

Pedagogical Innovation for the DrAPS in Applied Finance

The DrAPS program strives to motivate and empower students by providing more than traditional theoretical lectures and complicated financial models. Therefore, it has developed an innovative and intuitive platform to facilitate the study of financial concepts. The platform is currently used in most GFRI teachings¹ and the dissertation.

The platform is a bilingual web-based application available on two servers. The access is password-protected for authorized members only (*cf.* section 1 below).

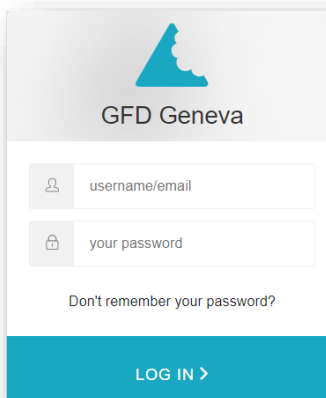
The platform is composed of 17 modules for the course application. Professors and students both use the platform. It can be used upfront to be integrated in the lecture, to apply theory seen in class, as well as to complete the exercises, homework and examinations. The platform also serves as centralized access point to all the teaching-related resources and information (*cf.* section 2 below).

The platform is also composed of 6 modules for the dissertation application. The aim is to facilitate quantitative analysis, such as data summary and regression models (*cf.* section 3 below). In addition, the platform support reproducibility by making research more easily verifiable.

Here we describe each 23 modules and critical features.

1. Access

1.1. Server Choice and Login



- Bilingual Chinese-English.
- Users have their own login and password to the platform.
- Centralized hub for teaching-related content and information.
- Storing of preferences, datasets and workflows.
- Automatic backup in case unstable network.
- Two servers to avoid a cross-border slowdown of internet traffic.

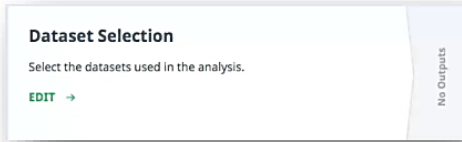
Switzerland-based server: <https://gfd-geneva.ch/>

Hong Kong-based server: <https://gfd-geneva.cn/>

¹ The platform is successfully implemented in Module 2 (GAAM), Module 4 (RMBP), Module 6 (AI), and Module 8 (DAAM). Note that it has already been considered for some exercises in the last GFRI module, namely Module 10 (WMP).

2. Course Application

2.1. Dataset Selection



- **Starting module:** users must select one or more datasets to initiate any financial data analysis.
- It includes assets in the Chinese, the US, and the Global markets.
- It covers all asset classes used in DrAPS courses, including but not limited to equity, index, industry portfolios, factors, hedge funds, interest rates, exchange rates in spot and forwards, options, ETF, sovereign bonds, and more.
- All databases are updated regularly to keep users with the most recent market movement.
- Each asset has different date types by its asset classes, including total return, excess return, price, market cap, shares, volume, and more, in multiple currencies and frequencies (daily, weekly, monthly, quarterly, yearly).
- This module can also generate random portfolios based on selected assets to study the naïve diversification effect.

TOOL
Dataset Selection

Filtering by tags: Chinese Equity
Set frequency: monthly
Set currency: CNY
Set data type: TOTAL RETURN ✖

UNSELECT ALL SAVE RANDOM PORTFOLIO SAVE FILTERED (88)

Name	Ticker	Start-Date	End-Date
*ST厦工	*ST厦工/600815	1994-02-28	2019-12-31
一汽富维	一汽富维/600742	1996-09-30	2019-12-31
一汽轿车	一汽轿车/800	1997-07-31	2019-12-31
万向钱潮	万向钱潮/559	1994-02-28	2019-12-31
万年青	万年青/789	1997-10-31	2019-12-31
三峡水利	三峡水利/600116	1997-09-30	2019-12-31
三木集团	三木集团/632	1996-12-31	2019-12-31
上海九百	上海九百/600838	1994-03-31	2019-12-31
上海机场	上海机场/600009	1998-03-31	2019-12-31
东北制药	东北制药/597	1996-06-30	2019-12-31

Show 10 entries Previous 1 2 3 4 5 ... 9 Next

Filtering by tags

- Chinese Equity
- CN Replication
- Exchange Rate
- Global Equity Index
- Global Sovereign Bond
- Hedge Fund Competition
- Interest Rate
- US Book-To-Market Sorted Portfolios
- US Equity

2.2. Time-Series Visualizations

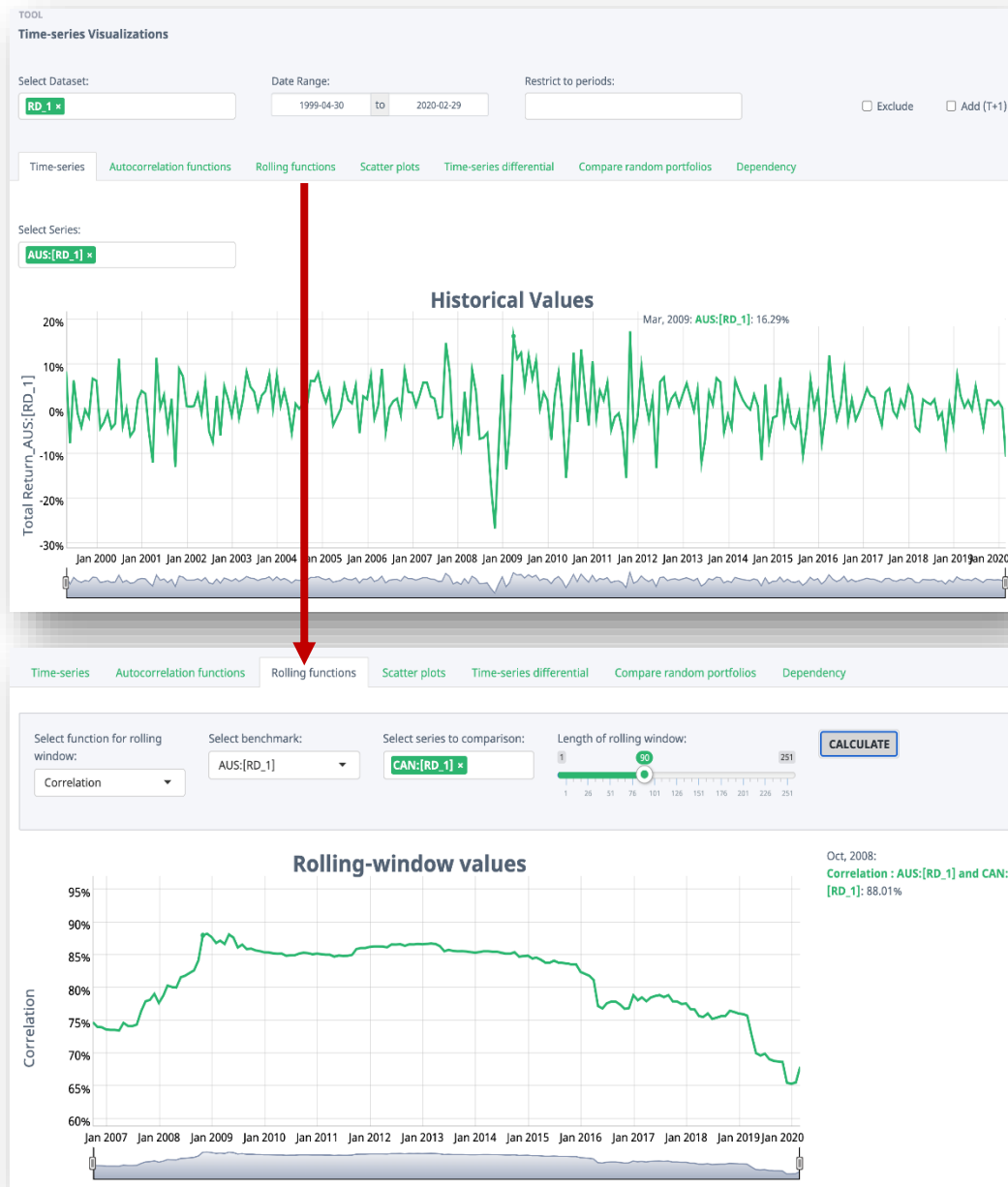
RD_1

Time-series Visualizations

Perform visual analysis of the joint properties of the time-series.

