LUNARIS Technical Appendix

Economic Models and Calculations

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1. Token Supply Mathematical Models

1.1 MOONX Supply Dynamics

Differential Equation:

$$\frac{dS}{dt} = E(t) - B(t)$$

Where:

- $S(t)$ = Circulating supply at time t
- $E(t)$ = Total emission rate
- $B(t)$ = Total burn rate

Emission Function:

$$E(t) = \sum_{i=1}^{N} \min(E_i(t), C_i)$$

Where:

- N = Total active users
- $E_i(t)$ = User i's potential earnings
- C_i = User i's tier-based daily cap

- $C_i \in \{100, 300, 800, 2000, 5000\}$ MOONX

Burn Function:

$$B(t) = B_{market}(t) + B_{craft}(t) + B_{upgrade}(t) + B_{storage}(t)$$

$$B_{market}(t) = 0.5 \times 0.02 \times V_{market}(t)$$

(50% of 2% marketplace fee)

Example Calculation (Month 1):

Assumptions:

- 1,000 active users
- Average tier: 2 (cap = 300 MOONX/day)
- Activity rate: 70% of users active daily
- Average actual earning: 60% of cap

Daily Emission:

$$E = 1000 \times 0.7 \times (300 \times 0.6) = 126,000 \text{ MOONX/day}$$

Daily Burns:

- Marketplace (volume $50K/day): $50,000 \times 0.02 \times 0.5/0.10 = 5,000$ MOONX
- Crafting (50 items/day): $50 \times 100 = 5,000$ MOONX
- Upgrades (10 upgrades/day): $10 \times 500 = 5,000$ MOONX
- Storage: 1,000 MOONX

Total Burn = 16,000 MOONX/day

Net Daily Change: 126,000 - 16,000 = **110,000 MOONX/day** (87% net inflation)

Mitigation: DAO buyback activates at 50,000 MOONX/day target

1.2 LUNAR Token Distribution Schedule

Total Supply: 100,000,000 LUNAR (immutable)

Vesting Schedule (Linear):

Community Rewards (40M):

- Month 0: 0 LUNAR
- Month 12: 10M LUNAR (25% released)
- Month 24: 20M LUNAR (50% released)
- Month 36: 30M LUNAR (75% released)
- Month 48: 40M LUNAR (100% released)

Team (20M):

- Months 0-12: 0 LUNAR (cliff)
- Month 13: 416,667 LUNAR
- Month 24: 5M LUNAR
- Month 48: 20M LUNAR (full unlock)

Circulating Supply Projection:

- Month 1: 20M (Treasury + Liquidity)
- Month 6: 25M (+5M community rewards)
- Month 12: 30M (+10M community, no team yet)
- Month 18: 37.5M (+7.5M community, +2.5M team starting)
- Month 24: 45M (+20M community, +5M team)
- Year 5: 100M (all vested)

1.3 MOON-3 Deflationary Model

Fixed Supply: 10,000,000 MOON-3

Emission Rate (100K active users):

- Tier 4-5 Mining: 500 users × 0.01 MOON-3/day = 5 MOON-3/day
- Eclipse Events (3/year): 1,500 MOON-3/year = 4.1 MOON-3/day avg
- Legendary Staking: 100 Legendary × 0.5 = 50 MOON-3/day

Total Emission: ~60 MOON-3/day = 21,900/year

Burn Rate:

- Fusion Crafts: 20 crafts/day × 100 = 2,000 MOON-3/day
- Tier Skips: 1 skip/day × 200 = 200 MOON-3/day

Total Burn: ~2,200 MOON-3/day = 803,000/year

Net Supply Change:

$$\frac{dS}{dt} = 21,900 - 803,000 = -781,100 \text{ MOON-3/year}$$

Supply Depletion Timeline:

- Year 1: 9,218,900 remaining (7.8% burned)
- Year 5: 6,094,500 remaining (39.1% burned)
- Year 10: 2,189,000 remaining (78.1% burned)

Extreme scarcity creates long-term value appreciation.

2. Equilibrium Stability Analysis

2.1 Price Stability Theorem

Theorem: If MOONX price drops below equilibrium P_{eq}, and DAO buyback $B(t) = \alpha \times P(t)$ where , then $P(t)$ converges to P_{eq} asymptotically.

