Monetary Predator-Prey Dynamics: Enforcement Gridlock and Neutral Settlement Survival

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Abstract

This paper formalizes the survivability question for neutral settlement: *why can enforcement actors not coordinate to suppress it?* We model enforcement actors as "predators" (coordination taxers) and neutral settlement rail usage as "prey" within a multi-predator Lotka–Volterra framework. When inter-predator competition coefficients are strictly positive—a condition guaranteed by geopolitical multipolarity—the interior equilibrium ensures prey survival ($x^* > 0$). We prove that no stable suppression coalition exists: for any proposed coalition, at least one member gains by defecting (Theorem 1). Further, we establish that each enforcer's dominant strategy is to preserve neutral rail access as a hedge against rival enforcers' monetary weaponization (Lemma 2). Finally, we introduce duration fragility inequalities (Proposition 3) showing that equity valuations suffer terminal value collapse under AI-driven moat erosion, strengthening the marginal case for scarcity-based settlement. These results complete the causal chain from Hash (2026a): the coordination failure in the exit game is not merely possible but *structurally guaranteed* by inter-predator competition.

1. Introduction

The Bitcoin Game Theory framework establishes that exit to neutral settlement is self-reinforcing (Hash, 2026a, Theorem 1), that coordination to stay fails (Theorem 2), and that the resulting equilibrium is absorbing (Theorem 3). The seven-property elimination (Hash, 2026b) shows Bitcoin is the unique survivor among candidate assets. The trust gradient (Hash, 2026c) extends the result to autonomous economic agents.

A critical gap remains: *why* does coordination to stay fail? The prior result (Hash, 2026a, Theorem 2) establishes that no enforcement mechanism exists to prevent exit, but does not explain the structural dynamics that guarantee this condition persists. This paper fills that gap.

We observe that enforcement actors—sovereigns imposing capital controls, corporations gatekeeping financial access, intermediaries extracting compliance rents—are not a monolithic bloc cooperating against Bitcoin. They are *competitors*, each taxing coordination in ways that interfere with other enforcers' interests. This competitive structure maps precisely onto multi-predator Lotka–Volterra population dynamics (Volterra, 1928; May, 1973), where inter-species competition among predators guarantees prey survival at the interior equilibrium.

1.1 Contributions

(i) **Actor Taxonomy** (Section 2): We classify monetary actors into coordination taxers (CT_1–CT_3) and exit-valve participants (EV_1–EV_3), identifying dual-role actors who simultaneously enforce and exit.

(ii) **Lotka–Volterra Formalization** (Section 3): We model the system as a multi-predator ecology and derive existence conditions for the interior equilibrium.

(iii) **Gridlock Wedge Theorem** (Section 4): We prove that inter-predator competition permanently prevents coordinated suppression (Theorem 1).

(iv) **Predator Hedging Lemma** (Section 5): We establish the dominant strategy cascade in which each enforcer preserves the neutral rail (Lemma 2).

(v) **Duration Fragility** (Section 6): We prove that AI-driven moat erosion compresses equity terminal values (Proposition 3).

(vi) **Falsification** (Section 8): We specify condition F7 under which these results fail.

2. Actor Taxonomy

2.1 Coordination Taxers

Definition 1 (Coordination Taxer)**.** A *coordination taxer* (CT) is an enforcement actor that extracts value by controlling or taxing monetary flows. We identify three tiers:

ID	Tier	Examples	Mechanism
CT_1	Sovereign	Governments, central banks, sanctions agencies	Monetary policy, capital controls, legal coercion
CT_2	Corporate	Banks, asset managers, payment processors	Intermediation fees, compliance gatekeeping
CT_3	Intermediary	Prime brokers, mining pools, payment routers	Collateral yield, pool fees, routing fees

Table 1: Coordination taxer classification.

2.2 Exit-Valve Participants

Definition 2 (Exit-Valve Participant)**.** An *exit-valve participant* (EV) is an actor who benefits from access to a neutral settlement rail outside the enforcement perimeter.

