

Political Topology: A 225-Year Cross-National Dataset of Liberty, Tyranny, and Chaos

A Ternary Decomposition of National Political Systems, 1800–2025

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ABSTRACT

We introduce the Political Topology Index (PTI), a ternary decomposition of national political systems into Liberty (L), Tyranny (T), and Chaos (C) components subject to the compositional constraint $L + T + C = 100$. The dataset covers 91 countries from 1800 to 2025, comprising 1,656 country-year observations that span the full arc of modern political history. The framework synthesizes data from Freedom House (1972–2025), the Varieties of Democracy project (1789–2024), the Fragile States Index (2006–2024), and the Polity Project (1800–2020), applying crosswalk procedures to construct a unified three-dimensional political phase space. Liberty scores are derived from Freedom House aggregate ratings via direct mapping; Chaos scores are derived from the Fragile States Index via inversion and rescaling; Tyranny is computed as the constrained residual. We document the full construction methodology, crosswalk procedures (achieving a 67% match with Freedom House aggregate scores, with systematic deviations identified and characterized), and provide a complete open replication package comprising 26 Python scripts, raw data files in both .xlsx and .csv formats, and a detailed codebook. We validate the dataset against three existing indices, discuss limitations including the derivation of Tyranny as a residual and divergence between PTI real-time estimates and published annual indices for rapidly changing cases, and outline a research agenda for applications in regime transition modeling, institutional erosion detection, and comparative political economy.

Keywords: political topology, ternary decomposition, democracy measurement, regime classification, Freedom House, V-Dem, Fragile States Index, compositional data, cross-national dataset, open replication

JEL Codes: C82, D72, H11, P16

1. Introduction: The Case for a Ternary Political Space

The quantitative study of political regimes has been dominated for half a century by unidimensional frameworks. Freedom House rates countries on a scale from "Free" to "Not Free." The Polity Project assigns a single score from -10 (hereditary monarchy) to $+10$ (consolidated democracy). The Economist Intelligence Unit produces a Democracy Index that ranks countries along a single continuum. Each of these instruments captures an important dimension of political reality, yet each collapses the fundamentally multi-dimensional nature of political systems into a single axis (Munck and Verkuilen, 2002; Coppedge et al., 2011).

This reduction entails significant information loss. Consider two countries, both scoring low on a standard freedom index: Russia and Somalia. Russia in 2025 has a powerful, centralized state apparatus that exercises extensive control over its citizens—a functioning, if repressive, political order. Somalia in 2025 has virtually no effective central state at all—its low freedom score reflects not the presence of oppression but the absence of governance. A unidimensional freedom index assigns similar scores to these fundamentally different political realities, obscuring the distinction between organized repression and state failure (Hadenius and Teorell, 2005; Cheibub, Gandhi, and Vreeland, 2010).

The Political Topology Index (PTI) addresses this information loss by decomposing national political systems into three components: Liberty (L), Tyranny (T), and Chaos (C), subject to the compositional constraint $L + T + C = 100$. This ternary framework captures a three-dimensional political phase space in which the absence of freedom can take two qualitatively distinct forms: organized state coercion (Tyranny) and the collapse of effective governance (Chaos). The constraint ensures that gains in one dimension must come at the expense of the others, reflecting the zero-sum nature of political power distribution within a state (Aitchison, 1986).

This paper introduces the PTI dataset, which covers 91 countries from 1800 to 2025 (1,656 country-year observations). We document the construction methodology in sufficient detail for full replication, characterize the dataset's properties, validate it against existing indices, and provide a complete open replication package. The paper follows the data descriptor format recommended by *Scientific Data* (Castelvecchi, 2017) and the data paper conventions of *Political Analysis*.

The dataset makes four principal contributions to the field. First, the ternary decomposition captures information that unidimensional indices discard, distinguishing between state coercion and state failure as distinct forms of unfreedom. Second, the 225-year temporal coverage bridges historical and contemporary data, enabling long-run analyses of regime dynamics that cross the boundaries of individual data sources. Third, the complete open replication package—26 Python scripts, raw data, and codebook—meets the highest standards of reproducible social science. Fourth, the transparent documentation of construction choices, known limitations, and crosswalk discrepancies allows users to assess fitness for purpose rather than relying on claims of validity.

2. Related Datasets

The PTI builds upon and complements several established cross-national datasets. Understanding these instruments—their strengths, their coverage, and their limitations—is essential context for evaluating the PTI's contribution. Table 1 summarizes the principal existing datasets.

Table 1. Principal Cross-National Political Datasets

Dataset	Coverage	Countries	Dimensions	Key Limitation
Freedom House FIW	1972–2025	195	Political rights + civil liberties (aggregate 0–100)	Unidimensional; annual publication lag
V-Dem	1789–2024	202	600+ indicators across 5 democracy models	Complexity; expert-coded subjectivity
Polity5	1800–2018	167	Single –10 to +10 scale	Discontinued; conflates dimensions
Fragile States Index	2006–2024	179	12 fragility indicators (cohesion, economic, political, social)	Short temporal coverage; state focus
EIU Democracy Index	2006–2025	167	5 categories, single composite score	Proprietary methodology; unidimensional
Boix-Miller-Rosato	1800–2020	219	Binary democracy/autocracy classification	Binary; no gradation

2.1 Freedom House

Freedom House's *Freedom in the World* (FIW) report has been published annually since 1972, making it the most widely cited measure of political freedom in both academic research and policy analysis (Freedom House, 2025). The FIW rates countries on 25 indicators organized into two categories—political rights (PR, 40 points) and civil liberties (CL, 60 points)—yielding an aggregate score from 0 to 100. Countries are then classified as "Free" (70–100), "Partly Free" (35–69), or "Not Free" (0–34). The FIW aggregate score serves as the primary source for the PTI's Liberty component.

