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# Fifty years of broad-based international data: What have we learned for asset allocation?


## Abstract

Much of the seminal work on international investing in the context of asset allocation and mean variance optimization was written based upon a somewhat limited broad-based data set. With just over 50 years of MSCI data now in hand, we reexamine the characteristics of the data with subsets for the first 25 years and latest 25 years plus, also utilizing the earlier historical data to create an efficient portfolio to evaluate out of sample. This evaluation is in the context of a variety of assets in an asset allocation framework, utilizing both asset-only mean variance optimization and some surplus optimization analyses. We evaluate international equity assets in hedged local currency terms and unhedged USD terms.

We find that there is a measurable index sector composition difference among various country indices, consistent with economic theory of specialization and rising global trade, which offers potential benefits to international diversification. We also find that the US returns have dominated in almost all index sectors in both local currency and US dollar terms based upon the available economic sector data, which is more short-lived. Additionally, there has been a noticeable trend in country return covariance behavior, with underlying local index equity returns increasing in correlation over time, along with a decrease in the correlation benefit of currency volatility over the same timeframe. International equities have provided lower returns with higher volatility for the US-based investor in the later data subset and do not show up in the efficient frontier set out of sample.

Despite these observations and potential drawbacks, we demonstrate that a diversified asset mix with sizeable international representation performs relatively well in both data subsets (in sample and out of sample) and that substantial international diversification remains a reasonable *ex ante* strategy. We conclude, however, that the optimal allocation to international assets for US investors—those with local, dollar-based cashflow liabilities to defease—is likely less than the global, market-neutral allocation that is often used as a baseline in global mandates.



**Keith Gustafson**
Managing Director



**Christopher O'Neill**
Managing Director,
Chief Investment Officer


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## Introduction

Much of the extant mantra on the benefits of diversification through international investing was formulated through various journal articles, working papers and books in the 1980s and 1990s, which included work on the investor home bias puzzle, the potential benefits of currency hedging, portfolio risk reduction, labor income hedging, and return enhancement through the inclusion of international equity assets to a domestic portfolio. At that point in time, there was roughly 20+ years of widely available and easily trackable, high quality index data at the country, regional and global levels that facilitated the analysis and logical conclusions. Of course, there were individual country datasets used by many researchers, but these were not widely disseminated and available to all investors.

This time period had witnessed a steady decline in global terms of US equity market capitalization from 1970, reaching a temporal nadir from the late 1980s to mid 1990s. At the same time, the value of the US dollar in trade-weighted terms and against most major individual foreign currencies also experienced a steady decline. These two elements effectively translated into an outperformance of foreign equities, in aggregate, relative to US equities and a return enhancement from hedging local equity currencies into US dollars.

At that time, the rising dominance of Japanese manufacturing and exports, foreign direct investment, strong equity market performance and rising Yen led to a dramatic increase in global equity weighting that rivaled the US and predictions of an imminent eclipse in economic dominance and equity market weight were legion. International currency management accords, such as the Plaza Accord, were introduced at the time to manage the disruptive nature of the Yen appreciation in a coordinated manner. It is not much of a stretch to see striking parallels today in discussions of Chinese economic growth and its future equity market potential vis-à-vis the US, along with extrapolated timeline predictions of when the US will be overtaken.

Interestingly, the next 20 plus years looked very different for global markets. The weight of the US equity market grew steadily from the mid 1990s onward in the global portfolio and did not look markedly different in 2020 from 1970. The biggest decline in market weight terms was the Japanese equity market. Similarly, the US dollar largely appreciated, dampening the benefits of currency hedging for international equities to an extent. Of course, the elements discussed to this point largely address the return components on assets, while many of the potential benefits may be related to volatility and correlation, particular in the context of a total portfolio asset mix. Unfortunately, the subsequent years were not beneficial in these terms either. There has been a definitive trend towards increased market correlations and the relative volatilities did not move to offset the lower return and higher correlations.

As practitioners, we now have in hand just over fifty years of broad-based MSCI Index data. This allows us to sub-divide the data into ample 25 year increments and look at in-sample, derived efficient frontier portfolios in a Mean Variance Optimization (MVO) framework on an out of sample basis, as well as a representative, prudently diversified asset mix to evaluate in both individual time periods for relative efficiency. While the benefits of international equity diversification from the US investor point of view might not be as clear cut as conclusions drawn based upon available data 25 years ago, we conclude that there are still solid arguments for international diversification, albeit perhaps not at the neutral, global market weighting that many recommend.

## Review of prior work

Some of the earliest and most influential work touting the benefits of international investing came from Bruno Solnik in 1974 in the *Financial Analysts Journal* with "Why Not Diversify Internationally Rather than Domestically"[i] and Gary Bergstrom in the *Journal of Portfolio Management* in 1975 with "A New Route to Higher Returns and Lower Risks."[ii] Bruno Solnik also authored a seminal book in 1988, *International Investments*, still widely in use today,[iii] while Bergstrom co-authored a chapter on "International Securities Markets" for the *Handbook of Financial Markets: Securities, Options and Futures* in 1986.[iv] Donald Lessard contributed "World, Country and Industry Relationships in Equity Returns" in the *Financial Analysts Journal* in 1976.[v] Work followed that built upon these early contributions and expounded on the resulting data in subsequent years that confirmed the benefits of international diversification. Bergstrom co-authored with Michaud, Frashure and Wolahan, "20 Years of International Investing" in the *Journal of Portfolio Management* in Fall 1996,[vi] noting that "International equity portfolio diversification is now well accepted by investors around the world…In these two decades the benefits of global portfolio diversification have been largely accepted by the academic and investment communities."[1] There was a paucity of published work that

was critical of international investing. Bartram and Dufey in "International Portfolio Investment: Theory, Evidence and Institutional Framework"[vii] from 1997 were somewhat cautious, focusing on barriers and constraints—"Even though these advantages might appear attractive, the risks of and constraints for international portfolio investment must not be overlooked…"[2] In all, the era of the 1990s saw the widespread movement from academia to adoption in portfolios for practitioners.

Other work from the 1990s forward often focused on specific aspects of international investing, rather than a justification of its benefits. One branch of work examined the home equity bias of various investor groups. This was an attempt to quantify and understand the perceived behavioral bias of various investor groups that led to a lower allocation to international equities than was deemed optimal in light of the empirical data. French and Poterba in an NBER working paper from 1991, "International Diversification and International Equity Markets"[viii] note an extreme home equity bias at that time and deduce that it implies an investor expectation of a substantial home equity return premium. They note that this appears to be due to investor preferences, rather than institutional constraints. A contrasting conclusion was offered by Michaelides in another working paper from a decade later in 2002, "International Portfolio Choice, Liquidity Constraints and the Home Equity Bias Puzzle,"[ix] where he notes the extreme sensitivity of the allocation decision to even small associated costs or perceived return differentials, while also noting "The benefits of international diversification are limited because consumption fluctuations can be smoother…while exchange rate risk makes foreign investment less appealing to risk averse investors."[3] Some other later works on this topic note the characteristics associated with more or less international diversification. Lane and Milesi-Ferretti in "The International Equity Holdings of Euro Area Investors"[x] found that "Bilateral equity holdings are strongly linked to bilateral trade in goods and services and are also associated with proxies for informational proximity."[4] They find a regional, euro-area bias. More recent work in 2014 from Bekaert, Hoyem, Hu and Ravina, "Who is Internationally Diversified? Evidence from 296 401(k) Plans"[xi] emphasizes some related aspects when they note that states with higher exports have higher international allocations and that "the fraction of foreign-born population measured at the zip code level have strong positive effects on international diversification, consistent with familiarity…"[5] They also note an increasing allocation to international investments for younger age cohorts, as well as for all age cohorts across time, which they conjecture may lead to the disappearance of the home equity bias over time. Recent work from Vanguard Research in 2021, "Global equity investing: The benefits of diversification and sizing your allocation"[xii] indicates wide variation in the home bias allocations among countries. This variation appears to be strongly related in an inverse fashion to the relative global share of the domestic equity market. For instance, the US investor home bias represents an average investor allocation that is 1.4 times the global equity weight share of the US market, while for Australia this is 30.0 times and 31.3 times for Italy.[6]

Some work has suggested that the home equity bias is not as large as believed based on the sizeable and growing exposure of multinational companies and foreign sales in domestic equities. Cai and Warnock addressed this issue in a working paper in 2004, "International Diversification at Home and Abroad."[xiii] They note, "after accounting for home-grown foreign exposure, the share of 'foreign' equities in investors' portfolios nearly doubles, reducing (but not eliminating) the observed home bias."[7] This exposure continued to expand and in 2013, "Understanding the S&P 500: This Index Offers a Lot of International Exposure,"[xiv] Indrani De notes that by that time almost 40% of market-weighted sales for the S&P 500 index came from international sources.

Another branch of international investing research focused narrowly on currency hedging, with mixed conclusions as to its benefits. Early work came from Perold and Schulman in 1988 in the *Financial Analysts Journal* with "The Free Lunch in Currency Hedging: Implications for Investment Policy and Performance Standards,"[xv] which advocated for complete hedging. In contrast, Froot in an NBER working paper in 1993, "Currency Hedging Over Long Horizons,"[xvi] posited that currency hedging was only useful for volatility reduction over short horizons and advocated no currency hedging for portfolios with a long investment horizon. Phillipe Jorion in the Journal of Portfolio Management in 1989, "Asset Allocation with Hedged and Unhedged Foreign Assets"[xvii] looked at issue in the context of a diversified portfolio of assets, rather than as standalone investments, concluding that optimal currency hedging depended upon the proportion of foreign assets with an allocation greater than 20% justifying the currency hedge.

