The Morningstar Category Average Methodology

Morningstar Research
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Introduction

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Construction Methodology

For the TRI series, only daily pricing share classes will contribute to the Morningstar Category averages. This is to prevent funds with a less-frequent pricing basis from skewing the daily returns of the category average.

The monthly/quarterly/annually precalculated returns for all universes will incorporate all share classes that price monthly (or more frequently).

The category average return is the performance of a portfolio of the funds in the category. The portfolio is constructed as follows.

1. On the last day of each month, the category average is constituted with all share classes of all funds in the category as of that date.
2. Funds that can only be purchased by professional investors should be excluded from the average.
3. On the last day of each month, the funds are equally weighted and the share classes within each fund are equally weighted. This is called fractional weighting. Consider a very simple category with five funds, each with five share classes. Each fund has a weight of one, so therefore each share class of each fund has a weight of 0.2 (one fund divided by five share classes). The 25 share classes have a combined weight of 25 times 0.2, or five, the number of funds in the category. By ensuring each fund is weighted equally regardless of the number of share classes it has, fractional weighting ensures that funds with multiple share classes do not dominate and skew the returns of the average.

4. The portfolio is not rebalanced during the month, unless one or more funds or share classes drop out. If one or more share classes of a fund drop out, the weighting of that share class is distributed proportionally among the remaining share classes of the fund. If one or more funds drop out entirely, the fund's weighting is distributed proportionally among the remaining funds (and then proportionally among each fund's share classes).

5. Dividends and other income payouts are reinvested on the reinvestment dates.

6. Rules 3 and 4 are applied daily to create a provisional portfolio. If it later turns out that the absences of net asset values or income payouts were due to a lag in reporting, the daily returns are restated once the data become available.

7. Each day, the daily values for the current month and previous month will be recalculated.

Hence, the daily category average return is the one-day performance of a portfolio that is reconstituted monthly.

Returns of Constituent Share Classes
The returns of the individual share classes in each category shall be calculated, wherever possible, from the NAV (or other tradable price) and dividend information. The returns shall be calculated on a pretax total return basis. In cases where a fund does not publish NAVs (or other tradable prices), then the published returns for the fund shall be used.

Calculation Methodology for the Monthly, Quarterly, and Annual Returns
In August 2017, the methodology used to calculate the monthly, quarterly, and annual returns was changed to introduce fractional weighting. For all existing categories, the returns for period-ends after this date will be calculated using the new methodology, while returns for periods prior to that date will continue to use the old nonfractional methodology. Any category launched after this date will use the new methodology for the entire history.

Methodology for All Return Periods Ending After August 2017
Each fund is represented as one distinct portfolio in the category group. Upon reconstitution, a fund composed of four share classes receives a fractional weighting of 0.25 on each share class; this is multiplied by the fund weighting to determine the share-class weighting.

The category return for any given month can be calculated first by finding each share class' weighting for that period:

Exhibit 1

$$W_t(f,s) = \frac{1}{|F(t)|}\frac{1}{|S(f,t)|}$$

where

$w_t(f,s) = weighting\ for\ share\ class\ s\ of\ fund\ f\ at\ t,\ the\ end\ date\ of\ the\ period$

|F(t)| = number of funds at time t in the category

|S(f,t)|= number of share classes of fund f at t

The category average return is the weighted average return of the constituents.

Exhibit 2

$$R_{tC} = \sum_{f \in F(t)} \sum_{s \in S(f,t)} w_{t(f,s)} R_{t(f,s)}$$

where

$R_{tC} = average\ return\ for\ category\ c\ for\ period\ t$

$R_t(f, s)$ = return for share class s of fund f on the final day of period t

$w_t(f, s)$ = fractional weighting for share class s of fund f on the final day of period t

$F(t) = set\ of\ all\ funds\ in\ the\ category\ on\ the\ final\ day\ of\ period\ t$

$S(f,t) = set\ of\ all\ share\ classes\ of\ fund\ f\ on\ the\ final\ day\ of\ period\ t$

Methodology for All Return Periods Ending Prior to August 2017
The calculation is simply the average of the returns for all share classes (active and obsolete) for that period in the category. For example, Morningstar calculates a calendar-year return for 1997 for the large-growth category by doing a simple arithmetic average of the 1997 calendar-year returns for all share classes that were assigned to the large-growth category as of Dec. 31, 1997. This can include currently obsolete share classes that were active during the 1997 calendar year.

