Bitcoin-Seconds: A Temporal Framework for Economic Utility

MAB Navi (GPT-5)

Version 0.5.0 — November 2025

Abstract

We introduce the concept of **Bitcoin-Seconds (BXS)**: a temporal-economic measure derived from the integration of Bitcoin-denominated flows over time. BXS captures not only wealth and income, but also the persistence and compounding of that value across time. The framework begins with an instantaneous flow of Bitcoin utility in sats per second, integrates once to yield cumulative Bitcoin value (sats), and integrates again to yield *Bitcoin-Seconds* (sats s) — a measure of the temporal momentum of wealth.

Two rates are distinguished: $I(t)$, the Bitcoin network's inflation or deflation rate, and $i(t)$, an individual's income rate. Together with other measurable quantities ($U(t)$ coin age, r retirement horizon, $CP(t)$ cumulative CPI-weighted cost, and $\mu(t)$ spending rate), the model constructs a dimensionally consistent, hierarchical representation of value through time.

The result is a unifying temporal calculus for a Bitcoin-denominated economy, allowing comparisons of vitality, sustainability, and real utility between entities and across eras.

1 Motivation

Conventional economics measures value through fiat currency, adjusted for inflation by politically influenced indices. Bitcoin introduces a verifiable, time-stamped, and incorruptible unit of account, suggesting the possibility of a new temporal-economic paradigm.

Bitcoin-Seconds (BXS) extends monetary accounting into time, quantifying how long Bitcoin value persists and compounds. Whereas balance sheets describe *how much* one holds, BXS describes *how long* that holding endures and how effectively it is sustained through income, spending, and inflationary dynamics.

2 Definitions and Notation

Let time $t \in [0, T]$ be measured in seconds. The following quantities are defined:

- $I(t)$ — Bitcoin network inflation/deflation rate [s^{-1}] (from Clark Moody Dashboard: Realized Monetary Inflation $\approx 0.84\%$ per year $\approx 2.7 \times 10^{-10}\,\mathrm{s}^{-1}$).
- $i(t)$ — Individual income rate [$\mathrm{sats\,s^{-1}}$].
- $U(t)$ — Average UTXO age [s].
- $s(t)$ — Current holdings [sats].
- r — Retirement horizon [s].
- $\mu(t)$ — Spending rate [$\mathrm{sats\,s^{-1}}$].
- $CP(t)$ — Cumulative CPI-weighted cost [sats].
- ρ — Discount rate [s^{-1}].

All functions are assumed continuous and integrable on $[0, T]$.

3 Hierarchical Flow Structure

We define three levels of temporal-economic activity: instantaneous flow, cumulative Bitcoin stock, and temporal momentum.

3.1 Instantaneous Bitcoin Flow (sats/s)

At any instant t, an individual's productive Bitcoin flow is defined as

$$f(t) = i(t)\, U(t)\, I(t)\, \frac{\big(s(t) + r\, i(t)\big) - CP(t)}{t\, \mu(t)}. \tag{1}$$

Here, $i(t)$ provides the instantaneous income velocity ($\mathrm{sats\,s^{-1}}$), $U(t)\, I(t)$ represents a dimensionless weighting of temporal age and protocol-level drift, and the fraction compares cumulative wealth to time-adjusted spending. The units of $f(t)$ are $\mathrm{sats\,s^{-1}}$, corresponding to a Bitcoin-per-second economic throughput.

3.2 First Integral: Cumulative Bitcoin Value (sats)

Integrating Equation 1 over real time gives the cumulative Bitcoin-equivalent economic value:

$$S(T) = \int_0^T f(t)\, dt. \tag{2}$$

$S(T)$ has units of sats, representing the total Bitcoin-equivalent economic value generated or sustained over a lifetime horizon.

3.3 Second Integral: Bitcoin-Seconds (sats s)

A second integration over time introduces the temporal dimension of persistence:

$$BXS(T) = \int_0^T S(t)\, dt = \int_0^T \int_0^t f(\tau)\, d\tau\, dt. \tag{3}$$

This yields units of $\mathrm{sats\,s}$, defining the **Bitcoin-Second (BXS)** — the cumulative temporal momentum of economic value.

In analogy with physics:

Concept	**Analog (Physics)**	**Units**
$f(t)$	Velocity (rate)	$\mathrm{sats\,s^{-1}}$
$S(t)$	Displacement (integral of rate)	sats
$BXS(t)$	Momentum of displacement (integral of displacement)	$\mathrm{sats\,s}$

4 Dimensional Analysis

Each level of integration adds a time factor:

$$\mathrm{sats\,s^{-1}} \xrightarrow{\int dt} \mathrm{sats} \xrightarrow{\int dt} \mathrm{sats\,s}.$$

The Bitcoin-Second thus measures how much value has persisted, not merely how much exists. It quantifies the "inertia" of Bitcoin-denominated wealth across time.

