Quantitative Trading Analysis
Vietnam market

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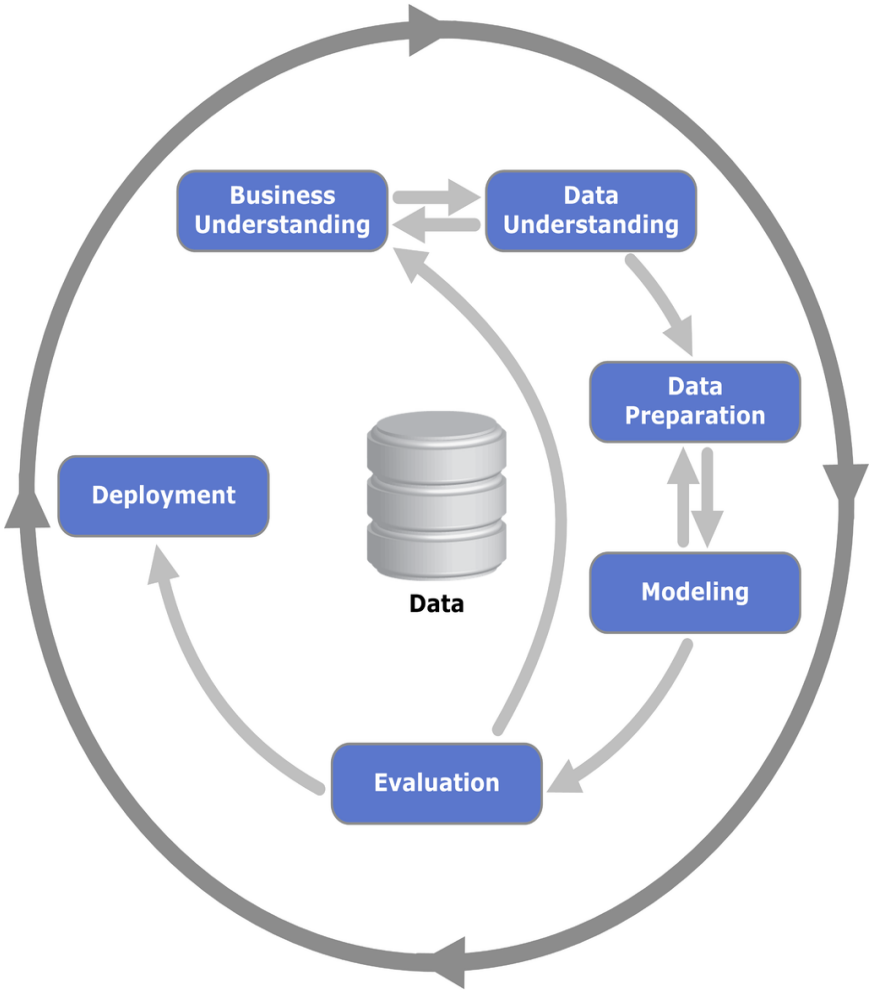
Madrid, Dec 24, 2021

Springboard

Agenda



1. **Problem Statements**
2. **EDA & Hypothesis Definition**
3. **Features selection & Modeling**
4. **Conclusions & Recommendations**

Problem Statement

Over 10 years historical dataset following quant-trading approach is used in integration of market risks with 03 well-known alpha factors: Momentum, Mean reversion & Seasonality. This is the massive trading algorithm that allows investors quantitatively working with an enormous number of stocks at a time. It is considered as a promising approach for investors, which could minimize bad behaviors during trading, beating the benchmark in Vietnam market.

1 Context

Vietnam stock exchange is one of the most potential raising up players in frontier markets. The country which has a dynamic, young population structure & a highly open economic regime with more than 20 years stock exchange life-long is explicitly a promising opportunity for domestic & foreign investors making profits. The market is in an early developing phase & lacking massive & advanced financial tools such as algo-trading (quant-trading), an alternative of fundamental & technical analysis.

2 Criteria for success

Vietnam stock exchange in a nutshell

Recommending a betas system & potential alpha factors

Build a hybrid model blending market risks & alpha factors in order to form a set of optimum weight schemes that then are used to design trading strategies to defeat the benchmark (VNindex/ VN30).

3 Scope of solution space

10 years of historical stock data of Vietnam market.
Project only targets to build a multi-factor model, the combination of risk & alpha model. Multi-factor model outcomes are optimum alpha weights for each stock & portfolio net factor exposures for each principal component. Strategy design & backtest are out of scope.
Deliverables include: code, documentation & slice deck

4 Constraints within solution space

Solution is just considered as a reference, not financial advice.
Solution is time bounded & subject to type of security

5 Stakeholders to provide key insight

Data from online open-source platforms

Solution could be advised from: stock traders, quantitative engineers/analysts, portfolio managers

6 Key data sources

https://www.vndirect.com.vn/portal/thong-ke-thi-truong-chung-khoan/lich-su-gia.shtml
https://s.cafef.vn/Lich-su-giao-dich-VNINDEX-1.chn#data

H D E I P

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Data Wrangling

Dataset:

1. Historical stock data: OHLC Volume Dividend of 621 tickers, from 2006-2021
2. Sector: 621 stocks' sector, from 2006-2021

Data cleansing:

Remove duplicate & unnecessary columns
Extract states from locations, correct states 'name convention
Convert data type from object to numeric one

Raw features:

'open', 'high', 'low', 'close', 'volume','dividend', 'sector''

Features definition:
Key feature: close (stock closing price)

Features transforming:
Create daily simple returns & log returns features

Feature extraction:
Create Bollinger band feature set
Create breakout feature set
Create Momentum feature set for 1 week, 1 month, 1 quarter, 1 half & 1 year

Features for visualization:
close, simple_returns, log_returns, Bollinger band feature set, breakout feature set

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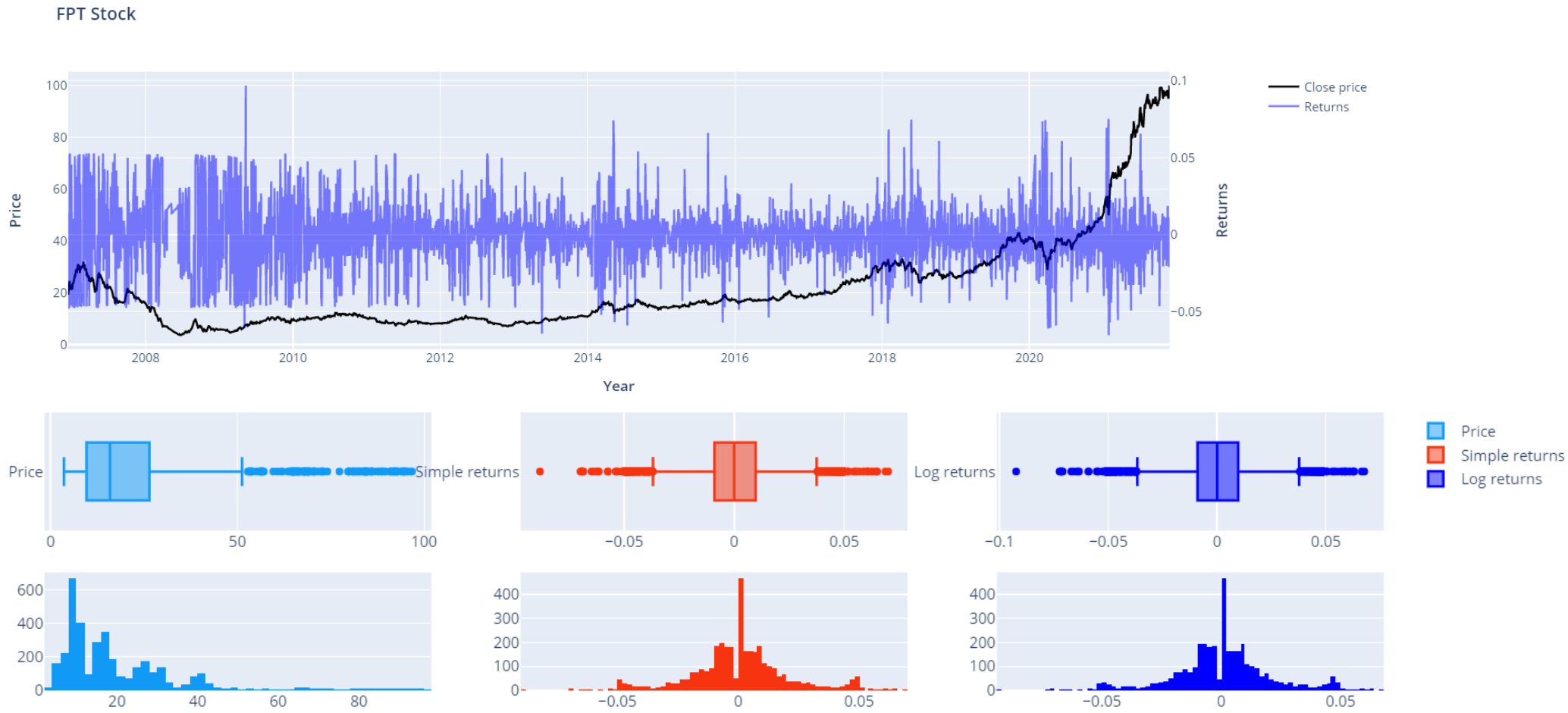
Exploration Data Analysis – Data Overview

