AON

Federal Retirement Thrift Investment Board

Thrift Savings Plan | Benchmark Study

November 2023

Contents

Executive Summary

The Federal Thrift Savings Plan (TSP) requested Aon Investments USA, Inc. ("Aon") review and evaluate the appropriate indices to use for the following investment options:

- Common Stock Index Investment Fund (C Fund)
- Small Capitalization Stock Index Investment Fund (S Fund)
- Fixed Income Index Investment Fund (F Fund)
- International Stock Index Investment Fund (I Fund)

As part of our analysis, we reviewed multiple indices/benchmarks for each investment option, the construction methodology and opportunity set covered by each, the investability and liquidity of the indices, acceptance of the indices by the investment community, the appropriateness of the indices for the TSP, and the estimated costs associated with making a change. We believe the above factors are the most relevant to consider when choosing a benchmark.

Based on our review, we have the following recommendations:

C Fund and S Fund

Maintain the S&P 500 Index for the C Fund and the Dow Jones U.S. Completion Total Stock Market Index for the S Fund

Our recommendation is based on the following primary reasons:

- The combination of the S&P 500 Index with the Dow Jones U.S. Completion Total Stock Market Index provides complete U.S. equity market coverage.
- The stocks in the S&P 500 Index and the Dow Jones U.S. Completion Total Stock Market Index are liquid and trade frequently, allowing index fund managers to hold the majority of the stocks in these indices.
- Total passive assets benchmarked to the S&P 500 and Dow Jones U.S. Completion Total Stock Market indices are about eight times of those benchmarked to the Russell 1000 and Russell 2000 indices.
- The S&P 500 Index has high recognition value among non-investment professionals, which constitute the vast majority of the participants.

F Fund

Maintain the Bloomberg U.S. Aggregate Index

We considered the Bloomberg U.S. Universal Bond Index and the FTSE US BIG Bond Index as the main alternatives. Our recommendation is based on the following main reasons:

- The Bloomberg U.S. Aggregate Index provides broad coverage to the investment-grade U.S. fixed income market and is the most widely recognized fixed income benchmark in the U.S.
- The Bloomberg U.S. Universal Index provides broader coverage to an investor; however, it includes high yield debt, which is more correlated to stocks, reducing the diversification benefit relative to the Bloomberg U.S. Aggregate.
- The Bloomberg U.S. Universal Index and the FTSE US BIG Bond Index have not received material traction in the institutional marketplace. None of the major index fund managers currently manage any passive assets to these benchmarks.

I Fund

Consider broadening the opportunity set of the I Fund by replacing the MSCI EAFE Index with an index that includes coverage of Canada, international small caps, and emerging markets.

Our recommendation is based on the following reasons:

- The MSCI ACWI ex USA IMI and the MSCI ACWI IMI ex USA ex China ex Hong Index both provide broad coverage of the international equity markets (99% and 90%, respectively).
- The MSCI indices remain the most popular indices for U.S. based institutional investors investing in overseas equity markets.
- The transition costs associated with the change in the I Fund benchmark are reasonable.
- Market Exposure:
    - Canada is the fourth-largest equity market in the world, representing 7.5% of the developed non-U.S. equity opportunity set.
    - Emerging Markets represents 27.8% of the international non-U.S. equity investable universe.
    - International small cap equities represent 13.7% of the international non-U.S. equity investable universe
- Liquidity:
    - We believe the inclusion of emerging markets and international small cap equities in the I Fund would not hinder the ability to meet the TSP's daily liquidity needs.
    - Overall, liquidity is managed through the use of the I Fund's cash buffer and other tools such as optimization and derivatives.
    - Additionally, historical daily cash flow assessment scaled to 28% illustrates cash flow activity was at reasonable levels to be traded in emerging markets without adversely impacting the prices of securities.
- Securities Lending:
    - The MSCI ACWI ex USA IMI and MSCI ACWI IMI ex USA ex China ex Hong Kong Index generated the highest expected yield and percentage out on loan.
    - Across each of the last three calendar years, the income to the TSP is estimated to have been at least 1.9x more if the I Fund tracked MSCI ACWI ex USA IMI or MSCI ACWI IMI ex USA ex China ex Hong Kong Index instead of the MSCI EAFE index.

- Administrative and Other Operational Complexities:
  - Overall, operational complexity has increased when investing in emerging markets in recent years given a range of events such as investment restrictions on sensitive Chinese technology sectors, delisting of Chinese companies, and sanctions on Russian securities due to the Russia-Ukraine conflict.
  - These types of unforeseen events can incur transaction costs and may cause performance and volatility swings. For example, the announcement of investment restrictions can cause the value of a stock to decline at a time where the investor is forced to sell. Additionally, even if the investment restriction is on a set of securities or sectors, the negative sentiment generally has a broader impact on the performance of the country for a certain period of time. Given the asset size of the I Fund, the forced selling of restricted investments could incur higher than average market impact costs due to liquidity challenges.
  - Tensions between the U.S. and China have been building, with the latest developments being the technology investment restrictions and export ban of US technology to China. If the current investment restrictions on China are the beginning of further restrictions spanning China and Hong Kong investments, this level of uncertainty can outweigh the benefits of expanding the I Fund to include China and retaining exposure to Hong Kong, based on the TSP's specific circumstances.
- Conclusion
  - Expanding the opportunity set of the I Fund to the MSCI ACWI IMI ex USA ex China ex Hong Kong Index would be viewed as a more efficient portfolio than the MSCI EAFE Index, benefiting from its broader opportunity set across the number of securities, market cap, and countries.
    - The index has performed favorably over the short- and long-term periods relative to the MSCI EAFE Index with favorable risk-adjusted returns over-the long-term.
    - The market cap coverage increases from 55% to 90% by replacing the MSCI EAFE Index with the MSCI ACWI IMI ex USA ex China ex Hong Kong Index.
  - We recommend the TSP broaden the opportunity set of the I Fund by replacing the MSCI EAFE Index with the MSCI ACWI IMI ex USA ex China ex Hong Kong Index, taking into consideration the TSP's unique circumstances. We recommend future reviews reassess the TSP's unique circumstances to determine whether further expansion of the benchmark is warranted, considering how administrative and operational complexities evolve over time.

C Fund and S Fund

We have reviewed the legislative guidelines related to the investment objectives for the Common Stock Index Investment Fund (C Fund) and the Small Capitalization Stock Index Investment Fund (S Fund) and have compared each of these Funds' existing benchmarks to several reasonable alternatives. We find that the existing benchmarks, the S&P 500 Index for the C Fund and the Dow Jones U.S. Completion Total Stock Market Index for the S Fund, are appropriate.

We therefore recommend no change in the benchmarks for the C and S Funds.

Legislative Guidelines

The goal or objective of any investment option or portfolio plays an important role in determining the appropriate benchmark for that investment. The Federal Employees Retirement System Act of 1986 (FERSA), as amended, states the following regarding the C Fund and the S Fund, under section 8438 (b):

C Fund

(2) (A) The Board shall select an index which is a commonly recognized index comprised of common stock the aggregate market value of which is a reasonably complete representation of the United States equity markets.

(B) The Common Stock Index Investment Fund shall be invested in a portfolio designed to replicate the performance of the index selected under subparagraph (A). The portfolio shall be designed such that, to the extent practicable, the percentage of the Common Stock Index Investment Fund that is invested in each stock is the same as the percentage determined by dividing the aggregate market value of all shares of that stock by the aggregate market value of all shares of all stocks included in such index.

S Fund

(3) (A) The Board shall select an index which is a commonly recognized index comprised of common stock the aggregate market value of which represents the United States equity markets excluding the common stocks included in the Common Stock Index Investment Fund.

(B) The Small Capitalization Stock Index Investment Fund shall be invested in a portfolio designed to replicate the performance of the index in subparagraph (A). The portfolio shall be designed such that, to the extent practicable, the percentage of the Small Capitalization Stock Index Investment Fund that is invested in each stock is the same as the percentage determined by dividing the aggregate market value of all shares of that stock by the aggregate market value of all shares of all stocks included in such index.

The C Fund is benchmarked against the S&P 500 Index, which provides coverage of the large capitalization segment of the U.S. equity market. The FERSA guidelines for the C Fund do not specify that it should be benchmarked to a large capitalization U.S. stock index. If the C Fund were *the only* U.S. equity investment option available to TSP participants, it would have made sense to consider a broader, more inclusive benchmark that also includes smaller capitalization stocks, such as the Russell 3000 Index or the Dow Jones U.S. Total Market Index.

We recognize, however, that the S Fund is meant to complement the C Fund, not to compete or overlap with it. This clearly implies that the C Fund should be benchmarked to a large capitalization U.S. index.

C Fund

We began our review by first compiling a list of broad U.S. equity benchmarks for consideration for the C Fund:

- CRSP U.S. Large Cap Index (The top 85% of the U.S. equity investable market capitalization)
- CRSP U.S. Total Market Index (Broad U.S. equity universe across mega, large, mid, small, and micro capitalizations)
- Dow Jones (DJ) U.S. Broad Stock Market Index (All stocks in DJ U.S. Total Stock Market Index, excluding those defined as micro-caps)
- DJ U.S. Large-Cap Total Stock Market Index (The largest ~750 stocks in DJ U.S. Total Stock Market Index Set)
- DJ U.S. Total Stock Market Index (Including all U.S. equity issues with readily available prices)
- MSCI USA All Cap Index (Broad U.S. equity universe coverage across large, mid, small, and micro capitalizations)
- MSCI USA Index (Captures the large and mid-capitalizations of U.S. equity universe)
- MSCI USA Investable Market Index (IMI) (Captures the large, mid, and small capitalizations of U.S. equity universe)
- Russell 1000 Index (The largest ~1,000 stocks in Russell 3000 Index)
- Russell 3000 Index (The largest ~3,000 U.S. companies)
- Standard & Poor's (S&P) 500 Index (500 leading U.S. companies covering ~85% of available market capitalization, provides large capitalization coverage as a component of the S&P Completion 1500 Index – **Current Benchmark**)
- S&P Composite 1500 Index (The combination of S&P 500, S&P MidCap 400 and S&P SmallCap 600 Indices covering 90% of U.S. market capitalization)

As the C and S Funds are complementary, and in combination should represent the broad U.S. equity market, we have excluded the broad-based all cap indices from consideration, such as the CRSP U.S. Total Market, DJ U.S. Broad Stock Market, DJ U.S. Total Stock Market, MSCI USA All Cap, MSCI USA IMI, Russell 3000, and S&P Composite 1500 indices.

Of the remaining indices focusing on large to mid capitalization stocks, the three major index providers MSCI, FTSE/Russell, and S&P/DJ provide benchmarks that track both the U.S. large and small cap markets. Table 1 lists the benchmarks that were considered further in the benchmark evaluation process.

Table 1: Benchmark Comparative Summary (As of 6/30/2023)

Index	Inclusion Criteria/ Construction Methodology	Opportunity Set Consistent with C Fund Legislation?	S Fund Complement Available?	U.S. Equity Market Coverage	# of Securities	Market Cap[1]	Largest & Smallest Holdings	Reconstitution Frequency	Available across multiple major index providers?	Meaningful AUM across major passive providers?
CRSP U.S. Large Cap Index	Includes U.S. companies that comprise the top 85% of investable market capitalization.	Yes	Yes	85%	537	$38.0 T	$2.9 T $1.0 B	Quarterly	No (20%)	Yes ($42 B)
MSCI USA Index	Measures the performance of the large and mid cap segments of the U.S. market.	Yes	Yes	85%	627	$39.4 T	$3.1 T $2.8 B	Quarterly	No (20%)	Yes ($28 B)
Russell 1000 Index	Approximately largest 1,000 stocks based on a combination of their market cap and current index membership.	Yes	Yes	94%	1,008	$41.1 T	$3.1 T $0.9 B	Annual	Yes (100%)	Yes ($257 B)
S&P 500 Index	Comprised of the largest 500 U.S. companies. Selected from the S&P Total Market Index according to market cap and other criteria such as profitability and liquidity.	Yes	Yes	85%	503	$39.1 T	$3.1 T $3.6 B	Annual	Yes (100%)	Yes ($3 T)

Source: CRSP, MSCI, S&P DJ Indices, FTSE Russell, FactSet, BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Market coverage ratios are based on the index providers broadest investable U.S. equity index within their suite of indices. Assets shown in AUM column include total passive assets provided by BlackRock, which are as of 3/31/2023. Assets of other providers are as of 6/30/2023.

[1] Float-adjusted

MSCI indices available for the U.S. equity market are constructed using a building block approach for large and small cap segments that, in combination, represent 99% of the U.S. market. We like the simplicity of MSCI's building block approach, however, the major drawback is that MSCI's U.S. indices have not been very popular among institutional investors.

Alternatively, FTSE/Russell's and S&P/DJ's U.S. indices are very popular, with the Russell 1000 Index and the S&P 500 Index being the most popular large cap index options used by institutional investors.

Finally, as for the Center for Research in Security Prices ("CRSP") indices, Vanguard is the only investment management firm out of the five major index fund providers in the U.S. that has assets benchmarked to CRSP's U.S. indices. While there are meaningful assets benchmarked to several of their indices (more within other asset classes such as all cap and small cap), competitive bidding would not be feasible if a CRSP index is recommended as the benchmark for the C Fund, a significant consideration given the size of the TSP.

We have therefore focused our analysis on the following benchmarks:

- S&P 500 Index
- Russell 1000 Index

Table 2: Benchmark Comparison (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
Inclusion criteria	Comprised of the largest 500 U.S. companies. Selected from the S&P Total Market Index according to market cap and other criteria such as profitability and liquidity.	Approximately largest 1,000 stocks based on a combination of their market cap and current index membership
# of securities	503	1,008
Market cap[1]	$39.1 Trillion	$41.1 Trillion
Largest company's market cap	$3.1 Trillion	$3.1 Trillion
Smallest company's market cap	$3.6 Billion	$0.9 Billion
Coverage of U.S. stocks	85%	94%
Reconstitution frequency	Annual	Annual
Turnover	4.5%	5.8%

Source: S&P DJ Indices, FTSE Russell, FactSet

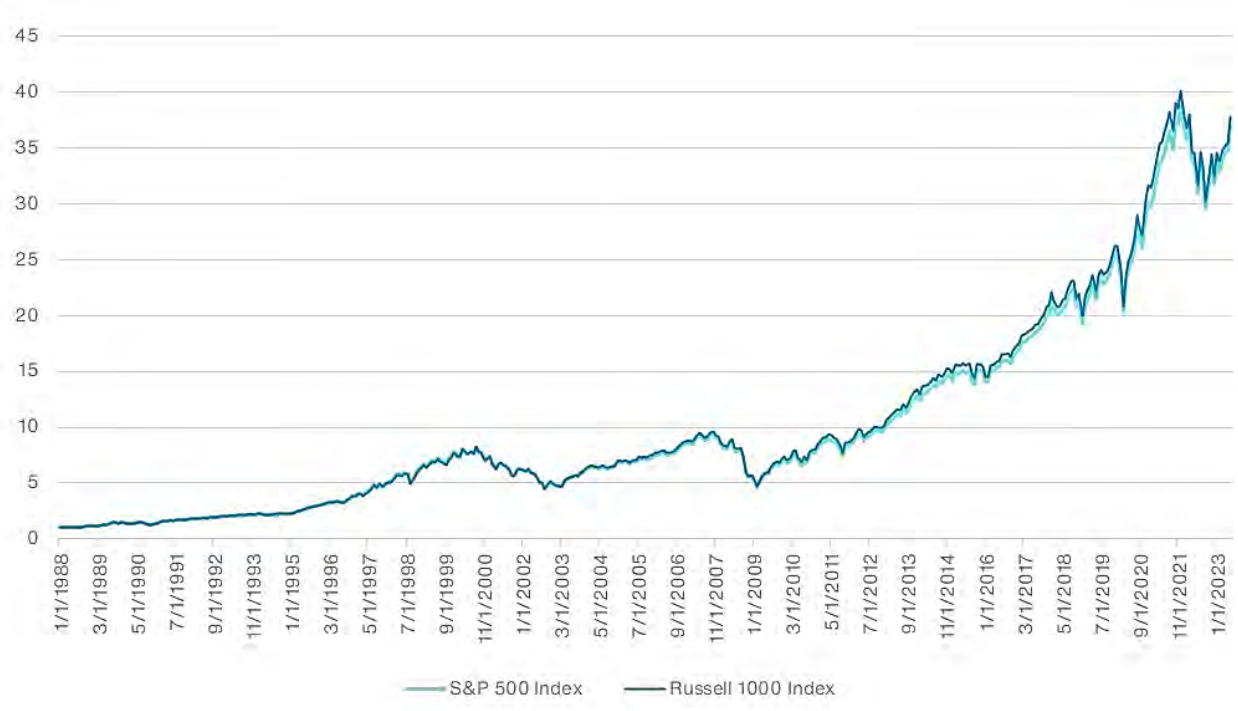
[1]Float-adjusted

The Russell 1000 index is a market capitalization weighted index. U.S. stocks are ranked from highest to lowest capitalizations, and the largest 1,000 stocks are included in the Russell 1000 Index. Unlike the Russell indices, the S&P 500 Index constituents are selected by an Index Committee. When considering eligibility for inclusion in the S&P 500 Index, the Index Committee assesses various criteria such as market capitalization, liquidity, whether it is listed on certain U.S. stock exchanges, and financial viability. Although the Index Committee's goal is to represent the largest 500 U.S. companies, the subjective nature of the process can lead to differences relative to repeatable, rules-based indices, such as the market cap weighted Russell 1000 Index. Although the indices cover different opportunity sets, the top 500 holdings in the S&P 500 index can differ from the top 500 holdings in the Russell 1000 Index, by weight and/or inclusion. Therefore, from a construction methodology point of view, Aon prefers rules-based indices like Russell because there is no subjectivity when selecting the constituents. Nevertheless, we find the S&P 500 Index as an acceptable benchmark for U.S. large capitalization stocks, as the S&P 500 Index provides very close coverage of the largest 500 U.S. stocks.

Performance

Chart 1 illustrates how $1 invested in each of the indices over the longest common time period (36 years) would have grown over time. As shown, the indices have tended to perform quite similarly over this time period.

Chart 1: Growth of A Dollar (As of 6/30/2023)



(As of 6/30/2023)	S&P 500 Index	Russell 1000 Index
Value At the End of 36 Years	**$37.13**	**$37.85**

The correlation coefficients between each pair of indices are shown in Table 3. Correlation coefficients can range from +1 to -1. A correlation of +1 between two indices implies that the returns of the two indices move in the same direction and in the same proportion, while a correlation of -1 means that the returns move in opposite directions but in the same proportion. As can be seen, the indices are highly positively correlated to each other.

