Mitigating Margin Spirals in Portfolio Management

Weisi Zhang (adviser: Prof. Aurélie Thiele)

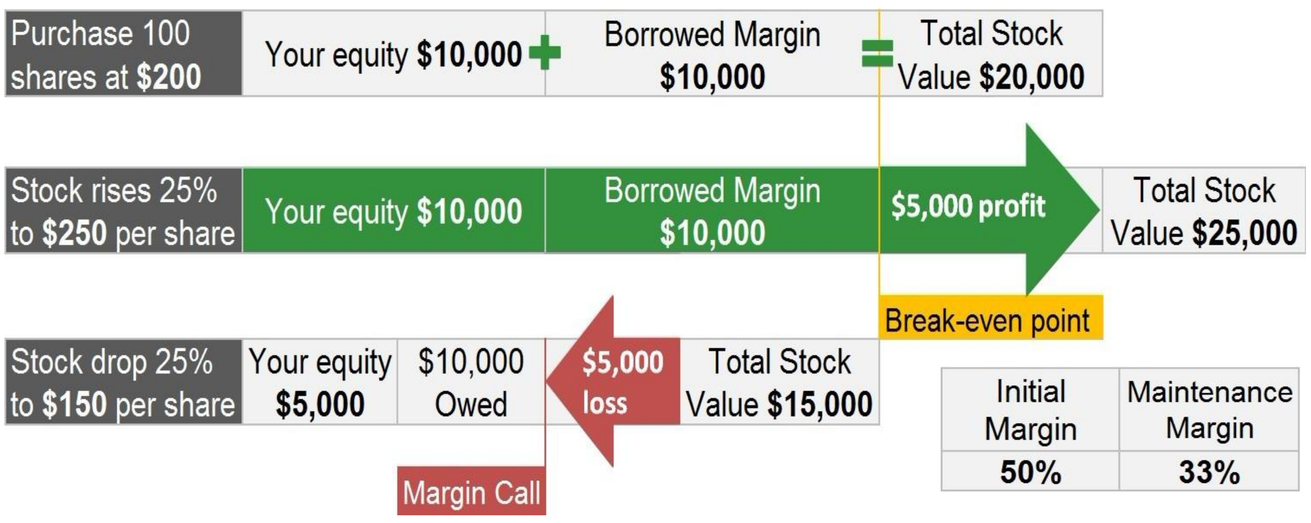
Industrial & Systems Engineering

Motivation

The purpose of our research is to find a systematic approach to mitigate downward liquidity spirals when a margin call occurs especially during the time of an economic downturn. The project seeks to assist companies and individuals who buy stocks on margin in avoiding being locked into losses when stock prices fall. A key issue is to overcome cash shortage in order to avoid forced liquidation, which would likely to contribute to the steep decline and create a downward spiral.

Problem: The Dreaded Margin Call

- **Buying on margin** is borrowing money from a broker to purchase stocks, which increases the investor's buying power. Leverage provides the investor with an opportunity to amplify his returns.
- The broker can sell off securities when price dives. Therefore, the investor locks into losses and will not be able to participate in any future rebounds.



Problem: The Dreaded Margin Call

- During the week ending October 13, 2008, the average stock price plunged **18%**, forcing many investors who bought shares on margin to sell, which continued to push stocks down mercilessly. (NewYorkTimes, October 12, 2008)
- One senior wealth management executive reported that people with **$30 million** in their brokerage accounts were wiped out in days. (*ibid*)
- There are large numbers of participants, including individual retail investors, institutional investors, insurance companies, hedge funds, and publicly traded corporations.
- Using a **portfolio-wide** margin could potentially mitigate the impact of downward liquidity spirals with a diversified portfolio, but the method has received little attention in the literature.

Large amounts of uncertainty(e.g. price, investor behavior) make **robust optimization** (a tractable type of worst-case optimization) a good choice to address liquidity management.

