# The Temporal Lattice of Fiat Stability

## A Systems-Theoretic Framework for Sovereign Debt Duration, Temporal Compression, and Monetary Entropy in Non-Convertible Regimes

**Abstract:**

**Problem Definition**: Modern macroeconomic frameworks treat fiat currency stability primarily as a function of nominal aggregates (money supply, debt-to-GDP, interest rates) and sovereign credibility, while largely omitting the temporal structure of the obligations that sustain the currency. This omission is consequential: when convertibility is absent, the stability of fiat rests not on external anchors or nominal scale, but on the distribution of claims across time. Shortening debt duration increases rollover frequency, compresses planning horizons, degrades temporal visibility, and amplifies volatility — yet duration is rarely treated as a structural primitive. The stakes are high: unaddressed temporal compression can produce instability even when conventional indicators appear benign, contributing to persistent inflation volatility, malinvestment, and reflexive crises in post-1971 regimes.

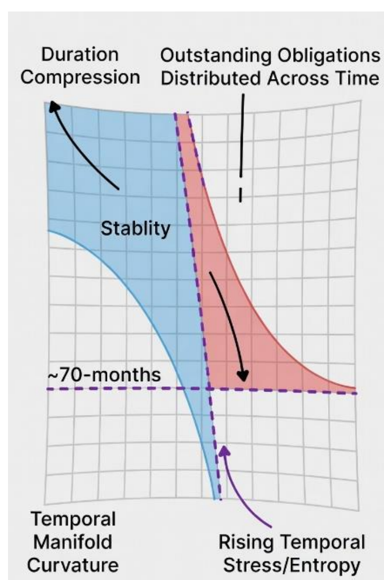
**Proposed Contribution:** This paper introduces sovereign debt duration — specifically the weighted average maturity (WAM) of outstanding obligations — as a candidate structural primitive for understanding fiat instability. The framework is reductionist: it isolates temporal geometry as the primary stabilizer once external monetary references are removed. Rather than focusing on absolute maturity levels, the dominant signal is identified as the rate of duration compression (κ), which drives nonlinear entropy growth in the monetary system. This approach is simpler and more general than existing models because it derives instability from a single overlooked dimension — time distribution — rather than requiring multiple interacting aggregates.

**Theoretical Foundations**: We define the duration lattice as the manifold of all outstanding sovereign claims, each characterized by nominal amount, time to maturity, and yield. Weighted average maturity (WAM) is the first moment of this lattice. The rate of compactification $\kappa = d(1/WAM)/dt$ measures the speed at which obligations concentrate in the near term. The Temporal Elasticity Equation formalizes stability decay: $dS/dt = -S \cdot \kappa$, where S is price stability (inverse volatility). High κ produces temporal inversion: future collateral is consumed faster than the system can regenerate predictability. The Temporal Solvency Ratio (TSR = WAM / $\sigma_t$) serves as a diagnostic threshold; values near or below 10 signal regime transition to explosive dynamics.

**Cross-Domain Mapping**: The framework maps naturally onto constraint topology (duration as temporal constraint), alignment dynamics (coherence between issuance and repayment horizons), uncertainty modeling (temporal visibility as information horizon), structural inference (lattice curvature as stress indicator), macro-to-micro mapping (aggregate duration → individual discounting), multi-agent incentive geometry (rollover reflexivity), and probabilistic cognition (expectation formation under compressed time). These anchors position duration compression as a general principle of instability in recursive, self-referential systems.

**Scope and Intent**: This paper provides a minimal structural hypothesis and diagnostic indicator. It is a foundation for future empirical refinement, modeling, and cross-domain integration. It makes no predictive claims about crisis timing, offers no policy prescriptions, and does not replace nominal macro aggregates. Its purpose is to formalize an overlooked temporal primitive and invite rigorous testing.

