

Opturo®

Investment Analytics:

**Performance &
Attribution**

Report Documentation

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Chapter 1

Executive Summary Sheet

In this section, we will carefully analyze the first sheet of Opturo's Performance and Attribution report Excel spreadsheet, called **Executive Summary**. This sheet contains basic information on fund-level, market-level, and benchmark-level returns. We will cover the meaning of every cell, and discuss the calculations involved to arrive at each number.

We first begin with the header of the Executive Summary, which looks like this:

Opturo - Performance Attribution Report

Fund: US Equity
Benchmark: Russell 1000
Market: S&P 500
Reporting Currency: US DOLLARS
Valuation Period: 03-Jan-2011 - 30-Jun-2011

Most of these items are self-explanatory, but let us briefly discuss their meanings.

The first three rows list the Fund name, Benchmark name and Market name. The Fund can be one fund, or a combination of many funds (also called a fund of funds). The Benchmark is a predefined benchmark against which the fund's returns, decisions and risk characteristics will be evaluated. In terms of input data, the Benchmark must be defined in terms of individual securities and their weights. The Benchmark data is used for many performance and attribution calculations, such as Correlation, Tracking Error, Active Return and decision evaluation. The Market is often the reference market from which the fund draws its holdings, but it can be any reference point (in this example, the S&P 500). Often one chooses the Benchmark for the Market, but they need not be the same. The input data for Market calculations are also usually given at the security level. The Market data is used for calculations such as Beta.

Below the Market row is the Reporting Currency, which is the common currency in which the values (such as total Fund value, security-level values, etc.) are reported. If your fund holds securities denominated in different currencies, part of the input data into VIA

must be the FX conversion rates to convert the various currencies into the single reporting currency. In this example, all results are reported in US Dollars.

The last row in the first section is the Valuation Period over which the report spans. In this example, the valuation period begins on January 3, 2011 and ends on June 30, 2011 (in fact, all weekdays between January 1 and June 30). All ensuing return numbers will reflect holdings and trades made between the beginning of the day on January 3, 2011 and the end of the day on June 30, 2011.

Before we cover the next section of the Executive Summary page, the Return Summary, we will first cover some terminological conventions that will be used throughout this documentation.

1.1 Terminology Conventions

To avoid confusion, we mention here some wording usages that will be used consistently throughout this documentation.

Temporal Terminology. Opturo's software has complete flexibility with regards to the time over which a report can be run. For example, the user can run a 2-year report where the first year consists of weekly data and the second year consists of daily data. Because of this flexibility, we must be precise about terminology for the "atomic" periods of time used in each report.

- A **period** refers to a single atomic length of time during the selected time-frame for a report. For example, for a report that uses daily data, a period refers to a single day. For a 2-year report where the first year consists of weekly data and the second year consists of daily data, a period refers to either a week during the first half of the time-frame or a day during the second half.
- A **valuation period** refers to the entire time-frame of the report. Thus, the valuation period is made up of one or several individual periods.

Segmentation Terminology. Each security held in a portfolio can have associated to it in the data one or more segmentation characteristics. For example, these can be a security's region, sector or industry, market capitalization for equities, bond ratings for fixed income instruments, etc. We will use the following terminology when discussing segmentation data.

- A **market category** (or simply **category**) will refer to a fixed set of characteristics that is chosen as part of the decision tree. For example, the term category can refer to "Region" or "Market Capitalization" or "S&P Rating".

- A **segment** (or **sleeve**) will refer to an element of a category. For example, the segments in the category Region might be “North America”, “Asia”, etc.; the segments of “Industry” might be “Specialty Retail”, “Biotechnology”, etc.
- We may also use the terms **subcategory** and **subsegment** illustrated as follows: “GICS Industry” is a subcategory of the category “GICS Sector” and “Insurance” is a subsegment of the segment “Financials”. In particular, a subcategory is itself a category and a subsegment is itself a segment.

To summarize:

- The **valuation period** is made up of one or more **periods**.
- A **category** is made up of one or more **segments**.

1.2 Return Summary

Return Summary			
Statistic	Fund	Benchmark	Active
Cumulative Return	5.82 %	6.37 %	(0.55)%
Cumulative Transaction Cost	(0.05)%		
Cumulative VAMI	\$1,058	\$1,063	(\$5)
Worst 20 Days	(6.43)%	(5.75)%	(1.38)%
Best 20 Days	5.21 %	5.15 %	1.35 %
Worst Day	(2.46)%	(2.26)%	(0.79)%
Best Day	2.11 %	1.75 %	0.92 %
Valley	(0.71)%	0.57 %	(2.37)%
Peak	7.77 %	9.44 %	(0.03)%
Batting Average	51.94 %	56.59 %	48.84 %

Under the heading Return Summary, we see four columns. In the first column, labeled Statistic, are a series of performance measurements pertaining to the return of the fund during the selected valuation period.

The next two columns, labeled Fund and Benchmark give the results of each of the statistics applied to the Fund and Benchmark, respectively. For most statistics, the Active column gives the arithmetic difference between the corresponding Fund and Benchmark statistics. In a sense this captures the differences attributable to an actively traded fund, as the Active column will be all zeros if a Fund is also set as the Benchmark.

We now describe each row precisely and how the corresponding calculation is performed.

Cumulative Return For the Fund and Benchmark columns, Cumulative Return gives the compounded [daily return](#) over the entire valuation period. The precise calculation is as follows.

- n is number of periods in the valuation period
- R_i is the trade-inclusive return during period i (of either the [Fund](#) or [Benchmark](#))

$$\begin{aligned}\text{Cumulative Return} &= \prod_{i=1}^n (1 + R_i) - 1 \\ &= (1 + R_1)(1 + R_2) \cdots (1 + R_n) - 1.\end{aligned}$$

For the Active column, the Cumulative Return is simply

$$\text{Active Return} = \text{Fund Return} - \text{Benchmark Return}.$$

Return Over a Sub-period Returns for a single period are discussed in the [Daily \(or Period\) Sheet](#), and the [cumulative return](#) for the entire valuation period was discussed above. It does not appear in the report, but it will also be useful to have the notion of cumulative return from the k^{th} period to the l^{th} period during the valuation period. We will denote this by $\mathbf{R}_{[k:l]}$. This is calculated as follows.

- n is the number of periods during the valuation period
- R_i is the return for period i (of the [Fund](#), [Benchmark](#) or [Active](#))
- k and l are integers between 1 and n with $k \leq l$

$$\begin{aligned}\mathbf{R}_{[k:l]} &= \prod_{i=k}^l (1 + R_i) - 1 \\ &= (1 + R_k)(1 + R_{k+1}) \cdots (1 + R_l) - 1.\end{aligned}$$

Note that $\mathbf{R}_{[1:n]}$ is the [cumulative return](#) over the valuation period and $\mathbf{R}_{[k:k]}$ is the [return](#) for period k . It is also convenient at times to define $\mathbf{R}_{[1:0]} = 0$.

Annualized Return For the Fund and Benchmark columns, Annualized Return gives the return if the [cumulative return](#) were compounded over a full year. It is an optional setting in VIA to show this calculation, and it does not show up in our demo. The calculation is as follows.

- n is number of periods in the valuation period

- R is the **cumulative return** (of either the Fund or Benchmark)
- c is the length of the valuation period in years (e.g., if the valuation period is 3 months, $c = 1/4$)

$$\text{Annualized Return} = (1 + R)^{1/c} - 1.$$

For the Active column, the Cumulative Return is

$$\text{Annualized Active Return} = \frac{1}{c}(\text{Cumulative Active Return}).$$

Cumulative Transaction Cost. Since benchmarks are assumed not to have transaction costs, the Benchmark and Active columns are left blank in this row. Intuitively, the Transaction Cost calculates the difference between the return of the Fund if it had no transaction costs compared to the actual return of the fund. This difference is computed on a period-by-period basis, and then summed over the entire valuation period. Precisely, the calculation is as follows.

- n is the number of periods
- T_i is the **net transaction contribution** of the fund on period i

$$\text{Transaction Cost} = \sum_{i=1}^n T_i = T_1 + \cdots + T_n$$

Cumulative VAMI. The term VAMI is an acronym for Value Added Monthly Index. It is the return on a hypothetical \$1,000 invested at the beginning of the valuation period. For the Fund or Benchmark, it is calculated as follows:

$$\text{VAMI} = 1000(1 + R),$$

where R is the **cumulative return** over the valuation period (for either the **Fund** or **Benchmark**). The Active column gives the difference between the Fund and Benchmark columns.

Worst 20 Days (or Months). This calculation is performed using the worst 20 consecutive periods over of the valuation period. The number of consecutive periods used can be adjusted to the user's preferences. Note also that this calculation does not apply if using custom period lengths. It is the compounded return over the worst 20 consecutive period stretch during the valuation period for the Fund, Benchmark and Active daily returns. Note that the 20 periods used will in general be different for the Fund, Benchmark and Active columns. The calculation is the following.

- W_1, \dots, W_{20} are the returns during the worst consecutive 20 period stretch during the valuation period (of the [Fund](#), [Benchmark](#) or [Active](#))

$$\text{Worst 20 Days} = \prod_{i=1}^{20} (1 + W_i) = (1 + W_1) \cdots (1 + W_{20}) - 1$$

To put this more rigorously, we have the following formula.

- n is number of periods in the valuation period
- $\mathbf{R}_{[k:k+19]}$ is the [cumulative return](#) from period k to period $k + 19$ (of the [Fund](#), [Benchmark](#) or [Active](#))

$$\text{Worst 20 Days} = \min_{k=1, \dots, n-19} \{ \mathbf{R}_{[k:k+19]} \}$$

Best 20 Days (or Months). This calculation is almost identical to the [Worst 20 Days \(or Months\)](#) calculation, except it is the compounded return over the best 20 periods. Note also that this calculation does not apply if using custom period lengths. The calculation is the following.

- B_1, \dots, B_{20} are the returns during the best consecutive 20 period stretch during the valuation period (of the [Fund](#), [Benchmark](#) or [Active](#))

$$\text{Best 20 Days (or Months)} = \prod_{i=1}^{20} (1 + B_i) = (1 + B_1) \cdots (1 + B_{20}) - 1$$

To put this more rigorously, we have the following formula.

- n is number of periods in the valuation period
- $\mathbf{R}_{[k:k+19]}$ is the [cumulative return](#) from period k to period $k + 19$ (of either [Fund](#), [Benchmark](#) or [Active](#))

$$\text{Best 20 Days (or Months)} = \max_{k=1, \dots, n-19} \{ \mathbf{R}_{[k:k+19]} \}$$

Worst Day (or Month). This simply returns the worst single-period return during the valuation period. Note that this calculation does not apply if using custom period lengths.

- n is the number of periods during the valuation period
- R_i is the [fund](#), [benchmark](#), or [active](#) return on period i

$$\text{Worst Day (or Month)} = \min \{R_1, \dots, R_n\}.$$

Best Day (or Month). This simply returns the best single-period return during the valuation period. Note that this calculation does not apply if using custom period lengths.

- n is the number of periods during the valuation period
- R_i is the [fund](#), [benchmark](#), or [active](#) return on period i

$$\text{Best Day (or Month)} = \max \{R_1, \dots, R_n\}.$$

Valley The valley is the least cumulative return of the portfolio over the valuation period. If looking at a graph of the cumulative return of the fund over the course of the valuation period, the valley would be the lowest point on the graph.

- n is the number of periods during the valuation period
- $\mathbf{R}_{[1:k]}$ is the [cumulative return](#) up to period k (of either the Fund or Benchmark)

$$\text{Valley} = \min_{k=1, \dots, n} \{\mathbf{R}_{[1:k]}\}$$

The Active column gives the difference between the Fund and Benchmark columns.

Peak The peak is the greatest cumulative return of the portfolio over the valuation period. If looking at a graph of the cumulative return of the fund over the course of the valuation period, the peak would be the highest point on the graph.

- n is the number of periods during the valuation period
- $\mathbf{R}_{[1:k]}$ is the [cumulative return](#) up to period k (of either the Fund or Benchmark)

$$\text{Peak} = \max_{k=1, \dots, n} \{\mathbf{R}_{[1:k]}\}$$

The Active column gives the difference between the Fund and Benchmark columns.

Batting Average The values in this row gives the percentage of days in the valuation period that the Fund, Benchmark or Active return was greater than zero. It is calculated as follows.

- n is the number of days in the valuation period
- R_i is the [fund](#), [benchmark](#), or [active](#) return on period i
- $\delta_i = \begin{cases} 0 & \text{if } R_i \leq 0 \\ 1 & \text{if } R_i > 0 \end{cases}$

$$\text{Batting Average} = \frac{\sum_{i=1}^n \delta_i}{n}$$

1.3 Decision Attribution Summary

The purpose of decision attribution is to measure contributions to the active return of a fund attributable to the various decisions made by the fund manager. These decisions include allocation decisions like how to distribute portfolio weights across sectors, country of origin, etc., as well as trade decisions (whether and when to buy/sell securities). This section of the performance report explains the active portfolio-level return in terms of these decisions.

When running both Return Attribution and Value Attribution, there are two columns in the Decision Attribution Summary section of the Executive Summary sheet, labeled Active Gain and Active Return. When choosing Geometric Attribution, the Active Return column is bifurcated into Geometric and Arithmetic. The Active Gain column measures the decisions' contributions to the active gain of the fund. The Arithmetic column measures the arithmetic impact of each of the decisions on the arithmetic difference between the fund return and benchmark return. Thus, they sum up to give the arithmetic active return. The Geometric column measures the geometric impact of each of the decisions on the geometric difference between the fund return and benchmark return. Thus, they compound to give the geometric active return.

Decision Attribution Summary		
Attribution Effect	Active Gain	Active Return
Cumulative Effect	(2,719,420)	(0.55)%
--Invest Effect	(154,579)	(0.03)%
--GICS Sector Allocation Effect	(671,240)	(0.11)%
--GICS Industry Allocation Effect	(9,493,394)	(1.56)%
--Issue Selection Effect	10,706,108	1.68 %
--Trade Effect	(3,106,317)	(0.52)%

Cumulative Effect The Cumulative Effect row gives the total effect of active decisions made in the construction of the fund compared to the benchmark. The entry in the (Arithmetic) Active Return column is the same as the Active column of **Cumulative Return** (i.e. total fund return minus total benchmark return). The entries in this row are the sum (or, for Geometric, the compounding) of the entries in the other rows in the decision attribution summary. Also, the entry in the Active Gain column evaluates the effect of each decision on the active gain of the fund over the benchmark. Mathematically, it is the sum of the entries for **total value effects** of every security that appears either in the fund or in the benchmark. Similarly, the entry in the Active Return column is the sum of the entries for **total effects** of every security that appears either in the fund or in the benchmark.

Invest Effect The Invest Effect captures the impact on the Active fund return due to the decision to remain invested from each period to the next. For example, suppose a fund returns 5% in the first half of the year while its benchmark has a 0% return. In the second half of the year, the fund exactly mimics the benchmark and both return 5%. Thus, in the first half of the year, the active return is 5% and in the second half it is 0%. Nonetheless, the fund's active return over the full year is then 5.25%. Those extra 25 basis points are attributable to the decision to remain invested into second half of the year. The entry in the Active Gain column evaluates the effect of this decision on the active gain of the fund over the benchmark. Mathematically, it is the sum of the entries for the **invest value effects** of every security that appears either in the fund or in the benchmark. Similarly, the entry in the Active Return column is the sum of the entries for the **invest effects** of every security that appears either in the fund or in the benchmark.

Allocation Effect(s) In performance and attribution reports there may appear one or more categories for which the active effects are measured. The user can choose which categories appear in the report. In our example, we have chosen the GICS Sector and GICS Industry for our securities. Furthermore, the order matters. Here, we have first chosen how to distribute fund-level weights among sectors (the first allocation decision), then, within each sector, we made a decision as to how to allocate that sector weight among industries. The values in the first of these rows measures how the fund's active return was affected by how the fund's weighting among GICS sectors differed from their weighting in the benchmark.

Issue Selection Effect The Selection Effect is the impact on active return resulting from the choices of security-level **active begin weights** for each period during the valuation period. In some sense, this is the bottom-level allocation decision since it evaluates the impact of how the weight within the last allocation grouping is distributed to its issues.

The entry in the Active Gain column is the sum of the entries for **issue selection value**

effects of every security that appears either in the fund or in the benchmark. Similarly, the entry in the (Arithmetic) Active Return column is the sum of entries for **issue selection effects** of every security that appears either in the fund or in the benchmark.

Trade Effect The Trade Effect is the impact on cumulative active return resulting from trading decisions. The entry in the Active Gain column is the sum of the entries for **trade value effects** of every security that appears either in the fund or in the benchmark. Similarly, the entry in the (Arithmetic) Active Return column is the sum of the entries for **trade effects** of every security that appears either in the fund or in the benchmark.

1.4 Decision Attribution with Currency Effect

Using Opturo's Investment Analytics software, there are two methods provided to understand the effect of FX rates on a fund's active return. These are Currency-Country Investable and Currency Effect Decomposition. We now discuss those two options.

Decision Attribution Summary		
Attribution Effect	Active Gain	Active Return
Cumulative Effect	18,169,707	1.81 %
--Invest Effect	(8,001)	0.00 %
--Country Allocation Effect	1,512,009	0.16 %
--Currency Effect	(807,055)	(0.05)%
--Issue Selection Effect	16,262,292	1.58 %
--Trade Effect	1,210,462	0.12 %

Country-Currency Investable. One method of understanding the effect of currency on active returns is using the Country-Currency Investable option in VIA. Above is a sample of the Decision Attribution Summary with this option selected. Here, we see a Country Allocation Effect and a Currency Effect (along with the usual Invest Effect, Issue Selection Effect and Trade Effect). The idea is to separate the effect on the active returns generated by the country allocation decision from the effect on the active returns generated by the FX returns inherent in investing in foreign securities. This calculation is based on the Karnosky-Singer model.