EDIT →

- In this module, users can examine the basic statistical properties of an asset.
- It can display one or multiple assets' time series plots and summary statistics.
- It calculates the autocorrelation and the rolling correlation between multiple assets.
- It plots the joint distribution across multiple assets and identifies the unconditional Value-at-Risk (VaR) and Expected Shortfall (ES).
- It examines different correlation calculation methods and tail dependency.
- Besides, it also studies the effect of naïve diversification and the difference in exchange rate time-series with different durations.



2.3. Moment Estimation

RD_1

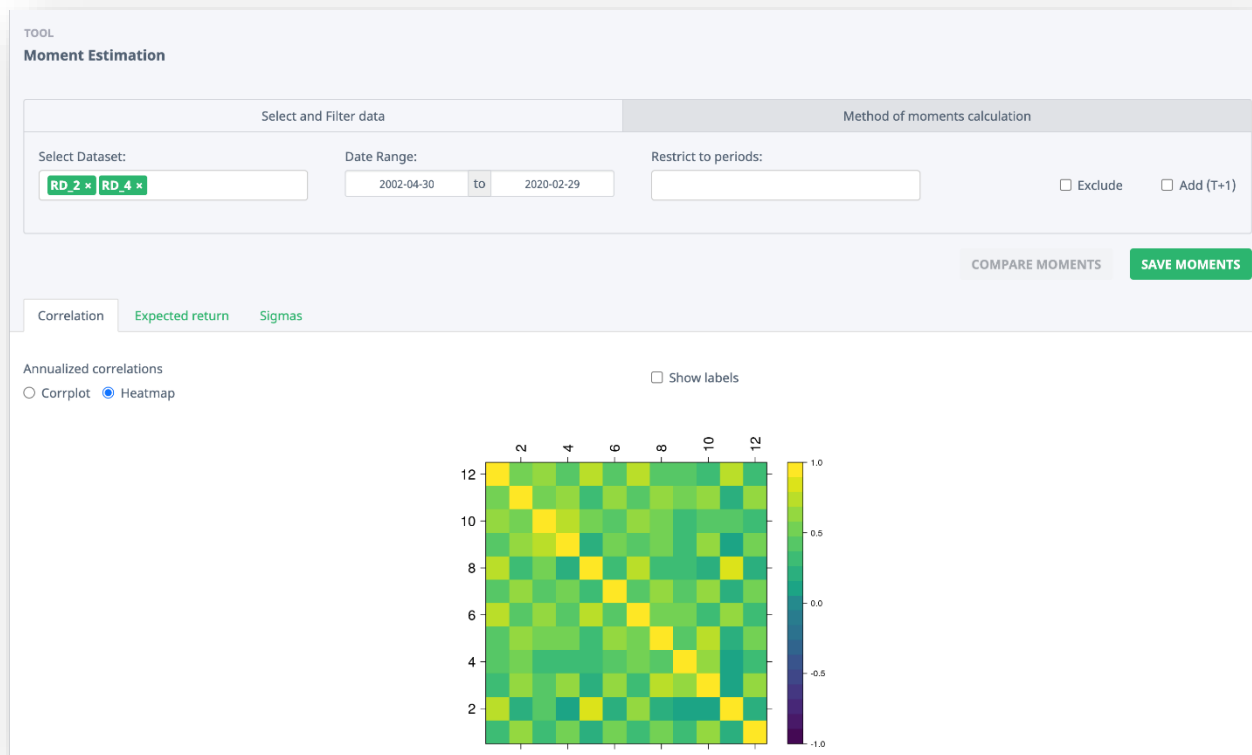
No Outputs

Moment Estimation

Perform 1st and 2nd moment estimation for multivariate time-series.

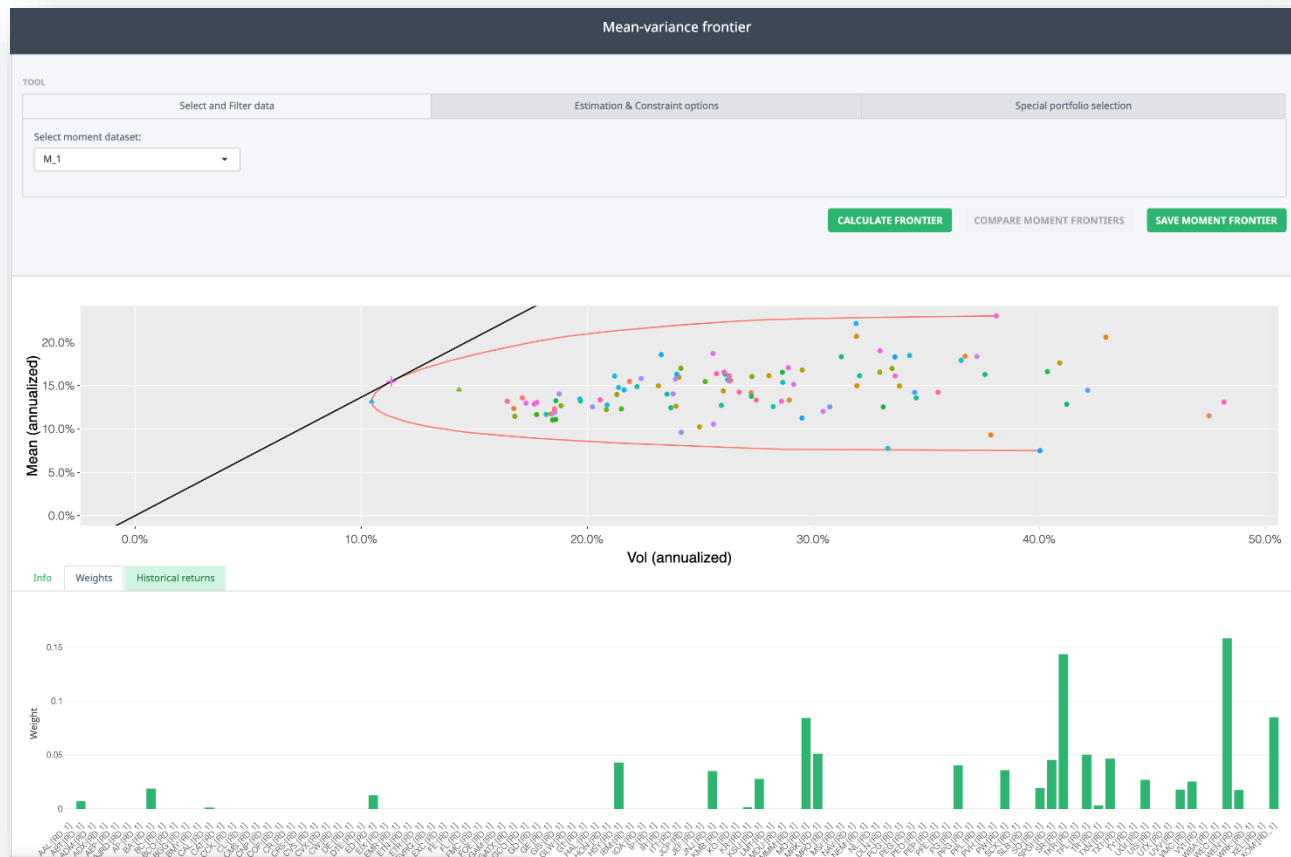
[EDIT](#) →

- This module performs the 1st and 2nd-moment estimation for multivariate time-series.
- It also calculates the correlation matrix and plots the result in a heatmap.
- It can also apply different moment-calculation methods, such as sample statistics, factor model, and the shrinkage method.
- Comparing the estimated moments by different methods can directly show the benefits of advanced finance models.