Table 3: Correlation Matrix (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
S&P 500 Index	1.00	
Russell 1000 Index	1.00	1.00

Note: Longest common time period = 36 years

Table 4 details the cumulative annualized returns over several trailing historical periods.

Table 4: Return History (%) (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
1 Year	19.6	19.4
3 Years	14.6	14.1
5 Years	12.3	11.9
10 Years	12.9	12.6
15 Years	10.9	10.8
20 Years	10.0	10.1
25 Years	7.6	7.8
30 Years	10.0	10.1
35 Years	10.6	10.7

Note: Please see appendix for annual returns

While returns do vary year to year, long term returns for both indices tend to be fairly consistent. However, the numbers above do not indicate the risk incurred to earn these returns. Table 5 shows the annualized standard deviation over various time periods. The ten-year standard deviation of the S&P 500 Index of 14.9% means that based on the last ten years of historical returns data, the return of the S&P 500 Index in any given year is expected to be in a range of +/- 14.9% around the average return, about two-thirds of the time.

Table 5: Annualized Standard Deviation (%) (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
3 Years	18.2	18.4
5 Years	18.8	19.2
10 Years	14.9	15.2
15 Years	16.1	16.5
20 Years	14.7	15.0
25 Years	15.7	15.9
30 Years	15.1	15.3
35 Years	14.8	15.0

The risk, as measured by the standard deviation of returns, also tends to be in a narrow range. The Sharpe ratio measures excess return over the risk-free rate (such as T-Bills) per unit of additional risk. Sharpe ratios are appropriate for any kind of investment, including indices and managers. The Sharpe ratio can be used to compare the *risk-adjusted* performance of two or more indices, compare the risk-adjusted performance of a manager with an index, or compare the risk-adjusted performance of two or more managers. A higher Sharpe ratio is always better. A positive Sharpe ratio means that the investment has produced a better return than the risk-free rate over the period analyzed. The Sharpe ratios for each of the indices over various periods are shown in Table 6.

Table 6: Sharpe Ratios (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
5 Years	0.57	0.54
10 Years	0.80	0.77
15 Years	0.63	0.61
20 Years	0.59	0.59
25 Years	0.37	0.37
30 Years	0.51	0.50
35 Years	0.52	0.52

Based on historical performance, we do not find evidence of superiority of one index relative to the other on a risk-adjusted basis.

Investability & Liquidity

A good benchmark should be investable, i.e., an investor should be able to earn a return similar to that of the index *after* costs.

The stocks in the S&P 500 Index are liquid and trade frequently, allowing index fund managers to hold all the stocks at the appropriate index weights. The existence of an extremely liquid market for S&P 500 futures contracts also allows index fund managers to manage cash flows more efficiently, resulting in tighter tracking of the Index.

The Russell 1000 Index is also relatively liquid, allowing index fund managers to replicate the index and control tracking error. However, the Russell 1000 Index tends to hold more mid cap stocks, which lowers liquidity, potentially at the cost of higher tracking error.

In order to evaluate the U.S. large cap market's ability to absorb the range of cash flow activity the TSP experiences, the following table outlines:

- Large and average daily net cash outflow size from January 2019 to June 2023
- Percentage of the cash flow the market can absorb on market on close (MOC) without exceeding 3% of average daily volume
- Estimated explicit cost (commissions + taxes)
- Implicit cost (MOC)

The results shown in Table 7 illustrate that both U.S. large cap markets can absorb 100% of the large and average daily net cash flow at the market on close without exceeding 3% of average daily volume. A threshold of 3% ADV is the amount that TSP's managers are generally comfortable trading at or near the close without causing undue market impact. Overall, we find the following markets have depth and liquidity to be able to absorb meaningful size daily cash flow activity at marginal cost.

Table 7: Liquidity Analysis (As of September 2023)

	Large Net Cash Flow - $1.5 Billion			Average Net Cash Flow - $250 Million		
U.S. Large Cap Equity Indices	% at MOC (3% of ADV)	Explicit Costs (Comm + Taxes)	Implicit Costs (MOC)	% at MOC (3% of ADV)	Explicit Costs (Comm + Taxes)	Implicit Costs (MOC)
S&P 500 Index	100%	0.01%	0.00%	100%	0.01%	0.00%
Russell 1000 Index	100%	0.01%	0.00%	100%	0.01%	0.00%

Source: BlackRock

Table 8 compares the historical 5-year tracking errors of institutional index funds managed by BlackRock, Bank of New York Mellon (Mellon), Northern Trust, State Street Global Advisors (SSGA), and Vanguard for the S&P 500 Index and Russell 1000 Index. Tracking error for both indices have been quite similar across the major providers over the 5-year time period.

Table 8: Index Fund 5-Year Tracking Error (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
BlackRock	0.02	0.02
Mellon	0.01	0.02
Northern Trust	0.01	0.02
SSGA	0.02	0.07
Vanguard	0.01	0.02

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Acceptance

An important consideration for benchmark selection is the benchmark's acceptance and use among the investment community. Table 9 displays the value of passively managed assets in all vehicles benchmarked to both indices by the above five index managers.

Table 9: Assets Indexed to Benchmark (As of 6/30/2023)

	S&P 500 Index	Russell 1000 Index
Total Passive Assets	$3 Trillion	$257 Billion

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Total passive assets include assets provided by BlackRock, which are as of March 31, 2023. Remaining data is as of June 30, 2023.

The S&P 500 Index has significantly more assets indexed to it than the Russell 1000 Index. However, across the other major U.S. large cap indices, both the S&P 500 Index and the Russell 1000 Index are by far the most popular, with the next most popular index, the CRSP U.S. Large Cap Index, having approximately $42B in total passive assets benchmarked to it.

Summary

Both the S&P 500 Index and the Russell 1000 Index are suitable index options for coverage of the U.S. large cap stock market. In addition, both providers have complementary indices for the U.S. small cap segment. When taken as a whole, the combined index exposure represents nearly 99% of the U.S. stock market. However, the Russell 1000 Index is considered slightly less liquid with exposure to mid cap stocks that may increase tracking error. The S&P 500 Index is the most widely followed and most liquid U.S. large cap index.

Both indices will be reviewed in conjunction with a recommendation for the benchmark for the S Fund to determine the most suitable combination for the C and S Funds.

S FUND

Benchmarks Considered

We considered the following U.S. equity small/mid capitalization indices in our initial review of benchmarks for the S Fund:

- CRSP U.S. Small Cap Index (U.S. companies that fall between the bottom 2%-15% of the investable market capitalization)
- DJ U.S. Completion Total Stock Market Index (DJ U.S. Total Stock Market Index excluding components of the S&P 500 Index – **Current Benchmark**)
- DJ U.S. Small-Cap Total Stock Market Index (including the next smallest ~1,750 stocks in DJ U.S. Total Stock Market Index ranked by capitalization relative to the DJ U.S. Large-Cap Total Stock Market Index)
- MSCI USA Small Cap Index (Captures the small capitalizations of U.S. equity universe and represents ~14% of the free float-adjusted market capitalization)
- Russell 2000 Index (The smallest ~2,000 stocks in Russell 3000 Index)
- Russell Small Cap Completeness Index (The Russell 3000 index constituents excluding components of the S&P 500 Index)
- S&P 1000 Index (1000 small and mid-sized U.S. companies, combination of S&P 400 and S&P 600 Indices)
- S&P Completion Index (~3,000 mid, small, and micro capitalization companies, S&P Total Market Index excluding S&P 500 Index members)
- S&P MidCap 400 Index (400 mid-sized U.S. companies covering ~5% of available market capitalization, provides mid capitalization coverage as a component of the S&P Completion 1500 Index)
- S&P SmallCap 600 Index (600 small-sized U.S. companies covering ~2% of available market capitalization, provides small capitalization coverage as a component of the S&P Completion 1500 Index)

Since we narrowed the C Fund options to the S&P 500 Index and the Russell 1000 Index, the best complementary small cap indices would be the S&P Completion Index, the DJ U.S. Completion Total Stock Market (TSM) Index, and the Russell Small Cap Completeness Index for the S&P 500 Index, and the Russell 2000 Index for the Russell 1000 Index. When the S&P 500 Index is combined with the DJ U.S. Completion TSM Index, Russell Small Cap Completeness Index, or the S&P Completion Index, the overall exposure is ~100% of the U.S. equity market. The

DJ U.S. Completion TSM Index, Russell Small Cap Completeness Index, and the S&P Completion Index are designed to represent the broad U.S. stock market excluding S&P 500 stocks, so there are no overlapping securities. The Russell 1000 Index and Russell 2000 Index together also represent ~99% of the U.S. equity market. Since Russell utilizes a building block approach, there are also no overlapping securities between these two indices. Finally, the CRSP U.S. Large Cap Index and CRSP U.S. Small Cap Index are also complementary indices and together provide broad representation for the U.S. equity market.

Given the complementary attributes of the aforementioned indices and the legislative guidelines of the S Fund, we eliminated all the other contenders from consideration. Table 10 lists the benchmarks that were considered further in the benchmark evaluation process.

Table 10: Benchmark Comparative Summary (As of 6/30/2023)

Index	Inclusion Criteria/ Construction Methodology	Opportunity Set Consistent with S Fund Legislation?	C Fund Complement Available?	U.S. Equity Market Coverage	# of Securities	Market Cap[1]	Largest & Smallest Holdings	Reconstitution Frequency	Available across multiple major index providers?	Meaningful AUM?
CRSP U.S. Small Cap Index	Includes U.S. companies that fall between the bottom 2% - 15% of the investable market capitalization.	Yes	Yes	15%	1,428	$4.7 T	$19.2 B $21.0 M	Quarterly	No (20%)	Yes ($123 B)
DJ U.S. Completion Total Stock Market Index	All stocks in the DJ U.S. Total Market Index minus the stocks in the S&P 500 Index.	Yes	Yes	15%	3,686	$7.3 T	$87.4 B $0.7 M	Annual	Yes (80%)	Yes ($120 B)
MSCI USA Small Cap Index	Measures the performance of the small cap segments of the U.S. market.	Yes	Yes	14%	1,844	$4.1 T	$14.3 B $88.5 M	Quarterly	Yes (60%)	No ($3 B)
Russell 2000 Index	Small cap segment stocks ranking from 1,001 to 3,000 based on market cap.	Yes	Yes	5%	2,002	$2.4 T	$13.1 B $43.6 M	Annual	Yes (100%)	Yes ($109 B)
Russell Small Cap Completeness Index	Measures the performance of the Russell 3000 Index companies excluding S&P 500 constituents.	Yes	Yes	15%	2,508	$13.7 T	$107.0 B $43.6 M	Annual	Yes (60%)	Yes ($47 B)
S&P Completion Index	Comprises all members of S&P TMI except for the current constituents of the S&P 500 Index.	Yes	Yes	15%	3,685	$7.3 T	$87.4 B $0.7 M	Annual	No (20%)	Yes ($112 B)

Source: CRSP, MSCI, S&P DJ Indices, FTSE Russell, FactSet, BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Market coverage ratios are based on the index providers broadest investable U.S. equity index within their suite of indices. Assets shown in AUM column include total passive assets provided by BlackRock, which are as of 3/31/2023. Assets of other providers are as of 6/30/2023.

[1] Float-adjusted

As shown in Table 10, the DJ U.S. Completion Total Stock Market and CRSP U.S. Small Cap indices are the most popular small cap stock indices across the major passive providers, with $120B and $123B of total assets benchmarked to these indices, respectively. Additionally, the Russell 2000 and S&P Completion Indices are popular options with about $109B and $112B in passive assets benchmarked to these indices. However, as noted, both the CRSP U.S. Small Cap Index and the S&P Completion Index are only offered by one of the five major passive providers, making competitive bidding unlikely, a significant consideration given the size of the TSP.

Conversely, although the MSCI USA Small Cap Index is offered by multiple passive providers, it remains an unpopular benchmark by other institutional investors with only $3B of passive assets benchmarked to this index.

Finally, the Russell Small Cap Completeness Index was evaluated. It has gained popularity over time across passive providers and institutional investors, however, there are no major compelling differences between the current benchmark, the DJ U.S. Completion TSM Index, and this index to justify a change. Both the current benchmark and the Russell Small Cap Completeness provide complete coverage of the U.S. equity market when paired with the S&P 500 Index.

We therefore focus our attention on the remaining two benchmarks:

- Russell 2000 Index (as a complement to the Russell 1000 Index)
- DJ U.S. Completion TSM Index (as a complement to the S&P 500 Index)

A comparison between the two benchmarks is shown in Table 11.

Table 11: Benchmark Comparison (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
Inclusion criteria	Small cap segment stocks ranking from 1,001 to 3,000 based on market cap	All stocks in the DJ U.S. TSM Index minus the stocks in the S&P 500 Index
# of securities	2,002	3,686
Market cap[1]	$2.4 Trillion	$7.3 Trillion
Largest company's market cap	$13.1 Billion	$87.4 Billion
Smallest company's market cap	$43.6 Million	$0.7 Million
Coverage of U.S. stocks	5%	15%
Reconstitution frequency	Annual	Annual
Turnover	34.1%	29.6%

Source: S&P DJ Indices, FTSE Russell, and FactSet

[1]Float adjusted

While the Russell 2000 Index provides coverage to only 5% of the U.S. stock market as opposed to 15% provided by the DJ U.S. Completion TSM Index, it is more relevant to consider it in combination with the Russell 1000 Index, which provides greater market coverage than the S&P 500 Index. As mentioned above, when paired with the complementary indices, both index combinations offer 99%-100% coverage of the U.S. equity market.

Performance

Chart 2 illustrates the growth of $1 invested in each of the indices over the longest common time period. The DJ U.S. Completion Total Stock Market Index has performed better than the Russell 2000 Index due to the inclusion of more small-cap stocks.

Chart 2: Growth of A Dollar (As of 6/30/2023)

(As of 6/30/2023)	Russell 2000 Index	DJ U.S. Completion TSM Index
Value At the End of 37 Years	$21.38	$28.24

The correlation between the indices is shown in Table 12. As shown, the correlation between the indices is quite high.

Table 12: Correlation Matrix (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
Russel 2000 Index	1.00	
DJ U.S. Completion TSM Index	0.97	1.00

Note: Longest common time period = 37 years

The cumulative annualized returns over several trailing historical periods are shown in Table 13.

Table 13: Return History (%) (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
1 Year	12.3	15.0
3 Years	10.8	9.2
5 Years	4.2	6.0
10 Years	8.3	9.2
15 Years	8.4	9.1
20 Years	8.9	9.9
25 Years	7.3	7.8
30 Years	8.7	9.4
35 Years	9.0	9.9

Note: Please see appendix for annual returns

Given the substantial differences in market coverage between the two indices, annual returns tend to differ by relatively large margins. The difference in returns generally narrows over longer periods of time but is still higher than that of large capitalization indices.

The standard deviation of these benchmarks is shown in Table 14.

Table 14: Annualized Standard Deviation (%) (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
3 Years	21.9	22.2
5 Years	24.0	24.1
10 Years	19.6	19.0
15 Years	21.1	20.2
20 Years	19.6	18.5
25 Years	20.7	20.3
30 Years	19.6	19.2
35 Years	19.2	18.5

The DJ U.S. Completion TSM Index has outperformed over all historical periods at a similar-to-lower risk level, particularly over longer time periods. The DJ U.S. Completion TSM Index has a higher Sharpe ratio over all time periods analyzed.

Table 15: Sharpe Ratios (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
5 Years	0.11	0.18
10 Years	0.37	0.43
15 Years	0.36	0.41
20 Years	0.39	0.46
25 Years	0.26	0.29
30 Years	0.32	0.37
35 Years	0.32	0.38

Over the longest common time period, the DJ U.S. Completion TSM Index has outperformed the Russell 2000 Index on a risk-adjusted basis. However, in combination with the corresponding large capitalization indices, these differences are diminished.

Investability & Liquidity

Most of the significant players in the index fund management business offer Russell 2000 Index funds and DJ U.S. Completion TSM Index funds. Managers for the DJ U.S. Completion Total Stock Market Index funds typically hold all the mid cap stocks, as well as most of the small cap stocks, and optimize the balance of the micro cap segment. Again, they have shown an ability to do this at reasonable costs and tracking error. Fund managers tend to hold all the stocks in the Russell 2000 Index as part of their investment strategy.

In order to evaluate the U.S. small-mid cap market's ability to absorb the range of cash flow activity the TSP experiences, the following table outlines:

- Large and average daily net cash outflow size from January 2019 to June 2022
- Percentage of the cash flow the market can absorb on market on close (MOC) without exceeding 3% of average daily volume
- Estimated explicit cost (commissions + taxes)
- Implicit cost (MOC)

The results shown in Table 16 illustrate that the candidate indices can absorb more than 70% of the large net daily cash flow and 100% of the average daily net cash flow at the market on close without exceeding 3% of average daily volume. A threshold of 3% ADV is the amount that TSP's managers are generally comfortable trading at or near the close without causing undue market impact. For a large net daily cash flow, if 100% of the trade is not executed on market on close, the trade can be executed through derivatives in a low-cost manner. Overall, we find the following markets have depth and liquidity to be able to absorb meaningful size daily cash flow activity at marginal cost.

Table 16: Liquidity Analysis (As of September 2023)

	Large Net Cash Flow - $700 million			Average Net Cash Flow - $120 Million		
U.S. Small-Mid Cap Equity Indices	**% at MOC (3% of ADV)**	**Explicit Costs (Comm + Taxes)**	**Implicit Costs (MOC)**	**% at MOC (3% of ADV)**	**Explicit Costs (Comm + Taxes)**	**Implicit Costs (MOC)**
DJ U.S. Completion TSM Index	86%	0.01%	0.03%	100%	0.01%	0.00%
Russell 2000 Index	70%	0.02%	0.06%	100%	0.02%	0.00%

Source: BlackRock

Table 17 compares the historical tracking errors of institutional index funds managed by BlackRock, Mellon, Northern Trust, SSGA, and Vanguard (however, Vanguard does not manage stand-alone index funds benchmarked to DJ U.S. Completion TSM Index). All managers have been successful in earning the returns of the indices within a reasonable level of tracking error.