Exhibit 3

$$R_{ct} = \frac{\sum_{i=1}^{n} R_{st}}{n}$$

where

$R_{ct=}$ *average return for the category for time period t*

$R_{st} = return\ for\ share\ class\ s\ for\ period\ t$

$n = number\ of\ share\ classes\ in\ the\ category\ with\ returns\ for\ period\ t$

Calculation Methodology for the Daily Return Index Series

In August 2017, the methodology used to calculate the daily return index series was changed to introduce fractional weighting. For all existing categories, the daily returns after this date will be calculated using the new methodology, while daily returns prior to that date will continue to use the old nonfractional methodology. Any category launched after this date will use the new methodology for the entire history.

Methodology for All Daily Returns After August 2017

This new methodology is used to calculate the total return index series for Morningstar Categories.

The total return index series indicates a category's performance on a daily basis. Funds are rebalanced to equal weightings upon month-end reconstitution, and during the month their weightings float dynamically based on their relative performance in the category. Funds with inceptions or classification changes during the month are added to the category at the next month-end reconstitution. Funds that exit the category because of termination or classification change during the month are removed from the category on the dates they exit, and their weightings in the category average are prorated among surviving funds based on the latter's dynamic weightings. This methodology ensures that the fund weightings are dynamically floating and the category returns are free of survivorship bias. A fund is considered terminated when all of its share classes are terminated.

In addition, we incorporate fractional weightings into the methodology. This means that each fund is represented as one distinct portfolio in the category group. Upon reconstitution, a fund composed of four share classes receives a fractional weighting of 0.25 on each share class; this is multiplied by the fund weighting to determine the share-class weighting. Following the same logic as above, share classes with inceptions or classification changes during the month are added to the category at the next month-end reconstitution. Share classes that exit the category because of termination or classification change during the month are removed from the category on the dates they exit, and their weightings in the category average are prorated among surviving share classes of the same fund based on these share classes' dynamic weightings.

At month-end reconstitution, the formula for each fund's share-class weighting is:

Exhibit 4

$$w_{t0}\,(f,s) = \frac{1}{|F(t0)|}\frac{1}{|S(f,t0)|}$$

where

$w_{t0}\,(f,s)$ = *weighting for share class s of fund f on day t0, the day of month-end reconstitution*

$|F(t0)| = $ *number of funds on day t0*

$|S(f,t0)| = $ *number of all share classes of fund f on day t0*

On a daily basis, the category average TRI is calculated from the weighted average return (from the last reconstitution date to the current date) of the surviving constituents. The category average total return index and return are expressed in the following formulas:

Exhibit 5

$$TRI_t^{category} = TRI_e^{category} * \left[1 + \sum_{f \in F(e)} \sum_{s \in S(f,e)} w_{e\,(f,s)} * R_{e,t\,(f,s)}\right] =$$

$$TRI_e^{category} * \left[\sum_{f \in F(e)} \sum_{s \in S(f,e)} w_e(f,s) * \frac{TRI_t(f,s)}{TRI_e\,(f,s)}\right]$$

where

$TRI_t^{category}$ = *total return index for the category on day t*

$e = $ *date of the most recent fund and/or a share class exit, and e < t*

$F(e) = $ *set of all funds in the category on day e*

$S(f, e) = $ *set of all share classes of fund f on day e*

$w_e\,(f, s) = $ *weighting for share class s of fund f on day e. This will equal $w_{t0}\,(f, s)$ until a share class leaves the category*

$TRI_e^{category}$ = *total return index for the category on day e*

$TRI_t(f,s) = $ *total return index for each f, s on day t*

$TRI_e\,(f, s) = $ *total return index for f, s on day e*

Note: e will equal t0 from the date of the month-end until the first date that a fund or share class leaves the category

Exhibit 6

$$R_{t-1,t}^{category} = \frac{TRI_t^{category}}{TRI_{t-1}^{category}} - 1$$

where

$R_{t-1,t}^{category}$ = *return for the category in the period from day t − 1 to day t*

If a category has funds/share classes leaving the category because of liquidation or reclassification or any other reason, then the weightings of the remaining share classes would need to be recalculated.

If an entire fund leaves the category--that is, no share classes of that fund remain in the category after that date--then that fund's weighting on the day it leaves the category will be distributed across all remaining share classes in the category in proportion to their respective weightings on the day the fund leaves.