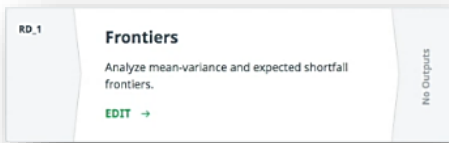


2.4. Mean-Variance Frontier

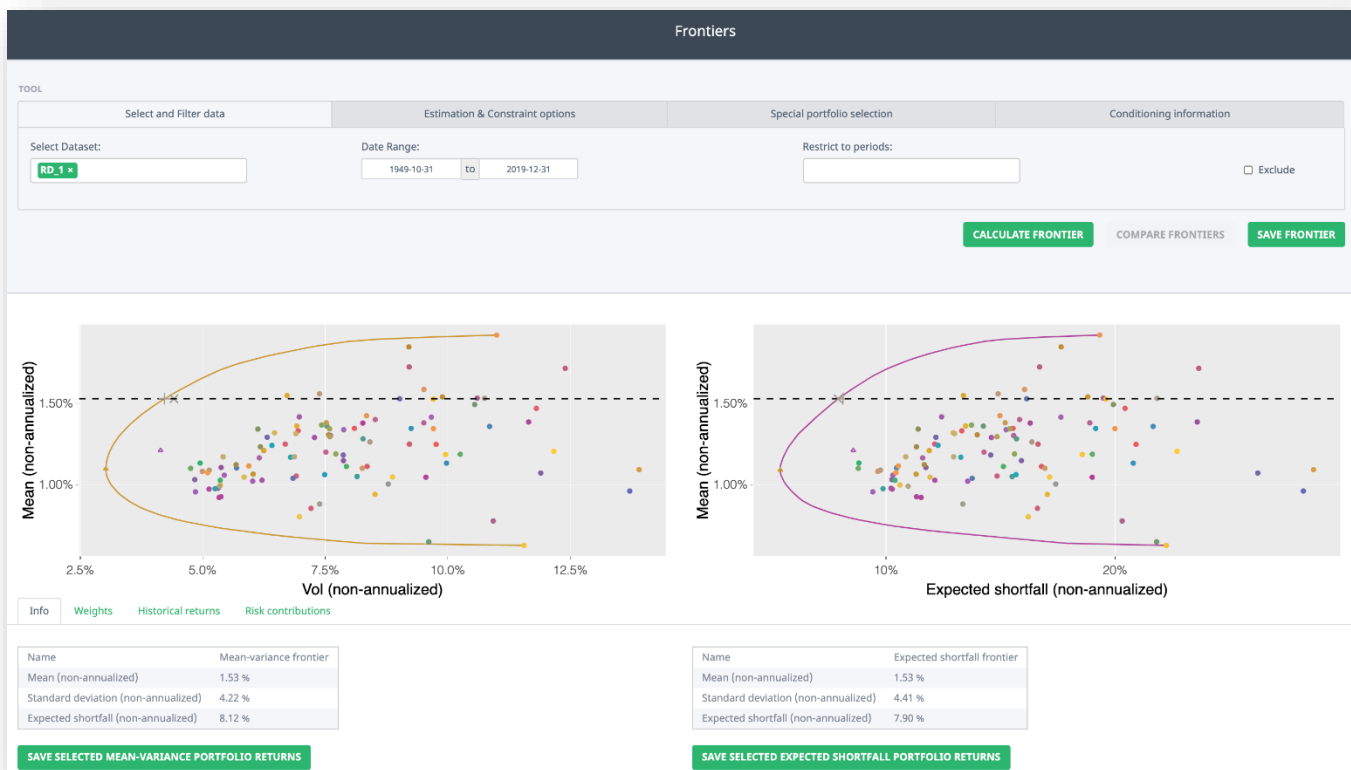
- This module helps a user to understand the mean-variance frontier.
- The saved moment estimation objects from the moment estimation module are required to calculate a mean-variance frontier.
- The plots of individual assets and the efficient frontier directly show the benefits of diversification and optimization.
- Users can click any portfolio on the frontier to examine its weights and distribution or save it for further analysis.
- Comparing frontiers with and without short-selling constraints (or any customized constraints) also shows the impact of trading limits.



2.5. Frontiers



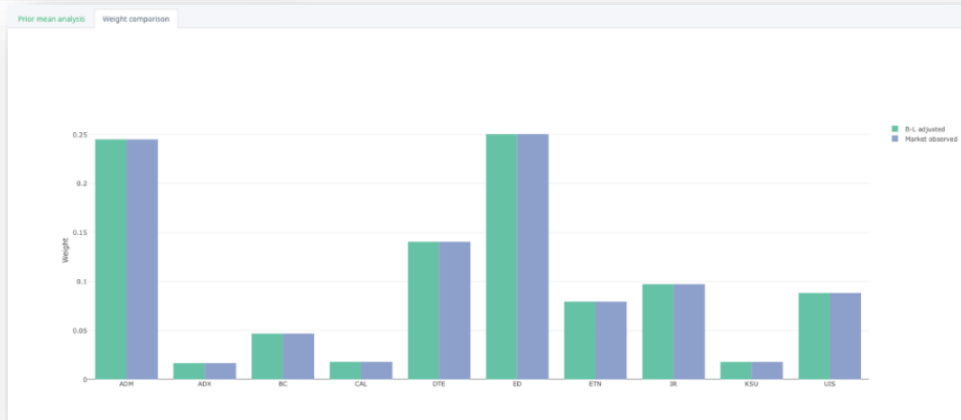
- Unlike the mean-variance frontier module, the frontiers module uses a return panel directly instead of a moment estimation result.
- This module gives more content beyond the conventional efficient frontier. It adds the optimization of the mean-ES frontier and compares it with the mean-variance frontier. This comparison helps the student to understand why and when we should consider a mean-ES optimization.
- This module can also add a conditional optimization, for example conditional on market downside pressure periods.



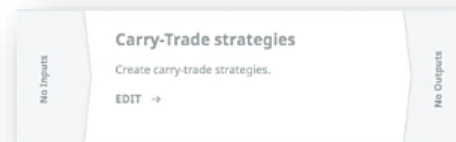
2.6. Black-Litterman Analysis



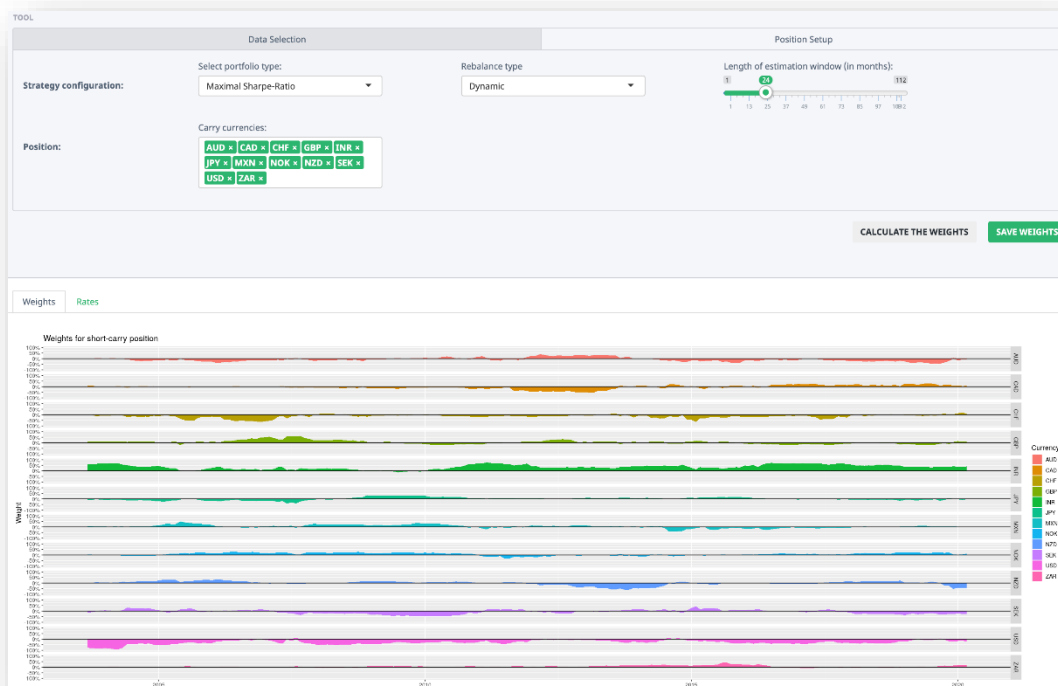
- This module can perform Black-Litterman model analysis, which is widely used in private banks in practice.
- Users can input their opinions on certain assets and see how this opinion adjusts the portfolio's optimal weights.



