March 2022

Solution Guide

OPTIMIZATION USE CASE COMPENDIUM

HIGHLIGHTS

Aladdin's proprietary optimizer, blkops, can now be widely accessed across three main Aladdin applications: Portfolio Construction (PfC), Explore and PortfolioRiskTools (PRT). This use case compendium details the list of common use cases which the client community leverages optimization on Aladdin for, and describes how to implement them across the relevant applications. The goal of this compendium is to act as a starting point for users who are new to Aladdin Optimization, or are looking to expand their usage of optimization for more investment workflows.

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Introduction

Aladdin's proprietary optimizer, blkops, can be accessed across three main Aladdin applications: Portfolio Construction (PfC), Explore, and PortfolioRiskTools (PRT). Each of these applications serves a different purpose and offers unique advantages in the optimization process.

To help users better understand Aladdin's optimization capabilities across these applications, this compendium serves as a compilation of common optimization use cases adopted by the Aladdin client community. This compendium provides users with an understanding of how they can leverage Aladdin's optimization capabilities. Once a user has identified a use case that they wish to integrate into their workflow, they can reference the respective application's user guide for more detailed steps on case setup and results validation.

Overview of Aladdin applications

Explore: Aladdin's portfolio analysis tool, using historical data (T-1 and before) for portfolio modeling, analysis, and reporting. Users can build reports showing exposures, analytics, and attribution in a single view, then generate an analysis through tabular and graphical formats. ***Explore optimization is commonly used by active portfolio managers or risk and performance analysts*** who conduct research on the factors affecting risk and return on their portfolios. This is because the nature of static data in Explore allows the tool to be nimble and offer a higher degree of customization (e.g., custom sectoring and custom calculated columns), and risk analytics as well as stress testing capabilities are more advanced compared to PfC.

Portfolio Construction (PfC): An intraday portfolio modelling tool, allowing users to view their portfolio's latest up-to-date exposures, layering on intraday activity like orders, trades, and new cash onto the start-of-day portfolio data. ***PfC optimization is commonly used by index tracking portfolio managers, wealth managers, and active portfolio managers.*** The key benefit of PfC lies in its ability to incorporate intraday data and its integration with the order execution process. Users can integrate information like portfolio substitutions, restrictions, corporate action impact, and tax lot data into the optimization process. They can also combine optimization with other investment workflows like equitization, FX hedging, etc. Proposed orders then run compliance before being posted to the dealing desk directly. PfC appeals to users who are more execution focused, with the intention to immediately implement the orders proposed by the optimizer.

Portfolio Risk Tools (PRT): An interactive tool for measuring portfolio risk and return based on a forward-looking parametric model for Tracking Error, Stress Testing, Analytic VaR, and Historical VaR. PRT allows users to do more advanced risk and return analysis compared to in Explore. It is also the only tool on Aladdin that allows users to run both mean-variance and Black-Litterman optimization, although it uses an earlier version of the Aladdin optimizer. ***PRT optimization is typically used by multi-asset managers or asset allocators*** due to its unique capabilities for asset allocation workflows. A detailed description can be found in the 'Asset Allocation' section of this guide.

Key feature differentiators across the applications

	PfC	Explore	PRT
Returns and stress P&L in objective function		✓	✓
Minimizing portfolio risk (on top of active risk)		✓	✓
Tax optimization	✓		
Upload alpha scores on the fly	✓		
Integration of custom scores/ research lists	✓	✓	
Custom calculated columns		✓	
Set soft constraints and relaxation controls	✓		✓
Asset allocation & Black-Litterman method			✓
Efficient frontier visualizations		✓	✓
Posting orders proposed by optimizer	✓		

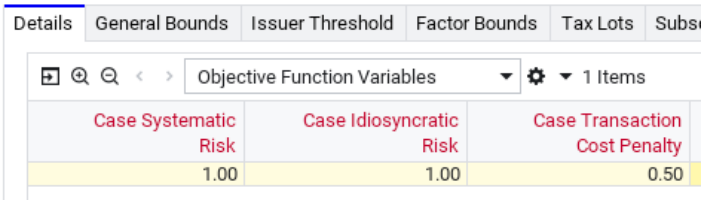
Use Case Catalogue

Minimize Active Risk

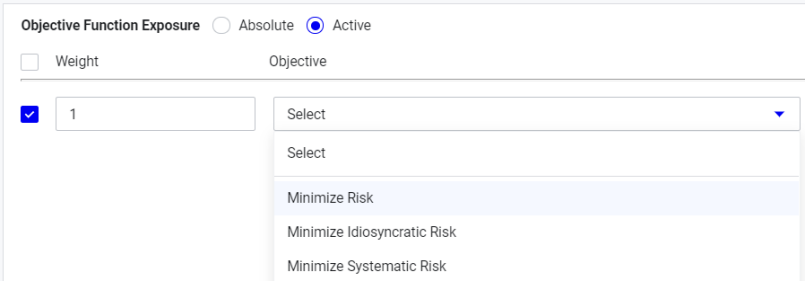
Minimizing active risk is one of the most common objectives in optimization. This is particularly popular amongst managers who track an index and have a mandate to reduce tracking error against the benchmark. In Aladdin's optimization capabilities, overall active risk can be minimized via reduction of idiosyncratic risk, systematic risk, or a combination of both. Systematic risk is risk that is prevalent throughout the market, while idiosyncratic risk is the volatility component of a security which cannot be explained by systematic factors.

When choosing risk minimization as part of the objective, users can define a risk aversion constant for each of the risk variables they have selected. This is indicated in the respective objective function variable columns in PfC, and in the 'Weight' column in Explore. This value is measured against the values for other objective function variables and drives how much the optimizer should seek to minimize risk compared to the other variables. For example, if Systematic Risk & Idiosyncratic Risk are set to 1 and Transaction Cost (TCost) is set to 0.5, the user is seeking to reduce Systematic Risk and Idiosyncratic risk twice as much as they want to reduce TCost.

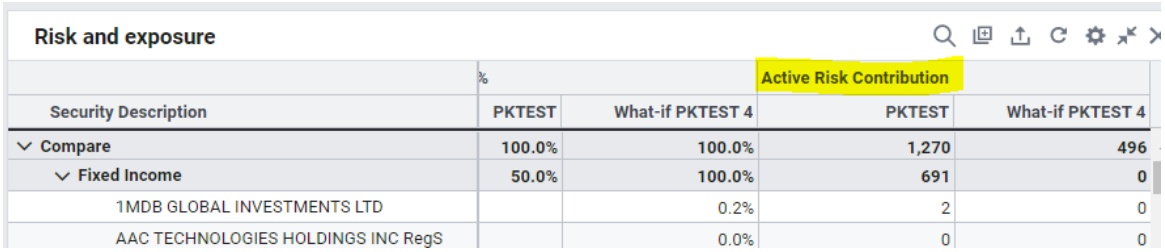
PfC Optimization Module – Details Tab



Explore Optimization Module – Objectives Tab



After the optimization algorithm returns results, users can compare the active risk of the portfolio with the initial value. This can be viewed in PfC's Portfolio Summary View, and in the Risk and Exposure widget in Explore. Note that users need to utilize the 'Compare' feature in order to compare the before and after risk values side-by-side in Explore.



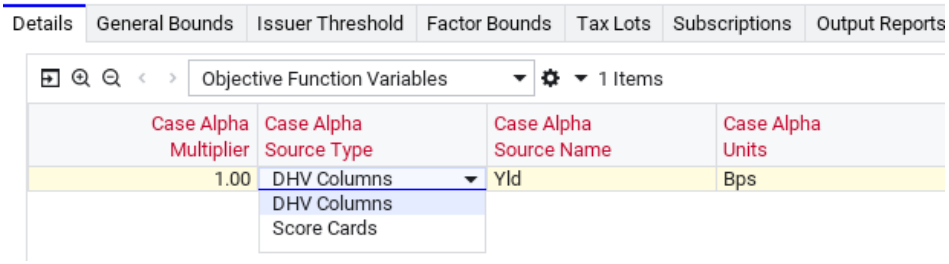
Alpha Maximization

Alpha in Aladdin Optimization is very flexibly defined. It can be viewed as a variable (other than risk and TCost) that users want to maximize (or minimize) as part of the optimization process. Some common examples are maximizing portfolio yield in fixed income portfolios or maximizing a projected profitability score calculated from fundamental equity data for equity portfolios. Alpha maximization is typically used in conjunction with other objective function variables like risk and TCost in the optimization process.

Users can define the alpha term by choosing an existing metric in the tool, maintaining a list of alpha scores in Aladdin, or uploading / calculating alpha scores on the fly. Below is a summary of the alpha related features in PfC vs. Explore:

Tool	Use existing metric as Alpha	Use existing list values as Alpha	Load Alpha scores with Excel	Custom calculate Alpha score using existing metrics
PfC	✓	✓	✓	
Explore	✓	✓		✓

PfC Optimization Module – Details Tab

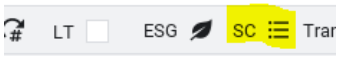


There are 4 main columns in PfC related to setting the Alpha for optimization:

1. **Alpha Multiplier**: Represents the coefficient of the Alpha variable and drives how much importance the optimizer places on maximizing Alpha compared to other variables (risk and TCost). To minimize alpha, use a negative integer value instead.