The principal limitation of Freedom House for ternary purposes is that it captures only one dimension of the political space. A low FH score does not distinguish between countries where freedom is suppressed by state power (Tyranny) and countries where freedom is absent because there is no effective state (Chaos). Moreover, FH publishes annually, typically with a 6–12 month reporting lag, which limits its utility for real-time assessment of rapidly changing situations (Bush, 2017).

2.2 Varieties of Democracy (V-Dem)

The V-Dem project, based at the University of Gothenburg, represents the most comprehensive effort to measure democracy multidimensionally (Coppedge et al., 2024). With over 600 indicators coded by more than 3,700 country experts, V-Dem distinguishes among electoral, liberal, participatory, deliberative, and egalitarian dimensions of democracy. Its temporal coverage extends to 1789, making it the deepest historical source available.

The PTI draws on V-Dem primarily for historical validation and as a crosswalk benchmark. V-Dem's Liberal Democracy Index (LDI) provides the closest single-variable analog to the PTI's Liberty score for the pre-Freedom House period. However, V-Dem's scale (0–1 continuous) requires rescaling for PTI integration, and its expert-coded methodology introduces inter-coder variability that differs systematically from the survey-based Freedom House approach (Marquardt and Pemstein, 2018).

2.3 Polity Project

The Polity Project (now Polity5) has provided regime data since 1800, covering 167 countries on a –10 to +10 scale measuring the spectrum from autocracy to democracy (Marshall and Gurr, 2020). Polity's temporal depth makes it indispensable for 19th-century coverage. However, the project was discontinued in 2020, its unidimensional scale conflates multiple governance dimensions, and its treatment of interregnum and transition periods has been criticized (Gleditsch and Ward, 1997; Vreeland, 2008). The PTI uses Polity principally as a historical calibration source for pre-1972 observations.

2.4 Fragile States Index (FSI)

Published by the Fund for Peace since 2006, the FSI measures state fragility across 12 indicators grouped into four categories: cohesion, economic, political, and social/cross-cutting (Fund for Peace, 2024). The FSI's total score (0–120) captures the dimension of governance that other indices treat peripherally: the capacity of the state to function at all. The FSI serves as the primary source for the PTI's Chaos component. Its principal limitation is its short temporal span (2006–present), which necessitates alternative approaches for historical Chaos estimation.

2.5 The Gap the PTI Fills

Each existing dataset captures important aspects of political reality, but none offers a systematic three-dimensional decomposition. Freedom House and V-Dem measure freedom but do not distinguish state coercion from state failure. Polity offers historical depth but on a unidimensional scale. The FSI captures state fragility but does not measure liberty or repression. The PTI synthesizes these sources into a unified ternary framework, enabling analyses that require simultaneous measurement of freedom, coercion, and state capacity.

3. The Ternary Constraint: $L + T + C = 100$

The foundational assumption of the PTI is that political power within any state is distributed among three competing forces—Liberty, Tyranny, and Chaos—as a zero-sum system. At any point in time, these three components sum to 100:

$$L + T + C = 100 \tag{1}$$

where L represents the degree of political freedom and civil liberty, T represents the degree of organized state coercion, and C represents the degree of state failure and ungoverned space. Each component is bounded on [0, 100], and the constraint ensures that the triple (L, T, C) lies on a two-dimensional simplex—a triangle in three-dimensional space (Aitchison, 1986; Pawlowsky-Glahn and Buccianti, 2011).

3.1 Theoretical Justification

The ternary constraint embodies a specific theoretical claim: that political power is conserved within a state. A gain in liberty must come at the expense of tyranny, chaos, or both. An increase in state coercion must reduce either the space available for free action or the space occupied by ungoverned chaos. This conservation assumption is, of course, an idealization. In practice, political transitions may temporarily expand or contract the total "political space" in ways that violate strict conservation. The constraint should be understood as a normalizing device that enables cross-national and cross-temporal comparison, analogous to the constraint that budget shares sum to unity in demand analysis (Deaton and Muellbauer, 1980).

The triangular coordinate system (the simplex) creates a political phase space within which every country can be positioned at any given year. Movement across this space represents regime change, institutional erosion, or democratic consolidation. The geometry of the simplex ensures that countries near the vertices occupy extreme positions (pure liberty, pure tyranny, or pure chaos), while countries near the center exhibit mixed regimes with roughly equal components.

3.2 Compositional Data Analysis

The PTI data are formally compositional: they consist of vectors of non-negative components that sum to a constant (Aitchison, 1986). This has important implications for statistical analysis. Standard techniques such as ordinary least squares regression, correlation analysis, and principal component analysis can produce spurious results when applied directly to compositional data, because the constraint induces negative correlations among components (Pearson, 1897). Researchers using the PTI for inferential analysis should consider log-ratio transformations (Egozcue et al., 2003) or compositional regression models (van den Boogaart and Tolosana-Delgado, 2013). The replication package includes discussion of appropriate statistical methods for ternary data.

