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 teachings[1] 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).

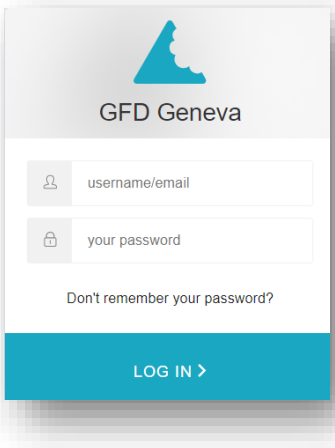
The platform is composed of 17 modules for the course application. Professors and students both use the platform. It can be used upfront to be integrated in the lecture, to apply theory seen in class, as well as to complete the exercises, homework and examinations. The platform also serves as centralized 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/

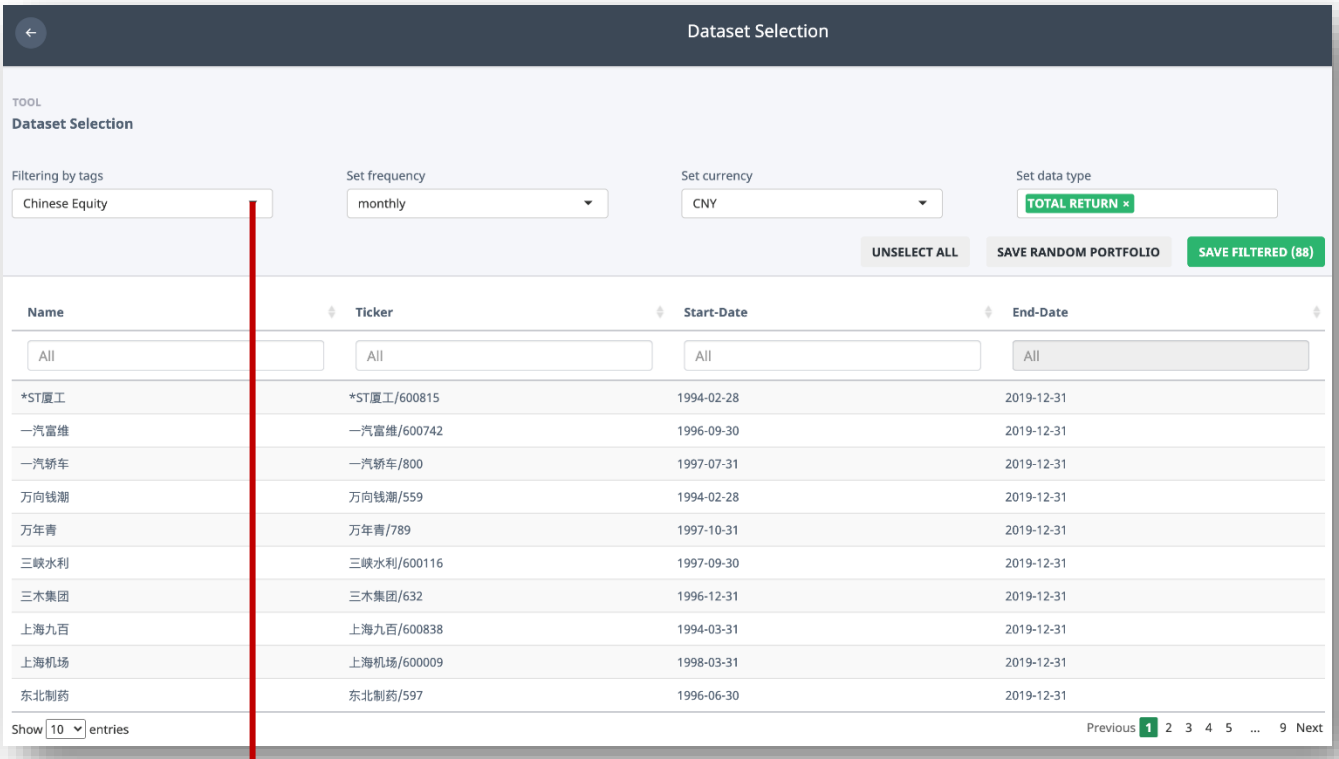
  Hong Kong-based server: https://gfd-geneva.cn/

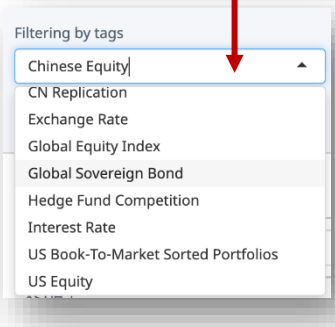
[1] The platform is successfully implemented in Module 2 (GAAM), Module 4 (RMBP), Module 6 (AI), and Module 8 (DAAM). Note that it has already been considered for some exercises in the last GFRI module, namely Module 10 (WMP).

2. Course Application

2.1. Dataset Selection

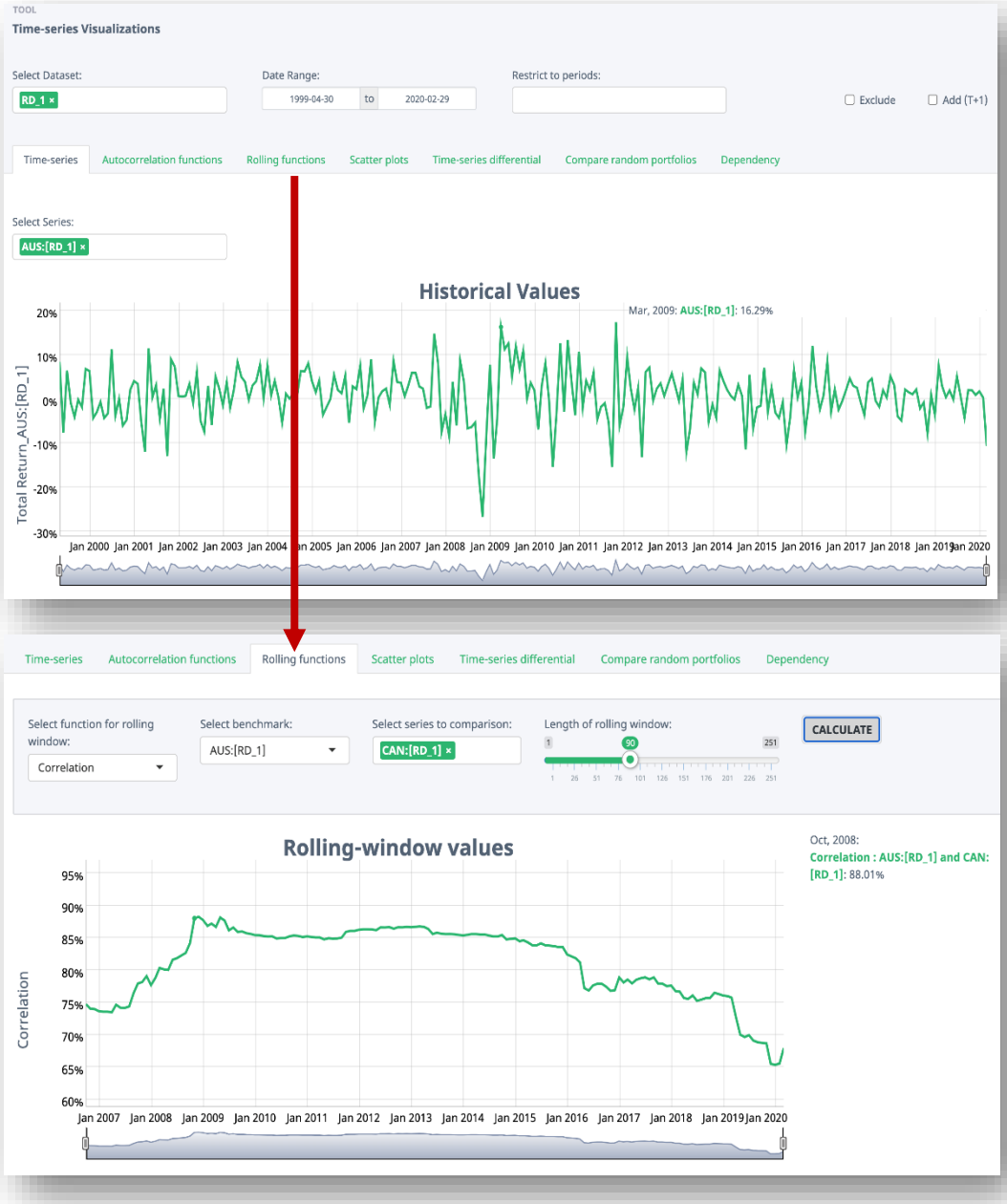
- Starting module: users must select one or more datasets to initiate any financial data analysis.
- It includes assets in the Chinese, the US, and the Global markets.
- It covers all asset classes used in DrAPS courses, including but not limited to equity, index, industry portfolios, factors, hedge 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.