2. **Alpha Source Type:** Select 'DHV Columns' if the alpha is one of the existing PfC columns in Detailed Holdings View; select 'Score Cards' if the alpha will be a custom list that the user has loaded in Aladdin

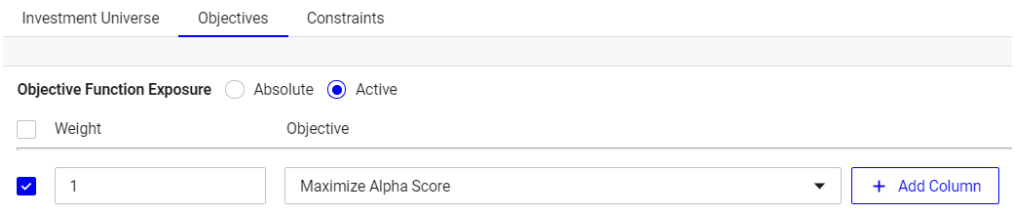
   Note that users intending to use custom lists need to load the list values in PfC prior to running the optimization. This can be done by clicking on the Retrieve Score Cards Data icon in the top toolbar:

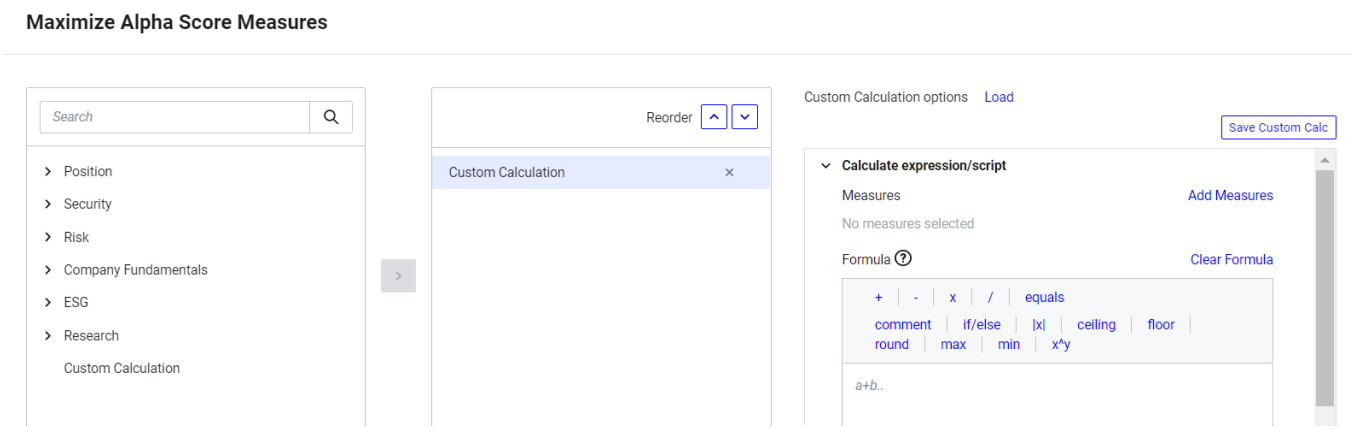
   

3. **Alpha Source Name:** Returns the list of columns / list names available depending on the user's selection of the source type

4. **Alpha Units:** Set as bps by default, allows users to scale alpha values by the appropriate unit

Explore Optimization Module – Objectives Tab





In Explore, users can select 'Maximize Alpha Score' as an objective then click on 'Add Column' to choose the relevant metric. Custom lists can be selected from the 'Research' section of the set of available measures. Users can also select 'Custom calculation', which allows them to calculate a new metric using other existing columns in Explore.

Maximizing Alpha within allowable risk ceiling

Rather than maximizing alpha while minimizing risk as an optimization objective, some active portfolio managers prefer using optimization to maximize alpha within certain risk limits / budgets instead. This will involve setting the objective to only maximize alpha and setting a constraint on the active risk of the portfolio.

Required configurations in PfC

Coefficients for alpha will be 1.0 and 0 for everything else in the objective function

Details | General Bounds | Issuer Threshold | Factor Bounds | Tax Lots | Subscriptions | Output Reports

Objective Function Variables — 1 Items

Case Systematic Risk	Case Idiosyncratic Risk	Case Transaction Cost Penalty	Case Alpha Multiplier
0.00	0.00	0.00	1.00

Max active risk target created in PfC's target set-up module and subscribed to the portfolio. Note that the risk ceiling is specified in the Upper Tolerance column

1 Items — Target Definition

Target Category	Target	Measure	Value Type	Target Value	Lower Tolerance	Upper Tolerance	Tolerance Type	Currency
PORTFOLIO	Total	Active Risk	Absolute	0.000	0.000	150.000	Absolute	

Case Use Max Active Risk set to 'Yes' in General Bounds tab, max active risk value will automatically populate in the optimization run window based on the target value set.

Details | General Bounds | Issuer Threshold | Factor Bounds | Tax Lots

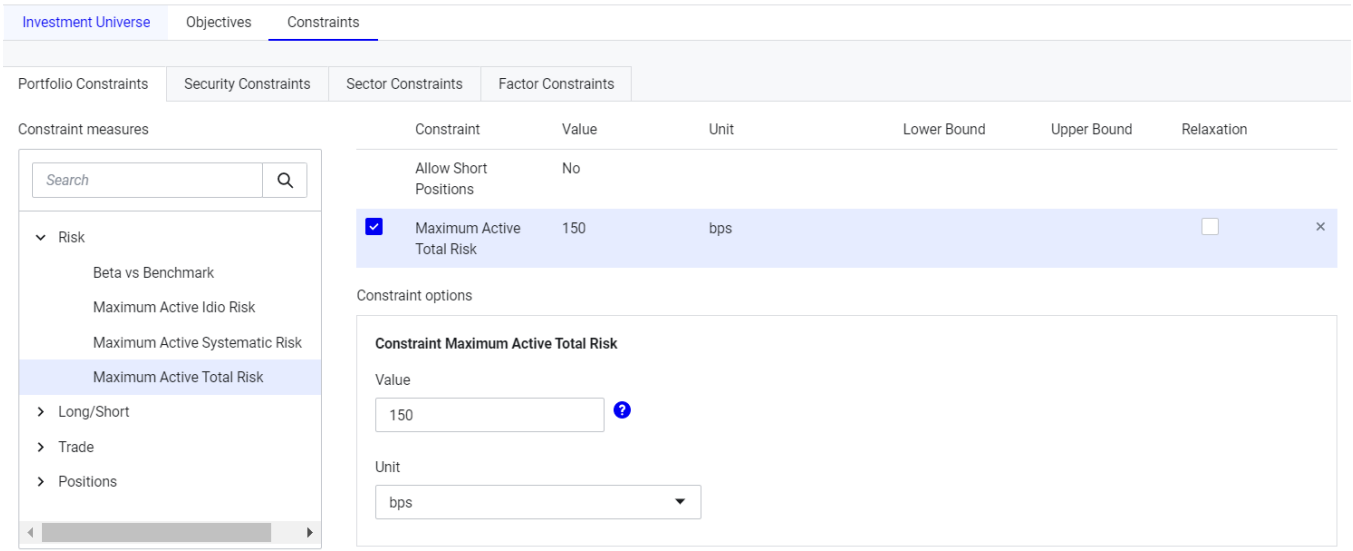
1 Items

Case Use Max Active Risk	Pf Max Active Risk	Case Enforce Issuer ABS Upper
Yes	150.00	

Required configurations in Explore

Only the maximize alpha objective is added to the objective function

Max active idiosyncratic risk / systematic risk / total risk constraint can be set in the Portfolio Constraints section of the Constraints tab



TCost Minimization

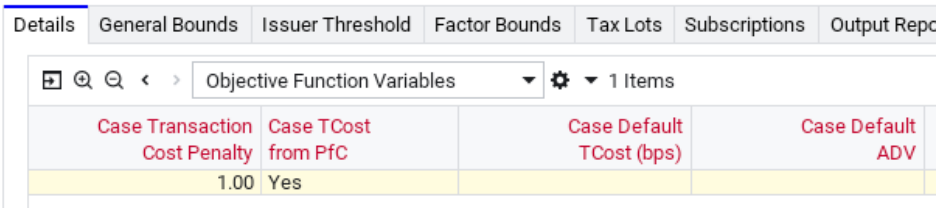
Including transaction cost minimization as part of the objective function allows users to incorporate liquidity costs and considerations into their optimization process. This is typically used in conjunction with other objective function variables like risk and alpha, although users can also use TCost minimization with exposure constraints to replicate a benchmark / model portfolio's exposures with minimal trading costs.

The total TCost in Aladdin is calculated using the below formula, where FC = Fixed Cost; MI = Market Impact; BAS = Bid-Ask Spread. Full Trip T-Cost is converted to Half Trip T-Cost by multiplying by 0.5. γ is 0.5, while κ_1 and κ_2 are regression coefficients and varies across assets.[1]

$$Econometric\ T\text{-}Cost = FC + MI = \kappa_1 * BAS + \kappa_2 * Risk * \left(\frac{Trade\ Notional}{Average\ Daily\ Volume} / Horizon\right)^{\gamma}$$

[1] To find out more about liquidity analytics and Aladdin's transaction cost models, check out the 'Solution for Liquidity Risk' guidebook, as well as the transaction cost model white paper for various asset classes in the Aladdin literature library

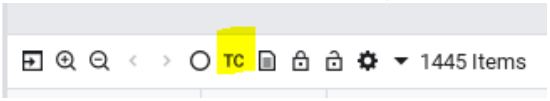
PfC Optimization Module – Details Tab



There are 4 main columns in PfC related to using TCost for optimization:

1. **Transaction Cost Penalty:** Represents the coefficient of the TCost variable and drives how much importance the optimizer places on minimizing TCost compared to other variables (risk and alpha).

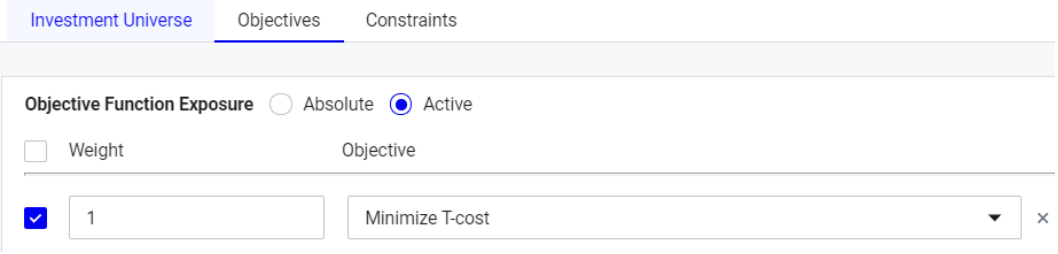
2. **TCost from PfC**[2]: Instruct PfC to use the TCost data in the 'Standalone Fixed Cost' (bps) column for optimization. This column can be populated by clicking on the 'TC' icon in Detailed Holdings View to retrieve TCost data calculated by the BlackRock TCost model. Users can also manually override the values in this column, or bulk upload the values via Excel.



3. Default TCost – specify a default TCost value for securities that do not have TCost data

4. Default ADV – specify a default ADV value for securities that do not have ADV data

Explore Optimization Module – Objectives Tab



Spend/Raise Cash

A common motivation for running optimization is to allocate subscriptions or choose an optimal set of securities to sell to raise cash for redemptions. This is typically implemented through specifying a budget which drives how much cash will be spent or raised through the optimization process. A negative budget will raise cash (for outflows) and a positive budget will spend cash (for inflows).