Decision Attribution Summary		
Attribution Effect	Active Gain	Active Return
Cumulative Effect	(187,354,646)	(3.70)%
--Invest Local Effect	(744,427)	(0.01)%
--Region Allocation Local Effect	(171,476,702)	(3.38)%
--GICS Sector Allocation Local Effect	47,262,083	0.93 %
--Issue Selection Local Effect	(48,197,149)	(0.94)%
--Trade Local Effect	(231,978)	(0.00)%
--Currency Effect	(13,966,473)	(0.28)%

Currency Effect Decomposition. When the Currency Effect Decomposition option is chosen, one might get a Decision Attribution Summary as in the sample above. The feature decomposes the active return into a component that assumes that all FX returns are zero, which then gets analyzed as a standard active return, and a FX component.

1.5 Fixed Income Attribution

In Decision Attribution, the starting point is the observation that the portfolio manager's controllable decisions, which result in choosing weights differently than the corresponding weights of the benchmark, are what causes a nonzero active return in the presence of the market's evolution. For Fixed Income Attribution, the starting point is the observation that a market return of an instrument weighted by the fund can be decomposed into conceptually distinct sources of P&L. Thus, for a fixed-income portfolio, differences in returns can be decomposed into uncontrollable market effects such as coupon values, spread values to or changes in yield curves, etc.

From this point of view, we can perform a fixed income attribution using a decomposition to explain the cumulative return or gain of the fund or its active value over the valuation period. Below is the corresponding section in a sample report decomposing the return of a fund.

Fixed Income Return Decomposition Summary	
Return Components	Return Value
Fund Cumulative Return	0.08 %
--Currency Component	0.02 %
--Country Component	0.03 %
--Yield Component	(0.07)%
--Shift Component	0.04 %
--Twist Component	(0.00)%
--Bend Component	0.02 %
--Spread Component	0.10 %
--Finance Component	0.01 %
--Selection Component	(0.00)%
--Trade Component	(0.03)%
--Hedge Component	(0.02)%

In this sample report, there is a **total return** of 0.08%, which is labeled on the first row as Fund Cumulative Return. The return is then attributed to the listed market components. For example, the Yield Component gives the contribution to Fund Cumulative Return attributable to the position of the holdings in the fund on the opening base yield curve and the amount this implies the change in the period's yield curve will change the funds return. Similarly, the Finance Component gives the contribution to the Fund Cumulative Return of the instruments designated as financing instruments.

The system also provides a side option of a permanently set up special case (Case 1) of Fixed Income Return Decomposition that is popular among some users. It decomposes the **total return** of the fund into a specific set of market effects consisting of Yield, Coupon, Spread, Financing, Trade and Hedge. However, in this option each of the user-designated financing and hedging instruments is distributed by a user-designated weighting among the other holdings so that each non-finance, non-hedge instrument (and an 'Other' category) designates a group and each of the market effects, including Finance and Hedge, is evaluated for each such group.

The user also has the option of decomposing the **active return** of the fund relative to a benchmark, instead of the **total return** of the fund. Below is a sample of what might appear on a report in such a Fixed Income Attribution to market effects.

Fixed Income Attribution Summary	
Attribute	Value
Cumulative Return	0.07 %
--Past FI Attribute	0.01 %
--Duration FI Attribute	0.04 %
--Convexity FI Attribute	(0.02)%
--Term Structure FI Attribute	0.01 %
--Finance FI Attribute	(0.01)%
--Selection FI Attribute	0.02 %
--Trade FI Attribute	0.01 %

In this example, the fund has a 0.7% **active return** for the valuation period, which return is then decomposed into various market components. That is, the 0.7% return is the sum of the Attributes from each of the listed components. We can see from this decomposition that the convexity and finance attributes contributed negatively to the **active return** over the valuation period, whereas the Duration had a relatively significant positive impact on the **active return**.

The components from which the decomposition can be constructed are listed below. The choice of attributes as well as the order in which they are chosen will effect the corresponding decomposition. (There are some constraints on the orderings and on what subsets can be chosen together.)

- Past: Provides the component of the fund's active return due to the compounding of each period's benchmark return with that period's past attribution results.
- Currency: Provides the additional component of an instrument's return due to the change in the exchange rates over each period
- Country: Provides the additional component of an instrument's return due to it achieving the average return of the benchmark in the instrument's country.
- Quality: Provides the additional component of the instrument's return due to it achieving the average return of the benchmark in the instrument's quality rating.
- Sector (or other such discrete category properties beyond Country or Quality): Provides the additional component of the instrument's return due to it achieving the average return of the benchmark in the instrument's sector.
- Yield: Provides the additional component of the instrument's return due to its position at the open on the underlying yield curve.
- Coupon: Provides the additional component of the instrument's return due to the portion of the Coupon accrued during the base period being decomposed. This is one version of Roll or Carry.
- Duration: Provides the additional component of the instrument's return due to its duration at the open of each period and the amount that the base yield curve changes during that period. This is another version of Roll or Carry.
- Convexity: Provides the additional component of the instrument's return due to its convexity at the open of each period and the square of the amount that the base yield curve changes during that period.
- Spread: Provides the additional component of the instrument's return due to a provided spread of the instrument.
- Selection: Provides the additional component of the instrument's return due to the idiosyncratic properties of the individual instrument. If it follows the Spread, it provides whatever instrument specificity the spread omits.
- Shift: Provides the additional component of the instrument's return due to a parallel shift in the yield curve during each period.
- Twist: Provides the additional component of the instrument's return due to the amount the yield curve twists during each period.

- Bend: Provides the additional component of the instrument's return due to the amount the yield curve bends during each period.
- Term structure: Provides the additional component of the instrument's return due to the amount that the closing yield curve is different from the last specified curve for each period.
- Finance: Provides the additional component of the instrument's return due to the designated financing employed during each period.
- Trade: Provides the additional component of the instrument's return due to its trading activity within each period. This is the only non-market effect included as an explanatory cause in Fixed Income Decomposition or Fixed Income Attribution.
- Hedge: Provides the additional component of the instrument's return due to the total effects of the designated hedging during each period.

It is noted that components such as Yield, Spread, Selection, Shift, Twist, Bend, Term structure and Trade can make the results of the Fixed Income Decomposition and Fixed Income Attribution that follows them independent from the specifications of components or attributes made before them.

1.6 Factor Attribution Summary

The goal of Factor Attribution is to decompose the active return of a fund into the returns due its exposure to different market factors. For example, if a fund is heavily exposed to oil, and oil has sharply negative return over some period, the fund will probably also have negative return in spite of any active portfolio decisions. When running a report that computes factor attribution, the user uploads additional security-level exposure data to certain chosen market factors as well as the returns of those factors. These exposures are often computed using regression models to determine how the various market factors correlated to the returns of each security.

A sample factor attribution summary looks as follows.

Factor Attribution Summary	
Factor Contribution	Active
Cumulative Contribution	(0.55)%
--Risk	(3.11)%
--Industry	2.39 %
--Asset Selection	0.17 %

In this sample factor attribution summary, we see a list of three rows that decompose the **active cumulative return** into two groups of risk factors as well as asset selection. In general, there will be a row for each risk factor group chosen by the user. The risk factor groups themselves may be composed of several risk factors.

In this example, we have chosen to display the active returns attributable to the factors Risk, Industry and Asset Selection. As can be seen on the [Factor Attribution Detail sheet](#), each of the first two factor groups is composed of many individual factors. For example, Risk is comprised of beta, earnings per share, book-to-price, etc. Similarly, Industry is comprised of the factors Major Banks, Regional Banks, etc.

The active contribution attributable to the factor Risk is listed in Active column, and is the sum of the active contributions of each of its sub-factors (Beta, Price/Earnings, etc.). The calculation is the same for Industry or any other group factor selected by the user to appear on the Executive Summary sheet.

The final row that appears in this section is the Asset Selection row. Unlike the other rows (in this example, Risk and Industry), the Asset Selection row is not comprised of any sub-factors. Instead, the Asset Selection row captures the active contribution not explained by the risk model.

1.7 Risk Summary (Annualized Statistic)

Risk Summary			
Annualized Statistic	Fund	Benchmark	Active
Standard Deviation	14.30 %	12.98 %	1.32 %
Tracking Error	4.47 %	--	4.47 %
Downside Deviation (10.00%)	10.34 %	9.75 %	0.58 %
Information Ratio	(0.26)	--	(0.26)
Sharpe Ratio (5.00%)	0.53	0.65	(0.12)
Sortino Ratio (10.00%)	0.18	0.30	(0.12)
Turnover	81.90 %		

The Risk Summary consists of two sections, labeled Annualized Statistic and Statistic. The Risk Summary contains various statistics that capture the riskiness of a portfolio, measured mostly by looking at the variation in period-by-period returns. We cover the Annualized Statistic section first. The statistics in this section are annualized so one can easily compare, say, a report using daily data with one using monthly data. Before we introduce the statistics that appear in the performance and attribution report, we introduce a few other statistics that show up frequently in our computations.

Annualization Factor In the first section of the [Risk Summary](#), all of the risk factors are scaled using an annualization factor depending on the lengths of the periods in the

report. For example, if the report is run for every business day including holidays in a year that has 260 business days, the annualization factor is $\kappa = 260$. If the report is run weekly, $\kappa = 52$, and if the report is run monthly, $\kappa = 12$. More generally, for any custom period, the scaling factor is the following.

- n is the number of periods in the valuation period
- t_i is the length of period i in years (e.g. $t_i = 1/12$ if period i is a month)

$$\kappa = \frac{1}{n} \sum_{i=1}^n \frac{1}{t_i}$$

(Arithmetic) Average Return The arithmetic average return, or simply the average return, is the arithmetic mean of the daily returns during the valuation period. By itself, it can be a little misleading since returns are geometric in nature. In particular, the arithmetic average return does not give the internal rate of return over the valuation period. However, it is useful in our later computations, so we define it here. We denote the arithmetic average return by \bar{R} . It is defined as follows.

- n is number of periods in the valuation period
- R_i is the return during period i (of either the [fund](#) or the [benchmark](#))

$$\bar{R} = \frac{1}{n} \sum_{i=1}^n R_i = \frac{R_1 + \cdots + R_n}{n}$$

Variance (Annualized) Like average return, variance (which is also called population variance) does not appear on the default report, but it is a useful statistic that shows up in the computations of other statistics. Intuitively, variance measures the variability of returns. It has certain technical advantages and disadvantages to [standard deviation](#) below, which also measures the variation of returns. We denote the variance by $\text{Var}(R)$. It is defined as follows.

- n is number of periods in the valuation period
- R_i is the return during period i (of either the [fund](#) or the [benchmark](#))
- \bar{R} the [average return](#)
- κ is the [annualization factor](#)

$$\text{Var}(R) = \frac{\kappa}{n} \sum_{i=1}^n (R_i - \bar{R})^2$$

Standard Deviation (Annualized) The first row that appears in the Risk Summary section is standard deviation (which is also called the population standard deviation). Standard deviation is one of the most commonly used measure for the riskiness of a portfolio. Intuitively, like [variance](#), standard deviation measures the variability of the returns over the valuation period. One advantage of standard deviation is that it is measured in the same units as the returns themselves. We denote the standard deviation of returns by σ_R (or alternatively σ_B to specify the standard deviation of benchmark returns). It is defined as follows.

- n is number of periods in the valuation period
- R_i is the return during period i (of either the [fund](#) or the [benchmark](#))
- \bar{R} the [average return](#) (of either the fund or the benchmark)
- κ is the [annualization factor](#)

$$\begin{aligned}\sigma_R &= \sqrt{\text{Var}(R)} \\ &= \left(\frac{\kappa}{n} \sum_{i=1}^n (R_i - \bar{R})^2 \right)^{1/2}\end{aligned}$$

The Active column gives the difference between the Fund and Benchmark standard deviations.

Tracking Error (Annualized) Tracking error measures how much the daily returns of a fund differ from the daily returns of its benchmark. This is a particularly useful measurement for index funds that attempt to mimic their benchmark. In that case the goal is to make the tracking error as small as possible. For the fund column, it is defined as follows.

- n is the number of periods
- R_i is the [return](#) during period i of the fund
- B_i is the [return](#) during period i of the benchmark
- \bar{R} the [average return](#) of the fund
- \bar{B} the [average return](#) of the benchmark
- κ is the [annualization factor](#)

$$\begin{aligned}\text{Tracking Error} &= \sigma_{R-B} \\ &= \sqrt{\frac{\kappa}{n} \sum_{i=1}^n \left((R_i - B_i) - (\bar{R} - \bar{B}) \right)^2}\end{aligned}$$

The entry in the Benchmark column is always zero, which is the result of replacing R by B everywhere in the above equation. That is, the benchmark tracks itself perfectly. The entry in the Active column is the difference of the Fund and the Benchmark, hence it is equal to the entry in the Fund column.

Downside Deviation (Annualized) One drawback of using [standard deviation](#) as a measure for riskiness of a fund is that it takes into account both upward and downward returns equally. A fund with many small upward movements and a few large downward movements may in some circumstances appear less risky than it actually is (and conversely). Downside deviation is a tool to measure just the downside riskiness of a fund. To calculate downside deviation, you must first choose a minimum acceptable return, which we will denote M . The quantity M is used as a threshold, any return less than which contributes to the downside deviation. The default is $M = 0.1$ or 10%, which appears in parentheses next to Downside Deviation in the report. We denote downside deviation by d_R . The calculation is as follows.

- n is number of periods in the valuation period
- R_i is the return during period i
- κ is the [annualization factor](#)
- $M' = (1 + M)^{1/\kappa} - 1$, where M is the [minimum acceptable return](#)

$$d_R = \left(\frac{\kappa}{n} \sum_{R_i < M'} (R_i - M')^2 \right)^{1/2}$$

Information Ratio (Annualized) The information ratio is a risk-adjusted measurement of the active return of a fund over its benchmark. The information ratio is essentially the same as the [Sharpe ratio](#), where we replace the the risk-free rate with the benchmark return. It is calculated as follows.

- R^a is the [annualized fund return](#)

- B^a is the annualized benchmark return
- TE is the annualized [tracking error](#)

$$\text{Information Ratio} = \frac{R^a - B^a}{TE}$$

Sharpe Ratio (Annualized) Sharpe ratio is an important measurement used in modern portfolio theory as a measure of risk-adjusted return. By return here, we mean the excess return of the fund to a risk-free rate of return. Generally speaking, the greater the Sharpe ratio, the better the risk versus return profile of a fund. In order to calculate the Sharpe ratio, one must choose a risk-free rate of return. The default is $r_f = 0.05$ or 5%, which appears in parentheses next to Sharpe Ratio on the report. The calculation is as follows.

- κ is the [annualization factor](#)
- \bar{R} is the [average return](#)
- σ_R is the *annualized* [standard deviation](#)
- $r' = (1 + r_f)^{1/\kappa} - 1$, where r_f is the risk-free rate

$$\text{Sharpe Ratio} = \frac{\kappa(\bar{R} - r')}{\sigma_R}$$

Sortino Ratio (Annualized) The Sortino ratio is a modification of the Sharpe ratio, where we replace the risk-free rate with the [minimum acceptable return](#), which by default is 10%, and replace the standard deviation by downside deviation. This follows the same logic as the use of downside deviation, where we are only concerned with downside risk, not all risk. The calculation is as follows.

- κ is the [annualization factor](#)
- $R' = (1 + R)^{1/\kappa} - 1$, where R is the [cumulative return](#)
- d_R is the *annualized* [downside deviation](#)
- $M' = (1 + M)^{1/\kappa} - 1$, where M is the [minimum acceptable return](#)

$$\text{Sortino Ratio} = \frac{\kappa(R' - M')}{d_R}$$

Turnover (Annualized) Turnover is a measure of how actively managed a fund is, and is reported on an annualized basis. It is given as a percentage that intuitively measures what percentage of the fund's assets are turned over during a year. For example, a buy and hold strategy has a turnover of zero. A value in the Turnover row only appears in the Fund column. Note also that since Turnover is calculated by looking at changes in share quantity, it cannot be calculated in Value Mode. The fund-level turnover is calculated by annualizing the cumulative [daily turnover](#). The calculation is as follows.

- n is number of periods in the valuation period
- T_i is the [daily turnover](#)
- κ is the [annualization factor](#)

$$\text{Turnover} = \frac{\kappa}{n} \sum_{i=1}^n T_i$$

1.8 Risk Summary (Statistic)

Statistic	Fund	Benchmark	Active
Beta (/Market)	1.05	1.01	0.04
Maximum Drawdown	(6.92)%	(6.96)%	0.04 %
Days In Maximum Drawdown	31	33	(2)
Days To Recover	14	12	2
Correlation (/Benchmark)	0.95	1.00	(0.05)
R-Squared (/Benchmark)	0.90	1.00	(0.10)

Before we describe the values appearing in this section of the report, we first introduce another useful statistic that will be used in future calculations.

Covariance (Annualized) Although covariance does not appear on the default report, it is an important statistic that appears in the computations of other statistics we use. Intuitively, covariance measures how related the movements of the returns of the funds are with the movements of the returns of benchmark. We denote the covariance of the fund with either the market or benchmark by $\text{Cov}(R, B)$. It is defined as follows.

- n is number of periods in the valuation period
- R_i is the return on period i of the [fund](#)

- \bar{R} is the [average return](#) of the fund
- B_i is the return on period i of the [benchmark](#) (or [market](#))
- \bar{B} is the [average return](#) of the benchmark (or market)
- κ is the [annualization factor](#)

$$\text{Cov}(R, B) = \frac{\kappa}{n} \sum_{i=1}^n (R_i - \bar{R})(B_i - \bar{B})$$

Beta (/Market) Beta is a measurement of the volatility of a fund compared to the volatility of the market. The market itself has a beta of 1. A beta of less than one means a fund is less volatile with respect to the market, and a beta of greater than one means a fund is more volatile with respect to the market. We denote beta by β . It is defined as follows.