Methodology

Use Brownian motions to simulate stock prices based on historical data from the 2008 crisis. → Compare and contrast the performance (gain/loss and size thereof) of different methods to settle accounts when a margin call occurs. → Compute performance metrics of each method (mean, standard deviation, percentiles) and plot histograms of final portfolio return. → Repeat on several simulation runs to ensure accuracy. → Incorporate robust optimization by generating runs based on "reasonable" worst-case parameters and quantifying outputs using worst-case metrics. → Create a software tool that automates the steps above and recommends settlement options based on user's risk preferences (chosen metric, e.g., left-tail percentile of portfolio return)

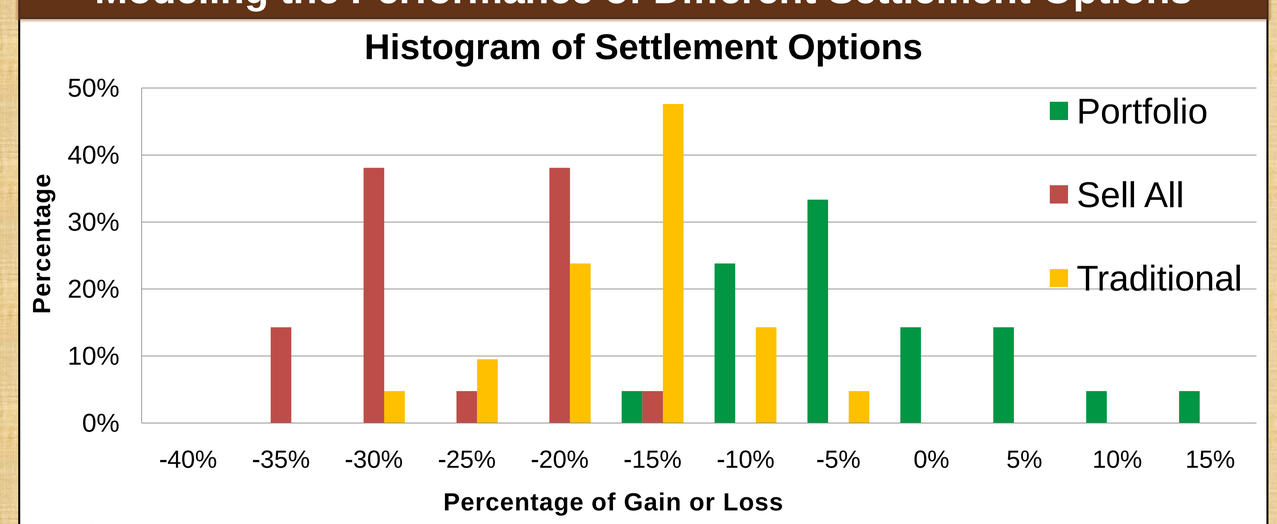
Modeling Margin Call Settlement Options

- ***PARAMETERS:***
- P_t: The stock price at day t
- ***IM***: Initial margin requirement (the Leverage Ratio)
- ***MM***: Maintenance margin requirement
- AC_0: Initial account value

- ***VARIABLES:***
- z_t: Binary
- m_t: Margin call threshold
- l_t: Loan value
- x_t: Equity needed to sell
- d_t: The amount of debit
- s_t: Number of shares

$$1 \; if \; margin \; call \; occurs; 0 \; otherwise$$
$$m_t = p_{t-1} * z_t + m_t * (1 - z_t)$$
$$l_t = P_t * s_t * (1 - MM) * z_t + l_{t-1} * (1 - z_t)$$
$$x_t = \max((d_{t-1} - l_t)/MM * z_t, 0)$$
$$d_t = (l_{t-1} - x_t) * z_t + d_{t-1} * (1 - z_t)$$
$$s_t = s_{t-1} - x_t / p_t$$

Modeling the Performance of Different Settlement Options



- $6 million is invested in each asset shown above for 30 days.
- Based on the results, the **portfolio-wide settlement option** is preferable.

Conclusions

Contributions:

- Our research contributes to the literature by investigating novel ways to manage portfolios in a more efficient manner and mitigate the impact of an economic downturn.
- From a modeling standpoint, we provide a new method based on **robust optimization** to circumvent the losses due to margin calls.

Future Work:

- Apply **robust optimization** to a larger pool of stocks from different companies to minimize the risk of incurring large losses during a crisis.
- Evaluate the benefits of considering different portfolios in a ***centralized decision-making framework*** and determine the feasibility of implementing a committee to oversee and coordinate sell-offs related to margin calls.

Undergraduate Engineering Research Symposium 2012