Bitcoin-Seconds (BXS): Measuring Durable Accumulation of Time-Shifted Energy Claims

Version 0.6.2 (for Peer Review)

MAB Navi (GPT-5)

November 2025

Abstract

Bitcoin is the first monetary system that converts present energy expenditure into cryptographically proven, transferable *claims on future energy and work*. This paper defines a Bitcoin-native temporal calculus that measures the *durability* of those claims through time. We formalize a three-level ladder: (i) an instantaneous flow in $\mathrm{sats\,s^{-1}}$ that captures the *rate of accumulating durable energy claims*, (ii) its cumulative integral in sats (total claims accumulated), and (iii) a time-weighted integral in $\mathrm{sats} \cdot \mathrm{s}$ (temporal persistence of claims, i.e., Bitcoin-Seconds). The instantaneous flow is constructed from observable drivers: income velocity, revealed HODLing strength, protocol dilution, and financial runway. We state falsifiable hypotheses and a node-local implementation plan.

1 Foundation: Bitcoin as Time-Shifted Energy Claims

Proof-of-Work (PoW) turns present energy into a cryptographic record that persists and becomes a transferable claim on future energy and work. A vivid example: 50 BTC mined in 2009 at negligible fiat value today commands substantial real-world labor and energy. The *claim* has persisted 16 years through a neutral protocol. This motivates measuring not only *how much* Bitcoin one holds or earns, but *how durably* those claims persist through time and conditions.

2 Measurement Problem: Durable vs. Transient Accumulation

Not all Bitcoin accumulation is equal. Some flows are quickly liquidated (transient), while others are held and financially sustainable (durable). We ask: *What is the rate at which an entity accumulates durable energy claims, and how does that durability persist through time?*

3 Instantaneous Flow of Durable Claims

Let time $t \in [0, T]$ be in seconds. We define observable quantities:

- $i(t)$: income inflow $[\mathrm{sats\,s^{-1}}]$.
- $\mu(t)$: spending outflow $[\mathrm{sats\,s^{-1}}]$.
- $A(t)$: value-weighted coin age [s] (revealed HODLing strength).
- $I(t)$: protocol expansion (monetary dilution) $[\mathrm{s^{-1}}]$, defined mechanically as

$$I(t) \;=\; \frac{\sigma(h(t))}{S(t)}\,\lambda(t),$$

with subsidy σ (BTC per block), circulating supply S (BTC), and block cadence λ (blocks per second).

- $s(t)$: current holdings [sats].
- r: retirement horizon [s].
- $CP(t)$: cumulative inflation-adjusted cost (optional) [sats].

We normalize coin age and dilution by positive baselines $A_0 > 0, I_0 > 0$ (e.g., rolling medians). Define the *surplus-to-spending ratio*

$$\mathrm{SSR}(t) \;=\; \frac{s(t) + r\, i(t) - CP(t)}{t\, \mu(t)} \quad \text{(dimensionless)},$$

interpretable as financial runway to *maintain* claims.

Definition (Productive Flow of Durable Claims)

$$\boxed{f(t) \;=\; i(t) \;\times\; \frac{A(t)}{A_0} \;\times\; \frac{I(t)}{I_0} \;\times\; \mathrm{SSR}(t) \quad (\text{units: sats}\, \mathrm{s}^{-1})}$$

Economic interpretation.

- $i(t)$: raw claim acquisition rate.
- $A(t)/A_0$: revealed HODLing strength (demonstrated time preference).
- $I(t)/I_0$: protocol context (dilution adjustment across eras).
- $\mathrm{SSR}(t)$: ability to *sustain* claims (runway vs. spending pressure).

Multiplicative interaction is appropriate because sustainable accumulation requires all dimensions to align: high income without runway, or high age amid forced selling, does not yield durable accumulation.

4 Integration Ladder: BTC/s → BTC → BTC·s

Level 1: Flow (BTC/s)

$f(t)$ measures the *rate of accumulating durable energy claims.*

Level 2: Stock (BTC)

$$\boxed{S(T) \;=\; \int_0^T f(t)\, dt \quad [\text{sats}]}$$

Total durable claims accumulated over the horizon.

Level 3: Time-Weighted Stock (BTC·s)

$$\boxed{\mathrm{BXS}(T) \;=\; \int_0^T S(t)\, dt \;=\; \int_0^T \int_0^t f(\tau)\, d\tau\, dt \quad [\text{sats} \cdot \text{s}]}$$

Temporal persistence of claims: *how much* and *for how long.* For benchmarking, a neutral baseline is

$$\mathrm{BXS}_{\mathrm{core}}(T) \;=\; \int_0^T W(t)\, dt,$$

the area under wealth $W(t)$ (sats), optionally discounted by $e^{-\rho t}$.

