Power Laws in Government Budgeting

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Policy Agendas Project
www.policyagendas.org

• Supported (sometimes) by NSF since 1994
• Allows analysis and distribution of datasets on many types of governmental activities from 1947 to present
• All data today from this source

• Major long-term collaborator: Bryan D. Jones of University of Texas, Austin
Pesticides: Looking good after World War Two

Media Coverage of Pesticides, 1900-1990

Number of Stories / Percent Positive Tone

Year

1900 1920 1940 1960 1980

100 80 60 40 20 0

Total Coverage

Percent Positive

100 80 60 40 20 0
Pesticides: No longer such good news after 1956

Media Coverage of Pesticides, 1900-1990

Year

1900 1920 1940 1960 1980

Total Coverage

Percent Positive

Graph showing media coverage of pesticides from 1900 to 1990.
Pesticides: From green revolution to nobody’s baby

Media Coverage of Pesticides, 1900-1990

Year

1900 1920 1940 1960 1980

Number of Stories / Percent Positive Tone

0 20 40 60 80 100

Total Coverage

Percent Positive
The problem of attention scarcity

- "Prime Minister’s portfolio": everything imaginable
- Division of labor allows governments to do many things simultaneously, unlike individuals
- However, high-level attention remains scarce
  - Prime Minister’s time
  - Space on Page One of newspapers, TV, radio
  - Election platforms of parties and candidates
  - Public concern

- Most policies, most of the time: continue the status quo while attention focuses on more urgent priorities
- Any policy, occasionally: a crisis
A threshold model of attention

• Threshold of “urgency”
  – Determined by space, how many problems can be on the agenda, and competition, how many other problems are already there

• Below the threshold: Under-response
  – No reason to call into question dominant paradigm
  – Status quo policy rubber-stamped
  – Only marginal responses to emerging trends in the severity of underlying problems

• Expectation: Stability, hyper-incrementalism
A threshold model of attention

- Over the threshold: “Alarmed discovery”
  - SQ policy obviously demands reconsideration
  - Core policy assumptions may be challenged
  - “Issue-definitions” can be revised dramatically
    - Pesticides example from above
    - Death penalty: from morality to innocence, DNA, errors
  - Among experts, previously dominant coalition may be discredited, challengers may gain power, credibility
  - No clarity on how rapidly to adjust, but clear need to “do something”
  - Tendency to over-respond
Disproportionality of Inputs to Outputs

• When a crisis does occur, how much of a response is enough?
• Current fiscal crisis is a great example, but it is not uncommon
• Often, it is completely unclear how much one might want to “respond” to some new signal

• Recent example: pornography “scandal” at NSF leads a Member of Congress to propose $1.5B reduction in budget. Why in billions rather than in millions???
Bounded Rationality

• These ideas of disproportionality should be quite general to many kinds of human decision-making.

• However, they should not apply to “simple” decisions.

• Where is the boundary between simple and complex?

• Government decision-making is clearly well beyond this threshold, and that is our focus.
Some Data

• US Federal Budget, 1800 to Present (one observation per year)
• US Federal Budget, 1947 to present (62 categories of spending, so about 3,000 observations)
• Similarly organized datasets for other systems
  – National-level systems
  – US States
  – Municipalities
  – School Districts in Texas
  – Municipal governments in Benin, national government in South Africa, other developing countries
The US Government, 1801-2000

Figure 2.1. US Federal Budget Outlays, Annually from 1801 to 2000 (log scale). Data are corrected for inflation and show a 13,000-fold increase over time.
The US Budget since 1800: A High-Cost Policy Process

Figure 12.6. Annual change in Real US Budget Outlays, 1800-1994.
Figure 2.7. Annual Percent Changes in Budget Outlays, 1800 to 1988.
Because the reasons for under-and over-reactions to signals have to do with bounded rationality, these patterns should obtain wherever complex decisions are being made.

(So any government, even any large organization of any type, should show it, as long as the environment is poorly understood)
A General Empirical Law of Public Budgets: A Comparative Analysis

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Frank R. Baumgartner, Pennsylvania State University
Christian Breunig, Toronto University
Christopher Wlezien, Temple University
Stuart Soroka, McGill University
Martial Foucault, University of Montreal
Abel François, École Nationale des Télécommunications
Christoffer Green-Pedersen, University of Aarhus
Chris Koske, James Madison University
Peter John, University of Manchester
Peter B. Mortensen, University of Aarhus
Frédéric Varone, University of Geneva
Stefaan Walgrave, University of Antwerp

(Forthcoming, October 2009, American Journal of Political Science)
UK, Denmark, Canada, Belgium

Cumulative Frequency Distribution

Midpoint of Budget Categories

Cumulative Frequencies

Midpoints of Budget Change Categories

Positive Tail
Negative Tail
Regression Fits

Plot 1 Regr

Midpoint of Proportion Budget Change

Cumulative Frequencies

Midpoint of Budget Categories

Right Tail
Left Tail (reversed)
Regression Fits
Institutional Design Adds Greater or Lesser Amounts of “Friction”
The Progressive Friction Hypothesis

Decision-making processes that have higher “friction” (e.g., decision-making costs) should produce distributions with progressively higher kurtosis.

