

Forecasting Market Regimes and Collateral Risk in Prediction Markets with Cross-Excitation Networks

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This study extends the published work:
Kunal Gaurav (2026). "Optimal Transport Stress Testing and Fund-Level Risk Management for DeFi Lending Against Prediction Market Collateral."
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01 / WHY

Can excitation reveal a transient risk regime before liquidity and collateral risk deteriorate?

Positive OOS likelihood gains across all three market domains.

16 contracts

161,894 repricings

3 market domains

02 / DATA

From order-book updates to Hawkes arrivals

Valid BBO

Midpoint repricing

Hawkes arrivals

Scientific clock: source timestamp; first valid midpoint initializes state; spread-only changes excluded.
Case windows: TRAIN • 1 h embargo • OOS

Long-lived

Sports

Crypto

TRAIN 8 h

1 h

OOS 3 h

TRAIN 6 h

1 h

1 h

TRAIN 16 h

1 h

OOS 7 h

03 / MODEL

Nested Hawkes models separate persistence from cross-market propagation

$$\lambda_i(t) = \mu_i + \sum_j \sum_{t_k^j < t} \alpha_{ij} \beta e^{-\beta(t-t_k^j)}$$

Adjacency structure $A = [\alpha_{ij}]$ determines which channels excite which.

M_0
 $A = 0$
independent

M_1
 $A = \text{diag}(A)$
self-excitation

M_2
 $A \geq 0$ full
cross-excitation

TRAIN-only decay: $\beta^{-1} = 10$ s in all three compact cases.

Stationary M2 fit: $\rho(A) = 0.995 < 1$ in the long-lived threshold case.

Risk state: learned excitation is carried into liquidity and first-breach models.

04 / OOS

Self-excitation improves held-out repricing forecasts in 3/3 domains

$\Delta \ell = (\ell_{M_1} - \ell_{M_0}) / N_{\text{OOS}}$; larger is better.

Long-lived
 $n_{\text{OOS}} = 9,299$

Crypto
 $n_{\text{OOS}} = 68,171$

Sports
 $n_{\text{OOS}} = 28$

+3.21

+2.24

+1.97

Positive OOS likelihood gains appear in every market domain tested.

05 / NETWORK

Cross-excitation network reveals strong propagation channels

Venezuelan crude-production thresholds. Ring thickness $\propto$ self-excitation; orange links highlight the strongest estimated propagation channels.

1.1m

1.2m

1.3m

1.4m

1.5m

1.7m

2.37

0.119

0.095

0.995
 $\rho(A)$ spectral radius

0.995
1.2m self-excitation

2.37
strongest cross-channel

06 / REGIME

A real-time excitation state tracks subsequent liquidity stress

dark blue = M2 network state for monitoring • light blue = quoted spread • -0.74% RMSE from spread+M1 vs spread-only

Log relative network intensity

Median quoted spread

-0.74% RMSE

minutes from case-window start; dashed vertical line = OOS start

07 / RISK

A forward-looking first-breach probability surface

$\Pi_T(s, \lambda) = \Pr(\tau_{\text{liq}} \leq T \mid S_t = s, \Lambda_t = \lambda, \mathcal{F}_t)$

$\tau_{\text{liq}} = \inf\{u > 0 : S_{t+u} \leq B\}$ • empirical horizon $T = 30$ min

First-breach probability (%)

Distance to liquidation ($\times 10^{-3}$ logit)

Relative excitation $N\hat{\lambda}$

Up to 28.3%

at the same collateral distance

At a fixed collateral state, higher excitation materially raises the 30-minute first-breach probability.

08 / EVIDENCE

Robustness and impulse dynamics strengthen the case

Stress robustness foundation

Shock propagation dynamics

5.5

8.8

92% moderate-stress wins
693 / 750

91.1m → 1.2m (u) = $\alpha \beta e^{-\beta u}$
 $\alpha = 2.37, \beta^{-1} = 10$ s
Half-life ≈ 6.9 s

Kernel contribution

Seconds since source repricing

Left: OT stress-testing foundation • Right: strongest fitted Hawkes impulse response 1.1m → 1.2m