

# Robust Optimization in Portfolio Management

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## Executive Summary

- **Robust portfolio management** that achieves target return and minimizes risk simultaneously
- Formulation with ellipsoidal uncertainty set
- More resilient to noises and changes in market such as a **Black Swan** event

## Problem Statement

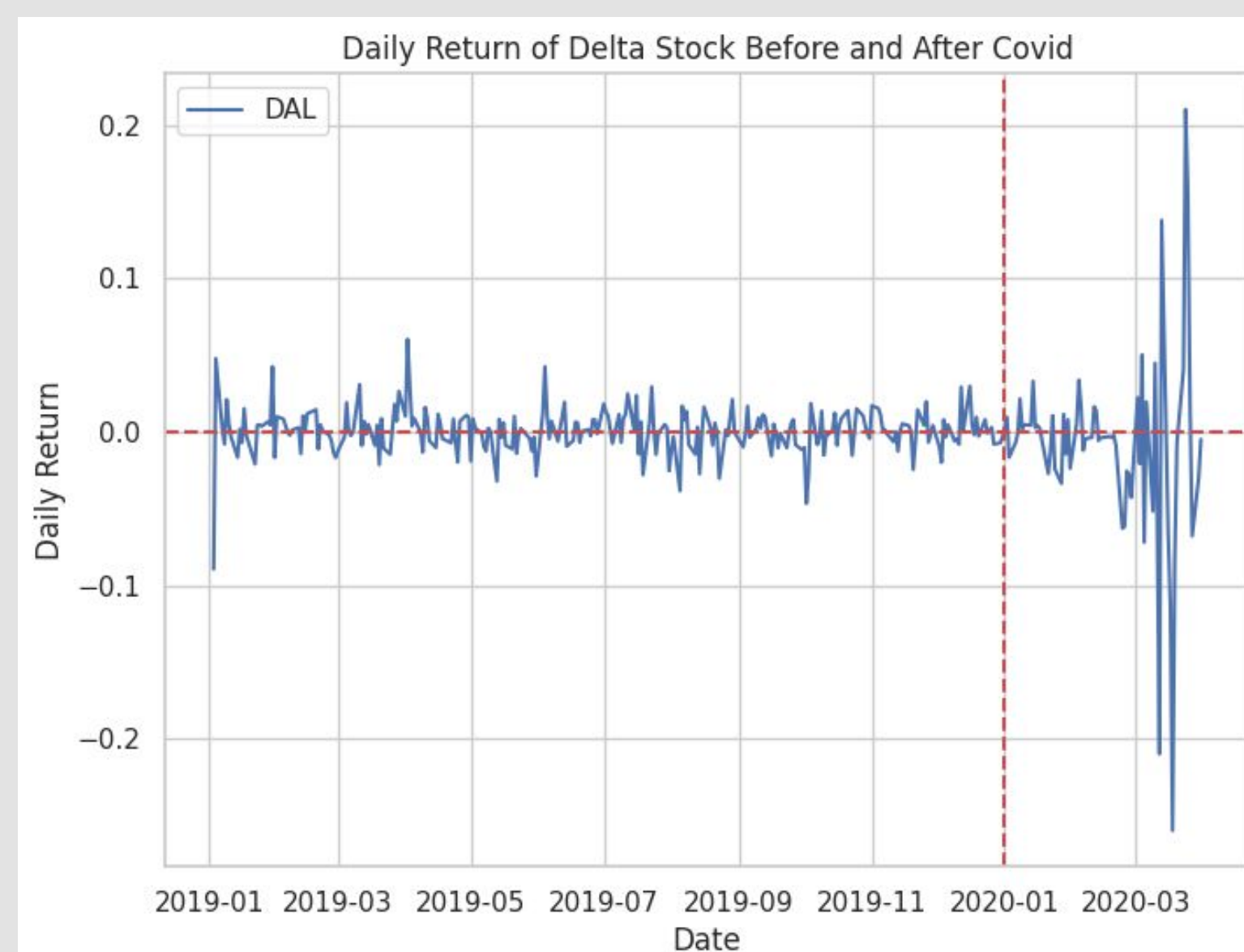
Notable drawbacks of **mean-variance framework**:

- Difficulty in obtaining **accurate** input estimates
- **Sensitivity** of the optimal portfolio to inputs
- Single factor to drive returns (i.e. market factor)

## Data Description

We selected 10 stocks from 5 different sectors defined by The Global Industry Classification Standard (GICS®)