Assume Gaussian inputs.

If Outputs are not transformed, they will be Gaussian as well.

The more the transformation, the more extreme the output distribution.
Punctuated Equilibrium in Comparative Perspective

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(Forthcoming July 2009, American Journal of Political Science)
US, Belgium Denmark

I. Input Series (lowest friction)

- Elections, President (US)
- Elections, House (US)
- Elections, Senate (US)
- *New York Times* stories (US)
- Elections, Parliament (DK)
- Radio News (DK)
- Elections, Parliament (B)
- Demonstrations (B)
- Newspaper stories (B)
- TV Coverage (B)
II. Policymaking Processes
(Higher decision costs, more friction)

US: Bill introductions, hearings, executive orders, CQ stories, laws

Denmark: Questions to Minister, parliamentary interpretations, parliamentary proposals, bills, laws

Belgium: Party platforms, government agreements, bills, parliamentary interpretations, executive orders, laws
III. Policy Outputs

(Highest friction expected)

US: total annual outlays, budget changes by 62 categories (data previously shown)

Denmark: appropriations, outlays

Belgium: budgets

L–kurtosis = 0.3
Progressive Institutional Friction in
Three Countries

![Bar chart showing average L-kurtosis for inputs, policy processes, and budgetary outcomes in the United States, Belgium, and Denmark.](chart.png)
## Elections, laws, and budgets in the US (left), Belgium and DK (right)

### Inputs

<table>
<thead>
<tr>
<th>Log Probability</th>
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<tbody>
<tr>
<td>$\beta_{pos} = -1.77$</td>
<td>$\beta_{neg} = -1.68$</td>
<td>$\beta_{pos} = -1.36$</td>
</tr>
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<td>$R^2 = 0.81$</td>
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### Policy Processes

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### Budgetary Outcomes

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<tr>
<td>$\beta_{pos} = -1.12$</td>
<td>$\beta_{neg} = -1.36$</td>
<td>$\beta_{pos} = -0.72$</td>
</tr>
<tr>
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### Log of Change

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$R^2$ values indicate the proportion of variance in the dependent variable that can be explained by the independent variables.
A Preliminary Model

\[ R_t = \beta S_t \quad \text{if} \quad S_t + \sum_{0<k} S_0 > C; \quad \text{otherwise} \quad R_t = \lambda S_t \]

Where: \( R_t \) = Response ; \( S_t \) = Input signal

The parameters:

\( C = \) Threshold \((0 < C > 1)\)
\( \lambda = \) friction \((0 < \lambda > 1)\)
\( \beta = \) amplification \((0 < \beta > 1)\)

\( 0 < t > k \) (time varies from zero to \( k \))
\( S_t = N(0,1) \) (inputs are standard normal)
Sample Model Results

Response:
\[ C = 3, \lambda = 0.4, \beta = 1. \]
\[ K = 370.89 \]

Signal:
\[ K = 2.998 \]
Extending this simple model

Work with Bryan D. Jones, U Texas, Austin; Péter Érdi Kalamazoo College Center for Complex Systems Studies and Hungarian Academy of Science; and László Zalányi, Hungarian Academy of Science

Problems (some already fixed):
Left and right tails not symmetrical
“Acceleration” parameter tends to be greater than merely the accumulated signal
(That is, the simulations never produce enough extreme values)
Model improvements

Different thresholds for negative and positive

Two positive thresholds, with a higher acceleration parameter above the second threshold.

Thresholds themselves can be made random, to avoid abrupt breaks in the simulated outputs

Some results:
Fitting a simulation to the US data

Upper: Gaussian inputs and the 3 thresholds as vertical bars
Lower: Actual US budget distribution (green), simulated data (red bars)
Fitting to the French Data

Upper: Gaussian inputs and the 3 thresholds as vertical bars
Lower: Actual French budget distribution (green), simulated data (red bars)
Government Budgets as Power Laws

Seems a general rule
Seems due to bounded rationality, complexity
Not clear what is the combination of:
a) Friction, or status-quo bias
b) Cascades, mimicking, or preferential attachment that leads to the fat tails
What is the line between simple and complex in human decision-making?

Can we design institutions that are more efficient? Do we want to?

Can we get direct measurements of decision making costs?

Why do budgets produce power laws but virtually all other distributions are less extreme?
Questions, Comments welcome

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