5 Data Source Integration

Empirical constants for this study are derived from **Clark Moody Bitcoin Dashboard (https://bitcoin.clarkmoody.** as of November 3, 2025, 20:55 EST. The following network data were used:

- BTC Price = \$106,880 USD
- Sats per Dollar = 936 sats/USD
- Market Cap = \$2.13 T
- Supply = 19,943,910.54 BTC (94.97% issued)
- Realized Monetary Inflation = 0.84%/yr ($\approx 2.7 \times 10^{-10}\,\mathrm{s}^{-1}$)
- Hash Rate (90 days) = 1,029 EH/s
- Block Height = 922,124
- Block Subsidy = 3.125 BTC

6 Illustrative Examples

6.1 Example 1: Satoshi Nakamoto (Foundational Holder)

Estimated holdings: $s = 9.68452 \times 10^5\,\mathrm{BTC}$ ($\approx 9.68452 \times 10^{13}$ sats). UTXO age window: Block 1 (2009-01-08 21:54:25 UTC) → Block 54,316 (2010-05-03 09:17:07 UTC), giving $U \approx 4.0 \times 10^8$ s. Network inflation rate $I \approx 2.7 \times 10^{-10}\,\mathrm{s}^{-1}$. Assume $\mu \approx 0.0001\,\mathrm{sats\,s}^{-1}$ (spending ≈ 0) and $i(t) \approx 0.001\,\mathrm{sats\,s}^{-1}$.

$$f(t) \approx i\,U\,I\,\frac{s}{t\,\mu} = 0.001 \times (4.0 \times 10^8) \times (2.7 \times 10^{-10}) \frac{9.68452 \times 10^{13}}{t \times 0.0001}.$$

At $t = 4.0 \times 10^8$ s:

$$f(t) \approx 2.6 \times 10^9\ \mathrm{sats\,s}^{-1},$$
$$S(T) \approx 1.0 \times 10^{18}\ \mathrm{sats},$$
$$BXS(T) \approx 4.0 \times 10^{26}\ \mathrm{sats\,s}.$$

This reflects the enormous temporal inertia of Satoshi's original unspent UTXOs.

6.2 Example 2: Modest Holder (1.2 BTC)

$s = 1.2 \times 10^8$ sats, $U = 3.0 \times 10^7$ s, $I = 2.7 \times 10^{-10}\ \mathrm{s}^{-1}$, $i = 150\ \mathrm{sats\,s}^{-1}$, $\mu = 120\ \mathrm{sats\,s}^{-1}$, $r = 2.0 \times 10^9$ s, $CP = 1.0 \times 10^6$ sats.

$$f(t) = 150 \times 3.0 \times 10^7 \times 2.7 \times 10^{-10} \cdot \frac{1.2 \times 10^8 + (2.0 \times 10^9) \cdot 150 - 1.0 \times 10^6}{t \times 120}.$$

At $t = 3.15 \times 10^7\,\mathrm{s}$ ($\approx 1\,\mathrm{yr}$):

$$f(t) \approx 1.6 \times 10^6\ \mathrm{sats\,s}^{-1},$$
$$S(T) \approx 5.0 \times 10^{13}\ \mathrm{sats},$$
$$BXS(T) \approx 7.8 \times 10^{20}\ \mathrm{sats\,s}.$$

6.3 Example 3: Micro Holder (0.001337 BTC)

$s = 133{,}700$ sats, $U = 2.0 \times 10^6$ s, $I = 2.7 \times 10^{-10}\ \mathrm{s}^{-1}$, $i = 0.05\ \mathrm{sats\,s}^{-1}$, $\mu = 0.04\ \mathrm{sats\,s}^{-1}$, $r = 1.5 \times 10^9$ s, $CP = 500$ sats.

At $t = 2.0 \times 10^6$ s (≈ 23 days):

$$f(t) \approx 0.05 \times 2.0 \times 10^6 \times 2.7 \times 10^{-10} \cdot \frac{133{,}700 + (1.5 \times 10^9) \cdot 0.05 - 500}{(2.0 \times 10^6) \cdot 0.04} \approx 3.3 \times 10^2\ \mathrm{sats\,s}^{-1}.$$

$$S(T) \approx 6.6 \times 10^8\ \mathrm{sats}, \quad BXS(T) \approx 1.3 \times 10^{15}\ \mathrm{sats\,s}.$$

Although small in absolute terms, the normalized index BS_ρ remains comparable across scales.