Required configurations in PfC

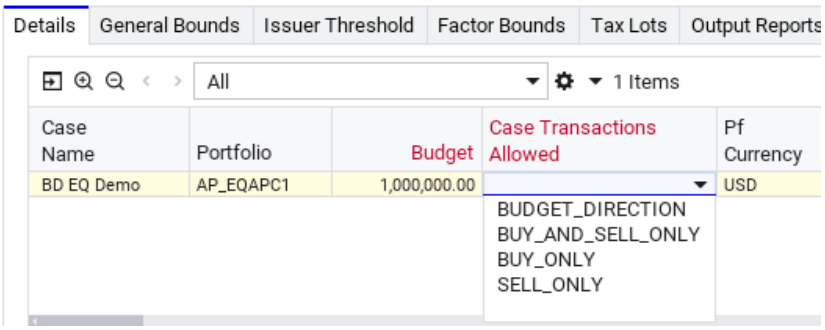
Optimization budget can only be set in the Run window, under the Budget column. Users can manually type in the budget amount before running the optimization. The budget can also be automatically populated in the below 3 scenarios:

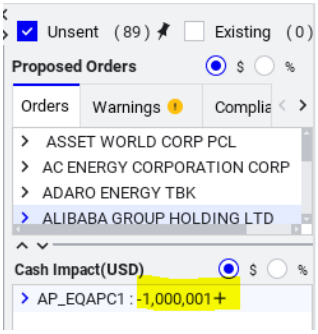
1. If a user selects "Spend Equity Budget" in Portfolio Summary View or Cash Detail View, they will see a pre-calculated budget based on the fund's Spendable Cash target.
2. If a user models cash or have a new cash inflow/outflow and specifies All Assets as the core asset definition, the cash amount will be used as the optimization budget.

[2] Note that while this parameter only influences the Standalone Fixed Cost column, when running an optimization problem with TCost, PfC sends standalone fixed cost, ADV and market impact coefficient to the optimizer to calculate linear Tcost and market impact Tcost.

3. If a user runs optimization from the Trade Flow window, the value in the 'Amount' column will be used as the optimization budget.

By default, PfC Optimization will propose trades in line with budget direction. This means that if a positive budget was specified, only buy trades will be proposed to spend the budget, vice versa for negative budget. If users would like to have both buy and sell trades (i.e. run a rebalance), they can change this behavior in the Case Transactions Allowed column. The budget constraint will then apply to the net cash impact of these transactions.





Required configurations in Explore

In the Portfolio Constraints section users can use the upper and lower bounds to define the optimization budget, as well as the unit of these values ($ or %). The impact of the budget constraint will appear on the base currency's riskless cash CUSIPs. For example, the scenario below raises 2 million on the riskless USD cash CUSIP, increasing the cash position from 9,756 to 11,756 million.

Portfolio Constraints

Edit

Constraint	Value	Unit	Lower Bound	Upper Bound	Relaxation
Allow Short Positions	No				false
Budget		$	-2000000	-2000000	false

		Market Value (m)		Market Value %	
Security Description	CUSIP	GLB-ACTFI (m)	Optimized GLB-ACTFI (m)	GLB-ACTFI	Optimized GLB-ACTFI
Compare		200,795	200,795	100.00000%	100.00000%
CASH		15,329	12,134	7.63401%	6.04275%
USD CASH(Alpha Committed)	USD_CCASH	9,756	11,756	4.85870%	5.85475%

The optimizer can propose both buy and sell trades regardless of the budget – the budget simply sets a constraint on the *net cash impact* of all the proposed trades. If users would like to raise either only buy or sell trades, they can utilize the Buy Only or Sell Only constraints under the Portfolio Constraints section.

Optimization with Adjusted Universe

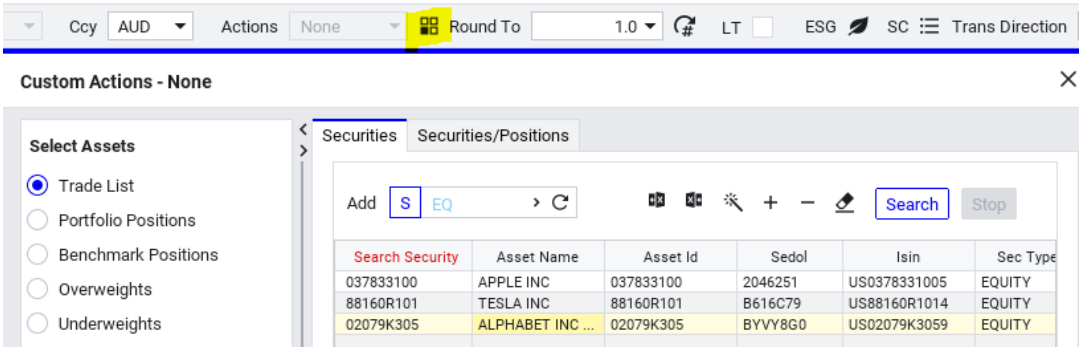
All portfolio and benchmark holdings loaded into the given Aladdin application form part of the optimization universe by default. There are many cases, however, where users want to add more securities, remove securities, or set trading restrictions on some of the securities in their default universe. The sections below describe how these can be done.

Expanding optimization universe

Users may want to add non portfolio or benchmark securities into the optimization universe for various reasons such as including new high-conviction names into their portfolio or trading new bond issues / IPO securities.

Required configurations in PfC

New securities can be loaded into PfC via the Smartcut function, or by loading a trade list. The Smartcut is typically only used if there are very few securities to be added, or the user does not know the security identifier and needs to search for it via the Smartcut. Otherwise, users typically upload the list of securities via the Trade List function in PfC, which automatically loads the securities into the PfC session. All securities loaded into the PfC session will be included into the optimization universe by default.



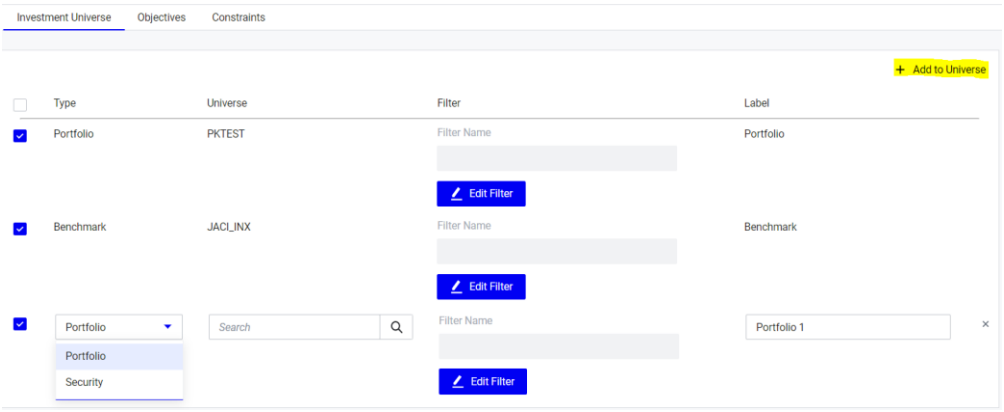
Required configurations in Explore

The optimization universe in Explore can be expanded in 2 ways:

1. Adding cash or securities to the What-if portfolio in the **What-if Position Modeling screen**. A single security or a list of securities which have already been set up in the environment can be added to the portfolio.

Expert Tip: users cannot run risk on the fly in Explore, so they need to add securities that already have risk data/ ran through overnight production in order to use them in optimization.

2. Adding securities in the **investment universe section** of the optimization module in Explore. Users can add securities from a portfolio or upload a list of securities. Filters can also be leveraged to choose only a subset of securities from the added portfolio to be included in the universe.



Reducing optimization universe

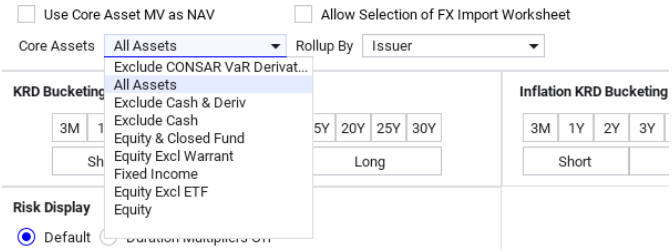
In some cases, users might want to exclude a set of securities from the optimization universe because they manage the portfolio in slices. For example, a portfolio manager who is managing only the equity portion of a multi-asset fund would want to exclude all non-equity securities from the optimization process.

Required configurations in PfC

There are two ways to exclude securities from the optimization universe in PfC: setting a core asset definition or using filters in the workspace.

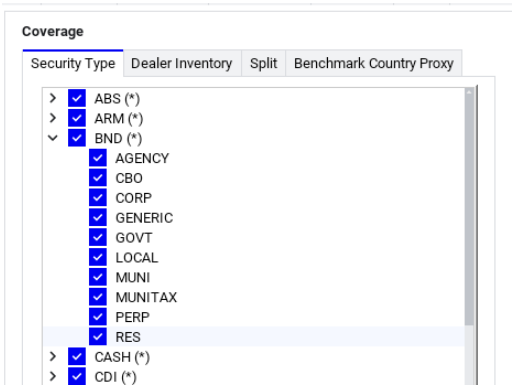
1. **Core Asset definition** – This allows users to directly define the set of securities that should form the optimization universe. For example, if "Equity" is selected as the Core Asset definition, then the optimizer can invest only in equities and NAV will be equal to sum of market value of the equity assets + any optimization cash budget indicated by the user. Also, the risk which the optimizer is minimizing is the Core Asset active risk, which is displayed as Equity Active Risk in PfC's Detailed Holdings View.

   Note that when using a Core Asset Definition, the "Use Core Asset MV as NAV" option should also be checked. This will recalculate all % columns in PfC using the Core Asset NAV and ensure alignment with the optimizer's calculations. The rules driving core asset definition are also not accessible by default but can be customized by clients. Clients must reach out to the Aladdin Client Engagement team to set up a new core asset definition to be used in PfC.