While currency hedging has real implications for the volatility and correlation impact on the underlying asset being hedged, the correlation trends of foreign and domestic equity assets in local currency terms is a more recent topic of concern. Earlier works mentioned relied on the diversification benefits stemming from relatively low correlations as a cornerstone for justifying international assets in a portfolio. Work from Ang and Baekert in an NBER working paper from 1999, "International Asset Allocation with Time-Varying Correlations,"[xviii] did find evidence, however, for international equity markets being more correlated on the downside during times of stress, which is something that has come to be known in common parlance as the 'crash critique'.

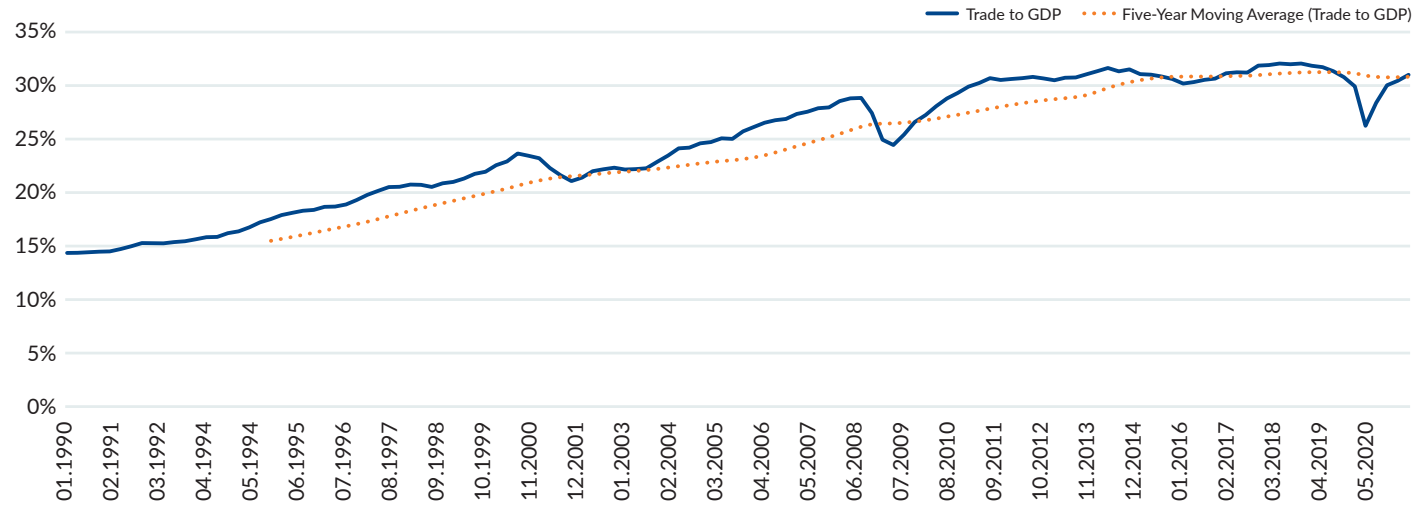
There has been a notable secular trend towards increasing international equity market correlations outside of extreme events, which we highlight in this paper, and which has been noted more in practitioner writings than in academic literature. Some of this practitioner work critically questions the continuing benefits of international diversification. "International Equities: Diversification and Its Discontents"[xix] by Fred Donohue in a CFA Institute blog from 2020 notes that correlations between US equities and international equities have increased meaningfully over the 50-year period of MSCI EAFE Index data. While using the full data set, one might conclude an allocation of 30% to international equity results in a minimum volatility portfolio, more recent correlation data would suggest substantially reduced optimal allocations. Sargen and Hogan in a 2021 paper, "Revisiting the Case for International Diversification"[xx] come to much the same conclusion, while also attributing the more recent outperformance of US equities to a greater weight in US markets to the technology sector and the global dominance of US technology companies in general.

## Economic and index composition arguments for international equity diversification

The theoretical gains from trade are well known in terms of production possibilities curves and specialization in production of goods and services in areas where a country is relatively more efficient. For instance, even in a case where one country is more efficient in every economic segment than another country, the two countries will still benefit from trade if each focuses more production where they are relatively more efficient. The implications are that one would expect to see sector and industry specialization that varies by country as the level of trade increases. One strong argument for international diversification is merely to accomplish prudent economic sector and industry diversification within equities as those weights can vary from region to region, and country to country, as well as over time.

Over the time period of our MVO study in this paper, particularly the out of sample period of 1995-2020, there have been steadily increasing levels of global trade, as trade barriers have lessened, and complex global supply chains have been established. The chart in Figure 1 shows this to be true even for a large and diverse economy, such as the US. The sum of exports and imports as a percentage of GDP has steadily risen over this time period, although it has leveled off in recent years.

FIGURE 1: **TOTAL TRADE AS A % OF GDP**




Source: Federal Reserve Bank of St. Louis (FRED) and Mesirow Calculations.

The table in Figure 2 shows the sector composition of various MSCI country and regional indices in terms of sector weightings, which varies substantially. France, Japan and the Nordic countries have relatively high weightings to the Industrial sector, for instance, while Australia, Canada and Mexico have the highest representation in Basic Materials. Taiwan, Korea and the United States have large Technology weightings, while China, France and Germany provide high exposure to Consumer Discretionary. Among emerging markets indices, it is clear that different regions provide different sector emphasis, with Asia emphasizing Technology the most, while Latin America focuses the most on Basic Materials and Europe on Energy.

At the aggregated level of the MSCI USA Index and the MSCI EAFE Index, it is clear that adding the international equity asset to the domestic portfolio will diminish the Technology and Communication Services exposure and diversify into Basic Materials, Industrials and Consumer Staples.

Given the economic theory of specialization, one could reasonably expect that the supply of profits and equity returns would also vary by country and region, as well as over time, with higher relative weights and capital flowing to the areas and sectors with the highest potential returns. There is more limited historical data for economic sector returns by country and region, which was limited largely to our out of sample time period of analysis, when we know that aggregate US index returns dominated those of the aggregate international index, as well as that of most individual countries. Yet, the breadth of US market outperformance across sectors, including those with higher foreign index sector weightings, is surprising nonetheless, as shown in Figure 3.

FIGURE 2

| | Basic Materials | Consumer Discretionary | Financials | Real Estate | Comm Services | Energy | Industrials | Technology | Consumer Staples | Healthcare | Utilities |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Australia | 19.75% | 5.58% | 35.03% | 6.62% | 3.05% | 3.74% | 5.73% | 3.56% | 4.92% | 10.84% | 1.17% |
| Canada | 10.72% | 3.56% | 36.59% | 0.70% | 2.58% | 13.96% | 9.94% | 12.86% | 4.51% | 0.74% | 3.84% |
| China | 2.30% | 33.25% | 12.72% | 4.60% | 19.13% | 1.36% | 4.61% | 6.50% | 5.44% | 8.36% | 1.74% |
| France | 5.77% | 20.18% | 10.18% | 1.41% | 3.81% | 5.79% | 22.52% | 5.94% | 11.35% | 11.02% | 2.03% |
| Germany | 9.16% | 22.26% | 13.70% | 4.63% | 5.31% | 0.00% | 14.03% | 13.49% | 2.54% | 10.81% | 4.06% |
| Hong Kong | 0.00% | 6.34% | 47.71% | 18.90% | 0.96% | 0.00% | 14.22% | 0.00% | 2.38% | 0.00% | 9.49% |
| Japan | 5.18% | 15.90% | 8.90% | 3.61% | 8.45% | 1.54% | 21.17% | 17.01% | 6.74% | 10.48% | 1.02% |
| Korea | 7.79% | 8.46% | 7.04% | 0.00% | 11.02% | 1.53% | 6.07% | 48.24% | 3.83% | 5.52% | 0.50% |
| Mexico | 21.43% | 0.00% | 12.71% | 2.28% | 23.32% | 0.00% | 7.61% | 0.00% | 32.66% | 0.00% | 0.00% |
| Nordic | 6.82% | 5.41% | 15.67% | 3.06% | 4.74% | 3.24% | 28.42% | 8.27% | 6.50% | 15.53% | 2.33% |
| Switzerland | 8.09% | 4.65% | 14.75% | 0.47% | 0.91% | 0.00% | 9.34% | 1.72% | 23.19% | 36.87% | 0.00% |
| Taiwan | 5.83% | 2.34% | 11.95% | 0.00% | 2.11% | 0.36% | 4.36% | 71.17% | 1.51% | 0.16% | 0.00% |
| United Kingdom | 12.21% | 6.37% | 17.53% | 1.26% | 6.78% | 10.33% | 8.53% | 0.67% | 21.24% | 11.60% | 3.48% |
| India | 9.76% | 7.74% | 25.25% | 0.36% | 3.38% | 12.95% | 3.73% | 17.73% | 9.36% | 5.50% | 4.14% |

| | Basic Materials | Consumer Discretionary | Financials | Real Estate | Comm Services | Energy | Industrials | Technology | Consumer Staples | Healthcare | Utilities |
|---|---|---|---|---|---|---|---|---|---|---|---|
| United States | 2.48% | 11.84% | 13.41% | 3.65% | 10.51% | 2.53% | 9.12% | 24.56% | 5.90% | 13.64% | 2.35% |
| EAFE | 8.13% | 11.46% | 16.71% | 3.01% | 5.50% | 3.37% | 15.13% | 9.93% | 10.43% | 12.99% | 3.35% |
| World ex USA | 8.43% | 10.65% | 18.69% | 2.78% | 5.20% | 4.37% | 14.61% | 10.25% | 9.86% | 11.74% | 3.41% |
| ACWI ex USA | 8.62% | 11.98% | 18.60% | 2.54% | 7.15% | 4.61% | 11.65% | 13.55% | 8.55% | 9.76% | 2.99% |

| | Basic Materials | Consumer Discretionary | Financials | Real Estate | Comm Services | Energy | Industrials | Technology | Consumer Staples | Healthcare | Utilities |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MSCI EM Asia | 5.85% | 18.14% | 14.61% | 2.14% | 11.39% | 2.98% | 5.05% | 27.17% | 4.98% | 5.83% | 1.86% |
| MSCI EM Europe | 16.26% | 4.58% | 27.19% | 0.00% | 10.10% | 33.98% | 0.78% | 0.00% | 4.02% | 0.96% | 2.13% |
| MSCI EM Latin America | 24.41% | 6.13% | 23.57% | 0.65% | 6.70% | 8.74% | 6.53% | 1.98% | 13.68% | 3.43% | 4.18% |

Source: Morningstar Direct, MSCI and Mesirow Calculations

This analysis in Figure 3 was conducted in US dollar currency terms, which includes the impact of currency movements on the return and volatility, and thereby, potentially clouding the interpretation of results. The same analysis was also performed for every index sector in local currency terms, which are only available for the time period after July 1998. These data are displayed in Figure 4. Of the eleven sectors, the MSCI USA Index had clearly superior returns and return relative to risk ratios in nine, Consumer Staples was essentially a push and only Energy tilted in favor of international equities. In local currency terms, the MSCI EAFE sectors exhibited lower standard deviations of returns in 10 of the 11 sectors, which was also notable.