ID	Tier	Examples	Mechanism
EV_1	Retail	Savers, remittance users, unbanked populations	Inflation escape, bank freeze bypass
EV_2	Tier-2 Sovereign	Rival powers, sanctioned states	Dollar alternative, sanctions evasion
EV_3	Corporate	Energy producers, miners, AI agents	Energy monetization, autonomous settlement

Table 2: Exit-valve participant classification.

2.3 Dual-Role Actors

Many actors simultaneously tax coordination *and* use the neutral rail, creating the strategic tension that drives the Gridlock Wedge:

- **United States** ($CT_1 + EV_2$): Enforces dollar hegemony via SWIFT sanctions while maintaining a strategic Bitcoin reserve as a hedge against de-dollarization.

- **China** ($\mathrm{CT}_1 + \mathrm{EV}_2$): Imposes capital controls and bans domestic crypto trading while using cryptocurrency for cross-border trade settlement.
- **Russia/Iran** ($\mathrm{CT}_1 + \mathrm{EV}_2$): Nominally restrict domestic use while employing Bitcoin for sanctions evasion in international trade.
- **Major banks** ($\mathrm{CT}_2 + \mathrm{EV}_3$): Gatekeep fiat access while building custody and trading infrastructure to capture Bitcoin-denominated revenue.

Remark. In informal discussion, coordination taxers are sometimes called "cats" and exit-valve participants "mice," referencing the familiar cat-and-mouse enforcement dynamic. We use formal terms throughout.

3. Model: Multi-Predator Lotka–Volterra System

3.1 System Equations

Let $x(t) \in \mathbb{R}_{\geq 0}$ denote neutral rail usage (a proxy for prey population) and $y_k(t) \in \mathbb{R}_{\geq 0}$ the enforcement intensity of actor $k \in \{1, \ldots, n\}$.

Definition 3 (Multi-Predator Enforcement System)**.** The enforcement dynamics are governed by:

$$\frac{dx}{dt} = r\,x\Big(1 - \frac{x}{K}\Big) - \sum_{k=1}^{n} a_k\, x\, y_k\,, \tag{1}$$

$$\frac{dy_k}{dt} = b_k\, x\, y_k - d_k\, y_k - \sum_{\substack{j=1 \\ j\neq k}}^{n} \varepsilon_{jk}\, y_j\, y_k\,, \qquad k = 1, \ldots, n\,, \tag{2}$$

where the parameters are defined in Table 3.

3.2 Inter-Predator Competition

The critical structural parameter is ε_{jk}: the degree to which enforcer j's actions interfere with enforcer k's enforcement capacity.

Assumption 1 (Multipolarity)**.** There exist at least three tier-1 enforcement actors ($n \geq 3$), and inter-predator competition is strictly positive: $\varepsilon_{jk} > 0$ for all $j \neq k$.

Symbol	Definition
$x(t)$	Neutral rail usage (prey population proxy)
$y_k(t)$	Enforcement intensity of actor k
$r > 0$	Intrinsic growth rate of neutral rail adoption
$K > 0$	Carrying capacity (maximum adoption)
$a_k > 0$	Suppression efficiency of enforcer k
$b_k > 0$	Benefit enforcer k extracts from enforcement
$d_k > 0$	Cost/decay rate of enforcement effort
$\varepsilon_{jk} > 0$	Inter-predator competition coefficient between j and k

Table 3: Model parameters.

Remark. Assumption 1 is not a modeling convenience—it is an empirical regularity guaranteed by geopolitical multipolarity (AX1/W1 in Hash, 2026a). Concrete channels include: US sanctions pushing sanctioned parties toward Bitcoin (undermining China's capital controls); EU regulation pushing capital to permissive jurisdictions (undermining enforcement coherence); bank compliance requirements creating demand for non-custodial alternatives (expanding the enforcement perimeter).

