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Ph.D. Dissertation Defense

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Title:	Contagion Dynamics in Traditional and Decentralized Finance
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Abstract

Financial systems are inherently interconnected, with shocks propagating through institutions in complex ways. Understanding contagion dynamics is crucial for identifying vulnerabilities, particularly during periods of financial turmoil. This dissertation explores these broader themes by combining network theory, statistical validation, and advanced risk modeling to analyze both traditional financial networks and decentralized finance (DeFi) systems.

First, we introduce a contagion centrality measure called the Katz-Bonacich Centrality Measure (KB) to assess the systemic risk and shock propagation in financial networks. We emphasize the need for statistical validation of network-based risk measures and provides an innovative testing framework to assess the accuracy of contagion risks through deriving the distribution of the measure and hypothesis testing. In empirical case studies using financial data, we show that KB is highly responsive during periods of financial distress, capturing underlying market dynamics and offering clearer insights than existing centrality measures.

We extend the application of the KB measure by incorporating it as a risk factor to predict Value at Risk (VaR) and Expected Shortfall (ES). The study compares several models from the literature, including Piecewise Linear Asymmetric Slope, CAViaR and GAS models, all developed using neural network architecture. We find that incorporating KB into these models improves the risk measures' predictions compared to models without it. The FZ loss function is employed to jointly evaluate VaR and ES predictions, addressing the challenge of ES being non-elicitable.

Finally, we explore contagion effects in Decentralized Finance (DeFi), focusing on modeling liquidation dynamics in lending platforms and Miner Extractable Value (MEV) on exchanges and from the liquidator's point of view. We aim to quantify the maximum profit a liquidator can earn within a single block of transactions. We examine scenarios where liquidators can cause liquidation spirals and explicitly include transaction fees into our models, in contrast to a large body of the existing literature. We discover that transaction fees can discourage front-running attacks meant to trigger liquidations because the cost may no longer be justified by the decreased profit. Understanding these mechanisms is key to identifying systemic risks and potential vulnerabilities in blockchain-based financial systems.

Thus, this dissertation is organized into four chapters. First, we give an introduction on the broader topics. Second, we introduce the KB Centrality to assess systemic risk in financial networks, emphasizing statistical validation through distributional analysis and hypothesis testing. Third, we incorporate KB as a risk factor to improve VaR and ES predictions, comparing its performance across neural network-based models. Fourth, we analyze contagion effects in decentralized finance, focusing on liquidation spirals incorporating transaction fees and assessing different frontrunning and liquidation combination scenarios.