“Structure and Dynamics of Trust in Anonymous and Identified Online Networks”

Complex Network Dynamics, CS-484
Project Presentation, Phase B

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Motivation & Problem Definition

- **The Context:** Trust is the cornerstone of online interaction (e-commerce, social bonds). Traditional networks rely on identity to establish trust.
- **The Problem:** Anonymous platforms (e.g. Bitcoin OTC) face high risks like fraud and Sybil attacks. They cannot rely on identity or legal recourse.
- **The Solution:** These platforms develop inherent reputation mechanisms based purely on behavioral history.
- **Research Goal:** To empirically compare the structure of trust in a purely anonymous network (Bitcoin OTC) versus a traditional identified network (Epinions).

Research Question & Hypotheses

- **Research Question:** *“How does anonymity affect the structure, stability, and diffusion of trust in online signed networks?”*
- **Hypothesis 1 (Polarization):** Anonymous networks will show higher volatility and use extreme ratings (-10 / +10) to signal scammers.
- **Hypothesis 2 (Robustness):** Anonymous networks will be more fragile due to centralization of trust in a few Hubs.
- **Hypothesis 3 (Structural Balance):** Anonymous networks will have fewer balanced triangles due to weaker social pressure.

Dataset Overview

Bitcoin OTC (Anonymous)

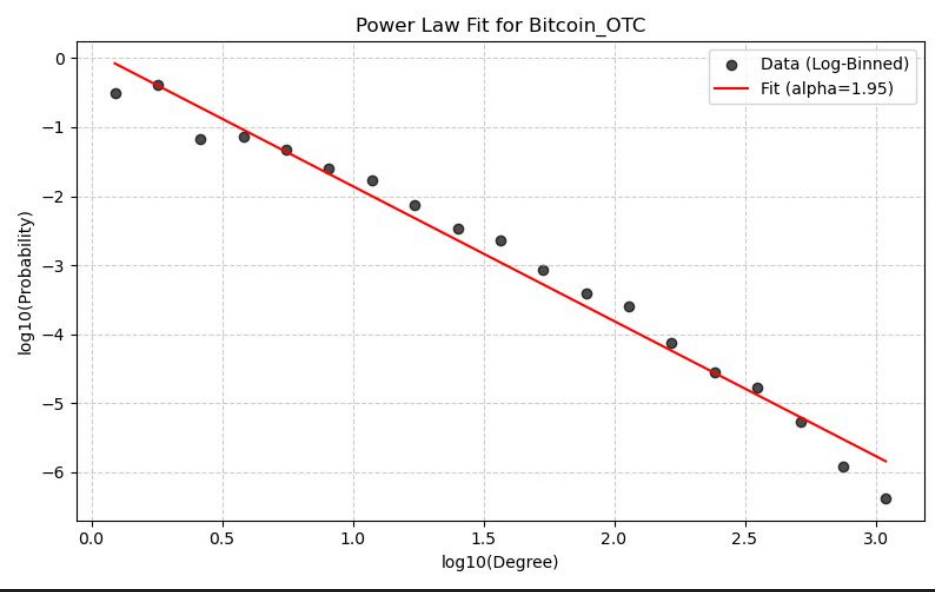
- “Web of Trust” for Peer-To-Peer Bitcoin trading.
- **Nodes:** 5,881 **| Edges:** 35,592
- **Rating Scale:** -10 (Distrust) to +10 (Trust)

