

Article

# Spatiotemporal Patterns of Risk Propagation in Complex Financial Networks

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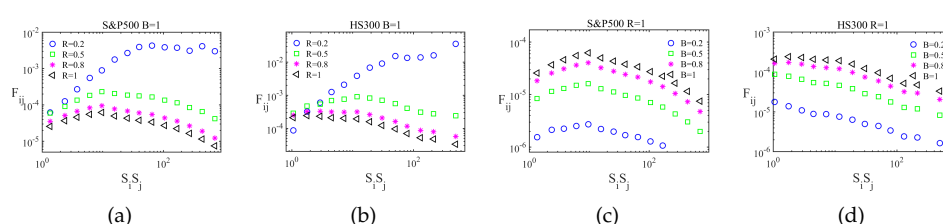
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We link  $F_{ij}$  with the product of  $i$  and  $j$ 's weighted degree, i.e.,  $S_i S_j$ . As shown by mark triangle in Figure S1,  $F_{ij}$  first positively then negatively scales with  $S_i S_j$  in most cases, i.e., the link first exhibit link-driven effect then anti-link-driven effect. The results of Chinese and American markets are similar. As indicated in Figure S1(a) and (b), the nodes tend to be more degree-driven when the recovery rate  $R$  decreases, while the links tend to be more anti-link-driven after the turning point when the recovery rate  $R$  increases. The smaller  $R$  is, the later the turning point appears. Figure S1(c) and (d) demonstrate that the nodes tend to be more degree-driven as the recovery rate  $B$  increases, and there is no substantive difference for the links with different  $B$ .



**Figure S1.** Spatiotemporal patterns of risk propagation with different dynamic parameters. We measure the risk propagation flow  $F_i$  and  $F_{ij}$  through all nodes/links with different dynamic parameters for S&P500 market and HS300 market. (a)  $F_{ij}$  vs. the product  $S_i S_j$  for S&P500 market with different infection rates  $R$ . (b)  $F_{ij}$  vs.  $S_i S_j$  for HS300 market with different infection rates  $R$ . (c)  $F_{ij}$  vs.  $S_i S_j$  for S&P500 market with different recovery rates  $B$ . (d)  $F_{ij}$  vs.  $S_i S_j$  for HS300 market with different recovery rates  $B$ .

We measure the risk propagation flow  $F_{ij}$  through all nodes/links for S&P500 market and HS300 market in extreme market states. As displayed in Figure S2,  $F_{ij}$  first positively then negatively scales with  $S_i S_j$ , i.e., the link first exhibit link-driven effect then anti-link-driven effect. As the threshold  $\sigma$  increases, the link-driven effect becomes greater, while the anti-link-driven effect gets weaker. Further, we distinguish from crashes and bubbles, then calculate risk propagation flow with the threshold PMFG graph  $A_{ij}^{\sigma, N}$  and  $A_{ij}^{\sigma, P}$ . As indicated in Figure S2 (c) and (d), when  $A_{ij}$  is smaller than the turning point, the link-driven effect increases in the order of two-tails, negative tail and positive tail; when  $A_{ij}$  is larger than the turning, the anti-link-driven effect decreases from two-tails, negative tail to positive tail.