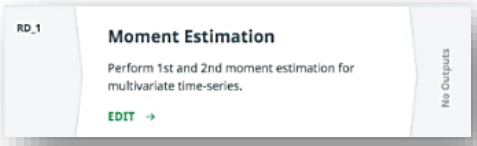


2.2. Time-Series Visualizations

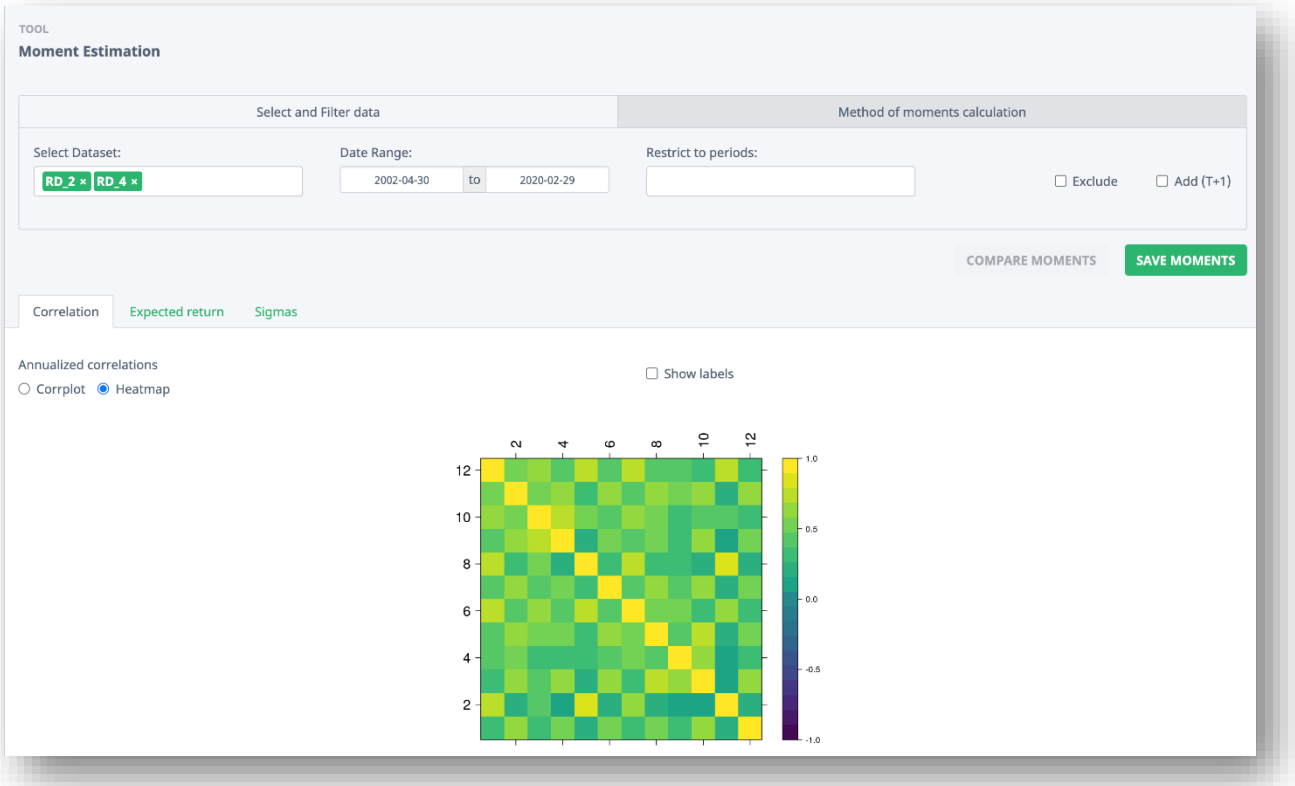
- In this module, users can examine the basic statistical properties of an asset.
- It can display one or multiple assets' time series plots and summary statistics.
- It calculates the autocorrelation and the rolling correlation between multiple assets.
- It plots the joint distribution across multiple 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

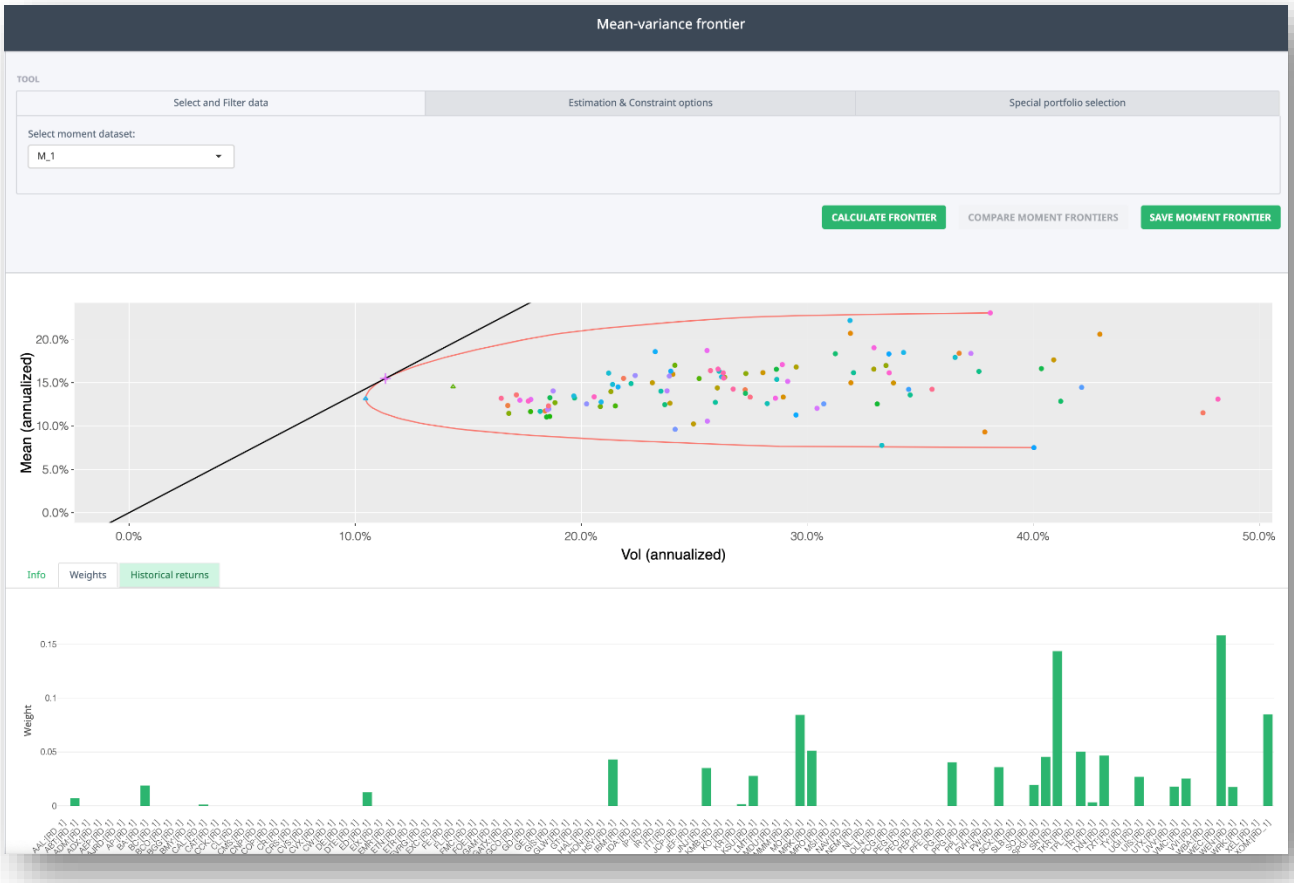


- This module performs the 1st and 2nd-moment estimation for multivariate time-series.
- It also calculates the correlation matrix and plots the result in a heatmap.
- It can also apply different moment-calculation methods, such as sample statistics, factor model, and the shrinkage method.
- Comparing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