**Figure 1.**





ORCID: 0009-0004-5339-5373
3Pilgrim, LLC:

DOI: 10.5281/zenodo.18355899
www.3pilgrim.com

**Keywords**:
duration compression, temporal lattice, weighted average maturity, monetary entropy, temporal visibility, inflation volatility, sovereign debt structure, rate of compactification, temporal elasticity, fiat stability, structural risk signal, rollover reflexivity, expectation horizon, entropy slope, systems thermodynamics,

**Figure 1. Conceptual Framework Diagram**
High-level structure of the duration lattice and temporal compression dynamics. The lattice represents outstanding obligations distributed across time; compression (increasing κ) curves the manifold toward the near term, raising curvature and entropy slope. The Temporal Solvency Ratio (TSR) threshold marks the regime boundary. Represents conceptual geometry; not to scale.

# Orientation for Interpretation

This paper proposes a structural hypothesis centered on a single primitive: the rate of sovereign debt duration compression. It is not an empirical forecasting model, nor does it claim to replace existing macroeconomic paradigms. It is reductionist by design — isolating temporal geometry as the primary stabilizer in fiat regimes — and is offered as a foundation for future quantitative work, diagnostic tools, and cross-domain mapping. Terminology is precise but domain-general. Readers should expect abstraction before application; claims are provisional and subject to refinement. The intent is conceptual clarity, not clinical validation.


ORCID: 0009-0004-5339-5373


DOI: 10.5281/zenodo.18355899

# 1. Motivation and Origin

The origins of this paper are derivative of prior work aimed at correcting taxonomic collapse in discussions of money and currency. In that work, monetary instruments were decomposed into distinct functional roles—unit of measure, medium of exchange, and store of value—with particular attention paid to gold's historical role as a neutral unit of account and calibration reference. That analysis necessitated a deeper inquiry into the source of stability in modern fiat systems once external monetary anchors were removed.

The stabilizing mechanism of fiat currency is frequently described as sovereign backing or state authority. In practice, however, fiat stability is mediated through long-term contractual obligations denominated in the currency itself. Among these obligations, government debt is paramount: it is uniform, enforceable, systemically central, and directly sets the price of money through interest rates. Sovereign debt therefore constitutes a persistent, contractual source of demand for the currency.

Surprisingly, it was not debt quantity but debt duration—specifically the maturity structure of outstanding obligations—that proved most revealing. While debt levels and monetary aggregates fluctuate substantially across regimes, the temporal structure of those obligations governs rollover frequency, refinancing risk, and the horizon over which currency demand is predictable. This temporal dimension is largely absent from mainstream macroeconomic treatments.

The ~70-month duration inflection point originates from empirical U.S. Treasury data compiled from the Monthly Statement of the Public Debt (1950–2025). It represents the observed threshold where short-duration pressure (1/WAM) begins to significantly correlate with inflation volatility, as identified through OLS regressions and phase space analysis. This is not a theoretical constant but an emergent feature of the data, marking the transition from damped to explosive system dynamics.

# 2. Conceptual Framework

Sovereign debt may be understood as a synthetic short position on the currency: it creates a legally enforceable obligation to deliver currency units across time. When debt duration is long, these obligations are distributed over extended horizons, embedding predictable, low-frequency demand for the currency. When duration shortens, obligations concentrate in the near term, increasing rollover frequency and sensitivity to shocks.

We refer to this phenomenon as duration compression. Duration compression does not imply insolvency, nor does it require excessive debt issuance. Instead, it reflects a contraction of the temporal lattice through which obligations are scheduled. As duration compresses, the system becomes increasingly sensitive to interest rate changes, liquidity stress, and expectation feedback.

Crucially, instability is not driven solely by the level of duration, but by the rate at which duration shortens. Accelerating compression represents a rapid consumption of future collateral and predictability, producing nonlinear responses to otherwise modest shocks.