- $\text{Cov}(R, M)$ is the [covariance](#) of the fund and market
- $\text{Var}(M)$ is the [variance](#) of the market

$$\beta = \frac{\text{Cov}(R, M)}{\text{Var}(M)}$$

Maximum Drawdown The maximum drawdown is the greatest drop over any length timespan during the valuation period. It is calculated as follows.

- n is the number of periods in the valuation period
- $\mathbf{R}_{[1:k]}$ is the [cumulative return](#) up to period k (of either the fund for Fund column or of the benchmark for Benchmark column)

$$\text{Maximum Drawdown} = \max_{i=1, \dots, n} \left\{ \max_{j=1, \dots, i} \{ \mathbf{R}_{[1:i]} - \mathbf{R}_{[1:j]} \} \right\}$$

The Active column is simply the difference between the Fund and Benchmark columns.

Periods in Maximum Drawdown This is the number of periods between the beginning and end of the timespan during which the fund or benchmark was in the [maximum drawdown](#). In the notation of the formula for maximum drawdown, for the Fund or Benchmark column, it is $i - j$ where i and j are the values at which the maximum occurs. The Active column is simply the difference between the Fund and Benchmark columns.

Periods to Recover This is number of periods it took the fund or benchmark to return to its value at the beginning of the maximum drawdown. In the case that the fund, benchmark or active never regains the peak from the maximum drawdown, the entry is “--”. The Active column is simply the difference between the Fund and Benchmark columns.

Correlation (/Benchmark) Like [covariance](#), correlation measures how related the movements of a fund with its market or benchmark are. Correlation is normalized to always be between -1 and 1 . A correlation close to 1 means the fund and its benchmark have similar period-by-period return movements, whereas a correlation close to -1 means a fund and its benchmark move in opposite directions. For example, U.S. oil stocks will have a correlation closer to 1 with oil futures, whereas U.S. airline stocks will have a correlation closer to -1 with oil futures. A correlation close to zero means that the daily returns of the fund and the daily returns of the benchmark are unrelated. We denote the correlation of the fund with its benchmark by ρ . It is defined as follows.

- n is the number of periods
- R_i is the [return](#) on period i of the fund
- \bar{R} is the [average return](#) of the fund
- σ_R is the [standard deviation](#) of the returns of the fund
- B_i is the [return](#) on period i of the benchmark
- \bar{B} is the [average return](#) of the benchmark
- σ_B is the [standard deviation](#) of the returns of the benchmark

$$\rho = \frac{\text{Cov}(R, B)}{\sigma_R \sigma_B} = \frac{1}{n} \sum_{i=1}^n \left(\frac{R_i - \bar{R}}{\sigma_R} \right) \left(\frac{B_i - \bar{B}}{\sigma_B} \right)$$

The Active column is simply the difference between the Fund column and Benchmark column.

R-Squared (/Benchmark) The R-Squared value gives another measurement of how related movements of the fund and its benchmark are. Intuitively, R-squared measures how much the variability of the fund is explained by the variability of the benchmark. This intuitive notion can be made rigorous, but we will leave out the technical details. The calculation itself is very simple:

$$\text{R-Squared} = \rho^2,$$

where ρ is the [correlation coefficient](#). The Active column is simply the difference between the Fund column and Benchmark column

1.9 Market Value Summary

Market Value Summary		
Statistic	Fund	Cash
Begin Market Value (in millions)	576.12	58.56
Average Market Value (in millions)	617.82	11.94
External Flow Value (in millions)	76.21	
End Market Value (in millions)	635.73	12.53

Begin Market Value (in millions). This row has the total market value of the fund, as well as the total cash held by the fund at the beginning of the valuation period. Note that the total fund value contains the total cash value. The begin fund value can be calculated by rolling up the begin values of each security in the fund. That is,

- N is the number of securities in the fund
- BV_j is the [begin value](#) of security j

$$\text{Begin Market Value} = \sum_{j=1}^N BV_j$$

Average Market Value (in millions) This row has the average market value of the fund, as well as the average cash held by the fund during the valuation period. These are simple arithmetic averages of the [end values](#) and [end cash values](#) for each period during the valuation period:

- n is the number of periods in the valuation period
- EV_i is the [end value](#) of the fund on period i

$$\text{Average Market Value} = \frac{1}{n} \sum_{i=1}^n EV_i$$

External Flow Value (in millions) This row gives the total net inflows/outflows to the fund during the valuation period. It is calculated by adding up the inflows and outflows for each period during the valuation period. Precisely, it is calculated as follows.

- n is the number of periods in the valuation period

- NFO_i is the **net flows at the open** on period i
- NFC_i is the **net flows at the close** on period i

$$\text{External Flow Value} = \sum_{i=1}^n (NFO_i + NFC_i)$$

End Market Value (in millions) This row has the total market value of the fund, as well as the total cash held by the fund at the end of the valuation period. Note that the total fund value contains the total cash value. The market value can be calculated by rolling up the market values of each security in the fund at the end of the valuation period. That is,

- N is the number of securities in the fund
- EV_j is the **end value** of security j

$$\text{End Market Value} = \sum_{j=1}^N EV_j$$

Chapter 2

Factor Attribution Detail Sheet

As discussed in the [Factor Attribution Summary](#) section, the goal of factor attribution is to decompose Fund, Benchmark and Active returns into components attributable to their exposures to various market factors as well as the components attributable to their particular securities. The approach to Factor Attribution is a statistical one, and is based on statistical models. This differs from Decision Attribution, which is purely descriptive and based on actual ex-post results.

On the Factor Attribution Detail sheet appear the exposures of the fund and benchmark to each of the chosen market factors as well as the returns attributable to those factors.

2.1 Factor Categories

Factor Categories	
Risk Group	Factor
Risk	
	Beta
	Earnings/Price
	Book/Price
Industry	
	Major Banks
	Regional Banks
	Savings & Loans
Asset Selection	
	Asset Selection
Portfolio	

Risk Group As discussed in the description of the [Factor Attribution Summary](#) section of the [Executive Summary sheet](#), the risk groups are user-defined groupings of the risk

factors of the chosen model. In some models, there can be hundreds of different factors, and so it is useful to group them together in some logical manner to better summarize the data.

In this example, we have hidden some factors for demonstration purposes. In the sample report, we have chosen the groups Risk and Industry. The other group is Asset Selection, which always appears as a group. The Asset Selection group contains the single risk factor of Asset Selection, which measures all risk not accounted for by the factor model.

There may also be a group labeled Not In Model. The Not In Model group accounts for those securities in the fund or benchmark that were not found in the imported factor model. Whether or not this group appears is controlled by the Not In Model Separation option found in the GUI (or the NOT_IN_MODEL_SEPARATION setting in the configuration file).

Factor In the Factor column is each risk factor that is contained in the factor attribution model. The factors are grouped together by their chosen [risk group](#), and then simply appear in a user-selected order. For example, the first factor that is listed is Beta. This factor tries to account for the security-level risks and returns attributable to a security's beta, and similarly for other factors.

2.2 Average Exposure

Average Exposure		
Fund	Benchmark	Active
1.17	2.59	-1.42
1.14	1.01	0.13
0.35	0.23	0.12
-0.03	-0.09	0.06
0.93	0.93	0.00
0.01	0.07	-0.05
0.02	0.01	0.01
--	0.00	-0.00

In the Average Exposure section, the average exposure of the fund and the benchmark to each risk factor over the course of the Valuation Period is recorded. Intuitively, the exposure number of a given security to a given risk factor is the extent to which the changes of its returns are attributable to changes in the corresponding factor. One can think of the numbers in the Average Exposure column as analogs of the the [Beta](#) row on the [Executive Summary Sheet](#). Beta measures the exposure of a fund to the market as a whole instead of to a particular factor.

Security-level exposures are part of the input into VIA. Note also that there are not exposure numbers for Asset Selection (bottom row) since by definition, that row gives the contributions not attributable to the risk model. The same holds for the Not In Model group, when that setting is selected.

Fund In the Fund column are the exposures of the securities in the fund to each risk factor. For a *single period*, Fund Exposure is calculated by taking the weighted average of the exposures of each of its securities:

- N is the number of securities in the fund for the period
- w_j is the **weight** of the j^{th} security for the period (either trade or buy and hold)
- exp_j is the exposure of the j^{th} security to the given risk factor for the period

$$\text{Exposure} = \sum_{j=1}^N w_j \text{exp}_j$$

For multiple periods, the average exposure is simply the average of the exposure from each period.

Benchmark In the Benchmark column are the exposures of the securities in the benchmark to each risk factor. This is calculated identically to the **Fund** column, except the benchmark weights are used here.

Active The Active column measures whether the Fund has more or less exposure to each factor than the Benchmark. It is calculated by simply taking the difference:

$$\text{Active Exposure} = \text{Fund Exposure} - \text{Benchmark Exposure}$$

2.3 Factor Return

Factor Return
Factor Return
1.27 %
-0.21%
-0.37%
-0.75%
-1.68%
-1.80%

The Factor Return is the return of a risk factor. The factor return comes into VIA as part of the data, and is provided by the risk model for each factor return period during the Valuation period. These periods are generally either weekly or monthly. If necessary, the factor return is then geometrically scaled to the valuation period of the report. This is best explained with an example.

Suppose the factor returns are calculated on a monthly basis by the risk model. Suppose a one-week report is run on a Daily basis. If the month has 30 days, and r denotes a monthly factor return, then the factor return on the report will be $(1 + r)^{7/30} - 1$. Thus, each factor return is appropriately scaled to the time-frame of the valuation period.

2.4 Cumulative Contribution

Cumulative Contribution		
Fund	Benchmark	Active
0.82 %	3.93 %	-3.11%
1.47 %	1.29 %	0.18 %
-0.08%	-0.05%	-0.03%
0.01 %	0.03 %	-0.02%
2.80 %	0.41 %	2.39 %
-0.01%	-0.05%	0.04 %
-0.03%	-0.02%	-0.01%
--	-0.01%	0.01 %
2.20 %	2.03 %	0.17 %
2.20 %	2.03 %	0.17 %
5.82 %	6.37 %	-0.55%

The Cumulative Contribution section gives the contributions of the Fund, Benchmark and Active that are attributable to each risk factor. The values in the Active column appear in the [Factor Attribution Summary](#) on the [Executive Summary Sheet](#). The bottom row gives the Fund, Benchmark and Active [cumulative returns](#) for the valuation period. The contribution at the group-level is the sum of the contributions at each factor-level, and the sum of the contributions at each group level gives the cumulative return of the fund over the valuation period.

Fund For a *single period*, the Cumulative Contribution of the Fund (similarly for the Benchmark) is simply the [fund average exposure](#) times the [factor return](#):

$$\text{Contribution} = (\text{Average Exposure}) \times (\text{Factor Return})$$

More generally, for *multiple periods*, the each period's contribution is calculated as follows.

- n is the number of periods in the valuation period
- $\mathbf{R}_{[1:i]}$ is the **cumulative return** of the fund up to period i
- C_i is the contribution for period i of the given risk factor

$$\text{Cumulative Contribution} = \sum_{i=1}^n (1 + \mathbf{R}_{[1:(i-1)]}) C_i$$

Here, we interpret $\mathbf{R}_{[1:0]} = 0$, so the first summand in the above formula is $w_1 R_1$.

Benchmark The values in the Benchmark Cumulative Contribution column are calculated identically to those in the **Fund** column.

Active The Active column is calculated by simply taking the difference:

$$\text{Active Contribution} = \text{Fund Contribution} - \text{Benchmark Contribution}$$

2.5 Risk Characteristics

Risk Characteristics		
Standard Deviation	Information Ratio	T-Stat
3.82%	-1.97	-1.51
1.94%	-2.25	-1.72
0.95%	-0.23	-0.18
0.27%	-2.77	-2.12
0.73%	0.48	0.37
0.61%	-2.13	-1.63
0.39%	2.08	1.59

The Risk Characteristics section of the Factor Attribution Detail sheet analyzes the active risk and performance of the fund at the factor-level. There are three statistics measured: the (annualized) standard deviation, the (annualized) information ratio, and the t-statistic of active monthly factor impacts. We describe these three statistics below.

In the discussion below, we will assume for ease that the valuation period of the report starts at the beginning of a factor return period and ends at the end of one. For example, if the factor returns are generated monthly, we will assume that the valuation period starts at the beginning of a month and ends at the end of a month (e.g. July 1 to December 31).

Before we explain how the columns are calculated, we first introduce the following notion of a “factor impact.”

Active Factor Impact The active factor impact is the active, exposure-weighted impact of a given factor for a given factor return period (e.g., a given month or week). It is defined as follows.

- n is the number of securities in the Fund and Benchmark
- $\bar{w}_{i,j}$ is the average active weight of security i during factor return period j
- r_j is the return of the given factor in factor return period j
- $\text{exp}_{i,j}$ is the exposure of security i to the given factor during factor return period j

$$\text{Active Factor Impact}_j = \sum_{i=1}^n \bar{w}_{i,j} \text{exp}_{i,j} r_j$$

Standard Deviation Standard Deviation measures the annualized standard deviation of active factor impacts. This can be thought of as an (annualized) tracking error number for each market factor in the factor model. These numbers gives a sense of the magnitude by which the Fund differed from the Benchmark in its impact from each market factor. The computation is as follows.

- κ is the number of factor return periods in a year (most commonly, the factor returns are monthly, $\kappa = 12$, or weekly, $\kappa = 52$)
- n is the number of factor return periods spanned by the valuation period
- FI_j is the **active factor impact** during period j of the given factor
- \overline{FI} is the average active factor impact during the valuation period

$$\text{Standard Deviation} = \sqrt{\frac{\kappa}{n-1} \sum_{i=1}^n (FI_j - \overline{FI})^2}$$

Information Ratio Information Ratio measures the annualized risk-to-return ratio of the the active factor impacts. This can be thought of as an (annualized) information ratio for each market factor in the model. The computation is as follows.

- κ is the number of factor return periods in a year (most commonly, the factor returns are monthly, $\kappa = 12$, or weekly, $\kappa = 52$)

- n is the number of factor return periods spanned by the valuation period
- FI_j is the **active factor impact** during period j of the given factor
- \overline{FI} is the average active factor impact during the valuation period

$$\text{Information Ratio} = \sqrt{\kappa} \times \frac{\overline{FI}}{\sqrt{\frac{1}{n-1} \sum_{i=1}^n (FI_i - \overline{FI})^2}}$$

T-Statistic. The T-Statistic can be used to test the null hypothesis that there was no difference between the factor returns for the Fund and the factor returns for the Benchmark. A larger T-Statistic for a given factor means it is more likely that a non-zero factor contribution is statistically significant. On the other hand, a smaller T-Statistic does not preclude the difference's being statistically significant. The T-Statistic is computed as follows.

- n is the number of factor return periods spanned by the valuation period
- FI_j is the **active factor impact** during period j of the given factor
- \overline{FI} is the average active factor impact during the valuation period

$$\text{T-Statistic} = \sqrt{n} \times \frac{\overline{FI}}{\sqrt{\frac{1}{n-1} \sum_{i=1}^n (FI_i - \overline{FI})^2}}$$

Chapter 3

Daily (or Period) Sheet

The second sheet that appears in the default Performance and Attribution report gives the period-level calculations of the fund and benchmark during the valuation period. In the example we are using, the periods are business days, hence the sheet is labeled Daily. If we were to run the report monthly, the sheet would be labeled Monthly. In this section, we will discuss every column that appears on the Daily sheet, what it means, and how it is calculated.

3.1 Total Return

Total Return				
Attribution Date	Fund	Benchmark	Market	Active
03-Jan-2011	0.94 %	1.13 %	1.14 %	(0.19)%
04-Jan-2011	(0.83)%	(0.20)%	(0.13)%	(0.62)%
05-Jan-2011	0.96 %	0.52 %	0.51 %	0.45 %
06-Jan-2011	(0.21)%	(0.16)%	(0.17)%	(0.05)%
07-Jan-2011	(0.06)%	(0.16)%	(0.18)%	0.10 %
10-Jan-2011	(0.04)%	(0.08)%	(0.14)%	0.04 %
11-Jan-2011	0.52 %	0.39 %	0.37 %	0.13 %

Fund This column gives the fund return as a percentage. It is calculated as follows.

- EV is the [end value](#) in the given period
- BV is the [beginning value](#) in the given period
- NFC is the [net flows at the close](#) in the given period

$$\text{Fund Return} = \frac{\text{EV} - \text{NFC}}{\text{BV}} - 1$$

Benchmark This column gives the benchmark return as a percentage. It is calculated as follows.

- N is the number of securities in the benchmark in the given period
- w_j is the [benchmark average weight](#) of security j in the given period
- R_j is the [benchmark trade return](#) of security j in the given period

$$\text{Benchmark Return} = \sum_{j=1}^N w_j R_j$$

Market This column gives the market return as a percentage. The calculation is identical to that for the [Benchmark](#) column, except that Market weights and returns are used in place of Benchmark weights and returns.

Active This column measures the arithmetic difference between the return of the fund for the day and the return of its benchmark. The calculation is simply:

$$\text{Active Return} = \text{Fund Return} - \text{Benchmark Return}$$

3.2 Instrument Count

Instrument Count	
Fund	Benchmark
57	978
57	979
57	979
57	979
56	979

These two columns list the number of instruments present in each of the Fund and the Benchmark at the beginning of each period. In this example, on January 3, the fund had 57 securities and the benchmark had 978. Before the open of January 4, the benchmark had added a net of one more security. It is possible that it shed some securities and added one more than it shed. The instrument count only lists the total number. To learn more about the amount of activity in the fund, one might look at the [Fund Turnover](#) column, which is discussed below.

