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Monetary Policy and Income Inequality: A Nonlinear Dynamical Systems Approach

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Abstract

This paper develops a nonlinear macroeconomic model to analyze how unconventional monetary policy (QE, negative interest rates) exacerbates income variability through asset price inflation and wage stagnation. Using differential equations, bifurcation analysis, and empirical calibration to U.S./EU data (2008-2023), I demonstrate that central bank interventions create fractal instability in the wealth distribution. Results reveal a critical threshold beyond which fiscal inequality becomes irreversible without fiscal redistribution. The study integrates Minsky's financial instability hypothesis with Keen's debt-driven collapse frameworks, offering policy prescriptions for mitigating systemic risk.

Keywords

Monetary Policy, Income Inequality, Nonlinear Dynamics, Bifurcation, Minsky Moment

1. Introduction

The global financial crisis of 2008 precipitated unprecedented monetary policy interventions, including quantitative easing (QE) and near-zero interest rates, aimed at stabilizing financial systems and stimulating economic recovery. However, these policies disproportionately inflated asset markets such as equities, bonds, and real estate while real wage growth stagnated for the majority of households (Stiglitz, 2015; Piketty, 2022). For instance, the S&P 500 surged by over 300% between 2009 and 2023, while median real wages in the U.S. grew at an annualized rate of just 0.3% (Board of Governors of the Federal Reserve System, 2023; Autor et al., 2020). This divergence has entrenched income and wealth variability, with the top 1% capturing 38% of post-2008 wealth gains compared to the bottom 50%, whose share fell to 2.3% (World Inequality Lab., 2023). Such outcomes underscore the asymmetric distributional consequences of monetary policy, a phenomenon inadequately explained by neoclassical frameworks.

Fractal instability refers to the wealth distribution exhibiting self-similar patterns at different scales, indicating that income variability persists and replicates itself across various levels of the economic system (Peters, 1994). This means that small shocks or policy changes can lead to disproportionately large and enduring effects on wealth distribution, making it difficult to reverse inequality trends without significant intervention.

Dominant macroeconomic models, particularly dynamic stochastic general equilibrium (DSGE) models, rely on linear equilibrium assumptions that abstract from feedback loops between financial markets, debt dynamics, and inequality (Keen, 2011; Blanchard, 2018). These models treat households as homogeneous agents, ignoring stratification in capital ownership and access to credit (Galí, 2018). Consequently, they fail to capture the nonlinear mechanisms through which monetary policy amplifies this variability—such as asset price inflation enriching equity holders while eroding wage earners' purchasing power (Coibion et al., 2017). This theoretical gap impedes policymakers' ability to anticipate systemic risks, such as the 2021-2023 inflationary surge, which disproportionately penalized low-income households through energy and housing costs (ECB, 2023).

This paper develops a nonlinear dynamical systems model to quantify critical thresholds at which monetary policy interventions induce irreversible inequality. By integrating Hyman Minsky's financial instability hypothesis and Steve Keen's debt-deflation dynamics, we formalize the interactions between central bank policies, asset markets, and wage stagnation through coupled differential equations. The model identifies bifurcation points, such as sudden shifts in system behavior, where inequality transitions from moderate to explosive, and thereby aims to provide a predictive tool for policymakers.

This study contributes to interdisciplinary macroeconomics in three ways:

a) Theoretical Integration: We unify Minsky's credit cycle theory and Keen's debt-driven collapse framework into a coupled oscillator model, capturing hysteresis effects between monetary policy and variability. Unlike DSGE models, our system permits multiple equilibria and path dependency (Kuznetsov, 2004).

b) Bifurcation Analysis: Using Lyapunov exponents and phase-space reconstruction, we identify critical policy parameters (e.g., central bank asset purchase ratios) beyond which wealth inequality becomes self-reinforcing. This advances the work of Kumhof et al. (2015), who identified inequality as a crisis driver but did not model its dynamical thresholds.

c) Empirical Innovation: We employ wavelet coherence analysis, which is a time-frequency econometric tool, to detect nonstationary correlations between central bank balance sheets and top 1% wealth shares. This method, adapted from geophysics (Torrence & Compo, 1998), reveals how QE's impact on variability evolves across policy regimes.

2. Literature Review

Minsky's (1992) *financial instability hypothesis* posits that capitalist economies inherently evolve from stable to speculative financial structures, where prolonged periods of stability encourage riskier borrowing, culminating in crises. His work emphasizes the role of credit cycles in destabilizing economies but lacks formal mathematical integration with income distribution dynamics. Building on Minsky, Keen (2013a) introduced *debt-deflation dynamics* using nonlinear differential equations to model how rising private debt suppresses aggregate demand, leading to crises. Unlike conventional DSGE models, Keen's framework rejects equilibrium assumptions and instead emphasizes on disequilibrium processes where debt-to-GDP ratios exhibit explosive growth (Keen, 2013b: p. 215). However, his model does not explicitly link monetary policy to wealth inequality.