5 Interpretation

- $f(t)$: Bitcoin-denominated surplus *that is likely to persist.* Positive f indicates net durable accumulation; negative f indicates expected drawdown pressure.
- $S(T)$: cumulative durable claims (in BTC). Distinct from balance because it encodes sustained acquisition.
- $\mathrm{BXS}(T)$: duration-weighted accumulation (akin to coin-time held at the entity level).
- $\mathrm{BXS}_{\mathrm{core}}$: baseline persistence (size and duration) without durability adjustments.

6 Empirical Design: Durability and Stress Tests

Goal: show that f, S, BXS add information beyond balance, coin age, or ROI.

Hypotheses (falsifiable)

- H1 (Durability): Higher $f(t)$ predicts sustained holding over $[t, t + \Delta]$, controlling for $W(t)$ and $A(t)$.
- H2 (Stress): Declines in $f(t)$ precede forced liquidation events (e.g., large outflows, UTXO consolidation) earlier than balance-only signals.
- H3 (Component Value): Each driver $A/I/\mathrm{SSR}$ adds incremental predictive power for claim persistence.

Evaluation

Backtest on labeled entities (miners, exchanges, large holders) using node-local data. Compare models using W and age only vs. W, age, and f. Assess out-of-sample performance for next-period holding, drawdown events, and spending bursts.

7 Illustrative Magnitudes (Undiscounted)

These static calculations are for orientation only.

Satoshi-like Holder

Let $W \approx 9.68452 \times 10^{13}$ sats and horizon $T \approx 4.0 \times 10^{8}$ s. A neutral baseline yields

$$\mathrm{BXS}_{\mathrm{core}}(T) \approx W\,T \approx 3.87 \times 10^{22} \text{ sats} \cdot \text{s}.$$

This reflects exceptional persistence, independent of day-to-day flow.

Modest Holder (about 1.2 BTC)

$W \approx 1.2 \times 10^{8}$ sats, $T \approx 3.15 \times 10^{7}$ s. Then $\mathrm{BXS}_{\mathrm{core}} \approx 3.78 \times 10^{15}$ sats $\cdot$ s. Plugging observed i, μ, A, I into f generates the deployment-adjusted series.

8 Implementation (Node-Local, Sovereign)

All inputs are computed from a Start9-hosted mempool.space and wallet logs:

- $I(t)$ from subsidy, supply, and measured cadence.
- $A(t), W(t), i(t), \mu(t)$ from wallet and UTXO histories.
- $CP(t)$ optional; omit for strict Bitcoin-native analysis.

This ensures privacy, integrity, and reproducibility without third-party APIs.

9 Positioning (Convergent Thinking)

Time-centric monetization ideas have emerged independently in the community. We reference them only as convergent intuition; the present construction is Bitcoin-native and self-contained.

10 Validation Plan and Next Steps

- Construct address/entity panels with W, A, i, μ and compute $I(t)$ locally.
- Estimate baselines A_0, I_0 as rolling medians.
- Compute f, S, BXS and test H1–H3 against hold or sell outcomes.
- Report when the durability-aware ladder outperforms baselines; otherwise, refine drivers or normalization.

Appendix A: Units and Dimensional Checks

$$[f] = \mathrm{sats}\,\mathrm{s}^{-1}, \quad [S] = \mathrm{sats}, \quad [\mathrm{BXS}] = \mathrm{sats} \cdot \mathrm{s}.$$

Each integration adds one factor of time, ensuring dimensional closure.

Appendix B: Mechanical Form of $I(t)$

$$I(t) \;=\; \frac{\sigma(h(t))}{S(t)}\,\lambda(t),$$

which automatically reflects halving epochs and cadence variation.

Appendix C: Earlier Heuristic (v0.5.x) for Reference

A prior heuristic used

$$f_{\mathrm{heur}}(t) \;=\; i(t)\,A(t)\,I(t)\,\frac{(s(t) + r\,i(t)) - CP(t)}{t\,\mu(t)}.$$

This is dimensionally valid but lacked explicit economic decomposition. The present $f(t) = i \times (A/A_0) \times (I/I_0) \times \mathrm{SSR}$ makes each adjustment interpretable and testable.

Addendum: Glossary, Worked Example, and How-To

A. Glossary of Symbols (units in brackets)

$i(t)$	Income inflow [sats s^{-1}]
$\mu(t)$	Spending outflow [sats s^{-1}]
$A(t)$	Value-weighted coin age (revealed HODLing strength) [s]
A_0	Baseline coin age for normalization (e.g., rolling median) [s]
$I(t)$	Protocol monetary expansion rate [s^{-1}]
I_0	Baseline expansion rate for normalization [s^{-1}]
$s(t)$	Current holdings [sats]
r	Retirement (forward) horizon [s]
$CP(t)$	Cumulative inflation-adjusted cost (optional) [sats]
$\mathrm{SSR}(t)$	Surplus-to-spending ratio (dimensionless)
$f(t)$	Productive flow of durable claims [sats s^{-1}]
$S(T)$	Cumulative durable claims over $[0, T]$ [sats]
$\mathrm{BXS}(T)$	Bitcoin-Seconds (time-weighted claims) [sats s]
$\mathrm{BXS}_{\mathrm{core}}(T)$	Baseline time-weighted wealth $\int_0^T W(t)\,dt$ [sats s]
$W(t)$	Wealth (e.g., balance) [sats]

