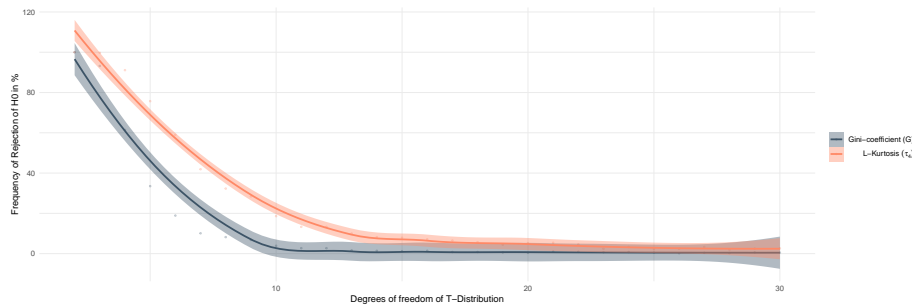


Figure A3: Type II error rate in percent against degrees of freedom of t-distribution. Simulated data: 1,000 draws $n=250$ from t-distribution with varying degrees of freedom. Line: LOESS with 95% CI

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