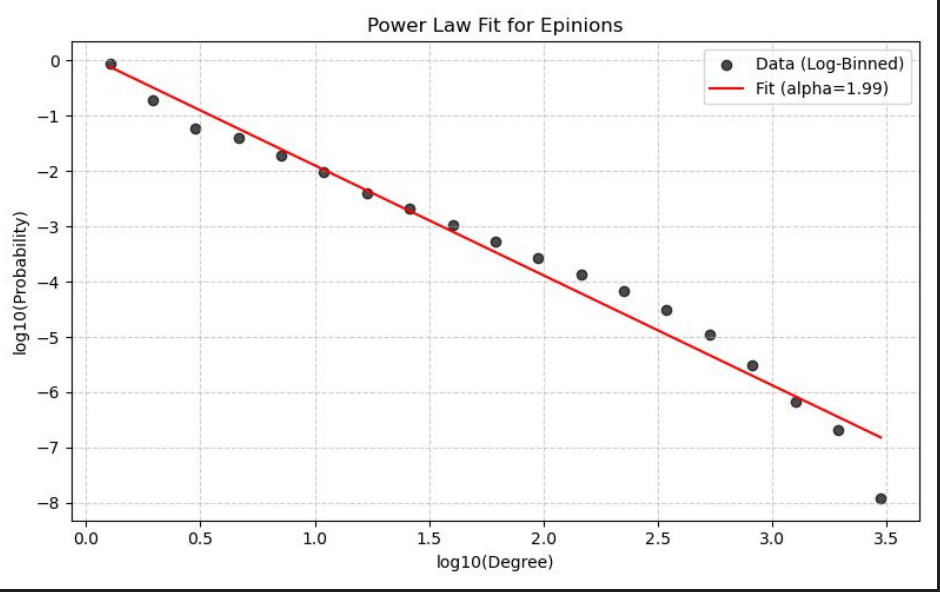
Epinions (Pseudo-Identified)

- Consumer review platform with social profiles.
- **Nodes:** 131,580 **| Edges:** 841,372
- **Rating Scale:** -1 (Distrust) to +1 (Trust)

Methodology

- **Phase A: Structure & Connectivity**
  - Power Law check (Scale-Free property)
  - Clustering Coefficient & Small World Effect
  - Reciprocity Analysis
- **Phase B: Centrality & Transitivity**
  - Weighted PageRank (for Global Reputation)
  - Trust Assortativity
- **Phase C: Signed Dynamics & Robustness**
  - Structural Balance (Triad classification)
  - Robustness check (targeted attack on Hubs)





Power Law Fit (Degree Distribution)

Both networks exhibit Scale-Free properties with a ≈ 2. Trust is concentrated in a small minority of nodes.

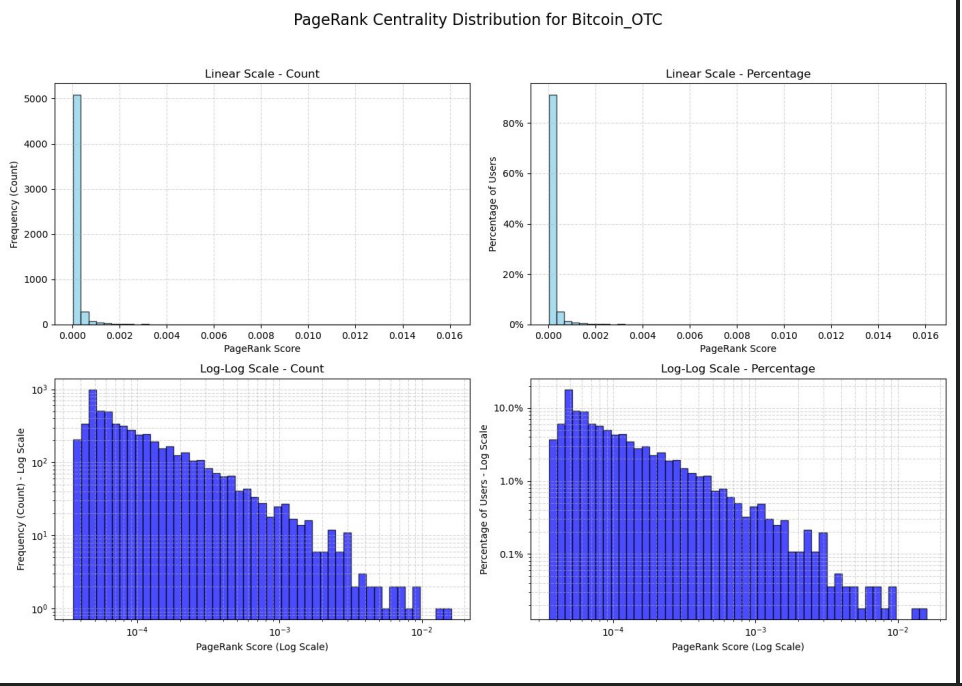
➔ The degree distribution follows $P(k) \sim k^{-\alpha}$. A smaller α (closer to 2) indicates a "heavier tail", meaning a higher probability of finding extreme outliers (super-hubs).

