CS 6850 Reaction Paper

Sanjana Nandi (sn523)

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1 Paper Overviews

1.1 Observing Cascade Behavior Depending on the Network Topology and Transaction Costs

In [1], the authors examine how network topology and transaction costs influence cascading behaviors in the network. In the paper, information cascades are defined as occurring when traders imitate each other's decisions rather than relying on personal information, leading to herding behavior in the market.

To do this they constructed a computational model that where artificial traders buy, sell, or hold an asset, using their private information and the observed decisions of their peers. The model is a network where the nodes are artificial traders (agents), the edges between nodes are communication pathways where agents can observe the trading decisions of their directly connected peers, the trading fee (the cost an agent incurs when buying or selling the asset) is the agent's private signal, and the search cost (the difficulty an agent faces in accessing the trading decisions of its peers) is the agent's external observations. Three types of network structures were examined for their effect on cascades:

- Spatially-Clustered Networks: Agents have a limited number of stable connections, following a normal distribution in connectivity.
- Random Networks: Connections between agents are assigned randomly, with a Poisson distribution.
- Scale-Free Networks: Highly connected hubs dominate, with a few nodes having many connections and many nodes having few, following a power-law distribution.

Different trading fees and search costs were also modeled to explore how these factors affect cascades. The metrics Gross Information Cascades (the number of instances where agents imitate the trading trend) and Trend Shift Cascades (market volatility due to cascades) were measured to determine cascade impact.

The authors identified several outcomes. Lower trading fees and search costs amplify the occurrence of information cascades, as agents are more likely to imitate trends if they can trade cheaply. Higher trading fees led to no-trade cascades where agents refrained trading to avoid costs. Furthermore, network structure significantly impacts cascade behavior: highly centralized, scale-free networks foster broader, market-wide cascades, especially when a central, highly connected agent's decision affects many others.

This paper's related course topic is Cascading Behavior in Networks. I found this paper interesting specifically because it incorporated transaction costs with respect to information cascades. A weakness of this paper is the lack of consideration of time-dependent effects. Connection pathways between agents are constant across time while in real life traders are not always aware of their peers' decisions over time.

1.2 Effects of temporal correlations on cascades: Threshold models on temporal networks

In [2], the authors focus on temporal networks, where connections between nodes are not always active but vary over time and how cascading behaviors are different in these networks. This paper adapts the threshold model to temporal networks where nodes adopt a behavior if a certain proportion of their active neighbors are already participating.

Their model starts off with a static network topology (random network, scale-free networks). Then each connection in the network is assigned an activation sequence, determining when it is "on" (active) or "off" (inactive). This sequence follows a probabilistic model that reflects the desired bursty pattern, ensuring that certain edges only activate in clusters over time.

They found that in networks where connections are only active in short, intense bursts, cascades are less likely to spread broadly because the periods of inactivity prevent continuous influence among nodes. This is even more pronounced in networks where the threshold for node activation is higher as they need a greater proportion of active neighbors to adopt the behavior. The timing of connection activation can either hinder or enhance cascades. If connection activation aligns with node activation, cascades propagate quickly, but if they aren't the cascade is abruptly stopped. In random graphs cascades tended to require longer periods of sustained activity to reach large parts of the network due to the uniform distribution of connections while scale-free networks triggered cascades more effectively due to their hubs.

I found this paper interesting because of its relation to Cascading Behavior in Networks and how it factored in temporal components to cascading behavior. A weakness of this paper is the lack of consideration of transaction costs in its model. Nodes may not necessarily do an action because its surrounding neighbors do something in real life scenarios.

1.3 Further Research

For the first paper, a valuable direction for future research would be to incorporate time-dependent connection pathways to better reflect real-world trading scenarios. Instead of static, constant communication paths, this extension could involve modeling dynamic networks where the edges between agents intermittently activate and deactivate, reflecting the fact that traders may only observe their peers' decisions at certain times or under specific market conditions. This approach could examine how the timing of connection availability affects cascade behavior, particularly if cascades are less likely to spread when agent observations are sporadic. It would be insightful to analyze whether intermittent observations dampen or enhance cascade size and frequency, especially in different network topologies.