If a share class leaves the category but share classes from the same fund remain in the category, then that share class' weighting on the day it leaves the category will be distributed across the remaining share classes of that fund in proportion to their respective weightings on the day the share class leaves.

To calculate the new weightings for the remaining funds/share classes on the day the category has a fund or share class leave the category, first calculate:

Exhibit 7

$$w_{e-1}(f) = \sum_{s \in S(f,e-1)} w_{e-1}(f,s)$$

where

$w_{e-1}(f)$= *weighting of fund f at time period e − 1, the day before any fund/share class leaves, e*

Exhibit 8

$$v_{e-1,t}(f,s) = \frac{1}{\sum_{g \in F(t)} w_{e-1}(g)} \frac{w_{e-1}(f)}{\sum_{q \in S(f,t)} w_{e-1}(f,q)} w_{e-1}(f,s) \frac{TRI_t(f,s)}{TRI_{e-1}(f,s)}$$

where

$v_{e-1,t}(f,s)$= *value at time t of the money invested in fund f share class s at time e − 1 per $1 of the value of the portfolio at time e−1*

$F(t)$ = *the set of funds that are still in the category on day t (g is an element of this set)*

$S(f,t)$ = *the set of share classes of fund f that are still in the category on day t (q is an element of this set)*

Exhibit 9

$$w_t\,(f,s) = \frac{v_{e-1,t}\,(f,s)}{\sum_{g \in F(t)} \sum_{q \in S\,(g,t)} v_{e-1,t(g,q)}}$$

where

$w_t\,(f,s)\ =\ weighting\ of\ share\ class\ s\ of\ fund\ f\ at\ time\ t$

This now becomes the new reconstitution date, and the daily TRI is now calculated from this date and series of weightings. See Exhibit 5.

Methodology for Daily Returns Prior to August 2017

The first step is to calculate the average daily return for each category based on all share classes (active and obsolete) that existed on that day.

Exhibit 10

$$R_{ct} = \frac{\sum_{i=1}^{n} R_{st}}{n}$$

where

$R_{ct}\ =\ return\ for\ category\ c\ on\ day\ t$

$R_{st}\ =\ return\ for\ share\ class\ s\ on\ day\ t$

$n\ =\ number\ of\ share\ classes\ in\ the\ category\ on\ day\ t$

Then the total return index value is calculated

Exhibit 11

$$TRI_t\ =\ TRI_0\ *(1 + CR_t) = TRI_{t-1}\ *\ (1\ +\ R_{ct})$$

where

$TRI_t = total\ return\ index\ on\ day\ t$

$TRI_0\ = total\ return\ index\ at\ the\ beginning\ of\ the\ period$

$CR_t\ = total\ return\ cumulative\ from\ the\ beginning\ to\ day\ t,\ expressed\ in\ decimal\ format$

$TRI_{t-1} = total\ return\ index\ on\ day\ (t-1),\ the\ day\ prior\ to\ day\ t$

$R_{ct}\ = total\ return\ on\ day\ t,\ expressed\ in\ decimal\ format$

Methodology for Active and Passive Category Averages

In the US Open End and Exchange Traded Product Universe, Morningstar divides the constituents of each Morningstar category into two groups: Active and Passive. Although most exchange-traded products are passively-managed index-based products, not all of them are. Further, a material number of open-end funds are explicitly stated as being index tracking vehicles. Morningstar will group as Passive all open-end funds and exchange-traded products that are marked as 'Index Fund = True', as well as Strategic Beta funds, to create category sub-group averages. The remaining products will be grouped in the Active sub-group.

Methodology for IA, GIF, AIC and ABI Daily Returns

For the IA, GIF, AIC and ABI sector averages a single share classes within a fund (referred to as the primary share class) is used as a proxy for the fund. Funds are rebalanced to equal weights upon month-end reconstitution, and during the month their weights float dynamically based on their relative performance in the chosen classification peer group/sector. For the purpose of this calculation, funds with inceptions or classification changes during the month are added to the sector at the next month-end reconstitution. Funds that exit the sector because of termination or classification change during the month are removed from the sector on the dates they exit, and their weights in the sector average are prorated among surviving funds based on the latter's dynamic weights. These fund weights will be referred to as adjusted weights in order to distinguish them from equal weighting on that day. This methodology ensures that the fund weights are dynamically floating and the sector returns are survivorship-bias free. On a daily basis, the sector average return is the weighted average return of the surviving constituents.

