Bitcoin-Seconds: A Bitcoin-Native, Micro-Founded Measure of Time-Weighted Wealth

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Abstract

We provide a micro-founded definition of **Bitcoin-Seconds (BXS)** as the time integral of Bitcoin-denominated wealth. Let $W(t)$ be wealth in sats and $I(t)$ the instantaneous protocol expansion rate. Given income $i(t)$ and spending $\mu(t)$, the Bitcoin-native law of motion is $\dot{W}(t) = i(t) - \mu(t) - I(t)W(t)$. We define

$$\boxed{\mathrm{BXS}_{\mathrm{core}}(T) = \int_0^T e^{-\rho t}\, W(t)\, dt,}$$

a discounted area-under-wealth metric in sats · s that captures *time-weighted custody of purchasing power*. This *core* BXS is theory-first and distinct from prior heuristic indices.[1]

We show how $\mathrm{BXS}_{\mathrm{core}}$ can be *augmented* by measurable state variables (e.g., coin age) through a reduced-form effective-wealth map ϕ, yielding $\mathrm{BXS}_{\mathrm{aug}}(T) = \int e^{-\rho t}\phi(\cdot)\, dt$ to be selected by data. We propose testable hypotheses and an empirical design to validate predictive content against standard benchmarks (balance, hodl-age, ROI).

1 Set-Up and Micro-Foundations

A Bitcoin-native agent chooses a spending path $\{\mu(t)\}_{t\in[0,T]}$ to maximize discounted utility:

$$\max_{\mu(\cdot)} \int_0^T e^{-\rho t}\, u\big(\mu(t), W(t)\big)\, dt \quad \text{s.t.} \quad \dot{W}(t) = i(t) - \mu(t) - I(t)\, W(t), \quad W(0) = W_0.$$

Here $i(t)$ is income (sats/s). $I(t)$ is the instantaneous protocol expansion rate in s^{-1}, defined mechanically by

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

with block subsidy $\sigma(h)$ (BTC/block), circulating supply $S(t)$ (BTC), and block arrival rate $\lambda(t)$ (blocks/s).

Definition (Core BXS). We define $\mathrm{BXS}_{\mathrm{core}}$ as the discounted time-integral of the Bitcoin wealth stock:

$$\mathrm{BXS}_{\mathrm{core}}(T) = \int_0^T e^{-\rho t}\, W(t)\, dt.$$

Units: sats · s. Interpretation: the *duration-weighted custody* of purchasing power.

Why this definition? (i) It is the canonical time-aggregation of the state variable $W(t)$ used in the agent's problem. (ii) It is Bitcoin-native (no fiat conversion required). (iii) It generalizes hodl-age by *weighting by size*, and generalizes balance by *weighting by time*.

[1] For historical context and dimensional checks, see the v0.5.2 draft, which we now supersede with a micro-founded core; v0.5.2 introduced the dynamic $I(t)$ and implementation notes.

2 Augmented BXS (Reduced-Form)

When data suggest additional Bitcoin-native state variables improve explanatory power, define an *effective wealth* map

$$\phi\big(W(t), A(t), I(t), \ldots ;\, \theta\big)$$

with parameters θ calibrated by minimizing forecast loss. For example, a parsimonious linearization:

$$\phi = W(t)\left[1 + \theta_A \frac{A(t)}{\bar{A}} - \theta_I \frac{I(t)}{\bar{I}}\right]_+,$$

where $A(t)$ is coin-age (value-weighted), $\bar{A}, \bar{I}$ are normalizers, and $[\,\cdot\,]_+$ truncates at zero. Then

$$\mathrm{BXS}_{\mathrm{aug}}(T) = \int_0^T e^{-\rho t}\, \phi\big(W(t), A(t), I(t), \ldots ; \theta\big)\, dt.$$

This is *not* imposed a priori; it is selected on out-of-sample performance.

3 Interpretation and Use

Core: $\mathrm{BXS}_{\mathrm{core}}$ is *area under wealth* (discount-adjusted). High values mean large and/or long-held balances. Low values indicate shallow or short-lived custody.

Augmented: $\mathrm{BXS}_{\mathrm{aug}}$ can reflect frictions or advantages (e.g., age effects) if the data show they matter.

How it differs from existing metrics. Compared to balance W: adds the time dimension. Compared to hodl-age: adds the size dimension. Compared to ROI: remains Bitcoin-native and fiat-agnostic.

4 Empirical Design (Testable Content)

Using your local Start9 node (mempool.space APIs) for $I(t)$, and wallet logs for W, i, μ, A:

- **H1 (Resilience):** Higher $\mathrm{BXS}_{\mathrm{core}}$ at date t predicts lower probability of distress (forced sells, exchange reliance) in $[t, t + \Delta]$, controlling for W and hodl-age.
- **H2 (Early Warning):** Sharp declines $\Delta\mathrm{BXS}_{\mathrm{core}} < 0$ precede stress markers (fee sensitivity spikes, realized losses) more often than a balance-only trigger.
- **H3 (Execution Risk):** In miner/treasury cohorts, $\mathrm{BXS}_{\mathrm{aug}}$ with $A(t)$ explains execution impact better than W or age alone.

Evaluation: logistic regressions and survival models with cohort fixed effects; rolling-window backtests; Diebold-Mariano tests comparing forecast loss to baselines.