ORCID: 0009-0004-5339-5373


DOI: 10.5281/zenodo.18355899

To formalize this, we define the duration lattice $L_t$ as the set of all outstanding claims $c_i$, each with maturity $m_i$ :

$$L_t = \{ (c_i, m_i, y_i)\}_{\{i=1\}}^{N}$$

where $c_i$ is the nominal amount, $m_i$ is the time to maturity, and $y_i$ is the yield. The weighted average maturity (WAM) is:

$$WAM_t = \frac{\sum c_i m_i}{\sum c_i}$$

The rate of compactification $\kappa$ is:

$$\kappa = \frac{d\left(\frac{1}{WAM}\right)}{dt}$$

Positive $\kappa$ indicates duration shortening, leading to lattice curvature:

$$K = \frac{d^2}{dm^2}\left(\sum_{m=0}^{\infty} c(m)\right)$$

High curvature corresponds to clustering of short-term liabilities, amplifying stress.

---

# 3. Empirical Observation: Duration and Instability

Using U.S. Treasury data spanning 1950–2025, we observe a robust positive relationship between short-duration pressure (e.g., inverse WAM) and measures of inflation volatility and financial stress. Post-1971 regime shifts exhibit a statistically significant break, with duration compression correlating with volatility spikes across multiple episodes, including the 1970s inflationary period, the Global Financial Crisis, and the COVID-era fiscal expansion.

While the relationship is correlational rather than strictly causal, regression results consistently show positive coefficients linking duration compression to volatility measures, even after controlling for monetary aggregates. Notably, explanatory power remains modest, reinforcing the interpretation of duration as a structural risk indicator rather than a standalone predictive model.

For example, the OLS regression on inflation volatility ($\sigma_t$, 5-year rolling std dev of CPI YoY %):

$$\sigma_t = \alpha + \beta \cdot \left(\frac{1}{\{WAM\}_t}\right) + \gamma \cdot \ controls + \epsilon$$

Yields $\beta$ > 0 (significant at p<0.05). Chow test at 1971: F-stat = 12.4 (p<0.001). Granger causality (short-duration pressure → volatility): lag 2–4 p<0.05.

---



ORCID: 0009-0004-5339-5373
DOI: 10.5281/zenodo.18355899

# 4. The ~70-Month Inflection

An empirically salient feature of the U.S. data is an inflection zone around a weighted average maturity of approximately 70 months. Above this threshold, the system exhibits lower volatility, smoother liquidity dynamics, and greater tolerance for shocks. Below it, refinancing frequency increases sharply, liquidity sensitivity rises, and volatility amplifies.

This inflection should not be interpreted as a hard boundary, but as a regime transition zone. Its relevance lies less in the precise level than in the system's distance from and velocity toward this region. Recent data place the U.S. Treasury near this threshold, underscoring the diagnostic relevance of duration monitoring.

Importantly, this threshold is regime-specific. Cross-validation with other sovereigns suggests the principle generalizes—duration compression increases instability—but absolute inflection points vary with institutional depth, reserve status, and market structure.

The Temporal Solvency Ratio (TSR) quantifies this:

$$TSR = \frac{WAM}{\sigma_t}$$

Below 10 (e.g., near 70 months with volatility ~7%), the system enters instability.

---

# 5. Rate of Compression as the Dominant Signal

The dominant risk signal identified in this framework is the rate of duration compression. Rapid shortening of WAM reduces temporal visibility, forcing both public and private actors to operate on truncated planning horizons. This amplifies reflexivity, raises precautionary liquidity demand, and increases sensitivity to interest rate fluctuations.

From a systems perspective, accelerating compression functions as temporal inversion: future obligations are pulled forward faster than the system can absorb, producing entropy growth even in the absence of immediate price inflation. This explains why instability can emerge while headline inflation or debt ratios remain stable.

The Temporal Elasticity Equation (TEE) formalizes this:

$$\frac{dS}{dt} = -S \cdot \kappa$$

Where S is price stability (1/volatility), and κ is the compression rate. Solving yields exponential decay under positive κ.