The implications of this data are certainly interesting, but it is difficult to draw any definitive conclusions without a relevant comparison for the earlier time period from 1970–1994 when we know that, in aggregate, international equity outperformed domestic US equity in absolute and risk-adjusted terms. Moreover, the last 25+ years is not prologue to what will occur out of sample in the future with any degree of certainty. The divergences are notable and bear watching to see if the trends continue or are subject to typical mean reversion over time.

In sum, any arguments for US-based investors relying upon industry and sector diversification are not strongly persuasive. The US index is widely diversified with multinational company presence in most sectors and the inclusion of international assets merely shifts the sector weightings to a limited degree that may or may not suit investor preferences. The arguments for needed diversification certainly are stronger for other country domiciled investors with much more concentrated sector weightings, less multinational company presence, and a low relative domestic country weight in the aggregate global portfolio.

FIGURE 3

| | Substantial US Sector Overweights | | Substantial EAFE Overweights | | | |
|---|---|---|---|---|---|---|
| | **Technology** | **Comm Services** | **Industrials** | **Basic Materials** | **Consumer Staples** | **Financials** |
| Sector Weighting Difference | 14.63% | 5.01% | 6.01% | 5.65% | 4.53% | 3.30% |
| **Historical Returns 1.1.1995–9.30.2021** | | | | | | |
| MSCI USA NR CAR | 13.99% | 5.96% | 9.96% | 7.89% | 9.50% | 8.88% |
| MSCI USA NR Std Dev | 25.09% | 19.95% | 18.44% | 21.13% | 13.08% | 21.69% |
| **Return/Risk Ratio** | **0.5576** | **0.2989** | **0.5400** | **0.3733** | **0.7264** | **0.4093** |
| MSCI EAFE NR USD CAR | 6.19% | 5.00% | 5.18% | 5.98% | 8.24% | 3.35% |
| MSCI EAFE NR USD Std Dev | 23.84% | 19.17% | 18.09% | 21.75% | 13.40% | 22.09% |
| **Return/Risk Ratio** | **0.2598** | **0.2608** | **0.2863** | **0.2750** | **0.6149** | **0.1516** |

Source: Morningstar Direct, MSCI and Mesirow Calculations. Past performance is not indicative of future results.

FIGURE 4

| **7/1/2008–9/30/2021** | **Basic Materials** | **Consumer Discretionary** | **Financials** | **Real Estate** | **Comm Services** | **Energy** | **Industrials** | **Technology** | **Consumer Staples** | **Healthcare** | **Utilities** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MSCI USA NR CAR | 6.24% | 17.19% | 8.15% | 7.39% | 9.21% | -1.99% | 9.50% | 17.40% | 9.54% | 13.25% | 5.82% |
| MSCI USA NR Std Dev | 21.83% | 19.26% | 23.06% | 22.73% | 16.06% | 26.35% | 20.02% | 18.46% | 12.02% | 14.30% | 14.40% |
| **Return/Risk Ratio** | **0.2857** | **0.8926** | **0.3537** | **0.3251** | **0.5736** | **-0.0757** | **0.4748** | **0.9422** | **0.7942** | **0.9271** | **0.4045** |
| MSCI EAFE NR LCL CAR | 3.27% | 8.24% | 2.89% | 4.34% | 5.89% | 1.15% | 6.73% | 8.50% | 8.60% | 9.31% | 1.86% |
| MSCI EAFE NR LCL Std Dev | 19.67% | 17.70% | 20.45% | 17.26% | 12.71% | 20.23% | 17.08% | 18.77% | 10.71% | 11.82% | 13.14% |
| **Return/Risk Ratio** | **0.1664** | **0.4657** | **0.1412** | **0.2516** | **0.4638** | **0.0569** | **0.3944** | **0.4527** | **0.8033** | **0.7876** | **0.1418** |

Source: Morningstar Direct, MSCI and Mesirow Calculations. Past performance is not indicative of future results.

FIGURE 5

| 1.31.1995 | EAFE Country | World ex US | ACWI ex US |
|---|---|---|---|
| Australia | 2.74 | 2.51 | 2.45 |
| Mexico | 0.00 | 0.00 | 0.72 |
| Japan | 44.52 | 44.14 | 40.08 |
| France | 5.73 | 5.55 | 5.27 |
| China | 0.01 | 0.01 | 0.01 |
| Korea | 0.00 | 0.00 | 0.32 |
| Taiwan | 0.00 | 0.00 | 0.00 |
| India | 0.08 | 0.00 | 0.63 |
| Hong Kong | 2.71 | 2.58 | 2.42 |
| UK | 16.26 | 16.34 | 15.42 |
| Canada | 0.09 | 2.96 | 3.00 |
| Germany | 6.64 | 6.39 | 5.93 |
| Switzerland | 4.31 | 4.46 | 4.23 |
| Other | 16.92 | 15.06 | 19.52 |

| 12.31.2020 | EAFE Country | World ex US | ACWI ex US |
|---|---|---|---|
| Australia | 6.94 | 6.31 | 4.34 |
| Mexico | 0.02 | 0.02 | 0.55 |
| Japan | 25.35 | 23.03 | 15.85 |
| France | 10.41 | 9.45 | 6.51 |
| China | 0.07 | 0.06 | 12.13 |
| Korea | 0.00 | 0.00 | 4.20 |
| Taiwan | 0.00 | 0.00 | 3.95 |
| India | 0.00 | 0.00 | 2.88 |
| Hong Kong | 2.86 | 2.60 | 1.90 |
| UK | 14.06 | 12.77 | 8.79 |
| Canada | 0.00 | 9.13 | 6.29 |
| Germany | 9.34 | 8.48 | 5.84 |
| Switzerland | 9.90 | 8.99 | 6.19 |
| Other | 21.05 | 19.15 | 20.58 |

Source: Morningstar Direct, MSCI and Mesirow Calculations

Another consideration that may prove more relevant for investors is the inclusion of ascendant economies and markets. This could come from either emerging markets (EM) exposure directly or through All Country World Index-type benchmarks (ACWI). Our analysis utilizes a developed market (DM) proxy in the EAFE Index because it has a live track record for the full time period. Other DM benchmarks with similar history include the MSCI World Index or MSCI World ex US Index. The live history is more limited for EM and ACWI indices. Figure 5 shows the different weightings from both 1995 and 2020 of various countries in some of these indices. There is not much difference in country weightings between EAFE and World ex US indices, but the ACWI ex US Index has notable and growing weights to countries such as Taiwan, Korea and China. Their combined weight in 2020 was over 20 percent versus a minimal exposure 25 years ago. Investors may see inclusion of these countries as a hedge for shifts over time in economic importance and equity market weight away from their home country.

The supply of returns, of course, is less certain. The criteria for index inclusion and weighting decisions does not correlate fully with market capitalization and return. Historical returns since inception for emerging markets indices have been less than stellar for US-based investors.

## Historical returns, risks and correlations for select countries and regions

As our analysis utilizes data from two roughly equal sub-periods over the 1970–2020 aggregate data period, it is potentially useful to examine the risk and return relationships visually (in both USD and local currency terms), as well as any potential trends in the data over time.

Figure 6 shows the geometric return (compound annual return) and standard deviation data for select MSCI country and region industries based upon annual observations (the frequency that we utilize in our efficient frontier analyses) over the 1970–1994 period.