Table 17: Index Fund 5-Year Tracking Error (%) (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
BlackRock	0.06	0.11
Mellon	0.04	0.15
Northern Trust	0.03	0.10
SSGA	0.08	0.10
Vanguard	0.03	N/A[1]

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

[1]Vanguard does not currently offer any products benchmarked to the DJ U.S. Completion TSM Index

Acceptance

An important consideration for benchmark selection is the benchmark's acceptance and use among the investment community. Table 18 displays the value of passively managed assets by the above leading fund managers and benchmarked to each of the two indices.

Table 18: Assets Indexed to Benchmark (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index
Total Passive Assets	$109 Billion	$120 Billion

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Total passive assets include assets provided by BlackRock, which are as of March 31, 2023. Remaining data is as of June 30, 2023.

Both indices are acceptable passive benchmarks. The assets managed by the above fund managers account for only a portion of the total passive assets benchmarked to the two indices. If other fund families and assets that are

part of other mandates are included, the total assets managed to these benchmarks are much larger. For example, the Russell 2000 Index fund could be managed on a stand-alone basis or within the mandate of a Russell 3000 index fund, which has a much larger asset base ($151B of total passive assets). The same holds true for the DJ U.S. Completion TSM Index being managed alone or within the DJ U.S. Total Stock Market Index.

There is also a fairly large level of overlap that exists between the different small capitalization indices at the underlying security level. Given the large overlap in securities between the indices, providers hold and trade most of the same securities that are held in the DJ U.S. Completion TSM Index as part of their other small capitalization index strategies. As a result, we believe it is appropriate to consider assets managed to indices such as the S&P Completion Index and CRSP U.S. Small Cap Index by the five major providers, in addition to the Russell 2000 Index and the DJ U.S. Completion TSM Index, when assessing the size of total passive assets benchmarked to the indices discussed above.

Table 19: Assets Indexed to Additional Benchmarks (As of 6/30/2023)

	Russell 2000 Index	DJ U.S. Completion TSM Index	S&P Completion Index	CRSP U.S. Small Cap Index	Total U.S. Small Capitalization Stock Indexed[1]
Total Passive Assets	$109 Billion	$120 Billion	$112 Billion	$123 Billion	$605 Billion

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Total passive assets include assets provided by BlackRock, which are as of March 31, 2023. Remaining data is as of June 30, 2023.

[1]Additional indices included in the total asset number are the following: Russell 2500 Index, Russell Small Cap Completeness Index, and S&P SmallCap 600 Equity Index

When looking at total passive assets benchmarked to these indices, the CRSP U.S. Small Cap Index leads the way despite being offered by only one of the major passive providers. However, the DJ U.S. Completion TSM Index is a close second with only $3B less benchmarked to this index. Further, four out of the five major providers utilize this benchmark, making the opportunity for competitive pricing much more feasible.

Benchmark Recommendation for the C and S Funds

There are two combinations of benchmarks that make the most sense for the C and S Funds:

1. The current combination of the S&P 500 Index for the C Fund and the DJ U.S. Completion TSM Index for the S Fund; or
2. An alternate combination of the Russell 1000 Index for the C Fund and the Russell 2000 Index for the S Fund

Either of these combinations would be consistent with the FERSA provisions. However, given there are no material benefits associated with moving away from the current indices, we recommend that the existing benchmarks be maintained for the C and S Funds. The following considerations support this recommendation:

- The combination of the S&P 500 Index with the DJ U.S. Completion Total Stock Market Index provides complete U.S. equity market coverage.
- The S&P 500 Index has high recognition value among non-investment professionals, a label that describes the vast majority of TSP participants.
- Total passive assets benchmarked to the S&P 500 and DJ U.S. Completion Total Stock Market indices are about eight times of those benchmarked to the Russell 1000 and Russell 2000 indices.
- The stocks in the S&P 500 Index and the DJ U.S. Completion Total Stock Market Index are liquid and trade frequently, allowing index fund managers to hold the majority of the stocks in these indices.
- The costs associated with picking up the smaller end of the market capitalization spectrum have not impacted index fund managers' ability to track the DJ U.S. Completion Total Stock Market Index and have provided a broader opportunity set.

F Fund

Summary

We have reviewed the Fixed Income Index Investment Fund's (F Fund) legislative guidelines and compared its current benchmark the Bloomberg U.S. Aggregate Index to other leading fixed income market indices. We recommend the continued use of the Bloomberg U.S. Aggregate Index for the F Fund.

Legislative Guidelines

FERSA states the following as it relates to the F Fund:

(B) The Board shall establish a Fixed Income Investment Fund under which sums in the Thrift Savings Fund are invested in—

I. insurance contracts

II. certificate of deposits; or

III. other instruments or obligations selected by qualified professional asset managers, which return the amount invested and pay interest, at a specified rate or rates, on that amount during a specified period of time.

The guidelines for the eligible instruments in which the F Fund may invest are very general in nature. There is no guidance on whether investments may be made in non-U.S. dollar denominated debt, non-investment grade loans, U.S. dollar-denominated foreign debt, etc.

The legislative guidelines specify that the F Fund may invest in insurance contracts and certificates of deposits. We note that the relative stability in returns provided by insurance contracts and certificates of deposit is already available to participants through the Government Securities Investment Fund (G Fund). Insurance contracts and certificates of deposit are not included in marketable security fixed income benchmarks. As participants have access to an investment option in the G Fund that provides the key elements of insurance contracts and certificates of deposit – return of capital and payment of interest – we believe that it is appropriate to offer participants exposure to a broad array of marketable fixed income securities as the F Fund currently provides. Therefore, we focus our attention on the leading broad-based fixed income indices that comprise publicly traded fixed income securities.

Benchmarks Considered

We initially considered the following indices in our review of reasonable benchmarks for the F Fund:

- Bloomberg Global Aggregate Index (Represents a broad-based measure of the global investment-grade fixed income market, including the three major components the U.S. Aggregate, the Pan-European Aggregate, and the Asian-Pacific Aggregate Indices. The index also includes Eurodollar and Euro-Yen corporate bonds, Canadian government, agency and corporate securities, and USD investment grade 144A securities)

- Bloomberg U.S. Aggregate Index – (An index representing the U.S. investment grade fixed rate bond market, with index components for government and corporate securities, mortgage pass-through securities, and asset-backed securities - **Current Benchmark**)
- Bloomberg U.S. Universal Index (An index composed of the U.S. Aggregate Index, the U.S. High-Yield Corporate Index, the 144A Index, the Eurodollar Index, the Emerging Markets Index, and the non-ERISA portion of the CMBS Index)
- FTSE US Broad Investment-Grade (BIG) Bond Index (An index designed to track the performance of US dollar-denominated bonds issued in the US investment-grade bond market, includes US Treasury, government sponsored, collateralized, and corporate debt)
- FTSE World Broad Investment-Grade (BIG) Bond Index (A multi-asset, multi-currency index designed to provide a broad-based measure of the global fixed income markets, includes investment-grade government, government-sponsored/supranational, collateralized, and corporate debt)
- FTSE World Government Bond Index (A broad index designed to provide exposure to the global sovereign fixed income market, the index measures the performance of fixed-rate, local currency, investment-grade sovereign bonds, includes sovereign debt from over 20 countries, denominated in a variety of currencies)

The FTSE World Government Bond Index was eliminated from further consideration since the opportunity set is limited to government issued bonds. Table 20 lists the benchmarks that were considered further in the benchmark evaluation process.

Table 20: Benchmark Comparative Summary (As of 6/30/2023)

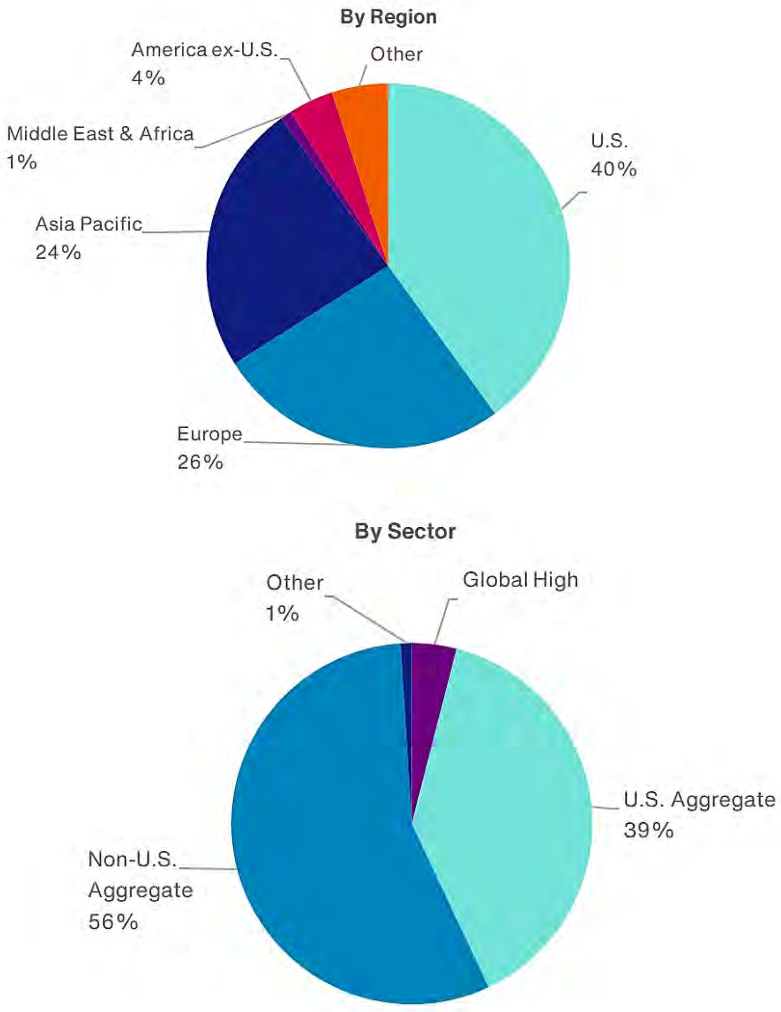
Index	Inclusion Criteria/ Construction Methodology	Opportunity Set Consistent with F Fund Legislation?	U.S. / Global Fixed Income Market Coverage	# of Securities	Market Cap	Reconstitution Frequency	Available across multiple major index providers?	Meaningful AUM?
Bloomberg Global Aggregate Index	U.S. Aggregate, the Pan-European Aggregate, and the Asian-Pacific Aggregate Indices. The index also includes Eurodollar and Euro-Yen corporate bonds, Canadian government, agency and corporate securities, and USD investment grade 144A securities.	Yes	96%	29,426	$61.9 T	Monthly	Yes (40%)	No ($11 B)
Bloomberg U.S. Aggregate Index	U.S. Investment grade, dollar denominated, non-convertible, fixed-rate instruments. Maturity greater than one year. Includes Treasuries, Agencies, mortgages, asset-backed securities, corporate debt. Minimum outstanding size $250 million.	Yes	85%	13,358	$28.2 T	Monthly	Yes (100%)	Yes ($567 B)
Bloomberg U.S. Universal Index	Bloomberg U.S. Aggregate Index + U.S. high yield, Eurodollars, U.S. dollar denominated emerging market debt, non-ERISA portion of the CMBS index, and the 144A index.	Yes	100%	20,148	$33.1 T	Monthly	No (0%)	No ($0)
FTSE US Broad Investment-Grade Bond Index	U.S. dollar denominated bonds issued in the U.S. investment-grade bond market. Maturity greater than one year. Includes U.S. Treasury, government-sponsored (U.S. agency and supranational), mortgage, asset-backed, and corporate securities. Minimum size on corporate and asset backed issues is $250 million. Higher minimum size requirements for Treasuries, Agencies and mortgage-backed issues.	Yes	84%	9,466	$27.7 T	Monthly	No (0%)	No ($0)
FTSE World Broad Investment-Grade Bond Index	The inclusion of government, government-sponsored/supranational, collateralized, and corporate debt makes the World BIG a comprehensive representation of the global, investment-grade universe.	Yes	100%	15,601	$45.1 T	Monthly	No (0%)	No ($0)

Source: Bloomberg, FTSE Russell, BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Market coverage ratios are based on the index providers broadest investable U.S and global fixed income indices within their suite of indices. Assets shown in AUM column include total passive assets provided by BlackRock, which are as of 3/31/2023. Assets of other providers are as of 6/30/2023.

Chart 3 provides a representation of the global investable fixed income market. The Bloomberg U.S. Aggregate Index, the most widely used benchmark by U.S. institutional investors, is broken out as a sub-component of the global fixed income markets.

Chart 3: Global Fixed Income Opportunity Set ($64.8 T As of 6/30/2023)



Source: Bloomberg, Multi-Verse Universe
*Other is comprised of Euro Treasury High Yield and EM Local Currency Govt: Non GLA Eligible

The fixed income portion of an investor's portfolio typically functions as a risk-reducer, providing stable returns and predictable income with low correlations to equities (e.g., C, S, and I Funds). Even though global bond indices such as the Bloomberg Global Aggregate Index and the FTSE World BIG Bond Index have the broadest bond market coverage globally, they contain significant foreign currency exposure, which adds volatility. Foreign currency risk tends to be the largest contributor to volatility for unhedged global bond portfolios. For this reason, we eliminated the Bloomberg Global Aggregate Index and the FTSE World BIG Bond Index from further consideration.

Table 21: Benchmark Comparison (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
Inclusion criteria	Includes U.S. Investment grade, dollar denominated, non-convertible, fixed-rate instruments. Maturity must be greater than one year. Includes Treasuries, Agencies, mortgages, asset-backed securities, and corporate debt. Minimum outstanding size is $250 million.	Inclusive of the Bloomberg U.S. Aggregate Index plus U.S. high yield, Eurodollars, U.S. dollar denominated emerging market debt, non-ERISA portion of the CMBS index, and the 144A index.	U.S. dollar denominated bonds issued in the U.S. investment-grade bond market. Maturity greater than one year. Includes U.S. Treasury, government-sponsored (U.S. agency and supranational), mortgage, asset-backed, and corporate securities. Minimum size on corporate and asset backed issues is $250 million. Higher minimum size requirements for Treasuries, Agencies and mortgage-backed issues.
# of securities	13,358	20,148	9,466
Market cap	$28.2 trillion	$33.1 trillion	$27.7 trillion
Coverage of U.S. dollar denominated fixed income opportunity set	85%	100%	84%
Reconstitution frequency	Monthly	Monthly	Monthly

As of 6/30/2023

Source: Bloomberg and FTSE Russell

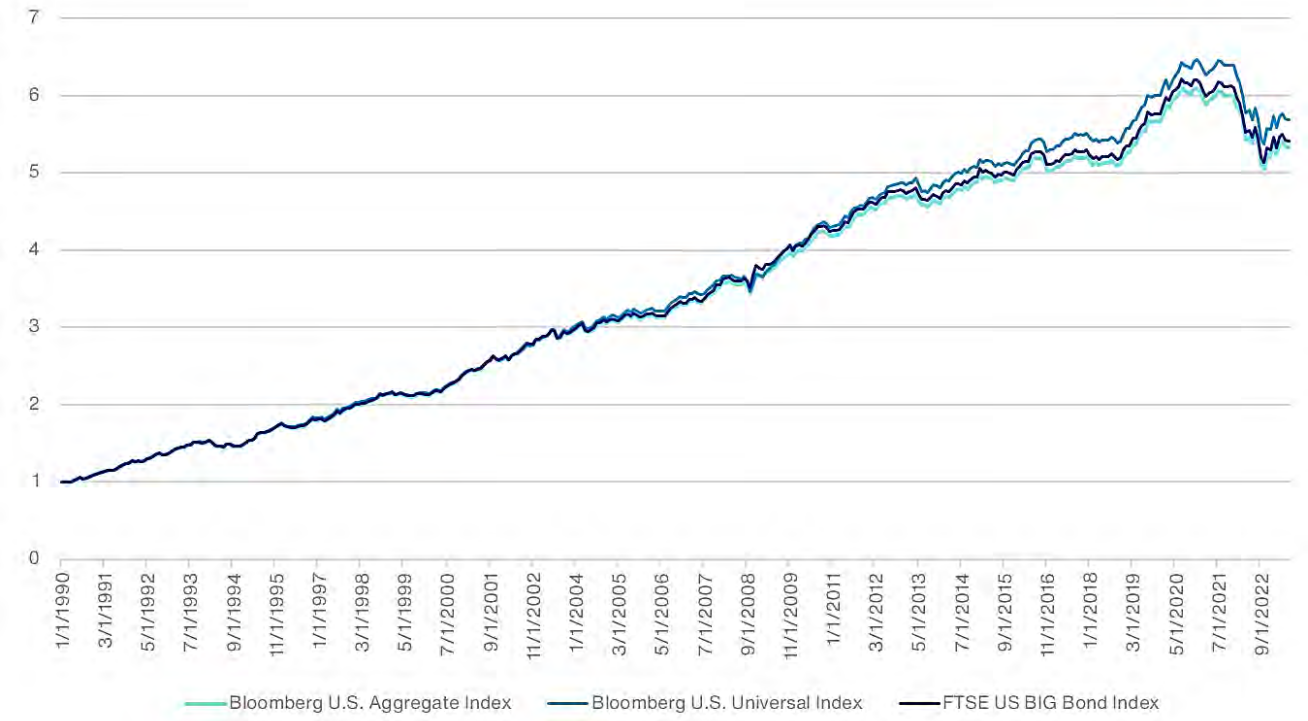
In Table 21, we narrowed the list of candidates to bond indices with 100% U.S. currency exposure to eliminate foreign currency risk. The Bloomberg U.S. Universal Index is the broadest with approximately 100% coverage of the U.S. bond market. However, a significant drawback is that it contains non-investment grade and U.S. dollar denominated foreign bond exposure. This leads to increased correlations to stocks, which would reduce the diversification benefits when paired with the C, S, and I Funds. Non-investment grade and foreign bonds tend to have less liquidity and may increase tracking error and trading costs.

The Bloomberg U.S. Aggregate and FTSE US BIG Bond indices cover approximately 85% of the U.S. bond market and contain only investment grade bonds, which would provide more liquidity and lower correlation to stocks. These indices would provide better diversification when paired with the C, S, and I Funds. Of these two indices, the Bloomberg U.S. Aggregate is by far the most popular.

Performance

Chart 4 on the following page illustrates the growth of $1 invested in each of the indices over the longest common time period. All three indices have performed quite similarly over time.

Chart 4: Growth of A Dollar (As of 6/30/2023)



(As of 6/30/2023)	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
Value At the End of 34 Years	**$5.33**	**$5.69**	**$5.41**

Table 22 shows the correlation between each of these fixed income indices, as well as with equities.