FPT stock:

Price is non-stationary data, not normal distribution with mean & variance change by time

Returns data is more stationary, normal distribution with mean=0 & variance/standard deviation stable by time

Return data will be the input for model construction later on



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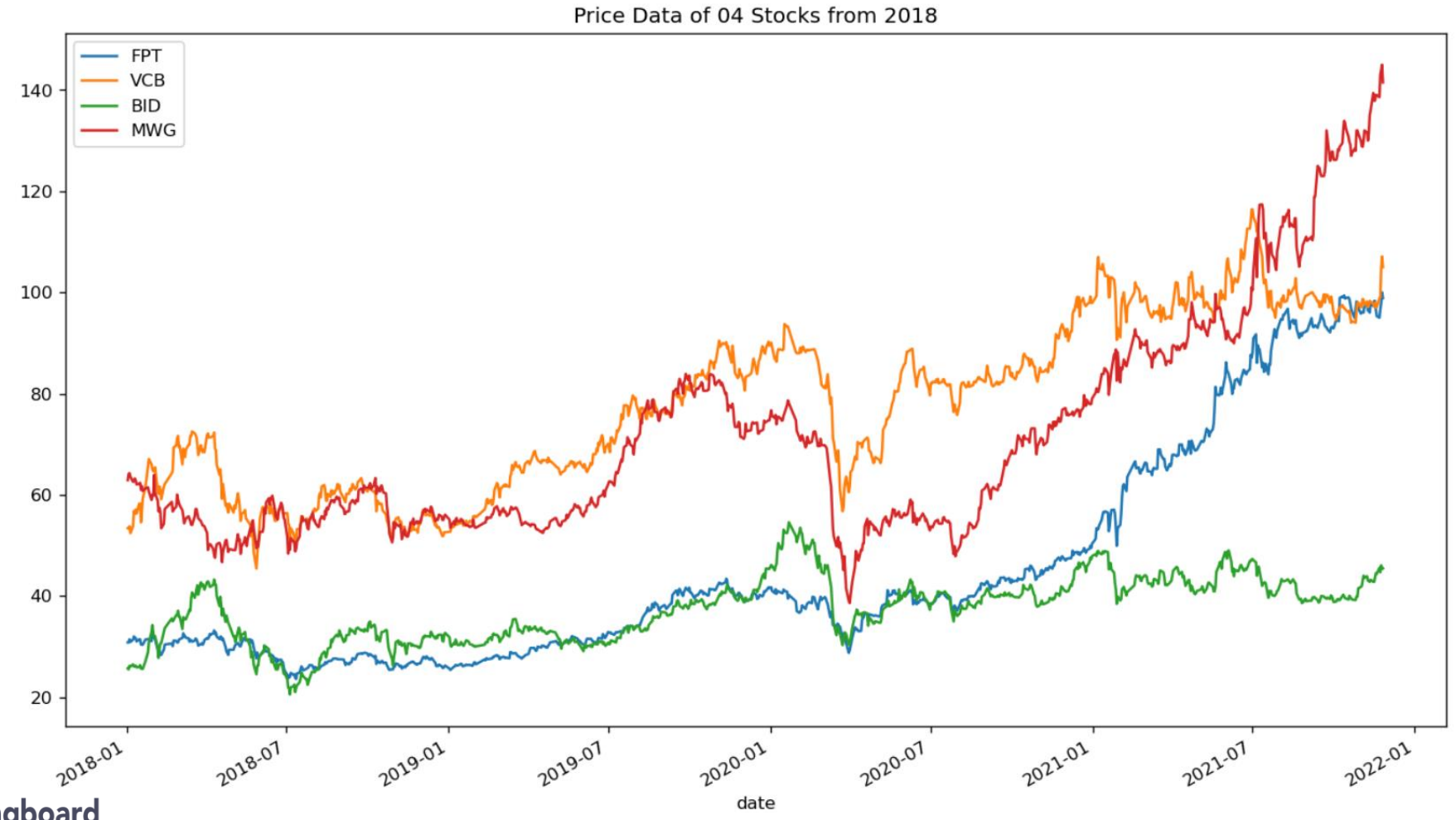
Exploration Data Analysis – Visualization Stock Price

Top 4 stocks of the market:

- Both momentum & mean reversion effect could be seen



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Exploration Data Analysis – Bollinger Band Effect

FPT stock Bollinger band effect from 2018-2021:

- 1 month simple moving average curve (sma), upper & lower bad cut the ticker price curve which are long & short signal

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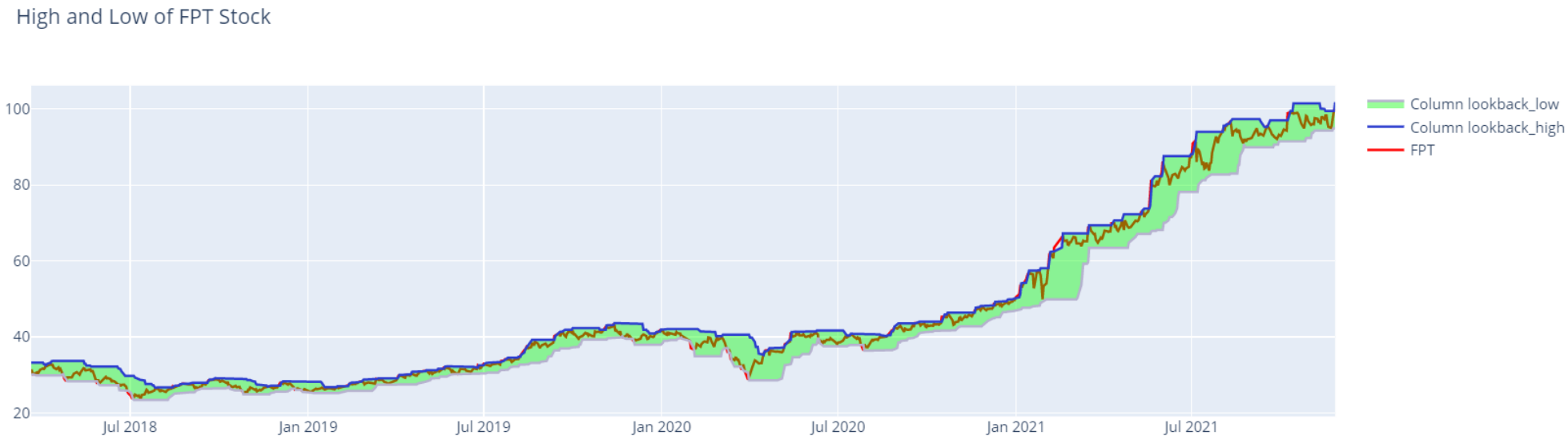
Exploration Data Analysis – Breakout Effect

Features visualization by time: 2009-2018:

- 1 month lookback low & high curves cut the FPT price one creating trading signals



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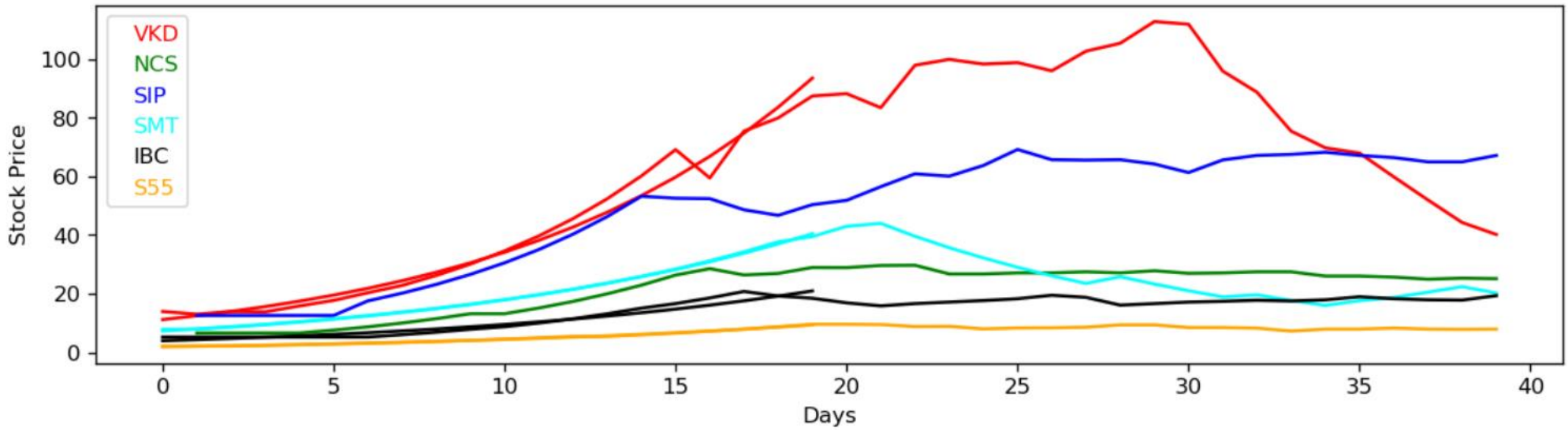
Exploration Data Analysis – Momentum Effect

Time series analysis: 2011-2021:

- Top 6 stocks have highest 1month momentum effect
- The first 3 stocks (VKD, SIP, SMT) seems having a significant momentum intensity
- 1month momentum effect for the rest are predicted from fair to weak, even negative.



