NextGen

Project Title

Digital Twin of Crypto Adoption vs Financial Crime and Government Control

-A system dynamics digital twin to study policy trade-offs in crypto regulation

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Context and Rationale for Modeling

Problem Context

- Rapid growth of crypto adoption due to decentralization
- Use of crypto in illicit financial activities
- Limited visibility and traceability for authorities
- Strong regulations and bans often push activity underground
- Government responses occur with policy and enforcement delays

Regulatory actions often produce unintended system-level effects.

Modeling Motivation

- Interaction between adoption, crime, trust, and control is dynamic
- Cause–effect relationships are non-linear
- Feedback loops amplify or counter system behavior
- Delays weaken policy effectiveness
- Static or isolated analysis is insufficient

System Dynamics enables analysis of behavior over time.

THE ROOT PROBLEM WITH CONVETIONAL CURRENCY IS ALL THE TRUST THAT'S REQUIRED TO MAKE IT WORK.
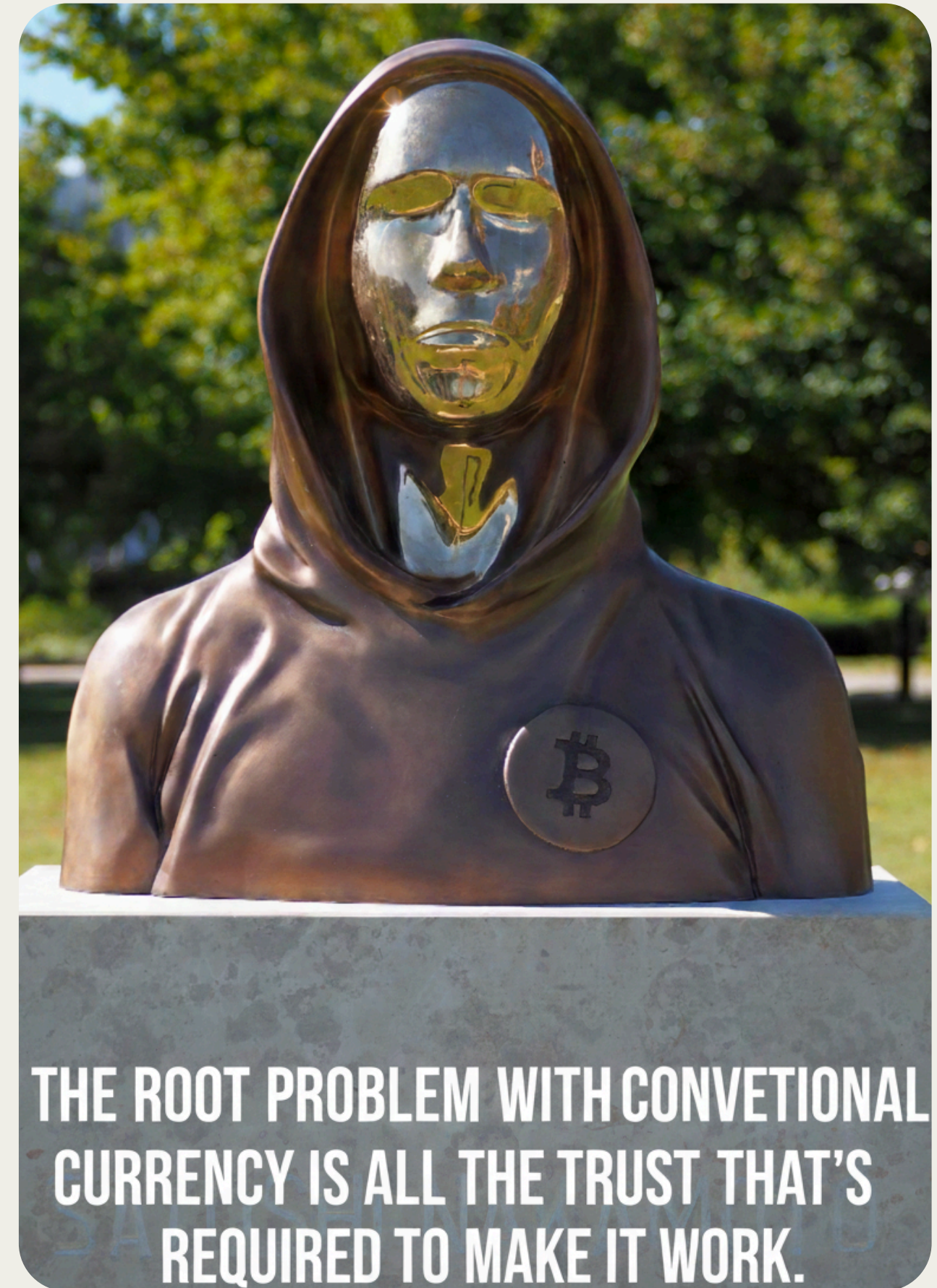
POLICY QUESTIONS AND ANALYTICAL FOCUS