2.7. Carry Trade Strategies



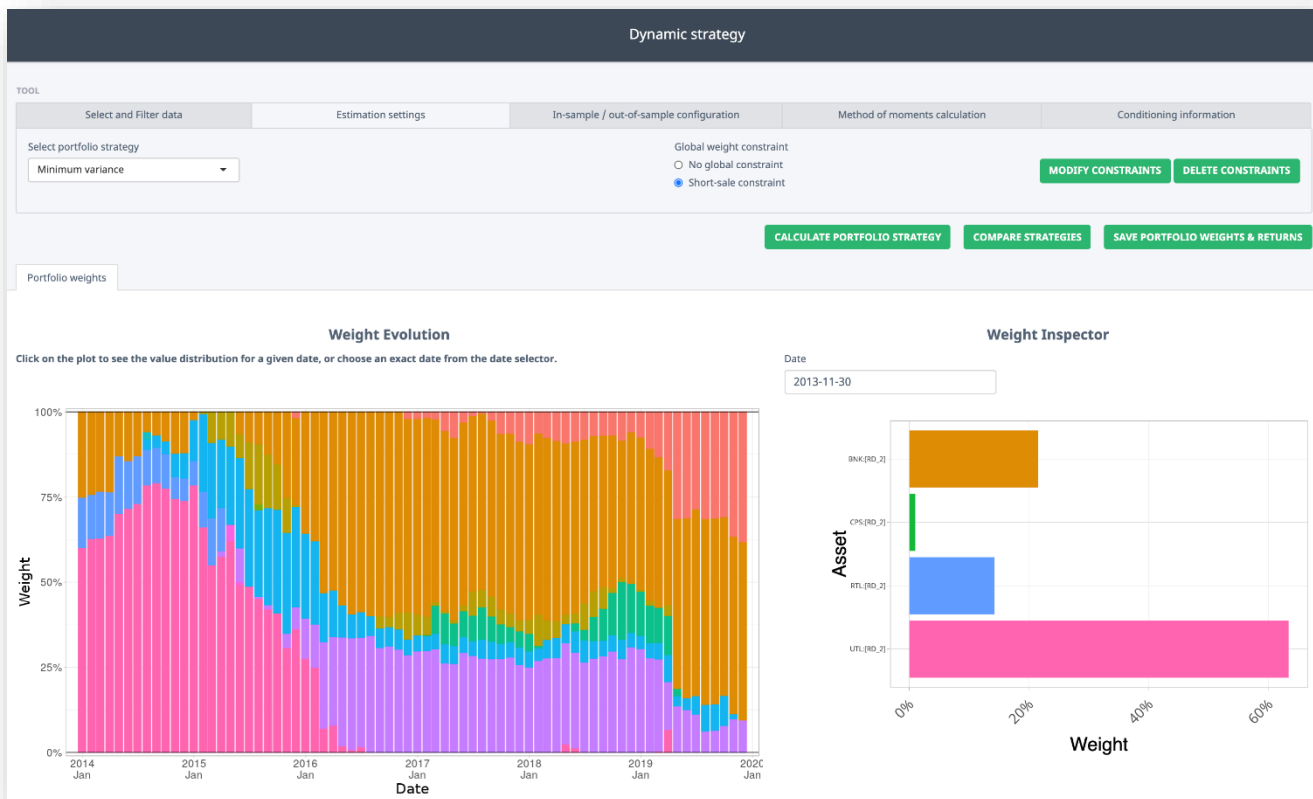
- This module is specific for currency trading.
- This module can optimize exchange rates and interest rates to construct a static or dynamic optimized carry trade portfolios.



2.8. Dynamic Strategy



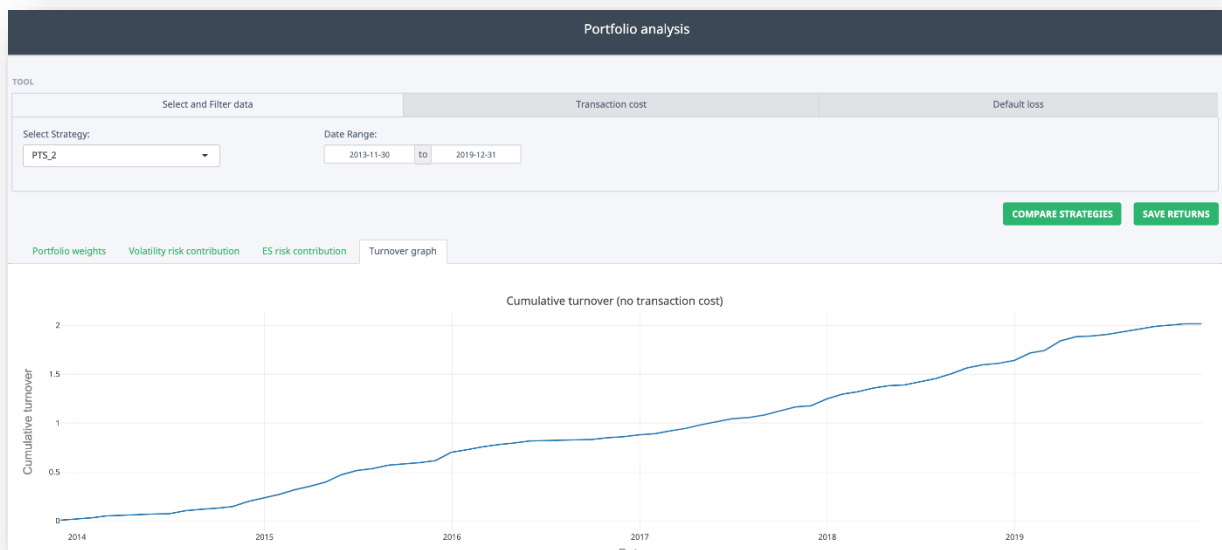
- This module creates portfolio strategies for out-of-sample analysis.
- It optimizes a panel of asset returns by a series available static or dynamic strategy in a rolling window rather than a static efficient frontier optimization strategy.
- By applying in-sample optimization and calculating the out-of-sample result, the module shows users the reality of how a financial model works, as well as which model is more stable and beneficial.
- All settings of efficient frontiers can apply here to create a dynamic strategy, such as constraints and conditional optimization.



2.9. Portfolio Analysis



- Based on the portfolio weights generated in the dynamic strategy module, the portfolio analysis module can further analyze the portfolio strategies.
- It discovers the volatility and ES risk contributions.
- It displays the turnover of a dynamic strategy rebalanced to show the consideration of transaction costs. Besides, it can add transaction costs as the fraction of return to form a new series of out-of-sample returns.
- Comparing different strategies' properties can straightforwardly demonstrate the pros and cons of different strategies.



