COMPUTER SCIENCE & ENGINEERING
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DISSERTATION DEFENSE

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Modeling Trading Strategies in Financial Markets with Data, Simulation, and Deep Reinforcement Learning

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ABSTRACT: Rapidly advancing algorithmic trading techniques and lagging financial market regulations have led to opportunities for traders to use these advancements to their own advantage. This dissertation explores trading practices that leverage superior market information or resources to benefit during certain market events. Studying trading activity during and around market events can provide insight into what may cause or exacerbate these events. I examine some common trading strategies that exploit an advantage to respond to market volatility before others are even aware of the event. I also analyze adversarial trading strategies that try to maximize combined profits between the market and an external contract whose value is dependent on a transaction-based financial market. These trading practices may increase market volatility, impact the profits of other market participants, or shift financial benchmarks.

This work analyzes the impact of various trading strategies in four studies. First, I use historical data to examine trading activity around mini flash crashes. I find that some trading practices may exacerbate these events and negatively affect retail investors. Second, I use an agent-based simulation and empirical game-theoretic analysis to study ETF arbitrage. I find that arbitrage increases market-wide volatility, but helps the asset which initially experienced volatility recover faster. Third, I study benchmark manipulation in an agent-based simulation. I examine three ways of constructing benchmark manipulation strategies. One form of strategy is hand-crafted and heuristic and the others are derived by deep reinforcement learning. I find that all three manipulators successfully move a benchmark by submitting aggressively priced orders during the trading period. The other trading agents benefit from benchmark manipulation because the manipulator takes a loss in the market to gain a larger profit through the benchmark. Benchmark manipulation negatively affects the parties on the other side of benchmark contracts. Lastly, I combine data-driven and computation approaches in a pilot study of close price manipulation. I use historical market data to generate a synthetic close auction order stream. A manipulator that learns its trading strategy through deep reinforcement learning tries to manipulate the close. In this initial implementation, the manipulator is unable to influence the close price.

CHAIR: Prof. Michael Wellman