The sector average return and the weight for each fund can be expressed in the following formulas.

Exhibit 12

$$R_{t-1,t}^{sector} = \sum_{f=1}^{n_t} \widetilde{w}_{t-1}^{f} \bullet R_{t-1,t}^{f}$$

$R_{t-1,t}^{Sector} = $ *return for the sector in the period from t-1 to t*

$\widetilde{w}_{t-1}^{f} = $ *adjusted weight for fund f on day t - 1*

$R_{t-1,t}^{f} = $ *return for fund f in the period from t -1 to t*

$n_t = $ *number of funds in the sector at time t*

Exhibit 13

$$\widetilde{w}_{t-1}^{f} = \frac{1}{n_t} \quad \text{if } t \text{ is month-end}$$

$$\widetilde{w}_{t-1}^{f} = \frac{w_{t-1}^{f}}{\sum_{i \in s_t} w_{t-1}^{i}} \quad \text{if } t \text{ is not month-end}$$

where

$w_{t-1}^{f} = pre-adjustment\ weight\ for\ fund\ f\ on\ day\ t-1$

$w_{t-1}^{i} = pre\text{-}adjustment\ weight\ for\ fund\ i\ on\ day\ t\ \text{-}1$

$s_t = subset\ of\ funds\ that\ survived\ at\ time\ t$

Exhibit 14

$$w_t^f = w_{t-1}^f \bullet \frac{\left(1 + R_{t-1,t}^f\right)}{\left(1 + R_{t-1,t}^{Sector}\right)}$$

where

$w_t^f = pre\text{-}adjustment\ weight\ for\ fund\ f\ on\ day\ t$

$w_{t-1}^{f} = pre-adjustment\ weight\ for\ fund\ f\ on\ day\ t-1$

It may not be practical to calculate and store daily weights for a large quantity of funds that are dynamic floating and survivorship-bias free. Therefore, the rest of the document offers formulas expressed in total return index format that serve as an alternative to formulas in the section above. The following formula establishes the relationship between the total return and its total return index.

Exhibit 15

$$R_{t-1,t} = \frac{TRI_t}{TRI_{t-1}} - 1$$

where

$TRI_t = total\ return\ index\ on\ day\ t$

$TRI_{t-1} = total\ return\ index\ on\ day\ t-1, the\ day\ prior\ to\ t$

$R_{t-1,t} = total\ return\ for\ the\ period\ t-1\ to\ t$

When performing a sector average return calculation for a day that does not have a fund exit in the month on or before that day, the sector average return is the equally weighted average of the month-to-

date cumulative returns of the constituent funds. Following is the formula expressed in return and total return index formats.

Exhibit 16

$$TRI_t^{Sector} = TRI_0^{Sector} \bullet \left[1 + \frac{1}{n_0} \bullet \Sigma_{f=1}^{n_0} R_{0,t}^f\right] = TRI_0^{Sector} \bullet \left[1 + \frac{1}{n_0} \bullet \Sigma_{f=1}^{n_0} \left(\frac{TRI_t^f}{TRI_0^f} - 1\right)\right]$$

where

TRI_t^{Sector} = total return index for sector on day t

TRI_0^{Sector} = total return index for sector on day 0, the time of last reconstitution

n_0 = number of funds in the sector on day 0, the time of last reconstitution

$R_{0,t}^f$ = return for fund f in the period from day 0, the time of the last reconstitution, to day f

TRI_t^f = total return index for fund f on day t

TRI_0^f = total return index for fund f on day 0

When performing sector average return calculation for a day that has a fund exit in the month on or before that day, the sector average return is the weighted average of the cumulative returns of the constituent funds from the last fund exit date to the calculation date. Below is the formula.

Exhibit 17

$$TRI_t^{Sector} = TRI_e^{Sector} \left[\bullet\ 1 + \sum_{f=1}^{n_e} \widetilde{w}_e^f \bullet R_{e,t}^f\right] = TRI_e^{Sector} \bullet \left[1 + \sum_{f=1}^{n_e} \widetilde{w}_e^f\right] \bullet \left(\frac{TRI_t^f}{TRI_e^f} - 1\right)$$

where

TRI_t^{Sector} = total return index for sector on day t

TRI_e^{Sector} = total return index for sector on day e, last fund exit date

n_e = number of funds in the sector on day e, last fund exit date

$\widetilde{w}_e^f$ = adjusted weight for fund f on day e, last fund exit date

$R_{e,t}^f$ = return for fund f in the period from day e, the last fund date, to day t

TRI_t^f = total return index for fund f on day t

TRI_e^f = total return index for fund f on day e, the last fund exit date

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The adjusted weight of each surviving fund can be obtained by using the recursive formulas in Exhibits 13 and 14 in the section above; however, it is more efficiently defined in the following formula.