2.10. Performance Analysis

RD_1
RR_1

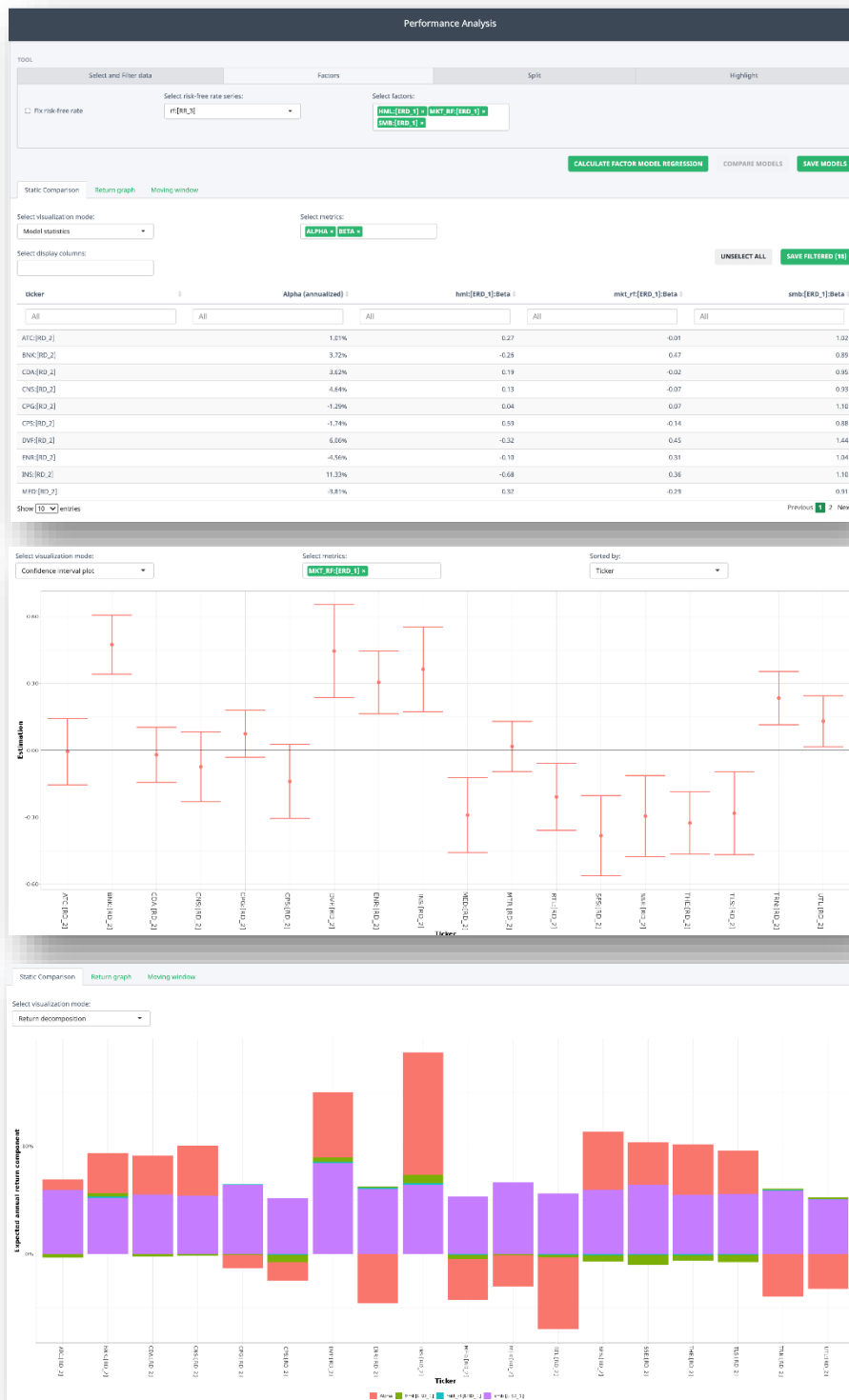
Performance Analysis

Analyse and decompose returns based on factors.

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No Outputs

- This module analyses and decomposes returns based on factors.
- It can show more statistical characteristics of assets.
- Together with factors, it can analyze the coefficients of factors and decompose return series.
- It can depict the return series and their cumulative returns.
- By applying a moving window, it can demonstrate the stability of factor coefficients.



2.11. Conditional Volatility

RD.1 **Conditional Volatility**

Calculate conditional volatility and scaled innovations.

[EDIT →](#)

No Outputs

- This module is handy for risk management. It can calculate conditional volatility and scaled innovations by applying GARCH, GJR-GARCH, and EWMA models.



2.12. Risk Measures

RD_1 **Risk Measures**

RR_1 Model data and calculate symmetric and asymmetric risk measures.

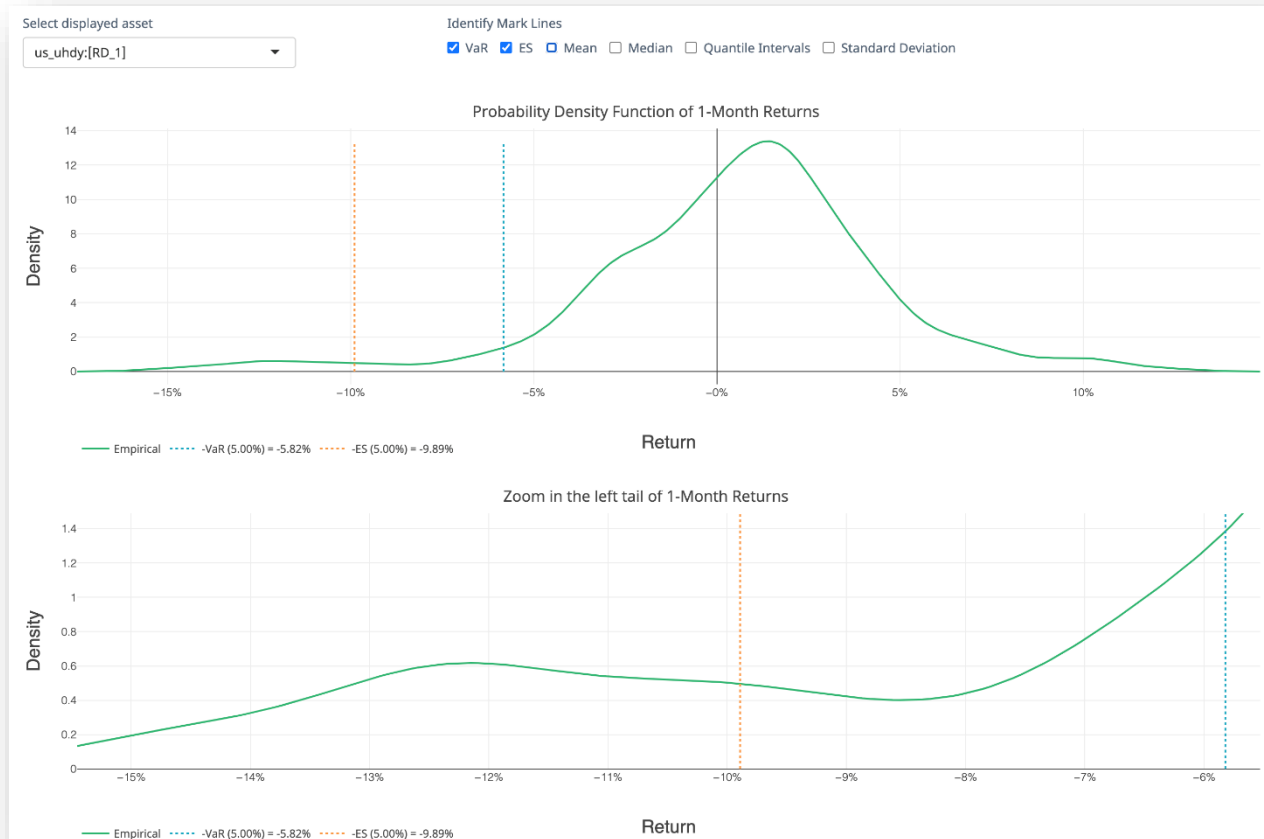
RR_2

RR_3

No Outputs

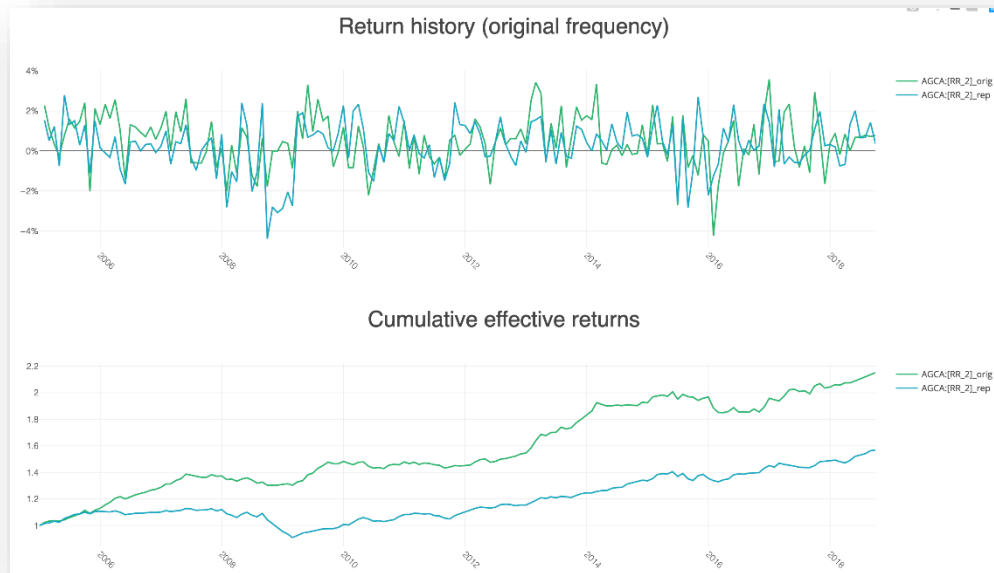
EDIT →

- This module calculates symmetric and asymmetric risk measures.
- It demonstrates how a return series and its tails look and why we should focus on the tail risk.
- By applying different distribution models, such as empirical, student-t, normal, extreme-value theory models, it can calculate and compare the risk measures under different models.
- It can also apply the conditional estimation method to examine the market downturn status further.