Analysis Focus

- Examination of interactions between crypto adoption, illicit financial activity, and government response
- Emphasis on system behavior resulting from regulatory and enforcement actions over time
- Assessment of trade-offs between decentralization, regulation, and enforcement

Key Policy Questions

- Why does illicit crypto activity persist despite strict regulations?
- How do bans and strong controls affect transparency?
- What is the impact of delayed enforcement on policy outcomes?
- How does public trust influence adoption and regulatory effectiveness?

Purpose of Analysis

- To understand unintended effects of regulatory actions by government,
- To identify leverage points for balanced policy design of crypto,
- To support informed policy discussion rather than numerical prediction,
- To provide a structured basis for scenario exploration of regulatory strategies

DIGITAL TWIN REPRESENTATION (VENSIM)
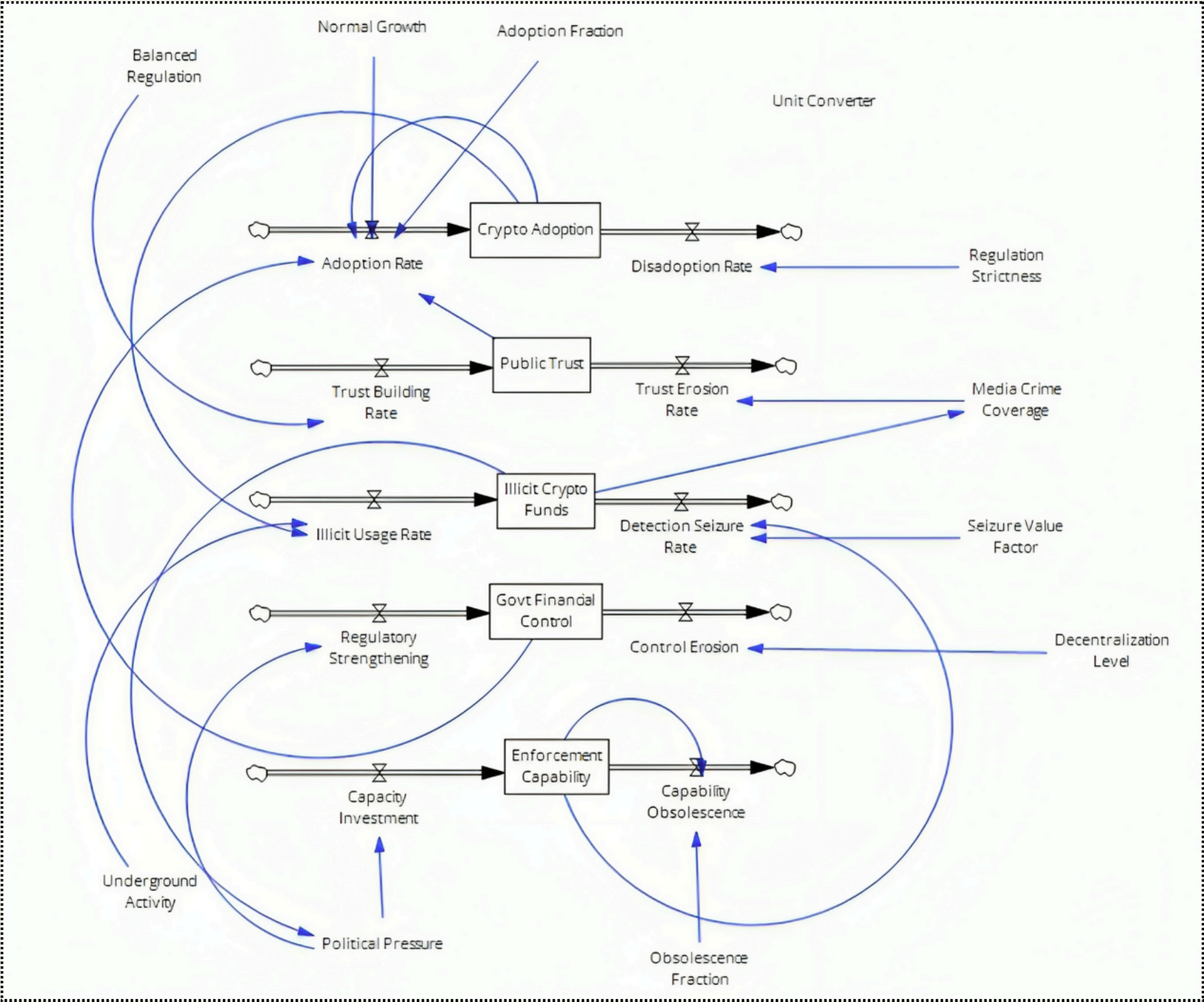
Model Components