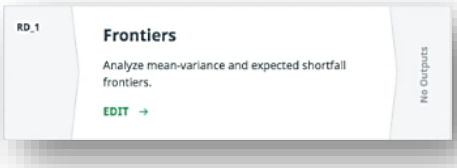


2.4. Mean-Variance Frontier

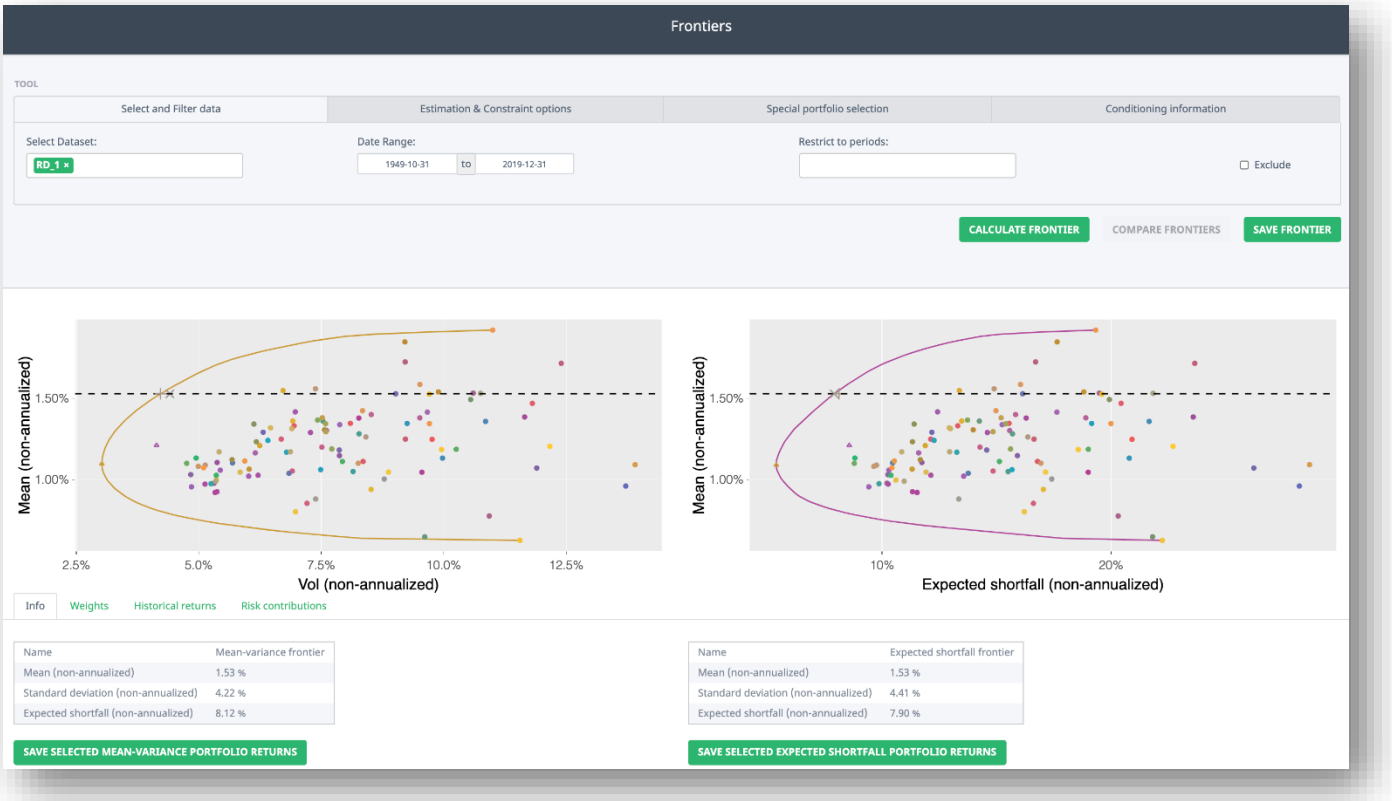
- This module helps a user to understand the mean-variance frontier.
- The saved moment estimation objects from the moment estimation module are required to calculate a mean-variance frontier.
- The plots of individual assets and the efficient frontier directly show the benefits of diversification and 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

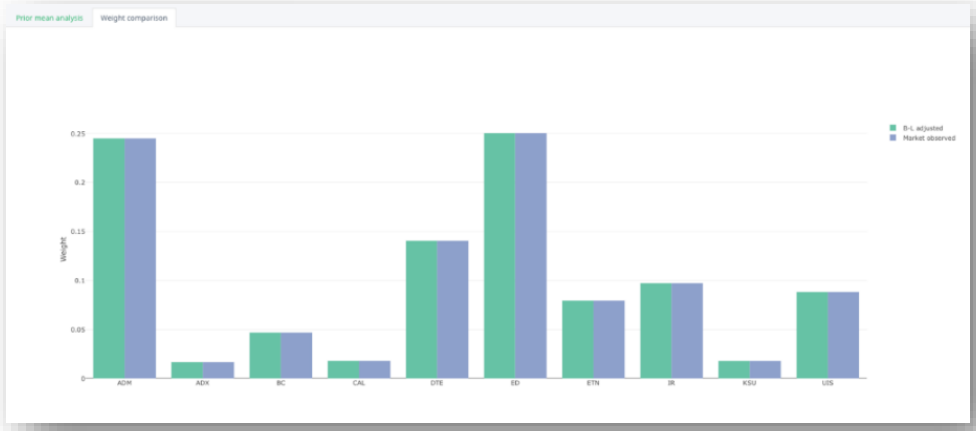


- Unlike the mean-variance frontier module, the frontiers module uses a return panel directly instead of a moment estimation result.
- This module gives more content beyond the conventional efficient frontier. It adds the optimization of the mean-ES frontier and compares it with the mean-variance frontier. 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.

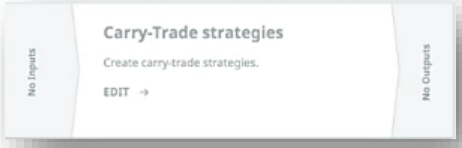


2.6. Black-Litterman Analysis

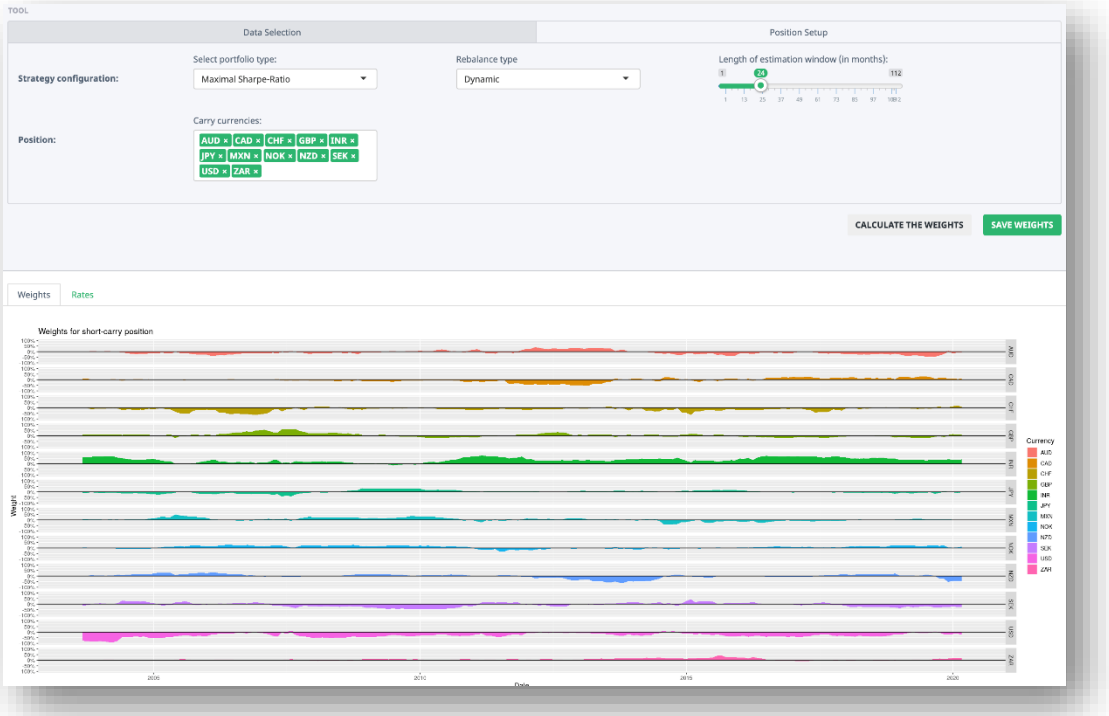
- This module can perform Black-Litterman model analysis, which is widely used in private banks in practice.
- Users can input their opinions on certain assets and see how this opinion adjusts the portfolio's optimal weights.



2.7. Carry Trade Strategies

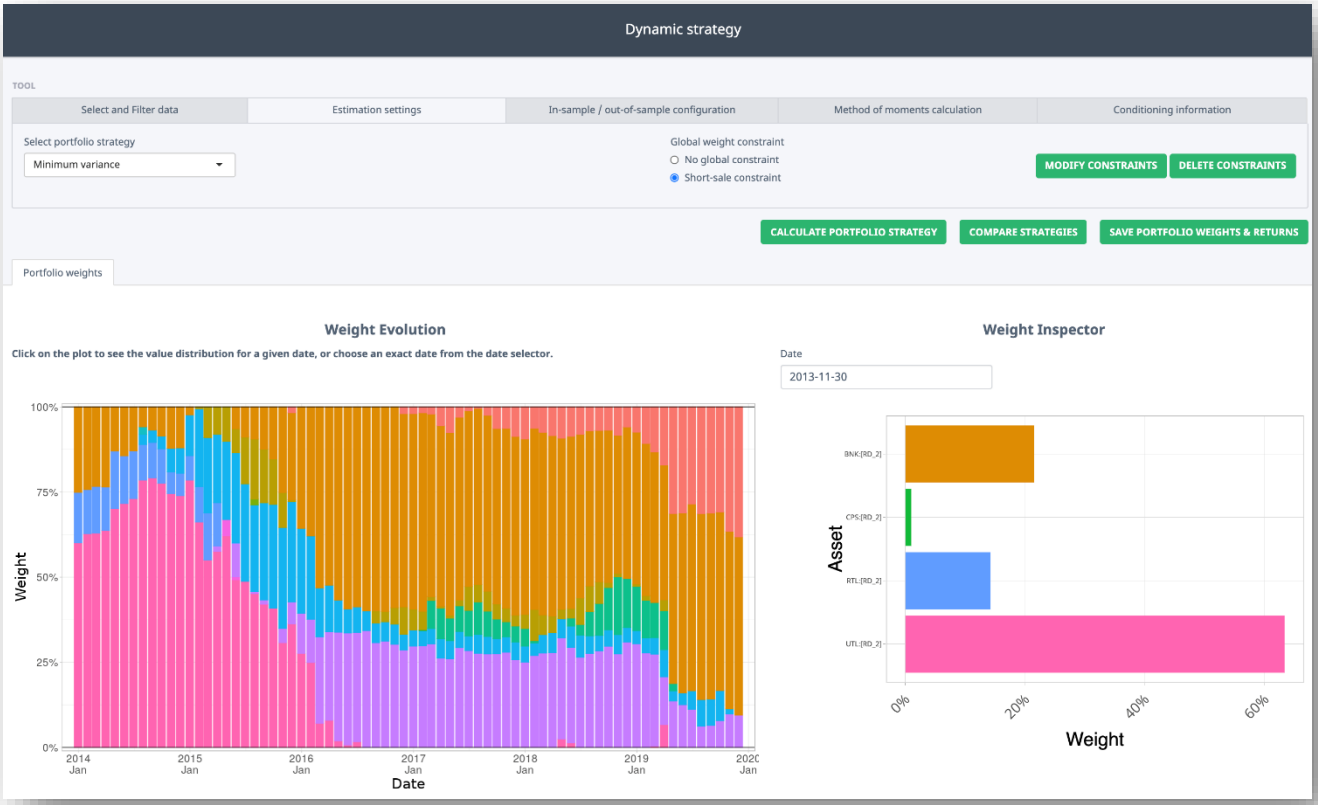


- This module is specific for currency trading.
- This module can optimize exchange rates and interest rates to construct a static or dynamic optimized carry trade portfolios.