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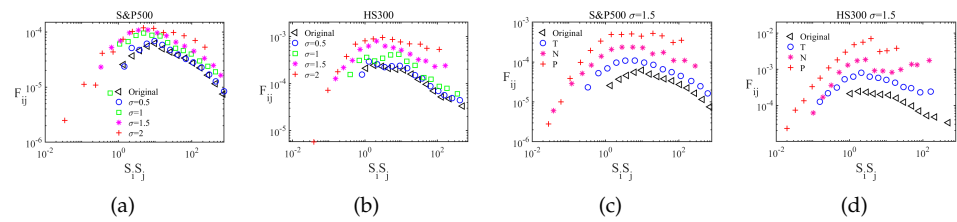
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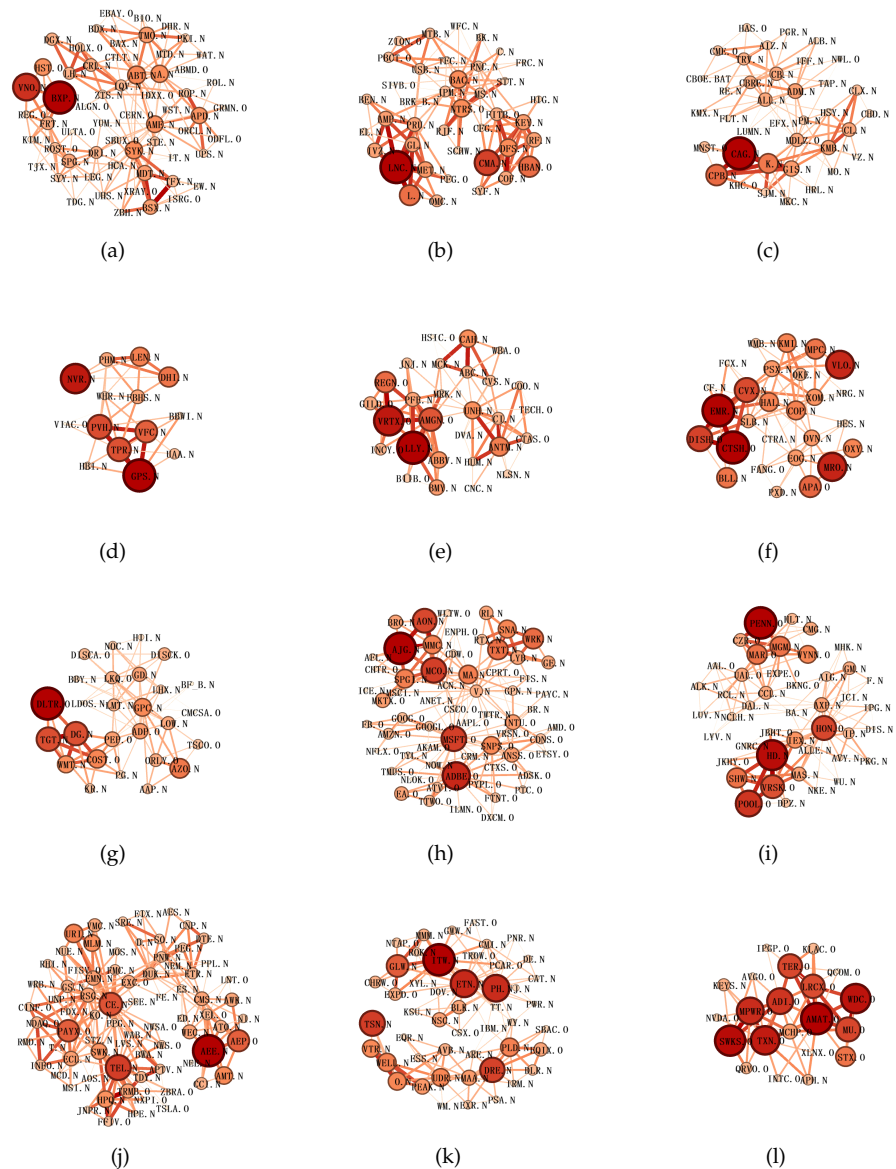


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**Figure S2.** Spatiotemporal patterns of risk propagation in extreme market states. We measure the risk propagation flow  $F_i/F_{ij}$  through all nodes/links for S&P500 market and HS300 market in extreme market states. For comparison, the results of original network are displayed in mark triangle. (a)  $F_{ij}$  vs. the product  $S_i S_j$  for S&P500 market with different threshold  $\sigma$  for two tails T. (b)  $F_{ij}$  vs.  $S_i S_j$  for HS300 market with different threshold  $\sigma$  for two tails T. (c)  $F_{ij}$  vs.  $S_i S_j$  for S&P500 market for two tails T, negative tail N and positive tail P. (d)  $F_{ij}$  vs.  $S_i S_j$  for HS300 market for two tails T, negative tail N and positive tail P. For (a) and (b),  $\sigma \in [0.5, 2]$ , while for (c) and (d),  $\sigma = 1.5$ .

The risk propagation flow networks in each community for the two markets are list in Figure S3 and Figure S4.



**Figure S3.** Risk propagation flow in each community for S&P500 market. (a) Medical device & service (b) Finance (c) Food & daily necessities (d) Consumer durables & apparel (e) Pharmaceuticals & biotechnology (f) Energy & materials (g) Retailing, capital goods & media (h) Software & service (i) Tourism & transportation (j) Utilities (k) Real estate (l) Semiconductors



**Figure S4.** Risk propagation flow in each community for HS300 market. (a) Securities (b) Food & daily necessities (c) Healthcare (d) Energy & materials (e) Real estate (f) Information technology (g) Transportation (h) Capital goods & utilities (i) Automobiles (j) Banks, insurance & industrials