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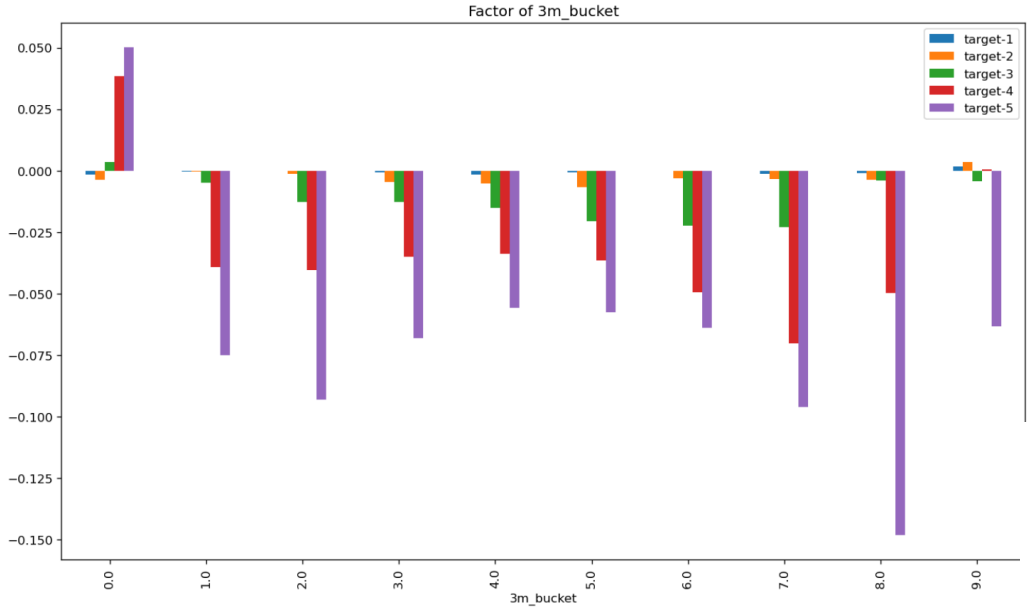
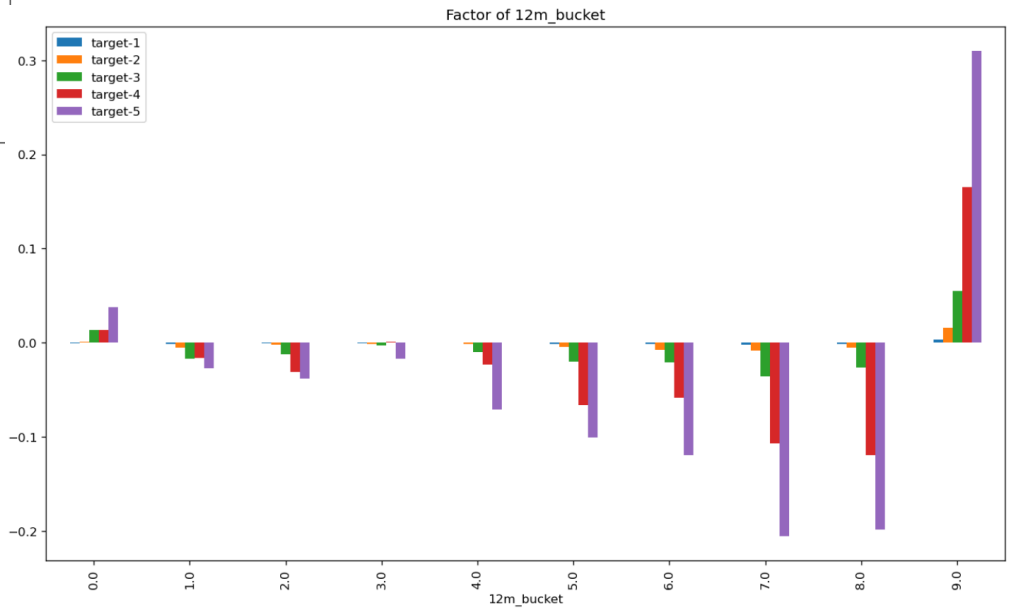
Exploration Data Analysis – Momentum Effect

Cross sectional momentum analysis: 04 stocks basket (FPT, VCB, BID, MWG)

- A year momentum works better than quarter one, quantile 10th also perform the best





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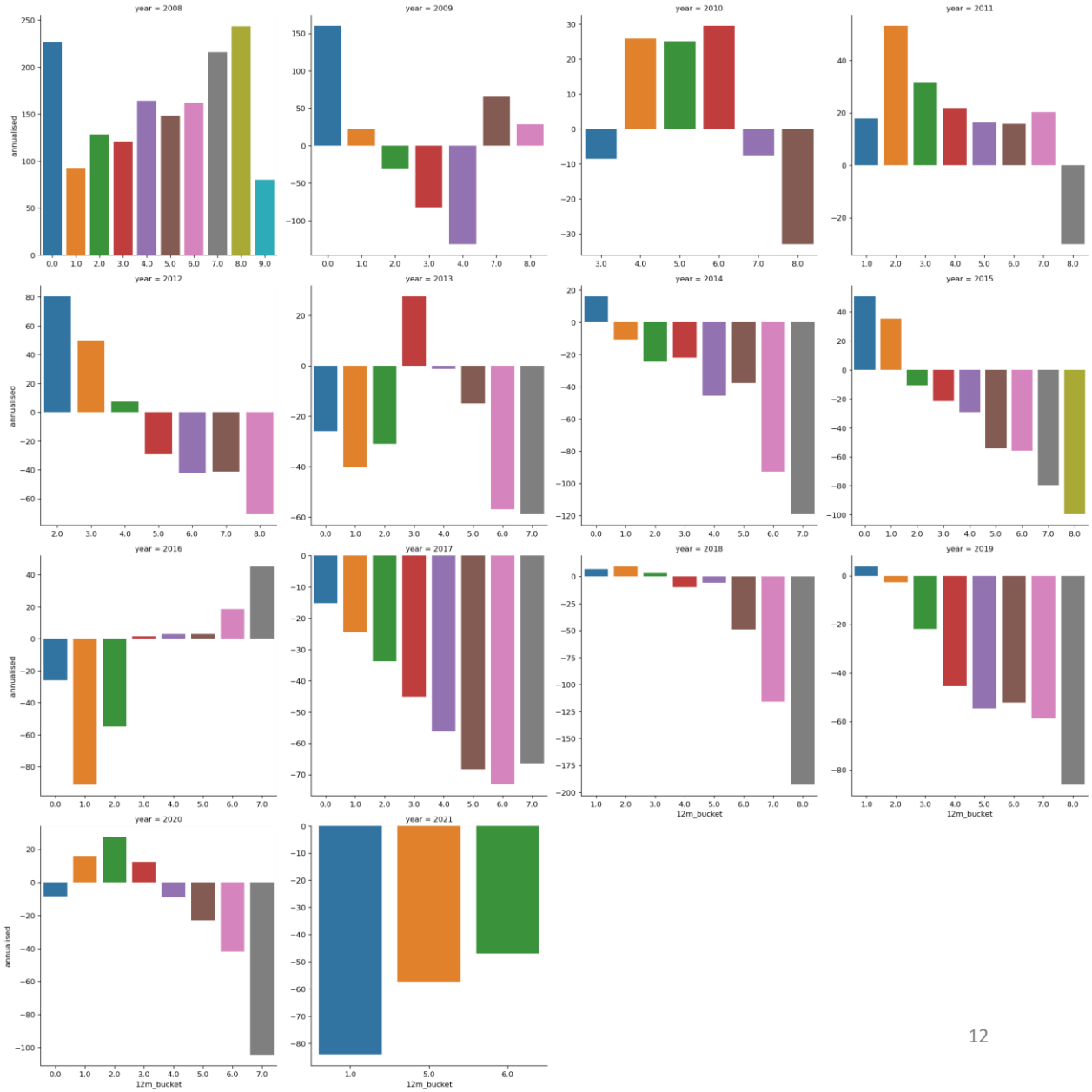
Exploration Data Analysis – Momentum Effect

Cross sectional momentum analysis:

04 stocks basket (FPT, VCB, BID, MWG) 2008-2021

- 12months momentum displays by year
- The first half quantile seem more resilient than the last



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Hypotheses Statements

Momentum

Weekly, monthly, quarterly, halfly & yearly momentum indicators have been observed both in time series & cross sectional analysis, they are considered as the short, mid & long-term alpha factors.