Stocks (Level Variables)
- *Crypto Adoption*
- *Public Trust*
- *Illicit Crypto Funds*
- *Govt Financial Control*
- *Enforcement Capability*

Auxiliary Variables
- *Balanced Regulation*
- *Normal Growth*
- *Adoption Fraction*
- *Regulation Strictness*
- *Media Crime Coverage*
- *Seizure Value Factor*
- *Decentralization Level*
- *Underground Activity*
- *Political Pressure*
- *Obsolescence Fraction*
- *Unit Converter*

Flows (Rate Variables)
Crypto Adoption
- *Adoption Rate (Inflow)*
- *Disadoption Rate (Out)*

Public Trust
- *Trust Building Rate (I)*
- *Trust Erosion Rate (O)*

Illicit Crypto Funds
- *Illicit Usage Rate (I)*
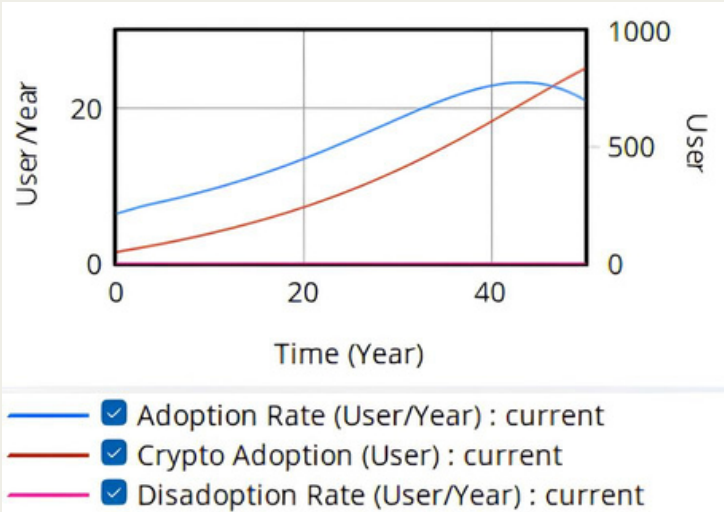- *Detection Seizure Rate (O)*