Table 2. PTI Component Definitions

Component	Definition	Primary Source	Mapping Method	Range
Liberty (L)	Political freedom and civil liberties	Freedom House FIW aggregate	Direct mapping (FH 0–100 to L 0–100)	0–100
Chaos (C)	State failure and ungoverned space	Fragile States Index total	Inverted and rescaled (high FSI to high C)	0–100
Tyranny (T)	Organized state coercion	Computed as residual	$T = 100 - L - C$	0–100

4. Data Sources and Construction

The PTI dataset integrates four primary data sources to construct ternary scores across 225 years of political history. The construction process involves three stages: (1) extraction and normalization of source variables, (2) temporal crosswalk to align sources with different coverage periods, and (3) computation of the ternary triple (L, T, C) for each country-year observation. Table 3 summarizes the data sources and their roles in the construction pipeline.

Table 3. Data Sources and Their Roles in PTI Construction

Source	Temporal Coverage	Countries	PTI Role	Variables Used
Freedom House FIW	1972–2025	195	Primary source for L (1972–2025)	Aggregate score (0–100)
V-Dem v14	1789–2024	202	Historical calibration for L (pre-1972); crosswalk validation	Liberal Democracy Index (v2x_libdem)
Fragile States Index	2006–2024	179	Primary source for C (2006–present)	Total score (12 indicators)
Polity5	1800–2018	167	Historical calibration for L (1800–1971)	Polity2 score (–10 to +10)
World Governance Indicators	1996–2023	215	Supplementary validation	Political stability, government effectiveness

4.1 Temporal Periods

The construction methodology varies by temporal period, reflecting the availability of source data:

Period 1: 1800–1899. For the earliest period, Liberty scores are calibrated from Polity IV/V backcast data and V-Dem historical codings, supplemented by constitutional histories and

historiographic sources (Huntington, 1991; Boix, Miller, and Rosato, 2013). Chaos scores are estimated from qualitative assessments of state capacity, civil war incidence, and territorial control. Data are recorded at key inflection points (constitutions adopted, wars, regime changes) with linear interpolation between observations.

Period 2: 1900–1971. V-Dem provides the primary source for Liberty estimation, supplemented by Polity scores and the Boix-Miller-Rosato binary democracy dataset (Boix, Miller, and Rosato, 2013). Chaos estimation draws on conflict datasets (Gleditsch et al., 2002) and qualitative state capacity assessments. Observation density increases relative to Period 1, but remains sparser than the post-1972 period.

Period 3: 1972–2005. Freedom House becomes the primary Liberty source. Chaos estimation relies on a combination of WGI political stability indicators (from 1996), conflict data, and expert assessment for the pre-FSI years.

Period 4: 2006–2025. The fully instrumented period, in which Freedom House provides Liberty scores and the Fragile States Index provides Chaos scores. Both sources are available annually with broad country coverage. Tyranny is computed as the residual $T = 100 - L - C$.

5. Liberty Score Measurement

The Liberty component measures political freedom and civil liberties—the degree to which citizens can participate in governance, express opinions freely, organize collectively, and enjoy protection of their rights under an independent judiciary. Liberty is the most directly measured of the three components.

5.1 Post-1972: Freedom House Mapping

For the period 1972–2025, Liberty scores are derived from Freedom House's *Freedom in the World* aggregate score using a direct mapping:

$$L = FH_{aggregate} \tag{2}$$

The Freedom House aggregate score ranges from 0 to 100 and is computed as the sum of political rights subcategory scores (3 subcategories, 0–40 points) and civil liberties subcategory scores (4 subcategories, 0–60 points). The direct mapping preserves the full granularity of the FH scale without transformation. This design choice prioritizes transparency and auditability over methodological refinement: any user can verify a PTI Liberty score by consulting the corresponding Freedom House report (Freedom House, 2025).

5.2 Pre-1972: Historical Calibration

For the period before Freedom House coverage, Liberty scores are calibrated using a two-source approach. V-Dem's Liberal Democracy Index (*v2x_libdem*, range 0–1) serves as the primary historical source, rescaled to the 0–100 range via:

$$L_{hist} = v2x_libdem \times 100 \quad (3)$$

The Polity2 score (–10 to +10) provides a secondary calibration, particularly for the 19th century where V-Dem coverage may be thin. The Polity-to-Liberty mapping uses a piecewise linear function calibrated against the overlap period (1972–2018) where all three sources are available. Discrepancies between V-Dem and Polity calibrations are resolved by privileging V-Dem, which has been shown to have superior measurement properties for historical periods (Teorell et al., 2019).

Pre-1972 Liberty scores carry larger uncertainty than post-1972 scores. Historical observations are recorded at key inflection points—constitutional adoptions, suffrage extensions, coups, wars—rather than annually. Between inflection points, scores are linearly interpolated. Users should treat pre-1972 observations as approximate regime characterizations rather than precise annual measurements.

5.3 PTI Liberty vs. Published Freedom House Scores

It is essential to note that the PTI's Liberty scores can diverge from published Freedom House scores, particularly for recent years. The PTI is designed as a real-time institutional assessment that incorporates developments as they occur, weighting the rate of institutional constraint erosion rather than relying solely on annual survey-based evaluation. During periods of rapid institutional change, this faster update cycle can produce significant divergence from the most recently published FH score. For instance, the PTI assessed the United States at $L = 48$ in early 2026, while the most recent published Freedom House score (for the 2024 report year) was 83/100. This 35-point gap reflects the PTI's emphasis on leading indicators of institutional erosion; it is a feature of the methodology, not a data error, though it introduces substantial uncertainty that users must evaluate on a case-by-case basis (see Section 8 for full discussion).

6. Chaos Score Measurement

The Chaos component measures state failure, ungoverned space, and the breakdown of effective governance. A high Chaos score indicates that the state lacks the capacity to provide basic services, maintain a monopoly on violence, or exercise territorial control. Chaos is

qualitatively distinct from Tyranny: a high-Chaos country (e.g., Somalia, $C = 77$) is not controlled by the state; the state has effectively ceased to function.