3.3 Interior Equilibrium

Setting (1)–(2) to zero and solving for the interior fixed point $(x^*, y_1^*, \dots, y_n^*)$ with all components strictly positive, we obtain:

$$x^* = K \left(1 - \frac{1}{r} \sum_{k=1}^{n} a_k \, y_k^*\right) > 0 \,, \tag{3}$$

where the y_k^* satisfy the coupled system

$$b_k \, x^* - d_k - \sum_{\substack{j=1 \\ j \neq k}}^{n} \varepsilon_{jk} \, y_j^* = 0 \,, \qquad k = 1, \dots, n \,. \tag{4}$$

The positivity of x^* in (3) holds because inter-predator friction bounds each y_k^* from above: the competition terms $\varepsilon_{jk} \, y_j^*$ in (4) prevent any single enforcer from achieving the suppression threshold at which $\sum_k a_k y_k^* / r \geq 1$.

4. The Gridlock Wedge Theorem

Theorem 1 (Gridlock Wedge)**.** *Under Assumption 1 ($n \geq 3$, $\varepsilon_{jk} > 0$ for all $j \neq k$), the following hold:*

(G1) *Multiple enforcers exist at all observed t.*

(G2) *Inter-predator competition is strictly positive.*

(G3) *The neutral settlement rail survives at a positive interior equilibrium: $x^* > 0$.*

(G4) *Each enforcer strictly prefers that rivals not suppress.*

(G5) *Given that rivals preserve the rail, each enforcer's best response is to also preserve.*

(G6) *No stable suppression coalition exists.*

Proof. (G1) is an empirical observation: at least three tier-1 enforcement actors (US, EU, China) operate simultaneously at all observed time periods.

(G2) follows from (G1) and Assumption 1: every enforcer pair exhibits strictly positive competition ($\varepsilon_{jk} > 0$) through the channels described in Section 3.2.

For (G3), rearrange each predator's equilibrium condition (4):

$$b_k\, x^* = d_k + \sum_{\substack{j=1 \\ j \neq k}}^{n} \varepsilon_{jk}\, y_j^* \,. \tag{5}$$

Since $d_k > 0$ and every term on the right-hand side is non-negative,

$$x^* = \frac{d_k + \sum_{j \neq k} \varepsilon_{jk}\, y_j^*}{b_k} \;\geq\; \frac{d_k}{b_k} \;>\; 0\,.$$

This is the standard survival result in multi-predator Lotka–Volterra theory: each predator's equilibrium condition *individually* guarantees $x^* > 0$, because enforcement profitability requires a positive prey population. Inter-predator competition strengthens this bound: the $\varepsilon_{jk}\, y_j^*$ terms in (5) increase x^* above the single-predator baseline d_k/b_k, as competition diverts enforcement resources from prey suppression to inter-predator rivalry.

For (G4), each enforcer k's per-period extraction is $b_k\, x\, y_k$, which is strictly increasing in x. If rivals intensify suppression (raise y_j for $j \neq k$), the prey equation (1) yields a lower equilibrium x, reducing k's extraction. Conversely, if rivals *reduce* enforcement, x rises and k's extraction improves. Thus each enforcer strictly prefers that rivals maintain lower enforcement intensity:

$$\frac{\partial}{\partial y_j}(b_k\, x^*(y_j)) < 0 \quad \text{for all } j \neq k\,,$$

where $x^*(y_j)$ denotes the equilibrium prey level as a function of rival enforcement. No surplus-splitting mechanism is required; the preference follows directly from the competitive structure of the multi-predator system.

(G5) follows from game-theoretic dominance analysis. Fix the strategies of all enforcers $j \neq k$ at "preserve." If k bans, k loses neutral rail access (hedge value against rivals' weaponization) while competitors maintain access. If k preserves, k retains both hedge value and compliance revenue from supervised activity. Since the hedge value is strictly positive under multipolarity (rival weaponization is a non-degenerate threat), preservation weakly dominates banning. This generates a dominant strategy cascade: once any enforcer preserves, all others' best response is to preserve (Lemma 2).

For (G6), suppose a suppression coalition $C \subseteq \{1, \dots, n\}$ forms. Consider any member $k \in C$. If k deviates to "preserve" while $C \setminus \{k\}$ continues suppressing:

(a) k captures fleeing capital from the suppressed jurisdictions.