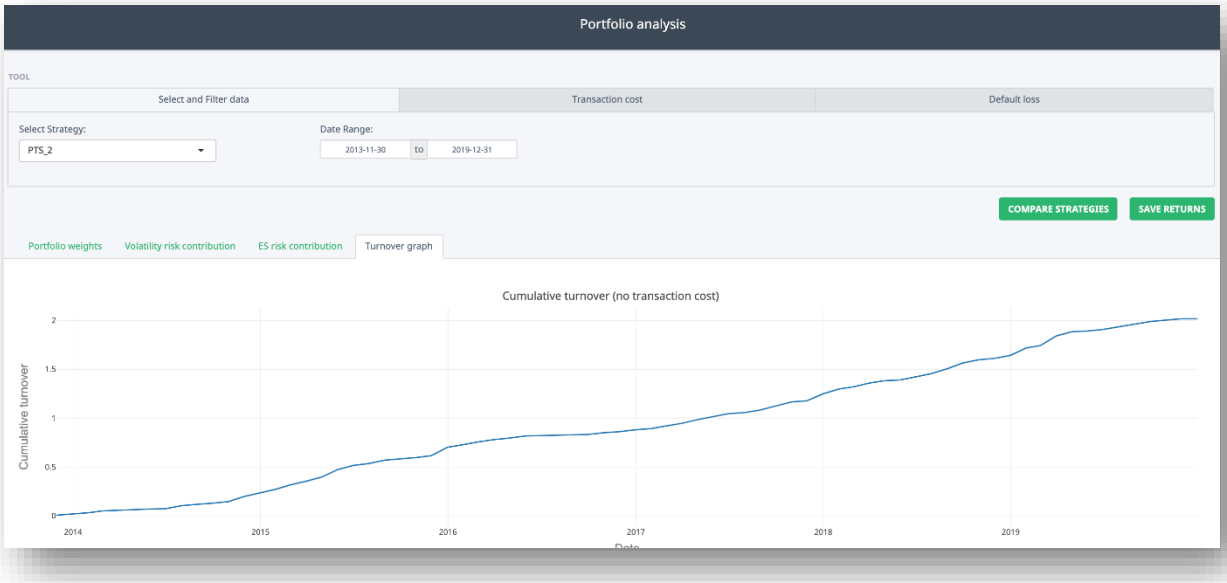
2.8. Dynamic Strategy

- 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.

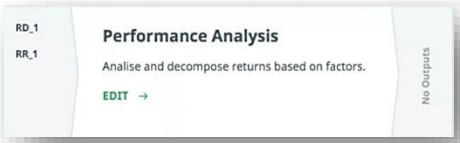


2.9. Portfolio Analysis

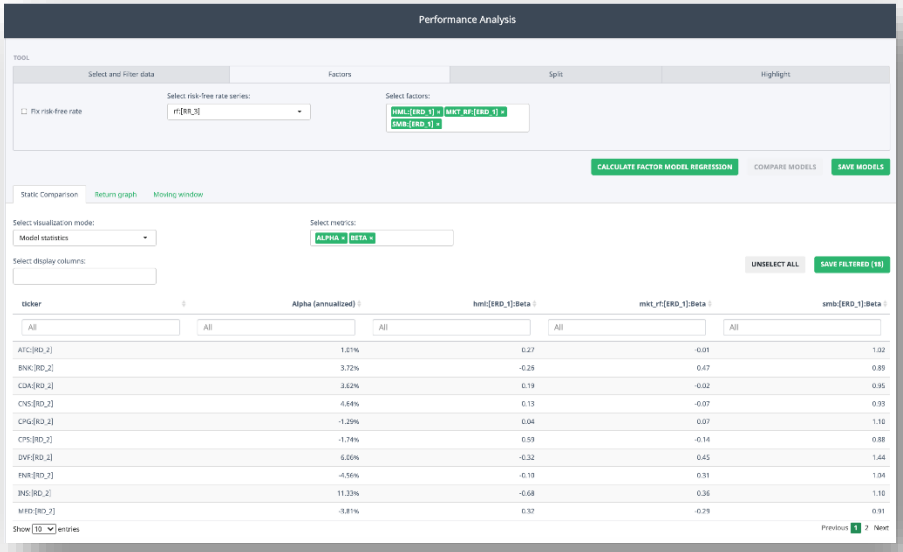
- Based on the portfolio weights generated in the dynamic strategy module, the portfolio analysis module can further analyze the portfolio strategies.
- It discovers the volatility and ES risk contributions.
- It displays the turnover of a dynamic strategy rebalanced to show the consideration of transaction 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.

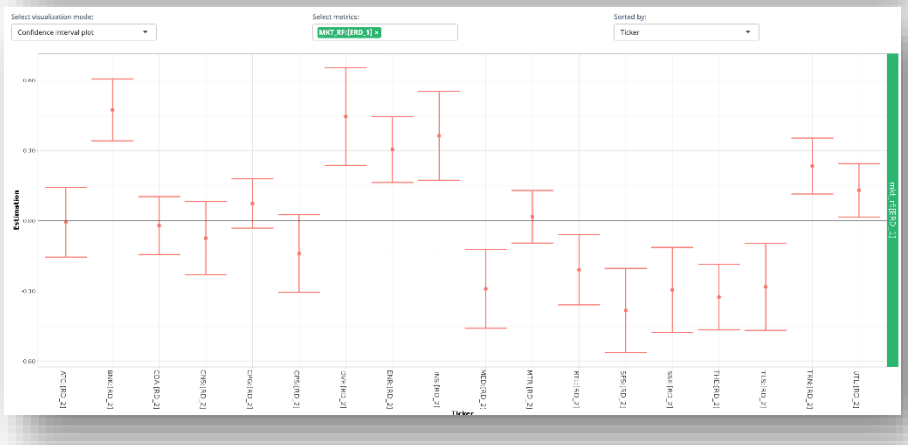


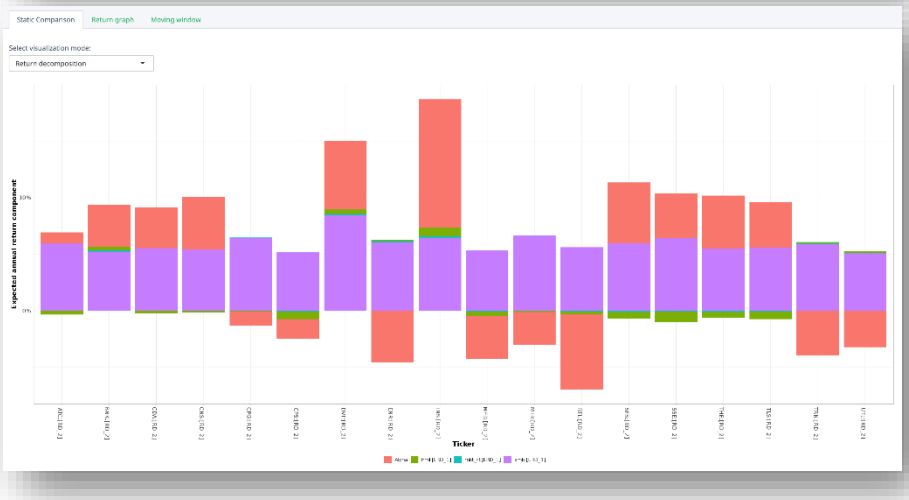
2.10. Performance Analysis



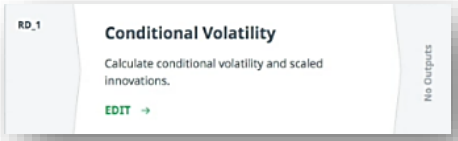
- This module analyses and decomposes returns based on factors.
- It can show more statistical characteristics of assets.
- Together with factors, it can analyze the coefficients of factors and decompose return series.
- It can depict the return series and their cumulative returns.
- By applying a moving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