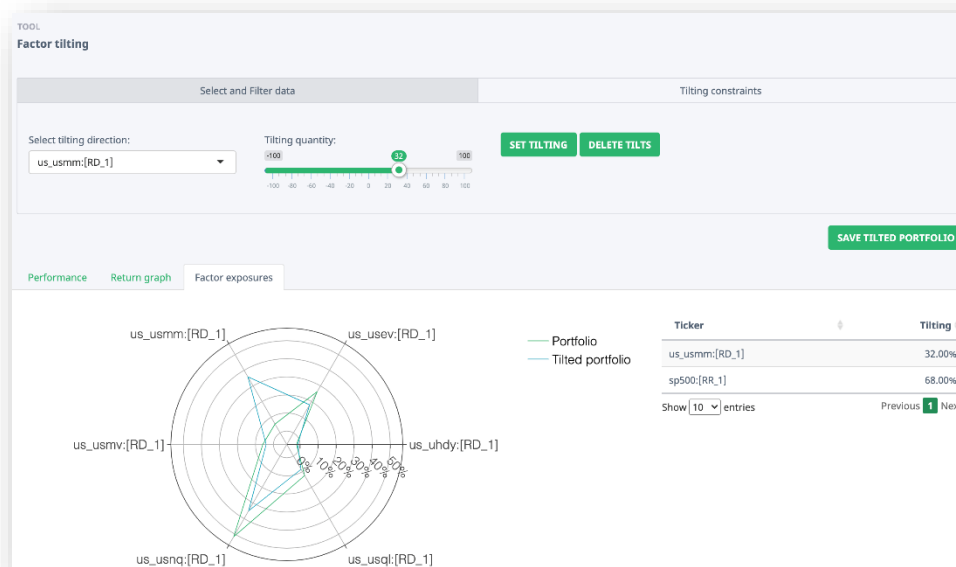
2.13. Replication

- This module is handy for the hedge fund analysis. It is a typical analysis for hedge funds to examine how to use high liquidity assets to replicate a hedge fund's return series. This module is designed for this purpose.
- It can analyze the replication results and how it performs in the out-of-sample.



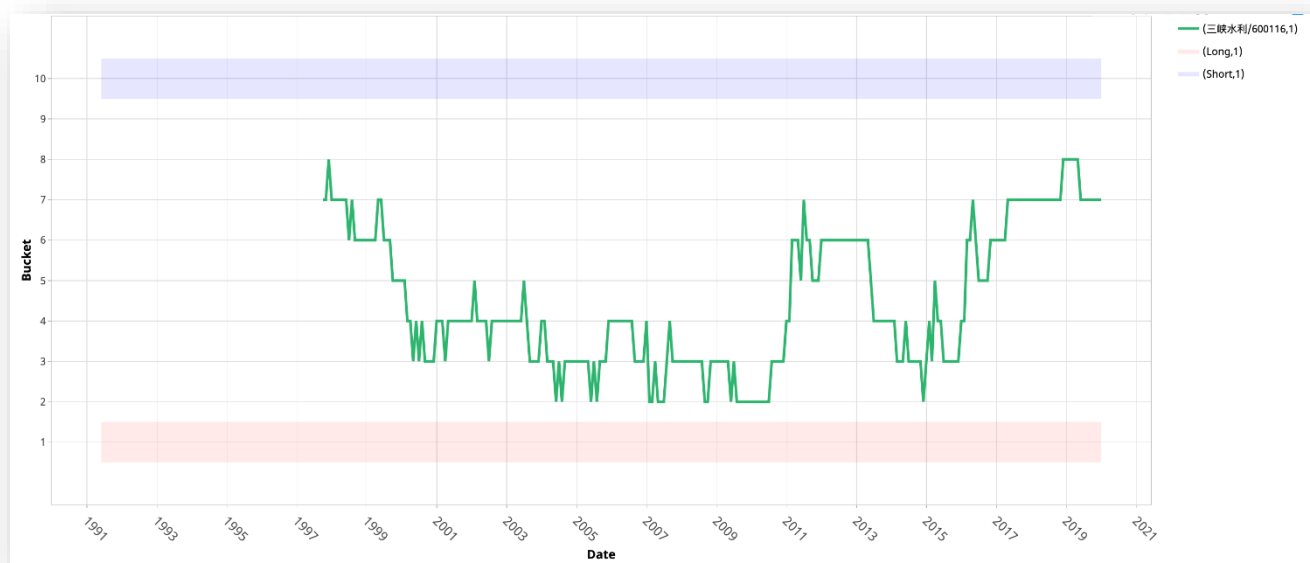
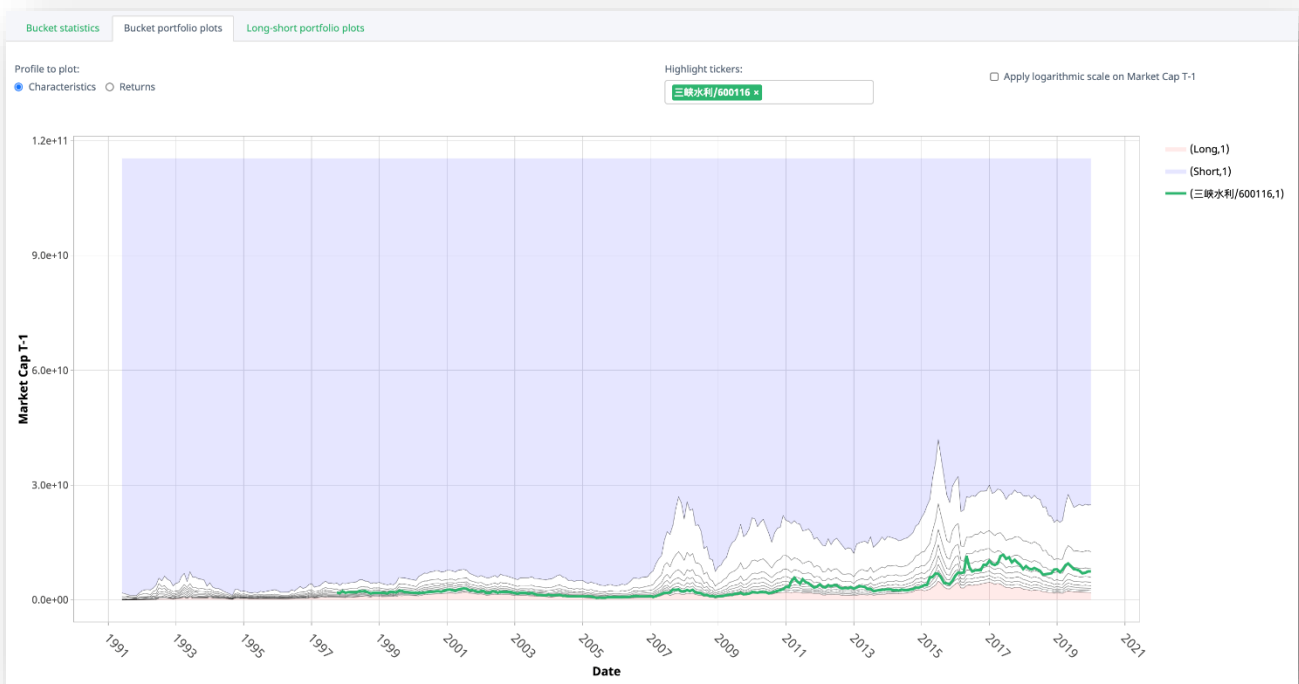
2.14. Factor Tilting

- This module analyzes and tilts the factor structure of the portfolio.
- Given the popular betting at beta exposure investment strategy, this module displays the factor exposure and the portfolio results after factor tilting.