There are a few interesting observations:

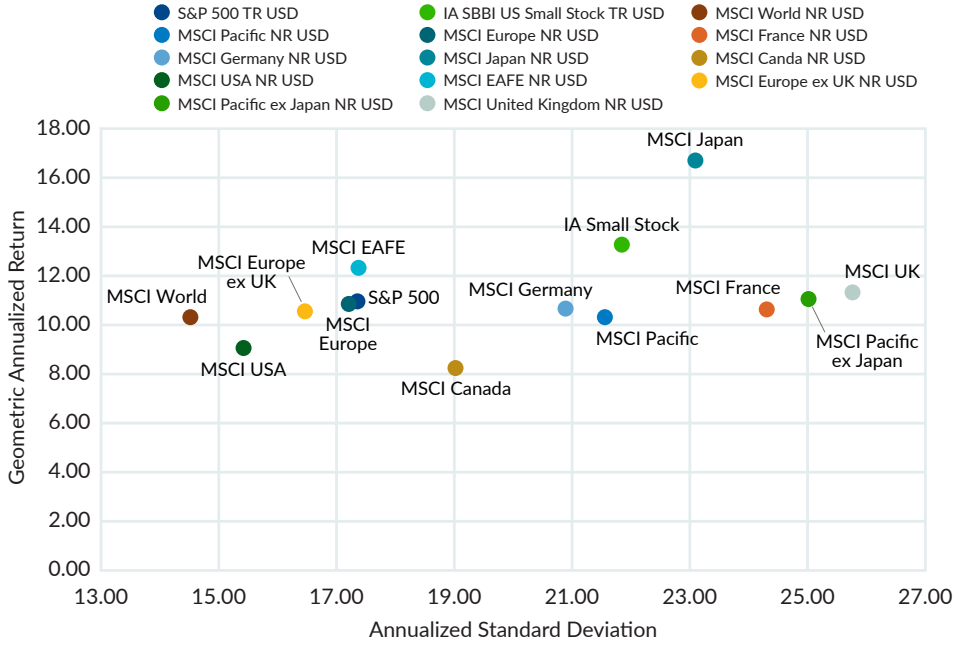
1. In US dollar hedged terms, most countries seem to provide returns within a relatively narrow range with the exception of Japan, differing mostly in terms of relative volatilities. There doesn't seem to be a clear relationship between risk and return that one might expect, although the length of observation period might be too brief and currency also is a confounding variable.
2. There is a distinct difference over this time period between MSCI USA Index and the S&P 500 Index. This difference lessens over time, but it is a characteristic which could have implications in efficient frontier analyses. This is something that we address in our analysis.

3. The regional portfolios that diversify across countries benefit from the low correlation aspect and are more efficient in risk and return space. This is prima facie evidence of the benefits of international diversification benefits.
4. The "neutral" weight MSCI World portfolio that is fully diversified across developed market countries weighted by relative market capitalization appears the least risky and is likely on a hypothetical global Capital Asset Pricing Model (CAPM) Security Market Line (SML) that could be drawn between it and the global risk-free rate over the period. It also indicates that US-based equity investors likely would have benefitted from international diversification over this period.

The return and risk scatterplot looks different in local currency terms, as shown in Figure 7. In local currency, there appears to be at least a loose relationship between relative risk and return with an upward sloping trajectory. Individual countries look very different in these terms. Japan is no longer a high returning outlier. It has lower return and lower risk, so we can clearly see the effect of yen appreciation that had been a primary driver of the Plaza Accord. The situation for the UK was the opposite, as the index was higher returning with higher volatility, as the relative currency depreciation vis-à-vis the dollar played out.

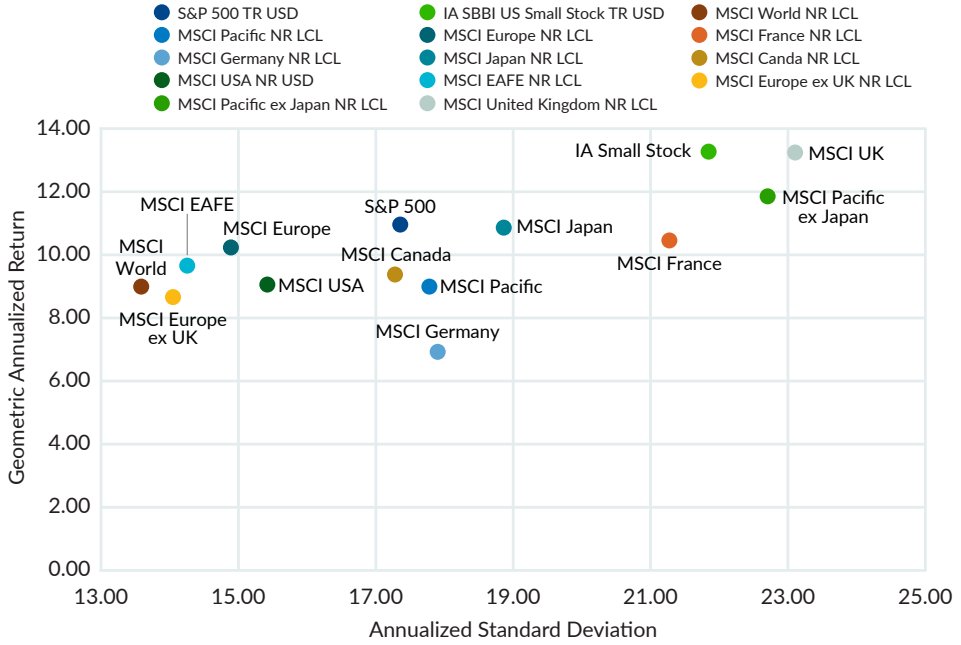
What doesn't change is the relative efficiency of the EAFE and World indices and the clear benefits of international diversification to US-based investors over this 1970–1994 period. It is obvious in retrospect how the data over this period resulted in numerous papers that established the mantra

FIGURE 6: GLOBAL EQUITY MARKET COMPARISON | 1970–1994 | USD




Source: Morningstar Direct, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

FIGURE 7: GLOBAL EQUITY MARKET COMPARISON | 1970–1994 LOCAL CURRENCY




Source: Morningstar Direct, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

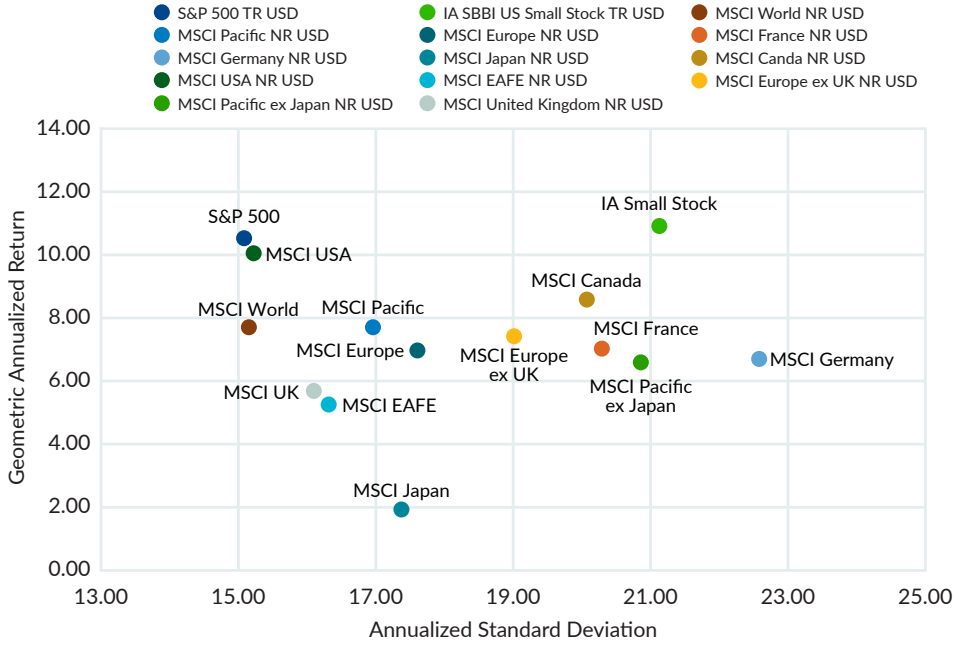
of the "free lunch" of international diversification that has largely remained as unchallenged dogma.

What is not obvious in comparing the two charts is whether the currency hedging would have been particularly beneficial. We utilize the local currency index as the proxy for a perfectly, hedged and costless strategy. There is a 100 percent hedged index utilizing forward rates, but this did not start until 1992. Many individual country currency movements may have cancelled out at the aggregated index levels. Conclusions in this regard may be more indicative in an MVO analysis based upon whether hedged (local) or unhedged (USD) options make a showing in the efficient frontier asset mixes.

Looking at the second half of the data set over the 1995–2020 period in Figures 8–9, the scatterplots of the world equity markets look very different from the earlier period. This is the time period that we utilize for our out of sample test for the output derived from the 'in sample' 1970–1994 period. There is not much of a clear patterned relationship between risk and return in either USD or local currency terms. Most country equity markets do look much less volatile in local currency terms than in USD terms, so the currency hedging value for US investors appears to have potential benefits from a volatility standpoint, depending upon the cost.

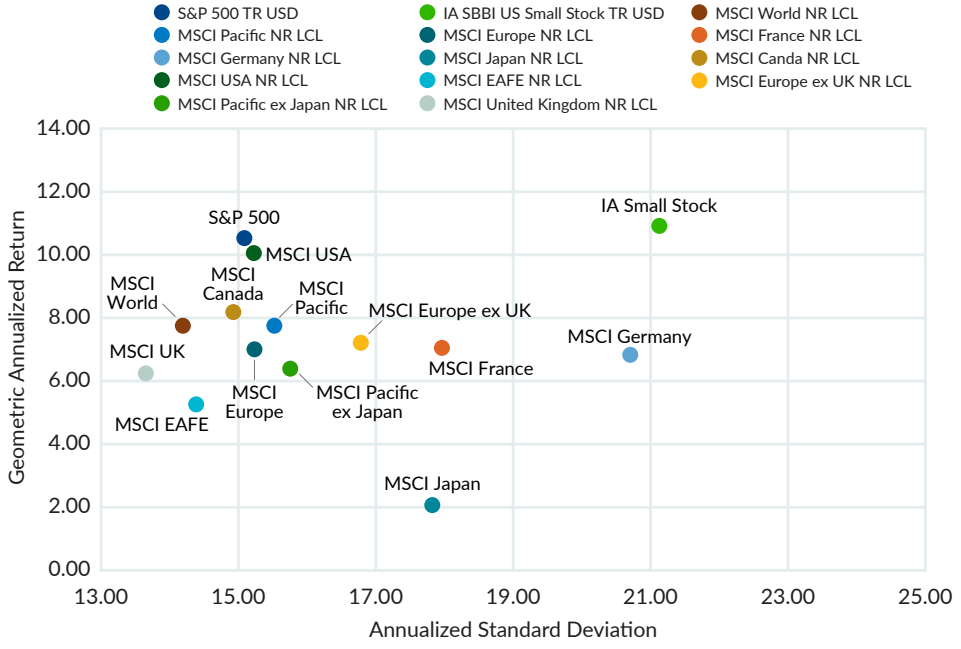
Another interesting observation is that Japan went from being a relatively high return country asset in the earlier period to a very negative outlier, while the UK moved from the most volatile to the least volatile in local currency terms. The US is now the positive outlier across countries in terms of return and return per unit of risk. Given this result, it is somewhat surprising that there

FIGURE 8: GLOBAL EQUITY MARKET COMPARISON | 1995–2020 | USD




Source: Morningstar Direct, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

FIGURE 9: GLOBAL EQUITY MARKET COMPARISON | 1995–2020
LOCAL CURRENCY




Source: Morningstar Direct, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

have not been more challenges to the standard advocacy of international diversification, just as there have been challenges with other perceived changing trends in long-term historical data manifestations—such as portfolio tilts based on value or size premia.