- Yearly momentum hypothesis: it is "Higher past 12-months (252 days) returns are proportional to future return."
- Halfly momentum hypothesis: it is "Higher past 6-months (120 days) returns are proportional to future return."
- Quarterly momentum hypothesis: it is "Higher past 3-months (60 days) returns are proportional to future return."
- Monthly momentum hypothesis: it is "Higher past 1-month (20 days) returns are proportional to future return."
- Weekly momentum hypothesis: it is "Higher past 1-week (5 days) returns are proportional to future return."

The other indicators such as mean reversion & overnight sentiment - seasonality, both are short-time factors, are also taken into account in the model.

Mean reversion

Mean reversion theory states that security prices and economic indicators such as interest rates will tend to revert to the historical mean prices.

- Mean_reversion_5day "Short-term outperformers(underperformers) compared to their sector will revert."
- Mean_reversion_5days_smoothed is a smoothed version of Mean_reversion_5day factor
- Mean_reversion_20day "Short-term outperformers(underperformers) compared to their sector will revert.

Overnight sentiment

The US stocks have significantly higher return during the night session compared to the daily session.

- Overnight Sentiment
- Overnight Sentiment Smoothed

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Model Construction

Candidate selection

This is a pretty high level research, it covers the whole VN stock exchange. 621 exchange-traded stocks, from 2011-09-01 to 2021-09-01 will be used as input for modeling process.

Poor candidate selection could lead to scattering/divergent in analysis & low performance of the models.

$$R_p(t) = \sum(B_{p,k} * R_m(t) + \alpha_p(t))$$

Risk factors are well-known and significant contributors to the variance of asset returns. **Risk model** actually is **Portfolio Covariance Matrix** will be built on stock returns data under CAPM, EMH & Modern Portfolio Theory-Effective Frontier theories to compute model factors: factor_betas, factor_returns, factor_cov_matrix, idiosyncratic_var_matrix & idiosyncratic_var_vector to estimate the portfolio risk. It will then be used as the constrains for alpha operation in the weight optimization process of multi-factor model

Factors that are proprietary and significant in describing the mean of asset returns can be candidates for alpha factors. **Alpha model** is built under Fundament law. Momentum, mean-reversion and seasonality effects are the key resilient factors for alpha model.

Finally, the two models are combined as a **Multi-factor model** in order to derive optimum weight schemes that neutralize market risks and maximize alpha returns. From that, investors/trader/portfolio managers can quantitatively design their own strategies & backtests that allows them quantitatively make up their further decision.

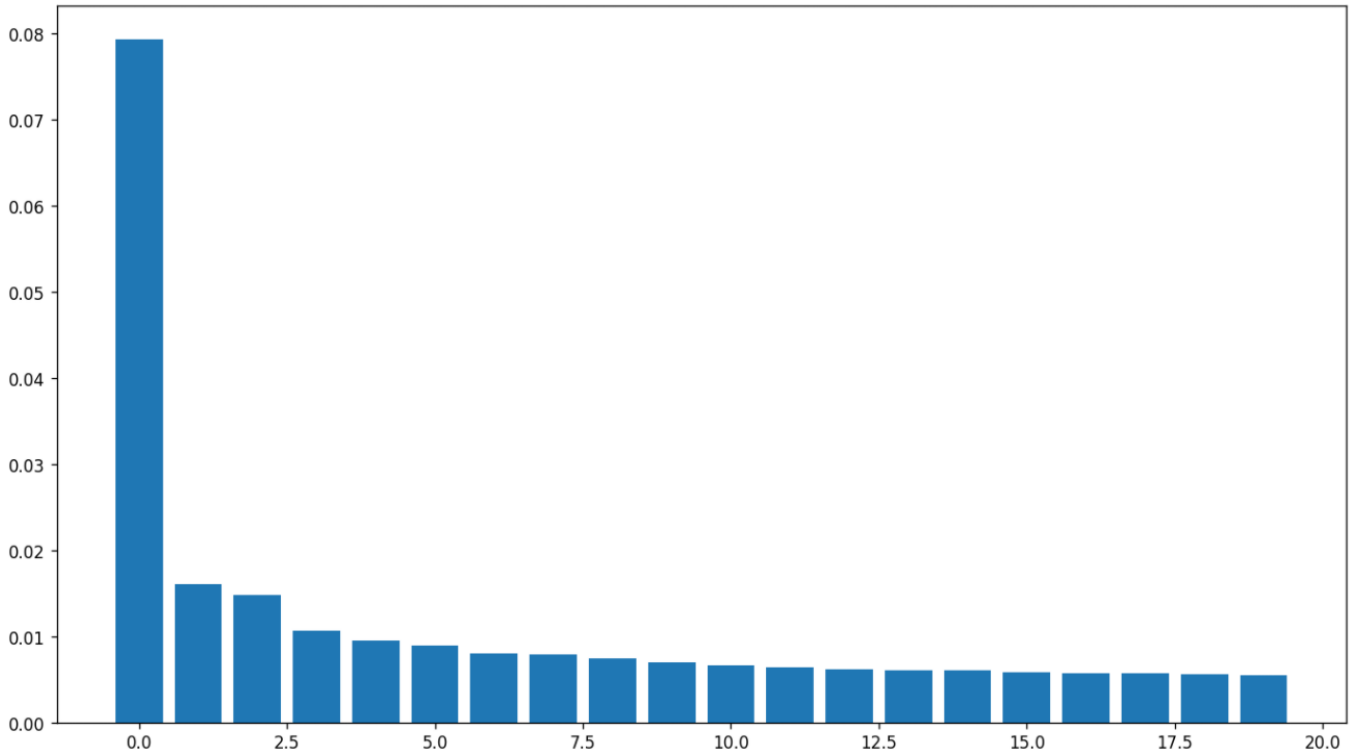
Project US Mass Shooting Crime Prediction

Model Construction – Risk Model

PCA squeezes stock dataset from (2517x621) matrix to (621x20) components.

Total variance of data is explained by 20 components (factor_betas) is about 23% which is low. It because of missing values from at least 30% of the universe has less than 5 year life long.

Top 5 stocks contribute the most in the variance of the first principal component
Equity(572 [VIG]) 9.6%, Equity(237 [HUT]) 10.3%, Equity(420 [SCR]) 9.8%, Equity(443 [SHS]) 11.7%, Equity(355 [PFL]) 10.2%
Sum square of stocks' contribution in each component approximates 1



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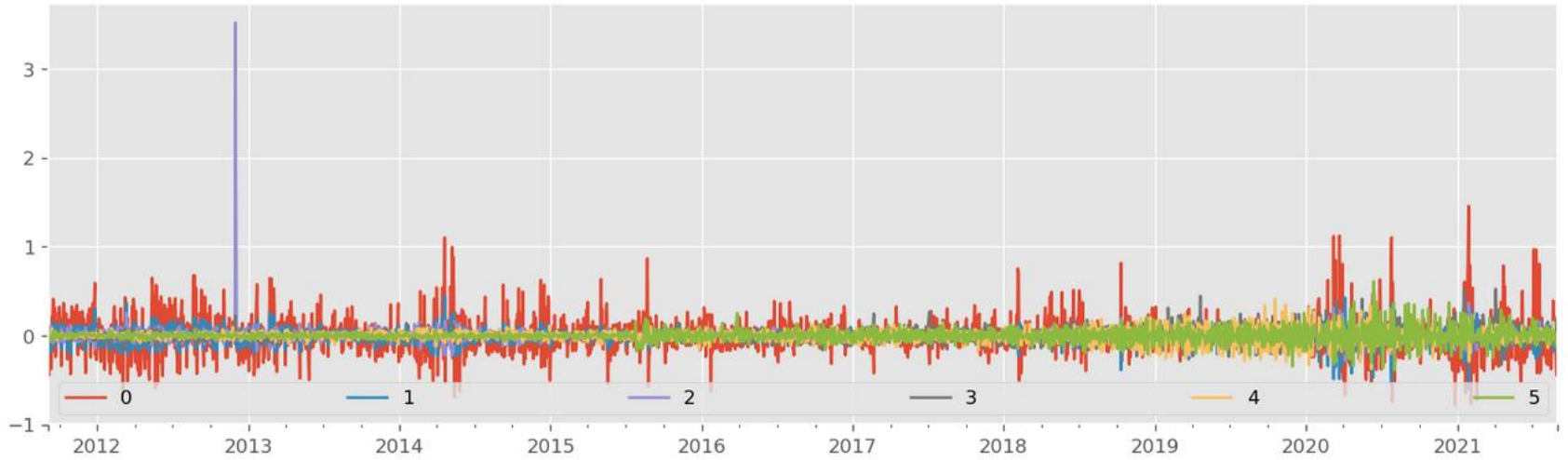
Model Construction – Risk Model

factor_returns is the returns time series for some kind of latent or unknown driver of return variance.
The first 06 components fator_returns