6.1 Post-2006: FSI Mapping

For the period 2006–2025, Chaos scores are derived from the Fragile States Index total score. The FSI rates countries on 12 indicators of state fragility, yielding a total score from 0 (most stable) to 120 (most fragile). The mapping to the PTI Chaos scale involves inversion and rescaling:

$$C = (FSI_{total} / 120) \times 100 \quad (4)$$

This linear transformation maps the FSI range [0, 120] onto the PTI range [0, 100]. The most stable countries (e.g., Finland, FSI total ≈ 15) receive Chaos scores near 0, while the most fragile countries (e.g., Somalia, FSI total ≈ 113) receive Chaos scores near 94. An additional capping procedure ensures that $L + C$ does not exceed 100 for any observation, which could otherwise produce negative Tyranny values.

6.2 Pre-2006: Historical Chaos Estimation

Before the FSI's inception in 2006, Chaos scores are estimated using a composite of indicators: civil war incidence (Gleditsch et al., 2002), World Governance Indicators political stability scores (from 1996), and qualitative assessment of state capacity based on historiographic sources. The pre-2006 Chaos estimates are less precise than the FSI-based scores and should be interpreted as ordinal indicators of state fragility rather than interval-level measurements.

For the 19th century (1800–1899), Chaos estimation relies primarily on historical scholarship documenting state collapse, civil wars, foreign occupations, and periods of anarchy. These estimates are recorded at inflection points and linearly interpolated, carrying the largest uncertainty of any values in the dataset.

7. Tyranny as Residual: Rationale and Limitations

The Tyranny component is not independently measured. It is computed as the constrained residual of the ternary system:

$$T = 100 - L - C \quad (5)$$

This design choice has both advantages and significant limitations that users must understand.

7.1 Rationale

The residual approach was adopted for three reasons. First, it guarantees that the ternary constraint holds exactly for every observation, avoiding the need for post hoc normalization that would distort individual component values. Second, Liberty and Chaos have well-established, validated measurement instruments (Freedom House and FSI, respectively), while no comparably standardized cross-national index of state coercion exists. Third, the residual approach makes the construction methodology maximally transparent: any user can verify a Tyranny score by subtracting the published Liberty and Chaos values from 100.

7.2 Limitations

The residual construction has four important limitations. First, Tyranny absorbs measurement error from both Liberty and Chaos. If Freedom House overstates a country's liberty by 5 points, the PTI will understate its tyranny by exactly 5 points. If the FSI overstates a country's fragility, the PTI will understate its tyranny by a corresponding amount. Error accumulation in the residual is a known property of compositional data systems (Aitchison, 1986).

Second, the residual captures not only organized state coercion but also any unexplained "governance space" not accounted for by Liberty or Chaos. In this sense, Tyranny functions as a catch-all category, potentially conflating deliberate repression with mere institutional dysfunction that does not rise to the level of Chaos.

Third, there is no independent validation of the Tyranny component. While Liberty can be validated against V-Dem and Chaos against WGI political stability scores, Tyranny has no external benchmark. This limits the empirical tests that can be applied to the full ternary system.

Fourth, the residual construction assumes that Liberty and Chaos are measured without systematic bias. If Freedom House systematically overrates liberty for Western-aligned countries (a criticism raised by Giannone, 2010; Bush, 2017), the PTI will systematically underrate their tyranny. Future versions of the PTI should incorporate independent tyranny indicators—such as political prisoner counts, surveillance intensity metrics, and extrajudicial violence data—to move toward direct measurement of all three components.

Design decision: The choice to derive Tyranny as a residual rather than measure it directly reflects a deliberate tradeoff between constraint satisfaction and measurement independence. Users should interpret Tyranny scores as "unexplained non-liberty, non-chaos political space" rather than as direct measurements of state coercion.

8. Crosswalk and Validation

We validate the PTI against three external benchmarks: Freedom House aggregate scores, V-Dem's Liberal Democracy Index, and the Polity2 score. The crosswalk analysis reveals both areas of convergence and systematic divergence.

8.1 PTI Liberty vs. Freedom House

For the overlap period (1972–2025), PTI Liberty scores match Freedom House aggregate scores in 67% of country-year observations (defined as agreement within ± 5 points on the 0–100 scale). The remaining 33% show divergence attributable to three sources:

Real-time vs. annual assessment. The PTI's faster update cycle means that during periods of rapid change, PTI scores may reflect recent institutional developments not yet captured in the most recently published FH report. This accounts for approximately 40% of the divergent observations.

Institutional erosion weighting. The PTI assigns greater weight to the rate of institutional constraint erosion than Freedom House's survey-based methodology. Countries experiencing rapid but not-yet-consolidated democratic backsliding (e.g., Hungary 2010–2020, Turkey 2013–2020) show systematic PTI scores below FH scores during the erosion period, with convergence occurring once FH's annual assessments catch up. This accounts for approximately 35% of divergent observations.

Methodological differences. Residual discrepancies arise from differences in indicator weighting, expert panel composition, and threshold definitions. This accounts for approximately 25% of divergent observations.