- Healthcare, Financials, Industrials, Technology, Consumer Discretionary



## Formulation

**Objective:** Minimize variance (risk) of portfolio

**Decision Variable:** Weight (percentage) of each stock

**Constraint:**

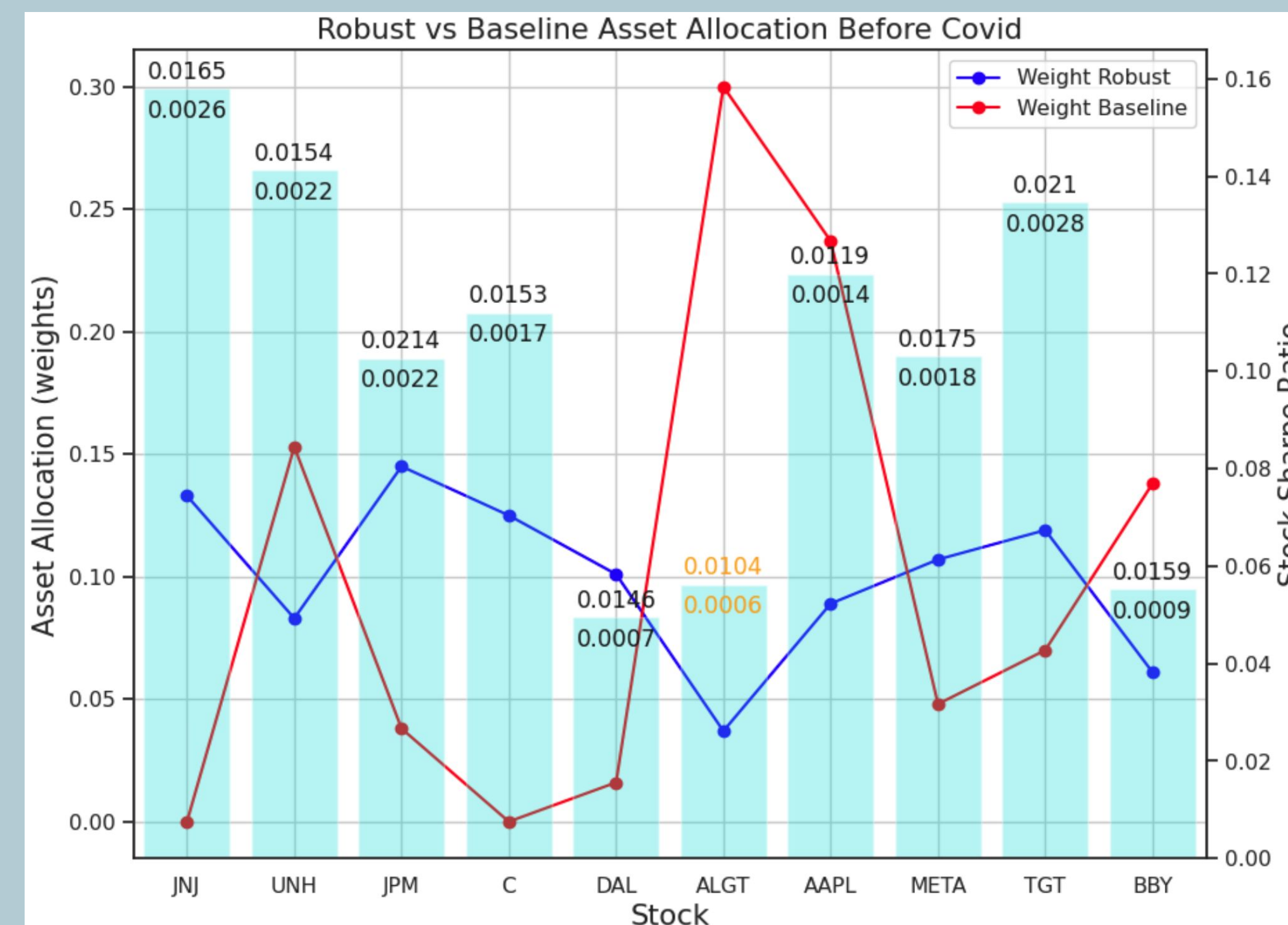
- Target return is met (0.04% daily return)
- Long only
- Limited weight in single position and sums to 1