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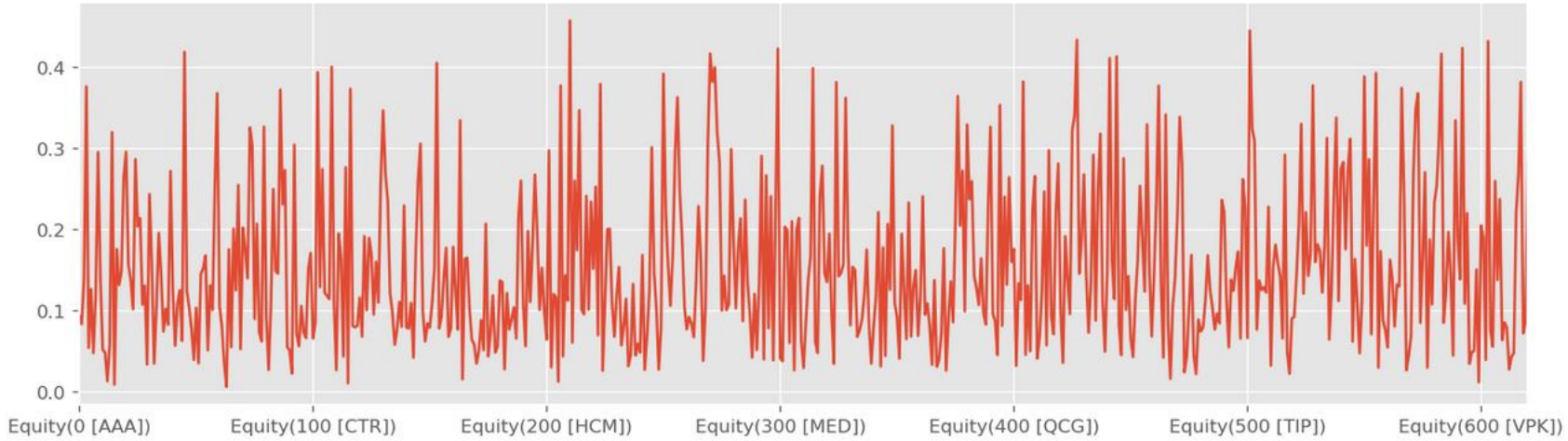
Model Construction – Risk Model

idiosyncratic variance vector over 621 stocks



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Model Construction – Alpha Model

Alpha factors and risk factors can be interchangeable by time and markets. Once alpha becomes publicly known and available, its profitable power will depreciate and turn to be a risk factor and vice versa. Alpha model is built & assessed using **Quantopian** API.

Raw alpha factors are created by **Zipline** module then processed for sector neutralizing, ranking & zscore

Processed alpha factors are modeled & assess the performances by **Alphalens** module

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Model Construction – Alpha Model – Alpha Factors Processing

Raw alpha factors are processed for sector neutralization, ranking & zscore

10 alpha factors are computed for a 5 year period:
- Momentum 1 Year, 1 Half Year, 1 Quarter, 1 Month, 1 Week Factors
- Mean Reversion 5Days, 20Days Sector Neutral Factors
- Mean Reversion 5 Day Sector Neutral Smoothed Factor
- Overnight Sentiment Factor
- Overnight Sentiment Smoothed Factor

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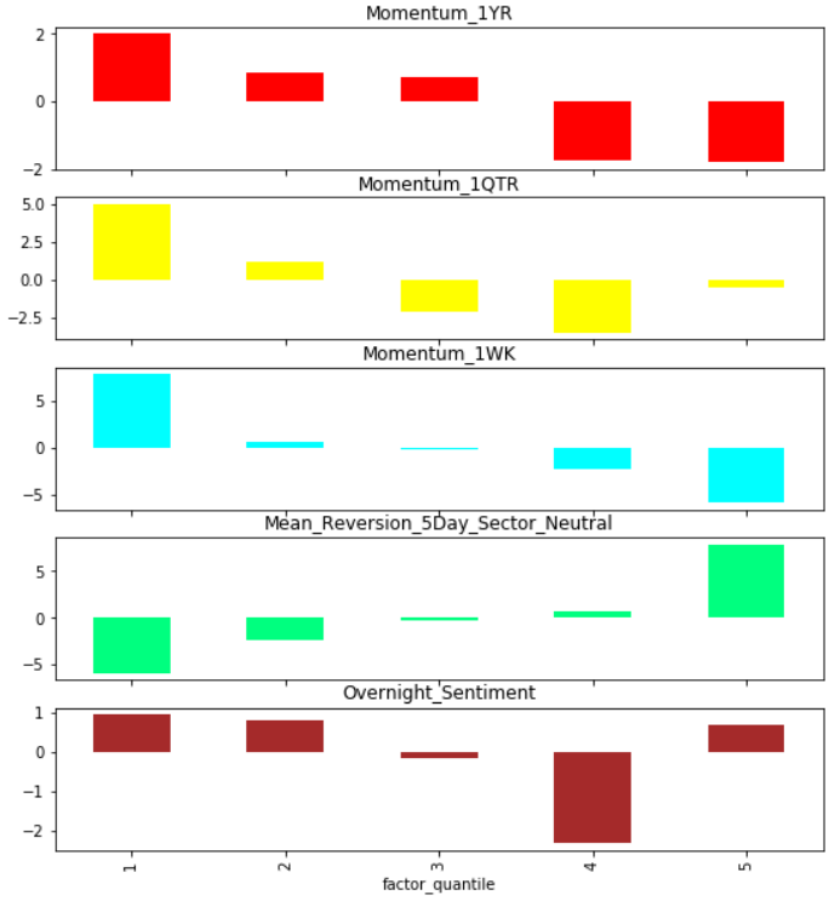
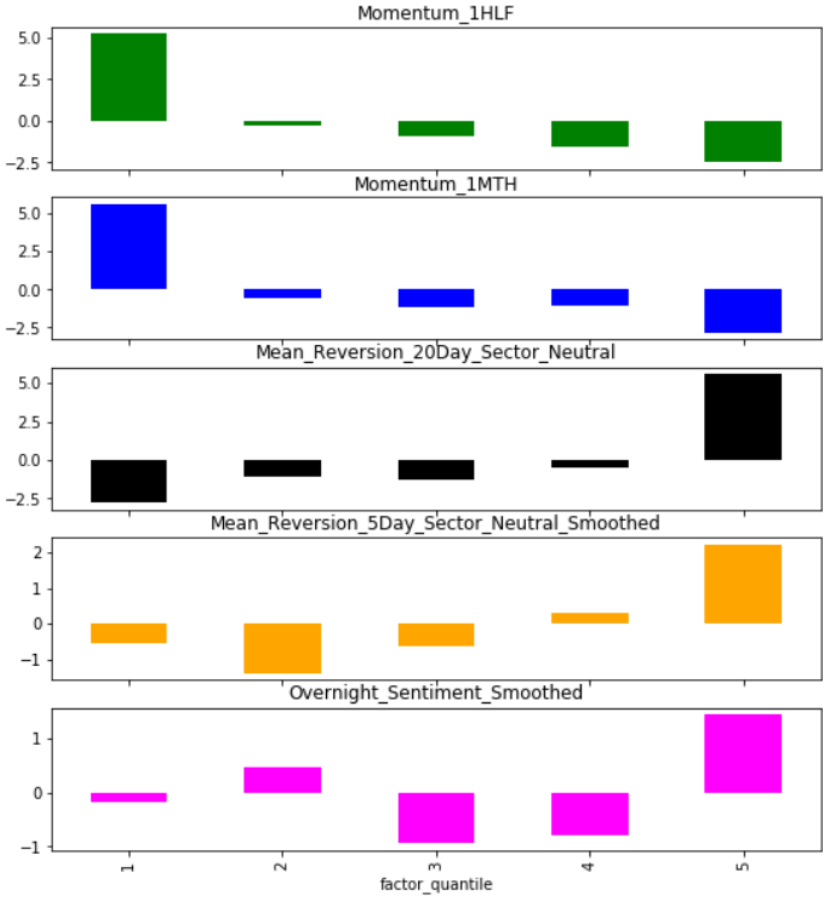
Model Construction – Alpha Model – Factor Operation