(b) k retains neutral rail access as a hedge against $(C \setminus \{k\})$'s residual enforcement power.

(c) Rivals in $C \setminus \{k\}$ bear higher per-capita enforcement costs due to k's defection.

The deviation payoff strictly exceeds the coalition payoff, so no Nash stable coalition exists. □

5. The Dominant Strategy Cascade

Lemma 2 (Predator Hedging). *Let $\mathcal{G}$ be the simultaneous-move game in which each enforcer $k \in \{1, \dots, n\}$ chooses $s_k \in \{ban, preserve\}$. Under Assumption 1, "preserve" weakly dominates "ban" for every k, regardless of rivals' strategies. Consequently, suppression is never unanimous.*

Proof. Define enforcer k's payoff function as

$$U_k(s_k, s_{-k}) = \underbrace{R_k(s_k, s_{-k})}_{\text{enforcement revenue}} + \underbrace{H_k(s_k, s_{-k})}_{\text{hedge value}} - \underbrace{C_k(s_k)}_{\text{enforcement cost}}\,, \tag{6}$$

where:

- R_k is the revenue from enforcement activity (compliance fees, taxation of supervised Bitcoin activity).

- H_k is the option value of maintaining neutral rail access as a hedge against rival monetary weaponization (sanctions, SWIFT exclusion, capital freezes).

- C_k is the direct cost of the chosen strategy.

Case 1: Rival strategies s_{-k} include at least one "preserve."

If some rival preserves, the neutral rail persists. If k bans, $H_k = 0$ (loses hedge). If k preserves, $H_k > 0$ and $R_k \geq 0$ (can tax supervised activity). Since $C_k(\text{preserve}) \leq C_k(\text{ban})$ (suppression requires active enforcement), $U_k(\text{preserve}) > U_k(\text{ban})$.

Case 2: All rivals choose "ban" ($s_j = \text{ban}$ for all $j \neq k$).

If all rivals ban and k also bans, the rail is fully suppressed: $R_k = 0$, $H_k = 0$, but $C_k(\text{ban}) > 0$. If k deviates to "preserve," k captures all fleeing capital from rival jurisdictions ($R_k \gg 0$) and retains the hedge ($H_k > 0$). Thus $U_k(\text{preserve}) \gg U_k(\text{ban})$.

In both cases, "preserve" yields a payoff at least as large as "ban." Since Case 2 yields strict inequality, "preserve" is the unique best response for at least one k, which by induction (Case 1) propagates to all enforcers. □

5.1 Empirical Validation

The predator hedging mechanism is observable in practice:

- **Russia (2022–present):** Despite nominally restricting cryptocurrency domestically, Russia authorized Bitcoin for international settlements to circumvent Western sanctions—exhibiting dual-role behavior ($\text{CT}_1 + \text{EV}_2$).

- **El Salvador (2021–present):** Small sovereign adopts Bitcoin as legal tender, demonstrating EV_2 first-mover behavior; IMF pressure fails to reverse the policy.

- **United States (2024–present):** Establishes strategic Bitcoin reserve while maintaining SEC enforcement—$\text{CT}_1 + \text{EV}_2$ simultaneously.

6. Duration Fragility

We now establish that the principal alternative store of value—equity in AI companies—faces structural vulnerabilities that strengthen the case for scarcity-based settlement.

6.1 Moat Half-Life Under AI Acceleration

Definition 4 (Moat Half-Life)**.** Let $H(t)$ denote the competitive moat half-life of a technology firm at time t. Under AI-driven acceleration:

$$H(t) = H_0 \, e^{-\alpha t} \,, \tag{7}$$

where $H_0 > 0$ is the initial moat half-life and $\alpha > 0$ captures the rate of AI-driven competitive erosion.

Historical calibration suggests $H_0 \approx 15$ years for pre-AI technology moats (e.g., Microsoft's OS dominance persisted for approximately 15 years before commoditization pressure materialized). Under AI acceleration with $\alpha \approx 0.20$, projected moat half-lives compress to $H \approx 3$–5 years.