For the second paper, future studies could explore the impact of transaction costs within temporal networks, combining both economic and temporal factors to create a more nuanced model of cascading behavior. In practice, agents don't act solely based on neighbor influence; transaction costs also play a crucial role in decision-making. Integrating these costs into a temporal network model could reveal under which conditions agents refrain from adopting behaviors due to prohibitive costs, even if neighbor influence is high. Researchers could explore questions such as: Do high transaction costs reduce the effectiveness of bursty temporal correlations? And, how do transaction costs interact with threshold levels in delaying or diminishing cascade spread? This extension would offer a more realistic framework for scenarios like financial markets, where both timing and costs drive agent behaviors.

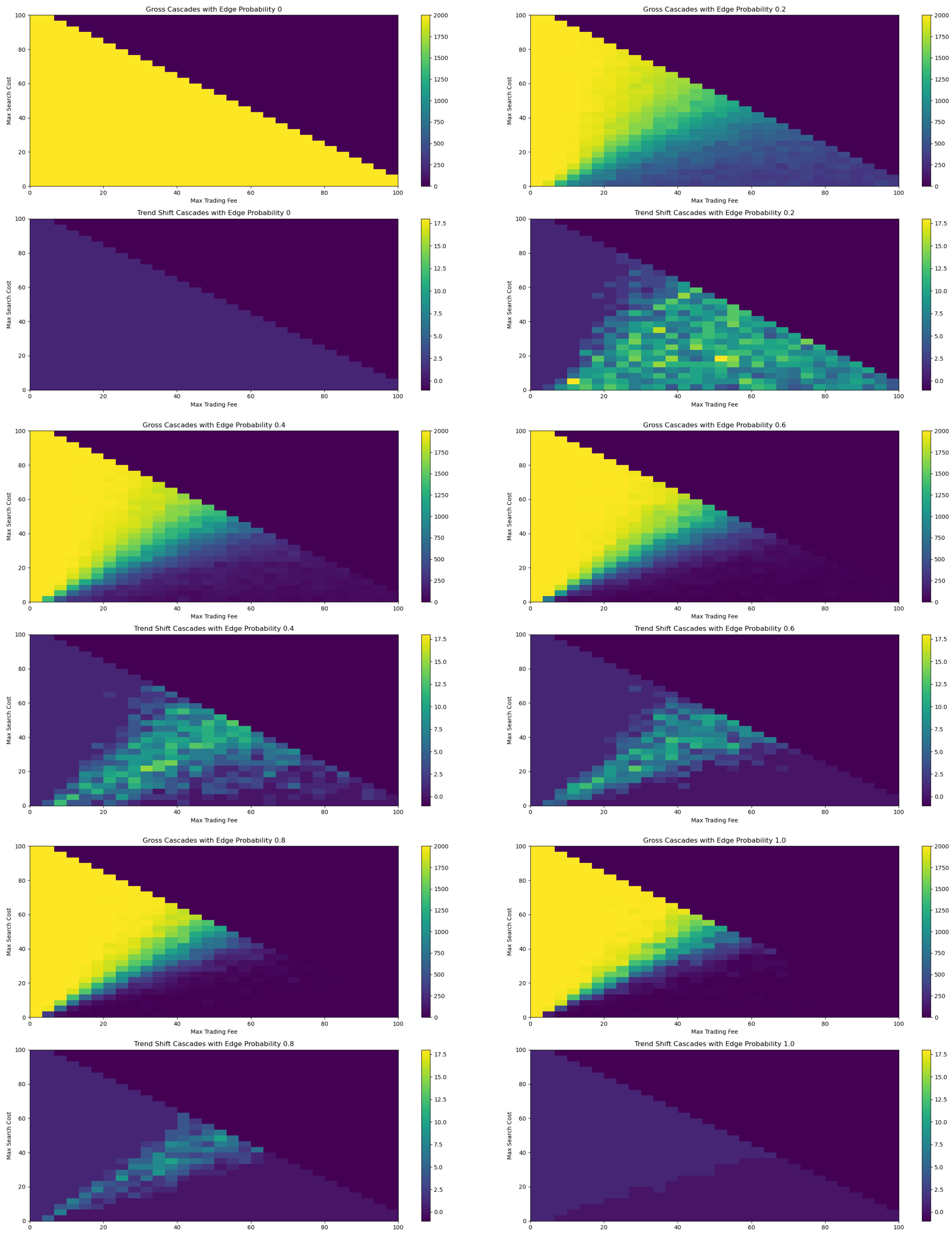
2 My Model

In order to address the areas for further research for both papers, I propose a model where we take a static topology, add a temporal component where the probabilistic distribution determines whether each connection exists during that time step, and the node can choose between buy/sell/hold depending on what it's neighbors do (threshold model) and the potential profit of buying/selling/holding its asset.

The model would look at three static network topologies (random networks, scale-free networks, and spatially-clustered networks), though presently we will look at random networks first. For now, the probability that an edge is active is set at a constant (though in the future this will be changed to be a distribution). There is a trading fee (which represents the cost an node incurs when buying or selling the asset) and a search fee (which represents the difficulty a node faces in accessing the trading decisions of its peers) which will be varied.

Each run will be 20 time steps long for a unique trading fee, search fee, and active edge probability. After each run we will record the Gross Buy/Sell Cascades and Trend Shift Buy/Sell Cascades (representing market volatility).

2.1 Results


Gross Cascades with Edge Probability 0
Gross Cascades with Edge Probability 0.2
Trend Shift Cascades with Edge Probability 0
Trend Shift Cascades with Edge Probability 0.2
Gross Cascades with Edge Probability 0.4
Gross Cascades with Edge Probability 0.6