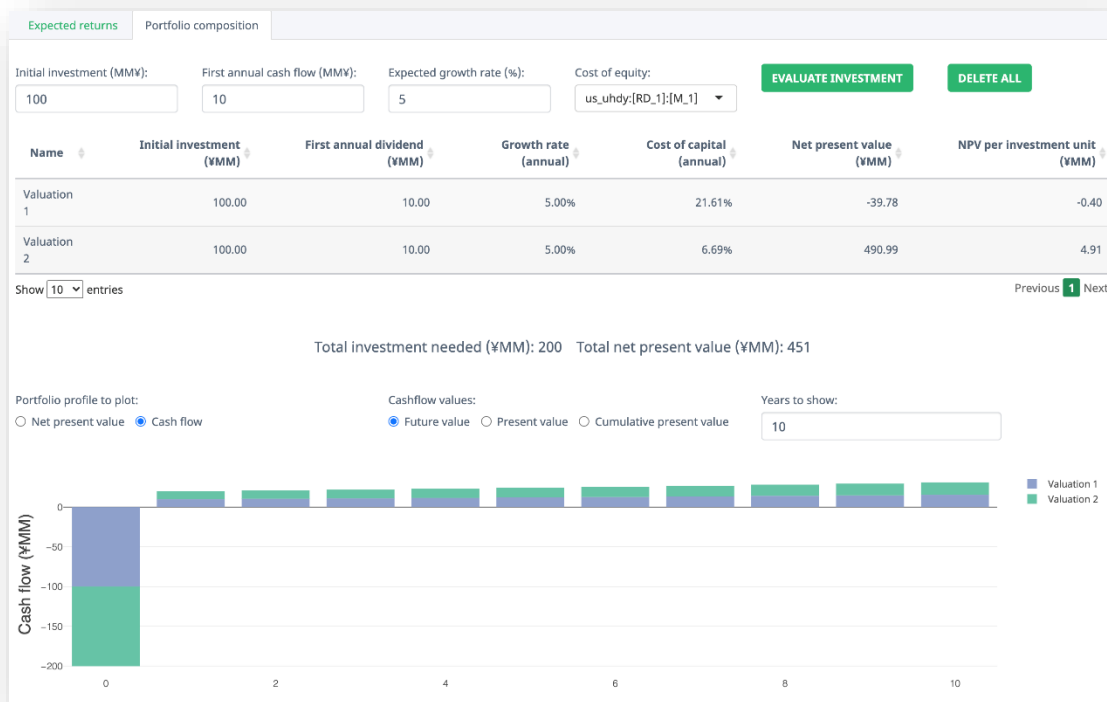
2.15. Factor Factory

- This module allows users to create factor portfolios themselves.
- Using unbalanced return and characteristic datasets, users can decide any percentile on one asset characteristic and choose long-short positions to construct a factor portfolio, which can be used in other module analyses.



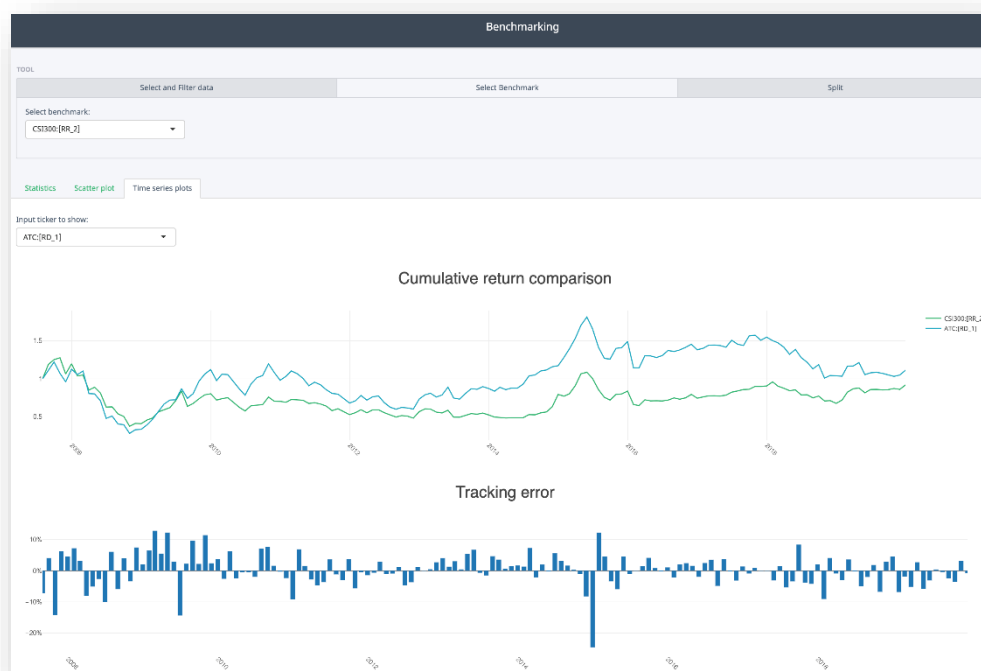
2.16. Valuation

- This module evaluates investment values with classical methods of discount free-cash-flow or Gordon growth model.



2.17. Benchmarking

- As the performance analysis module, this module can select any asset, including a calculated portfolio return series, as a benchmark asset. Then, users can assess relative performance using the benchmark reference series.



3. Dissertation Application

3.1. Data Import

- This module is the key to import any dataset from a student's local computer for analysis and operation in the next steps.

The screenshot shows the 'Load from file' tab with a 'Choose CSV File (no larger than 50MB)' section. A file named 'fomc_data.csv' is selected. Below this, there are settings for 'Field separator' (Comma selected), 'Quote character' (None selected), and 'Decimal separator' (Dot selected). A 'Header' checkbox is checked. A green 'IMPORT UPLOADED FILE' button is visible. Below the settings, it states 'Variable types loaded: 3 Categorical, 7 Numerical' and a 'SAVE DATASET' button. A 'Preview dataset' section shows a table with columns: date, excess_return, week, week0, week2, week4, week6, week0246, week246, fomc. The table contains 10 rows of data for dates from 1994-02-03 to 1994-02-16.

	date	excess_return	week	week0	week2	week4	week6	week0246	week246	fomc
1	1994-02-03	-0.21	week0	1	0	0	0	1	0	
2	1994-02-04	-2.32	week0	1	0	0	0	1	0	FOMC Date
3	1994-02-07	0.33	week0	1	0	0	0	1	0	
4	1994-02-08	0.05	week0	1	0	0	0	1	0	
5	1994-02-09	0.44	week0	1	0	0	0	1	0	
6	1994-02-10	-0.67	week1	0	0	0	0	0	0	
7	1994-02-11	0.03	week1	0	0	0	0	0	0	
8	1994-02-14	0.11	week1	0	0	0	0	0	0	
9	1994-02-15	0.47	week1	0	0	0	0	0	0	
10	1994-02-16	0.06	week1	0	0	0	0	0	0	

3.2. Data Analysis

- In the data analysis module, users can have a basic understanding of the imported dataset.
- The data summary tab presents the statistics for numeric and categorical variables separately based on the selected dataset and variables.
- The module calculates the correlation values between each pair of variables in the correlation analysis section and plots them in a heatmap.