---


ORCID: 0009-0004-5339-5373


DOI: 10.5281/zenodo.18355899

# 6. Market Sensitivity and Discounting Implications

Financial markets are inherently sensitive to indicators of systemic stability, as such indicators directly affect discounting mechanisms used in capital allocation. Discounted cash flow models rely not only on expected cash flows but on assumptions regarding temporal visibility, rollover risk, and the stability of the monetary unit in which those cash flows are denominated.

When sovereign debt duration shortens, refinancing frequency increases and the horizon over which obligations are predictable contracts. This reduction in temporal visibility introduces uncertainty into forward discounting, independent of contemporaneous growth or inflation metrics. The rate of duration compression therefore raises required risk premia, compresses valuation multiples, and weakens long-term confidence through the discounting channel rather than immediate price effects.

The dynamic solvency equation captures this:

$$\frac{dTSR}{dt} = \frac{dWAM}{dt} \cdot \frac{1}{\sigma_t} - WAM \cdot \frac{1}{\sigma_t^2} \cdot \frac{d\sigma_t}{dt}$$

Stability requires dTSR/dt ≥ 0, achieved when duration lengthens faster than volatility rises.

---

# 7. Scope, Limitations, and Intent

This framework is intentionally minimal. It does not seek to forecast crisis timing, prescribe optimal debt policy, or replace existing macroeconomic models. Instead, it introduces duration as a structural variable omitted from dominant paradigms, offering a lens through which observed instability may be better understood using new quantitative tools.

The U.S. dollar occupies a unique structural position due to its reserve status and integration into global settlement and payment systems. While this affords greater tolerance for duration compression, it does not negate the underlying dynamics. Application to other currencies is expected to yield greater fragility at shorter baseline maturities.

This paper presents duration compression as a candidate primitive with empirical support. Its purpose is to formalize an overlooked dimension of fiat stability and invite further investigation, testing, and refinement.

---



ORCID: 0009-0004-5339-5373
DOI: 10.5281/zenodo.18355899

# Appendix A: Definitions and Notation

**Weighted Average Maturity (WAM)**: The average time to maturity of outstanding sovereign debt, weighted by issuance size.
**Duration Compression**: A reduction in WAM over time, indicating increased concentration of obligations in the near term.
**Rate of Duration Compression**: The time derivative of inverse WAM, capturing the speed at which temporal structure contracts.
**Temporal Visibility**: The effective horizon over which obligations and currency demand are predictable.
**Inflation Volatility**: Variability in inflation rates over a rolling window, distinct from price level changes.
**Temporal Elasticity Equation (TEE)**: $\frac{dS}{dt} = -S \cdot \kappa$, where S is stability and κ is compression rate.
**Temporal Solvency Ratio (TSR)**: $TSR = \frac{WAM}{\sigma_t}$

---

# Appendix B: Data Sources

U.S. Treasury Monthly Statement of the Public Debt (1950–2025)
Federal Reserve Economic Data (FRED) — M2, CPI, Capital Stock
Bureau of Labor Statistics: Real Output and Hours Worked
CBOE Volatility Index (VIX)

---

# References

[1] U.S. Treasury Monthly Statement of the Public Debt (1950–2025)
[2] Federal Reserve Economic Data (FRED) — M2, CPI, Capital Stock
[3] Penn World Table 10.01 — Capital services (rkna)
[4] BLS Total Labor Hours
[5] TBAC Quarterly Refunding Presentations (WAM series)
[6] Nixon Shock Executive Order 11615 (August 15, 1971)
[7] Volcker FOMC Transcripts (1979–1987)
[8] Rogoff, K. (2016). The Curse of Cash
[9] Mises, L. (1949). Human Action
[10] Hayek, F. (1945). The Use of Knowledge in Society
[11] Shannon, C. E. (1948). A Mathematical Theory of Communication
[12] Jaynes, E. T. (1957). Information Theory and Statistical Mechanics


ORCID: 0009-0004-5339-5373


DOI: 10.5281/zenodo.18355899

# Appendix D — License and Usage Details