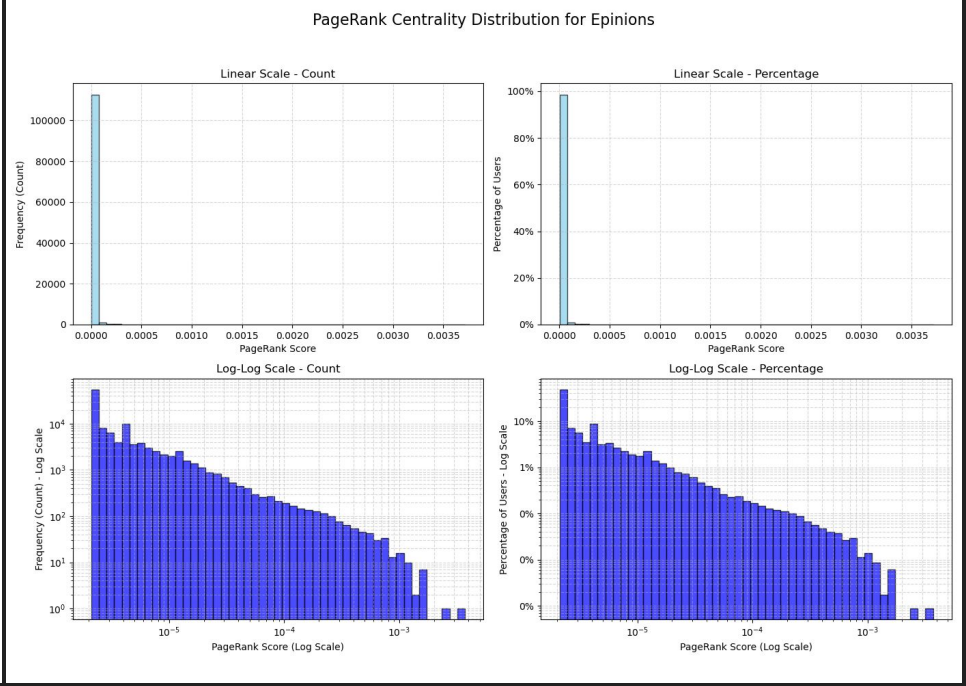
Bitcoin OTC (Anonymous)

- **Clustering Coefficient:** 0.151
  - 57% more clustered
- **Average Path Length:** 3.68 hops
- **Reciprocity:** 79% of edges are reciprocal

Epinions (Pseudo-Identified)

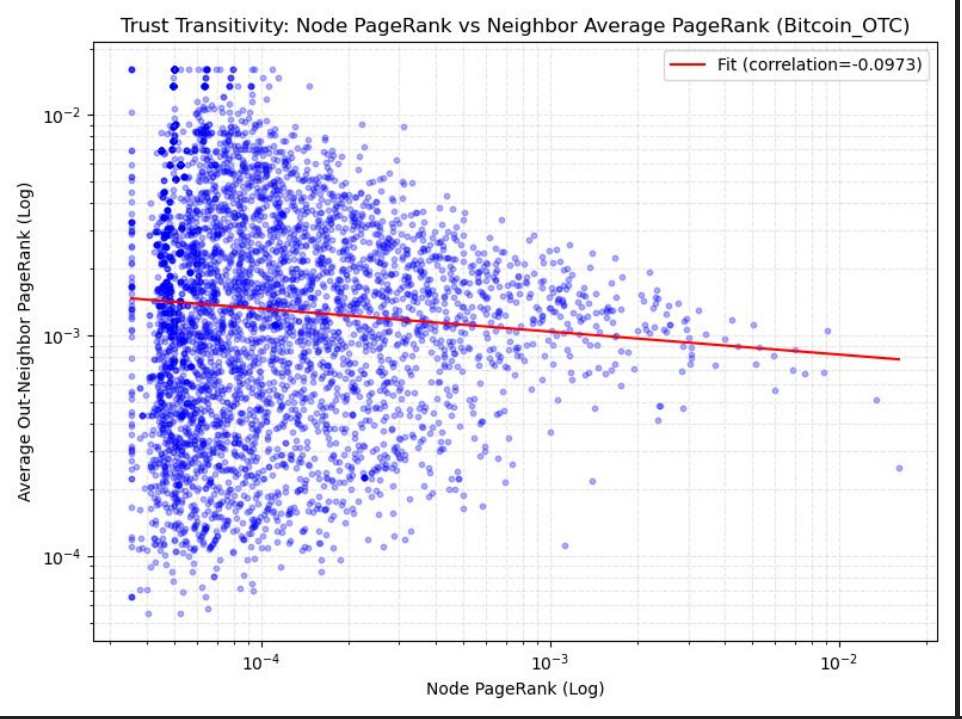
- **Clustering Coefficient:** 0.096
- **Average Path Length:** 4.24 hops
- **Reciprocity:** 31% of edges are reciprocal

