Geometric Liquidity: Modeling Financial Crises as Dilaton Collapse in Jackiw-Teitelboim Gravity

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Recent dimensional analysis of trade gravity models and the Fisher equation suggests that economic systems operate on a 2D topological manifold. In this letter, we propose an effective field theory for macroeconomics based on **Jackiw-Teitelboim (JT) Gravity**, a canonical model of 2D quantum gravity. We identify the **Dilaton field (Φ)** not as a geometric abstraction, but as the physical manifestation of **Market Liquidity** (or Confidence). We demonstrate that the JT field equations naturally describe the relationship between Capital Stress ($T_{\mu\nu}$) and Market Topology ($g_{\mu\nu}$). Within this framework, a financial crisis is modeled not as a stochastic shock, but as a **topological singularity** where $\Phi \to 0$ (Liquidity Black Hole). Furthermore, the non-local nature of 2D gravity explains the instantaneous global synchronization of systemic risk, distinct from the wave-like propagation in 3D systems.

I. INTRODUCTION

If the economy is a 2D fluid manifold (as established in our previous work [1]), standard General Relativity ($G_{\mu\nu} = 8\pi T_{\mu\nu}$) is mathematically trivial because the Einstein tensor vanishes in two dimensions ($G_{\mu\nu} \equiv 0$).

To describe gravity (structural interaction) in 2D, one must introduce a scalar field, the **Dilaton (Φ)**, to enforce dynamics. This leads to Jackiw-Teitelboim (JT) Gravity [2, 3], a theory originally developed for black hole thermodynamics and now central to AdS/CFT correspondence.

In this paper, we map the variables of JT Gravity to macroeconomic observables, proposing that Liquidity is the fundamental scalar field that maintains the spacetime fabric of the market.

II. THE JT ACTION AND ECONOMIC MAPPING

The action for JT gravity is given by:

$$S_{JT} = \frac{1}{16\pi G} \int d^2x \sqrt{-g}\Phi(R - 2\Lambda) + S_m, \qquad (1)$$

where Φ is the Dilaton field, R is the Ricci scalar, Λ is the cosmological constant, and S_m represents the matter sector (Capital/Labor).

A. The Dictionary

We propose the following isomorphism:

- **Metric ($g_{\mu\nu}$)**: The rigid topology of contract obligations and debt networks.
- **Matter ($T_{\mu\nu}$)**: Capital flows and asset shocks.
- **Dilaton (Φ)**: **Market Liquidity / Confidence**. It represents the "weight" or effective area of the economic spacetime.

III. FIELD EQUATIONS AND THE INTEREST RATE CURVATURE

Varying the action with respect to the Dilaton Φ yields the geometric constraint:

$$R = 2\Lambda. \qquad (2)$$

A. Curvature as Interest Rate

In our framework, the **Ricci Scalar (R)** physically manifests as the **Risk-Free Interest Rate (r)**.

- **AdS Space ($R < 0$)**: Corresponds to a standard economy with a positive interest rate ($r > 0$). The geometry is hyperbolic, enforcing exponential discounting of future value (e^{-rt}), shaping the "horn" of the economic time cone.
- **Flat Space ($R = 0$)**: Corresponds to a Zero Interest Rate Policy (ZIRP).
- **dS Space ($R > 0$)**: Corresponds to Negative Interest Rates, where future value expands anomalously.

Varying with respect to the metric $g_{\mu\nu}$ yields the dynamic equation for Liquidity:

$$(\nabla_\mu \nabla_\nu - g_{\mu\nu}\nabla^2 + \Lambda g_{\mu\nu})\Phi = -8\pi G T_{\mu\nu}. \qquad (3)$$

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IV. CRISIS DYNAMICS

A. Mechanism of Crisis

This equation states that **Capital Stress** ($T_{\mu\nu}$) directly drives the second derivative of **Liquidity** (Φ). When a massive shock hits the system (large $T_{\mu\nu}$, e.g., default cascade), it causes a rapid fluctuation in Φ.

A **Financial Crisis** occurs when the solution for Φ approaches zero locally:

$$\Phi(x, t) \to 0. \tag{4}$$

In JT gravity, Φ defines the effective gravitational coupling. When $\Phi = 0$, the spacetime "pinches off", forming a singularity. In economics, this is a **Liquidity Black Hole**: markets freeze, transactions halt, and the metric of value collapses.

V. NON-LOCALITY AND SYSTEMIC RISK

A unique feature of 2D gravity is the absence of local propagating degrees of freedom (gravitons). Gravity in 2D is **topological** and **non-local**.

This explains a key stylised fact of financial crises: **Instantaneous Synchronization**. unlike 3D seismic waves which travel at speed c_s, 2D topological failures are felt globally the moment the topology changes. The collapse of Lehman Brothers was not a "wave" propagating through the market, but a global collapse of the Dilaton field Φ, reducing the effective volume of the entire manifold simultaneously.

VI. CONCLUSION

By modeling the economy as a JT Gravity system, we formalize "Liquidity" as the fundamental Dilaton field that sustains the economic geometry. This framework provides a rigorous definition of financial crises as topological singularities ($\Phi \to 0$) and explains the non-local nature of systemic risk. Future work will explore the holographic dual of this system (SYK model) to derive macro-states from micro-transactions.

ACKNOWLEDGMENTS

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[1] F.-Y. Wang, Measuring the topological dimension of economic systems: A gauss's law approach, Preprints.org (2026).

[2] R. Jackiw, Lower dimensional gravity, Nuclear Physics B **252**, 343 (1985).

[3] C. Teitelboim, Gravitation and hamiltonian structure in two spacetime dimensions, Physics Letters B **126**, 41 (1983).