Govt Financial Control
- *Regulatory Strengthening (Inflow)*
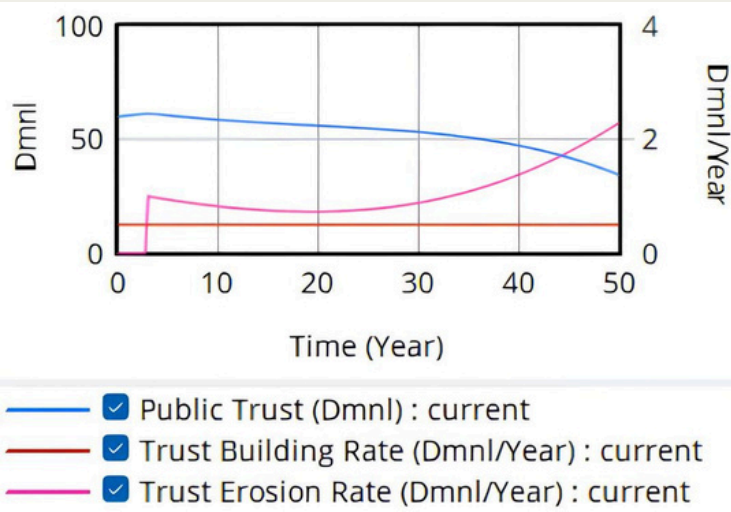- *Control Erosion (O)*

Enforcement Capability
- *Capacity Investment (I)*
- *Capability Obsolescence (O)*

SIMULATION RESULTS: SYSTEM BEHAVIOR OVER TIME

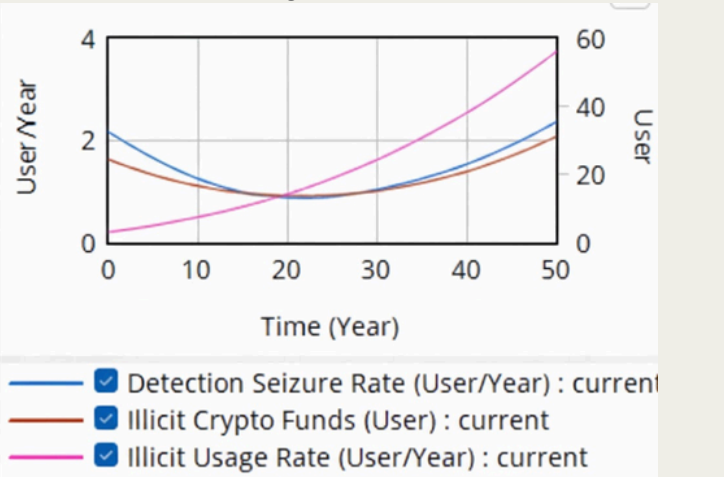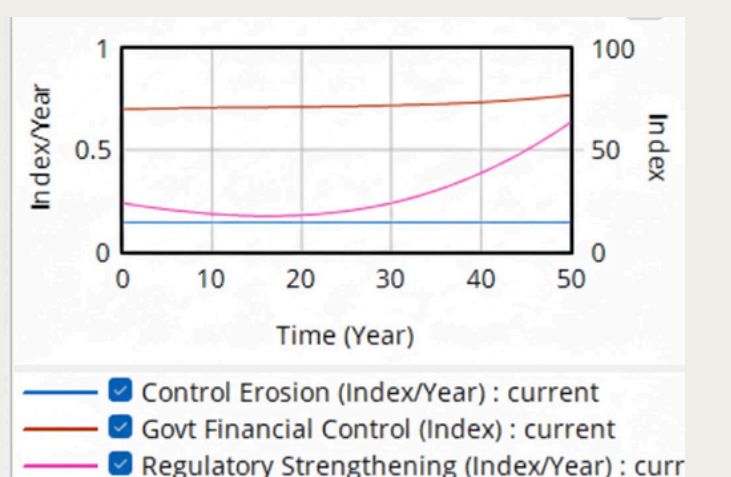## 1. Crypto Adoption Dynamics

- ☑ Adoption Rate (User/Year) : current
- ☑ Crypto Adoption (User) : current
- ☑ Disadoption Rate (User/Year) : current

2. Public Trust Evolution

- ☑ Public Trust (Dmnl) : current
- ☑ Trust Building Rate (Dmnl/Year) : current
- ☑ Trust Erosion Rate (Dmnl/Year) : current