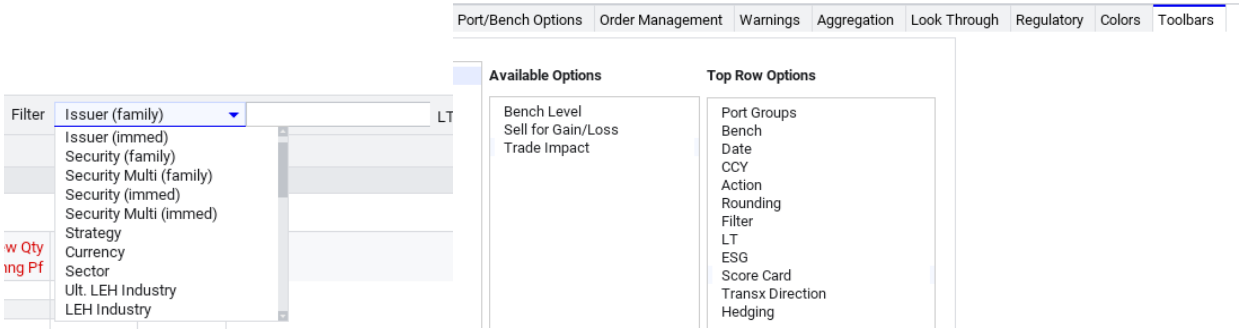


2. **Workspace filters** – This approach filters out a defined set of securities to be loaded the PfC session. When workspace filters are applied, PfC refreshes and only loads a subset of the portfolio. As mentioned above, all securities loaded into the PfC session will be included into the optimization universe by default. In the same way, all securities *not loaded* into PfC will therefore automatically be excluded from optimization.

   If users would like to filter securities by security group / type, they can leverage the Coverage section in View Options > Search Criteria tab. Any security type that is unchecked in this section will be filtered out from the portfolio.

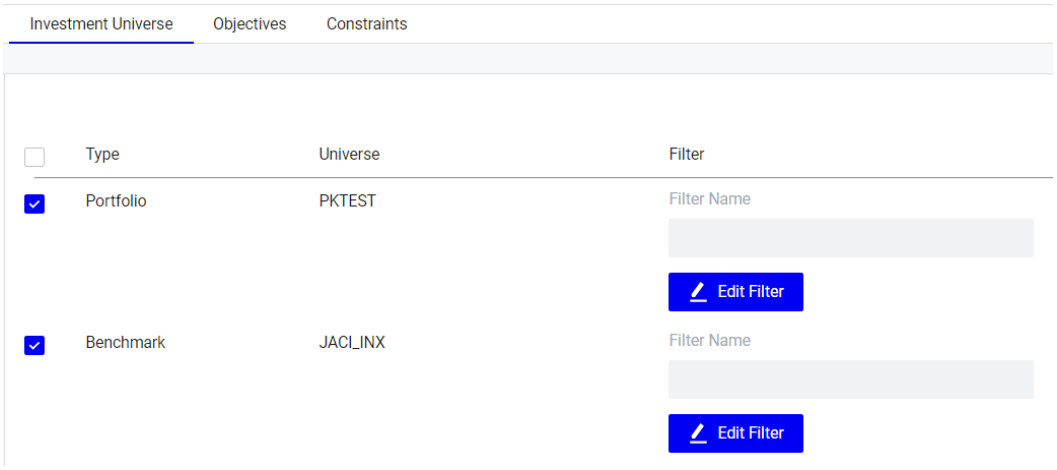


Alternatively, if users have more complex filter requirements, they can leverage the filter feature on the PfC toolbar. Note that the filter option must first be added to the toolbar in View Options > Toolbars. Users can check out the PfC User Guide for more details on using this feature.



Required configurations in Explore

Within the investment universe section of the optimization module in Explore, users can apply filters to reduce the universe to a specified subset of securities in the portfolio or benchmark.



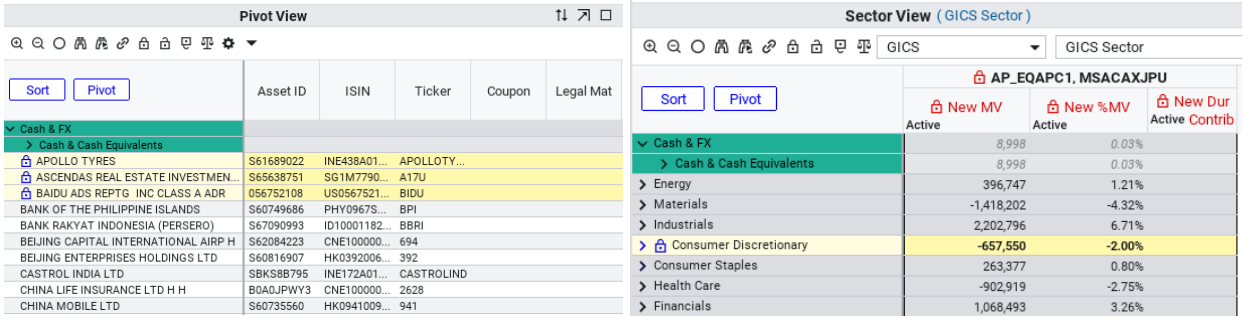
Restricting optimization's trading universe

Users may want all the portfolio and benchmark positions to form part of the optimization universe, but do not want to trade some of them. For example, when optimizing against a benchmark, users may not want to trade any tobacco securities which are present in the benchmark because that is against their ESG mandate. Note that this is different from removing securities from the optimization universe, as securities which are removed will have their exposures completely ignored in the optimization process and the final output.

Required configurations in PfC

Users can restrict trading in 2 ways:

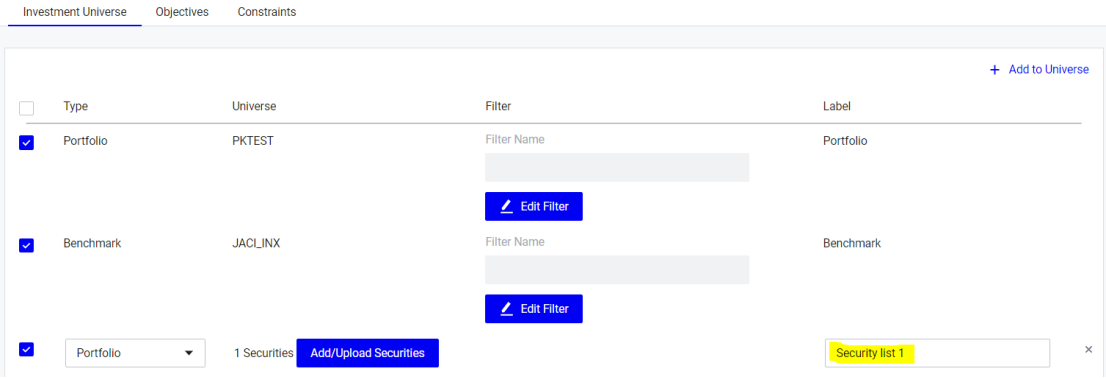
1. **Locking restricted securities** – Users can utilize the lock function in PfC views to lock individual securities or an entire sector of securities. A locked security or sector can be identified by the blue lock next to the security or sector name. All locked securities will automatically be included in a no-trade list to the optimizer.

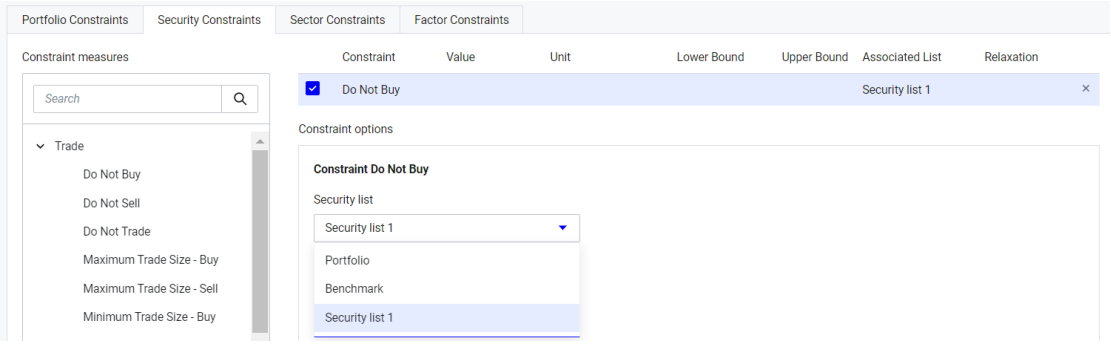


2. **Portfolio restrictions** – Using the restriction setup in PfC, users can create restrictions on a security or a list of securities and apply it to the portfolio. Restrictions can be one-sided (no buy / no sell) or two-sided (no trade). These restrictions will be subsequently respected in the optimization. Note that restrictions must first be enabled via the View Settings > Search Criteria > Show Restrictions option.

Required configurations in Explore

Trading restrictions in Explore are applied through security constraints. Users will need to first specify the security or list of securities as a separate list in the investment universe section, **even if the securities are already part of the portfolio / benchmark.** They can then select this list when applying the no buy/sell/trade constraints.





Tax Optimization

Tax optimization is commonly used by portfolio managers who want to incorporate tax liability considerations into their portfolio management process. Aladdin's tax optimization features allow managers to avoid or harvest tax gains/losses, incorporating their desired accounting method and other constraints on tax liability realized from trading the proposed orders. Note that to run tax optimization in Aladdin, clients need to load external lot data into the system. This functionality is only available in PfC as other tools currently do not support viewing of lot information. For the full list of tax parameters available, please refer to the appendix of the PfC Optimization User Guide.

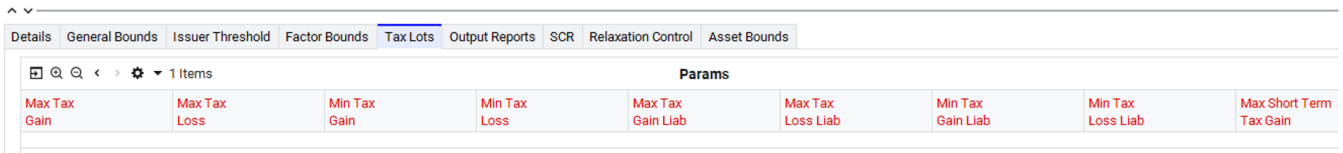
For Your Info: to load external lot data into Aladdin, users simply need to send the relevant book information through the Interface File 335. This includes information like book type, book value, book date, book price, book yield and book FX rate. Once the book information is loaded into Aladdin, users are able to access them immediately in Portfolio Construction. For more information on loading book data, please refer to the section on Interface File 335 in the 'Aladdin Standard Loaders' document.

The parameters related to tax optimization are found in the Tax Lots tab of PfC's optimization module. Incorporating tax considerations into the optimization problem involves adding two additional independent variables into the objective function: TaxGain and TaxLosses

$$- \alpha * \text{TaxGain} + \beta * \text{TaxLosses}$$

The Gains/Losses type determine the impact of TaxGain and TaxLosses on the overall utility. If the user wants to harvest losses for reduced tax liability, setting losses type as 'Harvest' will allow TaxLosses to contribute positively (have a '+' sign in the equation) to the overall utility, hence the optimizer will favor orders that maximize tax loss. Gains/Losses factor weights determine the coefficient of the respective variables. A higher value indicates that more importance should be placed on minimizing or maximizing that variable.