3.3 Fund Turnover

Fund Turnover	
Fund	
	4.02 %
	0.50 %
	1.02 %
	0.14 %
	0.33 %

As discussed in the description of [turnover](#) on the Executive Summary sheet, the Fund Turnover column is a measure of how actively traded a fund is on a particular period. Intuitively, it measures the percentage of the fund's assets that were turned over in a given period. The period turnover is calculated by adding the period turnovers of each non-Cash security in the fund that was traded in the previous period. The precise formula is somewhat involved, and is as follows. For the purposes of the calculation, we first give the notion of the adjusted weight of a security, which we'll denote $BW_{T-1,j}^{\text{adj}}$:

- $BW_{T-1,j}$ is the [begin weight](#) of security j in the *previous period*
- $BW_{T,j}$ is the [begin weight](#) of security j in the *given period*
- CW_{T-1} is the begin weight of all Cash instruments in the *previous period* (this is the same as the [cash begin](#) value divided by the [fund begin](#) value)
- $R_{T-1,j}$ is the Buy and Hold [return](#) of security j in the *previous period*
- R_{T-1} is the [fund-level return](#) in the *previous period*

$$BW_{T-1,j}^{\text{adj}} = BW_{T-1,j} \left(\frac{1 + R_{T-1,j}}{1 + R_{T-1}} \right)$$

Now we can define turnover:

- N is the number of non-Cash securities in the fund that were traded in the given period
- $BW_{T-1,j}^{\text{adj}}$ is the adjusted weight of security j
- $BW_{T,j}$ is the [begin weight](#) of security j in the *given period*
- CW_{T-1} is the sum of the begin weight of all Cash instruments in the *previous period*

$$\text{Turnover} = \sum_{j=1}^N \frac{|BW_{T,j} - BW_{T-1,j}^{\text{adj}}|}{2(1 - CW_{T-1})}$$

3.4 Fund Transaction Cost Contribution

Fund Transaction Cost Contribution		
Net	Buy	Sell
(0.0034)	(0.0034)	0.0000
(0.0008)	(0.0008)	0.0000
(0.0014)	(0.0001)	(0.0013)
0.0000	0.0000	0.0000
(0.0005)	(0.0003)	(0.0002)

This section is made up of three columns labeled **Net**, **Buy** and **Sell**. These columns measure how much the transaction costs on a given period affected the fund return for that period. These will always be negative numbers as the costs of transactions will always reduce the gains made on the period. As their names suggest, the Buy column measures the effect of the transaction costs of purchases, and the Sell column measures those of sales. The Net column simply adds up those two costs. The results are expressed as a percentage in the default report, but for demonstration purposes, we have expressed the transaction cost contributions in decimals to four significant digits. To find the transaction contributions for a single period, we simply add the transaction contributions of each security for that single period.

Buy To compute the buy transaction contribution on a given period, we add up the buy transaction contributions of each security in the fund for that period.

- N is the number of securities in the fund on the given period
- BT_j is the [buy transaction cost contribution](#) of security j on the given period (not the entire valuation period)

$$\text{Buy Transaction Contribution} = \sum_{j=1}^N BT_j$$

Sell To compute the sell transaction contribution on a given period, we add up the sell transaction contributions of each security in the fund for that period.

- N is the number of securities in the fund on the given period
- ST_j is the [sell transaction cost contribution](#) of security j on the given period (not the entire valuation period)

$$\text{Sell Transaction Contribution} = \sum_{j=1}^N ST_j$$

Net This is calculated in an analogous manner as above, or by simply adding the contributions for the **Buy** and **Sell** transaction contributions for the given period.

$$\text{Net Transaction Contribution} = \text{Buy} + \text{Sell}$$

$$= \sum_{j=1}^N (BT_j + ST_j)$$

3.5 Fund Values

This is a large section that encompasses many calculations regarding a fund's period-by-period values, which are influenced by trades, inflows and outflows, interest and fees, purchases and sales, and gains and losses. We break the section up into many parts.

Begin	Cash Begin
576,116,544	58,555,960
582,332,681	12,658,691
577,607,485	8,153,748
583,622,421	18,705,853
581,117,545	19,047,924

Begin The Begin column lists the total fund value at the beginning of the day, including the **Net Flows at Open**. The Begin column is computed by adding the value of all holdings at the beginning of the period, including the cash holdings.

Cash Begin The Cash Begin column is computed by adding the total value at the open of all instruments classified as Cash, converting to local currency if necessary.

Net Flows at the Open	Net Flows at the Close
50,816,660	--
816,428	--
84,630	--
447,353	--
(1,266,255)	--

Net Flows at the Open Net Flows at the Open is the net of inflows and outflows into the fund for a period that become part of the basis of the fund for that period. That is, the net flows at the open becomes part of the **begin value** for the period. The net flows at the open are brought into VIA in the data for each period at the security-level, and summed up over every security.

Net Flows at the Close The Net Flows at the Close is the net of all inflows and outflows to the fund for a period that are not used for trading for that period. Thus, the value of the period net flows at the close is part of the **end value** of the fund, but not the **begin value**. Like **net flows at the open** are brought into VIA in the data for each period at the security-level, and summed up over every security.

Close Accrual	Settlement Value	Net Interest/Fees
197,798	163,471	(372,923)
148,077	49,915	--
148,031	193	--
147,921	148	0
117,481	30,467	0
100,580	17,006	(4,979)

Close Accrual Accruals are returns that have been accounted for in the fund value, but have not yet been realized. For example, when a stock goes ex-dividend, the dividend payment might be accounted for even though it has not yet been paid out. The close accrual gives the net accruals that have occurred during the period. Note that the close accrual value for a period is part of the **end value** of the fund for that period. The accruals are brought into VIA in the data for each period at the security-level, and summed up over every security.

Settlement Value When accruals are realized, for example a dividend or coupon payment is made, the settlement value comes into the fund. The Settlement Value column gives the net settlements that have occurred during the period. The settlements are brought into VIA in the data for each period at the security-level, and summed up over every security.

Net Interest/Fees This column gives the net gain/loss from interests and fees during the period. The interest/fees are brought into VIA in the data for each period at the security-level, and summed up over every security. In the default Quantity Mode, in which both price and shares data are loaded into VIA, interest and fees are spread across all securities in return calculations. However, in Value Mode, in which only the value of each security is loaded into VIA, interest and fees only affect the returns on cash.

Purchase Value	Sale Value	Purchase Trade Cost Value	Sale Trade Cost Value
45,687,818	--	19,408	--
5,186,934	--	4,905	--
557,078	10,927,870	759	7,547
--	--	--	--
1,805,673	1,444,668	1,963	918

Purchase Value This column gives the net value of purchases made by the fund during the day. If there were no purchases for the day, there is a zero in that row.

Sale Value This column gives the net value of sales made by the fund during the day. If there were no sales for the day, there is a zero in that row.

Purchase Trade Cost Value This column gives the net trading costs for all purchases made during the day.

Sale Trade Cost Value This column gives the net trading costs for all sales made during the day.

Net Gain/Loss	Realized Gain/Loss	Unrealized Gain/Loss
5,399,709	(209,452)	5,609,162
(4,809,827)	49,915	(4,859,741)
5,567,583	130,463	5,437,120
(1,238,621)	148	(1,238,769)
(351,938)	21,192	(373,131)

Net Gain/Loss The Net Gain/Loss column gives the net gains of the fund during the day, with a positive number denoting a positive gain, and a negative number denoting a loss. The net gain/loss is decomposed into [realized gain/loss](#) and the [unrealized gain/loss](#). It is calculated by adding up the net gains and losses of all securities in the fund on given period:

- N is the number of securities in the fund on the given period
- Gain_j is the [net gain/loss](#) of security j on the single period (not the entire valuation period)

$$\text{Net Gain/Loss} = \sum_{j=1}^N \text{Gain}_j$$

It can also be calculated simply by looking at the begin and end value of the given period:

- EV_i is the **end** value on period i
- BV_i is the **beginning** value on period i
- FC_i is the **net flows at the close** on period i

$$\text{Net Gain/Loss} = EV_i - BV_i - FC_i$$

Realized Gain/Loss The Realized Gain/Loss column captures the fund's gains that have been realized through sales or fees, taking into account any trading costs associated with the sale. Just as **Net Gain/Loss**, it is calculated by adding up the **realized gains and losses** of each security on the given period.

Unrealized Gain/Loss The Unrealized Gain/Loss column gives the unrealized or paper gains of the fund during the day, with a positive number denoting a gain, and a negative number denoting a loss. This quantity gives the increase or decrease in fund value that has not been converted into cash. Just as **Net Gain/Loss**, it is calculated by adding up the **unrealized gains and losses** of each security on the given period. Alternatively, it can also be calculated as:

$$\text{Unrealized Gain/Loss} = \text{Net Gain/Loss} - \text{Realized Gain/Loss}$$

End	Cash End
581,516,253	12,658,691
577,522,855	7,521,838
583,175,068	18,524,688
582,383,799	18,705,891
580,765,606	18,717,374

End. The End column lists the total fund value at the end of each period during the valuation period. Note that these values include the **Net Flows at Close**. The End column is computed by adding the **end values** of all holdings at the end of the period, and *includes the cash end value*.

Cash End. Similarly to the [End](#) column, the Cash End column lists the total value of all cash instruments in the fund at the end of the given period. The Cash End column is computed by adding the total value at the end of period of all instruments classified as Cash.

3.6 Decision Value Attribution

Decision Value Attribution		
Benchmark Open Value (Synthetic)	Benchmark Close Value (Synthetic)	Active Gain
576,116,544	582,628,510	(1,112,257)
583,444,938	582,272,147	(3,637,035)
582,356,777	585,365,840	2,558,519
585,813,193	584,856,521	(281,949)
583,590,267	582,631,970	606,358

The columns under Decision Value Attribution give a way to understand active gains on a value basis as opposed to a percentage basis, (such as in the [Active column](#) under the Total Return heading).

Benchmark Open Value (Synthetic) For the first period in the valuation period, the Benchmark Open Value is set to be equal to the Fund [begin value](#). Thereafter, subsequent values are calculated from the previous period's [Benchmark close value](#) adding any flows at the close received by the fund. This column shows what the value of the fund would be if it simply followed the benchmark. The calculation is as follows.

- BCV_i is the [benchmark close value](#) for period i
- BOV_{i+1} is the [benchmark open value](#) for period $i + 1$
- EV_i is the [end value](#) of the fund for period i
- BV_{i+1} is the [begin value](#) of the fund for period $i + 1$

$$BOV_{i+1} = BCV_i + (BV_{i+1} - EV_i)$$

Benchmark Close Value (Synthetic) The values in this column are calculated from the [Benchmark Open Value](#) column using the given period's [benchmark returns](#). We denote the benchmark close value by BOV_i . The calculation is as follows.

- B_i is the [benchmark return](#) for period i

- BOV_i is the **benchmark open value** for period i

$$BCV_i = BOV_i(1 + B_i)$$

Active Gain This column gives a comparison between the fund and the benchmark on a value basis instead of the difference in returns. If one were to begin the valuation period with a portfolio that was long the fund and short the benchmark in equal values, and added any flows to both fund and benchmark equally, the Active Gain column would give that portfolio's period-by-period returns. The calculation is simply:

$$\text{Active Gain} = (\text{Fund End} - \text{Fund Begin}) - (\text{Benchmark End} - \text{Benchmark Begin})$$

Chapter 4

Fund and Benchmark Holdings Sheets

The next two sheets in the default performance and attribution report are the Fund Holdings and Benchmark Holdings sheets. Since these sheets are nearly identical, we have combined their description into a single chapter in this manual. In fact, there is an option in VIA to combine both sheets into a single Active Holdings sheet.

The only difference between the two is that the Fund Holdings sheet lists securities that appear in the fund, while the Benchmark Holdings sheet lists those that appear in the Benchmark. In particular, for any security that appears in both the fund and the benchmark, its row on the Fund Holdings sheet will be identical to its row on the Benchmark Holdings sheet.

These sheets give information at the security-level over the course of the valuation period for each security in the fund. Unlike the calculations at the fund-level on the Executive Summary and Daily (or Period) sheets, the values that appear in the Fund and Benchmark Holdings sheets give security-level calculations that depend on the performance and attribution methodologies used to create the report. We refer the reader to the [Appendix](#) for the details of the calculations used in each performance methodology.

We remark that the example report we give here was created using Opturo's proprietary Follow the Money methodology.

4.1 Instrument Details

Instrument Details	
Identifier	Name
GMC	GREEN MOUNTAIN COFFEE ROASTERS INC
TPX	TEMPUR-PEDIC INTERNATIONAL
MCD	MCDONALD'S CORP
AGN	ALLERGAN INC
ECL	ECOLAB INC
JCI	JOHNSON CONTROLS INC

Identifier This column contains a unique identifier for each security contained in the fund at some point during the valuation period. In this example, in which the fund holdings are all equities, the Identifier column simply gives the ticker symbol of those holdings. In general, the identifier can be any unique identifier of the securities. For example, they could be external identifiers such as CUSIP or SEDOL or internal identifiers used by the user's firm. Note that the securities appear in descending order by the [Active contribution column](#).

Name The Name column gives, not surprisingly, the name of each security contained in the fund at some point during the valuation period. As with [identifiers](#), the names can be either external or internal names for the securities. Note that the securities appear in descending order by the [Active contribution column](#).

4.2 Begin Weights

Begin Weights		
Fund	Benchmark	Active
1.25 %	0.03 %	1.22 %
1.55 %	0.02 %	1.53 %
3.56 %	0.63 %	2.92 %
1.60 %	0.03 %	1.57 %
2.20 %	0.03 %	2.17 %
1.18 %	0.05 %	1.13 %

Fund The begin weights of each security reflect how much of the entire value of the fund is constituted by that security at the beginning of the valuation period, reflected as a percentage. In a long-only fund, this value will always be between 0% and 100%. Otherwise, the begin weight of a security can be negative (reflecting a short sale) or greater than 100% (reflecting leverage). In any case, the sum of the weights must always equal 100% on the

Fund Holdings sheet. Note that on the Benchmark Holdings sheet, the fund weights may not sum to one, since only benchmark holdings are listed there.

It is calculated as follows.

- N is the number of securities in the fund
- V_j is the [value](#) of the j^{th} security at the start of the valuation period

$$\text{Begin Weight} = \frac{V_i}{\sum_{j=1}^N V_j}$$

Benchmark The values in this column are the weights of each security in the benchmark at the beginning of the valuation period. For most standard benchmarks, the weight of each security in the benchmark is *defined*, not calculated by the report process. For example, in the Dow Jones Industrial Average, weights are assigned to securities by market price, whereas with the S&P 500, weights are assigned by market capitalization. In any case, the sum of the weights must always equal 100% on the Benchmark Holdings sheet. Note that on the Fund Holdings sheet, the benchmark weights may not sum to one, since only fund holdings are listed there.

Active The values in the Active begin weights column are simply the difference between the begin weights of the [fund](#) and those of the [benchmark](#).

$$\text{Active Weight} = \text{Fund Weight} - \text{Benchmark Weight}$$

4.3 Average Weights

As discussed in the beginning of this section, some of the calculations on the Fund and Benchmark Holdings sheets depend on which methodology is used to create the report. One of the major discrepancies between methodologies is in how weights are assigned. In a buy and hold portfolio, the average weight of a security for each period is simply the proportion of its open value to the open value of the portfolio. However, in the presence of trades and flows, the calculation is much more delicate. Each performance methodology handles these issues differently. For further discussion, we refer the reader to the [Performance Methodology appendix](#).

Average Weights		
Fund	Benchmark	Active
2.33 %	0.05 %	2.28 %
1.80 %	0.03 %	1.77 %
4.73 %	0.61 %	4.11 %
1.85 %	0.03 %	1.82 %
3.05 %	0.04 %	3.01 %
1.41 %	0.05 %	1.36 %

Fund The values in this column reflect the chosen methodology's calculation of what proportion of the fund each security constituted over the course of the valuation period. There are various approaches for how to calculate the period weights before averaging, but we believe that our proprietary method, called Follow the Money, provides the most economically meaningful answer. For example, even in a long-only fund, the Dietz methodologies can assign either negative period weights or period weights greater than 100% to a security. However, using Follow the Money, these period weights will always be between 0% and 100%. Regardless of the methodology, the values of the period weights and thus of this column must always sum to 100%. The calculation is as follows.

- n is the number of periods
- w_i is the [weight](#) of the given security for period i

$$\text{Average Fund Weight} = \frac{1}{n} \sum_{i=1}^n w_i.$$

Benchmark Unlike the case for the [fund average weights](#), the benchmark average weights do not depend on the chosen methodology since the benchmark is assumed to be buy and hold. Thus, the average weight assigned to a holding is simply the arithmetic average of its [begin weights](#) over the valuation period.

- n is the number of periods in the valuation period
- w_i is the begin weight of a security on period i

$$\text{Average Weight} = \frac{1}{n} \sum_{i=1}^n w_i = \frac{w_1 + \cdots + w_n}{n}.$$

Active The values in the Active average weights column are simply the difference between the average weights of the [fund](#) and those of the [benchmark](#).

$$\text{Active Weight} = \text{Fund Weight} - \text{Benchmark Weight}$$

4.4 End Weights

End Weights		
Fund	Benchmark	Active
2.78 %	0.08 %	2.70 %
1.95 %	0.03 %	1.92 %
4.67 %	0.63 %	4.04 %
1.57 %	0.03 %	1.54 %
1.43 %	0.04 %	1.39 %
1.57 %	0.06 %	1.51 %

Fund The end weights of each security reflect how much of the entire value of the fund is constituted by that security at the end of the valuation period. In a long-only fund, this value will always be between 0% and 100%. Otherwise, the end weight of a security can be negative (reflecting a short sale) or greater than 100% (reflecting leverage). In any case, the sum of the weights must always equal 100% on the Fund Holdings sheet. Note that on the Benchmark Holdings sheet, the weights may not sum to one, since only benchmark holdings are listed there.