Table 22: Correlation Matrix (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index	DJ U.S. TSM Index	MSCI EAFE Index	MSCI ACWI ex U.S. IMI
Bloomberg U.S. Aggregate Index	1.00					
Bloomberg U.S. Universal Index	0.98	1.00				
FTSE US BIG Bond Index	1.00	0.97	1.00			
DJ U.S. TSM Index	0.10	0.23	0.08	1.00		
MSCI EAFE Index	0.11	0.25	0.09	0.85	1.00	
MSCI ACWI ex U.S. IMI	0.11	0.26	0.09	0.85	0.99	1.00

(Longest common time period = 28 years)

As would be expected, all three fixed income indices have a high correlation with each other. The correlation coefficient of the two investment grade indices, the Bloomberg U.S. Aggregate Index and the FTSE US BIG Bond Index, with U.S. and international stocks is low, pointing towards the diversification benefit they provide in a portfolio. While the Bloomberg U.S. Universal Index also provides a diversification benefit, the benefit is modestly reduced because of a higher correlation due to the inclusion of high yield securities, emerging market debt, etc., which tend to have a modestly higher correlation to equities.

The cumulative annualized returns over several trailing historical periods are shown in Table 23.

Table 23: Return History (%) (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
1 Year	-0.9	0.0	-1.0
3 Years	-4.0	-3.4	-4.0
5 Years	0.8	1.0	0.8
10 Years	1.5	1.8	1.5
15 Years	2.7	3.0	2.7
20 Years	3.0	3.3	3.1
25 Years	3.9	4.1	3.9
30 Years	4.4	4.6	4.4
35 Years	5.4	-	5.4

Note: See appendix for annual returns

The returns of the Bloomberg U.S. Aggregate Index and the FTSE US BIG Bond Index track each other closely over most annual periods and over trailing annualized periods. The Bloomberg U.S. Universal Index differs more on an annual basis but has generated similar returns as the other two indices over longer periods of time.

Table 24 shows the volatility (annualized standard deviation) of the indices over several trailing historical periods; there is little to no difference over longer time periods.

Table 24: Annualized Standard Deviation (%) (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
3 Years	6.2	6.2	6.2
5 Years	5.5	5.5	5.5
10 Years	4.3	4.3	4.3
15 Years	4.1	4.2	4.2
20 Years	4.0	4.0	4.1
25 Years	3.9	3.9	4.0
30 Years	3.9	3.9	4.0
35 Years	4.0	-	4.0

Sharpe ratios for each of the indices over various periods are shown in Table 25. The Bloomberg U.S. Universal has a higher Sharpe ratio over the trailing periods referenced below relative to the other benchmarks, indicating slightly better performance on a risk-adjusted basis.

Table 25: Sharpe Ratios (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
5 Years	-0.15	-0.11	-0.15
10 Years	0.12	0.19	0.12
15 Years	0.48	0.55	0.47
20 Years	0.42	0.50	0.43
25 Years	0.52	0.58	0.52
30 Years	0.51	0.57	0.52
35 Years	0.60	-	0.61

Investability & Liquidity

While the sheer number of securities in the Bloomberg U.S. Aggregate Index make it almost impossible to replicate the index precisely, index fund managers are able to track the benchmark quite closely by matching the industry, sector, duration, maturity, and quality characteristics of the Index. Passive managers that have assets managed against the Bloomberg U.S. Aggregate Index have, over the years, been able to accumulate a greater portion of the securities comprised in the index by investing in securities when liquidity opportunities have presented themselves.

The major index fund managers do not offer ERISA qualified DC passive funds benchmarked to the Bloomberg U.S. Universal Bond Index or the FTSE US BIG Bond Index. The high yield segment of the Bloomberg U.S. Universal Index can also present some challenges in terms of trading costs and tracking error due to optimization and can result in higher tracking error.

In order to evaluate the fixed income market's ability to absorb the range of cash flow activity the TSP experiences, the following table outlines:

- Large and average daily net cash outflow size from January 2019 to June 2022
- Transaction cost (T-cost) for a one-day trade

The results in Table 26 illustrate that the following markets can absorb 100% of the large and average daily net cash flow in one day. Overall, we find the Bloomberg U.S. Aggregate Index to be most liquid of the three indices.

Table 26: Liquidity Analysis (As of September 2023)

U.S. Fixed Income Indices	Large Net Cash Flow – $350 million (T-cost)	Average Net Cash Flow – $85 million (T-cost)
Bloomberg U.S. Aggregate Index	0.15%	0.15%
Bloomberg U.S. Universal Index	0.20%	0.20%
FTSE US BIG Bond Index	0.40%	0.40%

Source: BlackRock

Table 27 compares the historical tracking error of institutional index funds managed to the Bloomberg U.S. Aggregate Index by leading index fund providers. All of the managers have been able to track the Bloomberg U.S. Aggregate Index fairly closely, with tracking error ranging from 0.13% to 0.26%, a 0.13% spread across the different providers.

Table 27: Index Fund 5-Year Tracking Error (%) (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
BlackRock	0.13	--	--
Mellon	0.07	--	--
Northern Trust	0.21	--	--
SSGA	0.15	--	--
Vanguard	0.26	--	--

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Acceptance

Table 28 displays the value of passively managed assets benchmarked to each of the three indices by five leading index fund providers. As noted previously, the five index managers do not offer products indexed to the Bloomberg U.S. Universal or FTSE US BIG Bond indices.

Table 28: Assets Indexed to Benchmark (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
Total Passive Assets	$567 Billion	--	--

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Total passive assets include assets provided by BlackRock, which are as of March 31, 2023. Remaining data is as of June 30, 2023.

The Bloomberg U.S. Aggregate Index is a widely followed performance benchmark that is tracked by hundreds of billions of dollars in institutional assets. It is the most widely used fixed income benchmark by U.S.-based institutional investors. The Bloomberg U.S. Universal Index has still not gained acceptance as a passive benchmark, with no ERISA qualified DC products offered by the five major index managers. Similarly, there are no passive assets benchmarked to the FTSE US BIG Bond Index.

Benchmark Recommendation for the F Fund

Given there are no material benefits associated with moving away from the current index, we recommend that the existing benchmark, the Bloomberg U.S. Aggregate Index, be maintained for the F Fund. The main reasons for our recommendation are as follows:

- Remains a widely utilized benchmark for the U.S. bond market.
- Provides broad coverage of the U.S. bond market at approximately 85%
- Contains only investment grade bonds, which reduces correlations to equities, making it a better diversifier when pairing with the C, S, and I Funds
- Lack of foreign currency exposure eliminates a significant source of volatility for the F Fund

I Fund

Summary

We have reviewed the International Stock Index Investment Fund's (I Fund) legislative guidelines and compared its current benchmark index, the MSCI EAFE Index, to other leading international equity indices.

Legislative Guidelines

The legislative guidelines that describe the I Fund are stated below:

(4) (A) The Board shall select an index which is a commonly recognized index comprised of stock the aggregate market value of which is a reasonably complete representation of the international equity markets excluding the United States equity markets.

(B) The International Stock Index Investment Fund shall be invested in a portfolio designed to replicate the performance of the index selected under subparagraph (A). The portfolio shall be designed such that, to the extent practicable, the percentage of the International Stock Index Investment Fund that is invested in each stock is the same as the percentage determined by dividing the aggregate market value of all shares of that stock by the aggregate market value of all shares of all stocks included in such index.

Benchmarks Considered

We initially short-listed the following benchmarks for the I Fund:

- DJ Developed Markets ex-U.S. Index (95% coverage of the market capitalization of stocks traded in developed markets, excluding the U.S.; provides approximately 71% coverage of the international equity opportunity set)
- FTSE Developed All Cap ex US Index (a market capitalization weighted index representing the performance of large, mid, and small cap stocks in developed markets, excluding the U.S.; provides approximately 73% coverage of the international equity opportunity set)
- FTSE All-World ex US Index (includes large and mid cap stocks providing coverage of developed and emerging markets, excluding the U.S.; provides approximately 88% coverage of the international equity opportunity set)
- FTSE Global All Cap ex US Index (a market capitalization weighted index representing the performance of large, mid, and small cap stocks in developed and emerging markets, excluding the U.S.; provides approximately 97% coverage of the international equity opportunity set)
- FTSE Global All Cap ex US ex China ex Hong Kong Index (a market capitalization weighted index representing the performance of large, mid, and small cap stocks in developed and emerging markets, excluding the U.S., China, and Hong Kong; provides approximately 91% coverage of the international equity opportunity set)
- MSCI EAFE Index (captures large and mid cap stocks across developed markets, excluding the U.S. and Canada; provides approximately 55% coverage of the international equity opportunity set - **Current Benchmark**)

- MSCI World ex USA Index (captures large and mid cap stocks across developed markets, excluding the U.S.; provides approximately 62% coverage of the international equity opportunity set)
- MSCI World ex USA IMI (captures large, mid, and small cap stocks across developed markets, excluding the U.S.; provides approximately 71% coverage of the international equity opportunity set)
- MSCI ACWI ex USA Index (captures large and mid cap stocks across developed markets and emerging markets, excluding the U.S.; provides approximately 85% coverage of the international equity opportunity set)
- MSCI ACWI ex USA ex China ex Hong Kong Index (captures large and mid cap stocks across developed markets and emerging markets, excluding the U.S., China, and Hong Kong; provides approximately 77% coverage of the international equity opportunity set)
- MSCI ACWI ex USA IMI (captures large, mid, and small cap stocks across developed markets and emerging markets, excluding the U.S.; provides approximately 99% coverage of the international equity opportunity set)
- MSCI ACWI IMI ex USA ex China ex Hong Kong Index (captures large, mid, and small cap stocks across developed markets and emerging markets, excluding the U.S., China, and Hong Kong; provides approximately 90% coverage of the international equity opportunity set)
- S&P Global Ex-U.S. Broad Market Index (captures developed and emerging market stocks, excluding the U.S.; it is comprised of the S&P Developed Broad Market Index and the S&P Emerging Broad Market Index and provides approximately 100% coverage of the international equity opportunity set)

The benchmarks in the short list were selected with the goal of expanding the international equity opportunity set to include Canada, emerging markets, and small cap stocks.

We eliminated the DJ Developed Markets ex-U.S. Index and the S&P Global Ex-U.S. Broad Market Index from further consideration based on the lack of significant passive assets managed to them. None of the major index fund managers offer funds indexed to these benchmarks, either in the U.S. or internationally. For other passive providers like FTSE, we narrowed down the indices being considered to ones with broad opportunity sets due to the lack of passive assets managed across more than one major passive provider. Table 29 lists the benchmarks that were considered further in the benchmark evaluation process.

Table 29: Benchmark Comparative Summary (As of 6/30/2023)

Index	Inclusion Criteria/ Construction Methodology	Opportunity Set Consistent with I Fund Legislation?	Intl Equity Market Coverage	# of Securities	Market Cap	Largest & Smallest Holdings	Reconstitution Frequency	Available across multiple major index providers?	Meaningful AUM?
MSCI EAFE Index	Captures large and mid cap representation across DM, excluding the U.S. and Canada	Yes	55%	798	$15.6 T	$330.7 B $1.3 B	Quarterly	Yes (80%)	Yes ($266 B)
MSCI World ex USA Index	Captures large and mid cap representation across DM, excluding the U.S.	Yes	62%	885	$17.4 T	$330.7 B $1.3 B	Quarterly	Yes (60%)	Yes ($111 B)
MSCI World ex USA IMI	Captures large, mid, and small cap representation across DM, excluding the U.S.	Yes	71%	3,374	$20.1 T	$330.7 B $59.4 M	Quarterly	Yes (40%)	No ($17 B)
MSCI ACWI ex USA Index	Captures large and mid cap representation across DM and EM, excluding the U.S.	Yes	85%	2,308	$24.1 T	$455.6 B $25.6 M	Quarterly	Yes (80%)	Yes ($117 B)
MSCI ACWI ex USA IMI	Captures large, mid, and small cap representation across DM and EM, excluding the U.S.	Yes	99%	6,710	$27.9 T	$455.6 B $25.6 M	Quarterly	Yes (80%)	Yes ($168 B)
MSCI ACWI ex USA ex China ex Hong Kong Index	Captures large and mid cap representation across DM and EM, excluding the U.S., China, and Hong Kong	Yes	77%	1,518	$21.7 T	$2.1 T $0.7 B	Quarterly	N/A	N/A
MSCI ACWI IMI ex USA ex China ex Hong Kong Index	Captures large, mid, and small cap representation across DM and EM, excluding the U.S., China, and Hong Kong	Yes	90%	5,621	$25.4 T	$2.1 T $79.7 M	Quarterly	N/A	N/A
FTSE Global All Cap ex US Index	The index comprises large, mid, and small cap stocks globally, excluding the U.S.	Yes	97%	7,711	$27.9 T	$443.9 B $14.7 M	Semi-annual	No (20%)	Yes ($402 B)
FTSE Global All Cap ex US ex China ex Hong Kong Index	The index comprises large, mid, and small cap stocks globally, excluding the U.S., China, and Hong Kong	Yes	91%	5,812	$25.2 T	$418.1 B $18.7 M	Semi-annual	N/A	N/A

Source: MSCI and FTSE Russell, BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: DM = developed market countries & EM = emerging market countries. Market coverage ratios are based on the index providers broadest investable international equity index within their suite of indices. Assets shown in AUM column include total passive assets provided by BlackRock, which are as of 3/31/2023. Assets of other providers are as of 6/30/2023.

We eliminated the MSCI World ex USA Index because it lacked exposure to emerging market countries and small caps. Similarly, we eliminated the MSCI ACWI ex USA Index because it does not cover small caps. We eliminated the FTSE Global All Cap ex US ex China ex Hong Kong Index as the index is not currently available. The other FTSE international equity index was eliminated from further considerations as Vanguard is the only investment management firm out of the five major index fund providers in the U.S. that has assets benchmarked to FTSE international equity indices. MSCI international equity indices continue to be the most widely followed non-U.S. stock indices for U.S. based institutional investors. Additionally, counter to the FTSE ex China ex Hong Kong index, the MSCI ACWI ex USA ex China ex Hong Kong Index and MSCI ACWI IMI ex USA ex China ex Hong Kong Index are readily available for utilization, despite no major providers currently offering any passive strategies managed to them. Through our research, we were able to document that there are currently more than 10 existing licenses for the MSCI ACWI ex USA ex China ex Hong Kong Index and the MSCI ACWI IMI ex USA ex China ex Hong Kong Index. Of these licenses, we are aware of at least one institutional investor with approximately $4B managed to the MSCI ACWI IMI ex USA ex China ex Hong Kong Index across their asset pools.

Although included in our analysis, the current benchmark, the MSCI EAFE Index, contains only developed market countries and large and mid cap stocks covering only 55% of the non-US equity market. We prefer the alternative benchmark candidates which offer broader coverage ranging from 70% to 99% of the non-U.S. stock market. We believe the broader coverage of the alternative indices evaluated would be more consistent with the statutory requirement for the I Fund of offering an investment option that provides *reasonably complete* representation of the international equity markets. We would consider the indices offering exposure to both developed and emerging market countries to be the most aligned. To this point, it is also important to note that the international equity market has evolved since the I Fund was incepted in 2001. For example, in 2002 the MSCI EAFE Index captured 74% of the international equity market opportunity set compared to only 55% in 2023.

We compare the broad characteristics of each of the remaining benchmarks in Table 30.

Table 30: Benchmark Comparison (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index[3]	MSCI ACWI IMI ex USA ex China ex Hong Kong Index[3]
Inclusion criteria	Targets 85% market-cap coverage of each country (large and mid cap), excluding the U.S. and Canada	Targets 99% market-cap coverage of each country (large, mid and small cap), excluding the U.S.	Targets 99% market-cap coverage of each country (large, mid and small cap)	Captures large and mid cap representation across DM and EM, excluding the U.S., China, and Hong Kong	Captures large, mid, and small cap representation across DM and EM, excluding the U.S., China, and Hong Kong
Country coverage	21 DM	22 DM (includes Canada)	22 DM + 24 EM	21 DM + 23 EM	21 DM + 23 EM
Coverage of non-U.S. equity markets	55%	71%	99%	77%	90%
# of securities	798	3,374	6,710	1,518	5,621
Market cap[1]	$15.6 trillion	$20.1 trillion	$27.9 trillion	$21.7 trillion	$25.4 trillion
Reconstitution frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Turnover[2]	2.6%	2.5%	3.0%	N/A	N/A

Source: MSCI

Note: DM = developed market countries and EM = emerging market countries

[1] Float adjusted

[2] One-way annual turnover

[3] Historical performance is simulated for these benchmarks by MSCI

As we review index characteristics below and historical statistics in the following section, we will focus on the broad non-U.S. equity indices defined below, which include the current I Fund benchmark (MSCI EAFE Index) as well as each opportunity set being considered (i.e., expanding exposure to include Canada, emerging markets, and/or non-U.S. small-cap stocks):

- **Developed Market Indices:**
  - **MSCI EAFE Index *(current I Fund benchmark)***: an equity index that captures large and mid cap representation across developed market countries around the world, excluding the U.S. and Canada.
  - **MSCI World ex USA IMI**: an equity index that captures large, mid, and small cap representation across developed market countries, excluding the U.S.
- **Developed & Emerging Market Indices:**
  - **MSCI ACWI ex USA IMI**: an equity index that captures large, mid, and small cap representation across developed and emerging market countries, excluding the U.S.
  - **MSCI ACWI ex USA ex China ex Hong Kong Index**: an equity index that captures large and mid cap representation across developed and emerging market countries, excluding the U.S., Hong Kong, and China
  - **MSCI ACWI IMI ex USA ex China ex Hong Kong Index**: an equity index that captures large, mid, and small cap representation across developed and emerging market countries, excluding the U.S., Hong Kong, and China

Table 31 compares the country allocation of each of the indices. The MSCI ACWI ex USA IMI is the most diversified index with the largest country weight to Japan at 15.3% and China and Hong Kong representing 9.0%.

Removing China and Hong Kong does not significantly impact diversification among the countries. Japan, the largest country weight, increases to 16.1% for the MSCI ACWI ex USA ex China ex Hong Kong Index and 16.8% for the MSCI ACWI IMI ex USA ex China ex Hong Kong Index.

The MSCI ACWI ex USA ex China ex Hong Kong Index and the MSCI ACWI IMI ex USA ex China ex Hong Kong Index have emerging market exposures of 22% compared to the MSCI ACWI ex USA IMI exposure of 28%.