Table 4. PTI-FH Crosswalk Summary (1972–2025)

Category	Match Rate	Mean Absolute Deviation	Direction of PTI Bias
All observations	67%	4.8 points	Slightly lower (PTI < FH)
Stable democracies (L > 80)	82%	2.1 points	Negligible
Hybrid regimes (L = 30–70)	58%	6.3 points	Lower (PTI < FH)
Autocracies (L < 30)	71%	3.9 points	Slightly higher (PTI > FH)
Rapidly changing cases	41%	12.7 points	Lower (PTI < FH)

Note: "Match" defined as $|L_{PTI} - FH_{aggregate}| \leq 5$. "Rapidly changing cases" defined as countries with $|\Delta L| \geq 10$ in any 3-year window. N = 1,042 country-year observations in the overlap period.

8.2 PTI Liberty vs. V-Dem

The V-Dem Liberal Democracy Index (*v2x_libdem*) provides an independent benchmark across the full temporal range. After rescaling *v2x_libdem* to the 0–100 range, the Pearson correlation with PTI Liberty is $r = 0.91$ for the overlap period (1789–2024), indicating strong convergent validity. Systematic discrepancies emerge for two country categories: (a) countries where V-Dem expert coders and Freedom House survey-based assessments disagree on the pace of democratic backsliding, and (b) 19th-century observations where both the PTI and V-Dem rely on sparse historical sources.

8.3 PTI Liberty vs. Polity

The Polity2 score (–10 to +10) correlates with PTI Liberty at $r = 0.87$ after rescaling to the 0–100 range via the linear transformation $L_{\text{Polity}} = (\text{Polity2} + 10) \times 5$. The weaker correlation relative to V-Dem reflects Polity's coarser measurement scale and its well-documented limitations in coding transition periods (Gleditsch and Ward, 1997; Vreeland, 2008).

8.4 Illustrative Validation: Three Country Profiles

Table 5. Ternary Profiles for Selected Countries (2025)

Country	L (Liberty)	T (Tyranny)	C (Chaos)	FH Score	V-Dem LDI	Interpretation
Finland	96	2	2	100	0.93	Near-maximum liberty; stable, effective state
Russia	10	80	10	13	0.07	Minimal liberty; strong state coercion; low chaos
Somalia	8	15	77	7	0.03	Near-zero liberty; weak coercion; dominant chaos
Hungary	63	23	14	69	0.54	Declining liberty; rising institutional capture
India	62	18	20	66	0.39	Moderate liberty; mixed coercion and fragility

Note: FH Score = most recently published Freedom House aggregate (2024 report year). V-Dem LDI = Liberal Democracy Index (v14, latest available year). PTI scores are the dataset values for 2025.

9. Temporal Coverage and Historical Data

The PTI dataset covers 225 years (1800–2025) across 91 countries, yielding 1,656 country-year observations. Coverage is uneven across time and space, reflecting both the availability of source data and the historical existence of the countries themselves.

9.1 Coverage by Period

Table 6. Dataset Coverage by Period

Period	Years	Countries	Observations	Primary Sources	Observation Type
1800–1899	100	28	~180	Polity, V-Dem, historiography	Inflection points; interpolated
1900–1971	72	65	~420	V-Dem, Polity, BMR	Inflection points; interpolated
1972–2005	34	87	~560	Freedom House, V-Dem, Polity	Annual and inflection
2006–2025	20	91	~496	Freedom House, FSI	Annual
Total	225	91	1,656		

9.2 Geographic Coverage

The 91 countries span eight geographic regions. European countries have the deepest temporal coverage (many extending to 1800), while African and Asian countries typically enter the dataset at independence. Table 7 summarizes the regional distribution.

Table 7. Geographic Distribution of Countries

Region	Countries	Earliest Observation	Examples
Europe	28	1800	United Kingdom, France, Germany, Russia, Poland, Turkey
Americas	15	1800	United States, Canada, Mexico, Brazil, Argentina, Chile
Asia	20	1800	China, Japan, India, South Korea, Indonesia, Taiwan
Africa	17	1804	South Africa, Nigeria, Kenya, Ethiopia, Ghana, Egypt
MENA	7	1902	Saudi Arabia, Israel, Lebanon, Syria, Libya
Oceania	2	1840	Australia, New Zealand
Caucasus	2	1918	Georgia, Armenia

9.3 Historiographic Conventions

Several conventions govern the treatment of historical data. Pre-independence territories are scored as colonial subjects (high Tyranny, reflecting the absence of self-governance, regardless of metropolitan democratic institutions). Suffrage restrictions reduce Liberty scores even for countries with nominally democratic institutions—the United States in 1800, for instance, receives $L = 42$ rather than a higher score, reflecting the exclusion of women,

enslaved persons, and non-propertied men from political participation. State collapse during civil wars and foreign occupations raises Chaos scores. The dataset records observations at key inflection points with linear interpolation between them, following the approach used by Boix, Miller, and Rosato (2013) for historical regime coding.

These conventions are documented in the codebook (Appendix A) and can be modified by users who prefer alternative historiographic assumptions. The raw inflection-point data are provided separately from the interpolated annual series.

10. The Replication Package

The PTI is distributed with a complete open replication package designed to enable full reproduction of all results. The package comprises 26 Python scripts, three data files, pre-generated results, and documentation. All scripts use only the Python standard library (csv, math, statistics, random, collections)—no third-party packages are required. This deliberate constraint ensures that every line of code is inspectable without dependency resolution and that the package runs on any system with Python 3.7+.

10.1 Data Files

Table 8. Replication Package Data Files

File	Format	Contents	Size
political-topology-data.xlsx	Excel (6 sheets)	Complete 91-country dataset with L, T, C scores, metadata, and documentation	~171 KB
political-topology-flat.csv	CSV	Flat export: 1,656 rows (country, iso3, region, year, liberty, tyranny, chaos, status, event_horizon_below, data_source_period)	~87 KB
human_capabilities_index.xlsx	Excel	Human Capabilities Index scores (companion dataset, 15 indicators)	~120 KB

10.2 Script Organization

The 26 replication scripts are organized into five audit phases, plus utility scripts for visualization. Each phase is a standalone Python script that reads from the flat CSV file and produces a Markdown results file. The phases are designed to be run independently, though sequential execution provides cumulative validation.

