##### **Long/Short Global Macro Strategies with Target Beta Using the 3-Factor Model**

##### **Theo Dimitrasopoulos\*, Yuki Homma\***

\* Department of Financial Engineering; Stevens Institute of Technology Babbio School of Business

**Abstract**

In this project we construct a Long/Short Global Macro Strategy based on French Fama 3-Factor Model with a target beta term and evaluate its sensitivity to variation of Beta and its sensitivity to the length of the estimation for covariance matrix and the expected returns under different market scenarios. Several comparisons are drawn between each beta term and term structure combinations.

KEYWORDS - Global Macroeconomic Trends, Long/Short, French, Fama, Beta, 3-Factor Model, Trading Strategies, Portfolio Management

**I. INTRODUCTION**

**fama french 3-factor model**

Historically, French Fama 3-Factor Model is regarded as a development of CAPM which explains a relationship between expected returns and risk factors.

Fama and French proposed the eponymous French Fama 3-factor model which describes a cross section of average stock returns using three factors: market risk premium, market equity, and book-to-market ratio.

Under the 3-factor model, the random return of security is given by the formula,

With , , , , , the expected return on a given security can be written as

Where is a random return on a security, is a risk-free rate, is a market return, and three , , , is a sensitivity measure for risk premium of market portfolio, risk factor of market equity, and risk factor of book-to-market ratio, respectively.

**markowitz portfolio**

Markowitz portfolio theory also known as modern portfolio theory is a theory on how risk-averse investors can construct portfolio to maximize expected return based on a given level of market risk. The theory can also be used to construct a portfolio that minimize risk for a given level of expected return. In mathematical format:

Where is a vector of weights of securities, is a covariance matrix , is an expected return, is a target return.

**linear regression**

An approach for predicting a quantitative response Y n the basis of multiple predictor variable that assume an approximately linear relationship between and Y. For a model with p predictors, the linear regression takes the form

where is the th predictor and qualifies the relationship between that predictor and the response. Given estimates for , it can make predictors using the model

where we estimate these parameters by minimizing the residual sum of squares

**II. INVESTMENT UNIVERSE & BACKTESTING**

**data**

We used the 12 ETFs belowfrom March 1, 2007 to June 30, 2020:

1. CurrencyShares Euro Trust (FXE)
2. iShares MSCI Japan Index (EWJ)
3. SPDR GOLD Trust (GLD)
4. PowerShares NASDAQ-100 Trust (QQQ)
5. SPDR S&P 500 (SPY)
6. iShares Lehman Short Treasury Bond (SHV)
7. PowerShares DB Agriculture Fund (DBA)
8. United States Oil Fund LP (USO)
9. SPDR S&P Biontech (XBI)
10. iShares S&P Latin America 40 Index (ILF)
11. iShares MSCI Pacific ex-Japan Index Fund (EPP)
12. SPDR DJ Euro Stoxx 50 (FEZ)

The S&P 500 (SPY) was chosen to be the analysis benchmark. Lastly, the data used to construct the French Fama 3-Factor Model is quoted from Ken French’s website for the factors’ historical values.

**investment horizon**

The investment horizon was divided into the following sub-periods:

1. Pre-Subprime Crisis : March 22, 2007 – March 3, 2008
2. During Subprime Crisis : March 3, 2008 – September 10, 2010
3. Post-Subprime Crisis : September 10, 2010 – January1, 2015
4. Pre-COVID-19 Pandemic : January 1, 2015 – March 9, 2020
5. During COVID-19 Pandemic : March 9, 2020 – October 30, 2020

**backtesting**

Individual backtests were executed for each sub-period to compare strategies. We compared with different perspectives.

We considered the impact of each term structure and estimation term combination with a range of target β values, across each sub-period of the investment horizon. represents a term structure with days lookback period to estimate the expected return and days lookback period to estimate the covariance matrix.

We also ran a backtest across the full investment horizon, from March 1st, 2007 to November 30th, 2020.