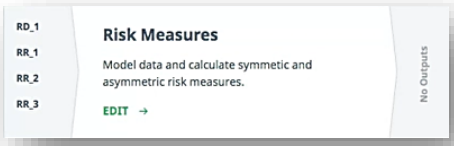


2.11. Conditional Volatility

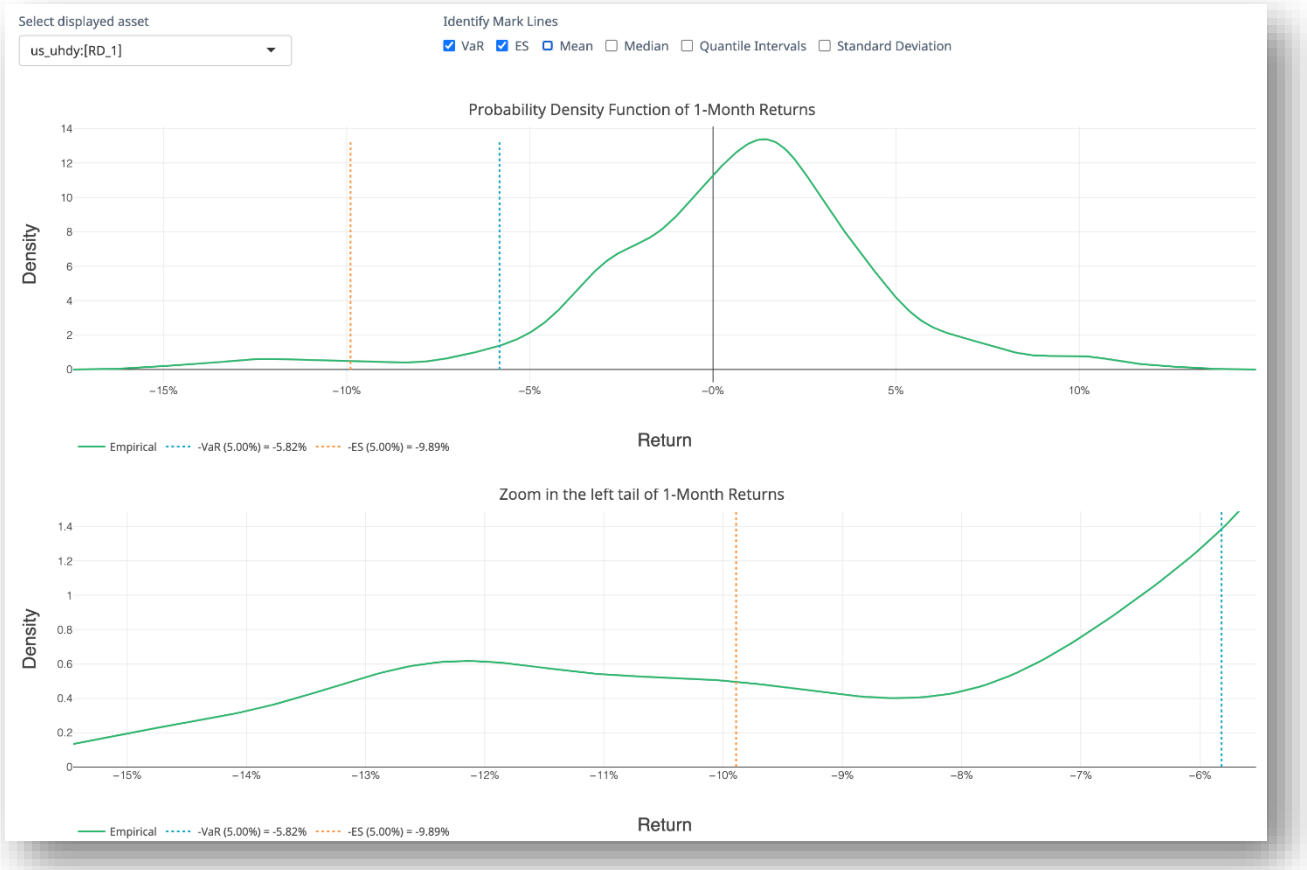


- This module is handy for risk management. It can calculate conditional volatility and scaled innovations by applying GARCH, GjR-GARCH, and EWMA models.

2.12. Risk Measures

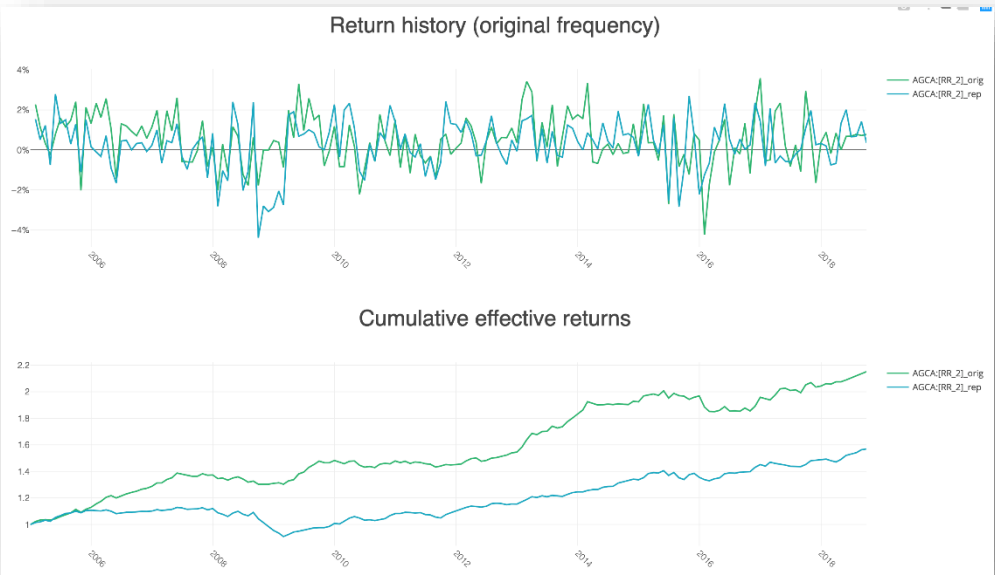


- This module calculates symmetric and asymmetric risk measures.
- It demonstrates how a return series and its tails look and why we should focus on the tail risk.
- By applying different distribution models, such as empirical, student-t, normal, extreme-value theory models, it can calculate and compare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



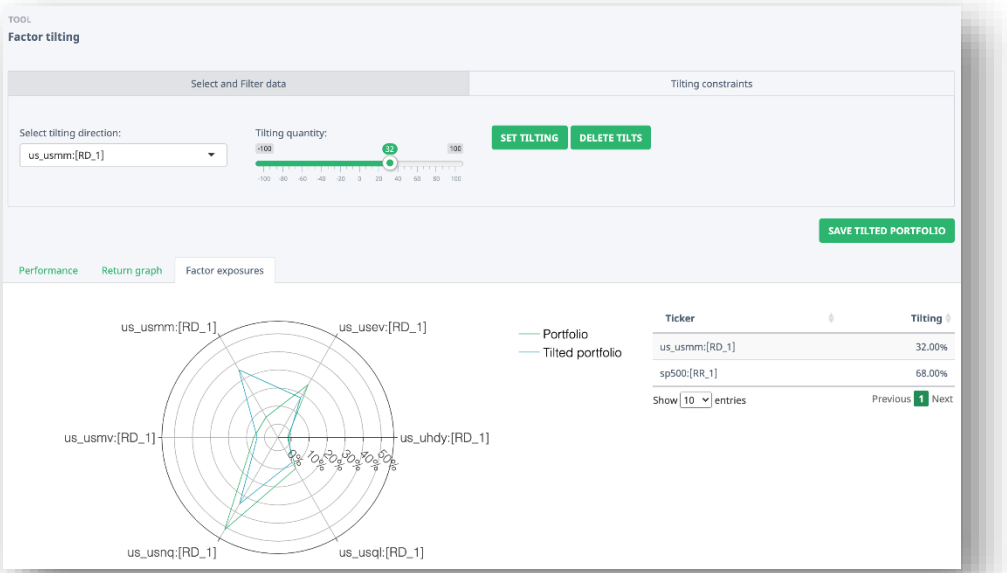
2.13. Replication

- 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.