The MSCI EAFE Index and the MSCI World ex USA IMI have no emerging market exposure, and, as a result, have more concentrated country exposures among the developed markets. Among these two indices, the MSCI World ex USA IMI index is more diversified, as it has exposure to Canada (10.4%), while the MSCI EAFE Index does not.

Table 31: Country Allocations (%) (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
Developed Markets					
Australia	7.3	6.9	5.0	5.3	5.5
Austria	0.2	0.3	0.2	0.1	0.2
Belgium	0.9	0.9	0.6	0.7	0.7
Canada	--	10.4	7.5	8.4	8.3
Denmark	3.1	2.6	1.9	2.2	2.1
Finland	0.9	0.8	0.6	0.6	0.7
Israel	0.6	0.8	0.6	0.4	0.6
France	12.4	10.1	7.3	8.9	8.0
Germany	8.6	7.3	5.3	6.2	5.8
Hong Kong	2.5	2.1	1.6	-	-
Ireland	0.8	0.7	0.5	0.6	0.5
Italy	2.5	2.4	1.7	1.8	1.9
Japan	22.4	21.2	15.3	16.1	16.8
Netherlands	4.6	3.9	2.8	3.3	3.1
New Zealand	0.2	0.3	0.2	0.1	0.2
Norway	0.6	0.8	0.6	0.5	0.6
Portugal	0.2	0.2	0.1	0.2	0.2
Singapore	1.4	1.3	1.0	1.0	1.1
Spain	2.6	2.3	1.6	1.9	1.8
Sweden	3.3	3.2	2.3	2.3	2.5
Switzerland	10.1	8.3	6.0	7.2	6.6
U.K	14.7	13.2	9.6	10.6	10.5
Emerging Markets					
Brazil	--	--	1.6	1.7	1.7
Chile	--	--	0.2	0.2	0.2
China	--	--	7.4	--	--
Colombia	--	--	0.0	0.0	0.0
Czech Rep.	--	--	0.0	0.0	0.0
Egypt	--	--	0.0	0.0	0.0
Greece	--	--	0.1	0.1	0.1
Hungary	--	--	0.1	0.1	0.1

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
Emerging Markets (cont.)					
India	--	--	4.4	4.5	4.9
Indonesia	--	--	0.6	0.6	0.6
South Korea	--	--	3.5	3.8	3.9
Kuwait	--	--	0.2	0.3	0.3
Malaysia	--	--	0.4	0.4	0.4
Mexico	--	--	0.8	0.9	0.8
Peru	--	--	0.1	0.1	0.1
Philippines	--	--	0.2	0.2	0.2
Poland	--	--	0.2	0.3	0.3
Qatar	--	--	0.2	0.3	0.3
South Africa	--	--	0.9	1.0	1.0
Saudi Arabia	--	--	1.2	1.3	1.3
South Korea	--	--	3.5	3.8	3.9
Taiwan	--	--	4.6	4.8	5.0
Thailand	--	--	0.6	0.6	0.6
Turkey	--	--	0.2	0.2	0.2
UAE	--	--	0.3	0.4	0.4
Total Developed	**100.0**	**100.0**	**72.2**	**78.3**	**77.6**
Total Emerging	**0.0**	**0.0**	**27.8**	**21.7**	**22.4**
Total Index	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: MSCI Index Service

Performance

Chart 5 represents the growth of $1 invested in each of the indices over the longest common time period of 21 years. All of the indices have outperformed the MSCI EAFE Index, over the past 21 years. This has been due to emerging market and international small cap exposure. Recent poor performance in China has helped the MSCI ACWI IMI ex USA ex China ex Hong Kong Index outperform all of the others. Chinese equities have performed poorly the last couple of years due to the zero-Covid policy hurting economic growth and property downturn focused on reducing excessive borrowing by developers and over supply of property. These securities bounced back at the end of last year after the abrupt end of China's zero-Covid policy, but returns have been down in 2023 due to concerns of China losing momentum on economic recovery and continued struggles in the property sector.

Chart 5: Growth of A Dollar (As of 6/30/2023)

(As of 6/30/2023)	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
Value At the End of 21 Years	**$3.63**	**$3.84**	**$3.89**	**$3.86**	**$4.02**

Table 32 shows the correlation between the indices under consideration. As expected, the correlation between the indices is high.

Table 32: Correlation Matrix (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
MSCI EAFE	1.00				
MSCI World ex USA IMI	1.00	1.00			
MSCI ACWI ex USA IMI	0.99	0.99	1.00		
MSCI ACWI ex USA ex China ex Hong Kong Index	0.99	1.00	1.00	1.00	
MSCI ACWI IMI ex USA ex China ex Hong Kong Index	0.99	1.00	1.00	1.00	1.00

(Longest common time period = 21 years)

Table 33 compares the correlation for the indices under consideration for the I Fund with those recommended for the C, S, and F Funds.

Table 33: Correlation Matrix (As of 6/30/2023)

	Bloomberg U.S. Aggregate Index	S&P 500 Index	DJ U.S. TSM Completion Index	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
Bloomberg U.S. Aggregate Index	1.00							
S&P 500 Index	0.16	1.00						
DJ U.S. Completion TSM Index	0.12	0.93	1.00					
MSCI EAFE Index	0.21	0.87	0.83	1.00				
MSCI World ex USA Index	0.21	0.88	0.84	1.00	1.00			
MSCI ACWI ex USA IMI	0.22	0.86	0.84	0.99	0.99	1.00		
MSCI ACWI ex USA ex China ex Hong Kong Index	0.21	0.88	0.84	0.99	1.00	1.00	1.00	
MSCI ACWI IMI ex USA ex China ex Hong Kong Index	0.21	0.88	0.84	0.99	1.00	1.00	1.00	1.00

(Longest common time period = 21 years)

The cumulative annualized returns over several trailing historical periods are shown in Table 34.

As shown in the table, over long time periods (20+ years) broader exposure to emerging markets and international small caps helped the broader indices to outperform the current MSCI EAFE index. However, when expanding market coverage to emerging markets and also removing exposure to China, Hong Kong, and Russia, historical performance has been better than the current benchmark over most time periods.

Table 34: Return History (%) (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
1 Year	18.8	16.3	12.5	16.8	16.1
3 Years	8.9	8.9	7.3	10.0	9.8
5 Years	4.4	4.2	3.4	4.8	4.5
10 Years	5.4	5.5	4.9	5.2	5.3
15 Years	3.4	3.4	3.1	3.2	3.4
20 Years	6.5	6.8	6.9	6.8	7.1
25 Years	4.3	4.8	4.9	-	-
30 Years	5.3	-	-	-	-
35 Years	5.0	-	-	-	-

Note: See appendix for annual returns

Table 35 shows the volatility (annualized standard deviation) of the indices over several trailing historical periods. Relative to the current MSCI EAFE Index, the broader indices have exhibited similar annualized standard deviation. The broader indices have tended to have moderately higher volatility over longer time periods due to the inclusion of emerging markets and international small caps relative to the MSCI EAFE Index.

Table 35: Annualized Standard Deviation (%) (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
3 Years	18.1	18.1	17.1	17.7	17.8
5 Years	17.8	18.2	17.7	18.0	18.3
10 Years	15.0	15.1	14.9	15.1	15.1
15 Years	18.0	18.1	18.3	18.2	18.4
20 Years	16.6	16.8	17.1	17.0	17.1
25 Years	16.8	16.9	17.3	-	-
30 Years	16.3	-	-	-	-
35 Years	16.9	-	-	-	-

The realized Sharpe ratios for each of the indices are shown in Table 36.

Table 36: Sharpe Ratios (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
5 Years	0.16	0.14	0.10	0.18	0.16
10 Years	0.29	0.30	0.26	0.28	0.29
15 Years	0.14	0.15	0.13	0.13	0.14
20 Years	0.31	0.33	0.33	0.33	0.34
25 Years	0.15	0.17	0.18	-	-
30 Years	0.18	-	-	-	-
35 Years	0.12	-	-	-	-

Over longer time periods (20+ years) the broader indices have slightly higher Sharpe ratios relative to the current MSCI EAFE Index due to higher realized returns and similar standard deviations. However, when expanding market coverage to emerging markets and also removing exposure to China, Hong Kong, and Russia, historical Sharpe ratios have been better than the current benchmark over most time periods.

Investability & Liquidity

All the benchmarks under consideration take into account the liquidity of stocks for inclusion in the index. Although some stocks in certain smaller countries can be difficult to trade, index fund managers still hold most, if not all stocks, though they may have a higher tolerance for mis-weights as the benefit from fully replicating the benchmark can be more than offset by transaction costs.

Investors have become increasingly interested in the non-U.S. equity markets over the past several decades, with prevalence among institutional investors dating back to the 1990s. Today, institutional investors have embraced non-U.S. equity as an essential component of their asset allocation strategies. As a result, liquidity in the non-U.S. equity related index products has increased substantially.

More specifically, liquidity in the markets related to the indices has reached a sizeable level, as shown in Table 37.

Table 37: Average Daily Trading Volume (ADV) ($) (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
30 Days	3,521,515,385	6,107,344,255	44,657,808,647	13,308,620,834	23,811,672,836
3 Months	3,050,604,196	5,432,422,718	42,655,577,733	10,121,891,856	20,016,336,517

Source: Bloomberg

In order to evaluate the international equity market's ability to absorb the range of cash flow activity the TSP experiences, the following table outlines:

- Large and average daily net cash outflow size from January 2019 to June 2022
- Percentage of the cash flow the market can absorb at Market on Close (MOC) without exceeding 3% of Average Daily Volume (ADV)
- Estimated Explicit Cost (commissions + taxes)
- Implicit Cost (MOC)

The results in Table 38 illustrate the following international equity markets can absorb more than 97% of the large and 100% of the average daily net cash flow at the market on close without exceeding 3% of average daily volume. A threshold of 3% ADV is the amount that TSP's managers are generally comfortable trading at or near the close without causing undue market impact. For a large net daily cash flow, if 100% of the trade is not executed on market on close, the trade can be executed through derivatives in a low-cost manner. Overall, we find the following markets have depth and liquidity to be able to absorb meaningful size daily cash flow activity at marginal cost.

Table 38: Liquidity Analysis (As of September 2023)

	Large Net Cash Flow - $1.0 Billion			Average Net Cash Flow - $150 Million		
International Equity Indices	**% at MOC (3% of ADV)**	**Explicit Costs (Comm + Taxes)**	**Implicit Costs (MOC)**	**% at MOC (3% of ADV)**	**Explicit Costs (Comm + Taxes)**	**Implicit Costs (MOC)**
MSCI EAFE Index	96.9%	0.14%	0.00%	100.0%	0.14%	0.00%
MSCI World ex USA IMI	99.0%	0.13%	0.01%	100.0%	0.13%	0.00%
MSCI ACWI ex USA IMI	98.9%	0.12%	0.01%	100.0%	0.12%	0.01%

Source: BlackRock

On the topic of tracking error, due to the unique nature of investing in international markets, different methodologies implemented by the investment managers will produce different levels of tracking error. For example, some investment managers apply fair value pricing adjustments to better reflect the value of foreign securities due to differences in market closure between foreign markets and the U.S. equity market. Since benchmarks typically are calculated using local closing prices and do not apply fair value pricing adjustments, the

difference in methodologies can cause tracking error between the investment manager's performance and the benchmark.

Acceptance

The MSCI indices are the most widely followed non-U.S. stock indices for U.S. based institutional investors. Table 39 shows the assets indexed to each of the international MSCI indices considered.

Table 39: Assets Indexed to Benchmark (As of 6/30/2023)

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
Total Passive Assets	$266 Billion	$17 Billion	$168 Billion	--	--

Source: BlackRock, Mellon, Northern Trust, SSGA, and Vanguard

Note: Total passive assets include assets provided by BlackRock, which are as of March 31, 2023. Remaining data is as of June 30, 2023.

In the table above, we illustrate the amount of assets that are benchmarked to the underlying index. This information represents assets benchmarked to each unique index and does not factor any overlap in assets between the different indices.

When looking at the assets invested across the passive providers, the MSCI EAFE Index is the most popular index, with $266 B invested in products tracking this index. The MSCI ACWI ex USA IMI is not far behind with $168 B benchmarked to this index. Although the assets benchmarked to the MSCI World ex USA IMI is much smaller, it remains a viable option with $17 B of total assets benchmarked to this index. However, it is important to note that only two of the five investment managers manage assets to this index.

Additionally, although there are no assets are managed to the MSCI ACWI ex USA ex China ex Hong Kong Index and MSCI ACWI IMI ex USA ex China ex Hong Kong Index by the major index providers, these indices are readily available for utilization. Through our research, we were able to document that there are currently more than 10 existing licenses for the MSCI ACWI ex USA ex China ex Hong Kong Index and the MSCI ACWI IMI ex USA ex China ex Hong Kong Index. Of these licenses, we are aware of at least one institutional investor with approximately $4B managed to the MSCI ACWI IMI ex USA ex China ex Hong Kong Index across their asset pools.

In addition to evaluating assets currently benchmarked to the various indices, Tables 40-42 also highlight the international benchmarks offered within Plans of several applicable peer groups. As illustrated in the tables, all plans evaluated currently offer exposure to both developed and emerging markets through their target date fund solution and core menu lineup (either actively or passively).

Table 40: International Fund Benchmarks of Investment Options of Top 15 Largest U.S. Defined Contribution Plans

	Company	TDF Non-U.S. Equity Benchmark	Core Lineup Non-U.S. Equity Benchmark
1	Boeing	*Custom TDF*[1] MSCI ACWI ex USA IMI	MSCI ACWI ex USA IMI
2	IBM	*Custom TDF*[1] FTSE Emerging Markets All Cap China A Inclusion Index MSCI ACWI ex USA Index MSCI Europe Index MSCI Pacific Index	FTSE Emerging Markets All Cap China A Inclusion Index MSCI ACWI ex USA Index MSCI Europe Index MSCI Pacific Index
3	AT&T	*Custom TDF* MSCI ACWI ex USA Index	MSCI ACWI ex USA Index
4	Bank of America	MSCI ACWI ex USA IMI	FTSE Global All Cap ex US Index MSCI ACWI ex USA Growth Index MSCI ACWI ex USA Index
5	Raytheon Technologies[2]	N/A	MSCI ACWI ex USA Index MSCI Emerging Markets Index
6	Wells Fargo	MSCI ACWI ex USA IMI	MSCI ACWI ex USA Index MSCI EAFE Index MSCI Emerging Markets Index
7	Lockheed Martin	*Custom TDF* Data not publicly available	Data not publicly available
8	Verizon	*Custom TDF* Data not publicly available	Data not publicly available
9	Microsoft	MSCI ACWI ex USA IMI	Data not publicly available
10	JP Morgan Chase	*Custom TDF*[3] MSCI EAFE Index MSCI EAFE Small Cap Index MSCI Emerging Markets Index	MSCI EAFE Index MSCI EAFE Small Cap Index MSCI EAFE Value Index MSCI Emerging Markets Index
11	Walmart	*Custom TDF* MSCI ACWI ex USA IMI	MSCI ACWI ex USA IMI
12	Northrop Grumman Corp.	*Custom TDF*[1] MSCI EAFE Index MSCI Emerging Markets Index	MSCI EAFE Index MSCI Emerging Markets Index
13	Kaiser Permanente	MSCI EAFE Index MSCI Emerging Markets Index	FTSE Global All Cap ex US Index MSCI ACWI ex USA Index
14	California University	*Custom TDF* MSCI Emerging Markets IMI ex Tobacco ex Fossil Fuels Index MSCI World ex USA IMI ex Tobacco ex Fossil Fuels Index	MSCI EAFE Index MSCI Emerging Markets IMI ex Tobacco ex Fossil Fuels Index MSCI World ex USA IMI ex Tobacco ex Fossil Fuels Index
15	New York State	MSCI ACWI ex USA Index	MSCI ACWI ex USA Index MSCI EAFE Index MSCI Emerging Markets Index

Source: Pensions & Investments as of 12/31/2022, Form 5500 filings, and publicly sourced plan information

Note: Benchmarks shown for data available and may be representative of the passive and/or active core lineup investment option. For custom strategies, benchmarks may represent the benchmarks of the underlying components.
[1]Custom target date fund solution offered in plan. If benchmark information was not available for custom TDF, core lineup benchmark(s) shown.
[2]Information provided for the Raytheon Retirement Savings Plan
[3]Custom target date fund solution offered in plan. Data was not available for the custom benchmark, however it was confirmed that the active international strategy is not included.

Table 41: International Fund Benchmarks of Investment Options of Top 10 Largest Government Contractor Defined Contribution Plans

	Company	TDF Non-U.S. Equity Benchmark	Core Lineup Non-U.S. Equity Benchmark
1	Lockheed Martin	*Custom TDF* Data not publicly available	Data not publicly available
2	Raytheon Technologies[1]	N/A	MSCI ACWI ex USA Index MSCI Emerging Markets Index
3	General Dynamics Corp.	FTSE Global All Cap ex US Index	MSCI ACWI ex USA IMI
4	Pfizer Inc.	FTSE Global All Cap ex US Index	MSCI ACWI ex USA IMI MSCI EAFE Index MSCI Emerging Markets Index
5	Boeing	*Custom TDF*[2] MSCI ACWI ex USA IMI	MSCI ACWI ex USA IMI
6	UnitedHealth Group Inc.	MSCI Emerging Markets Index MSCI World ex USA Index	MSCI ACWI ex USA IMI MSCI ACWI ex USA Index MSCI Emerging Markets Index
7	Northrop Grumman Corp.	*Custom TDF*[2] MSCI EAFE Index MSCI Emerging Markets Index	MSCI EAFE Index MSCI Emerging Markets Index
8	McKesson Corp.	FTSE Global All Cap ex US Index	MSCI EAFE Index MSCI EAFE Small Cap Index MSCI Emerging Markets Index
9	Leidos Holdings Inc.	FTSE Global All Cap ex US Index	FTSE Global All Cap ex US Index MSCI ACWI ex USA Index
10	Humana Inc.	MSCI EAFE Index MSCI Emerging Markets Index	MSCI ACWI ex USA IMI MSCI EAFE Index

Source: Bloomberg, Form 5500 filings, and publicly sourced plan information
Note: Benchmarks shown for data available and may be representative of the passive and/or active core lineup investment option. For custom strategies, benchmarks may represent the benchmarks of the underlying components.
[1]Information provided for the Raytheon Retirement Savings Plan
[2]Custom target date fund solution offered in plan. If benchmark information was not available for custom TDF, core lineup benchmark(s) shown.