**investment strategy**

We considered the following investment strategy,

constrained by,

where,

* : weight allocated to each security ,
* is the vector of weights for all securities in the Portfolio,
* : a vector of expected returns of security ,
* : the covariance matrix between securities returns derived from the Factor model,
* : composition of a reference Portfolio, the previous portfolio when rebalancing the portfolio,
* : small regularization parameter to limit turnover,
* : the beta term of each security
* : the Portfolio’s target beta term.

**estimation terms and target beta**

We analyzed the following combinations of term structures and beta terms for the following strategies: . The following target betas were tested for each investment strategy:

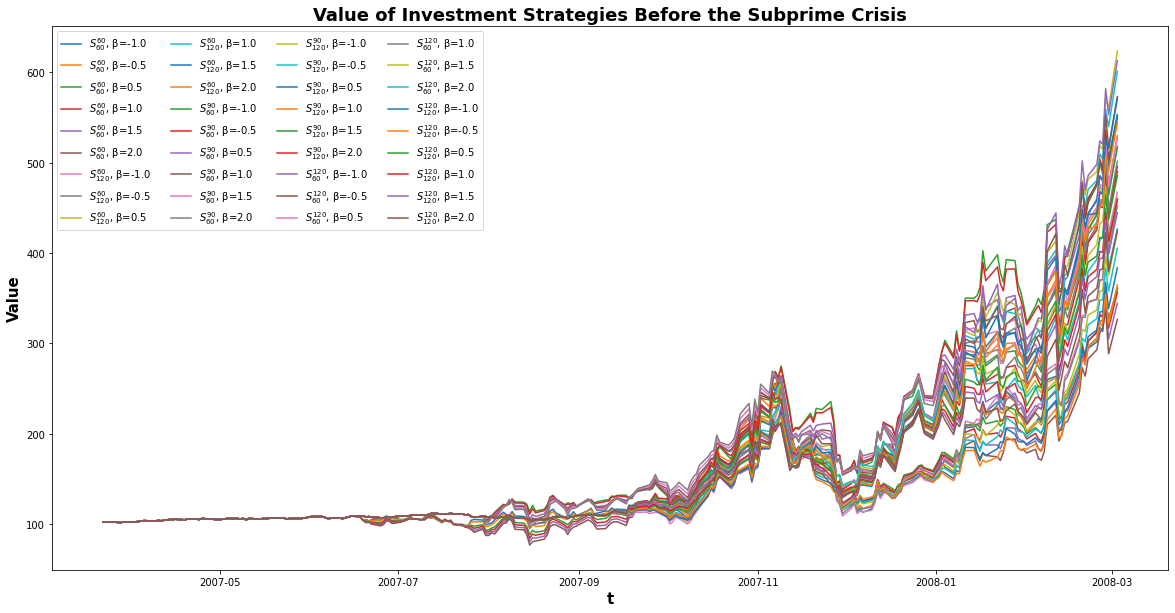
**performance and risk metrics**

The following performance and risk metrics were selected. To evaluate performance we computed the Cumulated Return, Annual Arithmetic Mean/Geometric Mean Return, Annual Min Return, Max 10-days Drawdown and Sharpe Ratio of the investment strategies. To assess the risk of each strategy, we considered Volatility, Daily VaR, Annual VaR, Modified VaR, Annual CVaR, Skewness and Kurtosis. In estimating the annualized metrics, we assume that each year includes 250 trading days