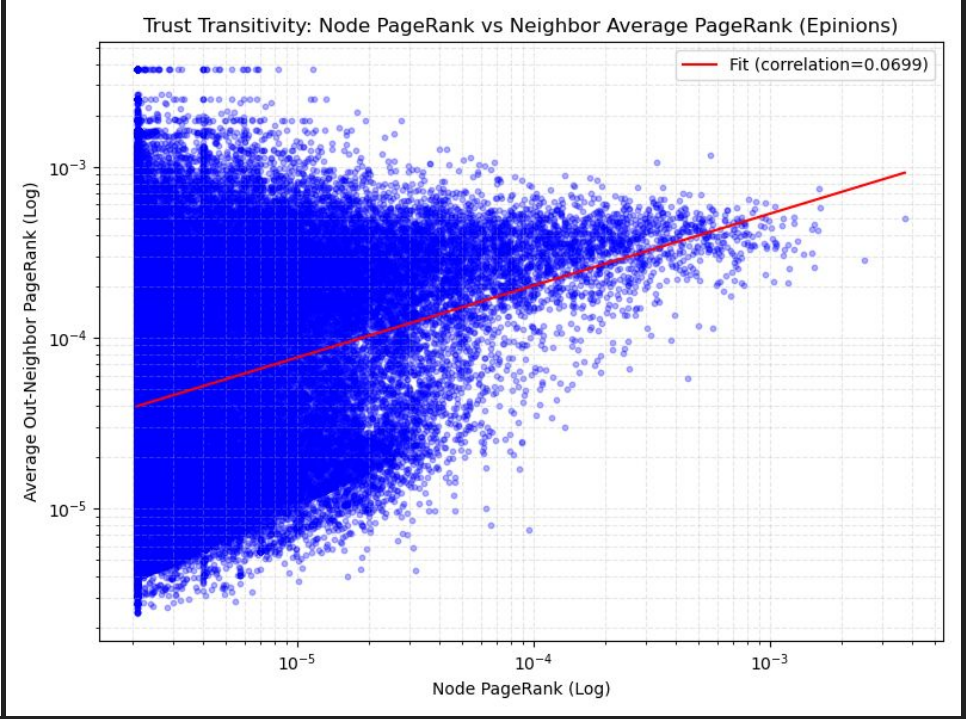




PageRank Distribution

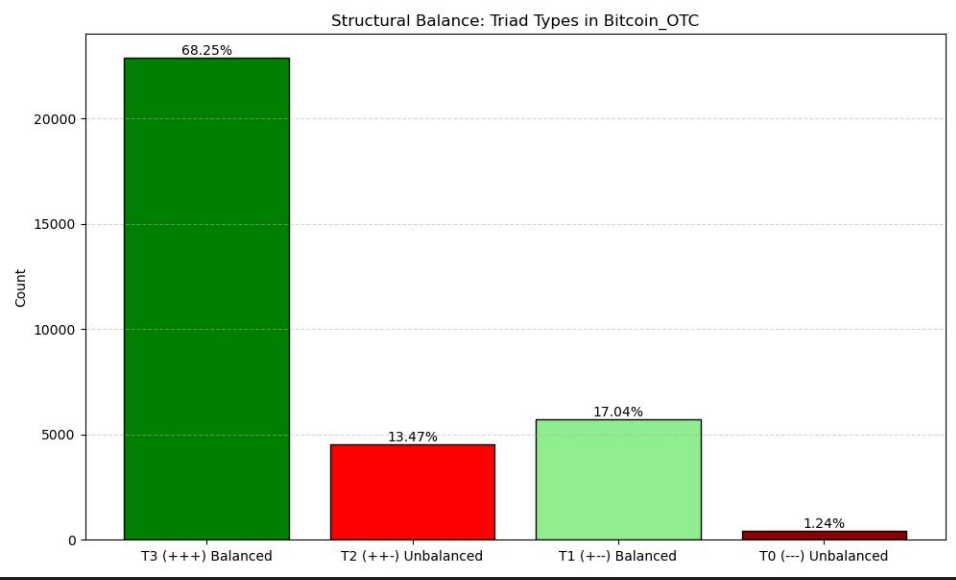
Confirms the “Rich-Get-Richer” effect.

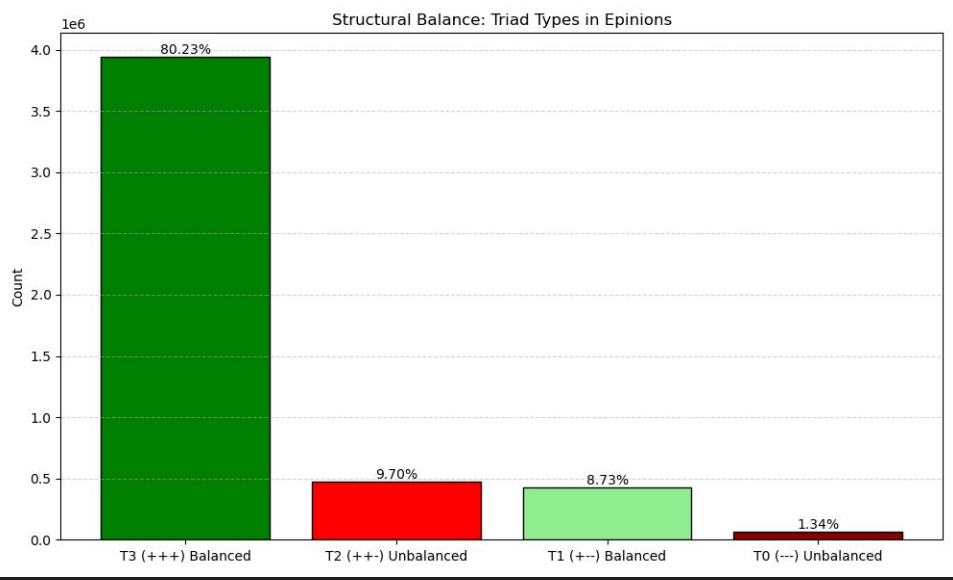




Trust Transitivity (Assortativity)

The Epinions network has positive correlation (it is assortative), high-trust users link to high-trust peers. The Bitcoin OTC network has negative correlation (it is disassortative), high-trust users link to low-trust users, indicating “Vouching” mechanism.