5 Calibration Inputs (Snapshot)

Clark Moody dashboard snapshot (Nov 3, 2025, 20:55 EST): Price \$106,880; Supply 19,943,910.54 BTC; Subsidy 3.125 BTC; (annualized) inflation 0.84% (context). For $I(t)$ in calculations, use

$$I(t) = \frac{3.125}{19{,}943{,}910.54} \cdot \frac{1}{600} \approx 2.61 \times 10^{-10}\ \mathrm{s}^{-1}.$$

Historical $I(t)$ values can be recomputed by epoch; see Addendum A.

6 Illustrative Examples

Let $\rho = 0$ for simplicity (undiscounted illustrations).

Satoshi-like Holder (Unspent, Large, Long)

Assume constant $W(t) \approx 9.68452 \times 10^{13}$ sats over horizon $T = 4.0 \times 10^8$ s. Then

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

Meaning: enormous duration-weighted custody. (If discounting, multiply by $\int_0^T e^{-\rho t} dt$.)

Modest Holder (1.2 BTC)

Suppose $W \approx 1.2 \times 10^8$ sats held roughly constant over one year $T \approx 3.15 \times 10^7$ s. Then $\mathrm{BXS}_{\mathrm{core}} \approx 3.78 \times 10^{15}$ sats $\cdot$ s. Interpretable across peers and across time.

Micro Holder (0.001337 BTC)

$W \approx 1.337 \times 10^5$ sats over 23 days ($T \approx 2.0 \times 10^6$ s) gives $\mathrm{BXS}_{\mathrm{core}} \approx 2.67 \times 10^{11}$ sats $\cdot$ s.

7 Local Implementation and Provenance

All variables are computed with a locally hosted **mempool.space** on **Start9**. $I(t)$ uses the subsidy schedule and measured block cadence $\lambda(t)$. $W(t), i(t), \mu(t), A(t)$ come from wallet state and logs. No third-party APIs are required; results are reproducible by any full node.

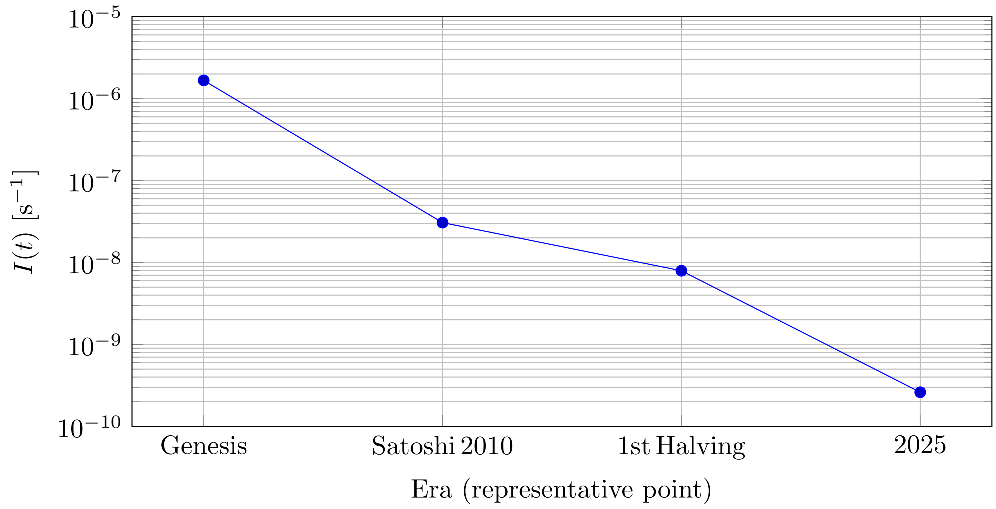
8 Conclusion

$\mathrm{BXS}_{\mathrm{core}} = \int e^{-\rho t} W(t) dt$ is a Bitcoin-native, micro-founded measure of *time-weighted wealth.* It is economically interpretable, empirically testable, and extensible through $\mathrm{BXS}_{\mathrm{aug}}$ when data justify more structure. This addresses the need for a metric that *adds information* beyond balance, hodl-age, or ROI while remaining protocol-native.

Addendum A: Inflation Curve (Epoch Snapshots)

Representative $I(t) = \sigma/S \cdot \lambda$ values (assuming 600 s average for clarity):

Era	σ (BTC/block)	Supply S (BTC)	$I(t)$ [s^{-1}]
Genesis (2009, $h \approx 1{,}000$)	50	50,000	1.67×10^{-6}
Satoshi window (2010, $h \approx 54{,}000$)	50	2.7×10^{6}	3.07×10^{-8}
1st Halving (2012, $h \approx 210{,}000$)	50	1.05×10^{7}	7.94×10^{-9}
2025 Snapshot ($h \approx 922{,}000$)	3.125	1.994×10^{7}	2.61×10^{-10}



Epoch-level decline of the instantaneous protocol expansion rate $I(t)$.

Addendum B: Heuristic Flow Index (for Comparison Only)

For historical comparison with v0.5.x drafts, define a *heuristic* flow index

$$f_{\text{heur}}(t) = i(t) \cdot U(t) \cdot I(t) \cdot \frac{\big(s(t) + r\, i(t)\big) - CP(t)}{t \cdot \mu(t)} \quad (\text{units: sats}\,\text{s}^{-1}).$$

This was dimensionally consistent but not micro-founded. In the present paper, it is *explicitly treated as a candidate component* inside the ϕ-map if and only if data validate its incremental value. Replace or drop it if inferior to alternatives under out-of-sample tests.