**III. RESULTS & DISCUSSION**

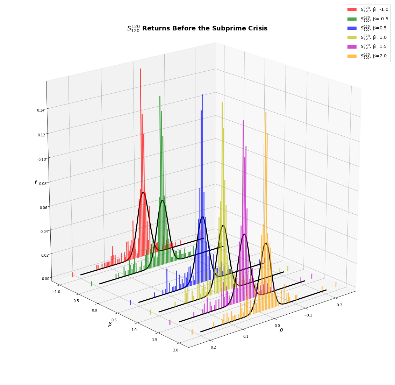
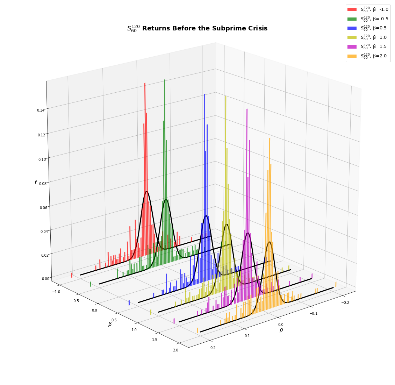
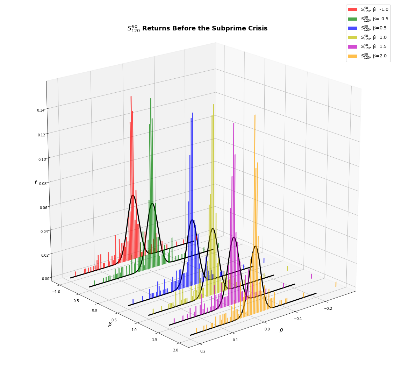
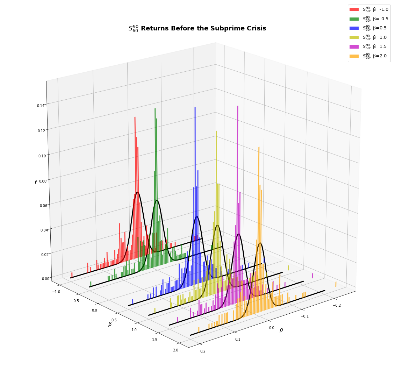
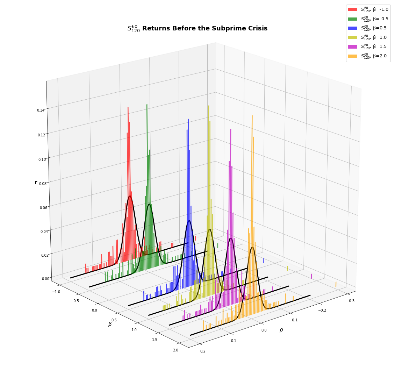
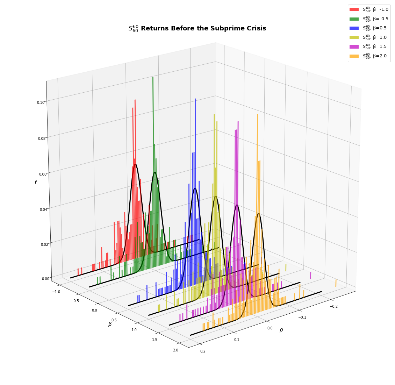
The daily Profit and Loss (P&L) graph of an investment of $100 was chosen to get a visual overview of strategy performance.

before the Subprime crisis



*Fig. 1: Evolution of cumulated daily profit and loss for several portfolio strategies (Pre-Subprime Crisis)*

The distributions of daily return for each investment strategy in the sub-period are shown in Fig. 2,



*Fig. 2: left to right, top to bottom: distribution of daily returns of , , , , and .*