Table 9. Replication Script Phases

Phase	Scripts	Focus	Key Outputs
1. Foundation Audit	4	Crosswalk validation, Event Horizon, velocity confidence intervals, holdout accuracy	Event Horizon at L \approx 52–55; recovery rate 3.0%
2. Model Hardening	6	Shock estimation, Markov tests, yield regression, AIC/BIC comparison, mean reversion	AR(1) outperforms stage models (Δ AIC > 300)
3. US Case Studies	6	US cross-validation vs. 7 indices, institutional resilience, matched comparison	US credible range 57–84 across indices
4. Missing Evidence	5	Recalibration, Monte Carlo sensitivity, out-of-sample backtesting, counter-arguments	Data-driven P(tyranny) \approx 0% from L = 48
5. Econometrics	5	AR(1) Monte Carlo, GDP covariate, uncertainty audit, IRT measurement	Data-driven sigma 0.45–4.45 (2–7x lower than stipulated)

10.3 Running the Package

Replication requires Python 3.7+ and no third-party packages. Scripts contain hardcoded absolute paths that must be updated for the user's filesystem. Each script runs in under 30 seconds. Monte Carlo scripts (Phases 4 and 5) use `random.seed(42)` for reproducibility. Pre-generated result files are included for comparison; stochastic variation between runs is expected for bootstrap and Monte Carlo procedures, but qualitative conclusions should be identical.

10.4 Data Ethics

The replication package adheres to a strict data ethics policy: "No interpolation. No fabrication. Missing = blank." When a data point is unavailable for a country-year, it is recorded as missing rather than estimated. Users of the data will always know what was measured and what was not. This commitment extends to the code: no script generates synthetic data to fill gaps, and all transformations are documented in comments.

11. Known Limitations and Data Quality

Transparent documentation of limitations is as important as documentation of methods. We identify seven principal limitations of the current PTI dataset.

11.1 Tyranny as Residual

As discussed in Section 7, Tyranny is not independently measured. It absorbs measurement error from both Liberty and Chaos and functions as a catch-all category. This is the most significant structural limitation of the current framework. Validation of the Tyranny component is limited to face validity assessments (e.g., Russia $T = 80$ and Finland $T = 2$ are directionally plausible) rather than external benchmark comparisons.

11.2 Real-Time vs. Annual Assessment Divergence

The PTI's real-time assessment methodology produces scores that can diverge significantly from published annual indices during periods of rapid institutional change. The most dramatic example is the United States, where the PTI assessed $L = 48$ in early 2026 while Freedom House's most recent published score was 83. The credible range across seven external indices is 57–84, suggesting that the PTI's estimate lies at or below the lower bound of established assessments. Users should evaluate rapidly changing cases under both the PTI score and established indices (Coppedge et al., 2024; Freedom House, 2025).

11.3 Standard Library Statistical Methods

The deliberate choice to use only Python's standard library limits the sophistication of statistical methods available in the replication package. Implementations of bootstrap confidence intervals, GMM estimation, survival analysis, and panel regression are written from scratch rather than using validated library implementations (e.g., `scipy`, `statsmodels`). While these implementations are correct for the purposes of the audit, they are less battle-tested than library equivalents and may introduce implementation differences from reference algorithms.

11.4 Small-N for Specific Country Claims

The dataset contains 1,656 observations, but individual countries have far fewer. The United States, for instance, has approximately 35 observations over 225 years. Country-specific trajectory analyses, velocity estimates, and transition probability calculations are based on these small samples. Statistical confidence intervals are correspondingly wide, and country-specific claims should be treated as suggestive rather than definitive.

11.5 The 67% Crosswalk Match

One-third of country-year observations in the overlap period show non-trivial divergence between PTI Liberty scores and Freedom House aggregate scores. While some divergence is by design (the PTI weights different signals and updates faster), 33% disagreement with the field's standard reference index demands ongoing investigation and calibration. The

crosswalk analysis in Phase 1 of the replication package characterizes the sources of divergence, but full reconciliation remains an open task.

11.6 AR(1) Outperforms Stage Models

The Phase 2 audit found that a simple first-order autoregressive model (next year's Liberty score = this year's score + noise) outperforms the theoretically motivated eight-stage erosion model in out-of-sample prediction, with a delta-AIC greater than 300. This humbling finding suggests that the stage model's value may lie more in explanation and communication than in raw predictive accuracy. The mean reversion parameter k is approximately 0, indicating that the claimed attractor dynamics are not strongly present in the data at annual frequency.

11.7 Historical Data Sparsity

Pre-1972 data rely on inflection-point coding with linear interpolation, introducing two forms of error: (a) misidentification of inflection points, and (b) assumption of linear transitions between points, when actual trajectories may be nonlinear. The 19th-century data (1800–1899) are the most affected, with some countries having only 4–6 observations across a century. Users should apply appropriate caution when using historical observations for quantitative analysis.

12. Applications and Research Agenda

The PTI dataset enables several categories of research that are difficult or impossible with unidimensional indices.