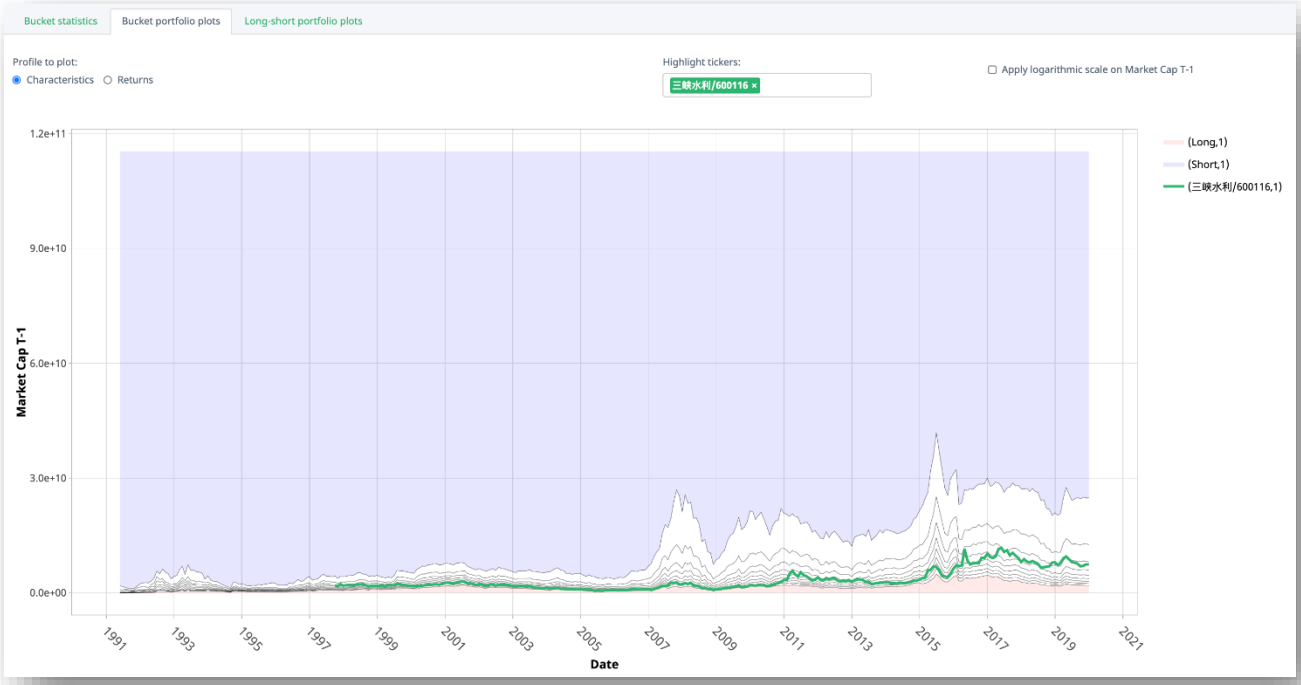
2.14. Factor Tilting

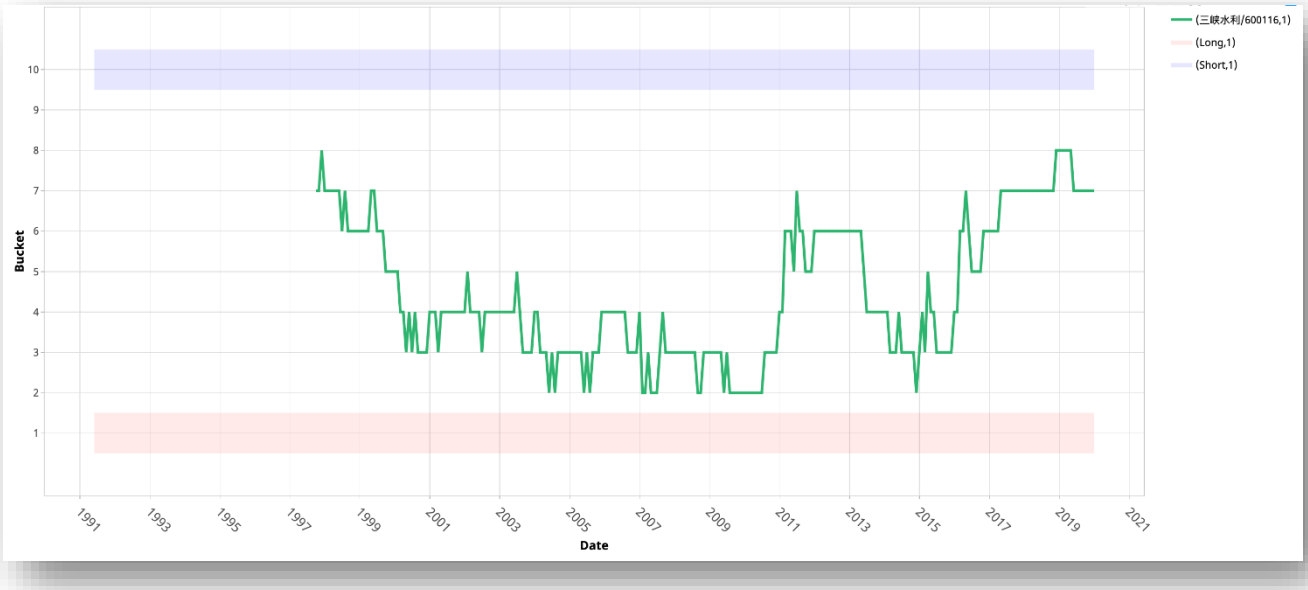
- This module analyzes and tilts the factor structure of the portfolio.
- Given the popular betting at beta exposure investment strategy, this module displays the factor exposure and the portfolio results after factor tilting.



2.15. Factor Factory

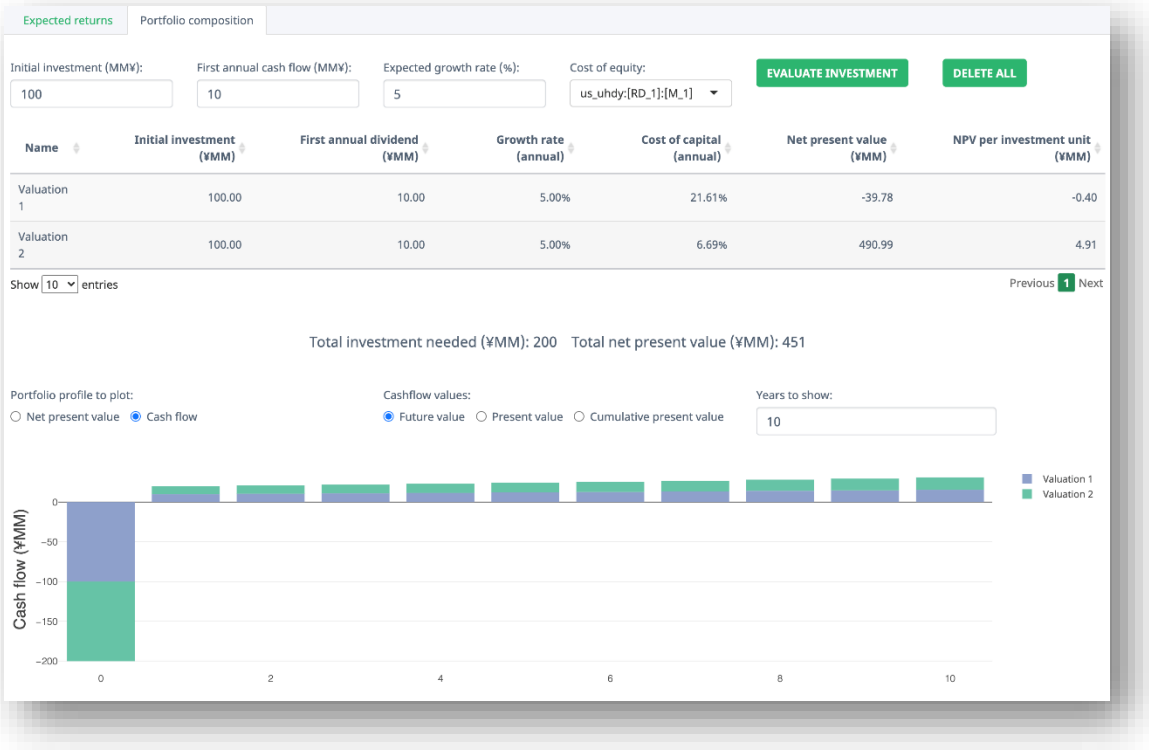
- This module allows users to create factor portfolios themselves.
- Using unbalanced return and characteristic datasets, users can decide any percentile on one asset characteristic and choose long-short positions to construct a factor portfolio, which can be used in other module analyses.