The MSCI EAFE Index on a standalone basis does not appear at initial observation to be an appealing asset to US-based investors. On the other hand, the MSCI World Index, which would be the weighted combination of the US and EAFE, still looks relatively efficient relative to most individual assets, just as it did over the earlier period. This result strongly implies that for most investors, some diversification away from home country continues to be very beneficial over the later 1995–2020 period, just as it was over the earlier 1974–1994 timeframe. It is not at all a surprising result that for different time periods, there would be individual countries from whose perspective diversification was not a winning ex post strategy. Yet, if there are mean reverting properties to individual country returns over time, it can still be a logical *ex ante* strategy.

For 1970–1994, international diversification looks to have benefited US-based investors based on the scatterplots, while for the 1995–2020 period, it does not appear to have added value. Of course, the opposite was true over the sub-periods for some individual foreign country domiciled investors—they may have benefited in the latter period and not the earlier. On average, if most country investors benefit, then it can be a logical ex ante strategy, rather than relying solely on US investor frame of reference to draw definitive conclusions.

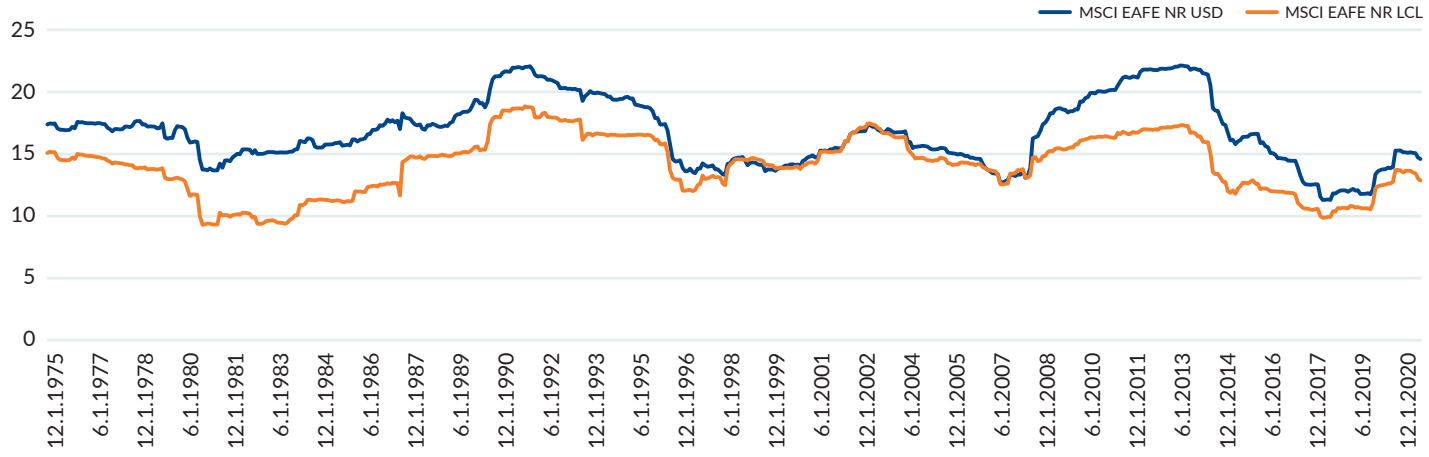
One legitimate area for exploration, however, is whether the returns, volatilities and correlations are mean reverting—therefore, both sub-period results should have an equal weighting in forward-looking expectations—or whether there are some secular trends in the underlying data that should be considered. Additionally, it is worth reexamining in our analysis the benefits of currency hedging that resulted in mixed conclusions in academic work. Lastly, we examine whether there have there been any changes in the appropriate level of international diversification that is logical for US investors based on the additional data now in hand.

## Trends in data and its implications

The volatility characteristics over our aggregate data period appears to be cyclical and somewhat mean reverting in nature. Figure 10 shows rolling 60-month annualized standard deviations for the MSCI EAFE Index in both local currency and US dollar terms. One obvious observation from this data is that there does not appear to be any major secular trend in the volatility of the series in either terms. Although not readily apparent, the volatility was slightly lower over the 1995–2020 timeframe versus the 1970–1994 period.

Clearly, the unhedged USD series is more volatile overall, but while it was consistently higher over the earlier 1970–1994 period, it is less consistent over the 1995–2020 timeframe. It is higher overall in the latter timeframe, but there is a period where it converges, spikes higher and then the gap closes somewhat again. Therefore, it is possible that the unhedged currency movements introduce less additional volatility relative to the hedged than during the earlier period. Of course, the costs to hedging may also have come down over the period as well.

FIGURE 10: **ROLLING 60 MONTH ANNUALIZED STANDARD DEVIATION**




Source: Morningstar Direct, MSCI and Mesirow Calculations

With respect to rolling correlations over the same 60-month horizon that are shown in Figure 11, there appears to be a definitive trend in the data. Correlations are clearly higher overall on a consistent basis between MSCI EAFE and MSCI USA indices over the last 25+ years relative to the earlier period. The diversification benefits are substantially lessened if correlations are in the 0.8 to 0.9 range going forward versus the 0.4 to 0.5 range for unhedged, or 0.5 to 0.7 range for the local currency, that had been the norm in an earlier era. The same integration of global supply chains and substantial increase in global trade alongside the integration of capital markets implies higher correlations going forward might be more likely than not.

Another important observation is that the unhedged USD series no longer shows any meaningfully lower correlation than the hedged local currency series. The implication of the charts in Figures 10 and 11 in tandem is that the unhedged series has higher volatility (albeit less than the earlier era) with no meaningful difference in the correlation to offset it. In the 1970–1994 period, hedging resulted in lower volatility and higher correlation. To the extent that international equity diversification still makes sense with higher correlations, this data implies that currency hedging could be preferred in the implementation of that international mandate—at least on a standalone basis.

While the correlation between international and domestic equity assets exhibits a noticeable trend, there are additional correlation trends that have implications for the Mean Variance Optimization (MVO) that we will perform over the two sub-periods of 1970–1994 and 1995–2020. These are discussed in detail in the MVO Framework and Efficient Frontier Overview.

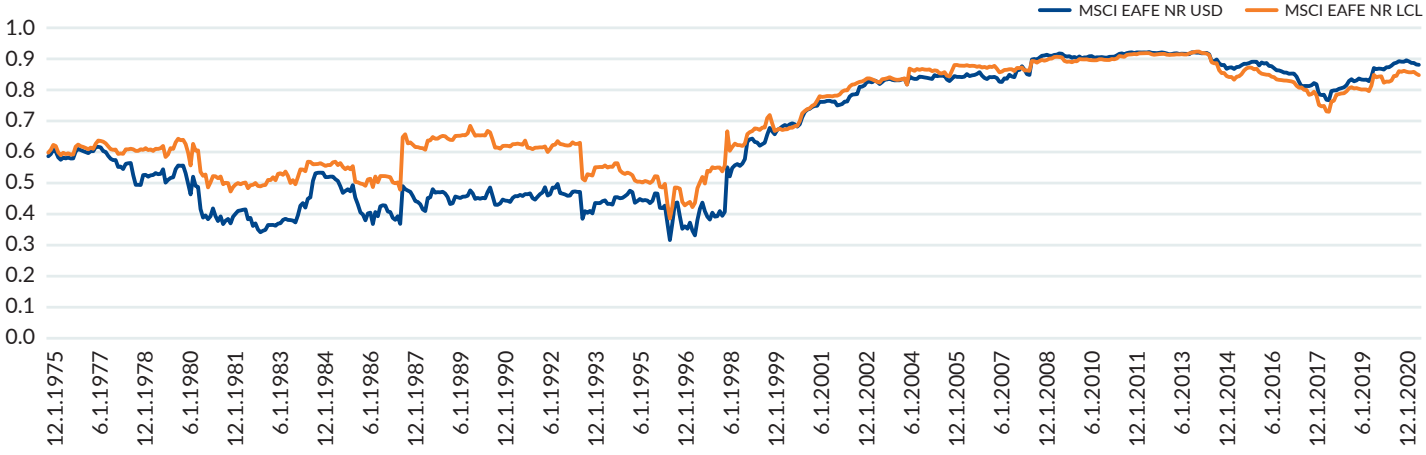
## MVO Framework and Efficient Frontier Overview

We perform asset-only MVO analysis for four different efficient frontier sets. These analyses utilize 1970–1994 data, 1995–2020 data, full period 1970–2020 data, and a mixed data set that incorporates the 1970–2020 asset class return data combined with the volatility and correlation data from 1995–2020. The mixed data set is an attempt to utilize the longest period return data, while accounting for the perceived changes in covariance noted earlier in discussion of the correlation trends.