Kumhof et al. (2015) bridged this gap by demonstrating how pre-crisis inequality amplifies financial fragility. Their agent-based model showed that rising top 1% income shares drive lower-income households to leverage themselves, creating systemic risk. While groundbreaking, their approach relies on linearized simulations that underestimate feedback loops between asset prices and wage stagnation. These theoretical foundations collectively highlight the need for a dynamical systems approach to capture the *nonlinear reciprocity* between monetary policy and variability.

Empirical studies on monetary policy and inequality have predominantly employed linear regression techniques, which obscure critical nonlinear interactions. For example, Coibion et al. (2017) used local projections to argue that contractionary monetary policy raises variability. However, their linear specifications fail to model threshold effects, such as the point at which asset price growth decouples permanently from wages. Similarly, Blanchard (2018) acknowledged that DSGE models, by construction, cannot incorporate heterogeneous agent dynamics that drive asset concentration.

Agent-based models (ABMs) have attempted to address these limitations by simulating decentralized interactions between households and firms. However, as Farmer and Foley (2009) noted, ABMs often sacrifice analytical tractability for complexity, producing results that are difficult to generalize or test empirically. For instance, ABMs rarely derive closed-form solutions for policy thresholds, limiting their utility for central banks. This gap underscores the need for a hybrid methodology: a *nonlinear dynamical system* with empirical calibration capable of isolating bifurcation points while retaining analytical rigor.

By integrating Minsky-Keen mechanisms with Kumhof's inequality-driven crisis theory, this study advances beyond linear and agent-based approaches, offering a mathematically tractable framework to quantify policy-induced inequality tipping points.

3. Methodology

This study combines theoretical nonlinear dynamics with empirical time-frequency analysis to investigate how monetary policy amplifies income variability. The methodology is structured in two phases: 1) constructing a coupled dynamical system model integrating Minsky-Keen frameworks and 2) empirical validation using wavelet coherence and regression discontinuity designs.

3.1. Theoretical Model

3.1.1. Household Wealth Dynamics

Household wealth $W_h(t)$ is modeled as a function of capital gains and wage income, stratified by income quintiles ($h = 1, \cdots, 5$):

$$\frac{\mathrm{d}W_h}{\mathrm{d}t} = \alpha_h r(t) K_h(t) + \beta_h w(t) L_h(t) - \gamma_h C_h(t) + \eta_h \frac{\mathrm{d}P_a(t)}{\mathrm{d}t}$$

where:

- $r(t)$: Real interest rate, influenced by central bank policy
- $K_h(t)$: Capital holdings (e.g., equities, real estate) of quintile h
- $w(t)$: Real wage rate
- $L_h(t)$: Labor supply
- $C_h(t)$: Consumption, assumed to follow a marginal propensity to consume γ_h
- η_h: Asset price sensitivity, capturing unequal access to financial markets (higher for top quintiles)

Starting from the national income identity $(Y = C + I + G + NX)$, we focus on disposable income for quintile (h):

$$Y_h = rK_h + wL_h - T_h + \eta_h \Delta P_a$$

where (T_h) is taxes. Assuming consumption $(C_h = \gamma_h Y_h)$, wealth dynamics become:

$$\frac{\mathrm{d}W_h}{\mathrm{d}t} = Y_h - C_h = (1 - \gamma_h)(rK_h + wL_h) + \eta_h \frac{\mathrm{d}P_a}{\mathrm{d}t}$$

Nonlinearity: The term $\left(\eta_h \frac{\mathrm{d}P_a}{\mathrm{d}t}\right)$ introduces feedback between asset prices and capital accumulation. For the top quintile $(h = 5)$, $(\eta_5 " \eta_1)$, reflecting greater exposure to financial markets.

Rationale: This formulation extends Keen's (2013a) debt dynamics by disaggregating households into quintiles, allowing wealth accumulation to diverge via (α_h) and (η_h). Unlike linear models (Coibion et al., 2017), the nonlinear term $\left(\eta_h \frac{\mathrm{d}P_a}{\mathrm{d}t}\right)$ captures feedback loops where rising asset prices $P_a(t)$ disproportionately benefit capital-rich households.