3. Illicit Activity and Enforcement

- ☑ Detection Seizure Rate (User/Year) : current
- ☑ Illicit Crypto Funds (User) : current
- ☑ Illicit Usage Rate (User/Year) : current

4. Government Financial Control

- ☑ Control Erosion (Index/Year) : current
- ☑ Govt Financial Control (Index) : current
- ☑ Regulatory Strengthening (Index/Year) : curr

5. Enforcement Capability Development

- ☑ Capability Obsolescence (Capacity Units/Year) : curren
- ☑ Capacity Investment (Capacity Units/Year) : current
- ☑ Enforcement Capability (Capacity Units) : current
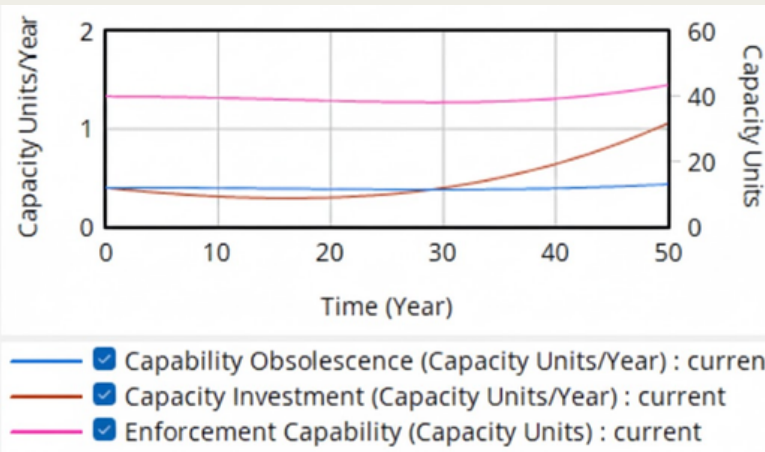
INITIAL VALUES & CONSTANT VALUES

| STOCK VARIABLES	INITIAL VALUES	SOURECES
Crypto Adoption	50	Calculated as a % of the "Total Addressable Market" (TAM) or based on existing user wallet data (e.g., Chainalysis Global Adoption Index).
Public Trust	60	Consumer sentiment surveys (e.g., Edelman Trust Barometer) or specialized FinTech trust indices.
Illicit Crypto Funds	20	Annual "Crypto Crime Reports" (e.g., Chainalysis or TRM Labs) indicating the % of total volume linked to illicit addresses.
Govt Financial Control	70	Central Bank indices or the "Financial Secrecy Index"; represents the baseline oversight of the traditional banking system.
Enforcement Capability	40	Budgetary allocations for cybercrime divisions or historical "clearance rates" of reported digital financial crimes.

# POLICY INSIGHTS FROM THE REGULATORY DIGITAL TWIN
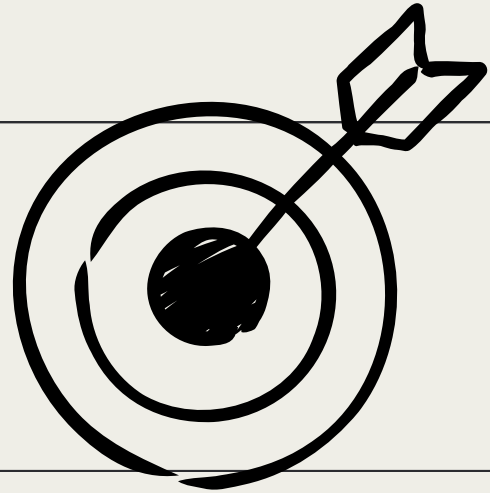
The Core Point

The goal isn't to predict crypto prices, but to create a Policy Sandbox. By building a Digital Twin, we simulate the **"Tug-of-War"** between **innovation** (Adoption) and **security** (Control). The point is to identify the tipping point where regulation stops protecting the public and starts pushing financial activity into unmonitored "Dark" channels,
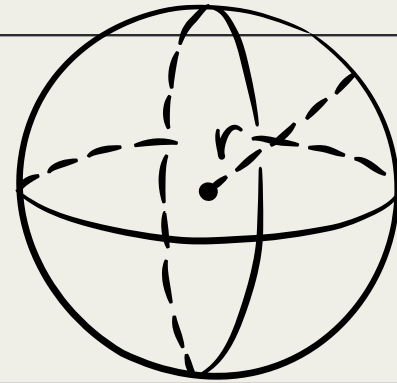
What We Have Developed