Table 42: International Fund Benchmarks of Investment Options of Top 15 Largest Publicly Traded U.S. Companies' Defined Contribution Plans

	Company	TDF Non-U.S. Equity Benchmark	Core Lineup Non-U.S. Equity Benchmark
1	Apple	MSCI ACWI ex USA IMI	FTSE Global All Cap ex US Index MSCI ACWI ex USA Index
2	Microsoft	MSCI ACWI ex USA IMI	Data not publicly available
3	Amazon	FTSE Global All Cap ex US Index	FTSE Global All Cap ex US Index MSCI ACWI ex USA Index MSCI World ex USA Index
4	Nvidia	MSCI ACWI ex USA Index	FTSE Global All Cap ex US Index MSCI ACWI ex USA Index MSCI ACWI ex USA SMID Cap Index
5	Alphabet[1]	FTSE Global All Cap ex US Index	FTSE Developed All Cap ex US Index FTSE Emerging Markets All Cap China A Inclusion Index MSCI EAFE Index
6	Tesla	MSCI ACWI ex USA Index	MSCI ACWI ex USA Index MSCI EAFE Index
7	Meta Platforms	FTSE Global All Cap ex US Index	MSCI ACWI ex USA IMI
8	Berkshire Hathaway[2]	Data not available	Data not available
9	ExxonMobil	N/A	MSCI World ex USA IMI
10	UnitedHealth Group Inc.	MSCI World ex USA Index MSCI Emerging Markets Index	MSCI ACWI ex USA IMI MSCI ACWI ex USA Index MSCI Emerging Markets Index
11	Eli Lilly & Co	*Custom TDF*[3] Data not publicly available	MSCI ACWI ex USA IMI MSCI ACWI ex USA Index
12	JP Morgan Chase	*Custom TDF*[4] MSCI EAFE Index MSCI EAFE Small Cap Index MSCI Emerging Markets Index	MSCI EAFE Index MSCI EAFE Small Cap Index MSCI EAFE Value Index MSCI Emerging Markets Index
13	Johnson & Johnson	Data not publicly available	Data not publicly available
14	Visa Inc.	FTSE Global All Cap ex US Index	FTSE Global All Cap ex US Index MSCI EAFE Index
15	Procter & Gamble	N/A	MSCI ACWI ex USA Index

Source: DJ U.S. Total Stock Market Index Holdings as of 9/30/2023, Form 5500 filings, and publicly sourced plan information

Note: Benchmarks shown for data available and may be representative of the passive and/or active core lineup investment option. For custom strategies, benchmarks may represent the benchmarks of the underlying components.

[1]Google LLC 401(k) Savings Plan shown as largest subsidiary of Alphabet

[2]Berkshire Hathaway does not offer a consolidated defined contribution plan. Each of the subsidiaries has autonomy. Therefore, the plans have not been included in the analysis.

[3]Enough information was available to confirm that the custom TDF does not utilize the core menu lineup. However, the benchmark of the international component of the custom TDF remains unknown.

[4]Custom target date fund solution offered in plan. Data was not available for the custom benchmark, however it was confirmed that the active international strategy is not included.

Analysis of International Equity Benchmarks

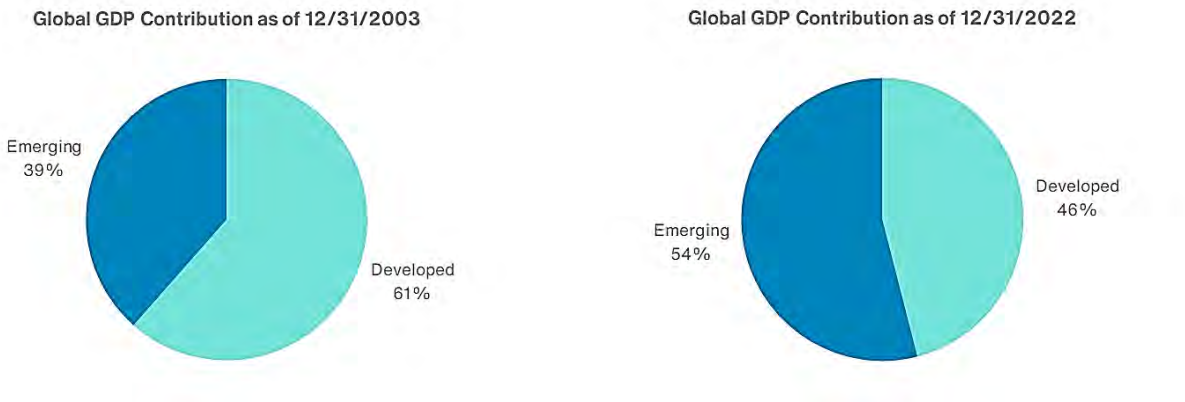
Modern Portfolio Theory suggests that the "market portfolio" is the most efficient portfolio (in terms of risk/return trade-off) that an investor can hold. The "market portfolio" is a market-cap weighted sum of all available asset classes/regions/countries. Excluding segments of the market limits investors' opportunities (return and/or diversification potential).

In general, we recommend constructing equity portfolios with the broadest possible market coverage. For instance, we would recommend the DJ U.S. Total Stock Market Index, which provides complete coverage of large, mid, and small-cap stocks, as the benchmark for the broad U.S. equity market. The C and S Fund's recommended benchmarks, the S&P 500 Index and the DJ U.S. Completion TSM Index, respectively, when combined, provide coverage of the broad U.S. equity opportunity set that is very similar to the coverage provided by the DJ U.S. Total Stock Market Index.

The I Fund's existing benchmark, the MSCI EAFE Index, excludes small cap stocks, Canadian equities, and emerging markets securities. As noted earlier, the Canadian equity market is the fourth-largest equity market outside of the United States, and emerging markets represent roughly one fourth of the non-U.S. equity opportunity set. Moreover, emerging markets represent a significant and growing portion of global growth or GDP and an increasingly larger portion of the world equity market capitalization. Over the past two decades, emerging economies, such as Brazil, China, India, Taiwan, and South Africa, have expanded at a much faster pace than developed countries.

Today, emerging markets contribute to 54% of global GDP as compared to 39% in 2003 (shown in Chart 6).

Chart 6: Global GDP Contribution



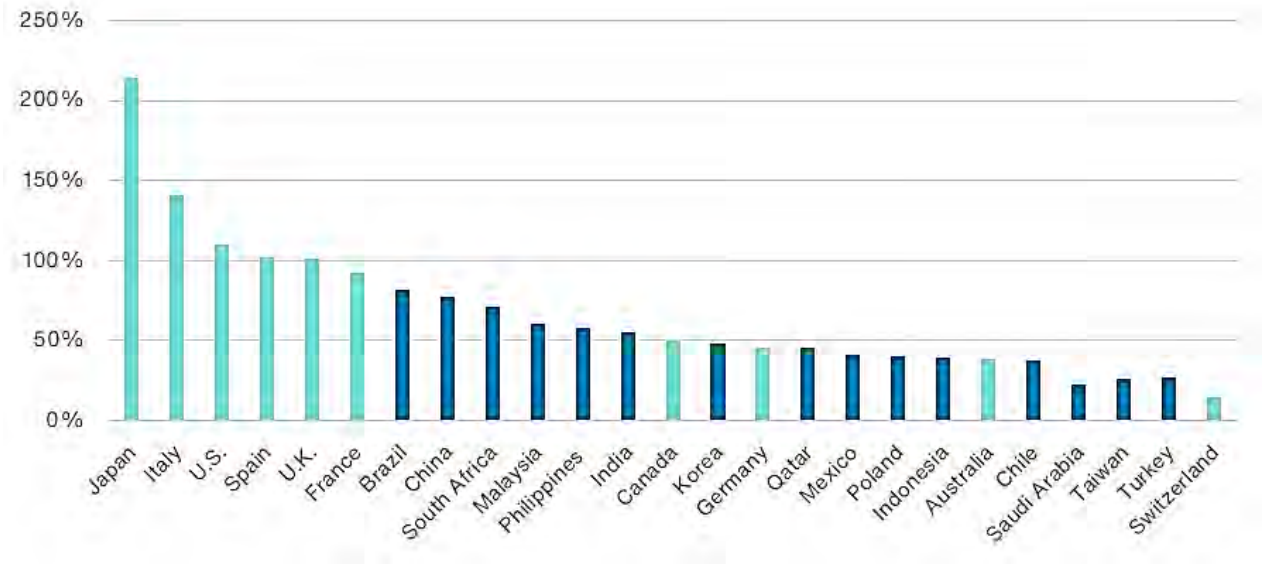
Source: The Conference Board of Global Economic Outlook (Global GDP shares using Purchasing Power Parities)

Many observers broadly expect emerging economies to continue to grow at a faster pace than developed economies. Reasons include:

- Favorable demographics and a growing middle class
- Growth in local consumption demand
- Improving economic, legal and regulatory systems
- Disciplined fiscal and monetary policies

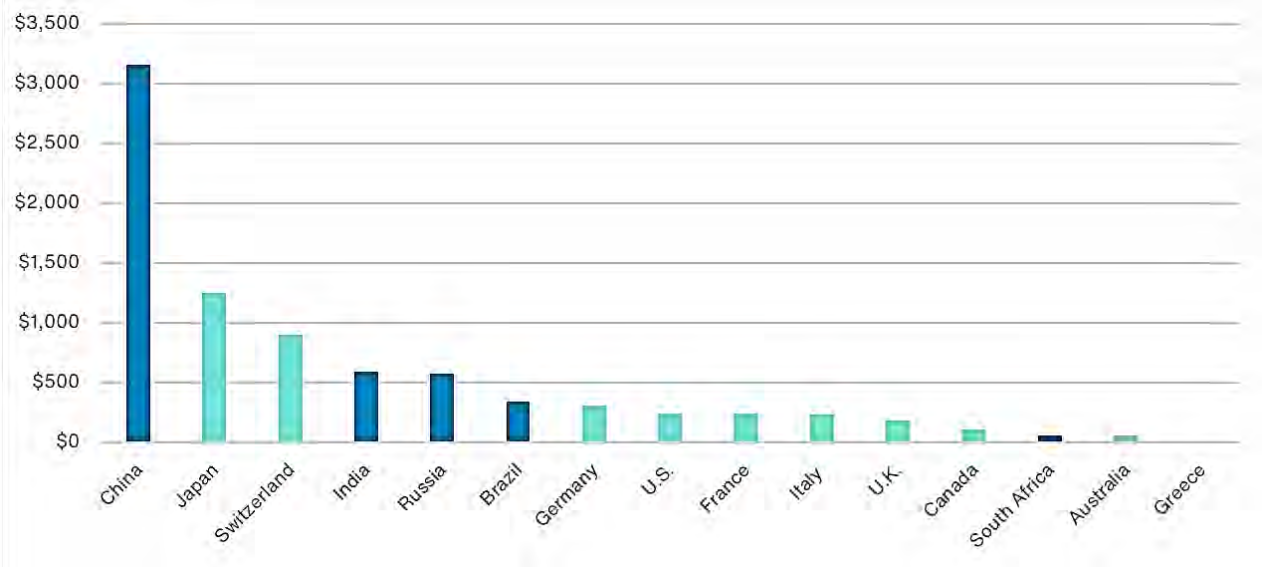
Emerging countries today are much less burdened by massive amounts of public debt as compared to their developed counterparts (Chart 7). Several emerging market countries have also accumulated massive amounts of foreign currency reserves (Chart 8), which have proven to provide a cushion against external economic shocks. The growth in foreign currency reserves, combined with growth in domestic consumption, helped many emerging economies soften the impact of the global economic downturn.

Chart 7: 2022 Public Debt as % of GDP



Source: IMF

Chart 8: Foreign Currency Reserve ($ Billion) (As of 6/30/2023)



Source: IMF

Along with the growing economic power of emerging markets as a whole, the capital markets in several emerging countries have also evolved over the past decade. Data from The World Federation of Exchanges shows that, assessed by total market capitalization and trade value, China's two major stock exchanges, if combined, rank the third-largest in the world after the New York Stock Exchange and NASDAQ. Other emerging countries such as India, Saudi Arabia, South Korea, Taiwan, and South Africa also claimed spots within the top-20 stock exchanges at the end of 2022. With the improved liquidity and transparency, lower transaction costs, and improved property rights and legal protections, institutional investors have become more comfortable investing in emerging markets.

While the case for investing in emerging markets has become more compelling, emerging markets have experienced, and, in our opinion, will experience greater volatility than that of developed markets. Some of the risks in emerging markets include:

- International governmental risk (rogue regimes, expropriation of assets, etc.)
- Slowing down or a reversal of favorable economic and monetary policies
- A higher willingness based on historical experience to default or devalue their currencies
- Growth that is heavily dependent on or tied to growth in developed markets (exports, commodities, etc.)

While several of these risks are not easily quantified, we do believe investors get compensated for these risks on a risk-adjusted basis. The volatility of emerging markets has been higher than developed markets over the last decade or two, but emerging markets have been able to keep pace with developed markets on a risk-adjusted basis.

Table 43 shows Aon's expected returns and risk (volatility) for developed and emerging markets over the long-term. These represent 30-year forward looking expectations.

Table 43: Aon 30-Year Capital Market Expectations (As of 6/30/2023)

	Expected Return	Expected Risk	Expected Sharpe Ratio
Developed Markets	7.3%	20.8%	0.19
Emerging Markets	7.7%	24.5%	0.18

As shown, we expect emerging markets to provide a higher return as compared to developed markets, but at a materially higher level of risk.

As for non-U.S. small cap stocks, because commonly used benchmarks for international equity, MSCI EAFE and MSCI ACWI ex USA indices, do not contain small cap stocks, we believe that non-U.S. small cap stocks are under-invested relative to their U.S. small cap peers. Additionally, relative to larger peers, smaller companies in the IMI are covered by a smaller pool of sell-side analysts. This under-investment and lack of analyst coverage may lead to less market efficiency and a greater return potential.

Non-U.S. small cap stocks are also tied more to their local economies than to the global economy. The lack of connection to the global economy should provide lower correlations to the broader equity market. Consequently, we believe that adding non-U.S. small cap exposure will likely improve the Sharpe ratio of the overall non-U.S. equity portfolio.

The broad non-U.S. equity market is of significant market size, and indexed assets under management are large. The broad non-U.S. equity market provides diversification across country, sector, and market capitalization. By broadening the exposure of the I Fund, there would be an increase in stock coverage by 1,510 stocks in the case of the MSCI ACWI ex USA Index and 5,912 stocks in the case of the MSCI ACWI ex USA IMI as of July 31, 2023.

Overall, we favor a benchmark that includes Canada, emerging markets, and international small cap equities as it provides broader coverage of the international equity markets, more fully captures global growth, and provides enhanced diversification of the international equity portfolio. From a theoretical standpoint, we recommend that clients utilize the MSCI ACWI ex USA Index or the MSCI ACWI ex USA IMI, as these indices provide complete coverage of the global equity opportunity set.

However, as we consider an appropriate benchmark for the I Fund, it is important to take into account the Thrift Savings Plan's unique circumstances. These include:

- Need to provide daily liquidity
- Transition cost and planning
- Securities lending income
- Administrative and other complexities: An asset class may have investment merits to be considered for inclusion in an investment line-up, however it is also important to consider the trade-offs of implementation considerations such as unusual cost and custody issues, international governmental risk, and administrative and operational complexities.

Considerations in Expanding the I Fund Benchmark to Include Emerging Markets

As we review the I Fund's current benchmark, the MSCI EAFE Index, the case to include Canada is very compelling and obvious given that it is the fourth-largest equity market outside the U.S. and a country that participants should have familiarity with.

The case for the inclusion of emerging markets and international small cap equities, while compelling, we will further investigate within this report. The foremost consideration in expanding the I Fund benchmark to include Canada, emerging markets, and international small cap equities is the need to provide daily liquidity. A sufficient level of cash must be maintained in the fund to meet participant withdrawal needs. As an example, the investment managers of the I Fund hold approximately 0-3% of the Fund's assets in cash in order to meet routine liquidity needs. The cash is equitized to the markets using futures contracts or other derivatives. While the use of derivatives minimizes the cash drag on the portfolio, they may not always track the benchmark precisely (e.g., if multiple country futures contracts are used to track a benchmark) or may not have adequate levels of liquidity. This could lead to potential sources of tracking error.

Liquidity

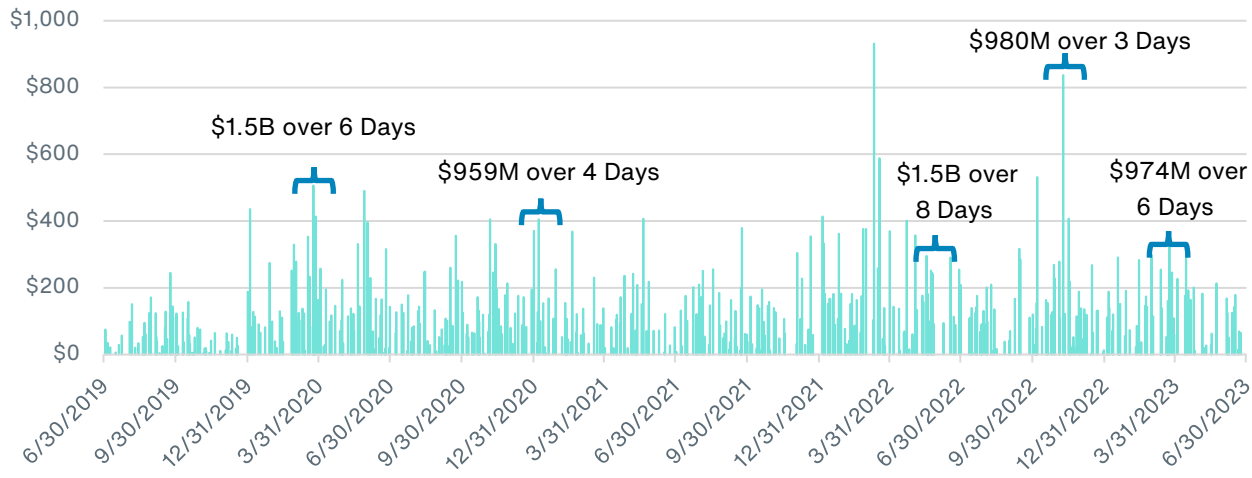
We reviewed the TSP I Fund's daily cash flow activity over a four-year period ending June 30, 2023. As of June 30, 2023, the I Fund's assets stood at $72.6 billion, as compared to $50.0 billion in June 2019. This period was characterized by elevated volatility across most major capital markets.