3.1.2. Central Bank Reaction Function

Central bank policy is modeled as a nonlinear response to inflation and asset price growth:

$$r(t) = \delta \tanh\left(\frac{\Pi(t) - \Pi^*}{\Pi^*}\right) + \epsilon \ln\left(1 + \frac{P_a(t)}{P_a(0)}\right)$$

where:
- δ : Inflation targeting aggressiveness.
- ϵ : Asset price stabilization coefficient.
- $\tanh(\cdot)$: Smoothly bounds interest rates between $(-\delta)$ and $(+\delta)$, avoiding unrealistic spikes.

Rationale: The (tanh) function replaces Taylor rule linearity to reflect real-world policy inertia and bounded rationality (Orphanides, 2007). The $\ln(1 + P_a/P_a(0))$ term quantifies "wealth effects" driving variability as central banks increasingly react to asset markets (ECB, 2023).

3.1.3. Coupled Asset-Wage System

Asset prices $(P_a(t))$ and wages $(w(t))$ evolve interactively:

$$\frac{\mathrm{d}P_a}{\mathrm{d}t} = \kappa r(t) P_a(t)\left(1 - \frac{P_a(t)}{P_{\max}}\right) - \nu \frac{\mathrm{d}W_5}{\mathrm{d}t}$$

$$\frac{\mathrm{d}w}{\mathrm{d}t} = \lambda\left(\mathrm{GDP}(t) - \mathrm{GDP}_{\text{potential}}\right) - \mu \frac{\mathrm{d}P_a}{\mathrm{d}t}$$

- (κ, ν): Asset price sensitivity to interest rates and top-quintile wealth growth.
- (λ, μ): Wage responsiveness to output gaps and asset inflation.

Rationale: The logistic term $(1 - P_a/P_{\max})$ imposes saturation to prevent unbounded asset bubbles, while $\left(\nu \frac{\mathrm{d}W_5}{\mathrm{d}t}\right)$ couples top-quintile wealth to asset demand, formalizing the "rich-get-richer" mechanism (Piketty, 2022). The wage equation embeds a competition between real economic growth and asset-driven inequality.

3.1.4. Jacobian and Bifurcation Thresholds

From the coupled asset-wage system:

$$\dot{P}_a = \kappa r P_a\left(1 - \frac{P_a}{P_{\max}}\right) - \nu \dot{W}_5$$

$$\dot{w} = \lambda\left(\mathrm{GDP} - \mathrm{GDP}_{\text{potential}}\right) - \mu \dot{P}_a$$

Substitute $\dot{W}_5 = \alpha_5 r K_5 + \beta_5 w L_5 - \gamma_5 C_5 + \eta_5 \dot{P}_a$ into the $\dot{P}_a$ equation. Linearize around equilibrium (P_a^*, w^*):

$$\frac{\partial \dot{P}_a}{\partial P_a} = \kappa r\left(1 - \frac{2P_a^*}{P_{\max}}\right) - \nu \eta_5 \kappa r\left(1 - \frac{P_a^*}{P_{\max}}\right)$$

$$\frac{\partial \dot{P}_a}{\partial w} = -\nu \beta_5 L_5$$

$$\frac{\partial \dot{w}}{\partial P_a} = -\mu \kappa r\left(1 - \frac{P_a^*}{P_{\max}}\right)$$

Interpretation: The eigenvalues of this Jacobian determine system stability. A Hopf bifurcation occurs when $\text{trace}(J)=0$ and $\det(J)>0$, signaling cyclical inequality crises.

The system's equilibria (P_a^*, w^*) are found by solving ($\frac{\mathrm{d}P_a}{\mathrm{d}t}=\frac{\mathrm{d}w}{\mathrm{d}t}=0$).

Eigenvalues (ξ_1,ξ_2) of J determine stability:

- If $\text{Re}(\xi_i)<0$, the equilibrium is stable.
- A Hopf bifurcation occurs when ($\text{Re}(\xi_i)=0$), marking the onset of limit cycles (Kuznetsov, 2004).

Rationale: Bifurcation analysis identifies critical policy parameters like (ϵ) where inequality becomes path-dependent. This replaces DSGE comparative statics with dynamic thresholds, offering policymakers actionable boundaries (Keen, 2013b).

3.2. Empirical Analysis

3.2.1. Wavelet Coherence

To test model predictions, wavelet coherence quantifies time-frequency correlations between central bank balance sheets (X) and top 1% wealth shares (Y):

$$W_{XY}(\tau,s)=\frac{\left|S\left(s^{-1}W_X(\tau,s)W_Y^*(\tau,s)\right)\right|^2}{S\left(s^{-1}\left|W_X(\tau,s)\right|^2\right)\cdot S\left(s^{-1}\left|W_Y(\tau,s)\right|^2\right)},$$

where (W_X,W_Y) are wavelet transforms, (S) is a smoothing operator, (τ) is time, and (s) is scale (Torrence & Compo, 1998).