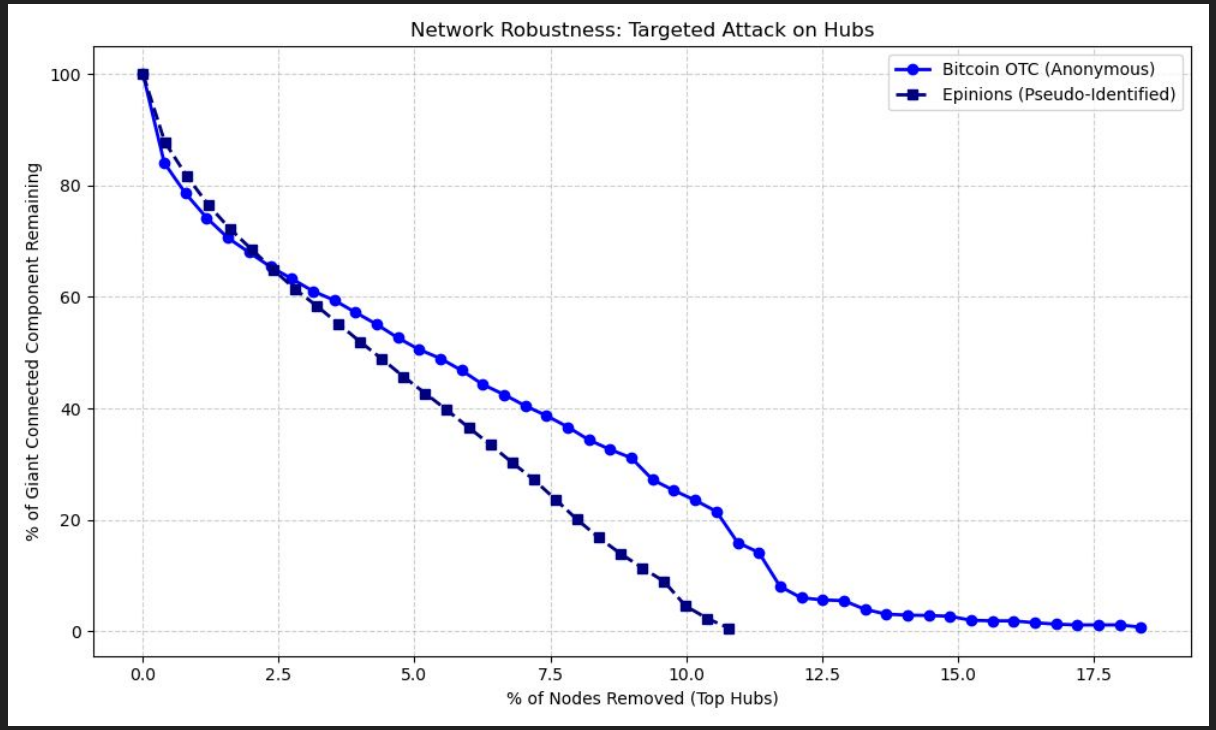


Structural Balance

The Bitcoin OTC network has 85.3% balanced triads, and the Epinions network has 89% balanced triads. Both are highly balanced. However, the anonymous network has a higher ratio of unbalanced triads (14.7% vs 11%), indicating higher social friction.

Robustness Comparison

Epinions collapses at 10.4% hub removal. Bitcoin OTC survives until 18.4%. This contradicts Hypothesis 2. The anonymous network is more robust.



Key Results - Summary

- **Polarization (Confirmed):** Bitcoin OTC uses full -10/+10 scale and has 79% Reciprocity (vs 31% in Epinions). Anonymity requires louder signals and tighter bonds.
- **Fragility (Refuted):** Epinions is fragile (Star topology dependent on influencers). Bitcoin OTC is resilient (Mesh topology, high clustering).
- **Structure (Confirmed):** Anonymous network is less balanced but features active “Vouching” (negative assortativity) to integrate new users.

Discussion & Conclusions

- **Transformation of Trust:** In the studied datasets, anonymity appears to transform trust rather than destroy it.
- **Identified Network:** The Epinions network exhibits characteristics of a Hierarchy - stable, assortative, but fragile and dependent on elites.
- **Anonymous Network:** The Epinions network exhibits characteristics of a Resilient Mesh - reciprocal, clustered, polarized, and robust against failure.
- **Takeaway:** The removal of identity forces a shift from “Who you are” to “Who you know”.

Future Work

- **Temporal Analysis:** Study the evolution of trust over time (e.g. analyzing “exit scams” where users build trust before defaulting).
- **Weighted Analysis:** Analyze if rating intensity (+1 vs +10) correlates with the longevity of the link.
- **Sybil Detection:** Distinguish genuine structural balance from artifacts created by Sybil attacks.

References

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