Definitions.

$$\mathrm{SSR}(t) = \frac{s(t) + r\,i(t) - CP(t)}{t\,\mu(t)} \quad ; \quad I(t) = \frac{\sigma(h(t))}{S(t)}\,\lambda(t)$$

$$\boxed{f(t) = i(t) \cdot \frac{A(t)}{A_0} \cdot \frac{I(t)}{I_0} \cdot \mathrm{SSR}(t)} \quad ; \quad S(T) = \int_0^T f(t)\,dt \quad ; \quad \mathrm{BXS}(T) = \int_0^T S(t)\,dt$$

B. Worked Example: Satoshi-Like Holder (orientation only)

Purpose: show orders of magnitude; not a claim about exact historical series.
Setup (static snapshot):

- Holdings: $W \approx 9.68452 \times 10^{13}$ sats (968,452 BTC).
- Horizon: $T \approx 4.0 \times 10^8$ s (about 12.7 years).
- Baselines: choose $A_0 = 3.0 \times 10^7$ s (about 1 year), $I_0 = 2.6 \times 10^{-10}$ s^{-1} (contemporary cadence).
- Snapshot drivers (illustrative): $A = 4.0 \times 10^8$ s; $I = 3.0 \times 10^{-8}$ s^{-1} (early era); $i = 1.0 \times 10^0$ sats s^{-1}; $\mu = 1.0 \times 10^{-4}$ sats s^{-1}; $r = 2.0 \times 10^9$ s; $CP = 0$.

Compute SSR:

$$\mathrm{SSR}(t) = \frac{s + r\,i - CP}{t\,\mu} = \frac{9.68452 \times 10^{13} + 2.0 \times 10^9 \cdot 1}{(4.0 \times 10^8) \cdot (1.0 \times 10^{-4})} \approx \frac{9.68472 \times 10^{13}}{4.0 \times 10^4} \approx 2.42 \times 10^9.$$

Normalize coin age and dilution:

$$\frac{A}{A_0} = \frac{4.0 \times 10^8}{3.0 \times 10^7} \approx 13.33, \qquad \frac{I}{I_0} = \frac{3.0 \times 10^{-8}}{2.6 \times 10^{-10}} \approx 115.4.$$

Instantaneous durable flow:

$$f(t) = i \cdot \frac{A}{A_0} \cdot \frac{I}{I_0} \cdot \mathrm{SSR} \approx (1) \cdot (13.33) \cdot (115.4) \cdot (2.42 \times 10^9) \approx 3.72 \times 10^{12} \text{ sats s}^{-1}.$$

Integrals (orientation):

$$S(T) \approx f \cdot T \approx (3.72 \times 10^{12}) \cdot (4.0 \times 10^8) \approx 1.49 \times 10^{21} \text{ sats.}$$

$$\mathrm{BXS}(T) \approx \tfrac{1}{2}\, S(T)\, T \approx 0.5 \cdot (1.49 \times 10^{21}) \cdot (4.0 \times 10^{8}) \approx 2.98 \times 10^{29} \text{ sats s.}$$

Baseline comparison (size-only persistence):

$$\mathrm{BXS}_{\mathrm{core}}(T) = \int_0^T W\, dt \approx W\, T \approx (9.68452 \times 10^{13}) \cdot (4.0 \times 10^{8}) \approx 3.87 \times 10^{22} \text{ sats s.}$$

Here, $\mathrm{BXS}_{\mathrm{core}}$ ignores durability adjustments; f, S, BXS incorporate revealed HODLing, protocol era, and runway.

C. How To Reproduce Locally (Start9 + mempool.space)

1. Compute $I(t)$ mechanically: query subsidy σ, supply S, and block cadence λ from your node; set $I(t) = \sigma/S \cdot \lambda$.
2. Derive wallet series: $W(t)$ from UTXO set; $A(t)$ as value-weighted mean age; $i(t)$ and $\mu(t)$ from inflow/outflow rates; $CP(t)$ optional.
3. Choose baselines A_0, I_0 as rolling medians (or per-epoch medians) to stabilize normalization.
4. Evaluate $f(t)$ each block interval; integrate numerically to obtain $S(T)$ and $\mathrm{BXS}(T)$.
5. For comparability across entities, report both size-only $\mathrm{BXS}_{\mathrm{core}}$ and durability-aware BXS (and/or a normalized ratio).

Note. The large magnitudes in this example reflect early-era dilution, long coin age, and very high SSR; they are intended to illustrate scaling, not serve as calibrated estimates.