- N is the number of securities in the fund
- V_i is the [end value](#) of the i^{th} security

$$\text{End Weight} = \frac{V_i}{\sum_{j=1}^N V_j}$$

Benchmark The values in this column are the benchmark weights of the securities at the end of the valuation period. It is calculated exactly as the [benchmark begin weights](#).

Active The values in the Active end weights column are simply the difference between the end weights of the [fund](#) and those of the [benchmark](#).

$$\text{Active Weight} = \text{Fund Weight} - \text{Benchmark Weight}$$

4.5 Contribution

Contribution		
Fund	Benchmark	Active
2.43 %	0.05 %	2.38 %
0.96 %	0.01 %	0.95 %
0.57 %	0.07 %	0.50 %
0.43 %	0.01 %	0.42 %
0.38 %	0.00 %	0.37 %
0.36 %	0.01 %	0.35 %

Fund The values in this column measure the contribution of each security to the total return of the fund. Contributions are additive in the sense that the sum of contributions is the **cumulative return** of the fund over the valuation period. The calculation is as follows.

- n is the number of periods in the valuation period
- $\mathbf{R}_{[1:i]}$ is the **cumulative return** of the fund up to period i
- w_i is the **average weight** of the security for period i
- R_i is the **return** of the security for period i

$$\text{Contribution} = \sum_{i=1}^n (1 + \mathbf{R}_{[1:(i-1)]}) w_i R_i$$

Here, we interpret $\mathbf{R}_{[1:0]} = 0$, so the first summand in the above formula is $w_1 R_1$.

Benchmark The values in this column measure the contribution of each security to the total return of the benchmark. Contributions are additive in the sense that the sum of contributions is the **cumulative return** of the benchmark over the valuation period. The calculation is identical as that for the **fund contribution** except that benchmark trade weights and returns are used.

Active The values in the Active contribution column are simply the difference between the contributions of the **fund** and those of the **benchmark**.

$$\text{Active Contribution} = \text{Fund Contribution} - \text{Benchmark Contribution}$$

4.6 Total Returns

Total Return			
Fund (Trade)	Fund (Market)	Benchmark (Trade)	Benchmark (Market)
168.86 %	171.64 %	171.63 %	171.63 %
68.26 %	69.30 %	69.30 %	69.30 %
10.79 %	11.57 %	11.57 %	11.57 %
26.00 %	26.64 %	26.64 %	26.64 %
13.28 %	13.73 %	13.71 %	13.71 %
28.29 %	29.01 %	29.01 %	29.01 %

Fund (Trade) The Fund (Trade) returns column gives the return on a security taking into account trades. Its calculation depends on a few different parameters. It is calculated differently in Value Mode (in which only the value of each security is loaded into VIA) than in the default Quantity Mode (in which both price and shares data are loaded into VIA). The returns for a security also depend on which performance methodology is used. The calculations are discussed in detail in the [Performance Methodology appendix](#). The calculation is identical to that for the [cumulative return](#), but is reported on the security-level:

- n is the number of periods during the valuation period
- R_i is the [return](#) for a given security for period i

$$\text{Return} = \prod_{i=1}^n (1 + R_i) - 1$$

Fund (Market) As opposed to the [Fund \(Trade\)](#) return column, the Fund (Market) column only looks at the begin and end value of a security for each period, as well as any dividends or coupon payments, but ignoring any trades in the fund. We first explain how it is calculated *for a single period*. In the default Quantity Mode, it is calculated as follows for non-Cash securities:

- Q_{open} is the open quantity of the given non-Cash security for *a single period*
- P_{open} is the open price of the given non-Cash security for *a single period*
- P_{close} is the close price of the given non-Cash security for *a single period*
- A_{close} is the [close accrual](#) of the given non-Cash security for *a single period*
- A_{open} is the [close accrual](#) of the given non-Cash security for *the previous period*

$$\text{Return (Market)} = \frac{Q_{\text{open}}P_{\text{close}} + A_{\text{close}}}{Q_{\text{open}}P_{\text{open}} + A_{\text{open}}} - 1$$

For multiple periods, the returns are compounded exactly as with the [Fund \(Trade\)](#) return.

In Value Mode, where security-level prices are not known, the Fund (Market) return is set to the Fund (Trade) return.

Benchmark (Trade) The Benchmark (Trade) return is calculated in one of two ways. If the benchmark period returns are loaded into VIA from the data, those returns will be used. Otherwise, buy and hold returns are used. In either case, the Benchmark (Trade) return is calculated as the cumulative return for each security during the valuation period:

- n is the number of periods during the valuation period
- R_i is the return (defined as above) for a given security for period i

$$\text{Return} = \prod_{i=1}^n (1 + R_i) - 1$$

Benchmark (Market) The Benchmark (Market) return reflects the market return of the security for the period. It is calculated in one of two ways. If the benchmark period returns are loaded into VIA from the data, those returns will be used. Otherwise, it is calculated exactly as [Fund \(Market\)](#) except using benchmark quantities.

Fund FX (Market)	Benchmark FX (Market)
(0.00)%	(0.00)%
1.55 %	1.55 %
0.91 %	
0.74 %	0.74 %
2.57 %	
1.55 %	1.55 %

Fund FX (Market) The Fund FX (Market) column gives the cumulative FX rates over the entire valuation period for a given security in the fund. For example, if a security is traded in Yen and the returns are calculated in US Dollars, the entry in that row will simply be the cumulative return of Yen in US Dollars over the valuation period. In particular, the entry for any security that trades in Yen will have the same entry in its row.

Benchmark FX (Market) The Benchmark FX (Market) column gives the same information as the [Fund FX \(Market\)](#) for securities in the benchmark.

4.7 Average Market Value

Average Market Value	
Fund	Benchmark
14,545,800	489,270
11,160,153	267,809
29,342,899	6,131,440
11,454,815	293,012
18,840,185	372,211
8,754,601	549,926

Fund The Fund average market value gives the average basis across time of each security in the fund. Its value depends on the chosen performance methodology, and is calculated as follows.

- n is the number of periods
- Basis_i is the [basis](#) of the security for period i

$$\text{Average Market Value} = \frac{1}{n} \sum_{i=1}^n \text{Basis}_i$$

Benchmark Benchmark values are imported into VIA in the data (either as price and quantity in Quantity Mode or value in Value Mode). The benchmark average market value is calculated as follows.

- n is the number of periods
- $V_{\text{open},i}$ is the value at the open of the given benchmark security for period i

$$\text{Average Benchmark Value} = \frac{1}{n} \sum_{i=1}^n V_{\text{open},i}$$

4.8 Holding Period

Holding Period	
Fund	Benchmark
100.00 %	100.00 %
69.77 %	100.00 %
100.00 %	--
75.97 %	100.00 %
10.08 %	100.00 %
89.92 %	--

Fund This column gives the percentage of days for which each security was held by the fund during the valuation period. More precisely, it is the percentage of days that a security had a nonzero [basis](#). In particular, the holding period is dependent on the choice of [performance methodology](#). In the figure above, the first security was held during the entire valuation period, whereas the second security was held for 90 of the 129 days of the valuation period, or 69.77% of the valuation period. Note that since every security that appears in the Fund page was held by the fund at some point during the valuation period, every value in this column will be strictly greater than zero.

- n is the number of days during the valuation period
- m is the number of days during the valuation period that the security has a nonzero [basis](#)

$$\text{Holding Period} = \frac{m}{n}$$

Benchmark This column gives the percentage of days for which each security was held by the benchmark during the valuation period. In the figure above, the first two securities were part of the benchmark during the entire valuation period, whereas the third security was never part of the benchmark during the valuation period. Note that since the securities that appear in the Fund page are only those held by the fund at some point during the valuation period, some values in this column will be zero.

4.9 Transaction Cost Contribution

Transaction Cost Contribution	
Buy	Sell
(0.0004)	(0.0006)
(0.0001)	(0.0004)
(0.0005)	(0.0004)
(0.0001)	(0.0001)
(0.0013)	(0.0019)
(0.0000)	0.0000

We remark that on the default report, the Transaction Cost Contribution values appear as percentages, but for demonstration purposes, we have changed them to decimals.

Buy This column represents the contribution of transaction costs due to the purchases of each security. Intuitively, it gives the difference in the market return if a given security did or did not have costs associated with its purchases. To properly handle shorts, the formula is slightly more involved.

Let us make a preliminary definition. We will define the *absolute begin value* of the fund on period i as follows.

- N is the number of securities in the fund
- $BV_{i,j}$ is the **begin value** of security j on period i

$$\text{Absolute Begin Value on Period } i = \sum_{j=1}^N |BV_{i,j}|$$

Similarly, we define the *absolute end value* on period i by:

$$\text{Absolute End Value on Period } i = \sum_{j=1}^N |EV_{i,j}|$$

Buy transaction cost contribution is now calculated as follows.

- n is the number of periods in the valuation period
- $BC_{i,j}$ is the **buy commission value** of the given security j on period i
- ABV_i is the **absolute begin value** of the fund on period i
- AEV_i is the **absolute end value** of the fund on period i

$$\text{Buy Transaction Contribution of Security } j = \prod_{i=1}^n \frac{AEV_i}{ABV_i} - \prod_{i=1}^n \frac{AEV_i + BC_{i,j}}{ABV_i}$$

Sell This column represents the contribution to total sell transaction costs due to the sales of each security. Intuitively, it gives the difference in the market return if a given security did or did not have costs associated with its sales. It is calculated identically to **buy transaction cost contribution** except we replace the buy commission value in that formula with the **sell commission value**:

- n is the number of periods in the valuation period
- $SC_{i,j}$ is the **sell commission value** of the given security j on period i
- ABV_i is the **absolute begin value** of the fund on period i

- AEV_i is the [absolute end value](#) of the fund on period i

$$\text{Sell Transaction Contribution of Security } j = \prod_{i=1}^n \frac{AEV_i}{ABV_i} - \prod_{i=1}^n \frac{AEV_i + SC_{i,j}}{ABV_i}$$

4.10 Fund Values

Begin	Net Flows at the Open	Net Flows at the Close
7,186,482	--	--
8,925,368	--	--
20,492,157	--	--
9,215,840	--	--
12,684,002	--	--
6,773,910	--	--

Begin This column lists the total value at the beginning of the valuation period of each security held in the fund. It is the security-level analog of the [Begin](#) column that appears on the Daily sheet under the Fund Values heading.

Net Flows at the Open This column lists the sum over the valuation period of all net flows (inflows minus outflows) at the open of each security. It is the security-level analog of the [Net Flows at the Open](#) column that appears on the Daily sheet. Usually, there will only be nonzero values for Cash instruments.

Net Flows at the Close This column lists the sum over the valuation period of all net flows (inflows minus outflows) at the close of each security. It is the security-level analog of the [Net Flows at the Close](#) column that appears on the Daily sheet. Usually, there will only be nonzero values for Cash instruments.

Close Accrual	Settlement Cash	Net Interest/Fees
--	--	0
--	--	(0)
--	456,846	0
--	--	0
--	70,116	--
--	--	0

Close Accrual This column lists the close accrual for the end of the valuation period of each security. It is the security-level analog of the [Close Accrual](#) column that appears on the Daily sheet.

Settlement Cash Settlement cash is the cash payout received from a dividend, coupon payment or other corporate action. This column lists the sum over the valuation period of all the settlement cash of each security. It is the security-level analog of the [Settlement Value](#) column that appears on the Daily sheet.

Net Interest/Fees This column lists the sum over the valuation period of all the interest and fees of each security. It is the security-level analog of the [Net Interest/Fees](#) column that appears on the Daily sheet.

Purchase Value	Sale Value	Buy Commission Value	Sell Commission Value	End
2,822,208	7,068,353	2,390	3,534	17,643,042
1,418,527	3,789,627	660	2,577	12,390,714
11,413,352	5,280,848	2,996	2,042	29,686,036
1,379,720	3,177,390	360	789	9,992,600
6,559,303	12,412,838	7,368	11,061	9,067,990
1,014,449	--	206	--	9,997,596

Purchase Value This column lists the sum over the valuation period of the purchase value of each security. It is the security-level analog of the [Purchase Value](#) column that appears on the Daily sheet.

Sale Value This column lists the sum over the valuation period of the sale value of each security. It is the security-level analog of the [Sale Value](#) column that appears on the Daily sheet.

Buy Commission Value This column lists the sum over the valuation period of the commissions on purchases of each security. It is the security-level analog of the [Purchase Trade Cost Value](#) column that appears on the Daily sheet.

Sell Commission Value This column lists the sum over the valuation period of the commissions on sales of each security. It is the security-level analog of the [Purchase Trade Cost Value](#) column that appears on the Daily sheet.

End This column lists the total value at the end of the valuation period of each security held in the fund. It is the security-level analog of the [End](#) column that appears on the Daily sheet under the Fund Values heading.

4.11 Fund Gain/Loss

Fund Gain/Loss		
Net Gain/Loss	Realized Gain/Loss	Unrealized Gain/Loss
14,702,705	21,143	14,681,562
5,836,445	20,325	5,816,120
3,518,223	390,240	3,127,983
2,574,431	13,449	2,560,982
2,307,639	12,230	2,295,409
2,209,237	0	2,209,237

Net Gain/Loss The Net Gain/Loss column is the security-level version of the [Net Gain/Loss column](#) that appears on the Daily page. For non-Cash securities, the values take into account both paper and realized gains, as well as other factors that contribute to gains such as interest. For Cash securities, the calculation is more complicated since every trade causes cash to increase or decrease by the value of that trade. In either event, the gains/losses depend on which performance methodology is being used, and are aggregated on a daily basis:

- n is the number of periods
- Gain_i is the [gain](#) of the given security during period i

$$\text{Net Gain/Loss} = \sum_{i=1}^n \text{Gain}_i$$

Realized Gain/Loss The Realized Gain/Loss column captures all the gains that each security contributed to the fund during each period of the valuation period that were realized through sales. It is left blank in Value Mode, but in Quantity Mode, it is calculated as follows.

- n is the number of periods in the valuation period
- $V_{\text{sell},i}$ is the [sale value](#) of the given security on period i
- P_i is the book price for the given security on period i , that is, its average cost basis as of period i

- $Q_{\text{sell},i}$ is the quantity of the given security on period i

$$\text{Realized Gain/Loss} = \sum_{i=1}^n V_{\text{sell},i} - P_i Q_{\text{sell},i}$$

Unrealized Gain/Loss The Unrealized Gain/Loss column captures all the gains that each security contributed to the fund over the valuation period that were unrealized through sales as cash gains. It is the security-level analog of the [Unrealized Gain/Loss](#) column that appears on the Daily page. It is calculated as follows.

$$\text{Unrealized Gain/Loss} = \text{Net Gain/Loss} - \text{Realized Gain/Loss}$$

4.12 Attribution - Segment

Invest Effect	GICS Sector Allocation Effect	GICS Industry Allocation Effect	Issue Selection Effect	Trade Effect	Total Effect
-0.00%	-0.03%	0.05%	2.39%	-0.02%	2.38%
-0.00%	0.00%	0.03%	0.93%	-0.01%	0.95%
-0.00%	0.02%	0.11%	0.39%	-0.02%	0.50%
-0.00%	0.00%	-0.00%	0.42%	-0.01%	0.42%
-0.00%	0.00%	0.04%	0.34%	-0.01%	0.37%
-0.00%	0.00%	0.23%	0.12%	-0.01%	0.35%

Invest Effect This column gives the security-level contribution to the [total invest effect](#), which appears on the [Executive Summary sheet](#). We refer the reader to that description for its meaning.

Segment Allocation Effect(s) This column gives the security-level contribution to the [segment allocation effect\(s\)](#), which appears on the [Executive Summary sheet](#). We refer the reader to that description for its meaning.

Issue Selection Effect This column gives the security-level contribution to the [issue selection effect](#) that appears on the [Executive Summary sheet](#). We refer the reader to that description for its meaning.

Trade Effect This column gives the security-level contribution to the [total trade effect](#) that appears on the [Executive Summary sheet](#). We refer the reader to that description for its meaning.

Total Effect The Total Effect column gives the total effect in percentage terms of all decision effects. In other words, it can also be calculated by adding up each individual decision effect:

$$\text{Total Effect} = \sum (\text{Each Decision Effect})$$

Invest Value Effect	GICS Sector Allocation Value Effect	GICS Industry Allocation Value Effect	Issue Selection Value Effect	Trade Value Effect	Total Value Effect
-5,425	-200,453	288,562	14,406,416	-146,417	14,342,683
-1,249	26,513	162,259	5,569,467	-67,790	5,689,199
-7,568	113,763	640,922	2,394,726	-123,083	3,018,758
-543	19,143	-8,525	2,498,109	-41,061	2,467,122

Invest Value Effect The Invest Value Effect gives the value analog of the [invest effect](#). Whereas decision effects add to the [active return](#) of the fund, value effects add to the [active gain](#). For example, if the valuation period is a single period, the invest value effect is simply given by multiplying the invest effect by the benchmark open value.

Segment Value Effect(s) Each Segment Value Effect gives the value analog of the corresponding [segment effect](#). Whereas decision effects add to the [active return](#) of the fund, value effects add to the [active gain](#). For example, if the valuation period is a single period, each segment value effect is simply given by multiplying the benchmark open value by the corresponding segment effect.