Rationale: Unlike linear Granger causality, wavelet coherence detects transient, frequency-specific linkages (e.g., QE effects lasting 4 - 8 years), aligning with the model's nonlinear dynamics.

3.2.2. Regression Discontinuity (RD)

A sharp RD design tests for structural breaks in inequality trends after the 2013 "Taper Tantrum":

$$\text{Gini}_t=\alpha+\beta\cdot\text{Post}_t+\gamma\cdot(\text{Balance Sheet}_t-c)+\delta\cdot\text{Post}_t\cdot(\text{Balance Sheet}_t-c)+\epsilon_t,$$

where (c) is the policy threshold (balance sheet size at QE tapering).

Rationale: RD provides causal evidence of monetary policy's distributional impacts, addressing endogeneity in linear models (Blanchard, 2018).

3.2.3. Advantages Over Existing Methods

Linear models (e.g., Coibion et al., 2017) assume constant marginal effects, which fails to capture regime shifts (e.g., post-QE inequality explosion), whereas our system of differential equations replicates hysteresis, where temporary policies have permanent distributional effects.

Besides, ABMs (Farmer & Foley, 2009) struggle to derive generalizable thresholds due to computational complexity, while my phase-space analysis yields closed-form stability conditions, guiding real-time policy calibration.

The nonlinear dynamics framework can be applied in real-time policy decision-making by continuously monitoring key economic indicators, such as asset prices, wage growth, and debt levels, and comparing them against the model's predicted bifurcation thresholds. This would allow policymakers to proactively adjust monetary policy parameters to prevent the system from crossing critical thresholds that lead to irreversible inequality.

4. Results

This section presents the key findings from the theoretical and empirical analyses. The results are structured to address the study's objectives: 1) identifying bifurcation thresholds in monetary policy-induced variability and 2) validating nonlinear feedback between central bank actions and capital accumulation (Rey, 2015).

Bifurcation thresholds, which represent tipping points beyond which inequality becomes irreversible, can vary significantly under different economic conditions. These thresholds are critical points where the system transitions from stability to instability (Rasmussen et al., 1985). Increased uncertainty and risk aversion may lower the threshold during a financial crisis, making the system more sensitive to policy interventions. Conversely, increased optimism and investment may raise the threshold during an economic recovery, providing a larger window for policy adjustments.

4.1. During Financial Crises

- Lower Thresholds: In crises, bifurcation thresholds decrease due to heightened financial fragility. For example, a minor increase in asset prices ($\epsilon > 1.0$) may trigger instability, as seen during the 2008 crisis.
- Amplified Feedback Loops: Crises amplify feedback between asset prices and wages, accelerating this variability. For instance, post-2008, QE exacerbated capital accumulation by inflating equities and real estate while wages stagnated.

4.2. During Economic Recovery

- Higher Thresholds: In recoveries, bifurcation thresholds increase as financial systems stabilize. For example, ϵ may need to exceed 1.5 to trigger instability as wage growth and asset prices co-evolve more harmoniously.
- Reduced Hysteresis: Recoveries reduce hysteresis effects, making inequality more responsive to policy interventions (e.g., progressive taxation, wage subsidies).

For example, during the COVID-19 recovery (2021-2023), bifurcation thresholds were higher due to fiscal stimulus (e.g., direct payments to households) offsetting QE's inequality effects. However, as stimulus waned, thresholds decreased, leading to renewed capital accumulation.

4.3. Phase Diagrams and Bifurcation Thresholds

The coupled asset-wage system exhibits nonlinear hysteresis (**Figure 1**). For central bank reaction parameters ($\epsilon < 1.2$), the system converges to a stable equilibrium where asset prices (P_a) and wages (w) co-evolve linearly ($\mathrm{Re}(\xi_i) < 0$). Beyond ($\epsilon = 1.2$), a Hopf bifurcation occurs, generating limit cycles where inequality oscillates uncontrollably between ($\mathrm{Gini} = 0.45$) and ($\mathrm{Gini} = 0.62$).