Users can indicate their preferred accounting method which drives the priority of lots that the optimizer is allowed to trade. They can also set the short-term and long-term tax rates, as well as the definition of a long term lot in the parameter set. The values typically depend on the tax regulations of the portfolio's jurisdiction. Tax rates are used to calculate the final tax liability that will be realized from trading the proposed orders. Users can therefore set limits on the Max/Min Tax Gain/Loss or Gain/Loss liabilities:



After optimization, users can view a series of tax reports to get more transparency into the results of the optimization. The tax reports available are:

- **Portfolio Tax Summary:** Shows users a summary of all the tax related metrics at the portfolio level post optimization. This includes metrics like overall tax gain/loss and gain/loss liabilities.
- **Asset Tax:** Shows users gain/loss information at the CUSIP level for every asset in the optimization universe. Realized gain/loss columns will reflect the gain/loss amounts that will be realized if the proposed orders were executed by the user.
- **Tax-lot Sell Report:** Shows the tax lot information for every lot where an order was proposed by the optimizer.

ESG Integration

Sustainability is a focal theme, with many portfolio managers starting to incorporate ESG data into their portfolio management process. Aladdin Optimization can be used to propose a set of orders that maximizes or minimizes[3] the overall portfolio's ESG score or incorporate ESG constraints in order generation so users can set limits on certain metrics like carbon emissions.

ESG Data in Aladdin

There are currently 4 different sources of ESG data in Aladdin: MSCI, Sustainalytics, Refinitiv, and a user's custom ESG scores. Vendor-provided data require various levels of licensing before they can be accessed on Aladdin, although certain Sustainalytics and Refinitiv data is available to all users as part of the ESG starter pack. Users can also load their own ESG scores into a list in Aladdin and use them in the optimization process.

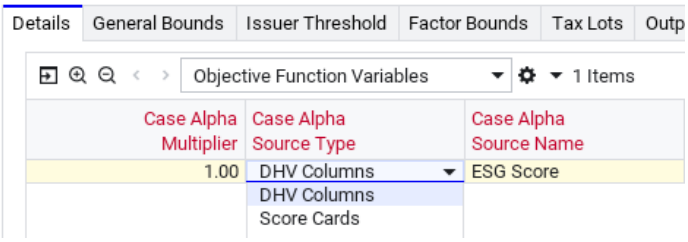
Please reach out to your Aladdin Client Engagement team for more details on ESG data licensing and custom data load.

For Your Info: ESG Starter Pack offers Aladdin clients access to a set of headline ESG metrics at no additional cost. There are currently 11 Sustainalytics and 16 Refinitiv metrics available to clients. Sustainalytics metrics include ESG Risk Ratings, Product Involvement, Corporate Governance Scores, Controversies, and Carbon Emissions. Refinitiv metrics include headline ESG scores, pillar scores and key issue scores for each pillar. It also offers Scope 1 + 2 emissions intensity data (measured in metric tonnes divided by company revenues).

ESG in Objective Function

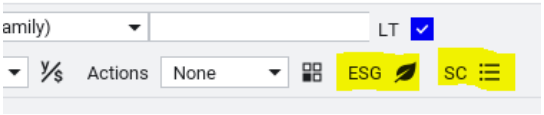
Users can define ESG metrics as an alpha that they want to maximize or minimize in the optimization process.

PfC Optimization Module – Details Tab



To use vendor-provided ESG scores, first select 'DHV Columns' from the Alpha Source Type column, then select the relevant metric in column 'Alpha Source Name'. To use custom ESG scores, first select 'Score Cards' from the Alpha Source Type column, then select the relevant custom list in column 'Alpha Source Name'.

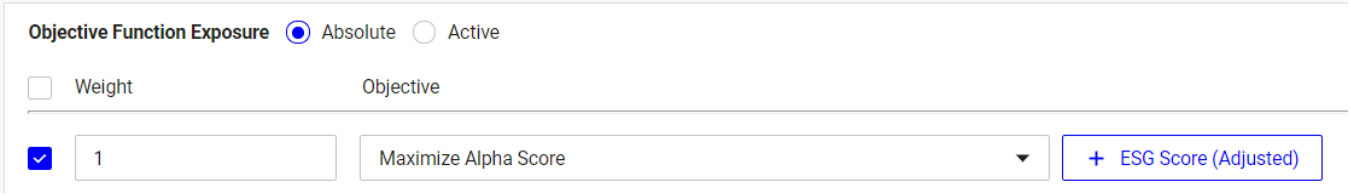
Note that users should load ESG or custom list values in PfC prior to running the optimization. This can be done by clicking on the ESG icon or the Retrieve Score Cards Data icon in the top toolbar:



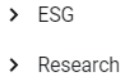
The alpha multiplier represents the coefficient of the Alpha variable and drives how much importance the optimizer places on maximizing ESG Score. To minimize the portfolio ESG score, use a negative integer (e.g. -1) as a multiplier instead.

[3] Some data providers like Sustainalytics use lower ESG scores to represent better ESG

Explore Optimization Module – Objectives Tab



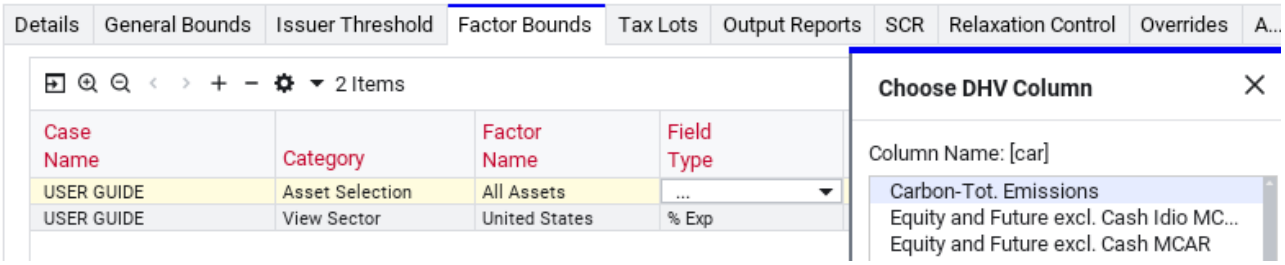
To use vendor-provided or custom ESG scores as the alpha, select 'Maximize Alpha Score' as an objective, then click on 'Add column' in the blue box next to it to select the relevant columns. Note that vendor scores are available for selection in the 'ESG' section while custom lists are in the 'Research' section.



The weight column represents the coefficient of the Alpha variable and drives how much importance the optimizer places on maximizing ESG Score. To minimize the portfolio ESG score, use a negative integer (e.g. -1) as the weight instead.

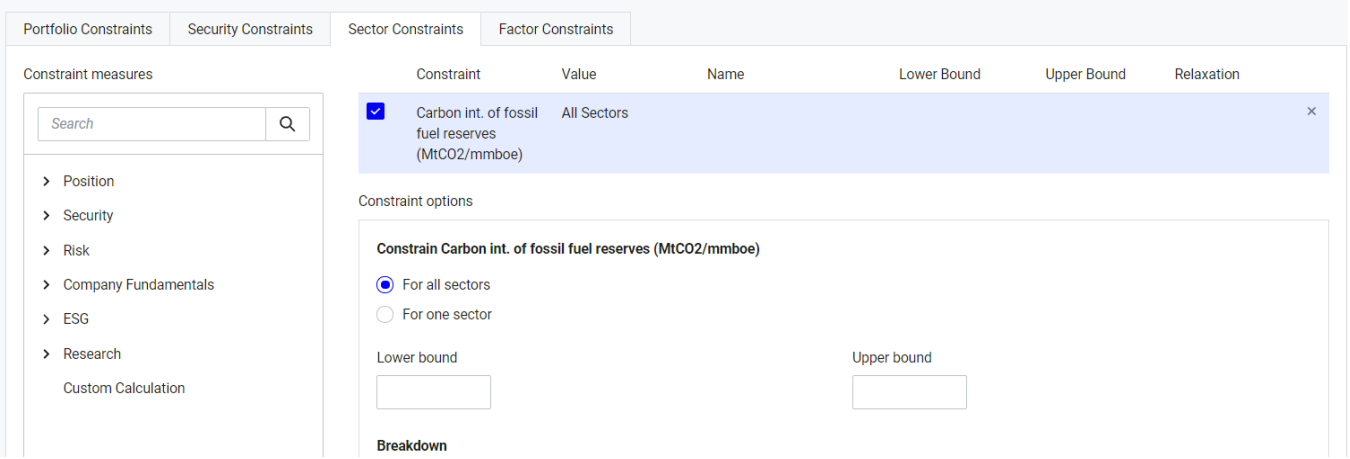
ESG as constraints

PfC Optimization Module – Factor Bounds Tab



To set ESG metrics as constraints in PfC, navigate to the 'Field Type' column and scroll to the '...' option in the dropdown window to launch the DHV column chooser. Here, users can search for the ESG metric of their choice. The constraint can either be set at the overall portfolio level, or on a specific sector level. Using a combination of 'Asset Selection' and 'All Assets' sets this constraint on the portfolio level, while setting it on a specific sector involves choosing the relevant sector view and sector name in the 'Category' and 'Factor Name' columns respectively.

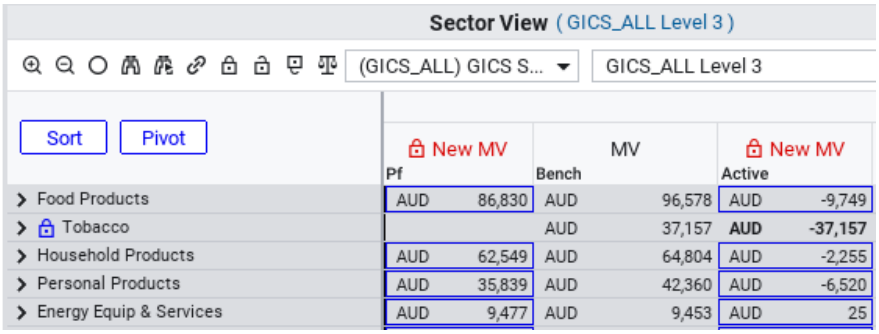
Explore Optimization Module – Constraints Tab



To add an ESG constraint in Explore, users can choose the ESG metric of their choice in the constraint measures chooser on the left. Double-clicking on the metric adds it as a constraint to the main panel on the right. Users can choose to apply it to all sectors (to set it at the portfolio level), or for just one sector. The sector universe can be defined in the 'Breakdown' section further down the right panel.