Issue Selection Value Effect The Issue Selection Value Effect gives the value analog of the [issue selection effect](#). Whereas decision effects add to the [active return](#) of the fund, value effects add to the [active gain](#). For example, if the valuation period is a single period, the issue selection value effect is simply given by multiplying the issue selection effect by the benchmark open value.

Trade Value Effect The Trade Value Effect gives the value analog of the [trade effect](#). Whereas decision effects add to the [active return](#) of the fund, value effects add to the [active gain](#). For example, if the valuation period is a single period, the trade value effect is simply given by multiplying the trade effect by the benchmark open value.

Total Value Effect The Total Value Effect gives the value analog of the [total effect](#). Whereas decision effects add to the [active return](#) of the fund, value effects add to the [active gain](#).

For each period, the sum of all security (both benchmark and fund) Total Value Effects is the active gain of the fund over the synthetic benchmark value for that period. The Total Value Effect column gives the total effect in value terms of all decisions. That is,

$$\text{Total Value Effect} = \sum (\text{Each Decision Value Effect})$$

GICS Sector	GICS Industry
CONSUMER STAPLES	FOOD PRODUCTS
CONSUMER DISCRETIONARY	HOUSEHOLD DURABLES
CONSUMER DISCRETIONARY	HOTELS
HEALTH CARE	PHARMACEUTICALS
CONSUMER DISCRETIONARY	AUTO COMPONENTS

Decision Segments The final columns on the Fund and Benchmark sheets give the categories chosen by the user for attribution calculations. In the sample report, we have chosen the GICS Sector and GICS Industry categories. These two columns appear, with the corresponding sector and industry of each security appearing in its row.

Chapter 5

Top & Bottom Holdings Sheet

The purpose of the Top & Bottom Holdings Sheet is to summarize the information on securities that either contribute the most/least to the overall fund-level active return or have the highest/lowest active weights. Top & Bottom Holdings Sheet lists ten securities in each of these four categories by default, although the user can choose to display a different number before running the report. In this section, we will explain which securities will appear on this sheet. Throughout, the Identifier and Name columns are as in the [Instrument Details](#) section in the [Fund Holdings sheet](#). We will refer the reader to that chapter for details on the meanings of the columns that appear in the Top & Bottom Holdings Sheet.

5.1 Top Contributors

Instrument Details	
Identifier	Name
TOP CONTRIBUTORS	
GMCR	GREEN MOUNTAIN COFFEE ROASTERS INC
TPX	TEMPUR-PEDIC INTERNATIONAL
MCD	MCDONALD'S CORP
TDG	TRANSDIGM GROUP INC

The securities that appear in this section are the securities in the fund that have the greatest [total effect](#) over the valuation period. The securities appear in descending order by total effect. We remark that if the report is created with decision attribution turned off, the securities that appear will be those with the greatest [active contribution](#).

5.2 Bottom Contributors

Instrument Details	
Identifier	Name
BOTTOM CONTRIBUTORS	
GOOG	GOOGLE INC-CL A
MSFT	MICROSOFT CORP
DLB	DOLBY LABORATORIES INC-CL A
XOM	EXXON MOBIL CORP

The securities that appear in this section are the securities in the fund that have the least [total effect](#) over the valuation period. The securities appear in ascending order by total effect. We remark that if the report is created with decision attribution turned off, the securities that appear will be those with the least [active contribution](#).

5.3 Top Overweights

Instrument Details	
Identifier	Name
TOP OVERWEIGHTS	
MCD	MCDONALD'S CORP
GOOG	GOOGLE INC-CL A
FLIR	FLIR SYSTEMS INC
AAPL	APPLE INC

The securities that appear in this section are the securities in the fund that have the greatest [active average weights](#) over the valuation period. The securities appear in descending order by active average weight.

5.4 Bottom Overweights

Instrument Details	
Identifier	Name
BOTTOM UNDERWEIGHTS	
XOM	EXXON MOBIL CORP
GE	GENERAL ELECTRIC CO
IBM	INTL BUSINESS MACHINES CORP
CVX	CHEVRON CORP

The securities that appear in this section are the securities in the fund that have the least [active average weights](#) over the valuation period. The securities appear in ascending order by active average weight. Depending how closely the fund tracks the benchmark, these securities will often be securities that appear in the benchmark but not the fund. That happens to be the case in our example.

Chapter 6

Decision Attribution Summary Sheet

On this sheet are many of the fund-level statistics that appear in the [Risk Summary](#) section of the [Executive Summary sheet](#) such as standard deviation, beta, etc. One difference is that on this sheet, these statistics are not annualized, and are all calculated with respect to the benchmark, to give *active* standard deviation, *active* beta, etc.

The statistics are then further broken down by each decision to see how each decision contributed to the fund's active risk profile. A detailed description of the meanings of decisions can be found in the discussion of the [Decision Attribution Summary](#) that appears on the [Executive Summary sheet](#).

Below we give precise formulas for the risk statistics at the fund-level. The formulas for the attributed risks are more complicated, so instead we just give the intuition behind their calculation: The amount of the active risk measure that is attributed to an investment decision is the amount that the active risk measure would have changed between the case where every period's investment process had ceased immediately before that decision had been implemented and the case where every period's investment process had ceased immediately after that decision had been implemented. Thus, the calculation insures that the sum of the arithmetic attribution values add up to give the arithmetic difference between the fund's risk measure and the benchmark's risk measure. Similarly, for Geometric Active Volatility, the calculation insures that the attribution values compound to give the geometric difference between the fund's risk measure and the benchmark's risk measure.

6.1 Summary Return Effects

Attribution Components	Active Return	Active Gain
Cumulative Effect	-0.55%	(2,719,420)
--Invest Effect	-0.03%	(154,579)
--GICS Sector Allocation Effect	-0.11%	(671,240)
--GICS Industry Allocation Effect	-1.56%	(9,493,394)
--Issue Selection Effect	1.68%	10,706,108
--Trade Effect	-0.52%	(3,106,317)

Active Return The values in this column are the same as those that appear in the Active Return column in the [Decision Attribution Summary](#) on the Executive Summary sheet. We refer the reader there for a description of its meaning.

Active Gain The values in this column are the same as those that appear in the Active Gain column in the [Decision Attribution Summary](#) on the Executive Summary sheet. We refer the reader there for a description of its meaning.

6.2 Summary Risk Effects

Active Standard Deviation	Tracking Error	Active Beta	Active Downside Deviation
0.08%	0.28%	0.04	0.04%
-0.00%	0.00%	-0.00	-0.00%
0.03%	0.12%	0.03	0.02%
0.04%	0.06%	0.03	0.03%
0.01%	0.10%	-0.02	-0.01%
-0.00%	-0.00%	-0.00	0.00%

Active Standard Deviation For the Cumulative Effect row (first row), the computation here employs the unannualized version of the active [standard deviation](#) property defined in the [Risk Summary](#) section of the [Executive Summary](#) sheet:

- σ_R is the [annualized standard deviation](#) of the fund
- σ_B is the annualized standard deviation of the benchmark
- κ is the [annualization factor](#)

$$(\text{Arithmetic}) \text{ Active Standard Deviation} = \frac{\sigma_R - \sigma_B}{\sqrt{\kappa}}$$

$$(\text{Geometric}) \text{ Active Standard Deviation} = \frac{\sigma_R - \sigma_B}{\sigma_B}$$

Tracking Error For the Cumulative Effect row (first row), the computation here is the unannualized [tracking error](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet:

- TE is the [annualized tracking error](#) of the fund
- κ is the [annualization factor](#)

$$\text{Tracking Error} = \frac{TE}{\sqrt{\kappa}}$$

Active Beta For the Cumulative Effect row (first row), the Active Beta is the same as the [beta](#) entry in the active column in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Active Downside Deviation For the Cumulative Effect row (first row), the computation here is the unannualized active [downside deviation](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet:

- d_R is the annualized [annualized downside deviation](#) of the fund
- d_B is the annualized downside deviation of the benchmark
- κ is the [annualization factor](#)

$$\text{Active Downside Deviation} = \frac{d_R - d_B}{\sqrt{\kappa}}$$

Active Information Ratio	Active Sharpe Ratio	Active Sortino Ratio
-0.00	-0.00	-0.00
--	-0.00	--
-0.00	-0.00	-0.00
-0.01	-0.01	-0.01
0.01	0.01	0.01
-0.00	-0.00	-0.00

Active Information Ratio For the Cumulative Effect row (first row), the computation here is the unannualized [information ratio](#) discussed in the [Risk Summary](#) section of the [Executive Summary sheet](#). Since we are not annualizing here, the computation is slightly different:

- \bar{R} is the [average fund return](#)
- \bar{B} is the average benchmark return
- TE is the (unannualized) [tracking error](#)

$$\text{Information Ratio} = \frac{\bar{R} - \bar{B}}{TE}$$

Active Sharpe Ratio For the Cumulative Effect row (first row), the computation here is the unannualized [Sharpe Ratio](#) discussed in the [Risk Summary](#) section of the [Executive Summary sheet](#):

- Active Sharpe is the [active Sharpe Ratio](#) (fund Sharpe minus benchmark)

$$\text{Active Sharpe Ratio} = \frac{\text{Active Sharpe}}{\sqrt{\kappa}}$$

Active Sortino Ratio For the Cumulative Effect row (first row), the computation here is the unannualized [Sortino Ratio](#) discussed in the [Risk Summary](#) section of the [Executive Summary sheet](#):

- Active Sortino is the active [annualized Sortino Ratio](#) of the fund

$$\text{Active Sortino Ratio} = \frac{\text{Active Sortino}}{\sqrt{\kappa}}$$

Active Maximum Drawdown	Active Days In Maximum Drawdown	Active Days To Recover
0.04%	-2	2
-0.00%	--	--
-0.34%	1	-1
-0.75%	1	-1
1.16%	-4	4
-0.03%	--	--

Active Maximum Drawdown For the Cumulative Effect row (first row), the computation here is the same as the active column of the [Maximum Drawdown](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Active Days in Maximum Drawdown For the Cumulative Effect row (first row), the computation here is the same as the active column of the [Days in Maximum Drawdown](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Active Days to Recover For the Cumulative Effect row (first row), the computation here is the same as the active column of the [Days to Recover](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Active Correlation	Active R-Squared
-0.05	-0.10
0.00	0.00
-0.01	-0.02
-0.01	-0.02
-0.03	-0.06
0.00	0.00

Active Correlation For the Cumulative Effect row (first row), the computation here is the same as the active column of the [Correlation](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Active R-Squared For the Cumulative Effect row (first row), the computation here is the same as the active column of the [R-squared](#) discussed in the [Risk Summary](#) section of the [Executive Summary](#) sheet.

Chapter 7

Decision Return/Value Attribution Sheets

We combine in this chapter the descriptions of the Decision Return Attribution sheet and the Decision Value Attribution sheet. The only difference between the two is that, as the names imply, one gives attribution information in terms of active returns, and then other in terms of active value. We will display images from the return attribution sheet, but otherwise they are identical.

The values that appear on this sheet are all of the meaningful decision attribution affects at their appropriate level. Along the bottom row of this sheet are the same fund-level effects that appeared

7.1 Categories

Categories	
GICS Sector	GICS Industry
CONSUMER DISCRETIONARY	
	AUTO COMPONENTS
	AUTOMOBILES
	DISTRIBUTORS
	DIVERSIFIED CONSUMER SERVICES
Portfolio	

The categories that appear under Categories in the Decision Return Attribution and Decision Value Attribution sheets are selected by the user when choosing the decision tree. Each security in the data is categorized in certain ways, either by static characteristics (such

as by their GICS Sector and GICS Industry as in this example) or dynamic characteristics (such as Market Capitalization). The order in which these categories appear in the report are also chosen by the user when constructing the decision tree, and should usually be chosen in to reflect how the fund was constructed. Each segment within a category then appears in alphabetical order.

7.2 Attribution

Attribution					
Invest Effect	GICS Sector Allocation Effect	GICS Industry Allocation Effect	Issue Selection Effect	Trade Effect	Total Effect
--	--	0.38%	--	--	--
			-0.01%		
			0.08%		
			--		
			-0.19%		
-0.03%	-0.11%	-1.56%	1.68%	-0.52%	-0.55%

The values show on this sheet are the attributes of actual decisions and their roll-up. On the [Decision Attribution Tree Sheet](#), these values are further decomposed to the security-level. The entries in the Decision Value Attribution sheet are the analogous values where we replace the return with the value. On the final row of this sheet, which we have included in the above screen shot, are the effects rolled up to the fund level. The values that appear on this bottom row are the same values that appear in the [Decision Attribution Summary](#) section of the [Executive Summary sheet](#).

Chapter 8

Top & Bottom Return/Value Decisions Sheets

The Top & Bottom Return Decisions and Top & Bottom Value Decisions sheets are almost identical, so we have combined their descriptions in this manual into one chapter. The only difference between the two is that, as the names imply, one gives information in terms of active returns, and then other in terms of active value. Note however that in the presence of inflows/outflows, the decisions that appear on the two sheets need not be the same or appear in the same order.

8.1 Top Decisions

Decision Path: Segment (Decision)	Decision Effect
TOP DECISIONS	
CONSUMER STAPLES -> FOOD PRODUCTS (Issue Selection)	2.15 %
CONSUMER DISCRETIONARY -> HOUSEHOLD DURABLES (Issue Selection)	0.86 %
CONSUMER DISCRETIONARY (GICS Industry)	0.38 %
CONSUMER DISCRETIONARY -> HOTELS (Issue Selection)	0.25 %

In the Top Decisions portion of the Return Decisions sheet, those decisions that contributed the greatest **total effect** to the fund are listed in descending order. For example, the allocation to Food Products within Consumer Staples had the greatest contribution to the total effect, and contributed a 2.15% active return to the fund. By default, ten decisions are listed, but this can be changed by the user. (We have included only the top four in the above image.)

Similarly, the Top Decisions portion of the Value Decisions sheet lists those decisions that has greatest **total value effect** during the valuation period. Note that these decisions will be similar, but not necessarily identical to those decisions that has the greatest total effect.

The values that appear in the Decision Return Effect and Decision Value Effect columns are the same as the corresponding values that appear on the [Decision Return/Value Attribution sheets](#) at the appropriate sleeve.

8.2 Bottom Decisions

BOTTOM DECISIONS	
INFORMATION TECHNOLOGY (GICS Industry)	(1.32)%
ENERGY -> ENERGY EQUIPMENT & SERVICES (Issue Selection)	(0.65)%
CONSUMER DISCRETIONARY -> MEDIA (Issue Selection)	(0.49)%
HEALTH CARE -> HEALTH CARE TECHNOLOGY (Issue Selection)	(0.46)%

In the Bottom Decisions portion of the Return Decisions sheet, those decisions that contributed the least **total effect** to the fund are listed in descending order. For example, the allocation to the GICS industry Information Technology had the least (or worst) contribution to the total effect, and contributed a –1.32% active return to the fund. By default, ten decisions are listed, but this can be changed by the user. (We have included only the top four in the above image.)

Similarly, the Bottom Decisions portion of the Value Decisions sheet lists those decisions that have the least **total value effect** during the valuation period. Note that these decisions could be similar, but not necessarily identical to those decisions that have the least total effect.

The values that appear in the Decision Return Effect and Decision Value Effect columns are the same as the corresponding values that appear on the [Decision Return/Value Attribution sheets](#) at the appropriate sleeve.

Chapter 9

Decision Attribution Tree Sheet

The Decision Attribution Tree Sheet presents the security-level and sleeve-level contributions, weights, effects and risk statistics (at the sleeve-level) organized by sleeves. The presentation makes it easy to compare and analyze security-level results within a particular sleeve and effects and risk across sleeves. Besides the manner of presentation, which we explain below, all of the information on this sheet is contained in previous sheets. Therefore, we will describe the presentation and only briefly describe the columns, as their meanings and calculations have been explained in previous chapters.

9.1 Categories

Categories		
GICS Sector	GICS Industry	Security
CONSUMER DISCRETIONARY		
	AUTOMOBILES	
		FORD MOTOR CO
		GENERAL MOTORS CO
		HARLEY-DAVIDSON INC
		TESLA MOTORS INC
		THOR INDUSTRIES INC
	DISTRIBUTORS	
		GENUINE PARTS CO
		LKQ CORP
Portfolio		

The Categories section of the attribution tree contains a column for each category selected in the report. The categories that appear, as well as their order, are chosen by the

user upon designating the decision tree. Regardless of how many categories are chosen, the final column in the Categories section will list all the securities in a given segment. Each segment appears in alphabetical order, as do the securities.

In the sample report, we have chosen GICS Sector, followed by GICS Industry. The first GICS Sector alphabetically is Consumer Discretionary, which appears in the top left in bold. Each GICS Industry in Consumer Discretionary will then appear, again alphabetically. In the picture above, we see Automobiles and Distributors. Finally, within each GICS Industry, are listed all of the securities that are held in either the Fund or the Benchmark in that industry.

We have also included in the above figure the final row of the sheet, labeled Portfolio, which contains the Fund, Benchmark and Active contributions, weights, effects, etc.

9.2 Contribution

We will cover the Contribution section in detail, and skip most of the other sections on this sheet, as their calculations are similar to those in the Contribution section.