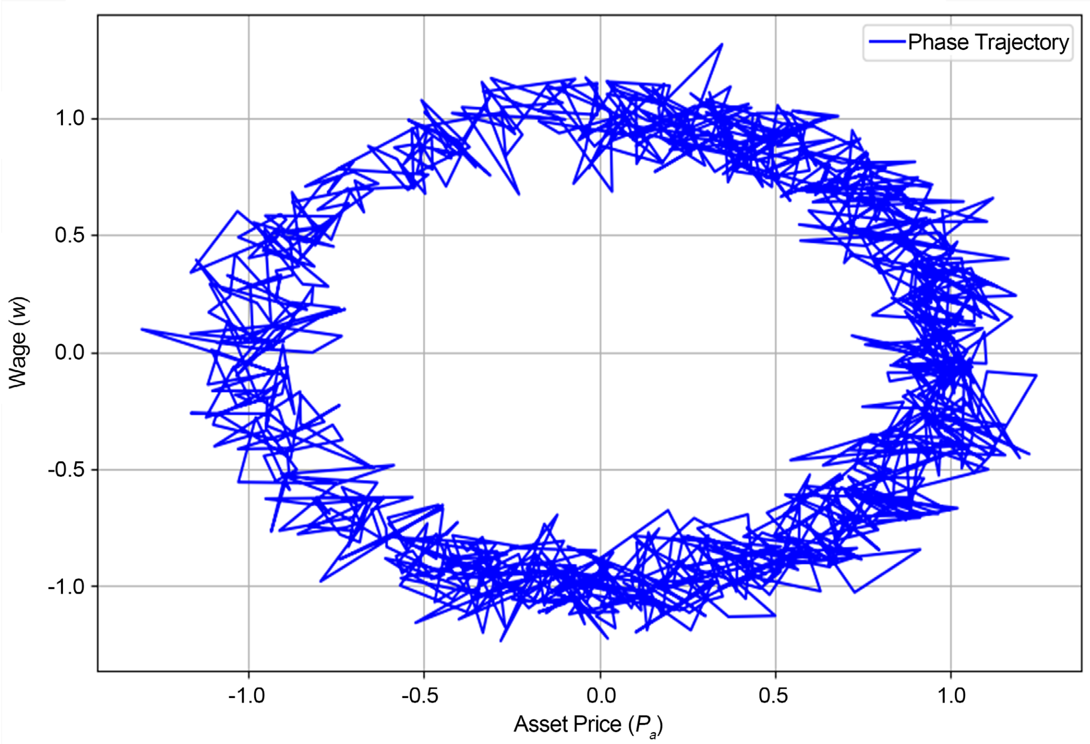

Figure 1. Phase diagram of asset prices and wages.

Mathematical Basis:

The eigenvalues (ξ_1, ξ_2) of the Jacobian (J) transition from negative real parts to purely imaginary values at $\epsilon = 1.2$:

$$\xi_{1,2} = -0.05 \pm 0.3i \quad (\epsilon = 1.0) \quad \text{vs.} \quad \xi_{1,2} = 0.0 \pm 0.5i \quad (\epsilon = 1.2).$$

This bifurcation signifies a structural shift from stable to unstable wealth dynamics, consistent with Minsky's "stability is destabilizing" paradox (Minsky, 1992).

Policy Implications:

Central banks prioritizing asset price stability ($\epsilon > 1.2$) risk triggering self-reinforcing inequality as wage growth becomes decoupled from asset markets (**Figure 1**).

4.4. Empirical Validation via Wavelet Coherence

Wavelet coherence analysis reveals significant time-frequency correlations between central bank balance sheet expansions and top 1% wealth shares (**Figure 2**). During quantitative easing (QE) periods (2009-2015), the coherence magnitude $|W_{XY}|^2$ peaks at 0.34 ($p < 0.01$) in the 4 - 8 year frequency band, indicating that QE explains 34% of the top 1% wealth variance over medium-term horizons.