Proof:

Let $P(t)$ = MOONX price at time t
Let $S(t)$ = Supply at time t
Let $D(t)$ = Demand at time t

Market clearing: $P(t) = D(t)/S(t)$

If , buyback activates:

$$B(t) = \alpha \times (P_{eq} - P(t))$$

(proportional controller)

New supply: $S(t+1) = S(t) - B(t)$

New price:

$$P(t+1) = \frac{D(t+1)}{S(t) - \alpha(P_{eq} - P(t))}$$

Assume $D(t)$ roughly constant short-term, $D(t+1) \approx D(t)$:

$$P(t+1) \approx \frac{D(t)}{D(t)/P(t) - \alpha(P_{eq} - P(t))}$$

$$= \frac{P(t) \times D(t)}{D(t) - \alpha \times P(t) \times (P_{eq} - P(t))}$$

Linearize around P_{eq}:
$\Delta P = P(t) - P_{eq}$

$$P(t+1) - P_{eq} \approx (1 - \alpha \times P_{eq}) \times \Delta P$$

If , then , so $\Delta P \to 0$ exponentially.

Thus $P(t) \to P_{eq}$. **QED.**

Practical Implication: Setting $\alpha = 0.3/P_{eq}$ ensures convergence.

2.2 Emission-Burn Balance

Target Steady State:

$$E_\infty = 1.1 \times B_\infty$$

(10% net inflation)

Feedback Loop:

If (inflation too high):

- DAO votes to reduce emission caps by 10%
- E decreases
- Ratio normalizes

If (deflation):

- DAO votes to increase caps by 10%
- E increases
- Ratio normalizes

Simulation (conceptual):

```
Initial: E = 100,000, B = 80,000
Month 0: E/B = 1.25 → Reduce E by 10%
Month 1: E = 90,000, B = 84,000 (volume grows)
Month 2: E/B = 1.07 → Close to target
...
Converges to E/B ≈ 1.1
```

3. Rarity Probability Calculations

3.1 Phase-Dependent Rarity Matrix

Weight Matrix W:

Phase	Common	Uncommon	Rare	Epic	Legendary
New Moon	0.80	0.20	0	0	0
Waxing Crescent	0.70	0.25	0.05	0	0
First Quarter	0.60	0.30	0.10	0	0
Waxing Gibbous	0.50	0.35	0.12	0.03	0
Full Moon	0.40	0.40	0.15	0.04	0.01

(Waning phases mirror waxing)

Probability Function:

$$P(r|\phi) = \frac{W_{\phi,r}}{\sum_{r'} W_{\phi,r'}}$$

Example (Full Moon):

$$P(\text{Common}) = \frac{0.40}{0.40 + 0.40 + 0.15 + 0.04 + 0.01} = 0.40$$

$$P(\text{Legendary}) = \frac{0.01}{1.00} = 0.01 \text{ (1\% chance)}$$

Expected Value Calculation:

If prices are:

- Common: $10
- Uncommon: $25
- Rare: $50
- Epic: $150
- Legendary: $500

Expected mint value at Full Moon:

$$E = 0.40 \times 10 + 0.40 \times 25 + 0.15 \times 50 + 0.04 \times 150 + 0.01 \times 500$$
$$= 4 + 10 + 7.5 + 6 + 5 = \$32.50$$

But mint cost = $50 (set above expected value to prevent arbitrage)

3.2 VRF Randomness Verification

Chainlink VRF Implementation:

Request:

- User calls mint() → contract requests VRF
- Gas limit: 200,000
- Callback: 6 blocks later

Callback:

- Receive random number R (256-bit)
- Compute rarity index: $i = R \mod 100$
- Map i to rarity based on cumulative weights

Cumulative Weight Mapping (Full Moon):

```
[0, 40)    → Common
[40, 80)   → Uncommon
[80, 95)   → Rare
```

```
[95, 99)   → Epic
[99, 100)  → Legendary
```

If $R \mod 100 = 99$ → Legendary mint

Verification: Anyone can check VRF proof on-chain to confirm fairness.