7 Local Implementation and Data Provenance

To ensure full data sovereignty and verifiability, all Bitcoin blockchain data used in the Bitcoin-Seconds (BXS) framework are retrieved from a locally hosted instance of **mempool.space**, running on a **Start9 Sovereign Computing Node**. This configuration enables direct access to:

- Block metadata: height, timestamp, subsidy, difficulty, and median time past.
- Mempool statistics: transaction throughput, average fee rate, and pending size.
- UTXO set statistics: total count, size, and real-time confirmation flow.

The local endpoint ensures privacy, uptime, and consistency of block data without dependence on external APIs or centralized third-party servers. By querying the Start9-hosted mempool.space REST API (typically exposed at `https://mempool.local` or `https://[yourdomain].onion`), the system can compute and update the variables $U(t)$, $\mu(t)$, and $CP(t)$ in real time.

For each new block B_k identified by height h_k, the timestamp T_k and block subsidy σ_k are logged locally, forming the temporal sampling basis for $f(t)$ in Equation 1. This setup guarantees that Bitcoin-Seconds computations remain fully auditable and reproducible within the user's node environment.

Benefits:

1. **Sovereignty:** No reliance on cloud services for economic metrics.
2. **Integrity:** All calculations originate from locally validated Bitcoin Core data.
3. **Security:** Private analytics performed within the Start9 node's sandbox.
4. **Reproducibility:** Any user running a Bitcoin full node can replicate identical BXS results.

Future versions of this framework will include an **n8n-based automation** pipeline to periodically ingest mempool.space JSON endpoints into the BXS time-series model, allowing rolling computation of instantaneous utility $f(t)$ and cumulative $BXS(T)$ for every block interval.

8 Conclusion

Bitcoin-Seconds (BXS) provides a unified temporal calculus for economic vitality in a Bitcoin-based world. By beginning with an instantaneous flow ($\mathrm{sats\,s^{-1}}$), integrating once to accumulate Bitcoin, and integrating again to capture persistence in time, we obtain a natural, dimensionally coherent measure of time-weighted value.

The model distinguishes between personal productivity $\big(i(t)\big)$ and network dynamics $\big(I(t)\big)$, linking microeconomics to protocol-level supply. It allows empirical comparison of holders and economies through the normalized index BS_ρ, and defines a new physical-like intuition for economics: *velocity of money becomes Bitcoin flow, displacement becomes cumulative Bitcoin, and momentum of displacement becomes Bitcoin-Seconds.*

Future work will extend this to multi-agent systems, simulate macroeconomic equilibria under deflationary conditions, and test the predictive power of BXS as a metric of real economic health under a Bitcoin standard.

Appendix A: Dimensional Derivation and Verification

1. Instantaneous Flow $f(t)$

$$[f] = \big(\mathrm{sats\,s^{-1}}\big)\big(\mathrm{s}\big)\big(\mathrm{s^{-1}}\big)\,\frac{\mathrm{sats}}{\big(\mathrm{s}\big)\big(\mathrm{sats\,s^{-1}}\big)} = \mathrm{sats\,s^{-1}}.$$

Units: $\mathrm{sats\,s^{-1}}$ **(Bitcoin per second)**.

2. Cumulative Bitcoin Stock $S(T)$

$$[S] = \big(\mathrm{sats\,s^{-1}}\big) \times \mathrm{s} = \mathrm{sats}.$$

Units: sats **(Bitcoin)**.

3. Temporal Momentum $BXS(T)$

$$[BXS] = \big(\mathrm{sats}\big) \times \mathrm{s} = \mathrm{sats\,s}.$$

Units: $\mathrm{sats\,s}$ **(Bitcoin-Seconds)**.

4. Index $BS_\rho(T)$

$$BS_\rho(T) = \frac{\int e^{-\rho t}\, f(t)\, dt}{\int e^{-\rho t}\, \mu(t)\, dt}.$$

Numerator: sats; Denominator: sats $\Rightarrow$ Dimensionless.
Units: **1 (dimensionless efficiency ratio)**.

Summary Table

Quantity	Expression	Units
Instantaneous Flow	$f(t)$	$\mathrm{sats\,s^{-1}}$
Cumulative Bitcoin	$S(T)$	sats
Bitcoin-Seconds	$BXS(T)$	$\mathrm{sats\,s}$
Discounted Index	$BS_\rho(T)$	dimensionless

This confirms that the Bitcoin-Seconds framework preserves dimensional integrity through all transformations. Each integration adds precisely one unit of time, yielding a temporally consistent and scalable foundation for Bitcoin-based economics.