Processed alpha factors & pricing data are used to compute 1 day forward returns & classify to 5 quantiles:

- Momentum returns performances seems working well in the 1st quantile
- Mean reversion & sentiment returns performances are good at the 5th quantile





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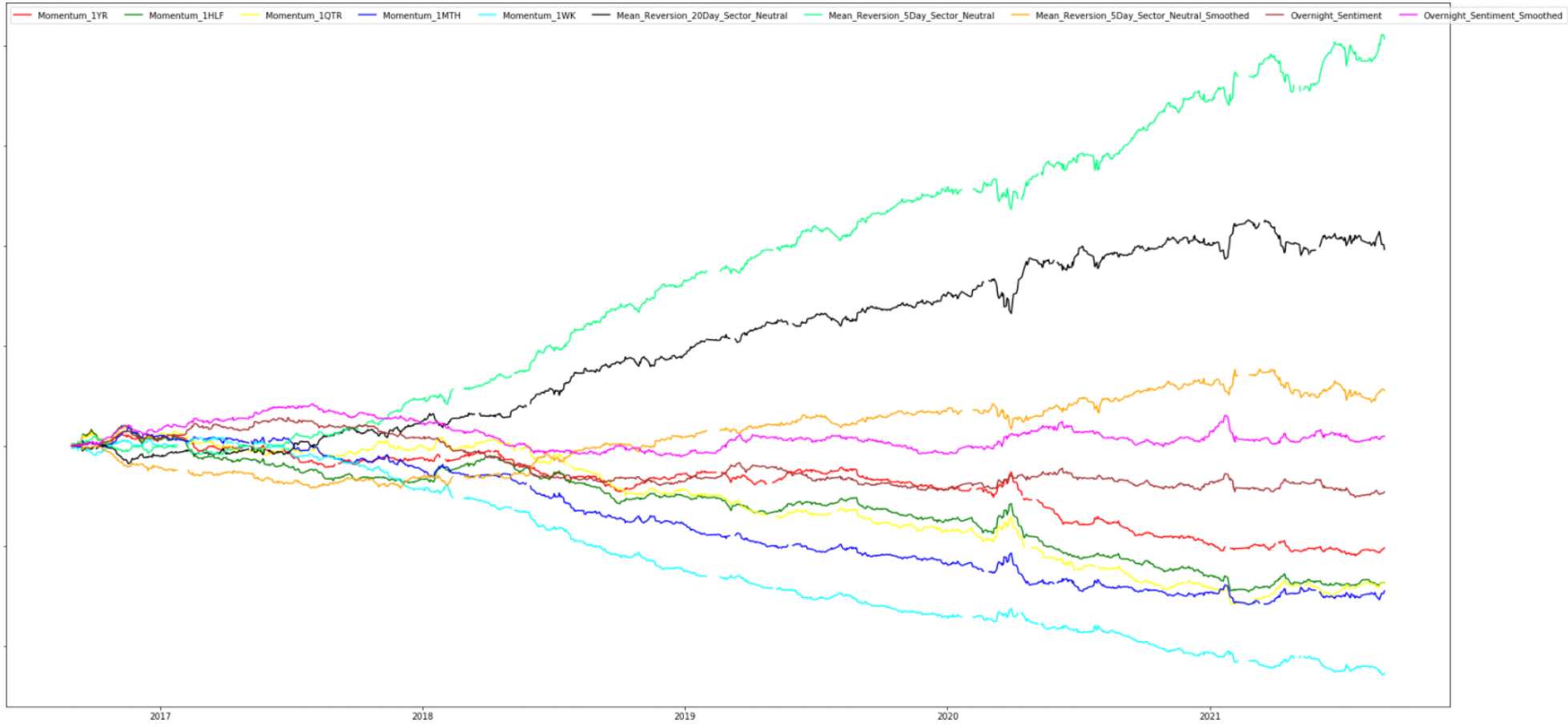
Model Construction – Alpha Model – Factor Performance

Alpha factors cumulative returns for all quantiles.

- Momentum factors perform from weak to negative
- Sentiment factors show a fair to week performance
- Mean reversion factors perform the best



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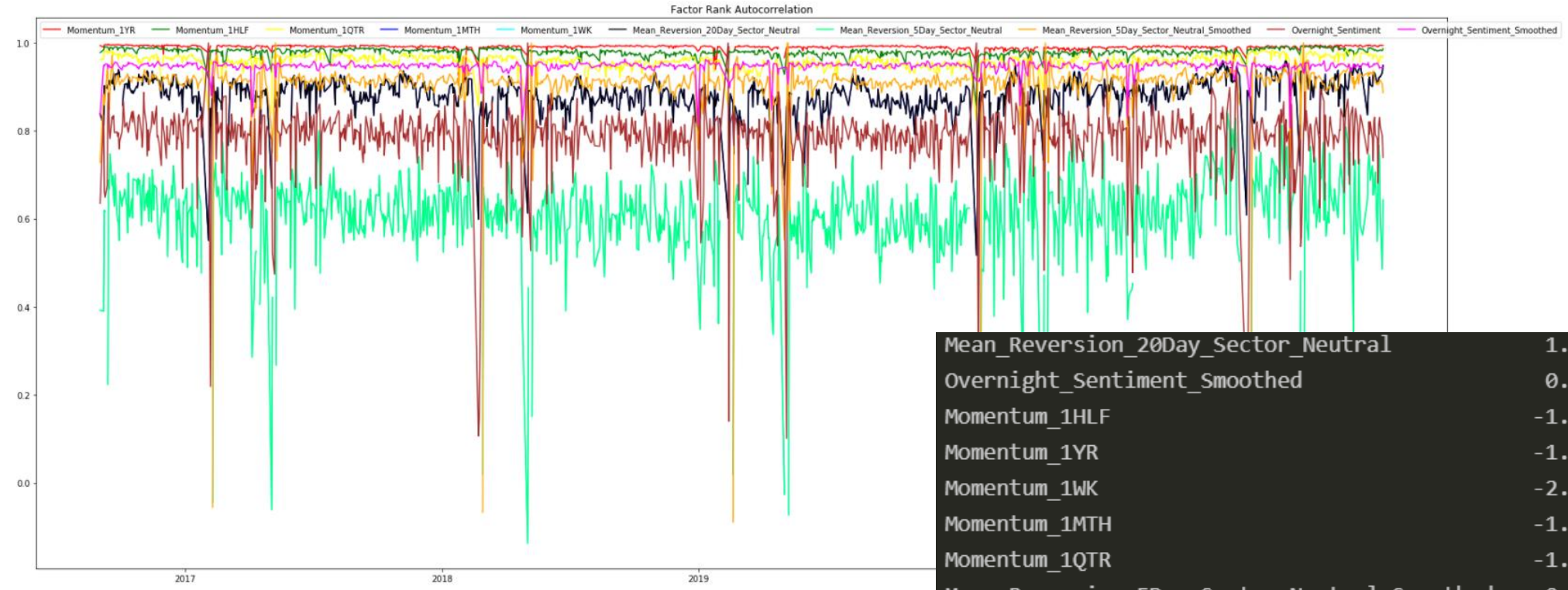
Model Construction – Alpha Model – Factor Assessment

Turnover & Sharpe Ratio are two key indicators to assess alpha factors performances:
Turnover or Factor Rank Autocorrelation expresses how persistent the factors are for future prediction. The closer to 1 the more consistent performance of a factor is.