4. Mining Reward Simulations

4.1 Individual Session Calculation

Formula:

$$R = R_{base} \times M_{rover} \times M_{phase} \times M_{region} \times T_{session}$$

Example Scenario:

User:

- Uncommon Plot (Titanium specialist, Mare Tranquillitatis)
- Rare Rover (2.5× efficiency, Titanium-spec)
- Phase: Full Moon (2.0× multiplier)
- Region: Ti weight 1.0 → +30% bonus
- Session: 4 hours

Calculation:

- R_{base} = 40 MOONX/hour
- M_{rover} = 2.5
- M_{phase} = 2.0
- M_{region} = 1.3 (1 + 0.3×1.0)
- $T_{session}$ = 4

$$R = 40 \times 2.5 \times 2.0 \times 1.3 \times 4$$
$$= 40 \times 26 = 1,040 \text{ MOONX}$$

At $0.10/MOONX = **$104 per 4-hour session**

Daily Earnings (2 sessions): $208
Monthly (30 days): $6,240

ROI: If total NFT cost = $150 (Uncommon Plot $25 + Rare Rover $99), breakeven in <1 day.

4.2 Population-Level Simulation

Assumptions:

- 10,000 users
- Distribution: 60% Tier 1-2, 30% Tier 3-4, 10% Tier 5
- Average daily activity: 50% of users
- Average session length: 3 hours

Expected Daily Emission: ~150,000 MOONX/day

5. DAO Treasury Projections

5.1 Revenue Sources

Month 1 (1,000 users):

- NFT mints: 1,000 × $30 avg = $30,000
- Marketplace fees (2%): $50K volume × 0.02 = $1,000
- Partnership: $0 (too early)
- **Total:** $31,000

Month 6 (5,000 users):

- Mints: 4,000 × $30 = $120,000
- Marketplace: $500K × 0.02 = $10,000
- Partnership: $5,000
- **Total:** $135,000

Month 12 (10,000 users):

- Mints: 5,000 × $30 = $150,000
- Marketplace: $2M × 0.02 = $40,000
- Partnership: $20,000
- **Total:** $210,000

5-Year Projection: ~$15M cumulative

5.2 Treasury Allocation

DAO-Voted Split:

- 30% → Buyback & burn MOONX
- 30% → Community rewards/airdrops
- 20% → Development/audits

- 15% → Marketing/partnerships
- 5% → Emergency reserve

Month 12 Treasury Use:

- $210,000 × 0.30 = $63,000 → Buyback 630,000 MOONX at $0.10 → Burn 315,000
- $210,000 × 0.30 = $63,000 → Airdrop to active users
- $210,000 × 0.20 = $42,000 → Development
- $210,000 × 0.15 = $31,500 → Marketing
- $210,000 × 0.05 = $10,500 → Reserve

6. Gas Cost Estimations

6.1 Polygon PoS Costs (October 2025)

Current Gas Price: ~30 Gwei average
MATIC/POL Price: ~$0.50

Transaction Types:

Mint Plot NFT:

- Gas used: 150,000
- Cost: $150,000 \times 30 \times 10^{-9} \times 0.50 = \$0.00225 \approx \$0.002$

Stake NFT:

- Gas: 80,000
- Cost: $0.0012

Mining Session (claim):

- Gas: 100,000
- Cost: $0.0015

Marketplace Trade:

- Gas: 120,000
- Cost: $0.0018

Daily Cost (active user, 2 sessions):
$0.002 + $0.0015×2 = $0.005/day = **$0.15/month**

Negligible compared to earnings ($100+/month).

6.2 Gas Optimization Techniques

Batch Minting:

- Single mint: 150K gas
- Batch 3 mints: 250K gas (83K per mint, **44% savings**)

Storage Packing:

```
struct PlotMetadata {
    int32 latitude;     // 4 bytes
    int32 longitude;    // 4 bytes
    uint8 region;       // 1 byte
    uint8 rarity;       // 1 byte
    // Total: 10 bytes in single uint256 slot (32 bytes)
    // Saves 1 SSTORE (~20K gas)
}
```

ERC-721A Optimization:

Consecutive token IDs minted in batch share storage, reducing mint cost from 150K → 90K per NFT.

Conclusion

This appendix provides mathematical foundations for LUNARIS economic claims. All models are subject to real-world validation and DAO governance adjustments.

Key Takeaways:

1. Token supply reaches equilibrium via DAO buyback controller
2. MOON-3 is structurally deflationary (78% burned in 10 years)
3. Mining ROI positive within days for active users
4. Gas costs negligible (<1% of earnings)
5. Treasury sustainable for 5+ years of operations

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