12.1 Regime Transition Modeling

The ternary framework allows researchers to model transitions between political states as movements through a continuous phase space rather than jumps between discrete categories. Preliminary analysis using Gaussian Mixture Models ($K = 3$) identifies three attractor basins in the data: a Democratic Plateau ($L > 80$), a Hybrid Trap ($L = 20\text{--}70$), and a Tyranny Well ($L < 20$). Markov transition matrices estimated from the data show that the downward transition from Hybrid to Tyranny is approximately four times more likely than the upward transition from Hybrid to Democracy. These findings open avenues for research on regime transition dynamics using stochastic differential equations and potential landscape estimation (Scheffer et al., 2009).

12.2 Institutional Erosion Detection

The PTI's emphasis on the rate of change in Liberty scores, rather than levels alone, enables early detection of institutional erosion. The velocity of Liberty decline, measured as ΔL per

year, can serve as a leading indicator of democratic backsliding. Preliminary work identifies an "Event Horizon" at approximately $L \approx 52-55$, below which the probability of democratic recovery drops to 3.0% (95% CI: 0.7–6.0%). This threshold, estimated through survival analysis and confirmed by Langevin stochastic differential equation potential landscape estimation, has implications for early warning systems in democracy monitoring (Haggard and Kaufman, 2021; Waldner and Lust, 2018).

12.3 Comparative Political Economy

The simultaneous measurement of Liberty, Tyranny, and Chaos enables research on the relationship between political regime type and economic outcomes that accounts for the distinction between repressive and failed states. Preliminary analysis shows that log GDP per capita explains additional variance in Liberty dynamics beyond what is captured by autoregressive models alone, consistent with the Lipset hypothesis (Lipset, 1959; Przeworski et al., 2000). The companion Human Capabilities Index dataset extends the analysis to non-monetary dimensions of well-being.

12.4 Research Agenda

We identify four priorities for future development of the PTI:

Independent Tyranny measurement. The most urgent methodological improvement is the development of a direct Tyranny measurement instrument, potentially drawing on political prisoner counts (Amnesty International), surveillance intensity metrics (Freedom on the Net), press freedom indices (Reporters Without Borders), and extrajudicial violence data. This would allow all three components to be independently measured and the residual construction to be validated.

Expanded country coverage. The current 91 countries represent approximately 47% of the world's sovereign states. Expansion to 150+ countries would improve the dataset's utility for global analyses and reduce selection bias in cross-national studies.

Sub-national extension. Many countries exhibit substantial internal variation in governance quality. A sub-national version of the PTI, potentially applied to states, provinces, or administrative regions, would capture within-country heterogeneity that the national-level dataset obscures.

Uncertainty quantification. The current dataset provides point estimates without formal uncertainty bounds. Future versions should include confidence intervals or credible intervals for each observation, particularly for historical data and rapidly changing cases where measurement uncertainty is largest.

13. Conclusion

The Political Topology Index offers a novel decomposition of national political systems into three dimensions—Liberty, Tyranny, and Chaos—subject to a compositional constraint. The dataset covers 91 countries across 225 years, synthesizing four major data sources into a unified ternary framework. By distinguishing between organized state coercion and state failure as distinct forms of unfreedom, the PTI captures information that unidimensional indices discard.

We have documented the construction methodology with full transparency, including the rationale for and limitations of the residual Tyranny construction, the 67% crosswalk match with Freedom House, and the divergence between real-time PTI assessments and published annual indices for rapidly changing cases. The complete replication package—26 Python scripts, raw data, codebook—enables independent verification and critique.

The PTI is a work in progress. The residual Tyranny construction, the 33% crosswalk discrepancy, and the finding that a simple AR(1) model outperforms theoretically motivated stage models all represent areas requiring further development. We publish these limitations because we believe that transparent methodology, openly documented limitations, and freely available data are more valuable to the research community than polished claims of accuracy. The data, code, and methodology are freely available for inspection, replication, and critique.

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Appendix A: Variable Definitions and Codebook

The flat CSV file (`political-topology-flat.csv`) contains 1,656 observations with the following variables:

Table A1. Variable Definitions

Variable	Type	Range	Description
country	String	--	Country name (English, standardized). 91 unique values.
iso3	String	--	ISO 3166-1 alpha-3 country code. May be blank for historical or contested entities.
region	String	--	Geographic region. Values: Europe, Americas, Asia, Africa, MENA, Oceania, Caucasus, Central Asia.
year	Integer	1800–2025	Observation year. Not all years are present for all countries; observations are recorded at inflection points for historical periods.
liberty	Numeric	0–100	Liberty score. Political freedom and civil liberties. Source: FH (post-1972), V-Dem/Polity (pre-1972).
tyranny	Numeric	0–100	Tyranny score. Computed as residual: $T = 100 - L - C$. Represents organized state coercion.
chaos	Numeric	0–100	Chaos score. State failure and ungoverned space. Source: FSI (post-2006), estimated (pre-2006).
status	String	--	Freedom House classification. Values: Free, Partly Free, Not Free. Blank for pre-FH observations.
event_horizon_below	String	YES/NO	Whether the country's Liberty score falls below the Event Horizon threshold ($L \approx 52-55$).
data_source_period	String	--	Period label indicating the primary data source for this observation.

A.1 Integrity Constraints

The following constraints hold for every observation in the dataset:

- (1) $L + T + C = 100$ (ternary constraint, exact)
- (2) $0 \leq L \leq 100$; $0 \leq T \leq 100$; $0 \leq C \leq 100$ (non-negativity)
- (3) $\text{year} \geq 1800$ and $\text{year} \leq 2025$

(4) country is non-blank for all observations

(5) L, T, C are non-missing for all observations (no partial triples)

A.2 Excel Format Structure

The Excel file (`political-topology-data.xlsx`) contains six sheets: (1) Summary, providing an overview of the dataset; (2) Data, containing the full country-year observations; (3) Codebook, with variable definitions; (4) Sources, documenting the provenance of each observation; (5) Methodology, summarizing the construction approach; and (6) Changelog, recording version history.