We utilize annual return data for a variety of equity, fixed income and cash equivalent asset classes for which data was readily available for the full 1970 to 2020 time period. We utilize annual returns because the serial correlation for many shorter duration fixed income assets results in subdued volatility estimates when utilizing monthly annualized return data. The data source for the majority of the data is Morningstar Direct and the MVO analysis is performed in the asset allocation software from them as well. This software is an incarnation of the original Ibbotson Associates EnCorr optimization package used for asset allocation analysis. Morningstar acquired Ibbotson Associates in 2006. Many of the asset class proxies are also original Ibbotson Associates data series that have an IA designation in the series name.

The S&P 500 Index was used for US large cap equity asset class representation in our analyses, rather than the MSCI USA Index for reasons noted earlier related to their relative performance. For similar reasons, we utilize data for US small cap from Kenneth French's website for the 6-8 decile data for all stock exchanges, rather than the IA US Smallcap series.

FIGURE 11: **ROLLING 60 MONTH CORRELATION WITH MSCI USA NR INDEX**




Source: Morningstar Direct, MSCI and Mesirow Calculations

The return is comparable for the small cap data that we use to the IA US Smallcap series, but the volatility is lower and the correlations with other equity assets are higher. We believe this data to more closely approximate standard small cap indices utilized in practice, but which are not as long-lived (e.g. the S&P SmallCap 600 Index and the Russell 2000 Index).

For the international data, we use the MSCI EAFE NR USD Index and the MSCI EAFE NR Local Index. Whereas the correlation matrix was ill-conditioned if both MSCI USA and S&P 500 indices were utilized together, it was possible to include both MSCI EAFE proxies and allow them to compete for allocations. The correlation matrices were still well-conditioned in all analyses, as the currency component provides enough differences between the two series. This was convenient and allowed for a direct test of hedging strategy in an asset allocation setting.

The list of asset classes with their returns and standard deviations are presented in Figure 12 for all MVO analyses. This is purely historical data with no additional alteration. One obvious characterization of the data is that the 1970–1994 inputs exhibit substantially higher returns in nominal terms than the 1995–2020 period. Inflation averaged 5.72 percent in the earlier period and 2.16 percent in the later timeframe. In real inflation-adjusted terms, the shorter duration bonds had lower returns and the longer duration bonds higher returns in the later period, with the latter assets benefitting from steady disinflation. US small cap was very similar over the two periods in real terms, but US large cap (S&P 500) was substantially higher returning in the 1995–2020 period. The international equity assets were substantially lower

FIGURE 12

| Asset Class | Arithmetic Mean | Standard Deviation |
|---|---|---|
| **1970 to 1994** | | |
| IA US Inflation | 5.72 | 3.32 |
| IA US 30-Day T Bill | 7.05 | 2.79 |
| IA US 1 Yr Constant Maturity T Bonds | 7.98 | 3.65 |
| IA IT US Govt Bonds | 9.23 | 6.99 |
| IA LT US Govt Bonds | 9.44 | 11.65 |
| IA LT US Corp Bonds | 9.89 | 11.58 |
| IA US HY Bonds | 10.75 | 13.37 |
| MSCI EAFE NR USD | 14.60 | 23.30 |
| MSCI EAFE NR LCL | 11.55 | 20.26 |
| US Smallcap | 15.46 | 22.61 |
| S&P 500 | 12.11 | 15.86 |
| **1995 to 2020** | | |
| IA US Inflation | 2.16 | 0.94 |
| IA US 30-Day T Bill | 2.27 | 2.16 |
| IA US 1 Yr Constant Maturity T Bonds | 2.80 | 2.62 |
| IA IT US Govt Bonds | 5.33 | 5.16 |
| IA LT US Govt Bonds | 8.56 | 12.00 |
| IA LT US Corp Bonds | 8.54 | 8.40 |
| IA US HY Bonds | 8.44 | 14.51 |
| MSCI EAFE NR USD | 7.11 | 19.08 |
| MSCI EAFE NR LCL | 6.81 | 17.33 |
| US Smallcap | 12.66 | 19.01 |
| S&P 500 | 12.14 | 18.11 |
| **1970 to 2020** | | |
| IA US Inflation | 3.90 | 0.94 |
| IA US 30-Day T Bill | 4.61 | 2.16 |
| IA US 1 Yr Constant Maturity T Bonds | 5.34 | 2.62 |
| IA IT US Govt Bonds | 7.24 | 5.16 |
| IA LT US Govt Bonds | 8.99 | 12.00 |
| IA LT US Corp Bonds | 9.20 | 8.40 |
| IA US HY Bonds | 9.58 | 14.51 |
| MSCI EAFE NR USD | 10.78 | 19.08 |
| MSCI EAFE NR LCL | 9.13 | 17.33 |
| US Smallcap | 14.03 | 19.01 |
| S&P 500 | 12.12 | 18.11 |
| **Mixed Data Efficient Frontier** | | |
| IA US Inflation | 3.90 | 3.00 |
| IA US 30-Day T Bill | 4.61 | 3.45 |
| IA US 1 Yr Constant Maturity T Bonds | 5.34 | 4.08 |
| IA IT US Govt Bonds | 7.24 | 6.38 |
| IA LT US Govt Bonds | 8.99 | 11.72 |
| IA LT US Corp Bonds | 9.20 | 10.01 |
| IA US HY Bonds | 9.58 | 13.87 |
| MSCI EAFE NR USD | 10.78 | 21.38 |
| MSCI EAFE NR LCL | 9.13 | 18.78 |
| US Smallcap | 14.03 | 20.69 |
| S&P 500 | 12.12 | 16.87 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

returning in either nominal or real terms in the later period, which was evident in the return and risk scatterplots displayed earlier in this paper.

Overall, standard deviations were higher in the earlier timeframe with the exception of long-term government bonds IA US LT Govt Bonds) and high yield bonds (IA US HY Bonds), which were more volatile in the 1995–2020 period.

The correlations tables for the two sub-periods are shown in Figure 13. The correlation for the Mixed Data MVO analysis utilizes the same 1995–2020 in Figure 13. The correlation table for the full period 1970–2020 MVO analysis is shown in Figure 14.

FIGURE 13

| | IA US 1 Yr Constant Maturity T Bonds | IA US 30-Day T Bill | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | IA US HY Bonds | US Smallcap | Inflation | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1970–1994 Correlation Matrix** | | | | | | | | | | | |
| IA US 1 Yr Const Mat T Bds | 1.0000 | 0.8476 | 0.6815 | 0.4547 | 0.4463 | -0.2193 | 0.0036 | 0.2611 | 0.1247 | 0.2288 | 0.1781 |
| IA US 30-Day T Bill | 0.8476 | 1.0000 | 0.2432 | -0.0022 | -0.0356 | -0.2313 | -0.0401 | -0.0772 | -0.0054 | 0.5501 | -0.0027 |
| IA IT US Govt Bonds | 0.6815 | 0.2432 | 1.0000 | 0.9302 | 0.9255 | 0.0546 | 0.1633 | 0.6231 | 0.2564 | -0.3400 | 0.3704 |
| IA LT US Govt Bonds | 0.4547 | -0.0022 | 0.9302 | 1.0000 | 0.9591 | 0.2399 | 0.3061 | 0.6493 | 0.3237 | -0.5037 | 0.4292 |
| IA LT US Corp Bonds | 0.4463 | -0.0356 | 0.9255 | 0.9591 | 1.0000 | 0.2187 | 0.3079 | 0.7173 | 0.3717 | -0.5583 | 0.5004 |
| MSCI EAFE NR USD | -0.2193 | -0.2313 | 0.0546 | 0.2399 | 0.2187 | 1.0000 | 0.8485 | 0.3127 | 0.4455 | -0.3743 | 0.5627 |
| MSCI EAFE NR LCL | 0.0036 | -0.0401 | 0.1633 | 0.3061 | 0.3079 | 0.8485 | 1.0000 | 0.3993 | 0.6099 | -0.3407 | 0.7051 |
| IA US HY Bonds | 0.2611 | -0.0772 | 0.6231 | 0.6493 | 0.7173 | 0.3127 | 0.3993 | 1.0000 | 0.6297 | -0.5182 | 0.5763 |
| US Smallcap | 0.1247 | -0.0054 | 0.2564 | 0.3237 | 0.3717 | 0.4455 | 0.6099 | 0.6297 | 1.0000 | -0.1109 | 0.8489 |
| IA US Inflation | 0.2288 | 0.5501 | -0.3400 | -0.5037 | -0.5583 | -0.3743 | -0.3407 | -0.5182 | -0.1109 | 1.0000 | -0.2806 |
| S&P 500 | 0.1781 | -0.0027 | 0.3704 | 0.4292 | 0.5004 | 0.5627 | 0.7051 | 0.5763 | 0.8489 | -0.2806 | 1.0000 |
| **1995–2020 Correlation Matrix** | | | | | | | | | | | |
| IA US 1 Yr Const Mat T Bds | 1.0000 | 0.9186 | 0.6544 | 0.3466 | 0.2129 | -0.2351 | -0.2174 | -0.2441 | -0.2163 | 0.2522 | -0.0688 |
| IA US 30-Day T Bill | 0.9186 | 1.0000 | 0.4121 | 0.1685 | 0.0329 | -0.0197 | 0.0500 | -0.1758 | -0.0963 | 0.4448 | 0.0856 |
| IA IT US Govt Bonds | 0.6544 | 0.4121 | 1.0000 | 0.8390 | 0.6970 | -0.5260 | -0.6272 | -0.3835 | -0.4750 | -0.0132 | -0.3263 |
| IA LT US Govt Bonds | 0.3466 | 0.1685 | 0.8390 | 1.0000 | 0.8231 | -0.5233 | -0.5465 | -0.4301 | -0.4712 | -0.0984 | -0.2760 |
| IA LT US Corp Bonds | 0.2129 | 0.0329 | 0.6970 | 0.8231 | 1.0000 | -0.2129 | -0.2884 | 0.0314 | -0.1120 | -0.0580 | 0.0301 |
| MSCI EAFE NR USD | -0.2351 | -0.0197 | -0.5260 | -0.5233 | -0.2129 | 1.0000 | 0.9053 | 0.6697 | 0.8082 | 0.3208 | 0.8174 |
| MSCI EAFE NR LCL | -0.2174 | 0.0500 | -0.6272 | -0.5465 | -0.2884 | 0.9053 | 1.0000 | 0.5743 | 0.7906 | 0.2999 | 0.8314 |
| IA US HY Bonds | -0.2441 | -0.1758 | -0.3835 | -0.4301 | 0.0314 | 0.6697 | 0.5743 | 1.0000 | 0.7592 | 0.2571 | 0.6483 |
| US Smallcap | -0.2163 | -0.0963 | -0.4750 | -0.4712 | -0.1120 | 0.8082 | 0.7906 | 0.7592 | 1.0000 | 0.1346 | 0.8477 |
| IA US Inflation | 0.2522 | 0.4448 | -0.0132 | -0.0984 | -0.0580 | 0.3208 | 0.2999 | 0.2571 | 0.1346 | 1.0000 | 0.1458 |
| S&P 500 | -0.0688 | 0.0856 | -0.3263 | -0.2760 | 0.0301 | 0.8174 | 0.8314 | 0.6483 | 0.8477 | 0.1458 | 1.0000 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 14