Trend Shift Cascades with Edge Probability 0.4
Trend Shift Cascades with Edge Probability 0.6
Gross Cascades with Edge Probability 0.8
Gross Cascades with Edge Probability 1.0
Trend Shift Cascades with Edge Probability 0.8
Trend Shift Cascades with Edge Probability 1.0
Max Search Cost
Max Trading Fee

For all active edge probabilities, when both trading fees and search fees are low, the number of gross cascades are high, indicating that nodes are more likely to imitate others' trading behaviors regardless of network connectivity. As either the trading fee or search fee increases (though specifically the trading fee), gross cascades decrease, leading me to think that higher fees discourage nodes from imitating each other. As the active edge probability increases, the number of gross cascades stays relatively the same irrespective of the fees. This seems to indicate that higher connectivity enables cascades to spread quickly even with cost constraints.

When the trading fee and search fee are low, there are more trend shift cascades, suggesting that when costs are low, nodes imitate others' trading behavior but the market as a whole experiences more frequent shifts in trends. As either trading fees or search fees rise, trend shift cascades go down, though more notably when search fees go up. This seems to say that higher costs dampen volatility. At a low active edge probability (above 0), there are more trend shift cascades. As the active edge probability increases, there are less trend shift cascades at higher trading fees. This makes sense as nodes are less likely to act on others' behaviors when cost is high.

2.2 Further Work

Above I only looked random networks, but in the future I would look at other static network topologies as base, such as spatially-clustered networks and scale-free networks. While I did a surface level analysis of my results, I would like to look at some other papers in this area to get the background as to why these results are happening.

3 References

[1] Kim, Joohyun, et al. "Observing cascade behavior depending on the network topology and transaction costs." Computational Economics, vol. 53, no. 1, 5 Sept. 2017, pp. 207–225, https://doi.org/10.1007/s10614-017-9738-9.

[2] Backlund, Ville-Pekka, et al. "Effects of temporal correlations on cascades: Threshold models on Temporal Networks." Physical Review E, vol. 89, no. 6, 26 June 2014, https://doi.org/10.1103/physreve.89.062815.