Mixed Integer Linear Programming for Portfolio Optimization Bay Area Decision Science Summit 2025

Qamil Mirza bin Abdullah
qamilmirza@berkeley.edu
University of California, Berkeley

Kenny (Pattaraphon) Wongchamcharoen
pattaraphon.kenny@berkeley.edu
University of California, Berkeley

Aadil Jamari
aadil@berkeley.edu
University of California, Berkeley

Jake Juhyung Lee
jakejuhyung@berkeley.edu
University of California, Berkeley

ABSTRACT

Our team explored the application of a Mixed Integer Linear Programming (MILP) approach to optimize the portfolio of equity derivatives. We have developed an optimization model that seeks to minimize the net costs spent on options over a given period. By utilizing MILP, our approach ensures a minimum exposure of +$10,000,000 for a given scenario, while minimizing the total premium costs across a time frame of one month.

ACM Reference Format:
Qamil Mirza bin Abdullah, Kenny (Pattaraphon) Wongchamcharoen, Aadil Jamari, and Jake Juhyung Lee. 2025. Mixed Integer Linear Programming for Portfolio Optimization Bay Area Decision Science Summit 2025. In *Proceedings of* . ACM, New York, NY, USA, 1 page.

1 NET COSTS APPROACH

1.1 Definitions

- The set of options $o \in O$.
- The set of trading dates $d \in D$.

1.2 Decision Variables

For each option $o \in O$:

- $x_o \in \mathbb{Z}^+ :=$ the number of **contracts** to buy.
- $y_o \in \mathbb{Z}^+ :=$ the number of **contracts** to sell.

1.3 Parameters

- a_o : Ask Price
- b_o : Bid Price
- A_o : Ask Size
- B_o: Bid Size
- M: Contract Size
- k_o : Strike Price
- s_o: Underlying Price
- d_o: Trading Date
- T_o: Maturity Date
- β: Spot Move

1.3.1 *Exposure Function (per Option)*

We know that Min exposure $\geq 10,000,000\ \forall d \in D$. Since the next day underlying price is based on spot move, the exposure function per option, E is given by:

$$E(o) = \max(\beta \cdot s_o - k_o\ ,\ 0) - \max(s_o - k_o, 0)$$

1.3.2 *Non-Expired Options*

For each trading date $d \in D$: Let $O_d = \{o \in O \mid T_o \geq \text{next\_date}(d)\}$, the set of non-expired options.

1.4 Objective Function & Constraints

With this approach, we want to minimize total premium cost over all options:

$$\boxed{\min \sum_{O} M \cdot (a_o x_o - b_o y_o)}$$

Subject to:

(i) **Purchase Limits:** $x_o \leq A_o\ \forall o \in O$
(ii) **Sales Limits:** $y_o \leq B_o\ \forall o \in O$
(iii) **Net Position:** $y_o \leq x_o\ \forall o \in O$
(iv) **Expiry:** For any option o where $d_o \geq T_o$, set $x_o = 0$, $y_o = 0$.
(v) **Daily Minimum Exposure:**
For each training date $d \in D$ such that $d + 1 \in D$, our **aggregate exposure** must meet the minimum:

$$M \sum_{o \in O_d} (x_o - y_o)\ E(o) \geq 10,000,000$$

, ,
2025.