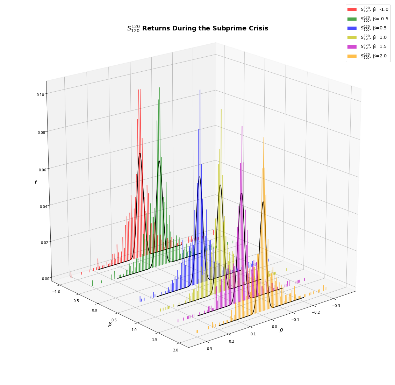
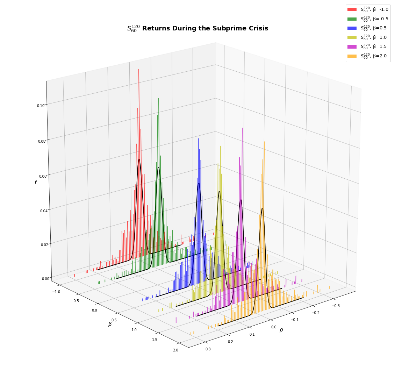
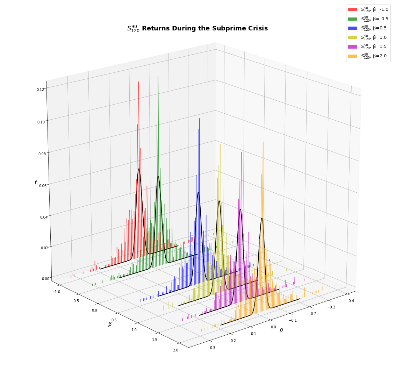
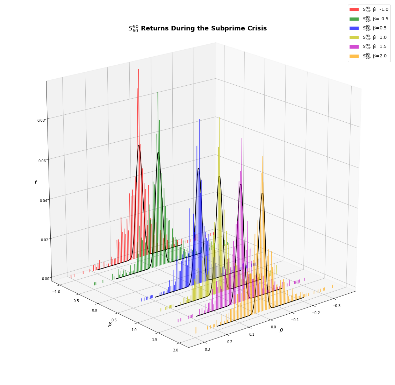
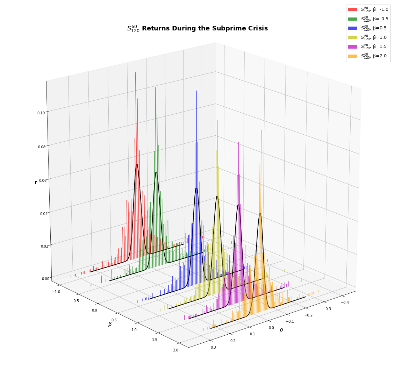
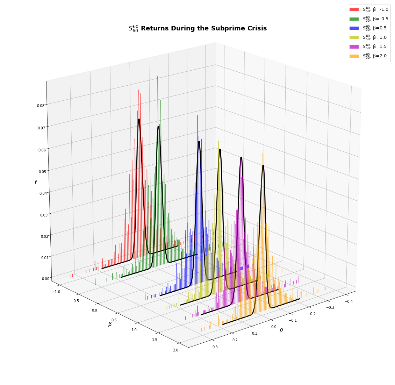
during the Subprime crisis

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*Fig. 3: Evolution of cumulated daily profit and loss for several portfolio strategies (During the Subprime Crisis)*

The distributions of daily return for each investment strategy in the sub-period are shown in Fig. 4,



*Fig. 4: left to right, top to bottom: distribution of daily returns of , , , , and .*

