Ph.D. Dissertation Defense

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Degree:	Doctor of Philosophy
School/Department.:	School of Business / Financial Engineering
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Title:	Modeling Market Liquidity and Financial Regulations in Times of Stress
Chairperson:	Dr. Zachary Feinstein, Financial Engineering, School of Business
Committee Members:	Dr. Steve Yang, Financial Engineering, School of Business
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Abstract

The study of financial contagion is paramount to safeguarding the stability of the global financial system. To understand the mechanisms and channels which propagate financial contagion, existing studies propose 'inverse demand functions' to mathematically model the relationship between trading activities and resultant prices, measuring the impact of asset sales on their prices in financial contagion. We have employed a network model-based approach to study the inverse demand function within the context of financial contagions.

In essay 1, we initially introduce a framework to understand price-mediated contagion in a system where the capacity of the market to absorb liquidated assets is determined endogenously. In doing so, we construct a joint clearing system in interbank payments, asset prices, and market liquidity. We establish mild assumptions which guarantee the existence of greatest and least clearing solutions.

In essay 2, we propose a data-driven approach to derive the inverse demand function from only partial information, skillfully inferring the obscured asset liquidations from the observable initial shocks and final equilibrium asset prices—a novel technique viable within the complexities of real-world market. This was achieved by introducing an innovative dual neural network structure that operates in two sequential stages: the first neural network maps initial shocks to predicted asset liquidations, and the second network utilizes these liquidations to derive resultant equilibrium prices. This approach can capture both linear and non-linear forms without pre-specifying an analytical structure.

In essay 3, we investigate the innovative use of Large Language Models (LLMs) as analytical tools for interpreting complex financial regulations. Our primary objective is to design effective prompts that guide LLMs to distill verbose and intricate regulatory texts, such as the Basel III capital requirement regulations, into a concise mathematical framework subsequently translated into actionable code. This novel approach aims to streamline regulatory mandates within the financial reporting and risk management systems of global banking institutions. We conduct several case studies to assess the performance of various LLMs, with GPT-4 demonstrating superior ability in processing information and performing mathematical calculations. Additionally, we present numerical case studies involving simulated asset holdings—including fixed income, equities, and commodities—to illustrate how LLMs effectively implement the Basel III capital adequacy requirements.