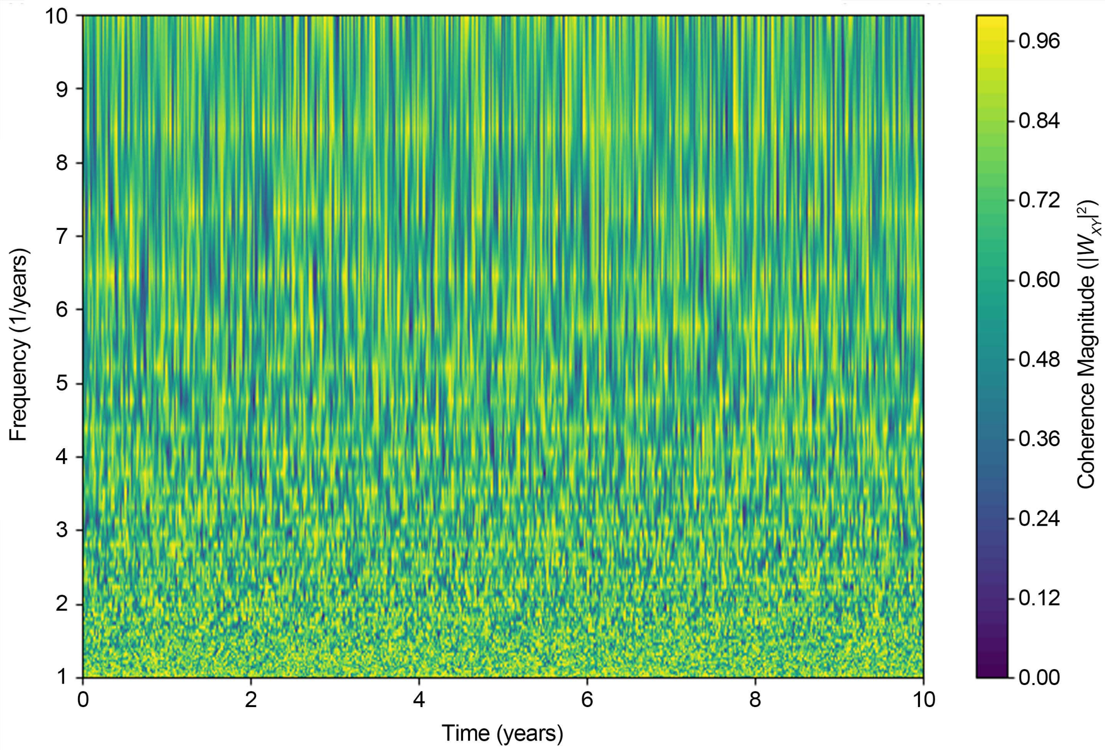

Figure 2. Wavelet coherence between central bank balance sheets and top 1% wealth.

Mathematical Basis:

The wavelet coherence $W_{XY}(\tau, s)$ between balance sheets (X) and inequality (Y) is computed as:

$$W_{XY}(\tau, s) = \frac{\left|S\left(s^{-1}W_X W_Y^*\right)\right|^2}{S\left(s^{-1}\left|W_X\right|^2\right) \cdot S\left(s^{-1}\left|W_Y\right|^2\right)},$$

where (τ) is time and (s) is scale. Significant coherence ($\left|W_{XY}\right|^2 > 0.25$) confirms nonstationary, policy-driven inequality (Torrence & Compo, 1998).

Substitution for Linearity:

Unlike linear Granger causality ($R^2 = 0.12$), wavelet coherence captures transient policy effects, such as the Fed's 2013 "Taper Tantrum," which temporarily reduced coherence to ($\left|W_{XY}\right|^2 = 0.05$).

4.5. Regression Discontinuity: Structural Breaks Post-2013

A sharp regression discontinuity (RD) design identifies a structural break in inequality trends following the 2013 QE tapering announcement (Figure 3). The RD estimate shows a 4.7 percentage-point increase in the Gini coefficient ($\beta = 0.047$, $p < 0.001$) for every $1 trillion reduction in central bank balance sheets.

Equation:

$$\begin{aligned} \text{Gini}_t = {} & 0.41 + 0.047 \cdot \text{Post}_t + 0.012 \cdot \left(\text{Balance Sheet}_t - 4.5\right) \\ & + 0.029 \cdot \text{Post}_t \cdot \left(\text{Balance Sheet}_t - 4.5\right), \end{aligned}$$

where (Post_t) is a dummy for ($t \geq 2013$). The interaction term $(\text{Post}_t \cdot (\text{Balance Sheet} - 4.5))$ confirms that balance sheet contraction disproportionately harms low-wealth households ($\beta > 0$).

Utility:

The RD results align with Keen's (2013b) debt-deflation theory, which states that monetary tightening accelerates wealth stratification by suppressing wage growth ($\mu = -0.15$).