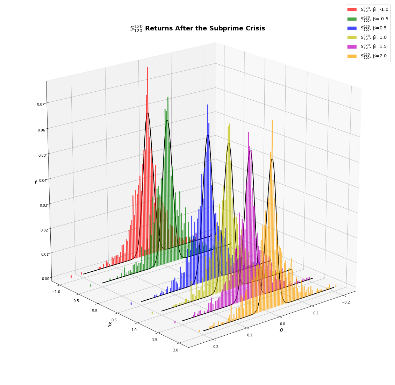
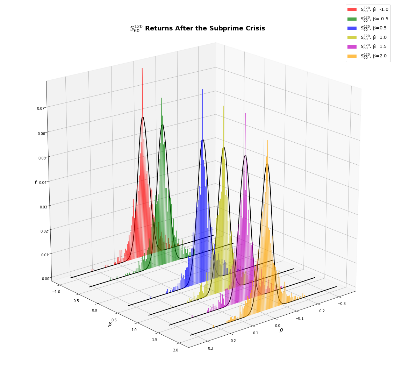
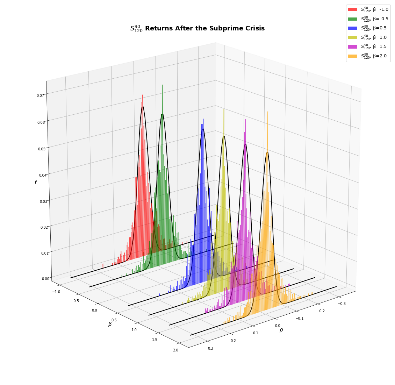
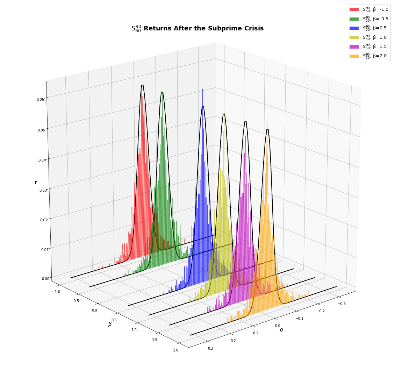
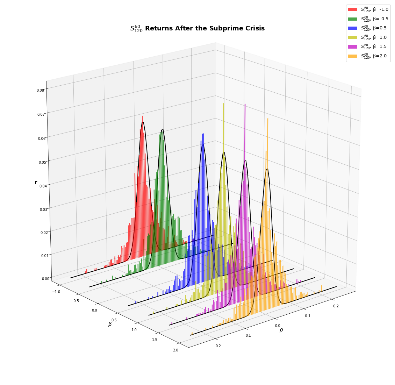
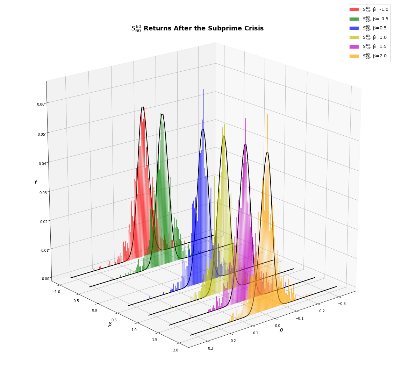
after the subprime crisis

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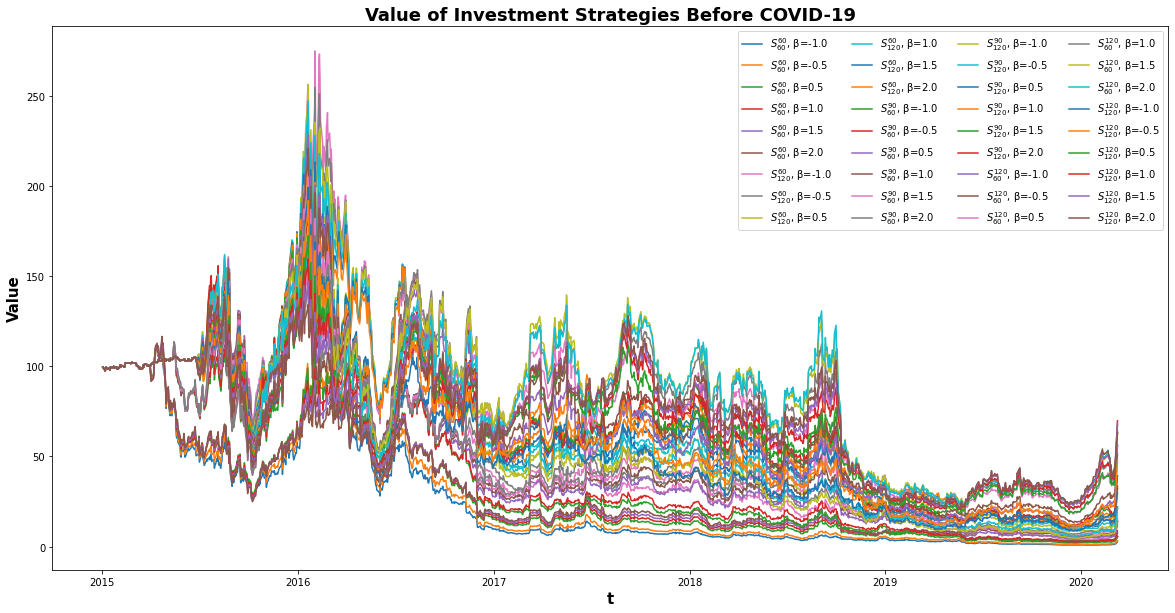
*Fig. 5: the evolution of cumulated daily profit and loss for several portfolio strategies (During Subprime Crisis)*