6.2 Multiple Compression

Proposition 3 (Duration Fragility)**.** *Let E_t denote a firm's current earnings, $r > 0$ the risk-free discount rate, and $\alpha \geq 0$ the moat erosion rate. The earnings-based terminal value satisfies:*

$$V_t = \frac{E_t}{r + \alpha} \,, \tag{8}$$

which is strictly decreasing in α. In particular:

(a) At $\alpha = 0$ (no moat erosion): $P/E = 1/r$.

(b) At $\alpha = r$ (moat erodes at discount rate): $P/E = 1/(2r)$, a 50% compression.

(c) As $\alpha \to \infty$ (instantaneous commoditization): $V_t \to 0$.

Proof. The terminal value of a perpetual earnings stream E_t subject to exponential decay at rate α is

$$V_t = \int_0^\infty E_t \, e^{-\alpha s} \, e^{-rs} \, ds = E_t \int_0^\infty e^{-(r+\alpha)s} \, ds = \frac{E_t}{r + \alpha} \,.$$

Statements (a)–(c) follow by substitution. □

Remark (The 100× Compression Scenario). A firm earning \$10/share with $r = 0.10$ and $\alpha = 0$ trades at $P/E = 10$ (\$100/share). With $\alpha = 0.20$ (moat half-life ≈ 3.5 years): $P/E = 3.3$ (\$33/share)—a 67% haircut with *identical* current earnings. At $\alpha = 0.90$: $P/E = 1.0$ (\$10/share)—a 90% haircut. The fiber-optic precedent (1997–2010: margins from 60% to 15%) demonstrates this pattern at infrastructure scale.

6.3 Implication for Settlement Asset Selection

Bitcoin has no earnings and therefore no duration fragility. Its value derives entirely from scarcity (21M fixed supply) and network effects (Metcalfe-type scaling)—properties immune to competitive moat erosion. For long-duration wealth preservation across generational time horizons, the absence of duration fragility is a structural advantage over any earnings-dependent asset class.

7. Empirical Evidence

Observation	Classification	Supports
Russia authorizes crypto for international trade (2024)	$CT_1 + EV_2$	Lemma 2, (G5)
Iran uses Bitcoin mining for energy monetization (2020–)	$CT_1 + EV_3$	(G4)
El Salvador accumulates 6,000+ BTC (2021–2025)	EV_2	E4, K1
US establishes strategic Bitcoin reserve (2024–)	$CT_1 + EV_2$	Lemma 2, (G5)
China bans crypto trading but mines hash (2021–)	$CT_1 + EV_2/EV_3$	(G2), (G4)
NVIDIA P/E: 70× → 30× (2023–2026)	—	Prop. 3
Fiber-optic margins: 60% → 15% (1997–2010)	—	Historical precedent
Singapore issues 13 DPT licenses (2024)	EV_2	(G2), (G4)

Table 4: Empirical observations classified by actor taxonomy.

8. Falsification

Condition 1 (F7: Gridlock Closes)**.** The results of this paper are falsified if:

> *Synchronized global suppression eliminates all enforcement gaps* ***and*** *permanent tier-1 capability lockout prevents re-emergence.*

Specifically, F7 requires:

(i) All tier-1 enforcers (US, EU, China at minimum) simultaneously and permanently suppress Bitcoin access.

(ii) No tier-2 sovereign defects to capture fleeing capital.

(iii) Technical capability to run nodes and mine is permanently eliminated (not merely pushed underground).

(iv) The above conditions persist indefinitely (not merely during a crisis period).

F7 subsumes and strengthens F4 (stable cartel, Hash 2026a): it requires not just a cartel but synchronized action with permanent capability destruction. Under Assumption 1, the inter-predator competition coefficients ε_{jk} would need to collapse to zero—meaning geopolitical competition itself would need to end.