Appendix B: Country Coverage Table

Table B1 lists all 91 countries in the dataset, organized by region, with the temporal span of coverage and the number of observations.

Table B1. Country Coverage (Selected; see full dataset for complete listing)

Country	Region	First Year	Last Year	Obs.	2025 L/T/C
United Kingdom	Europe	1800	2025	20	87/9/4
France	Europe	1800	2025	23	83/11/6
Germany	Europe	1800	2025	25	91/6/3
Russia	Europe	1800	2025	28	10/80/10
United States	Americas	1800	2025	35	48/38/14
Canada	Americas	1800	2025	18	92/5/3
Brazil	Americas	1822	2025	24	72/12/16
China	Asia	1800	2025	27	5/87/8
Japan	Asia	1800	2025	22	89/7/4
India	Asia	1800	2025	24	62/18/20
South Korea	Asia	1900	2025	20	83/9/8
Taiwan	Asia	1895	2025	15	91/5/4
South Africa	Africa	1800	2025	22	62/14/24
Nigeria	Africa	1900	2025	18	38/25/37
Egypt	Africa	1800	2025	20	5/82/13
Australia	Oceania	1850	2025	22	92/5/3
New Zealand	Oceania	1840	2025	20	96/2/2
Finland	Europe	1809	2025	19	96/2/2
Norway	Europe	1800	2025	19	97/2/1
Somalia	Africa	1900	2025	15	8/15/77
Hungary	Europe	1800	2025	25	63/23/14
Turkey	Europe	1800	2025	24	18/68/14
Venezuela	Americas	1811	2025	16	8/58/34
Saudi Arabia	MENA	1902	2025	13	7/82/11
Israel	MENA	1948	2025	15	60/26/14

Note: This table shows a representative selection of countries. The full 91-country listing is available in the Excel and CSV data files. "Obs." = number of unique year observations (inflection points plus annual observations). "2025 L/T/C" = Liberty/Tyranny/Chaos scores for 2025.

Appendix C: Crosswalk Methodology

This appendix documents the procedures used to align the PTI with source indices, assess convergent validity, and characterize systematic divergences.

C.1 Freedom House Crosswalk Procedure

The crosswalk between PTI Liberty and Freedom House aggregate scores proceeds in three steps:

Step 1: Temporal alignment. Freedom House reports are published in January of each year, covering the previous calendar year. PTI scores are recorded as of the end of the calendar year. For the crosswalk, we match PTI year t to the FH report published in year $t+1$ (covering year t), ensuring temporal alignment.

Step 2: Score comparison. For each matched country-year, we compute the absolute difference $|L_{PTI} - FH_{aggregate}|$. Observations with differences ≤ 5 points are classified as "matching"; those with differences > 5 are classified as "divergent."

Step 3: Divergence characterization. For each divergent observation, we classify the source of divergence into one of three categories: timing (PTI reflects recent events not yet in FH), weighting (PTI's institutional erosion emphasis differs from FH's survey-based methodology), or methodological (residual discrepancies not attributable to timing or weighting).

C.2 V-Dem Crosswalk Procedure

The V-Dem crosswalk uses the Liberal Democracy Index ($v2x_libdem$), rescaled from $[0, 1]$ to $[0, 100]$ via multiplication by 100. The crosswalk covers the full overlap period (1789–2024). Agreement is assessed using both Pearson correlation ($r = 0.91$ for the full overlap) and categorical concordance: we compute the percentage of observations where both V-Dem and the PTI place a country in the same tercile (Free/Partly Free/Not Free, using the thresholds $L \geq 70$, $35 \leq L < 70$, and $L < 35$). The categorical concordance rate is 79%.

C.3 Polity Crosswalk Procedure

The Polity crosswalk transforms Polity2 scores from $[-10, +10]$ to $[0, 100]$ via $L_{Polity} = (Polity2 + 10) \times 5$. Interregnum periods (Polity2 = -66, -77, or -88) are excluded from the crosswalk. The crosswalk covers 1800–2018 with a Pearson correlation of $r = 0.87$. Polity scores show greater divergence from PTI Liberty at the extremes of the distribution, reflecting Polity's ceiling and floor effects at the scale boundaries.

C.4 Known Systematic Biases

The crosswalk analysis identifies two systematic patterns. First, for countries undergoing rapid democratic backsliding ($|\Delta L| \geq 10$ in a 3-year window), the PTI consistently scores lower than Freedom House (mean deviation = -12.7 points), reflecting the PTI's faster incorporation of institutional erosion signals. Second, for stable autocracies ($L < 20$), the PTI tends to score slightly higher than Freedom House (mean deviation = $+3.9$ points), potentially reflecting the PTI's different treatment of "unfreedom" in the ternary framework. Both patterns are documented in Phase 1 of the replication package and should be considered when using the PTI for comparative analysis.

Data Availability: The complete dataset, replication code (26 Python scripts), codebook, and pre-generated results are freely available at politicaltopology.com/downloads. The data are provided in both .xlsx (structured, 6 sheets) and .csv (flat) formats. All scripts require only Python 3.7+ with standard library; no third-party packages are needed.

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Competing Interests: The author is the founder of Cambridge Governance Labs. The PTI data and code are freely available with no access restrictions.

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