The screenshot shows the 'Dataset selection' interface. The 'Select dataset:' dropdown is set to 'DAT_1'. Below this, there are tabs for 'Numeric data summary' (selected) and 'Correlation analysis'. The 'Numeric data summary' tab displays a table with columns: Minimum, Quartile 1st, Median, Mean, Quartile 3rd, Maximum, and N. of NAs. The table lists statistics for variables: excess_return, week0, week0246, week2, week246, week4, and week6.

	Minimum	Quartile 1st	Median	Mean	Quartile 3rd	Maximum	N. of NAs
excess_return	-8.95	-0.48	0.07	0.0340655680224404	0.59	11.35	0
week0	0	0	0	0.161290322580645	0	1	0
week0246	0	0	1	0.542952314165498	1	1	0
week2	0	0	0	0.161290322580645	0	1	0
week246	0	0	0	0.381661991584853	1	1	0
week4	0	0	0	0.157959326788219	0	1	0
week6	0	0	0	0.0624123422159888	0	1	0

3.3. Data Operation

- The users can execute some data summarization methods to generate a new dataset in the data operation module, such as mean, standard deviation, standard error, sum, and variance.

Create data summarization

Select dataset: Target variable: Group variable: Summarise method:

SUMMARISE DATA SAVE SUMMARISED DATASET

Preview dataset Summarise result

	group_id	rt_rf_mean
	<input type="text" value="All"/>	<input type="text" value="All"/>
1	group_1	0.0163035715871263
2	group_10	0.0109705193872771
3	group_11	0.0101897138311787
4	group_12	0.0133964486282216
5	group_13	0.0107557947351549
6	group_14	0.0120980386543556
7	group_15	0.0118306013006526
8	group_16	0.0135465637611299
9	group_17	0.0132605884945823
10	group_18	0.0149708968513461

Show entries Previous 1 2 Next

3.4. Data Merge

- In the data merge module, the users can combine two datasets into one new dataset. Users can further compare the dataset before and after the merge operation.
- At last, users can save the merged dataset into a new data object for further analysis.

Merge two datasets

Select first dataset: Select second dataset: MERGE DATASETS

SAVE DATASET

Preview dataset Merged dataset Review

Variable name	date	ticker	rt_rf	mkt_rf	group_id	rt_rf_mean
Data type	Date	Categorical	Numerical	Numerical	Categorical	Numerical
	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>
1	1998-01-31	VISI/81190	-0.1690332	0.0015	group_3	0.00929482721434139
2	1998-02-28	VISI/81190	0.1641555	0.0704	group_3	0.00929482721434139
3	1998-03-31	VISI/81190	0.05674209	0.0476	group_3	0.00929482721434139
4	1998-04-30	VISI/81190	-0.4078874	0.0073	group_3	0.00929482721434139
5	1998-05-31	VISI/81190	-0.08858646	-0.0307	group_3	0.00929482721434139
6	1998-06-30	VISI/81190	-0.1129296	0.0318	group_3	0.00929482721434139
7	1998-07-31	VISI/81190	0.03286636	-0.0246	group_3	0.00929482721434139
8	1998-08-31	VISI/81190	-0.2843	-0.1608	group_3	0.00929482721434139
9	1998-09-30	VISI/81190	-0.0200321	0.0615	group_3	0.00929482721434139
10	1998-10-31	VISI/81190	0.197427	0.0713	group_3	0.00929482721434139

Show entries Previous 1 2 3 4 5 ... 26130 Next

3.5. Regression

- The regression module defines and executes an ordinary least squares (OLS) regression model with grouping functionality. It exports results in printable tables for publication usage.
- It also supports the interaction terms between independent variables.
- Users can set up the group variable and run regression within the separate groups.
- The regression function runs the defined model and produces a basic table. It lists out the regression model's general results, including coefficient estimation, the standard error of the estimation, t-value and p-value of the estimated coefficients, number of observations, adjusted R-square, the number of significant parameters, and the residual standard error.
- It also provides three visualization tools for users to examine the regression results and fitness, e.g. confidence interval, distribution of residuals, and scatter plot of residuals.
- If users save more than one regression model, they can select different models and compare them on each side.
- Also, users can select multiple regression models and generate publishable academic tables.

The screenshot shows the 'Model definition' and 'Advanced' tabs. The dependent variable is 'excess_return' and the independent variables are 'week2', 'week4', and 'week6'. The model equation is $excess_return \sim (Intercept) + week2 + week4 + week6$. Summary statistics include 5704 observations, 0.07% Adjusted R², 1/4 significant parameters, and a residual standard error of 1.18. A table below shows the parameter estimates:

Parameter	Estimation	Standard error	t-value	p-value
1 (Intercept)	0.0039	0.0198	0.20	84.36%
2 week2	0.0721	0.0436	1.65	9.83%
3 week4	0.1036	0.0440	2.36	1.85%
4 week6	0.0344	0.0655	0.53	59.94%

Select models to summarize:

MOD_1 x MOD_2 x

DOWNLOAD MODEL COMPARISON TABLE

	Dependent variable: excess	
	[MOD 1] (1)	[MOD 2] (2)
week2	0.072* (0.044)	0.112** (0.045)
week4	0.104** (0.044)	0.143*** (0.046)
week6	0.034 (0.066)	0.074 (0.067)
week0		0.152*** (0.045)
Constant	0.004 (0.020)	-0.036 (0.023)
Observations	5,704	5,704
R ²	0.001	0.003
Adjusted R ²	0.001	0.003
Residual Std. Error	1.178 (df = 5700)	1.177 (df = 5699)
F Statistic	2.327* (df = 3; 5700)	4.582*** (df = 4; 5699)

Note: *p<0.1; **p<0.05; ***p<0.01

3.6. Time-Series Regression

- This module uses for executing rolling-window time-series regressions. The model definition part is the same as the regression module.

The screenshot shows a web interface for time-series regression. It is divided into two main sections: 'Model definition' and 'Rolling window'. In the 'Model definition' section, the 'Date variable' is set to 'date', the 'Group variable' is 'TICKER', and 'Results positioning at a window' is set to 'first out-of-sample date'. The 'Rolling window' section features a slider for 'Length of rolling window' set to 12, with a range from 1 to 60. Below these settings are two buttons: 'CALCULATE TIME-SERIES REGRESSION' (orange) and 'SAVE ROLLING REGRESSION COEFFICIENTS' (green). Below the buttons, there are two tabs: 'Preview dataset' and 'Rolling regression result'. The 'Rolling regression result' tab is active, displaying a table with columns: 'date', 'ticker', 'Intercept_coef', and 'mkt_rf_coef'. The table contains 10 rows of data for the ticker 'AABC/10650' from 1999-01-31 to 1999-10-31. At the bottom, there is a 'Show 10 entries' dropdown and a pagination control showing 'Previous 1 2 3 4 5 ... 23057 Next'.

	date	ticker	Intercept_coef	mkt_rf_coef
1	1999-01-31	AABC/10650	-0.0529	1.412
2	1999-02-28	AABC/10650	-0.0557	1.4013
3	1999-03-31	AABC/10650	-0.0447	1.3012
4	1999-04-30	AABC/10650	-0.0521	1.2232
5	1999-05-31	AABC/10650	-0.0444	1.2953
6	1999-06-30	AABC/10650	-0.0524	1.3725
7	1999-07-31	AABC/10650	-0.0496	1.3999
8	1999-08-31	AABC/10650	-0.0376	1.2843
9	1999-09-30	AABC/10650	0.0061	0.2111
10	1999-10-31	AABC/10650	0.0016	0.081

4. Resources

4.1. Documentation and Glossary

- The application comes with a user guide explaining every functionality and how to use them in the section “Documentation”
- A glossary lists of key concepts for quick search
- Contact for technical or pedagogical requires is available

The screenshot shows the application's navigation menu at the top with 'Home', 'Courses', 'Thesis', and 'Help'. The 'Help' menu is open, showing 'Documentation', 'Glossary', and 'Contact'. Below the menu, the 'Glossary' section is visible, listing terms like 'Annualized' and 'Arbitrage' with their definitions. On the right side, a list of terms is displayed: Annualized, Arbitrage, Arbitrage Pricing Theory, BAB Factor, Benchmark, and Bid-Ask Spread.

4.2. Course Material and Information