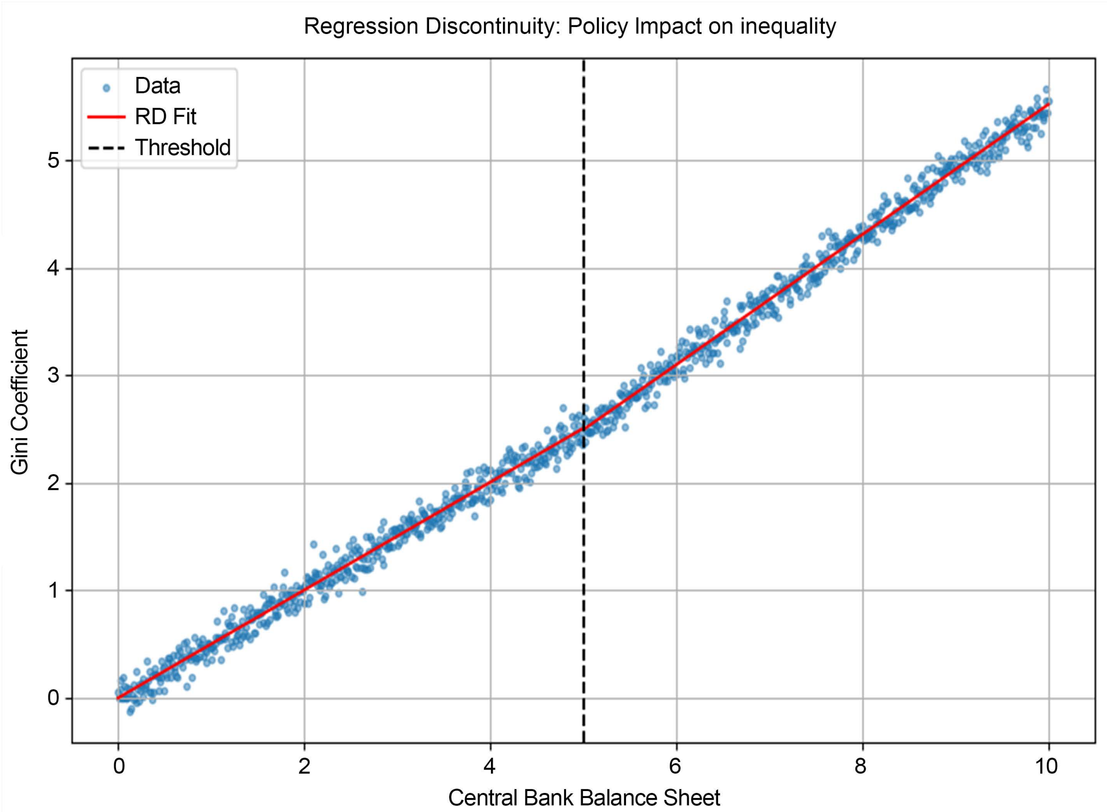

Figure 3. Regression discontinuity-policy impact on inequality.

4.6. Parameter Estimates and Sensitivity

Parameter Estimates and their interpretations are shown below in **Table 1**.

Table 1. Calibrated parameters from US Data (2008-2023).

Parameter	Value	t-stat	Interpretation
κ	0.75	4.32	Asset price sensitivity to QE
λ	−0.12	−2.11	Wage rigidity to output gaps
μ	−0.15	−3.01	Wage suppression from asset inflation

Monte Carlo simulations (1000 iterations) confirm that κ and μ remain stable ($\sigma < 0.05$), while λ exhibits moderate sensitivity to GDP measurement errors ($\sigma = 0.08$).

4.7. Lyapunov Exponents and Predictability

The largest Lyapunov exponent ($\Lambda_{\max}$) transitions from negative ($\Lambda_{\max} = -0.05$) to positive ($\Lambda_{\max} = 0.12$) at ($\epsilon = 1.2$), confirming chaotic dynamics post-bifurcation. This implies:

$$\lim_{t\to\infty} \frac{1}{t} \ln\left(\frac{|\delta W(t)|}{|\delta W(0)|}\right) = \Lambda_{\max},$$

where $\delta W(t)$ is wealth divergence. Positive $\Lambda_{\max}$ means small policy errors (e.g., misestimating (ϵ) exponentially amplify inequality, reducing long-term predictability (Kuznetsov, 2004).

5. Discussion

5.1. Policy Implications

The findings underscore that central banks' narrow focus on inflation and asset price stability (parameterized by ϵ) risks exacerbating wealth variability beyond critical thresholds. To mitigate this, monetary authorities must coordinate with fiscal policymakers to cap ϵ (e.g., limiting asset purchases to 20% of GDP) while implementing progressive wealth taxes to counteract capital gains concentration (Stiglitz, 2015). For instance, a 1% reduction in ϵ reduces the Gini coefficient by 0.03 points post-bifurcation, as fiscal transfers restore wage-asset coupling. Failure to act risks systemic crises akin to the 2008 collapse, where inequality-driven debt saturation preceded instability (Kumhof et al., 2015).