The distributions of daily return for each investment strategy in the sub-period are shown in Fig. 6,



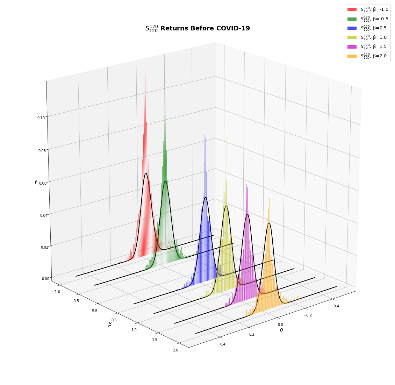
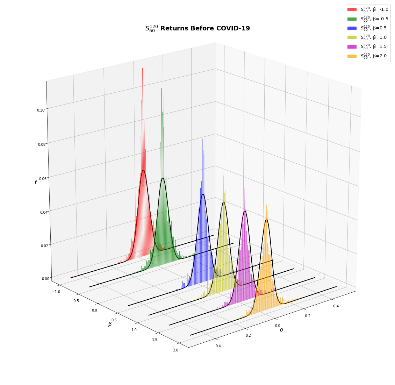
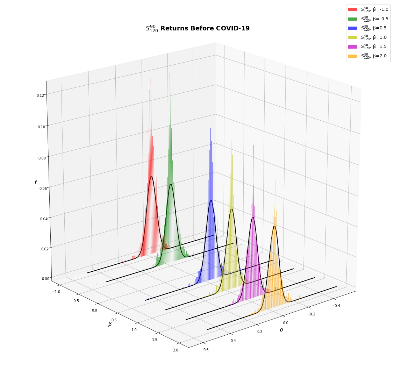
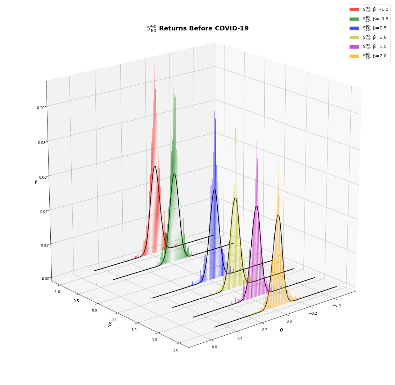
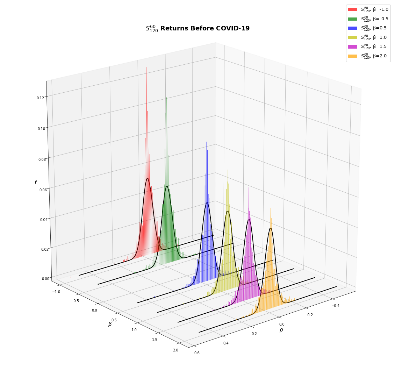
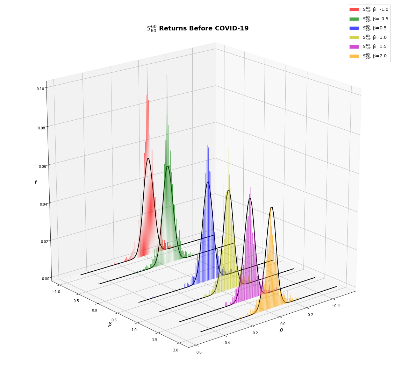
*Fig. 6: left to right, top to bottom: distribution of daily returns of , , , , and .*

before covid-19



*Fig. 7: left to right, top to bottom: distribution of daily returns of , , , , and across the sub-period March 3, 2008 – September 10, 2010.*

The distributions of daily return for each investment strategy in the sub-period are shown in Fig. 8,