We focused our attention on withdrawals out of the I Fund over the four-year period in order to assess the ability to provide liquidity on a daily basis to meet participant redemption requests. The average daily net withdrawal over the period was $125 million, which on an asset base of $73 billion represents about 0.2% of assets. The largest single cash withdrawal out of the I Fund was $931 million, which occurred on March 11, 2022. This cash flow represented approximately 1.4% of the I Fund's assets as of that day.

While the average daily cash withdrawal and the largest single day withdrawal are well within the cash buffer that it maintained to meet ongoing liquidity, as mentioned earlier, withdrawals tend to spike around periods of poor market performance. We reviewed aggregate cash flows over consecutive days of withdrawals out of the I Fund over a four-year period. There were 14 instances when aggregate withdrawals over consecutive days exceeded $400 million over this period and 4 instances when aggregate withdrawals over consecutive days exceeded $500 million. Chart 9 shows the daily net withdrawal activity over the four-year period.

As shown in Chart 9, there has been five instances where cash flows over consecutive days equaled approximately $950 million – 1.5 billion or 2% of the I Fund during that time period (which occurred between 3/23/2020 – 3/30/2020; 12/30/2020 – 1/6/2021; 5/17/2022 – 5/26/2022; 11/8/2022 – 11/10/2022; 3/20/2023 – 3/27/2023), illustrating a significant outcome, however still falls within the 0-3% cash allocation that the TSP's international equity managers generally hold to meet liquidity needs. Consistent selling or buying in the market can increase transactions costs during periods of increased volatility. Based on historical cash flow data, we have not seen net outflows reach levels that would cause us concern.

Chart 9: I Fund Daily Net Cash Outflow Activity ($ Millions)

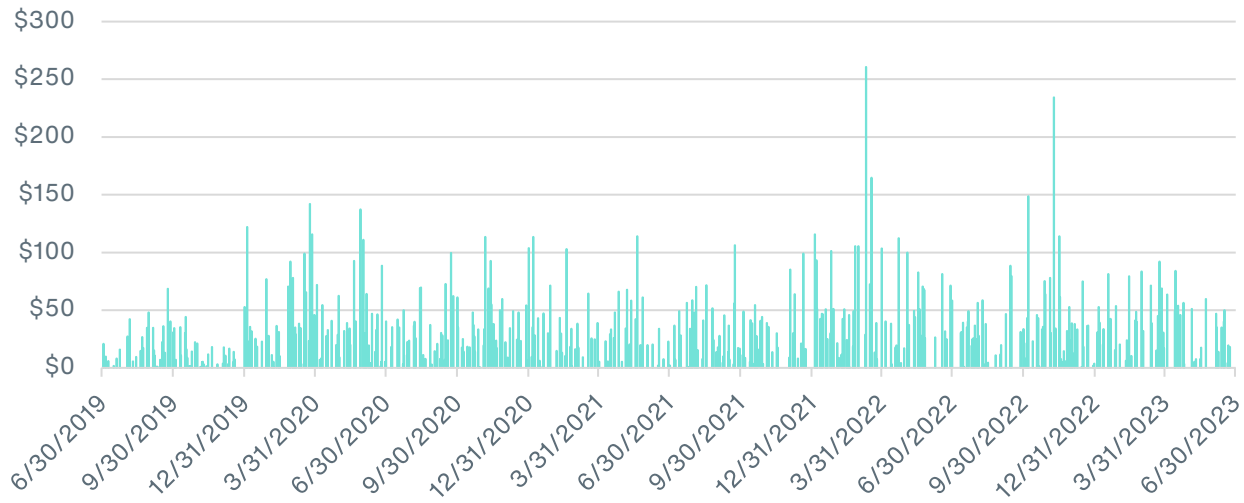


As we think about the inclusion of emerging markets into the benchmark for the I Fund, it is critical to take into consideration the liquidity needs of the TSP. While the liquidity in emerging markets has generally improved, we typically see a flight to quality from emerging markets (and other riskier markets) in times of market stress. Liquidity can be adversely impacted in times of market stress.

Based on discussions with the TSP's largest index fund manager, they indicate that they are normally able to trade about $250 million to $300 million on behalf of the I Fund in emerging market flow on a daily basis, without impacting the prices of securities adversely.

Chart 10 shows the withdrawals over consecutive days for the I Fund at 28% of the actual cash flow. Emerging markets represent approximately 28% of non-U.S. equity markets and hence this analysis gives us a sense for the potential extent of emerging market flows.

Chart 10: I Fund Daily Net Cash Outflow Activity Scaled to 28% ($ Millions)



While the average cash outflow (from the I Fund scaled to 28%) over this period appears to be well within the $250 - $300 million range that managers indicate that they are able to comfortably trade in emerging markets, there are two instances where the cash flows over consecutive days exceeded the $250 - $300 million range to $417 and $433 million (which occurred between March 30, 2020 and May 26, 2022).

Further, it is important to note that these cash flows represent I Fund (developed market) cash flows scaled to 28%. The inclusion of emerging markets in the I Fund benchmark could result in a higher level of cash withdrawals in times of market stress given the higher volatility of emerging markets.

During periods of large flows, futures can be used to quickly gain or divest exposure. When expanding the coverage of the I Fund to track to the MSCI ACWI ex USA IMI, the investment strategy is to fully replicate the benchmark by owning the majority of the stocks in the benchmark, if not all. However, due to liquidity challenges in certain markets, the small cap portion may be optimized via sampling at any given time. Since the small cap segment of the index represents 14%, the impact on tracking error is expected to be marginal. Overall, liquidity is managed through the use of the I Fund's cash buffer and other tools such as optimization and derivatives.

Derivatives play a role in managing I Fund liquidity during time periods where local foreign markets are closed. The existence of a liquid market for emerging market futures contracts also allows index fund managers to manage cash flows more efficiently, resulting in tighter tracking of the Index. Derivatives also mitigate daily tracking error since futures contracts are traded during U.S. market hours and incorporate fair value pricing (FVP). FVP is an adjustment made by passive providers to align the closing price or NAV of a passive fund with the current value of that Fund's underlying holdings. FVP is typically used in international equity funds that are priced at the U.S. market close. Therefore, there may be price adjustments made to foreign securities from the local market close to the U.S. market close due to events or news that impacted the securities' price after the local market close. In order to mitigate tracking error, U.S. index managers typically trade closer to the U.S. market close. Since international local markets are generally closed by then, the manager could utilize futures contracts to get

exposure to the equity market or could close out of future contracts in the event liquidity is needed. Over time, the index manager could close out of futures contracts and rebalance the portfolio through physical securities. Therefore, the liquidity of the derivatives market for emerging markets is critical in this analysis. In September 2023, emerging market futures contracts traded approximately $4.0 billion a day.

Futures exposure is not available for international small cap exposure; therefore, small cap exposure would be obtained through physical securities and potentially ETF instruments to assist in cash management needs. The daily tracking error, when not owning international small cap, is estimated to be 0.04% a day based on an annualized tracking error of 0.60%. We believe the inclusion of emerging markets and international small cap equities in the I Fund would not hinder the ability to meet the TSP's daily liquidity needs. The TSP's historical daily cash flow activity over the last four years has been at reasonable levels where the activity can be traded in emerging markets without adversely impacting the prices of securities. As mentioned earlier, the trading would likely be conducted through derivatives, a market with ample liquidity. In the event cash flow activity is above the $250-$300 million trade size for emerging markets within the I Fund, the index manager may have to trade futures contracts across a longer time period than trading at the market close, which may increase the tracking error of the mandate.

Transaction Costs & Planning

Table 44 details the estimated costs involved in transitioning the Fund's benchmark from the MSCI EAFE Index to the indices under review. The estimated cost in dollars is based on expected trading costs and the asset value of the I Fund as of July 31, 2023, which was $75 billion.

Table 44: Trading Costs for Multi-Tranche Transition (As of September 2023)

	MSCI World ex USA IMI		MSCI ACWI ex USA Index		MSCI ACWI ex USA IMI		MSCI ACWI IMI ex USA ex China ex Hong Kong Index	
	Bps	$	Bps	$	Bps	$	Bps	$
Commissions	1.1	8,250,000	2.3	17,250,000	2.8	21,000,000	2.6	19,500,000
Taxes	1.2	9,000,000	1.9	14,250,000	2.7	20,250,000	2.2	16,500,000
Bid/Ask Spread	0.4	3,000,000	0.5	3,750,000	0.7	5,250,000	0.6	4,500,000
Market Impact	2.2	16,500,000	3.4	25,500,000	4.2	31,500,000	3.8	28,500,000
FX Cost	--	--	1.2	9,000,000	1.3	9,750,000	1.4	10,500,000
Mean Expected Cost	**4.9**	**$36,750,000**	**9.3**	**$69,750,000**	**11.7**	**$ 87,750,000**	**10.6**	**$ 79,500,000**
Opportunity cost	+/- 7.0	+/- $52,500,000	+/- 17.0	+/- $127,500,000	+/- 18.0	+/- $135,000,000	+/- 13.0	+/- $97,500,000

Source: BlackRock

Note: Bps = basis points = 100th of a percent; FX = foreign exchange

The transaction cost associated with transitioning the I Fund's benchmark from the MSCI EAFE Index to the MSCI ACWI ex USA IMI is expected to be about 11.7 bps or approximately $88 million on average. Depending on market activity at the time of the transition, we would expect the actual cost of transition to range between a cost of 29.7 bps ($222.8 million) or a gain of 6.3 bps ($47.3 million) about 67% of the time. We believe that these transition

costs are reasonable given the overall shift from developed markets to emerging markets, as well as into international small cap.

We recommend that the transition be conducted in a phased, methodical manner over a period of time as liquidity opportunities present themselves, as opposed to a transition in a day or a few days. Rebalancing from the MSCI EAFE Index to the MSCI ACWI ex USA IMI would result in approximately a 55% overlap between the legacy and target portfolios. To help lower bid/ask spread and market impact costs associated with the transition, it is expected that 16 trading tranches would be required to achieve 100% of the rebalance. The tranches would occur every 5 days over the span of 4 months. Each tranche would be built to match the composition of the target index. Tranche size would depend on the liquidity of the required rebalance trade with an expected size of $4.7 billion. We believe the transition should be staggered across the two I Fund investment managers where manager B (manages 20% of the I Fund) can complete the transition of their portfolio first before manager A (manages 80% of the I Fund) begins their transition. This avoids the case where both managers are competing for liquidity to complete their trades. The staggered approach could be executed over the 16-tranche transition period.

The analysis assumed the transition trading would be executed at the same commission levels that the TSP currently pays to execute global equity trades. Therefore, the analysis assumed the TSP would not pay additional commissions over what they generally would incur.

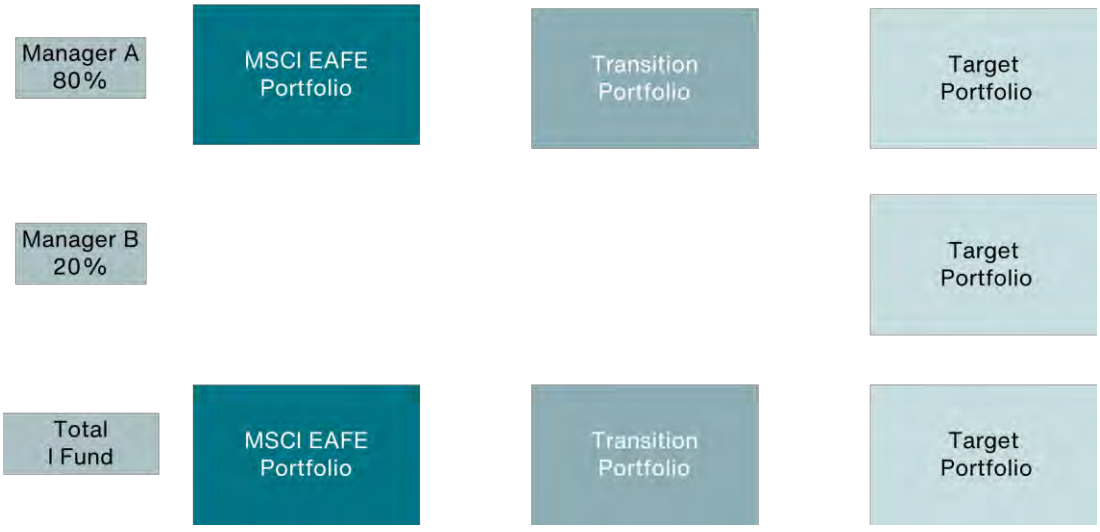
We recommend using a transition account to build each tranche; therefore, assets for each tranche would be transferred out of the legacy account to the transition account. Once the tranche is built to match the composition of the target index, assets would be transferred to the target portfolio account. Performance would be tracked separately for the legacy, target, and transition accounts and participants would experience the return of all three accounts as the performance of all three accounts would be rolled up into a composite return. In this fashion, the historical return stream of the legacy I Fund may be maintained and not impacted by the transition. The legacy portfolio would continue to track the MSCI EAFE Index, and the target portfolio would track the new target benchmark. This would be feasible since the transition would be done in multiple tranches and each tranche would be rebalanced in the transition account and then transferred to the target portfolio. This approach is also cleaner from a portfolio management standpoint, since the portfolio manager would manage the legacy and target portfolio accounts, while the transition management team would manage the transition account.

In this scenario, the performance benchmark during the transition period would generally be daily asset weighted between MSCI EAFE Index and the target benchmark. The legacy portfolio would be benchmarked against the MSCI EAFE Index, and the transition and target portfolio accounts would be benchmarked against the target benchmark. The tracking error between the I Fund's performance and the new benchmark would be due to the transaction costs associated with the benchmark change.

The below outlines a schematic of the staggered transition approach.

Staggered Transition – Step 1: Manager B Transition

Staggered Transition – Step 2: Manager A Transition



The main considerations in this scenario are the setup of securities lending for an additional account (target portfolio account) and the additional operational step in the movement of assets as securities would need to be moved to the transition account and then to the target portfolio. We believe the benefits outweigh the considerations given the portfolio manager accounts would be isolated from the transition account, performance benchmarking could be easily tracked, and the historical MSCI EAFE Index return stream should not be impacted by the transition.

Another option is to conduct the rebalancing in the legacy account where the existing portfolio is rebalanced over multiple tranches and each tranche would be transferred to the target portfolio as they would be completed. Having

two accounts per manager instead of three may result in less operational work given assets will only need to be transferred to the target portfolio. If the rebalance takes place in the legacy portfolio, transition related performance is not easily tracked and historical strategy performance for the I Fund could be impacted. The portfolio manager would manage the transition in the legacy account, and as each tranche is completed, the assets would transfer to the target portfolio account.

Performance benchmarking in this scenario would not be as clean given the legacy assets would be managed in the same account as the transition is taking place. Therefore, the legacy account including the transition assets would be benchmarked against the MSCI EAFE Index, and the target portfolio would be benchmarked against the target benchmark.

A benefit of this scenario relative to the first scenario is fewer custodial asset movements. We believe the considerations outweigh the benefits largely due to the challenges around performance benchmarking. Additionally, the transition assets would not be benchmarked against the target benchmark since the assets would be held in the legacy account. However, major passive providers typically have the capabilities to conduct the transition in the legacy account if desired.

Securities Lending

The market demand for lending emerging markets and international small cap equity is generally greater than developed large and mid cap stocks. The higher demand is primarily driven by the lack of supply of small capitalization securities available for lending. The same reason applies to emerging markets, although demand is not as prominent. Other reasons for the higher demand for these two segments are the higher volatility associated with these two markets and less public information compared to developed large and mid cap stocks.

The following tables outline the expected yield and utilization changes as a result of a move from the MSCI EAFE Index to the MSCI World ex USA IMI, MSCI ACWI ex USA Index, MSCI ACWI ex USA IMI, and MSCI ACWI IMI ex USA ex China ex Hong Kong Index. The yields referenced below incorporate both intrinsic and reinvestment yield and only account for the net yield to the TSP. Overall, the below table illustrates the additional securities lending income incurred as the opportunity set is expanded to include exposure to Canada, international small cap, and emerging markets. The MSCI ACWI IMI ex USA ex China ex Hong Kong Index generated the highest expected yield and percentage out on loan followed by the MSCI ACWI ex USA IMI. We applied the average daily market value of the I Fund to the below estimated yields in order to derive the estimated yield in dollars. The following table illustrates that across each of the last four calendar years, the income to the TSP is estimated to have been between 1.8x to 2.4x more if the I Fund tracked the MSCI ACWI IMI ex USA ex China ex Hong Kong Index instead of the MSCI EAFE Index, which is 0.2x more than the MSCI ACWI ex USA IMI. Overall, the marginal increase in securities lending income between the MSCI ACWI IMI ex USA ex China ex Hong Kong Index and the MSCI ACWI ex USA IMI was driven by the ability to lend more in France, and to a lesser extent in South Korea, Taiwan, and Thailand, which offset the lending income incurred by the H-Shares in both China and Hong Kong.

Table 45: Securities Lending Yield Estimates

Yield to TSP (bps)					
	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA Index	MSCI ACWI ex USA IMI	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
2020	2.6	5.3	3.6	5.9	6.3
2021	2.9	4.3	3.9	5.9	6.2
2022	3.2	4.8	3.8	6.1	6.7
2023 (YTD)[1]	4.4	6.0	4.6	7.1	8.0
Yield to TSP ($ millions)					
	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA Index	MSCI ACWI ex USA IMI	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
2020	19.2	38.5	25.9	42.9	45.7
2021	21.0	31.4	28.7	42.6	44.9
2022	23.1	34.7	27.8	44.4	48.6
2023 (YTD)[1]	31.9	43.5	33.6	51.5	58.0
On-Loan (%)					
	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA Index	MSCI ACWI ex USA IMI	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
2020	1.6%	2.2%	2.1%	2.7%	2.9%
2021	1.4%	1.9%	1.9%	2.4%	2.8%
2022	2.2%	2.7%	2.4%	3.0%	3.6%
2023 (YTD)[1]	2.7%	3.2%	2.9%	3.5%	4.4%

Source: BlackRock

[1]2023 YTD is annualized data through July 31, 2023

Note: The above analysis assumes all markets are held in a separate account except Taiwan, which is assumed to be held in a commingled for Manager B, since a second separate account cannot be opened. Manager B holds 20% of the I Fund. Bps = basis points = 100th of a percent

Operational Considerations

Please note the following custody considerations apply to international strategies managed in separate accounts. Most of the world's largest custodians do not have custody operations in every country, requiring these organizations to contract with a local custodian that does have these local capabilities. Requiring global custody services introduces additional risks including:

- Failure or default of sub-custodian that could result in losses if proper segregation of securities and cash is not in place

- Lack of contingency planning and/or sufficient contractual protection by main custodian for adverse organizational events
- Settlement and other operational-related risks if the sub-custodian does not have strong controls & processes in place

We believe the above risks are generally mitigated across the world's largest custodians since the custodian is responsible for selecting the foreign custodian (sub-custodian), which is typically based on a very robust, in depth, and complex due diligence process. Custodians also monitor their sub-custodian relationships on an ongoing basis to ensure financial stability, monitor changes in personnel, and identify any changes to the business (technology, client service structure, etc.) that warrant a response.