Trade restrictions in certain securities or sectors

In some scenarios, portfolio managers would like to restrict trading securities or sectors like Tobacco which are considered controversial. This can be easily done in PfC by locking the sector before running the optimization, or setting a factor bound with 0% exposure as the absolute upper and lower bounds. The same bounds can be set in Explore to achieve the same effect.



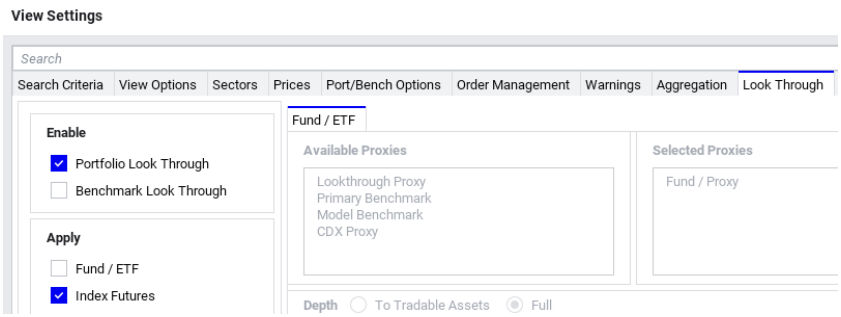
Futures Replication of Benchmark

Futures can be a cost-efficient way to replicate a benchmark's risk and exposures. Users can choose not to trade the physical assets in their portfolio and have the optimizer use only orders on futures to adjust for risk or exposure deviations from the benchmark. Alternatively, they can also use optimization to create a synthetic portfolio that uses only futures to replicate the benchmark.

Expert Tip: Optimization on Aladdin requires equity securities to have exposure to the BFRE factor model. Index futures will only have exposures to the STORM model and as a result will have their risk ignored in the optimization if clients do not have constituent access to the underlying index. Users can reach out to the Aladdin support team to set up risk proxies for these futures, proxying the risk to a similar portfolio or index which will have exposures to BFRE factors.

<u>Required configurations in PfC</u>

Users can instruct the optimizer to only raise orders on futures by locking all other assets in their portfolio before running optimization. Please refer to above section on "Restricting optimization's trading universe" for more information. When optimizing with futures, users can enable lookthrough in PfC to decompose an index future's exposure into its underlying assets. The assets can then be bucketed in their respective sectors and optimization constraints on these securities / sectors will be respected (i.e. when proposing orders on the futures, the optimizer will adjust the order size accordingly such that the change in the future's underlying exposures will not violate these sector constraints).



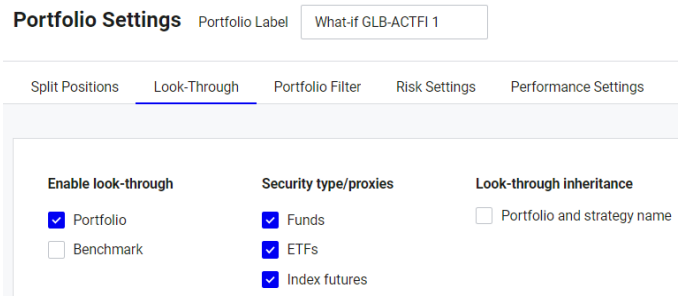
Please note that PfC currently does not support futures optimization with budget constraints. As there is no cash impact when buying or selling futures, any budget indicated in the optimization process will be irrelevant since that budget field measures the change to the base currency cash in the fund. Specifying the total exposures of futures to be bought or sold in an optimization will require the use of a notional budget constraint which is not available in PfC yet.

Other settings to note when optimizing with futures in PfC includes:

- **Case Include Notional Prices**: Set to Yes. This is required for the optimizer to recognize the notional exposures from futures
- **Maximum Long Position**: Set to a value >100%. By default, the max long position allowed for the optimized fund is 100%. With futures (or derivatives in general), total %Exp can become >100% since overall exposure is more than NAV which is used as the denominator when calculating %Exp.

Required configurations in Explore

Users can instruct the optimizer to only raise orders on futures by adding all other assets in their portfolio into the Do Not Trade list. Please refer to above section on "Restricting optimization's trading universe" for more information. Similar to PfC, when lookthrough on index futures is enabled in Explore, the exposures from underlying assets will be taken into account when the optimizer evaluates security/sector constraints.



Spending a notional budget

In Explore, users can define a notional budget that targets the notional market value of the fund. This constraint can be set up in the Portfolio Constraints section, and enables users to specify the total exposures of futures that should be raised in an optimization – a helpful feature for use cases like:

- Creating/seeding a synthetic portfolio
- Optimally equitizing cash balances in the fund

As an example, the case below starts from an empty portfolio and replicates the benchmark with a set of futures. When the Notional Budget bounds are both set to 100%, we would expect the portfolio to be fully invested and 100% of the notional budget to be spent. Under this fully invested scenario users would see a Notional Market Value % of 200% and a Market Value of 100%.

Edit

Constraint	Value	Unit	Lower Bound	Upper Bound	Relaxation
Allow Short Positions	No				false
Notional Budget		PERCENTAGE	100	100	false

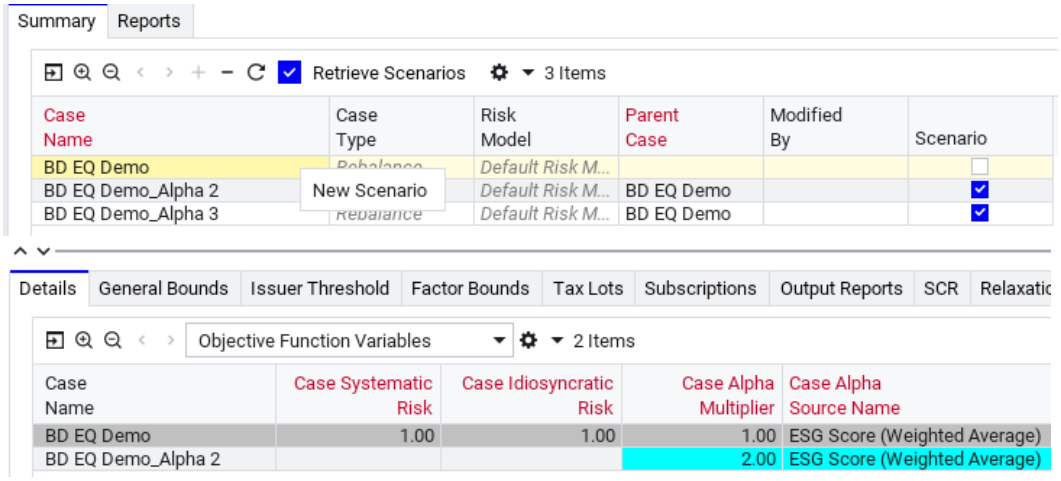
		Notional Market Value %	
Security Description	CUSIP	CASH ONLY	Replication with Futures
Compare		100.0%	200.0%
CASH		100.0%	100.0%
NO_BENCH SECURITY	BRS0VYSN1	100.0%	100.0%
USD CASH(Committed)	USD_CCASH		0.0%
FUTURE			100.0%
EMINI ENERGY SELECT SECT...	IXPU12027		1.6%
EMINI FINANCIAL SELECT SE...	IXAU12023		17.2%
NASDAQ 100 E-MINI SEP 21	NQU120217		54.4%
S&P MID 400 EMINI SEP 21	FAU120211		26.8%

Efficient Frontier Analysis

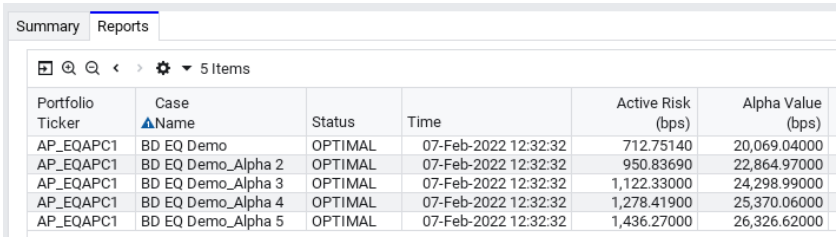
The efficient frontier is made up of optimal portfolios that offer the highest expected return for various levels of risk or the lowest risk for given levels of expected return. Portfolios below the efficient frontier are sub-optimal because they earn insufficient return for the level of risk. In Aladdin Optimization, we extend the efficient frontier analysis to calculate the highest achievable alpha for defined levels of risk, where the definition of alpha can be flexibly defined by the user.

Required configurations in PfC

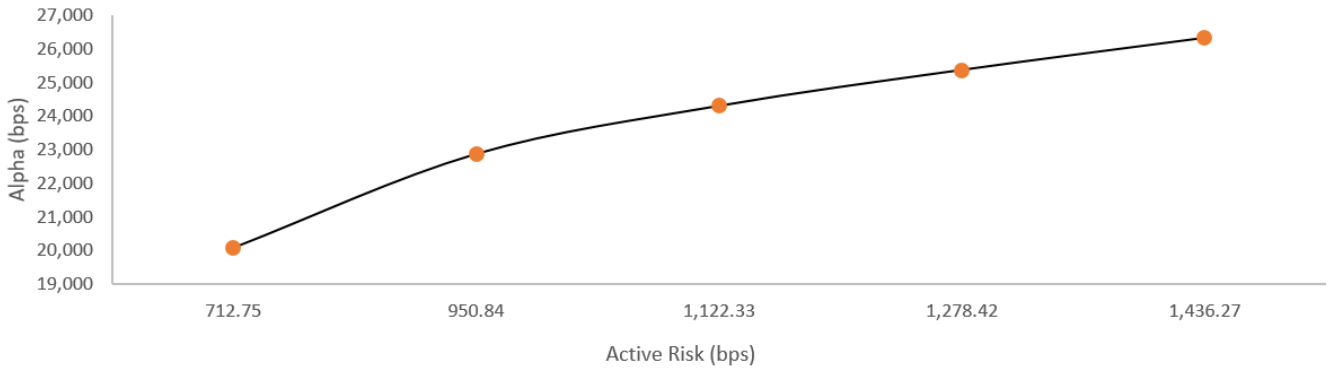
Users can leverage the Scenario Analysis feature in PfC to conduct an efficient frontier analysis. Scenario analysis is a feature that allows users to create multiple iterations of an existing base case, tweaking various parameters in each iteration. All the iterations can then be run simultaneously, allowing users to easily compare changes in optimization results due to the tweaked parameters. In the below example, multiple versions of the original case "BD EQ Demo" is created, where each version has a different alpha multiplier. Running this set of iterations then allows the user to see how the optimization result changes as more and more emphasis is placed on maximizing ESG scores.