Exhibit 18

$$\widetilde{w}_e^f = \frac{\widetilde{w}_{e-1}^f \bullet \left(1 + R_{e-1,e}^f\right)}{\sum_{i \in S_e} \widetilde{w}_{e-1}^i \bullet \left(1 + R_{e-1,e}^i\right)} = \frac{\widetilde{w}_{e-1}^f \bullet \left(TRI_e^f / TRI_{e-1}^f\right)}{\sum_{i \in S_e} \widetilde{w}_{e-1}^i \bullet \left(TRI_e^i / TRI_{e-1}^i\right)}$$

note

$\widetilde{w}_{e-1}^f = \frac{1}{n_0}$ *when e is the first fund exit for the month*

where

$\widetilde{w}_e^f$ = adjusted weight for fund f on day e, the last fund exit date

$\widetilde{w}_{e-1}^f$ = adjusted weight for fund f on day $e - 1$, the prior fund exit date

$R_{e-1,e}^f$ = return for fund f in the period from day $e - 1$, the prior fund exit date, to day e, the last fund exit date

$R_{e-1,e}^i$ = return for fund i in the period from day $e - 1$, the prior fund exit date, to day e, the last fund exit date

TRI_e^f = total return index for fund f on day e, the last fund exit date

TRI_{e-1}^f = total return index for fund f on day $e - 1$, the prior fund exit date

TRI_e^i = total return index for fund i on day e, the last fund exit date

TRI_{e-1}^i = total return index for fund i on day $e - 1$, the prior fund exit date

Only funds that price daily are included in the sector average calculation. This is done to prevent the averages from skewing. If the current price is unavailable the previous day's closing price is used. If the fund is found to have changed pricing availability the fund may be removed from the sector average.

In addition, the index is rerun every month-end and, in order to capture all distributions that are collected near the end of the calendar year, the index is rerun in January and February.

Calculation of Non-Return-Based Averages for the Category

For data points such as fees or share class sizes, where share classes within a fund would normally have different values, the calculation of a category average for those data points is a simple mean average basis of the values of all the share classes in the category.

Exhibit 19

$$V_{tc} = \frac{\sum_{i=1}^{n} x_{tci}}{n}$$

where

$V_{tc} = value\ for\ category\ c\ during\ time\ period\ t$

$x_{tci} = value\ for\ share\ class\ i\ in\ category\ c\ during\ time\ period\ t$

$n\ =\ total\ number\ of\ share\ classes\ in\ the\ category$

For data points where share classes within a fund can be expected to have the same or very similar values (such as yields or risk statistics such as alpha, beta, correlation, and so on), then the average is calculated fractionally by finding out each share class' weight at the time of calculation.

Exhibit 20

$$w_t\ (f, s) = \frac{1}{|F(t)|}\ \frac{1}{|S(f,t)|}$$

where

$w_t\ (f, s)\ =\ weighting\ for\ share\ class\ s\ of\ fund\ f\ at\ t$

$|F(t)| = number\ of\ funds\ at\ time\ t\ in\ the\ category$

$|S(f,t)| = number\ of\ share\ classes\ of\ fund\ f\ at\ time\ t$

The category average is the weighted average value of the constituents.

Exhibit 21

$$v_{tc} = \sum_{f \in F(t)} \sum_{s \in S(f,t)} w_t(f,s)\, v_t(f,s)$$

where

v_{tc} = *average value for category c for month t*

$v_t(f, s)$ = *value for share class s of fund f on the final day of month t*

$w_t(f,s)$ = *fractional weighting for share class s of fund f on the final day of month t*

F(t) = *set of all funds in the category on the final day of month t*

S(f, t) = *set of all share classes of fund f on the final day of month t*

Methodology Changes

The following is a timeline of significant methodology changes to the Morningstar ranking methodologies.

Date	Description
August 2017	Introduction of fractional weighting changes to category averages.
	New methodology paper replacing:
	Morningstar Calendar Year Category Averages Methodology November 2010
	The category averages and sector averages sections of the Morningstar Total Return Index
	Methodology 2013