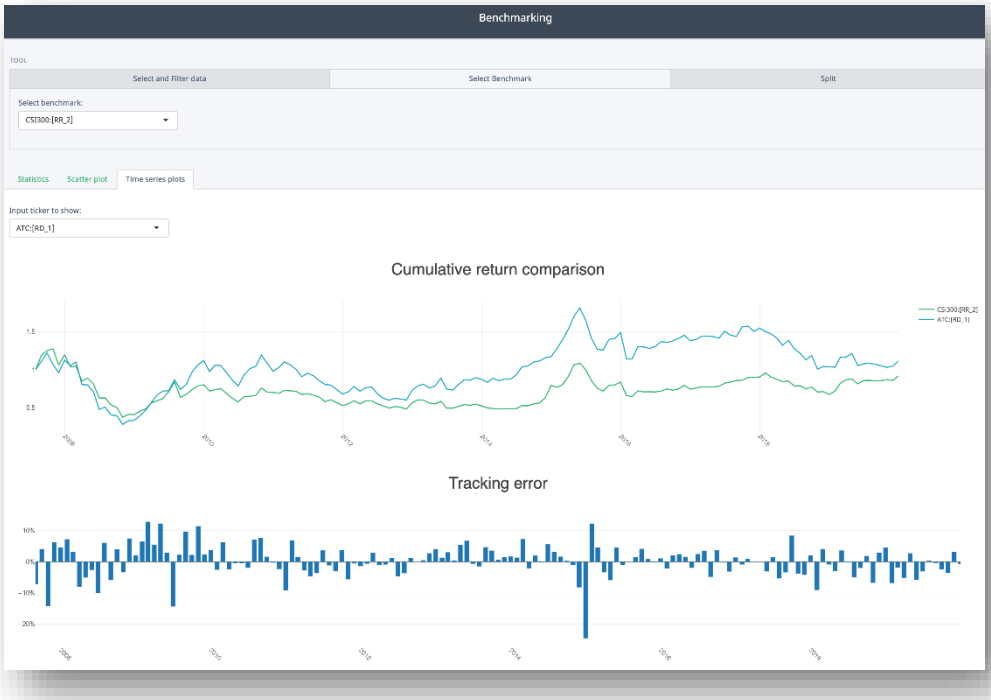
2.16. Valuation

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



2.17. Benchmarking

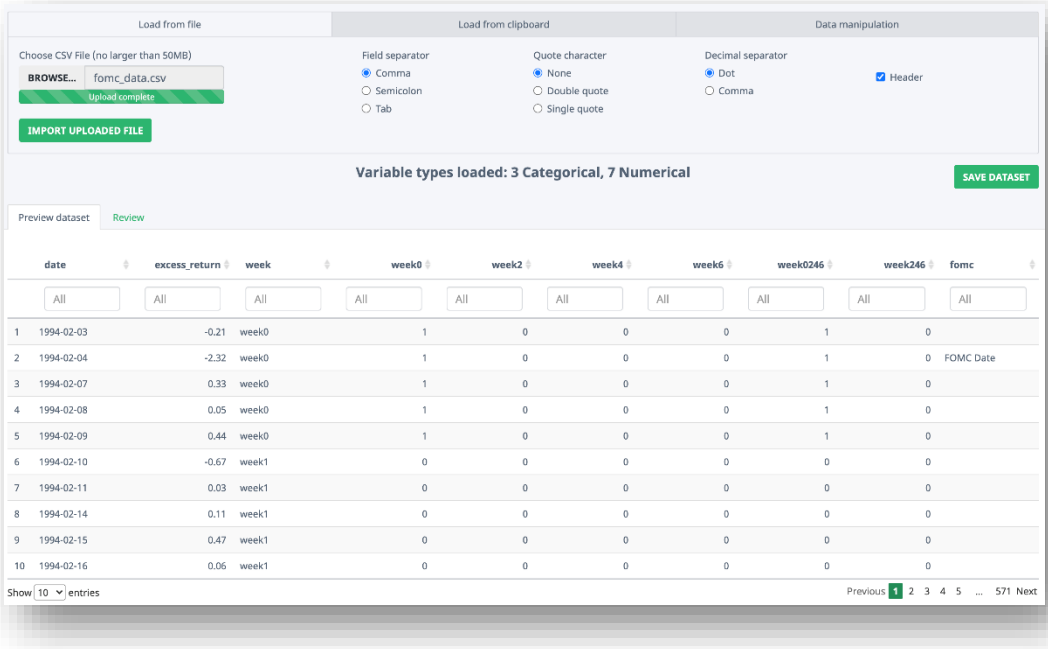
- As the performance analysis module, this module can select any asset, including a calculated portfolio return series, as a benchmark asset. Then, users can assess relative performance using the benchmark reference series.



3. Dissertation Application

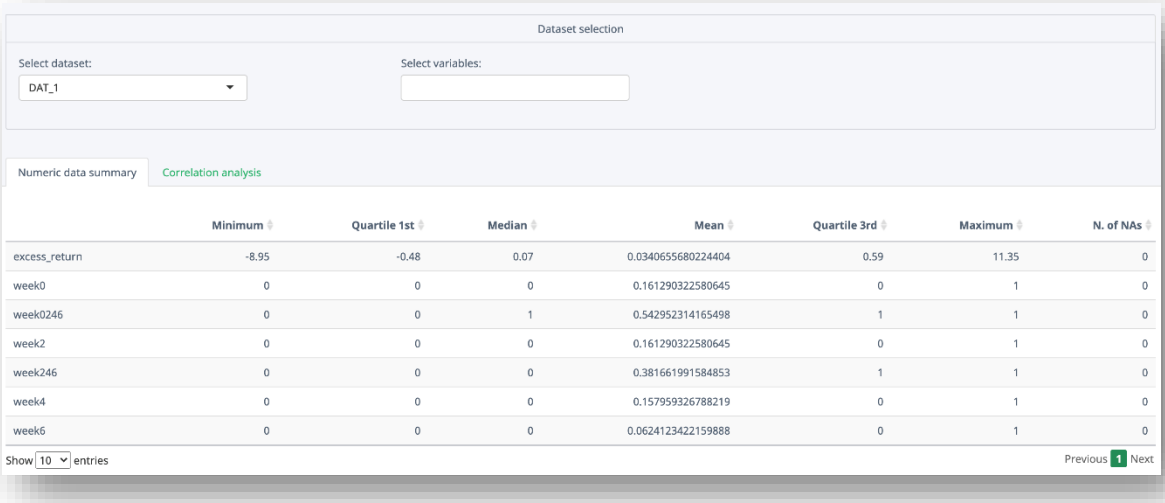
3.1. Data Import

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



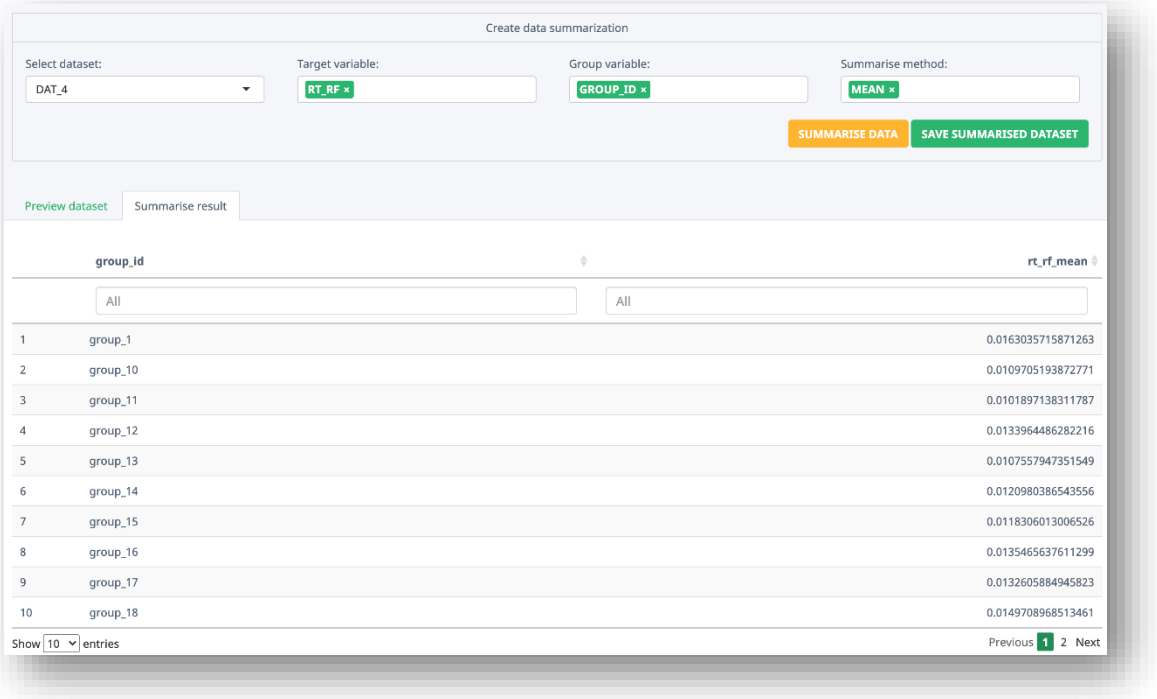
3.2. Data Analysis

- 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.



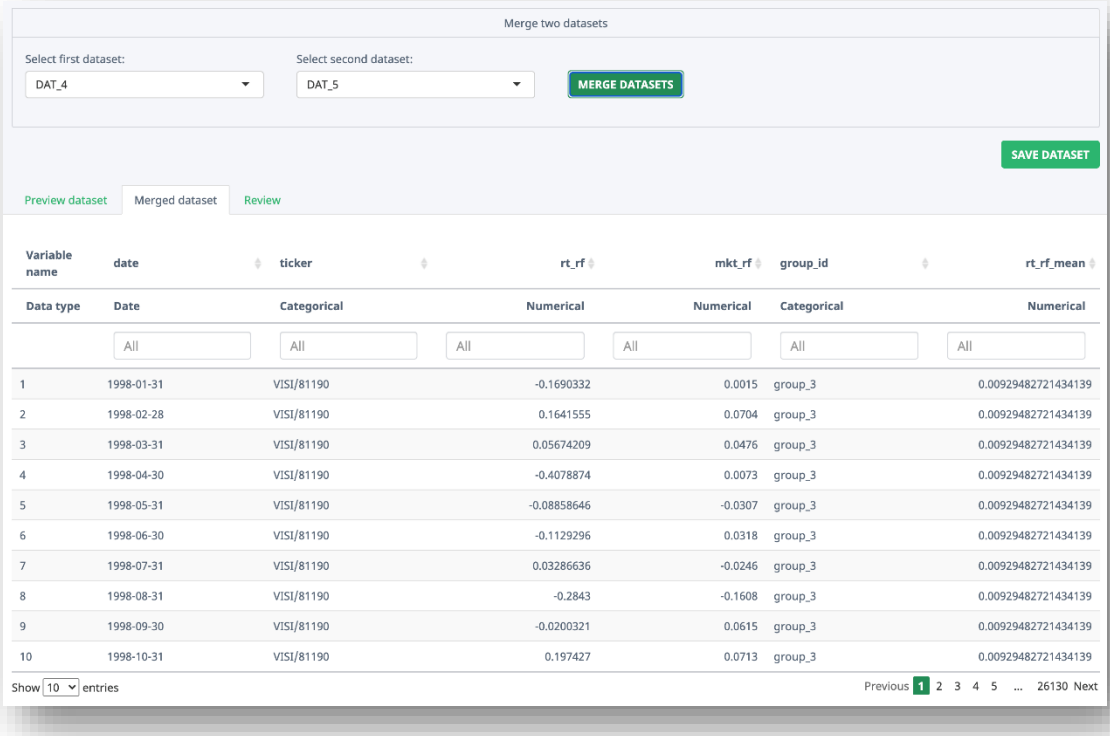
3.3. Data Operation

- 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.