Settlement Risk

Settlement cycles vary across market; settlements tend to range from T+0 to T+3. This can cause out of market balances, overdrafts, or leverage. Passive managers may use broker-facilitated short settlements and their foreign exchange trading desk to ensure settlement cycles match up.

Local Account Openings

A majority of market accounts are expected to take no longer than 3 weeks to open with an exception to six markets. China is projected to take up to 3 months to open. Saudi Arabia, Taiwan, Qatar, and Kuwait are projected to take 3+ months to open. India is projected to take up to 6 months to open. Therefore, the majority of the markets can be open during the account setup process before asset transition begins. During the 6 month setup, passive managers can obtain exposure to the Indian market by using ADRs/GDRs, ETFs, and derivatives, or they can potentially omit. This could cause potential delays in a full replication strategy and possibly higher tracking error.

Transferability of Stocks

In emerging markets, several countries do not allow for shares to be transferred between accounts, nor do they allow for change of beneficial ownership. If the market does allow assets to be transferred, there is generally an associated charge around exchange fees, stamp taxes, registration fees, etc.

Restricted Currencies

There are emerging market currencies that are restricted, which means currency trades can only be traded by the local sub-custodian, whereas in developed markets, currency trades can be auctioned to a number of banks in order to receive the most favorable rate. Restricted currencies can result in higher tracking error. Major passive providers tend to have a rigorous due diligence framework before utilizing local foreign exchange agents. They also conduct ongoing monitoring and review of foreign exchange executions.

Local Tax Advisor

The client is generally responsible for hiring local tax advisors in some emerging markets such as Taiwan and India. Passive providers may assist the TSP in hiring a local tax advisor in these countries depending on the account structure the TSP has in place. Given the TSP's existing account structure, the passive manager would generally provide a meaningful amount of assistance in hiring a local tax advisor in these countries.

Foreign Ownership Limits

International companies may impose foreign ownership limits on their stock. Passive managers tend to optimize around foreign ownership limits. Foreign ownership limitations can result in potentially higher tracking error.

Repatriation Issues

In markets where repatriation issues exist, such as Egypt, custodial standing instructions may be used to begin the repatriation process. Passive managers may also choose to reduce the size of the fund's exposure to such a country to mitigate the risk of delayed repatriation. This can result in a potential delay in receiving proceeds in USD and thus can result in potentially higher tracking error.

International Governmental Risk

International Governmental risk is managed on a case-by-case basis, in consultation with passive providers. Passive managers may use various strategies to mitigate emerging market governmental risk to the extent possible. One example is shifting exposure from local currency names to depository receipts to mitigate liquidity risk in a market that may be at risk for capital restrictions/sanctions.

Overall, international governmental risk has increased when investing in emerging markets in recent years given a range of events such as investment restrictions on sensitive Chinese technology sectors, delisting of Chinese companies, and sanctions on Russian securities due to the Russia-Ukraine conflict.

These types of unforeseen events can incur transaction costs and may experience performance and volatility swings. For example, the announcement of investment restrictions can cause the value of a stock to decline at a time where the investor is forced to sell. Additionally, even if the investment restriction is on a set of securities or sectors, the negative sentiment generally has a broader impact on the performance of the country for a certain period of time. Given the asset size of the I Fund, the forced selling of restricted investments could incur higher than average market impact costs due to liquidity challenges.

Account Timeline and Documentation

Table 46 lists the estimated time frame of the account opening process for each country. Most market accounts are expected to take no longer than 3 weeks to open with an exception to six markets that make up 18% of the MSCI ACWI ex USA IMI (bolded in the table). China, Taiwan, and Qatar are projected to take up to 3 months to

open. Saudi Arabia and Kuwait are projected to take 3+ months to open, and India is projected to take upwards of 6 months to open.

Table 46: Custody Account Timeline

Global Market	Acct. Open Timeframe[1]	Global Market	Acct. Open Timeframe
Brazil	3-5 days	Mexico	1-2 days
Canada	1-2 day	Peru	5-7 days
Chile	2-3 days	Philippines	1-2 days
China	**3 Months**	Poland	2-3 weeks
Colombia	10-12 days	**Qatar[2]**	**3-4 months**
Czech Republic	1-2 days	**Saudi Arabia[2]**	**3+ months**
Egypt	3-5 days	South Africa	1-2 days
Greece	1-2 days	South Korea	10-13 days
Hungary	3 days	**Taiwan[2]**	**3-4 months**
India	**6-7 months**	Thailand	1-2 days
Indonesia	2 days	Turkey	7-10 days
Kuwait[2]	**3+ months**	UAE[2]	3-12 days
Malaysia	2-7 days		

Source: State Street

[1]These timeframes are based on receipt of documents by the sub-custodian in good order. Days referenced represent business days.

[2]The timeframe to open these specific markets for BlackRock is expected to be between 2-4 weeks once all documentation is complete and submitted to the local markets.

Country specific custodial documentation is required in order to trade in international markets. The table on the following page outlines the required documentation for registration by emerging market country. Given the TSP's existing account structure, the TSP's responsibility should be reduced as the passive manager would generally take on some of the market opening responsibilities.

Table 47 outlines the account structures that would be used to open the Canadian and emerging market accounts for the I Fund. Regardless of the account structure, the TSP would always be considered the legal and beneficial owner of the assets. However, in the case where the account structure is an omnibus account, the TSP's existing manager may be the registered owner of the assets on the local exchange. We have also outlined which securities are permitted to be transferred in-kind to another account held in the name of the TSP in the event the TSP were to move to an independent custodian in the future. There are conditions to consider that are country specific and may include increased documentation, disclosure to the local regulator, pre-approval to trade, and fees.

Table 47: Account Structure

Market	Manager A	Manager B	In-Kind Permitted
Brazil	Segregated	Segregated	Yes – conditions apply
Canada	Segregated	Omnibus	Yes
Chile	Segregated	Segregated	Yes – conditions apply
China	Segregated	Segregated	No
Colombia	Segregated	Segregated	Yes – conditions apply
Czech Republic	Segregated	Segregated	Yes
Egypt	Segregated	Segregated	Yes – conditions apply
Greece	Segregated	Segregated	Yes
Hungary	Segregated	Segregated	Yes
India	Segregated	Segregated	Yes – conditions apply*
Indonesia	Segregated	Segregated	Yes – conditions apply
Kuwait	Segregated	Segregated	Yes – conditions apply *
Malaysia	Segregated	Segregated	Yes – conditions apply
Mexico	Segregated	Omnibus	Yes
Peru	Segregated	Segregated	Yes – conditions apply
Philippines	Segregated	Segregated	Yes – conditions apply
Poland	Segregated	Segregated	Yes
Qatar	Segregated	Segregated	Yes – conditions apply*
Saudi Arabia	Segregated	Segregated	Yes – conditions apply *
South Africa	Segregated	Omnibus	Yes
South Korea	Segregated	Segregated	Yes – conditions apply
Taiwan	Segregated	Segregated	Yes – conditions apply*
Thailand	Segregated	Segregated	Yes
Turkey	Segregated	Segregated	Yes
UAE	Segregated	Segregated	Yes – conditions apply

*The securities within the five markets that Manager B would hold in a commingled fund cannot be traded in-kind.

Source: BlackRock and State Street

Benchmark Recommendation for the I Fund

Consider broadening the opportunity set of the I Fund by replacing the MSCI EAFE Index with an index that includes coverage of Canada, international small caps, and emerging markets.

Our recommendation is based on the following reasons:

- The MSCI indices remain the most popular indices for U.S. based institutional investors investing in overseas equity markets.
- The transition costs associated with the change in the I Fund benchmark are reasonable.
- Market Exposure:
  - Canada is the fourth-largest equity market in the world, representing 7.5% of the developed non-U.S. equity opportunity set.
  - Emerging Markets represents 27.8% of the international non-U.S. equity investable universe.
  - International small cap equities represent 13.7% of the international non-U.S. equity investable universe
- Liquidity:
  - We believe the inclusion of emerging markets and international small cap equities in the I Fund would not hinder the ability to meet the TSP's daily liquidity needs.
  - Overall, liquidity is managed through the use of the I Fund's cash buffer and other tools such as optimization and derivatives.
  - Additionally, historical daily cash flow assessment scaled to 28% illustrates cash flow activity was at reasonable levels to be traded in emerging markets without adversely impacting the prices of securities.
- Securities Lending:
  - The MSCI ACWI ex USA IMI and MSCI ACWI IMI ex USA ex China ex Hong Kong Index generated the highest expected yield and percentage out on loan.
  - Across each of the last three calendar years, the income to the TSP is estimated to have been at least 1.9x more if the I Fund tracked MSCI ACWI ex USA IMI or MSCI ACWI IMI ex USA ex China ex Hong Kong Index instead of the MSCI EAFE index.
- Administrative and Other Operational Complexities:
  - Overall, operational complexity has increased when investing in emerging markets in recent years given a range of events such as investment restrictions on sensitive Chinese technology sectors, delisting of Chinese companies, and sanctions on Russian securities due to the Russia-Ukraine conflict.
  - These types of unforeseen events can incur transaction costs and may cause performance and volatility swings. For example, the announcement of investment restrictions can cause the value of a stock to decline at a time where the investor is forced to sell. Additionally, even if the investment restriction is on a set of securities or sectors, the negative sentiment generally has a broader impact on the performance of the country for a certain period of time. Given the asset size of the I Fund, the forced selling of restricted investments could incur higher than average market impact costs due to liquidity challenges.
  - Tensions between the U.S. and China have been building, with the latest developments being the technology investment restrictions and export ban of US technology to China. If the current investment

restrictions on China are the beginning of further restrictions spanning China and Hong Kong investments, this level of uncertainty can outweigh the benefits of expanding the I Fund to include China and retaining exposure to Hong Kong, based on the TSP's specific circumstances.

- Conclusion
  - Expanding the opportunity set of the I Fund to the MSCI ACWI IMI ex USA ex China ex Hong Kong Index would be viewed as a more efficient portfolio than the MSCI EAFE Index, benefiting from its broader opportunity set across the number of securities, market cap, and countries.
    - The index has performed favorably over the short- and long-term periods relative to the MSCI EAFE Index with favorable risk-adjusted returns over-the long-term.
    - The market cap coverage increases from 55% to 90% by replacing the MSCI EAFE Index with the MSCI ACWI IMI ex USA ex China ex Hong Kong Index.
  - We recommend the TSP broaden the opportunity set of the I Fund by replacing the MSCI EAFE Index with the MSCI ACWI IMI ex USA ex China ex Hong Kong Index, taking into consideration the TSP's unique circumstances. We recommend future reviews reassess the TSP's unique circumstances to determine whether further expansion of the benchmark is warranted, considering how administrative and operational complexities evolve over time.

Appendix

Annual Returns

Table 48: Annual Return History – U.S. Equity (%)

The table below details the annual return histories of the following U.S. equity indices.

	S&P 500 Index	Russell 1000 Index	Russell 2000 Index	DJ U.S. Completion TSM Index
1979	--	22.3	43.1	--
1980	--	31.9	38.6	--
1981	--	-5.1	2.0	--
1982	--	20.3	24.9	--
1983	--	22.1	29.1	--
1984	--	4.8	-7.3	--
1985	--	32.3	31.0	--
1986	--	17.9	5.7	--
1987	--	2.9	-8.8	--
1988	--	17.3	25.0	20.8
1989	31.7	30.4	16.3	24.1
1990	-3.1	-4.2	-19.5	-13.2
1991	30.5	33.0	46.0	43.2
1992	7.6	8.9	18.4	11.7
1993	10.1	10.2	18.9	14.5
1994	1.3	0.4	-1.8	-2.6
1995	37.6	37.8	28.5	33.6
1996	23.0	22.4	16.5	17.1
1997	33.4	32.9	22.4	25.5
1998	28.6	27.0	-2.5	8.7
1999	21.0	20.9	21.3	35.5
2000	-9.1	-7.8	-3.0	-15.7
2001	-11.9	-12.4	2.5	-9.4
2002	-22.1	-21.7	-20.5	-17.8
2003	28.7	29.9	47.3	44.0
2004	10.9	11.4	18.3	18.0
2005	4.9	6.3	4.6	10.0
2006	15.8	15.5	18.4	15.3
2007	5.5	5.8	-1.6	5.4

	S&P 500 Index	Russell 1000 Index	Russell 2000 Index	DJ U.S. Completion TSM Index
2008	-37.0	-37.6	-33.8	-39.0
2009	26.5	28.4	27.2	37.4
2010	15.1	16.1	26.9	28.5
2011	2.1	1.5	-4.2	-3.7
2012	16.0	16.4	16.4	17.9
2013	32.4	33.1	38.8	38.0
2014	13.7	13.2	4.9	7.6
2015	1.4	0.9	-4.4	-3.4
2016	12.0	12.1	21.3	15.8
2017	21.8	21.7	14.6	18.1
2018	-4.4	-4.8	-11.0	-9.6
2019	31.5	31.4	25.5	27.9
2020	18.4	21.0	20.0	32.2
2021	28.7	26.5	14.8	12.4
2022	-18.1	-19.1	-20.4	-26.6

Table 49: Annual Return History – Fixed Income (%)

The table below details the annual return histories of the following fixed income indices.

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
1977	3.0	--	--
1978	1.4	--	--
1979	1.9	--	--
1980	2.7	--	--
1981	6.2	--	6.5
1982	32.6	--	31.8
1983	8.4	--	8.2
1984	15.1	--	15.0
1985	22.1	--	22.3
1986	15.3	--	15.4
1987	2.8	--	2.6
1988	7.9	--	8.0
1989	14.5	--	14.4
1990	9.0	--	9.1
1991	16.0	16.4	16.0
1992	7.4	7.5	7.6
1993	9.7	10.4	9.9
1994	-2.9	-3.1	-2.8
1995	18.5	18.5	18.5
1996	3.6	4.5	3.6
1997	9.7	9.8	9.6
1998	8.7	7.3	8.7
1999	-0.8	0.2	-0.8
2000	11.6	10.8	11.6
2001	8.4	8.1	8.5
2002	10.3	9.8	10.1
2003	4.1	5.8	4.2
2004	4.3	5.0	4.5
2005	2.4	2.7	2.6
2006	4.3	5.0	4.3
2007	7.0	6.5	7.2
2008	5.2	2.4	7.0
2009	5.9	8.6	5.1

	Bloomberg U.S. Aggregate Index	Bloomberg U.S. Universal Index	FTSE US BIG Bond Index
2010	6.5	7.2	6.3
2011	7.8	7.4	7.9
2012	4.2	5.5	4.2
2013	-2.0	-1.3	-2.0
2014	6.0	5.6	5.9
2015	0.5	0.4	0.5
2016	2.6	3.9	2.7
2017	3.5	4.1	3.6
2018	0.0	-0.3	0.0
2019	8.7	9.3	8.9
2020	7.5	7.6	7.7
2021	-1.5	-1.1	-1.6
2022	-13.0	-13.0	-13.3

Table 50: Annual Return History – International Equity (%)

The table below details the annual return histories of the following international equity indices.

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
1970	-11.7	--	--	--	--
1971	29.6	--	--	--	--
1972	36.3	--	--	--	--
1973	-14.9	--	--	--	--
1974	-23.2	--	--	--	--
1975	35.4	--	--	--	--
1976	2.5	--	--	--	--
1977	18.1	--	--	--	--
1978	32.6	--	--	--	--
1979	4.8	--	--	--	--
1980	22.6	--	--	--	--
1981	-2.3	--	--	--	--
1982	-1.9	--	--	--	--
1983	23.7	--	--	--	--
1984	7.4	--	--	--	--
1985	56.2	--	--	--	--
1986	69.4	--	--	--	--
1987	24.6	--	--	--	--
1988	28.3	--	--	--	--
1989	10.5	--	--	--	--
1990	-23.4	--	--	--	--
1991	12.1	--	--	--	--
1992	-12.2	--	--	--	--
1993	32.6	--	--	--	--
1994	7.8	--	--	--	--
1995	11.2	8.9	--	--	--
1996	6.0	5.5	5.0	--	--
1997	1.8	-0.4	-3.3	--	--
1998	20.0	18.3	11.9	--	--
1999	27.0	35.5	37.6	--	--
2000	-14.2	-17.3	-19.5	--	--
2001	-21.4	-21.9	-19.8	--	--

	MSCI EAFE Index	MSCI World ex USA IMI	MSCI ACWI ex USA IMI	MSCI ACWI ex USA ex China ex Hong Kong Index	MSCI ACWI IMI ex USA ex China ex Hong Kong Index
2002	-15.9	-13.8	-12.9	--	--
2003	38.6	41.2	42.1	40.5	42.0
2004	20.2	21.4	21.9	21.1	22.1
2005	13.5	15.7	17.7	16.5	17.6
2006	26.3	25.6	26.4	25.7	25.5
2007	11.2	11.7	16.1	15.1	14.6
2008	-43.4	-44.0	-46.0	-44.6	-45.1
2009	31.8	35.3	43.6	39.8	41.8
2010	7.8	10.7	12.7	11.1	12.7
2011	-12.1	-12.7	-14.3	-13.3	-13.9
2012	17.3	16.5	17.0	16.4	16.6
2013	22.8	21.6	15.8	16.2	16.6
2014	-4.9	-4.5	-3.9	-4.0	-4.0
2015	-0.8	-2.0	-4.6	-5.7	-4.6
2016	1.0	3.0	4.4	4.4	4.4
2017	25.0	25.2	27.8	25.4	26.4
2018	-13.8	-14.7	-14.8	-14.0	-14.7
2019	22.0	22.9	21.6	21.3	21.6
2020	7.8	8.3	11.1	9.0	9.7
2021	11.3	12.4	8.5	12.4	12.5
2022	-14.5	-15.3	-16.6	-14.6	-15.4

About

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