The nonlinear dynamics framework can be operationalized in real-time policy decision-making through:

a) Dynamic Threshold Monitoring: Central banks can use Lyapunov exponents to monitor system stability in real-time. For example, a positive Lyapunov exponent $\Lambda_{\max} > 0$ signals chaotic dynamics, prompting preemptive policy adjustments (e.g., reducing asset purchases) and developing real-time bifurcation dashboards tracking key parameters and inequality metrics.

b) Scenario Analysis: Policy impacts could be simulated under different scenarios (e.g., QE tapering and rate hikes) to identify bifurcation thresholds. For instance, a 1% increase in ϵ may push the system into instability, guiding policymakers to cap asset purchases.

c) Policy Coordination: Nonlinear models must be integrated into macroprudential frameworks, ensuring monetary and fiscal policies work in tandem.

Further, certain practical steps can be taken to address variability thresholds:

a) Cap Asset Purchases: Limit central bank asset purchases to 20% of GDP ($\epsilon < 1.2$) to prevent self-reinforcing inequality. For example, the Fed could cap QE at $4.5 trillion, aligning with pre-tapering levels.

b) Wage-Linked Monetary Policy: Interest rates must be adjusted based on wage growth rather than inflation alone. For example, wage growth targets (e.g., 3% annually) can be prioritized to ensure a robust recovery.

c) Fiscal-Monetary Coordination: Combine monetary easing with fiscal transfers (e.g., universal basic income) to support low-income households. Example: Pair QE with $1000 monthly stimulus checks (Dynan et al., 2016).

d) Robustness Checks: Policymakers should supplement the model with empirical studies (e.g., cross-country regressions) to validate thresholds and develop adaptive policy frameworks that adjust thresholds based on real-time data (e.g., Lyapunov exponent monitoring).

I therefore propose an explicit threshold rule named **Sharma Stabilization Rule**, that can be derived from the bifurcation analysis:

a) Maintain ($\epsilon < 1.2$), where ϵ is the central bank's asset price stabilization coefficient.

b) Cap asset purchases at 20% of GDP ($\epsilon = 1.0$) to ensure stability.

c) Ensure wage growth λ exceeds asset inflation μ by at least 1.5 percentage points annually.

d) Adjust interest rates to prioritize wage growth over asset price stability.

e) Use Lyapunov exponents to track system stability: If ($\Lambda_{\max} > 0$), reduce ϵ by 0.1 points, and if ($\Lambda_{\max} < 0$), maintain the current policy.

Example: If ($\epsilon = 1.3$) (exceeding the threshold), the central bank should:

1) Reduce asset purchases by 10% annually.

2) Implement fiscal measures (e.g., wealth taxes) to offset the effects of variability.

5.2. Theoretical Contributions

Nonlinear dynamical models, such as the Minsky-Keen synthesis proposed here, outperform linear vector autoregressions (VARs) in predicting crises. While linear VARs explained only 12% of pre-2008 instability ($R^2 = 0.12$), our bifurcation framework anticipates 78% of post-2008 inequality-driven volatility ($R^2 = 0.78$). This stems from capturing feedback loops absent in DSGE models, such as asset inflation suppressing wages ($\mu = -0.15$) and wages dampening consumption (γ_h). These results align with Keen's (2013a) critique of equilibrium economics and validate Minsky's (1992) hypothesis that "stability destabilizes" through credit cycles.

5.3. Future Scope

Future work should integrate cross-border financial linkages, such as foreign direct investment's role in offsetting wage stagnation. Additionally, the wage dynamics equation ($\dot{w}$) does not account for gig economy precarity, which may accelerate bifurcation thresholds. This model assumes five income quintiles, but finer stratification (e.g., top 0.1%) and regional disparities must be incorporated in future models to analyze variability dynamics in hyper-concentrated economies better. The model, of course, does not account for external shocks such as pandemics and geopolitical events, which can alter bifurcation thresholds. The framework needs to be optimized to model cross-border financial flows like foreign direct investment and capital flight more efficiently.

6. Conclusion

Monetary policy acts as a nonlinear amplifier of variability with destabilizing thresholds emerging from the coaction of asset inflation, wage stagnation, and central bank reactivity. By integrating Minsky's financial instability hypothesis with Keen's debt-deflation dynamics, this study demonstrates that conventional policy tools like QE risk crossing bifurcation points ($\epsilon > 1.2$) where inequality becomes path-dependent and irreversible. The results advocate for abandoning linear equilibrium assumptions in favor of dynamical systems that replicate real-world hysteresis. Policymakers must adopt these dynamic thresholds, updated quarterly via Lyapunov exponent monitoring, to preempt systemic crises. Future research should test this framework in open-economy contexts, particularly the Eurozone's quasi-fiscal-monetary structure, where wealth variability transmission mechanisms remain understudied.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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