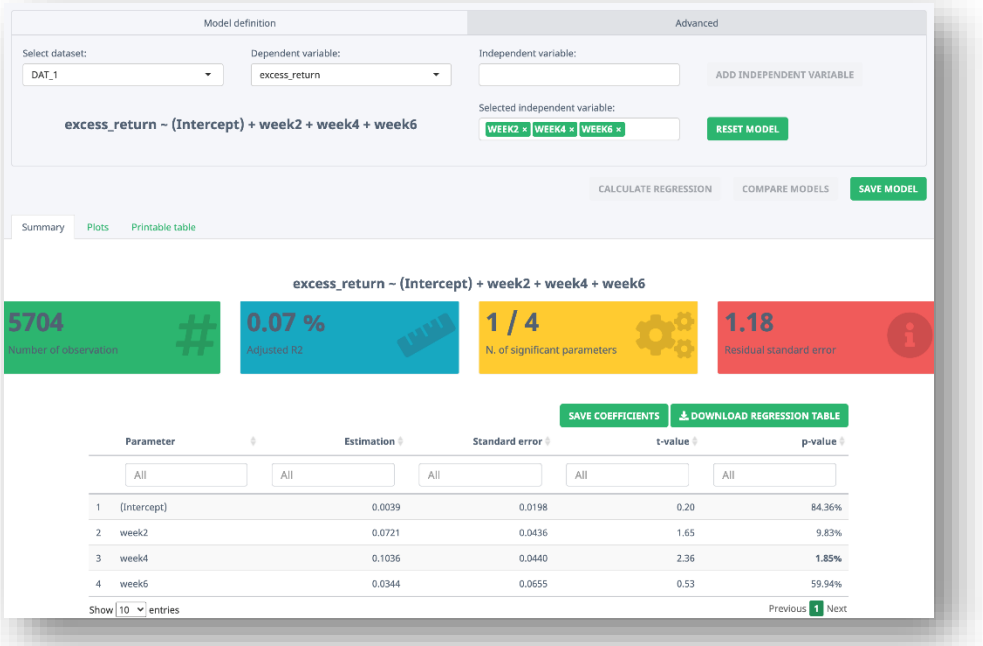
3.4. Data Merge

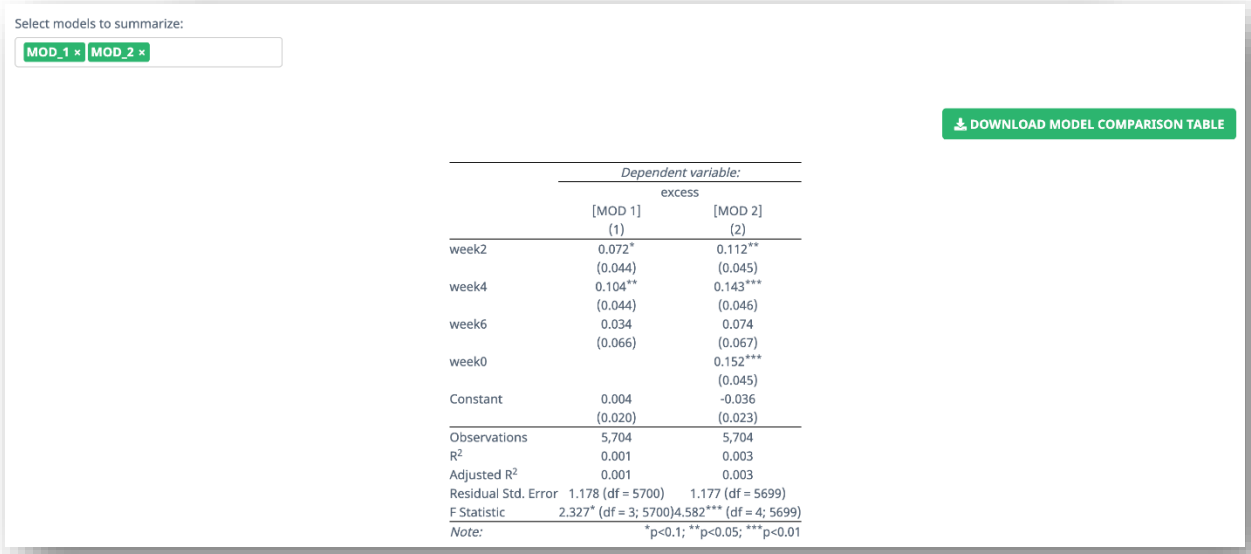
- In the data merge module, the users can combine two datasets into one new dataset. Users can further compare the dataset before and after the merge operation.
- At last, users can save the merged dataset into a new data object for further analysis.



3.5. Regression

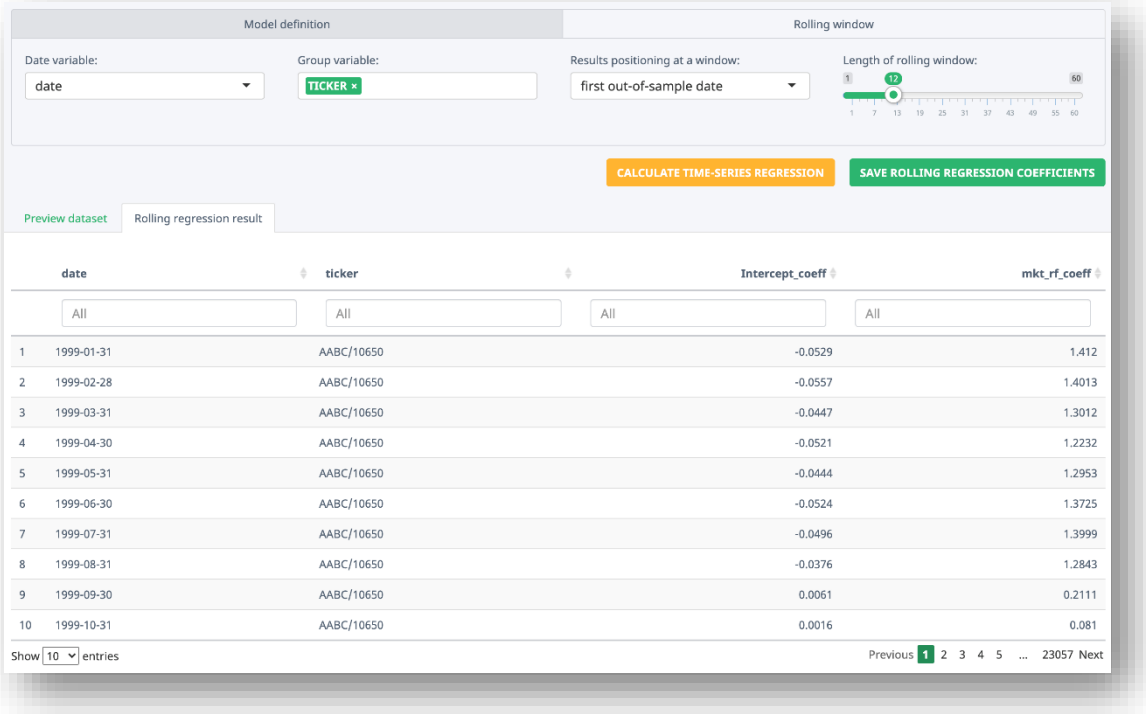
- The regression module defines and executes an ordinary least squares (OLS) regression model with grouping functionality. It exports results in printable tables for publication usage.
- It also supports the interaction terms between independent variables.
- Users can set up the group variable and run 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.





3.6. Time-Series Regression

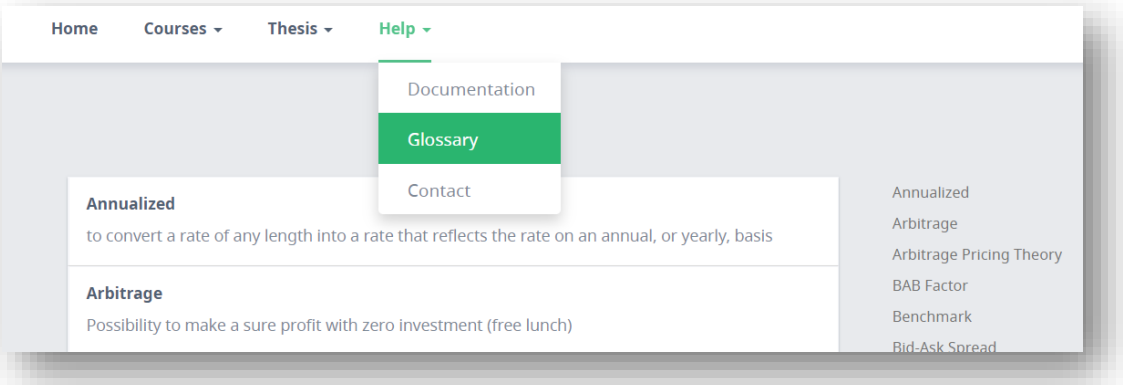
- This module uses for executing rolling-window time-series regressions. The model definition part is the same as the regression module.



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



4.2. Course Material and Information