We have engineered a Dynamic Feedback Model that captures the non-linear relationship between enforcement and crime. Unlike a static report, our twin shows how delays in legislation create **"windows of opportunity"** for illicit funds to grow exponentially, and how "Trust" acts as a volatile stock that can crash the entire ecosystem if government over-regulation occurs,
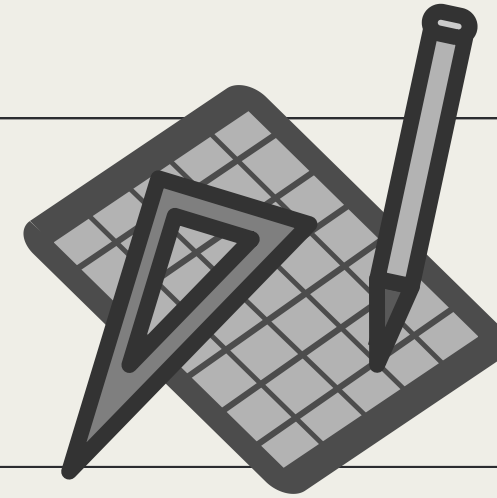
Critical Issues Faced

01 | Modeling the "Unmeasurable"
Issue: Variables like Political Pressure & Underground activity have no units or official data,
Solution: Used 0-to-1 Normalized Ratios ,
02 | Capturing Hidden Transactions
Issue: Illicit Funds are hidden by design and impossible to track directly.
Solution: Created a Parallel Stock that grows alongside adoption to simulate the "hidden" economy.
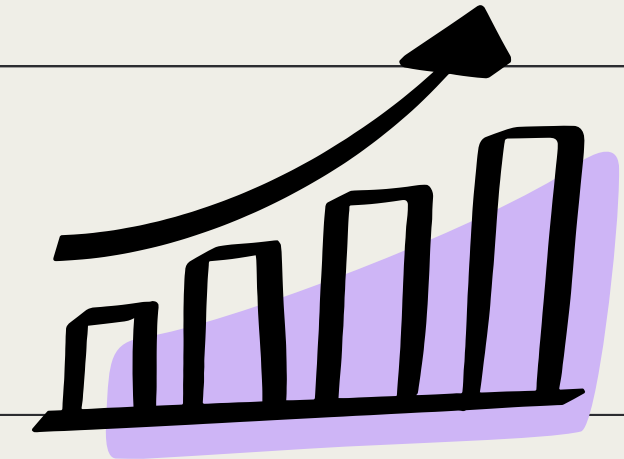
The Critical Insight

We discovered a **"Backfire Loop"** In our simulations, when Government Control is applied too rapidly (**a sudden ban**), it doesn't delete illicit funds; it simply **increases** the Delay in detection. The Digital Twin proves that adaptive, moderate regulation actually results in a cleaner ecosystem than a total ban, because it keeps transactions within "visible" regulated flows,

CONCLUSION AND FUTURE SCOPE

Conclusion

- The digital twin captures how crypto adoption, financial crime, and government response co-evolve over time
- System behavior is driven by feedback loops and policy delays, not linear cause–and–effect
- Extreme regulation can backfire by increasing underground activity
- Balanced regulation with effective enforcement improves long-term stability

Key Insight

Crypto-related financial crime persists primarily due to delayed and reactive policy responses, with public trust acting as a critical mediating factor.

Future Scope

- Evaluation of alternative regulatory and enforcement strategies
- Extension to country-specific policy environments
- Inclusion of CBDC or formal digital currency interactions

Thank you!

Digital twins help reason about policy, not promote outcomes

ACM India Winter School 2025

Digital Twins using Vensim (System Dynamics)