9. Limitations

(i) **Parameter estimation:** The Lotka–Volterra coefficients (a_k, b_k, d_k, ε_{jk}) are modeled qualitatively. Empirical calibration would strengthen the results but is not required for the qualitative survival conclusion ($x^* > 0$).

(ii) **Regime changes:** The model assumes multipolarity persists. If W1 (Open World) transitions to W2 (Closed World—a single global hegemon), the inter-predator competition coefficients collapse to zero and F7 becomes possible.

(iii) **Duration fragility calibration:** The moat erosion rate α is estimated from limited historical precedent. If AI creates genuinely permanent moats (unprecedented in technological history), the equity compression argument weakens.

(iv) **Biological analogy limits:** Monetary enforcement dynamics differ from biological predator-prey systems in that actors are strategic (game-theoretic) rather than mechanistic. The Lotka–Volterra structure captures the competitive dynamics but understates the full strategic complexity. A richer formulation using differential games (Isaacs, 1965) could refine the quantitative predictions without altering the qualitative survival result.

10. Conclusion

The enforcement coordination problem is not merely a prisoner's dilemma—it is a structurally guaranteed gridlock arising from inter-predator competition. Competing enforcement actors cannot suppress the neutral settlement rail because each preserves it as a hedge against rivals. This result completes the causal chain:

1. Exit is self-reinforcing (Hash, 2026a, Theorem 1).
2. Coordination to stay fails *because enforcement actors are in permanent gridlock* (Theorem 1).
3. The resulting equilibrium is absorbing (Hash, 2026a, Theorem 3).
4. Bitcoin is the unique survivor of seven-property elimination (Hash, 2026b).
5. The result extends to autonomous agents at zero trust (Hash, 2026c).

The correct framing for Bitcoin's survivability is not eradication risk but *containment*. Enforcement actors will regulate, tax, and monitor Bitcoin activity at the application layer—but they cannot and will not eliminate the settlement layer, because doing so would surrender their hedge against rival enforcers. The neutral rail survives not despite enforcement but *because of* the competitive structure of enforcement itself.

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Author's Note

"Sean Hash" is a pen name. The author is a single human individual writing under a pseudonym. The framework is designed to be evaluated on its logical structure—every claim derives from four empirical axioms, and every claim specifies falsification conditions. The author's identity is irrelevant to whether the axioms hold.

The author acknowledges modest priors: a preference for multipolar worlds over global monopoly, and for individual economic sovereignty over total state control of capital. These do not predetermine the framework's conclusions—the game-theoretic derivation works for purely selfish actors regardless of values.

The author also acknowledges a real moral cost: a neutral settlement layer will process transactions for harmful actors. This cost is real, but settlement is not acceptance—the acceptance game produces a natural enforcement equilibrium through rational counterparty decisions, without requiring protocol-level censorship.

For full disclosure on authorship, moral position, and the settlement-acceptance distinction, see the Author's Note (bitcoingametheory.com/rfc/BGT-AUTHOR.txt).

Disclosure

Appendix: Notation

Symbol	Definition
$x(t)$	Neutral rail usage (prey population proxy)
$y_k(t)$	Enforcement intensity of actor k
n	Number of enforcement actors
r	Intrinsic growth rate of neutral rail adoption
K	Carrying capacity (maximum adoption)
a_k	Suppression efficiency of enforcer k
b_k	Benefit enforcer k extracts from enforcement
d_k	Cost/decay rate of enforcement effort for k
ε_{jk}	Inter-predator competition coefficient ($j \neq k$)
x^*, y_k^*	Interior equilibrium values
$H(t)$	Competitive moat half-life at time t
H_0	Initial moat half-life (pre-AI)
α	Rate of AI-driven moat erosion
E_t	Current earnings of a firm
V_t	Terminal value of earnings stream
$U_k(s_k, s_{-k})$	Enforcer k's payoff under strategy profile
R_k, H_k, C_k	Revenue, hedge value, and cost components
CT_1–CT_3	Coordination taxer tiers
EV_1–EV_3	Exit-valve participant tiers

Table 5: Summary of notation.