*Fig. 10: left to right, top to bottom: distribution of daily returns of , , , , and .*

*Fig. 8: left to right, top to bottom: distribution of daily returns of , , , , and .*

**authors**

**Theo Dimitrasopoulos** – MSc. Financial Engineering, Stevens Institute of Technology 2021, Bachelor of Science in Engineering, Structural Engineering, Princeton University 2017; tdimitr1(at)stevens(dot)edu

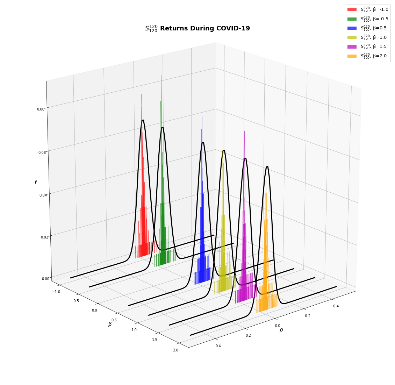
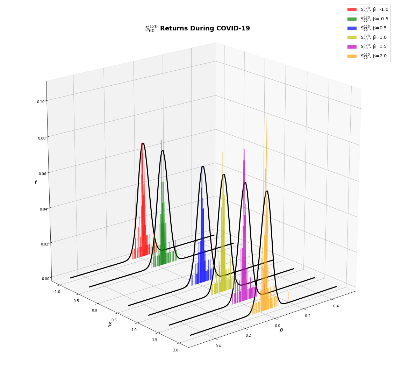
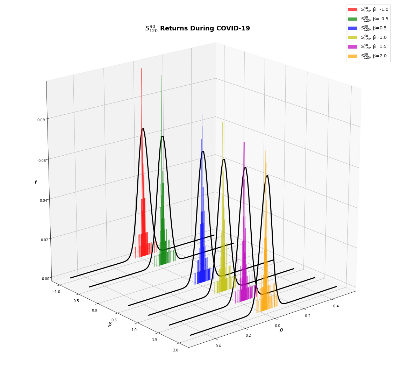
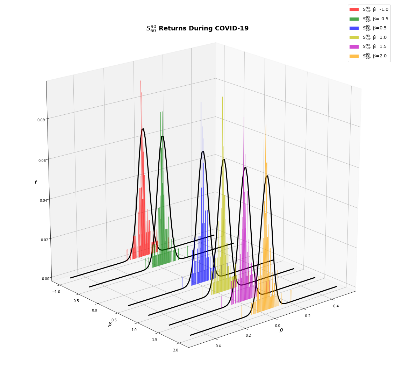
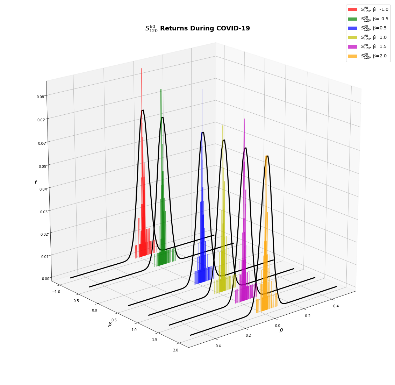
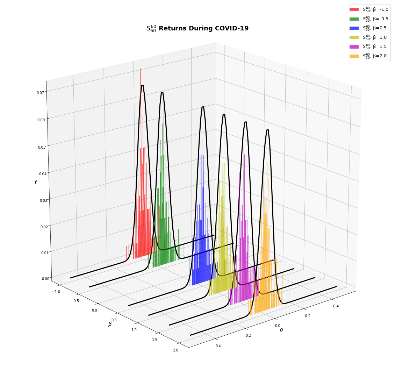
**Yuki Homma** – MSc. Financial Engineering, Stevens Institute of Technology 2021, Bachelor of Science, Physics, Keio University 2019; yhomma(at)stevens(dot)edu

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The distributions of daily return for each investment strategy in the sub-period are shown in Fig. 10,



*Fig. 9: the evolution of cumulated daily profit and loss for several portfolio strategies (During Subprime Crisis)*

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