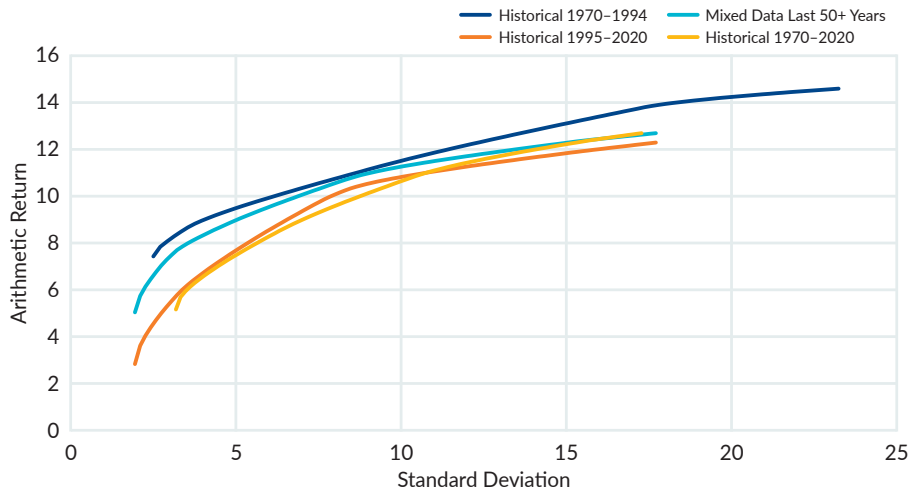
| | IA US 1 Yr Constant Maturity T Bonds | IA US 30-Day T Bill | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | IA US HY Bonds | US Smallcap | Inflation | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1970–2020 Correlation Matrix** | | | | | | | | | | | |
| IA US 1 Yr Cons Mat T Bds | 1.0000 | 0.9272 | 0.6888 | 0.3325 | 0.3226 | -0.0567 | 0.0189 | 0.0798 | 0.0383 | 0.5187 | 0.0475 |
| IA US 30-Day T Bill | 0.9272 | 1.0000 | 0.4245 | 0.0801 | 0.0403 | 0.0204 | 0.0869 | -0.0278 | 0.0177 | 0.7003 | 0.0272 |
| IA IT US Govt Bonds | 0.6888 | 0.4245 | 1.0000 | 0.8461 | 0.8215 | -0.1040 | -0.1021 | 0.1796 | -0.0082 | -0.0144 | 0.0410 |
| IA LT US Govt Bonds | 0.3325 | 0.0801 | 0.8461 | 1.0000 | 0.8861 | -0.1075 | -0.0956 | 0.0716 | -0.0502 | -0.2594 | 0.0408 |
| IA LT US Corp Bonds | 0.3226 | 0.0403 | 0.8215 | 0.8861 | 1.0000 | 0.0647 | 0.0814 | 0.4036 | 0.1870 | -0.3107 | 0.2747 |
| MSCI EAFE NR USD | -0.0567 | 0.0204 | -0.1040 | -0.1075 | 0.0647 | 1.0000 | 0.8741 | 0.4852 | 0.5982 | -0.0663 | 0.6681 |
| MSCI EAFE NR LCL | 0.0189 | 0.0869 | -0.1021 | -0.0956 | 0.0814 | 0.8741 | 1.0000 | 0.4870 | 0.6888 | -0.0758 | 0.7545 |
| IA US HY Bonds | 0.0798 | -0.0278 | 0.1796 | 0.0716 | 0.4036 | 0.4852 | 0.4870 | 1.0000 | 0.6889 | -0.1735 | 0.6144 |
| US Smallcap | 0.0383 | 0.0177 | -0.0082 | -0.0502 | 0.1870 | 0.5982 | 0.6888 | 0.6889 | 1.0000 | -0.0043 | 0.8364 |
| IA US Inflation | 0.5187 | 0.7003 | -0.0144 | -0.2594 | -0.3107 | -0.0663 | -0.0758 | -0.1735 | -0.0043 | 1.0000 | -0.1165 |
| S&P 500 | 0.0475 | 0.0272 | 0.0410 | 0.0408 | 0.2747 | 0.6681 | 0.7545 | 0.6144 | 0.8364 | -0.1165 | 1.0000 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

Many asset behaviors changed distinctly between the two sub-periods. For instance, the high yield bond asset class (IA US HY Bonds) was highly correlated with other bonds in the 1970–1994 period, but more highly correlated to equities in the 1995–2020 period and negatively correlated to most fixed income assets. Overall, the correlations between all equity assets and US fixed income assets dramatically declined between the earlier and later period, but they went the most inverted for international equities. Interestingly, the correlation between US inflation and international equities was more negative than for US equities in the earlier data set, but higher in the later data set. As our MVO analyses are performed with nominal data, this fact does not impact the analyses.

An overview of all the efficient frontiers in risk and return space is shown in Figure 15. For our analyses, we establish two hypothetical portfolios of 60 percent equity and 40 percent fixed income, with one having an allocation to MSCI EAFE USD and the other to the hedged local currency index of MSCI EAFE Local. These portfolios are meant to be prudently diversified across asset classes with a substantial allocation to international equity that approximates the current global weight that is recommended by many industry stalwarts. Vanguard notes, "The standard asset allocation approach, whether for a global allocation or for an allocation within a specific market, is to invest proportionally according to market capitalization…US investors who follow a market-capitalization approach would invest 58.3 percent of their equity portfolio in US equities…."[8] Similarly, MSCI research states "A global integrated equity approach that places the global market portfolio as the natural starting point for equity allocation is both theoretically sound and practically viable."[xxi,9]

FIGURE 15: **EFFICIENT FRONTIER OVERLAY ALL MODERATE CONSTRAINT**




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

As of mid-2021, the weight of non-US equities is roughly 34 percent among developed markets (MSCI World Index), but 43 percent in all-country world terms (MSCI ACWI Index) based upon relative market capitalization. The Vanguard reference is clearly utilizing the MSCI ACWI Index or the like as a reference point. MSCI writes "In the late 1980s…the MSCI ACWI Index…started replacing the MSCI World Index as the proxy for the global market portfolio."[10] We utilize 5 percent increments in our allocations, but our 25 percent allocation equates to just under 42 percent of total equity weight, which is largely consistent with the ACWI weighting scheme even though our benchmark (due to historical availability) is consistent with the developed markets MSCI World schema.

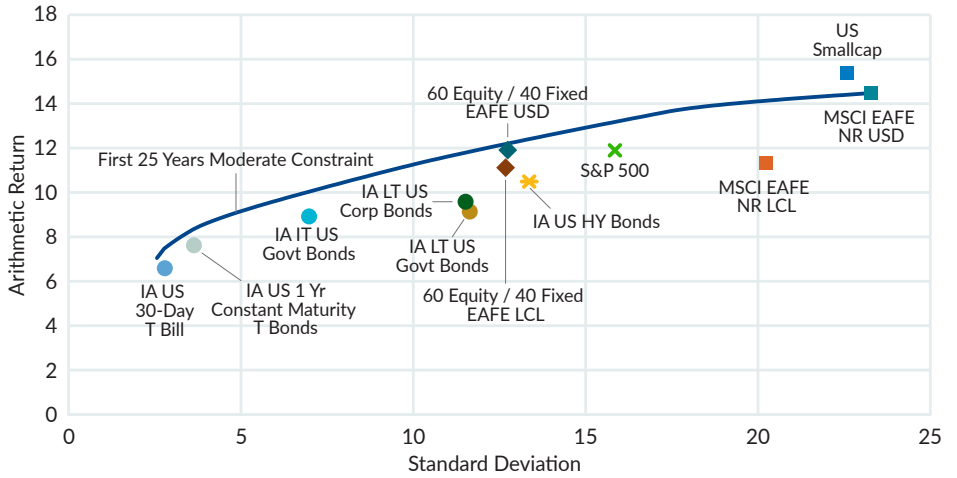
We examine the diversified portfolios for relative efficiency in each MVO scenario. We are interested in how each 60/40 portfolio looks in relation to each other, but also in relation to an equivalent risk efficient frontier portfolio. This allows us to examine a constant allocation portfolio as we vary the capital market inputs in each MVO scenario.