Note that the scenario analysis feature allows users to change any parameter in the scenarios, so this frontier analysis can be extended to any two parameters beyond risk and alpha.

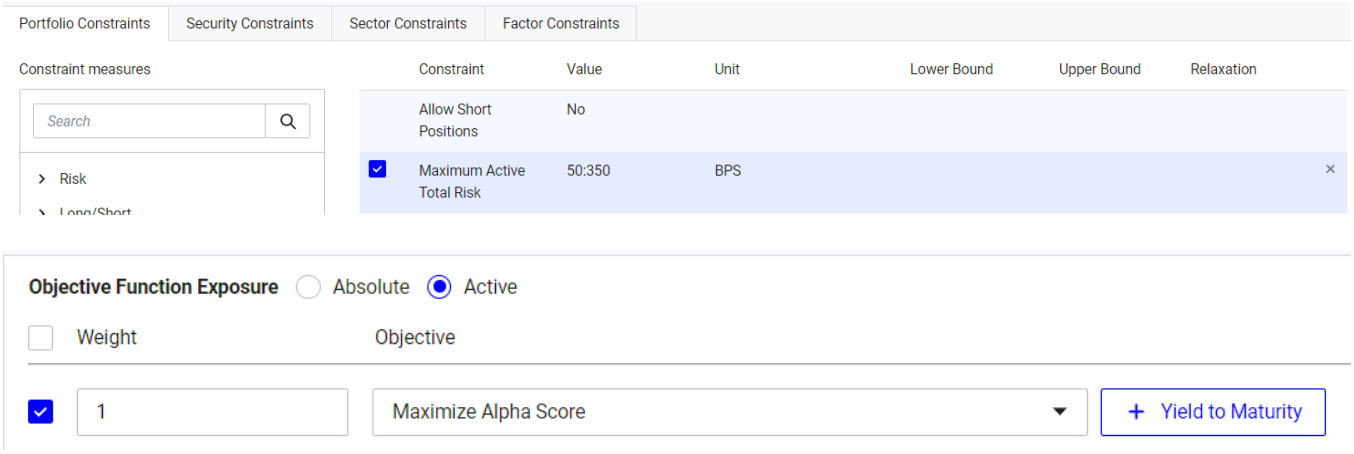


For Your Info: Although PfC currently does not support visualizations within the tool, users can export the results summary from the optimization module and plot a chart in Excel showing how portfolio risk changes as alpha (portfolio ESG score) increases.



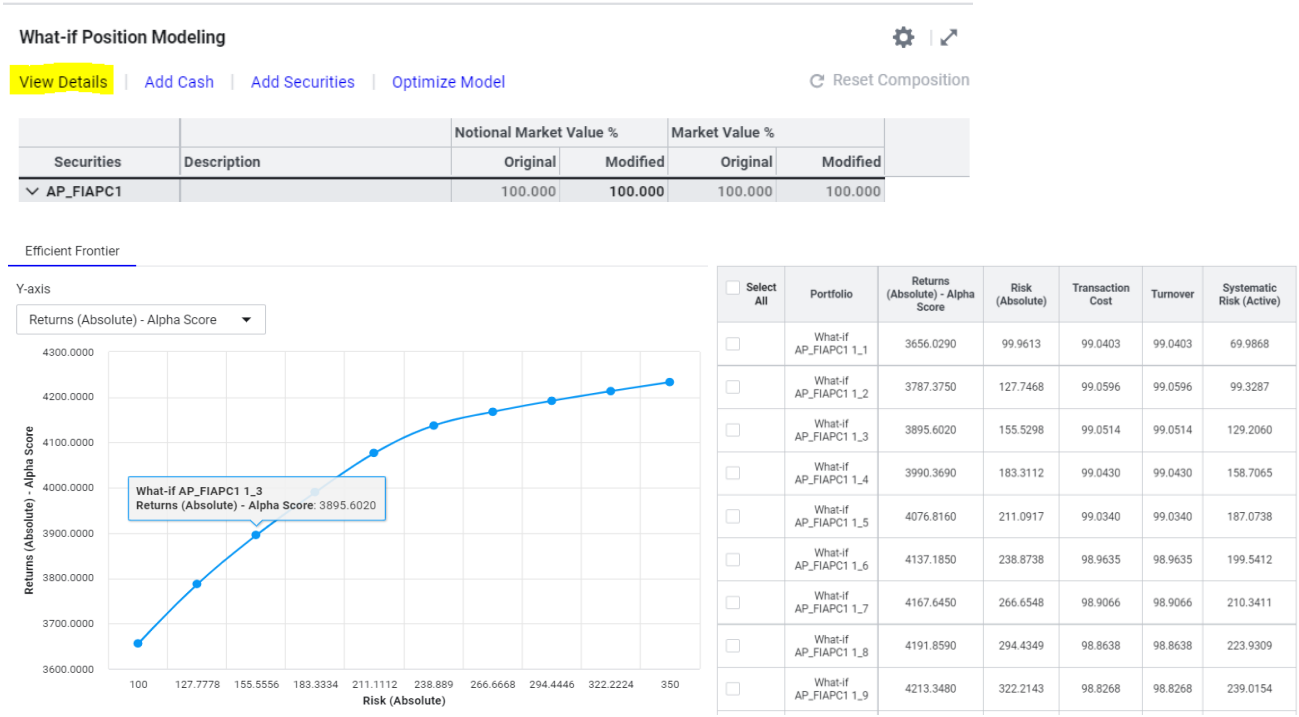
Required configurations in Explore

The efficient frontier in Explore allows users to set a range for the portfolio's Max Total Risk which the optimizer must solve for based on the additional objectives defined within the optimization problem. In the below example, we are analyzing the trade-off between yield and tracking error, for a tracking error range between 50 to 350bps.



By default, the analysis will create ten iterations on the frontier, which means ten optimization problems are solved for to find the efficient portfolios. Users can change the default setting in 'Optimization Settings' where the Frontier Iterations option will be made available after the Maximum Active Total Risk constraint has been added to the optimization parameters. The minimum number of iterations is 2 and maximum is 20.

Post optimization, users can find the summary of the optimization results in the 'View Details' section, together with the efficient frontier chart. The result of each iteration will be saved as a 'What-if Portfolio' for users to do further analysis in Explore.



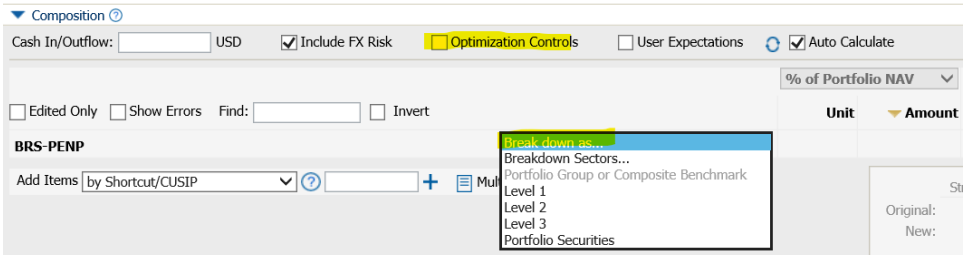
Asset Allocation

Asset Allocators or Multi-Asset fund managers can determine their strategic asset allocation by using optimization to derive optimal weights for asset classes or sectors in their portfolios. They can do this top-down allocation process through mean-variance optimization where users upload their own return expectations or utilize P&L from stress scenarios as part of the optimization objective. Alternatively, they can leverage the Black-Litterman method to optimize using market equilibrium returns and user expectations.

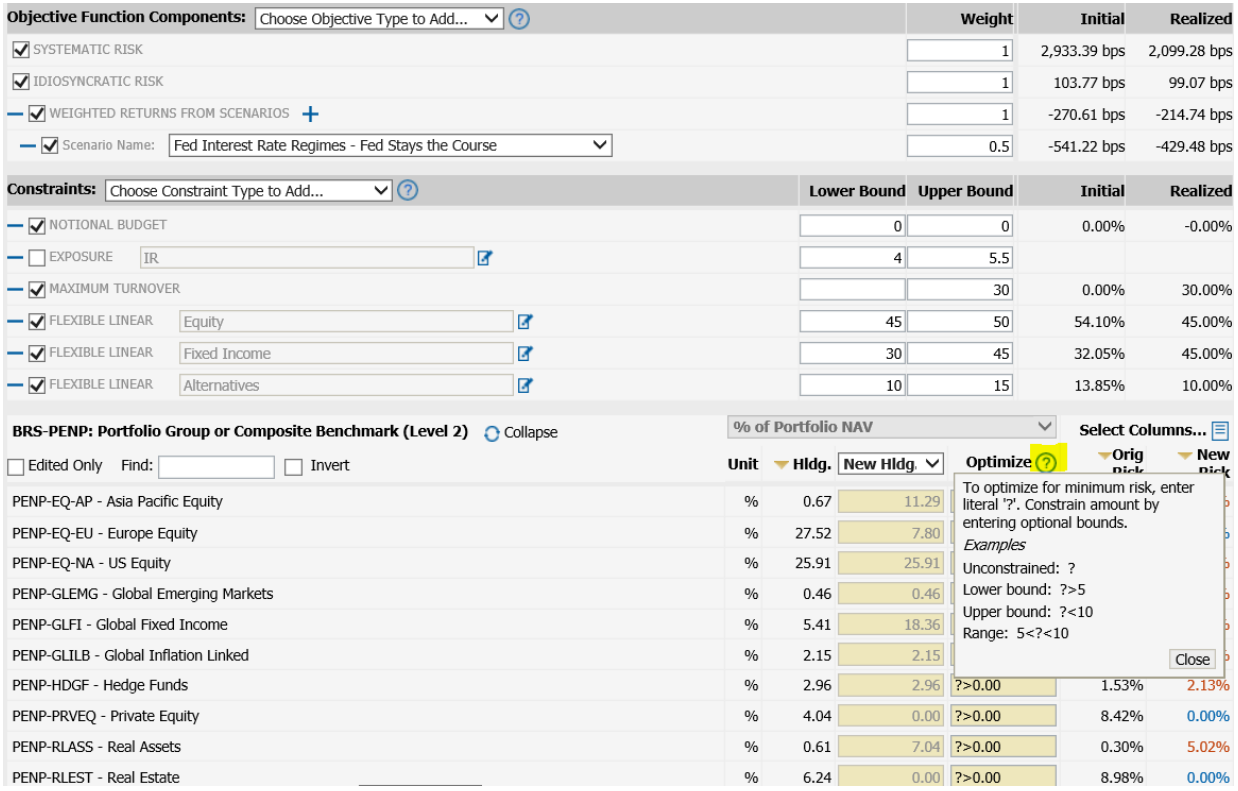
Mean-Variance Optimization

Users can leverage PRT to conduct Mean-Variance Optimization (MVO) at the asset class or sector level. PRT provides the ability to aggregate portfolio exposures by a user-defined breakdown, then treating each sector in the breakdown as a single asset during the optimization process. This is aligned to the top-down approach adopted by asset allocators, where we solve for asset classes or sectors rather than individual securities. This means that the result of the optimization problem is going to be the asset class or sector allocation.