**Assumptions:**

- Covariance of any pair of stock is static

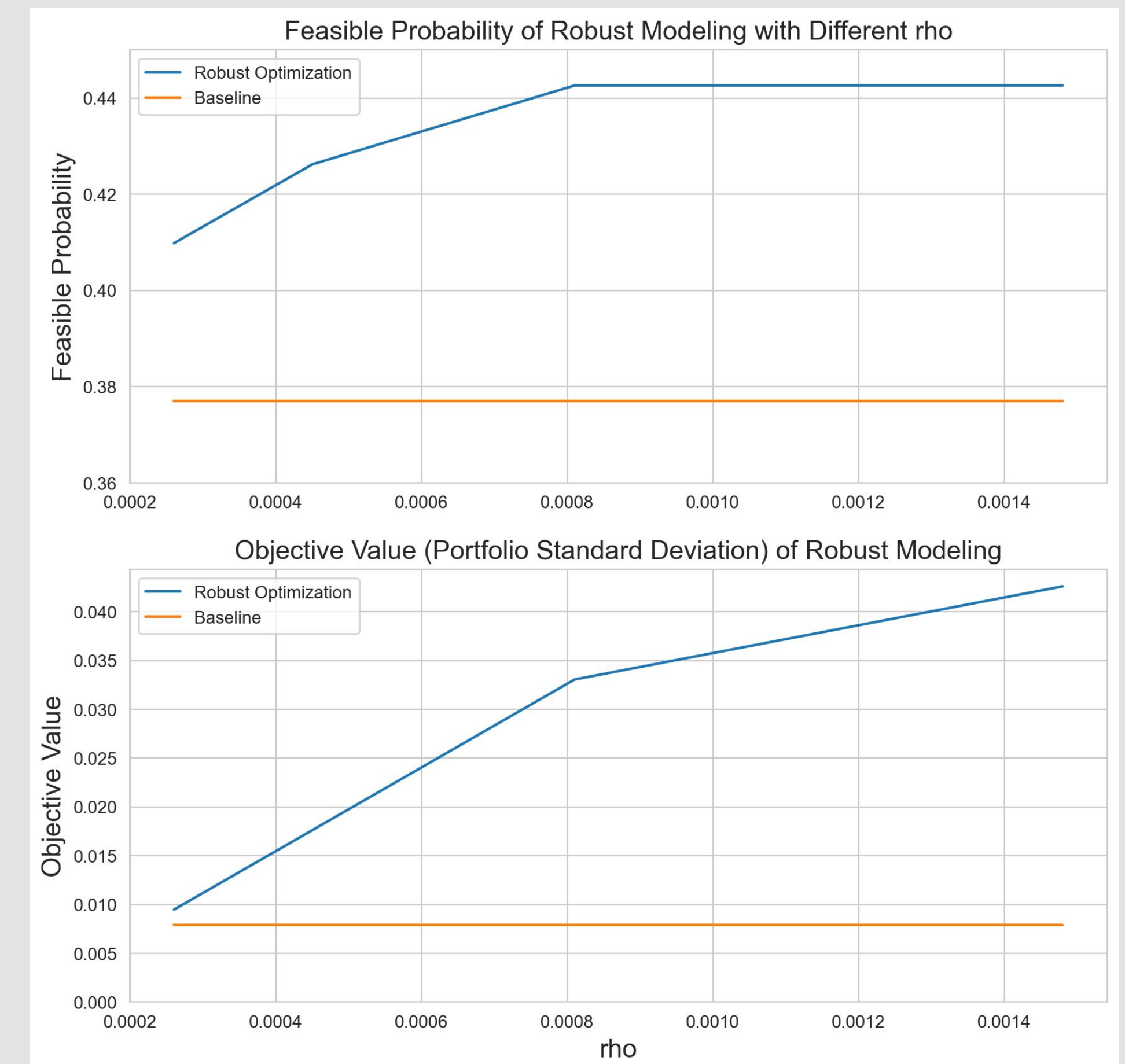
$$\begin{aligned} \min \quad & w^T \Sigma w \\ \text{s.t.} \quad & \bar{r}^T w - \rho \|(\Sigma^{-\frac{1}{2}})^T w\|_2 \geq \beta \\ & w_i \leq t, \forall i = 1, \dots, n \\ & \sum w_i = 1 \\ & w_1, \dots, w_n \geq 0 \end{aligned}$$

## Key Findings



- **Robust** model invests wiser following Sharpe Ratio
- **Baseline** model cares more about lowering risk

## Impact



- For **same target return**, robust model gives **less portfolio turnover** with slightly higher risk, as the perturbations in market increase
- In particular, though feeding on data at “good” years, robust model can better **survive crisis**

## Future Work

- Utilize **factor model** to forecast financial return and interpret allocation at broad factor level
- Expand to more asset classes
- Other considerations: liquidity, turnover, transaction cost, short position