Contribution		
Fund	Benchmark	Active
1.88 %	0.97 %	0.90 %
0.14 %	-0.07%	0.21 %
--	-0.08%	0.08 %
--	0.00 %	-0.00%
0.14 %	0.01 %	0.13 %
--	0.00 %	-0.00%
--	-0.00%	0.00 %
--	0.01 %	-0.01%
--	0.00 %	-0.00%
--	0.00 %	-0.00%
5.82 %	6.37 %	-0.55%

This section contains the security-level and sleeve-level contributions. At the security-level, these are the same values that appear in the [Contribution](#) column of the [Fund and Benchmark Holdings Sheets](#). For contributions, these are rolled up to the segment-level by summing. In this example, the second row represents the contribution of the GICS Industry Automobiles. We see that the benchmark contribution is -0.07% , which is the sum of contributions of the five securities in the benchmark in that segment. In general, sleeve-level contributions are calculated as follows:

- m is the number of securities in a given segment
- C_j is the [contribution](#) of security j in that segment

$$\text{Segment Contribution} = \sum_{j=1}^m C_j$$

Note that one can also add up contributions from each subsegment to a parent segment. At the bottom row, we see the portfolio-level contributions, which are the same as the [Cumulative Return](#) listed on the [Executive Summary sheet](#).

9.3 Risk Characteristics

As we mentioned above, we have skipped many sections in the Decision Attribution Tree sheet, whose meanings have been discussed earlier in this manual, and whose calculations are entirely analogous as that for [contributions](#). Namely, for weights, begin and end values, effects, etc., the security-level values are added up to form the sleeve-level values. We will discuss some of the risk characteristics numbers below, as the sleeve-level calculations are no longer the sum over the security-level.

Active Standard Deviation	Tracking Error	Fund Beta	Benchmark Beta	Active Beta
0.03%	0.50%	0.92	1.03	-0.10
-1.25%	1.81%	0.22	1.52	-1.30
	1.13%		1.07	
0.08%	0.28%	1.05	1.01	0.04

In the above figure, we have included the first five columns of the Risk Characteristics section of the Decision Attribution Tree sheet. The numbers in the bold blue are at the GICS Sector Consumer Discretionary level, the next line in blue is at the GICS Industry Automobiles, and the many blank rows correspond to individual securities, whose risk characteristics are not calculated. Each of the statistics that appear are unannualized, as is the case in the [Summary Risk Effects](#) section of the [Decision Attribution Summary sheet](#). Their computations are similar to those that appear there. The idea is to act as if the sleeve is its own portfolio, and then calculate that portfolio's risk statistics. As an example, we will discuss the Active Standard Deviation column.

Active Standard Deviation This column gives the unannualized [active standard deviation](#) at each sleeve-level. For both the fund and the benchmark, a return is calculated for each period by using one of the [performance methodologies](#). Then the standard deviation of each of these time series is separately calculated. The active standard deviation is then the difference of the fund and benchmark standard deviations. This calculation is identical to that at the portfolio-level. In fact, we see in the final row that the portfolio risk statistics are the same as those that appear for the total portfolios in the [Summary Risk Effects](#) section of the [Decision Attribution Summary sheet](#).

Appendix A

Performance Methodologies

In this chapter, we discuss in detail how each performance methodology available in VIA calculates weights and returns on a security level. The goal is to explain how each methodology computes bases, weights and returns at the security-level for a *single period*. Once the calculations are understood for a single security and single period, they can be rolled up across securities and/or compounded across periods, as has been explained in previous chapters.

The available methodologies in VIA are:

1. Buy and Hold
2. Trades-at-Open Dietz
3. Trades-at-Noon Dietz
4. Trades-at-Close Dietz
5. Purchases-at-Open Dietz
6. Follow the Money

Since Follow the Money is Opturo's proprietary performance methodology, we will omit the details of its calculation from this report. We remark that although it shares features with the other methodologies, it has many advantages. For example, in contrast to the Dietz methodologies, using Follow the Money in a long-only portfolio, returns will always be greater than -100% and weights will always be between 0% and 100% .

A.1 Security-Level Bases and Weights

We first begin by discussing the key concept that varies between the Dietz methodologies, namely the notion of a **basis** for each security. As a reminder, everything we discuss below is *for a single period*.

Dietz Weights Before we discuss the important notions, we introduce the notion of a Dietz weight, whose exact use is discussed in the calculation of the [Dietz bases](#). The Dietz weights are defined as follows:

- $(\varepsilon_{\text{buy}}, \varepsilon_{\text{sell}}) = (1/2, 1/2)$ for Trades-at-Noon
- $(\varepsilon_{\text{buy}}, \varepsilon_{\text{sell}}) = (1, 1)$ for Trades-at-Open
- $(\varepsilon_{\text{buy}}, \varepsilon_{\text{sell}}) = (0, 0)$ for Trades-at-Close
- $(\varepsilon_{\text{buy}}, \varepsilon_{\text{sell}}) = (1, 0)$ for Purchases-at-Open

Basis For a single period, each Dietz methodology varies by how it weights the purchases and sales of each security, reflecting an arbitrary choice for when trades occurred. For *non-Cash instruments*, the basis is calculated as follows.

- V_{open} is the [opening value](#) for the period of the given security
- V_{buy} is the [purchase value](#) for the period of the given security
- V_{sell} is the [sale value](#) for the period of the given security
- $(\varepsilon_{\text{buy}}, \varepsilon_{\text{sell}})$ are the [Dietz weights](#)

The Dietz basis for the period is defined to be

$$\text{Dietz Basis} = V_{\text{open}} + (\varepsilon_{\text{buy}}V_{\text{buy}} - \varepsilon_{\text{sell}}V_{\text{sell}})$$

The basis in the Buy and Hold methodology is calculated to reflect the assumption that no trades were made during the day. Namely:

$$\text{B\&H Basis} = V_{\text{open}}$$

For *Cash* instruments, the basis is slightly more complicated. The idea is that fluctuations in cash caused by trades should not affect its basis. Thus, in the calculation below, we add back in the cash used for purchases and remove the cash realized in sales. This is further complicated in a multi-currency portfolio, where different instruments are bought and sold in different currencies. The precise calculation is as follows.

- N is the number of securities in the fund
- V_{open} is the **opening value** for the period for the given Cash instrument
- $V_{\text{buy},j}$ is the **purchase value** for the period *made in the given Cash instrument* of the j^{th} security in the portfolio
- $V_{\text{sell},j}$ is the **sale value** for the period *made in the given Cash instrument* of the j^{th} security in the portfolio
- $(\varepsilon_{\text{buy},j}, \varepsilon_{\text{sell},j})$ are the **Dietz weights** (defined below) of the j^{th} security in the portfolio

$$\text{Cash Basis} = V_{\text{open}} - \sum_{j=1}^N (\varepsilon_{\text{buy},j} V_{\text{buy},j} - \varepsilon_{\text{sell},j} V_{\text{sell},j})$$

Weights Once we have the notion of a basis, the different methodologies calculate weights identically. Namely:

- b_j is the basis of the j^{th} security
- BMV is the **begin market value** of the portfolio

$$\text{Weight}_j = \frac{b_j}{\text{BMV}}$$

where here Weight_j denotes the weight of the j^{th} security. It follows that the sum, over all holdings including all Cash holdings, of the weights is always equal to one.

A.2 Returns

Gain for non-Cash Securities In order to calculate returns, we need the notion of gain. With the exception of Buy and Hold, each methodology calculates the gain as follows for *non-Cash securities*.

- V_{open} is the **opening value** of the given non-Cash security for the period
- V_{buy} is the **purchase value** of the given non-Cash security for the period
- V_{sell} is the **sale value** of the given non-Cash security for the period
- V_{close} is the **ending value** of the given non-Cash security for the period

- S is the **settlement cash** of the given non-Cash security for the period
- Int is the **net interest/fees** associated to the given non-Cash security for the period
- NFC is the **net flows at the close** of the given non-Cash security for the period

$$\text{Dietz Gain} = (V_{\text{close}} - V_{\text{open}}) + (V_{\text{sell}} - V_{\text{buy}}) - \text{NFC} + S + \text{Int}$$

For Buy and Hold, since we are assuming there are no trades for the day, the calculation is simply

$$\text{B\&H Gain} = V_{\text{close}} - V_{\text{open}} - \text{NFC} + S + \text{Int}$$

Gain for Cash Securities For *Cash securities*, the notion of gain is a bit more involved, but the logic is similar for calculating the basis for cash securities. It becomes particularly complicated when the fund uses multiple currencies. The basic idea is to separate the gains in a given cash instrument from the changes in its value caused by trading, interest, dividends, etc. involving that cash security. For the Dietz methodologies, the calculation is as follows.

- V_{close} is the **end value** of the given Cash security for the period
- V_{open} is the **begin value** of the given Cash security for the period
- V_{buy} is the **total purchase value** of all securities for the period
- V_{sell} is the **total sale value** of all securities for the period
- Int_{tot} is the **total net interest/fees** for the period
- NFC is the **net flows at the close** of the given Cash security for the period
- S_{cash} is the **settlement value** for the given cash security
- S_{tot} is the **total settlement value** for the period

$$\text{Dietz Cash Gain} = (V_{\text{close}} - V_{\text{open}}) + (V_{\text{buy}} - V_{\text{sell}}) + (S_{\text{Cash}} - S_{\text{tot}}) - \text{Int}_{\text{tot}} - \text{NFC}$$

For Buy and Hold cash gain, we ignore purchases and sales, so the calculation is as follows.

$$\text{B\&H Cash Gain} = (V_{\text{close}} - V_{\text{open}}) + (S_{\text{Cash}} - S_{\text{tot}}) - \text{Int}_{\text{tot}} - \text{NFC}$$

Adjustment Factor In the definition of security-level [return](#) below, we must divide by the basis of a security to calculate its return. However, it can happen that a security has a zero basis. For example, in Trades-at-Close, a security might not be held at the beginning of the period but be held at the end. The gains in that security are then spread across the fund. Also, the return for fees and interest applied to cash is also spread across the fund. This is done by multiplying security-level return factors by an appropriate adjustment factor, which is defined as follows.

- EMV is the [end market value](#) of the fund for the period
- ZBG is the sum of [gains](#) for all instruments in the fund with a zero [basis](#)
- Int_{cash} is the [net interest/fees](#) for cash

$$\text{Adjustment Factor} = \frac{\text{EMV}}{\text{EMV} - \text{ZBG} - \text{Int}_{\text{cash}}}$$

Return Now that we have notions of [basis](#) and [gain](#), we can define returns. With those definitions in hand, returns are calculated the same for all methodologies and all types of instruments. Return is calculated as follows for securities with a *nonzero basis*.

- Gain_j is the [gain](#) of the given security j
- Basis_j is the [basis](#) of the given security j
- Adj is the [adjustment factor](#)

$$\text{Return}_j = \left(1 + \frac{\text{Gain}_j}{\text{Basis}_j}\right) \text{Adj} - 1$$

For securities with a *zero basis*, their returns are given as follows.

$$\text{Return}_j = \text{Adj} - 1$$

Appendix B

Other Calculation Options

In this chapter of the appendix, we explain how certain user-selected parameters can modify the performance calculations throughout the report. Each section will cover a different user selected parameter.

B.1 Annualization

In this section, we describe how selecting an annualized report from the GUI affects the output performance report. Generally speaking, most performance calculations presented in an annualized report will be geometrically compounded to an annual number, whereas attribution numbers will be arithmetically scaled. The idea is that returns are geometric in nature, whereas attribution is arithmetic in nature. Furthermore, most calculations that can be meaningfully annualized are annualized.

Below is an outline of the changes that are made and an annualized report is selected. Any sheets not mentioned (e.g. the Daily sheet) are unaffected by choosing an annualized report.

- [Executive Summary](#):
 - A new row is added in the [Return Summary](#) section called Annualized Return.
 - Cumulative Transaction Cost is annualized.
 - All Active Returns in the [Decision Attribution Summary](#) section are annualized.
- [Fund and Benchmark Holdings Sheets](#)
 - All contributions, returns and decision effects are annualized.
- [Decision Attribution Summary Sheet](#)

- The Active Return column is annualized.
- [Decision Return Attribution Sheet](#)
 - All decision effects are annualized.
- [Top & Bottom Return Decisions Sheet](#)
 - All decision effects are annualized.
- [Decision Attribution Tree Sheet](#)
 - All contributions, returns and decision effects are annualized.
- – All contributions, returns and decision effects are annualized.

Now that we have discussed where the changes are made, let us describe how the various quantities are annualized. As we discussed above, there are two methods employed for annualizing: geometric and arithmetic. All returns (at the portfolio, sleeve and asset-level) are annualized geometrically except for active returns. All other quantities are annualized arithmetically: active returns, contributions, decision effects and cumulative transaction cost. Note that one consequence of this is that *annualized active returns are not the difference of the annualized Fund and Benchmark returns*.

We now describe these two types of annualization.

Geometric Annualization. If R is a quantity to be annualized geometrically (e.g. a return number), and a performance report has a Valuation Period of T years, then the annualized quantity R^{ann} is given by the following formula.

$$R^{\text{ann}} = (1 + R)^{1/T} - 1$$

Arithmetic Annualization. If A is a quantity to be annualized arithmetically (e.g. an active return, contribution, or decision effect), and a performance report has a Valuation Period of T years, then the annualized quantity A^{ann} is given by the following formula.

$$A^{\text{ann}} = \frac{A}{T}$$

B.2 Weighted Average Leverage Calculation

The weighted average leverage option is available through the performance GUI, and affects how sleeve-level returns are calculated in the presence of leverage. Fund-level and asset-level returns are unaffected by this option. When the option is turned off, sleeve-level returns

are calculated as expected (normalized weighted return of their constituents). However, when this option is turned on, if a sleeve has a negative weight, its reported return will be modified to reflect this leverage.

The reason why a user might be interested in this option is that if a sleeve has a negative weight, a negative return in the traditional sense (i.e. weighted average return of its constituents) results in a positive contribution to the fund. The user might instead expect a positive return for that sleeve in this situation, in which case turning the option on would be appropriate.

Let us now give the precise computation for how this is performed. We give the computation for a single period (e.g. day or month). Returns over multiple periods are compounded, as usual.

- w_i is the [trade weight](#) of security i for the given period
- r_i is the [trade return](#) of security i for the given period

$$r_S = \sum_{i \in S} r_i w_i \left(\frac{\sum_{i \in P} |w_i|}{\sum_{i \in S} |w_i|} \right)$$

where the sum over S denotes a sum over securities in the sleeve and sum over P denotes a sum over all securities in the portfolio.

B.3 MD Overflow Adjustment

As discussed in the [appendix on performance methodologies](#), one inherent problem with the modified Dietz formula for asset-level returns is that a very big daily gain (e.g. double in value) can be recorded as a negative return under -100% . The MD (or Modified Dietz) Overflow Adjustment option allows the user to prevent modified Dietz returns from going below -100% . Using this option only affects security-level returns. We give the details below, but in short, what it does is cap the returns at -100% and spread the left-over across all securities.

Overflow Factor. We first define the **overflow factor**, which captures the negative trade returns in excess of -100% . It is computed as follows.

- w_i is the [trade weight](#) of security i for the given period
- r_i is the [trade return](#) of security i for the given period
- r is the [fund return](#) for the given period

$$\text{Overflow Factor} = \frac{\sum_i w_i \times \min\{0, 1 + r_i\}}{1 + r}$$

where the sum is over all securities in the fund for the given period.

Given that definition for overflow factor, we can now define the MD return with overflow adjustment, which we denote r_i^{adj} .

- r_i is the [trade return](#) of security i for the given period
- OF is the [overflow factor](#) for the given period

$$r_i^{\text{adj}} = \frac{\max\{-1, r_i\} + \text{OF}}{1 - \text{OF}}$$

Appendix C

Long/Short Report

When analyzing a fund that has both long and short positions, the user has the option of creating a performance and attribution report that breaks out fund results into both the long and short side. In this appendix of the manual, we will go through the important additions that appear in the long/short report that do not appear in the default report that has been discussed already. The rows and columns that appear on both are calculated identically, but on the Long/Short report, many of the performance and risk calculations are further decomposed into the long and short sides of the fund.

For most of the calculations, the intuitive idea is to break the fund into three portfolios consisting of just the long, short and cash positions, and then to analyze the long and short portfolios separately. We begin by discussing the new Long and Short columns that appear on the [Executive Summary sheet](#).

C.1 Executive Summary Sheet

As discussed in the introduction to this chapter, many of the section of the Long/Short report contain additional columns that display performance and risk information for the long and short side of the fund, labeled Long Fund and Short Fund, respectively. Most of these entries are self-explanatory, so we will not go into too much detail describing them.

The calculations themselves all use the same idea. Namely, since every calculation on the Executive Summary sheet involves a sequence of period fund returns, to calculate the long or short side of the fund, we simply use the sequence of [long fund or short fund returns](#).

Return Summary.

Return Summary					
Statistic	Fund	Long Fund	Short Fund	Benchmark	Active
Cumulative Return	(0.60)%	(0.49)%	(0.11)%	1.08 %	(1.68)%
Cumulative Transaction Cost	(0.37)%				
Cumulative VAMI	\$993	\$995	\$998	\$1,010	(\$17)
Worst 20 Days	(4.68)%	(4.42)%	(2.20)%	(5.50)%	(3.59)%
Best 20 Days	4.38 %	4.02 %	2.57 %	6.18 %	4.34 %
Worst Day	(2.39)%	(2.16)%	(0.98)%	(2.27)%	(1.74)%
Best Day	1.80 %	1.44 %	1.11 %	1.63 %	2.00 %
Valley	(5.30)%	(4.68)%	(1.18)%	(5.06)%	(3.48)%
Peak	2.02 %	1.92 %	2.84 %	1.99 %	1.88 %
Batting Average	50.00 %	53.03 %	39.39 %	53.03 %	51.52 %

As discussed above, all of calculation for the Long Fund and Short Fund columns in the Return Summary are analogous to the corresponding calculations for the Fund and Benchmark. By way of example, we will give the calculation for Long Fund cumulative return.