Once a portfolio has been loaded in the tool, users would be able to view their portfolio securities and set constraints accordingly. If users would like to group securities into sectors for optimization (e.g. group them by asset class), they should first navigate to the Composition panel and select a breakdown in the 'Break down as...' dropdown, before enabling 'Optimization Controls' to expose the optimization related fields.



Users can define their objective function and constraints, then optimize by filling in appropriate values in the 'Optimize' field as directed. The new asset class allocations will populate in the 'New Hldg' columns.



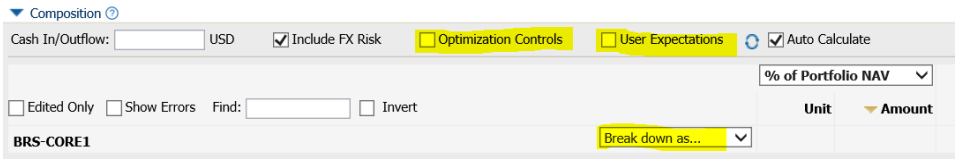
The asset class constraints in the above screenshot are 'Flexible Linear' constraints. This allows users to set allocation bounds in a particular asset class or a group of asset classes. For example, if the user wants to specify a max allocation to equities, flexible linear allows combining different assets to limit their holding.

Note that this is different from the MVO available in PfC and Explore where even though security exposures are aggregated at the sector level, optimization runs at a single-security level. However, in PRT optimization runs at an asset-class level and the result of the problem is asset class allocations. PfC and Explore users typically conduct asset allocation optimization on a model portfolio, where each asset class is represented / proxied by a single asset (e.g. SNP500 ETF to proxy US Equities), and the final weight of that asset post optimization will represent the optimal weight of the corresponding asset class in the actual portfolio. These model portfolios are then frequently used as the benchmark for actual portfolios.

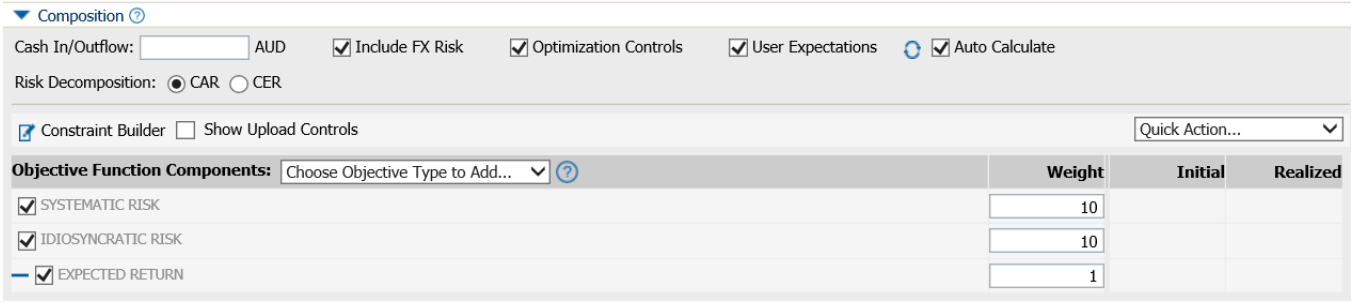
Black-Litterman Optimization

The Black-Litterman method, also known as reverse optimization, derives returns from combined market equilibrium implied returns and user expected returns. This framework makes the optimization analysis more tailored to personal investment beliefs and styles without having to specify return assumptions for every asset in the investment universe. It also helps to overcome the commonly observed problems of plain mean-variance optimization such as input-sensitivity and unintuitive or concentrated optimal portfolios.

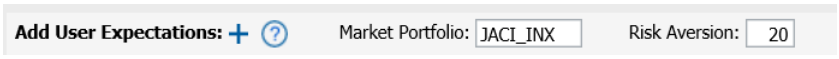
Black-Litterman optimization is currently only available in the PRT application. To run this in PRT, users will first have to load a portfolio then enable 'Optimization Controls' and 'User Expectations'. They can also choose to assign a breakdown to group their securities via the 'Break down as…' dropdown.



Users also need to add Expected Return as one of the objectives of the optimization. "Expected return" objective term is only used to solve for Black Litterman optimization problems.



Users can subsequently define the market portfolio and risk version in the User Expectations section. By specifying a **market portfolio**, one assumes that the asset allocation in this market portfolio is efficient – the market is in equilibrium and hence the weights in the portfolio are optimal. The market implied PnL is then derived from the asset weights in the market portfolio[4]. **Risk aversion** is a concept derived from the utility theory that investors demand return compensation for every additional unit of risk. A more risk averse investor will have a higher risk aversion factor as they demand more returns for every unit of additional risk. When setting the risk aversion factor, users should review the weights of systematic and idiosyncratic risk in the objective function as well. Typically, these are set to half of the risk aversion factor.



[4] To learn more about how market implied PnL is derived, please refer to the PRT Optimization guide.

Expert tip: Why should we set weights of systematic and idiosyncratic risks to half of the risk aversion factor?

From the objective function:

$$w^{sys} \times \sigma_{sys}^2 + w^{idio} \times \sigma_{idio}^2 - 1000 \times w^{ret} \times exp.return = 0$$

We assume w^{ret} to be 1. In addition, 1000 * w^{ret} is done to adjust return to the proper units of the optimization equation. To simplify the return portion, we assume $1000 \times w^{ret} \times exp.return = exp.return^*$. We also assume $w^{sys} = w^{idio}$. Therefore,

$$w^{risk} \times \left(\sigma_{sys}^2 + \sigma_{idio}^2\right) - exp.return^* = 0$$

By Utility theory, $return = 0.5 \times risk\ aversion \times \sigma^2$. Hence,

$$w^{risk} \times (VaR)^2 = 0.5 \times risk\ aversion \times \sigma^2$$

$$w^{risk} = 0.5 \times risk\ aversion$$

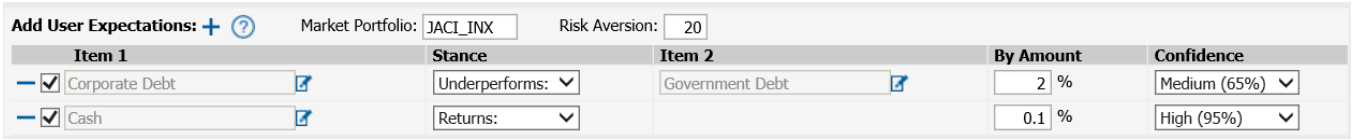
$$\frac{w^{risk}}{risk\ aversion} = 0.5$$

Note: Utility Theory is an economic theory defined by public research, users can read up more about this on their own accord to better understand its significance.

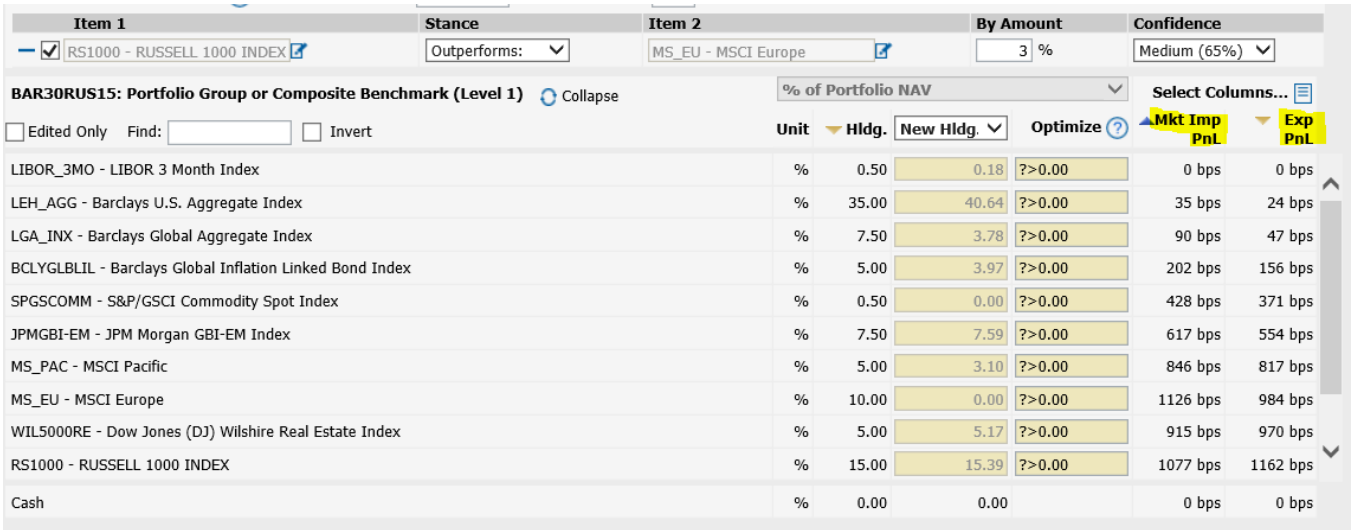
On top of specifying the market portfolio, users can also layer on their own relative and absolute performance assumptions for assets

- **Relative**: Take a stance on whether one asset will underperform, outperform or match performance of another asset.
- **Absolute**: Users input the exact % an asset will return

Users can also specify the confidence level for their return expectations, which dictates how much the user expected return is leveraged in the optimization. There are 4 choices available: low (35%), medium (65%), high (95%) and certain (100%). Confidence level dictates how much the user expected return is leveraged in the optimization. The higher the confidence, the more the optimization leverages user expected return.



When running the optimizer with the Black Litterman method, we recommend changing the columns from the default Original Risk and New Risk columns to Market Implied PnL and Expected PnL columns. This allows users to see the full impact from return expectations they have layered on. Mkt Imp PnL is calculated by only Market portfolio. Exp PnL is calculated by layering user expectation on returns from Mkt Imp PnL.



DOCUMENT HISTORY

Date	Version	Updates
March 2022	1.0	Creation of the Optimization Use Case Guide

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