- Momentum & smoothed factors are showing a stable status
- Mean reversion & sentiment factors are unstable

Sharp Ratio shows how well the factor making profit. Mean reversion factors are good candidates



Mean_Reversion_20Day_Sector_Neutral	1.44
Overnight_Sentiment_Smoothed	0.20
Momentum_1HLF	-1.61
Momentum_1YR	-1.02
Momentum_1WK	-2.77
Momentum_1MTH	-1.44
Momentum_1QTR	-1.48
Mean_Reversion_5Day_Sector_Neutral_Smoothed	0.35
Overnight_Sentiment	-0.47
Mean_Reversion_5Day_Sector_Neutral	2.77

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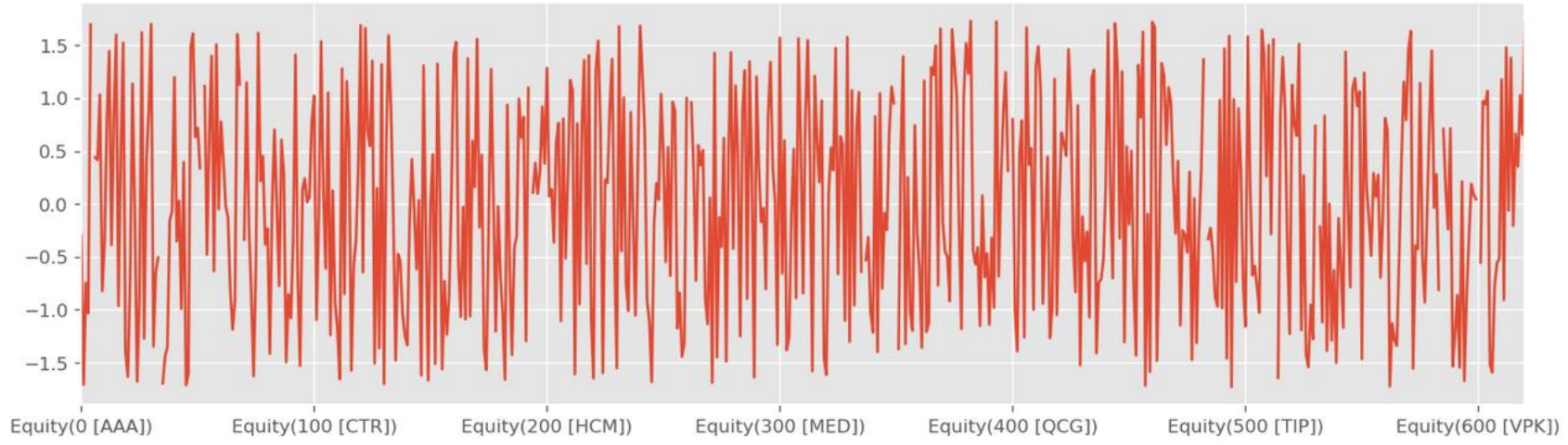
Model Construction – Alpha Model – Factor Assessment

Regardless of low FRA, Mean_Reversion_5Day_Sector_Neutral & Mean_Reversion_20Day_Sector_Neutral Factors are still selected as input for Multi-Factor Model.

They are simply blended by averaging to the alphas. Below is the alpha vector of the last day 2021-08-31 of all 621 stocks that we think will be proportional to the next day returns



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Model Construction – Multi Factor Model

Alpha model and risk model are available. Let's find a portfolio that trades as close as possible to the alpha model but limiting the risks as measured by the risk model by optimizing the weights under risks constrain.

Multi factor model comprises objective function & its constraints

Where**:**

- Objective function is maximizing (**$\alpha^T * x$**) with **x** is the portfolio weights and **α** is the alpha vector.
- Constraints are risk model as following:

r is the portfolio risk, $risk^2_{cap}$ is market (vnindex/ETF…) volatility

B is the factor betas, $factor_{max,min}$ are max & min portfolio factor exposures

sum of weights = 0 (market neutral)

leverage (borrow cash/stocks) constraint <= 1

minimum and maximum limits on individual holdings, kind of insurance.

$$r \leq risk^2_{\text{cap}}$$
$$B^T * x \preceq factor_{\max}$$
$$B^T * x \succeq factor_{\min}$$
$$x^T 1 = 0$$
$$\|x\|_1 \leq 1$$
$$x \succeq weights_{\min}$$
$$x \preceq weights_{\max}$$

Output is optimum weights scheme for a period of time (1 day forward for this case). Negative weight is short position, positive is long position

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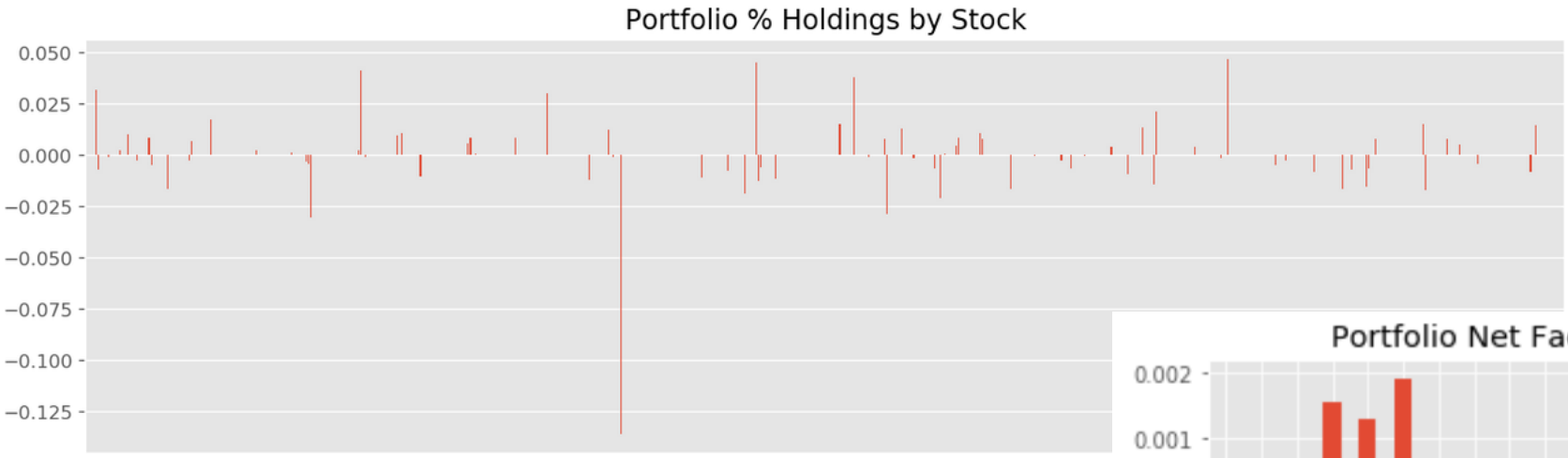
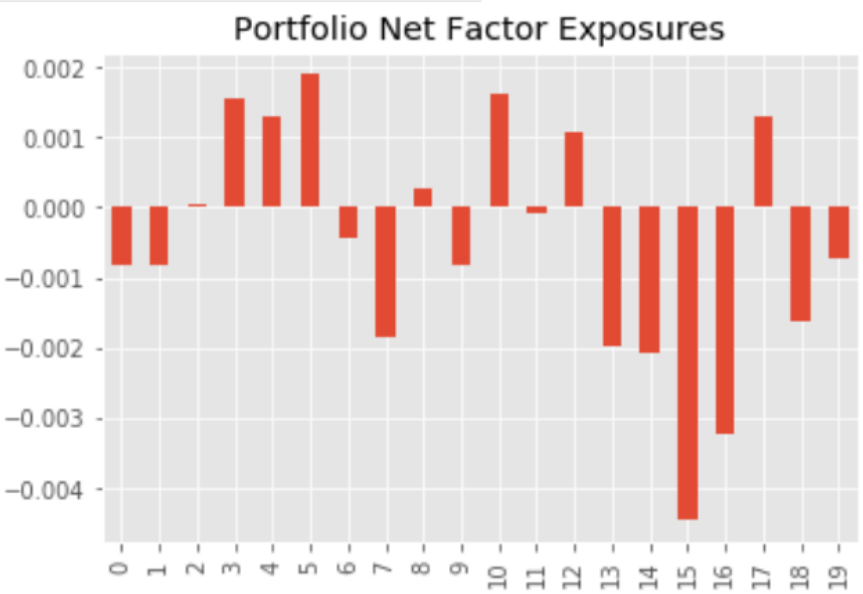
Model Construction – Multi Factor Model

Optimizing object function ($\alpha^T * x$)

Default portfolio constraints: risk_cap=0.05, factor_max=10, factor_min=-10, weights_max=0.55, weights_min=-0.55

- Weights allocation seems not diversity, not optimum for lowering risks
- Weights allocation for the case of portfolio contains 20 components