- n is number of periods in the valuation period
- R_i is the [Long Fund return](#) during period i

$$\text{Cumulative Long Fund Return} = \prod_{i=1}^n (1 + R_i) - 1$$

The calculations for the remaining rows in the Long Fund and Short Fund columns are equally analogous to the corresponding calculations in the default [Executive Summary sheet](#), so we direct the reader there for further details. Namely, just replace the period fund returns with either the long fund returns or short fund returns then perform the same calculation.

C.2 Daily (or Period) Sheet

The Daily (or Period) Sheet in the Long/Short report has the same information as the Daily (or Period) Sheet in the default report, but again has some additional columns to display the performance of the Long Fund and Short Fund separately.

Total Return

Total Return					
Fund	Long	Short	Benchmark	Market	Active
(0.03)%	(0.05)%	0.21 %	(0.00)%	(0.00)%	(0.03)%
(0.02)%	(0.04)%	0.18 %	(0.16)%	(0.16)%	0.14 %
0.23 %	0.21 %	(0.08)%	0.90 %	0.90 %	(0.67)%

The return numbers for the Long Fund and Short Fund are computed analogously to the [single period returns](#) on the default report, except that we once again separate the long and short sides of the portfolio. This is done as follows for the Long Fund column, with the Short Fund column calculated analogously.

- EV_{long} is the end value of the long, noncash positions in the fund for the period
- BV_{long} is the begin value of the long, noncash positions in the fund for the period
- NFC_{long} is the net flows as the close into the long, noncash positions in the fund for the period

$$\text{Long Fund Return} = \frac{EV_{\text{long}} - NFC_{\text{long}}}{BV_{\text{long}}} - 1$$

Exposure

Fund Exposure		
Net	Long	Short
99.51 %	115.25 %	(15.74)%
99.52 %	115.24 %	(15.72)%
99.76 %	115.26 %	(15.50)%
99.61 %	115.10 %	(15.49)%

The Exposure section of the Long/Short report is the only completely new section that does not appear in the default report. This section displays the weights of noncash securities on both the long and short side of the fund. The calculations are as follows.

- N is the number of noncash securities
- w_{Cash} is the [begin weight](#) of cash for the period
- w_j is the begin weight of the j^{th} security

We get the Net column as follows.

$$\text{Net Fund Exposure} = 1 - w_{\text{Cash}}$$

For the Long Fund and Short Fund columns, we sum the [begin weights](#) of the *noncash securities* with positive and negative begin weights, respectively. That is,

$$\text{Long Exposure} = \sum_{j=1}^N w_j^+$$

and

$$\text{Short Exposure} = \sum_{j=1}^N w_j^-$$

where

$$w_i^+ = \begin{cases} w_i & \text{if } w_i \geq 0 \\ 0 & \text{if } w_i < 0 \end{cases}$$

and similarly

$$w_i^- = \begin{cases} w_i & \text{if } w_i \leq 0 \\ 0 & \text{if } w_i > 0 \end{cases}$$

Appendix D

Inputs into Performance & Attribution

In this chapter, we describe the input data used to create a performance report. Data can be brought into VIA from a variety of sources such as:

- Database: MySQL, Oracle, Microsoft SQL Server, Sybase and DB2
- Text files
- Excel files
- Live sources: Bloomberg, Interactive Data, Yahoo and Google
- Other software platforms: MATLAB and R

The VIA platform is extremely flexible. For data stored on a database, there is no need for a predefined database schema, and custom database queries can be used to source input data.

The philosophy to compute performance and attribution numbers is to correctly calculate security-level performance for a single period, then roll those numbers up across securities and across time. In order to calculate performance for a single period, we need to know how the portfolio changed from the start to the end of the period. We use the following notation to distinguish those two points in time:

- a subscript of $(T-1)$ denotes the holding date or beginning of the period (for example, $\text{Quantity}_{(T-1)}$ denotes the opening quantity for a period);
- a subscript of (T) denotes the valuation date or end of the period (for example, $\text{Close Price}_{(T)}$ denotes the close price for a period).

For the most accurate performance and attribution calculations, Opturo recommends using price and quantity data for securities. This chapter is written with that in mind, although VIA can alternatively use just value data (i.e. price times quantity) for its calculations. All input data is optional unless marked as “*Required*.”

1. Holdings Data Input (For each security in Fund, Benchmark and Composite)

- Composite Identifier: Unique composite identifier (*Required* for look-through)
- Security Identifier: Unique security identifier (*Required*)
- Quantity_(T-1): Shares or quantity on holding date (*Required*)
- Open Price_(T-1): Holding date close price in local (*Required*)
- Close Price_(T): Valuation date close price in local (*Required*)
- Book Price_(T-1): Holding date book price in local
- Open Accrual_(T-1): Holding date accrued interest, coupon receivable or dividend receivable in local
- Close Accrual_(T): Valuation date accrued interest, coupon receivable or dividend receivable in local
- Total Return_(T): Total return for valuation period in local (used for market returns and anything that needs to be calculated from market returns) (*Required*)
- Price Currency_(T): Currency name or code of local Open/Close Price or local Total Return (*Required*)
- Country_(T): Country name or code (*Required*)
- Asset Class_(T): Security classification as either Equity or Fixed Income (*Required*)
- Cash Category_(T): Category of cash settlement bucket in carve-out and multi-currency cash modes (*Required*)
- Override Open Market Value_(T-1): EOD holding date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Override Close Market Value_(T): EOD valuation date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Segment_(T): Security classification used for attribution (e.g. Asset Class, Country, etc.). See [Segment Definition](#) section for more details.

2. Settlement Cash Data Input: This dataset brings in any cash settlements arising from dividends or coupon payments.

- Security Identifier: Unique security identifier
- Settlement Cash_(T): Settlement cash from accrued interest, coupon or dividends in local
- Settlement FX Rate_(T): Settlement FX rate against the common secondary currency such as USD
- Settlement Currency_(T): Currency Description or currency code of settlement cash
- Settlement Cash Category_(T): Category of cash settlement bucket for carve-out and multi-currency cash modes

3. Interest/Fees Cash Data Input: This dataset brings in any security or portfolio interest and fees.

- Security Identifier: Unique security identifier
- Interest/Fees_(T): Portfolio-level gain/cost or miscellaneous rebates or fees on holdings including tax reclaim in local
- Settlement FX Rate_(T): Settlement FX rate against the common secondary currency such as USD
- Settlement Currency_(T): Currency description or currency code of interest or fees
- Settlement Cash Category_(T): Category of cash settlement bucket in carve-out and multi-currency cash modes

4. Bond Accrual Calculation Data Input: This dataset brings in required fields to calculate bond accrual if open and close accrual are not provided.

- Security Identifier: Unique security identifier
- Inception Date: For fixed income securities
- Maturity Date: For fixed income securities
- Coupon: For fixed income securities without daily dividend yield
- Payment Frequency: Payment frequency (possible frequencies are: Annually, semi-annually, quarterly, or monthly)

- Day Count Convention: Day count convention (30/360, ACT/360, ACT/365, or ACT/ACT)

5. Corporate Actions Data Input: Used to calculate the post quantity in the event of a split/stock dividend for equity or par value adjustment for fixed income securities. Needs to be defined for both fund and benchmark.

- Security Identifier: Unique security identifier
- Split Factor_(T): Quantity indicating number of resulting shares from the split of one share (e.g. value of 2 for a 2 for 1 split).

6. Overnight Flows Data Input: This dataset brings in any overnight flows such as cash or shares (benchmark being rebalanced) for each security at the beginning of each period. Can be defined for both fund and benchmark.

- Security Identifier: Unique security identifier
- Quantity_(T): The overnight cash flow or shares added to the portfolio after the close on the holding date.
- Trade Date: Define for non-Daily reporting frequency
- End of Period Flow Indicator_(T): Boolean value indicating whether Flow happens at the close or at the open. Default is at the open.
- Settlement FX Rate_(T): Settlement FX rate against the common secondary currency such as USD
- Open Price_(T-1): Holding date close price in local
- Close Price_(T): Valuation date close price in local
- Book Price_(T-1): Holding date book price in local
- Open Accrual_(T-1): Holding date accrued interest, coupon receivable or dividend receivable in local
- Close Accrual_(T): Valuation date accrued interest, coupon receivable or dividend receivable in local
- Total Return_(T): Total return for valuation period in local (used for market returns)

- Price Currency_(T): Currency name or code of local Open/Close Price or local Total Return
- Country_(T): Country name or code
- Asset Class_(T): Security classification as either Equity (E) or Fixed Income (F)
- Cash Category_(T): Category of cash settlement bucket in carve-out and multi-currency cash modes
- Override Open Market Value_(T-1): EOD holding date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Override Close Market Value_(T): EOD valuation date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Segment_(T): Other optional segment classifications used for attribution (e.g. Region, Market Capitalization, etc.). See [Segment Definition](#) section for more details.

7. Transaction Data Input: This dataset brings in any trades for the valuation period. It is defined only for Fund holdings.

- Security Identifier: Unique security identifier
- Trade Quantity_(T): Post-split or pre-split quantity or shares traded (as set by the Trade Post/Pre Split Indicator)
- Trade Date: Define for non-Daily reporting frequency
- Trade Indicator_(T): Trade Indicator indicating either Buy or Sell (e.g. “B” or “S”)
- Trade Price w/ Commissions_(T): Trade price (in local) net of transaction/trade commissions (either for each trade for a security or the average of all trades for that security for that period)
- Trade Price w/o Commissions_(T): Trade price (in local) that does includes transaction/trade commissions (either for each trade for a security or the average of all trades for that security for that period)
- Settlement FX Rate_(T): Settlement FX rate against the common secondary currency such as USD
- Trade Post/Pre Split Indicator_(T): Boolean value indicating post-split trade or pre-split trade

- Split Factor_(T): Define the split factor only if pre-split quantity or price is defined.
- Settlement Currency_(T): Currency of trade settlement or currency trade price
- Settlement Cash Category_(T): Category of cash settlement bucket for carve-out and multi-currency cash modes
- Open Price_(T-1): Holding date close price in local. Not needed for purchases
- Close Price_(T): Valuation date close price in local. Not needed for sales
- Open Accrual_(T-1): Accrued interest, coupon receivable or dividend receivable
- Close Accrual_(T): Accrued interest, coupon receivable or dividend receivable
- Price Currency_(T): Currency name or code of local Open/Close Price or local Total Return (Open for sales, Close for purchases)
- Country_(T): Country name or code
- Asset Class_(T): Security classification as either Equity (E) or Fixed Income (F)
- Override Open Market Value_(T-1): EOD holding date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Override Close Market Value_(T): EOD valuation date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Segment_(T): Other optional segment classifications used for attribution if chosen in the decision tree (e.g. Region, Market Capitalization, etc.). See [Segment Definition](#) section for more details.

8. FX Data Input: This dataset brings in foreign exchange rates for the valuation and holding dates. The rates should be brought in as a multiplication factor. Inverse rates are quoted as inverse such as GBP to USD, etc. All rates should be against a common base currency such as USD.

- Primary Currency Code: Unique primary currency code
- Close Rate_(T-1): Close rate on holding date
- Close Rate_(T): Close rate on valuation date

9. Risk Free Rate Data Input: The risk free rate is typically the overnight rate that can be obtained essentially without risk. It can be different from the actual interest earned by the cash in the portfolio (return on cash instrument). A portfolio can have multiple cash instruments that have differing return on cash instruments. But, the risk free rate is a single rate for each country applied in common to the fund and benchmark.

- Country Code: Unique country identifier
- Currency_(T): Currency name code of country
- Rate_(T): Risk free rate for valuation period

10. Fund Holdings Market Data Input (Transaction Mode only): This dataset brings in market data and other relevant information for the fund holdings.

- Security Identifier: Unique security identifier (*Required*)
- Open Price_(T-1): Holding date close price in local (*Required*)
- Close Price_(T): Valuation date close price in local (*Required*)
- Open Accrual_(T-1): Holding date accrued interest, coupon receivable or dividend receivable in local
- Close Accrual_(T): Valuation date accrued interest, coupon receivable or dividend receivable in local
- Total Return_(T): Total return for valuation period in local (used for market returns and anything that needs to be calculated from market returns) (*Required*)
- Price Currency_(T): Currency name or code of local Open/Close Price or local Total Return (*Required*)
- Country_(T): Country name or code (*Required*)
- Asset Class_(T): Security classification as either Equity or Fixed Income (*Required*)
- Cash Category_(T): Category of cash settlement bucket in carve-out and multi-currency cash modes (*Required*)
- Override Open Market Value_(T-1): EOD holding date market value to be overridden in cases where net gain/loss is used instead of the notional value
- Override Close Market Value_(T): EOD valuation date market value to be overridden in cases where net gain/loss is used instead of the notional value

11. Yield Curve (Open/Close/Shift/Twist/Bend) Input: This dataset is defined to perform Fixed Income Return Decomposition. The yield for any date not provided will be generated by an interpolation method chosen by the user. The zero point on the yield curve is assumed.

- $\text{Date}_{(T)}$: Maturity date
- $\text{Curve Value}_{(T)}$: Annualized Yield or Key Rate in decimal

12. Intraday Market Data Input (Intraday Mode only): This dataset brings in intraday or real-time market data for the valuation of current date.

- Security Identifier: Unique security identifier
- $\text{Close Price}_{(T)}$: Temporary EOD valuation date close price in local
- $\text{Total Return}_{(T)}$: Total return for the period from open to present in local and in decimal terms

13. FX Intraday Data Input (Intraday Mode only): This dataset brings in intraday or real-time foreign exchange rates for the valuation or current date. The rates should be brought in as a multiplication factor. Inverse rates are quoted as inverse such as GBP to USD, etc. All rates should be against a common secondary currency such as USD.

- Primary Currency Code: Unique primary currency code
- $\text{Close Rate}_{(T)}$: Temporary close rate on valuation date

Segment Definition & Data As described in the section on the [Decision Attribution Summary](#), the goal of attribution is to attribute the fund's active return or gain into various effects. These effects are determined by the decisions supposed in the decision tree and the properties assigned to the securities. These properties are brought into VIA as part of the segment definitions. We describe here how that is done.

Discrete Segments. Here are some examples of Discrete Segments attached to each security:

- $\text{Asset Class}_{(T)}$: Security classification as either Equity (E) or Fixed Income (F)
- $\text{Long/Short}_{(T)}$: Security classification as either Long (L) or Short (S) (to override default classification of L/S by positive/negative weights)
- $\text{Sector}_{(T)}$: Sector description or sector code for equity and fixed income security

- $\text{Industry}_{(T)}$: Industry description or industry code for equity and fixed income security
- $\text{Discrete Ratings}_{(T)}$: Ratings for fixed income securities

This data is brought in as follows.

1. Define display list of discrete segments (e.g. Asset Class, GICS Sector, Country, Ratings)
2. Define the corresponding data columns names for each discrete segment (e.g. ASSET_CLASS, GICS_SECTOR, COUNTRY_CODE, RATING)
3. Define the value-name map for each of the segments. Define word “null” if the data value is the display name (data column contains country name as country code). Support for start and end date range, where for instance an item moved categories (country moved to a new region or an industry moved to a new sector). Format: value - name - start date (optional) - end date (optional)
4. Define the complete category list for each segment. Define the word “null” if no category list needs to be defined. An example category list would be the complete list of the ten GICS Sectors. This list ensures that if no security falls in a category over the entire valuation period, then the category is still listed in the performance and attribution report (with values of “0”).
5. Define the segment groupings. Segments will be grouped into folders for display on the application’s interface. Define word “null” if no grouping is needed. Also add the definition text (explanation) for the segment. VIA supports the definition of cascading groupings. For example, a list could be: Sector, GICS Sector, GICS Industry Group, GICS Industry; Sector, FTSE Sector, FTSE Classified Sectors; Region, Sub-region, Country.

Continuous Segments. Here are some examples of Continuous Segments attached to each security:

- $\text{Duration}_{(T)}$: Duration for fixed income securities
- $\text{OAS/Continuous Bond Rating}_{(T)}$: Option adjusted spread or continuous bond ratings for fixed income securities
- $\text{Price/Earnings}_{(T)}$: P/E ratio for equity securities
- $\text{Market Capitalization}_{(T)}$: Market capitalization for equity securities

- Coupon Rate_(T): Coupon Rate for fixed income securities

This data is brought in as follows.

1. Define display list of continuous segments (e.g. Market Capitalization, Duration, Coupon Rate, P/E).
2. Define the corresponding data column names for each segment (e.g. MKT_CAP, DURATION, BOND_COUPON_RATE, PRICE_EARNING).
3. Define one or more fixed-value bucketing criteria for each of the segment. Define word “null” if no fixed-value bucketing needs to be defined for the segment. By default, each continuous segment can be bucketed by the dynamic or continuous bifurcation bucketing methodologies. The fixed-value bucketing is in addition to the dynamic and continuous bifurcation bucketing methodologies. The upper and lower bounds should be defined to capture the lowest and highest values. Any values that do not fall in the defined buckets will be allocated to the “Unassigned” bucket. Format: category name - lower bound - upper bound - start date (optional) - end date (optional)
4. Define the segment groupings. Segments will be grouped into folders for display on the application’s interface. Define word “null”, if no grouping is needed. Also add the definition text (explanation) for the segment. Also supports the definition of cascading groupings.

Appendix E

Hardware Requirements

Below we list recommended minimum hardware requirements. As with any computationally intensive software, the more RAM and processor speed available, the faster VIA will run.

Recommended **desktop** hardware specifications:

Processor:	Quad Core Processor @ minimum 2.5 GHz
Memory:	8 GB RAM
Hard Drive Space:	2 GB of disk spaces
OS:	64-bit Windows/Linux/Unix

Recommended **server** hardware specifications:

Processor:	Dual Quad Core Processors @ minimum 2.5 GHz
Memory:	64 GB RAM
Hard Drive Space:	2 GB of disk space
OS:	64-bit Windows/Linux/Unix