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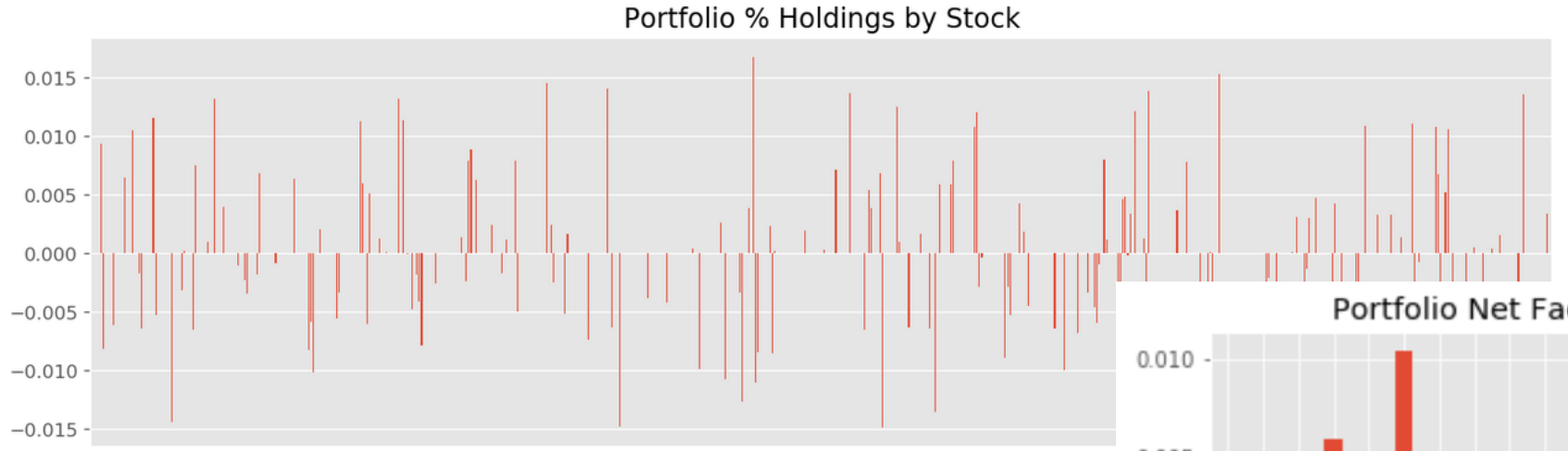
Model Construction – Multi Factor Model

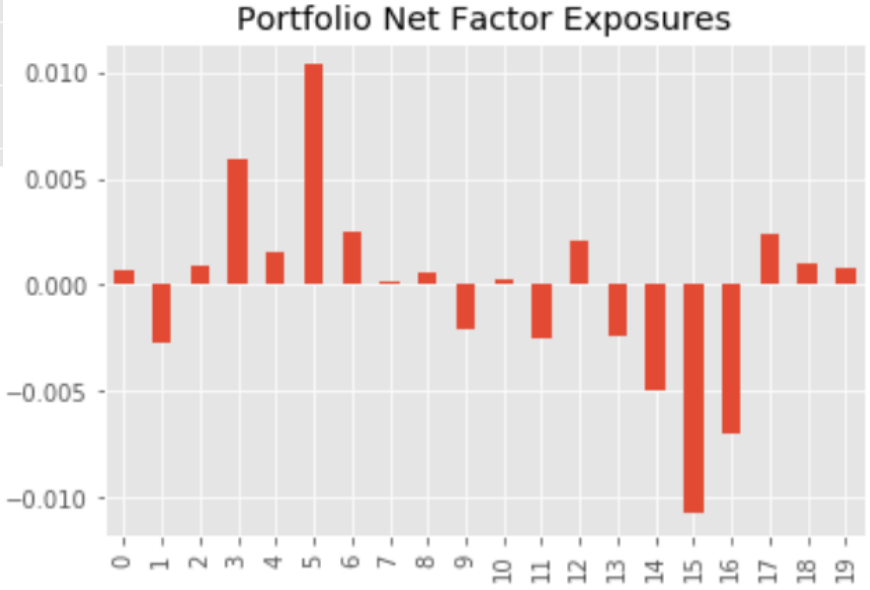
Optimizing object function $(\alpha^T * x) + \lambda||x||_2$

Regularization parameter penalize the extreme weights & re-attribute to the whole portfolio

Default portfolio constraints: **λ** =0.5, risk_cap=0.05, factor_max=10.0, factor_min=-10.0, weights_max=0.55, weights_min=-0.55

- Weights allocation is now pretty diversified
- Weights allocation for the case of portfolio contains 20 components





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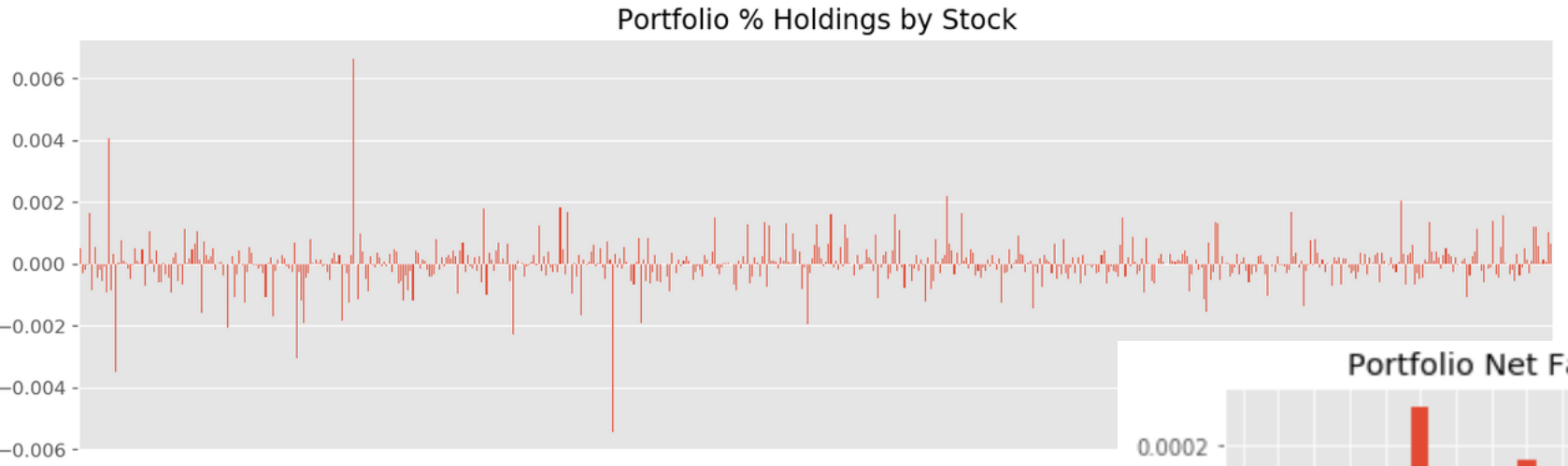
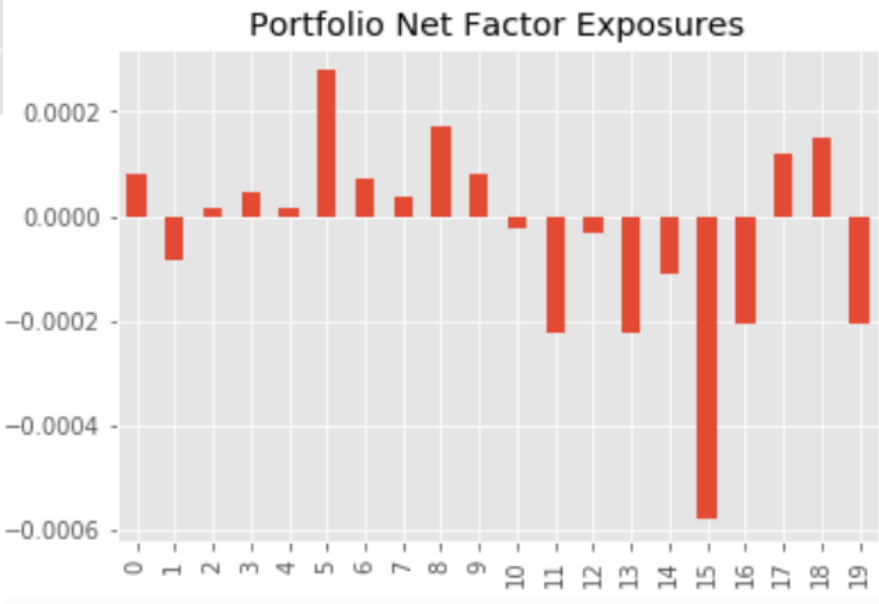
Model Construction – Multi Factor Model

Optimizing object function $-(\alpha^T * x) + ||x - x^*||_2$

Specific portfolio constraints: weights_max=0.02, weights_min=-0.02, risk_cap=0.0015, factor_max=0.015, factor_min=-0.015

- Portfolio weighs scheme is much more diversified
- Weights allocation for the case of portfolio contains 20 components





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Conclusions

Project achievements:

- Successfully ingest Vietnam stock data to Quantopian API format
- Conventional quant effect analysis: Bollinger band, breakout & momentum
- Fully create risk model for universe of 621 stocks
- Create 10 alpha factors model, operating & performance assessment: **Mean reversion factors outperform** for the universe of 621 stocks working for 1 day looking forward
- 03 cases of weight optimization under 02 risks constraints cases. The 3rd weights scheme reflects the best real trading condition.

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Recommendations

- Stock universe (candidate selection) could be filtered by size (volume), value (price) or other fundamental factors such as: dividend, P/E… or even following ETF indexes: vnindex, vn30index…

- Recommended further steps: create more portfolios, back-testing under real trading condition in order to fully assess how effective, persistent & resilient the factor models are