Additionally, the risk-equivalent efficient frontier portfolios that are generated from each of the four MVO input sets are also examined within all of the other MVO scenarios to see how their relative efficiency changes as the inputs vary. The efficient frontier portfolios tend not to be diversified and *a priori*, we would expect more variation in other frontiers' analyses. The test that we consider a legitimate out of sample analysis is represented by the risk-equivalent efficient frontier portfolio generated from 1970–1994 and examined in the 1995–2020 input MVO analysis.

We also construct four portfolios that are equally spaced along the efficient frontier that we label P0, P25, P50 and P99. These portfolios allow us to examine the changing composition of assets along each efficient frontier, rather than just examining one specific risk point as with the 60/40 portfolio. These portfolios are loosely comparable to each other, but they are not matched exactly in risk space since the spans of the efficient frontiers from lowest to highest standard deviation. For instance, the P50 portfolio, which is the midpoint from the 1970–1994 efficient frontier, is a different standard deviation than P50 from the 1995–2020 efficient frontier.

Our analyses employ few constraints, but we did find the US Small Cap asset surprisingly dominant in both sub-periods, and therefore, it was useful to employ varying constraint levels to ensure that the frontier portfolios and allocations to international equities was not being driven purely by the optimizer preference for the US Small Cap asset. We employ an unconstrained small cap allocation version that we label SC Unconstrained, a forced zero allocation that we label SC Constrained, and a SC Moderate Constraint version that employs a constraint that is defined in relative terms, such that the allocation to US small cap is less than or equal to 50 percent of US large cap. We note that the allocation to US Small Cap does not follow market capitalization neutrality, but instead allows for an overweight or underweight relative to the 7 percent to 10 percent (depending on the specific index framework) market neutral weighting.

FIGURE 16: **1970–1994 | EFFICIENT FRONTIER**




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

## 1970–1994 MVO ANALYSIS

This time frame was favorable to international equities from the vantage point of US-based investors. We know from the risk and return scatterplots displayed earlier in this paper that MSCI EAFE NR Index had similar risk and higher return in US dollar terms and lower risk with slightly lower return in local currency terms. What we do not know is the efficient frontier allocation to international equities in relation to domestic equity assets.

The efficient frontier that is displayed in Figure 16 represents the usage of the SC Moderate Constraint, which is why the standalone US Small Cap asset appears above the efficient frontier. The composition of the diversified 60/40 portfolios with EAFE USD and EAFE local currency allocations are shown in Figure 17, along with the efficient frontier portfolio that most closely matches the risk of the more efficient 60/40 portfolio (with MSCI EAFE NR USD).

The efficient frontier portfolio looks surprisingly similar to our “straw man” 60/40 portfolio in terms of equity weightings. The efficient frontier portfolio allocates a little more weight to equity overall and skews slightly higher to international and US small cap assets. It achieves the higher equity allocation by allocating all fixed income assets to the less volatile intermediate-term bonds relative to our ‘straw man’ 60/40 portfolio which allocates more to longer duration fixed income. The relatively longer duration tilt to the fixed income assets in the straw man portfolio is a crude attempt to represent both the typical longer duration asset tilt in defined benefit portfolios and the relatively long average time horizon for defined contribution investors.

The shorter duration fixed income assets performed better on a risk-adjusted basis over this earlier timeframe, which experienced high inflation and rising rates for a substantial portion.

FIGURE 17

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Smallcap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| 60 Equity / 40 Fixed EAFE USD | | | 5.00 | 15.00 | 15.00 | 5.00 | 25.00 | | 10.00 | 25.00 |
| 60 Equity / 40 Fixed EAFE LCL | | | 5.00 | 15.00 | 15.00 | 5.00 | | 25.00 | 10.00 | 25.00 |
| 60/40 Equivalent Risk Efficient Frontier Portfolio | | | 30.43 | | | | 30.64 | | 12.98 | 25.95 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 18

| 1970–1994 | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|
| 60 Equity / 40 Fixed EAFE USD | 12.12 | 11.33 | 12.76 | 0.95 |
| 60 Equity / 40 Fixed EAFE LCL | 11.36 | 10.57 | 12.69 | 0.90 |
| First 25 60/40 Equivalent Risk Efficient Frontier Portfolio | 12.43 | 11.63 | 12.84 | 0.97 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 19

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| P0 SC Unconstrained | 92.24 | | | | 3.02 | 1.59 | 3.16 | | | |
| P0 Moderate Constraint | 92.24 | | | | 3.02 | 1.59 | 3.16 | | | |
| P0 SC Constrained | 92.24 | | | | 3.02 | 1.59 | 3.16 | | | |
| P25 SC Unconstrained | | 22.89 | 41.31 | | | | 17.44 | | 18.36 | |
| P25 Moderate Constraint | | 15.74 | 46.55 | | | | 19.61 | | 6.03 | 12.07 |
| P25 SC Constrained | | 9.75 | 56.25 | | | | 24.03 | | | 9.97 |
| P50 SC Unconstrained | | | 36.90 | | | | 26.41 | | 36.69 | |
| P50 Moderate Constraint | | | 28.96 | | | | 31.15 | | 13.30 | 26.59 |
| P50 SC Constrained | | | 25.74 | | | 11.51 | 40.56 | | | 22.18 |
| P75 SC Unconstrained | | | 6.93 | | | | 36.13 | | 56.94 | |
| P75 Moderate Constraint | | | | | | | 55.31 | | 14.90 | 29.79 |
| P75 SC Constrained | | | | | | 5.81 | 63.04 | | | 31.16 |
| P99 SC Unconstrained | | | | | | | | | 100.00 | |
| P99 Moderate Constraint | | | | | | | 98.50 | | 0.50 | 1.00 |
| P99 SC Constrained | | | | | | | 98.54 | | | 1.46 |

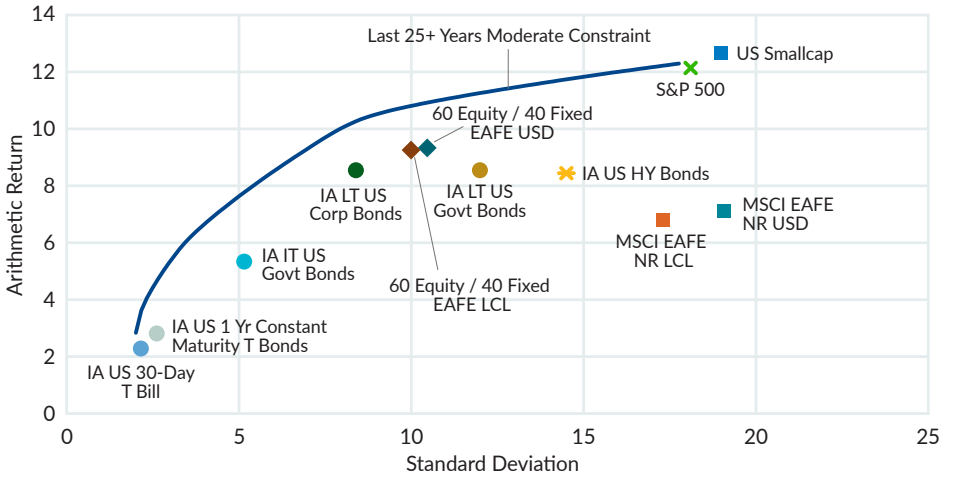
Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

The optimizer also preferred unhedged international equity assets that are exposed to currency volatility over this time period. As the dollar depreciated against the broader currency basket, the return was high enough and correlation low enough to offset the higher standalone volatility. Our diversified 60/40 straw man portfolio looks relatively efficient and closely approximates the efficient frontier portfolio for the first 25 year data set in risk-adjusted terms, with a Sharpe Ratio of 0.95 versus 0.97, as shown in Figure 18.

These portfolios obviously represent a very narrow range in terms of standard deviation. The efficient frontier position portfolios shown in Figure 19 illustrate the changing composition of the mathematically most efficient combination of assets at various risk points, along with variation that accompanies changes in the US small cap constraint parameter.

The international equities are clearly dominant, showing up in all frontier portfolios, except for the highest risk portfolio when US small cap is unconstrained. Even when small cap is forced to be 50 percent of US large cap in the high risk P99 portfolio, the optimization favors international equities. International equities are the only equity asset to show up in the minimum risk portfolio, clearly providing substantial risk diversification over this timeframe. One other interesting observation in the various constraint permutations of the efficient portfolios is that when the US Small Cap asset is completely constrained, US High Yield Bonds enter into the asset mixes.

FIGURE 20: **1995–2020 | EFFICIENT FRONTIER**




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

Given this extant data set that was the basis for many conclusions and influenced the formative years of the international investing literature, it is not surprising that there was such a strong conclusion of international diversification representing a "free lunch" and becoming essentially unchallenged dogma. One might ponder if the same body of literature and same conclusions would have developed had the data sets for 1970–1994 and 1995–2020 occurred in reverse time sequence, because the later dataset produces starkly different MVO results.

## 1995–2020 MVO ANALYSIS

The MVO efficient frontier looks very different using data from the next 25+ years from 1995–2020. We commented earlier on the differing nature of the correlations, returns and volatilities both in nominal and real terms over this period versus the earlier timeframe. The resulting efficient frontier shown in Figure 20 looks more hump-shaped than the relatively smooth frontier derived from 1970–1994. This characteristic is largely due to a sharp increase in the return opportunity set among the fixed income assets with small increases in risk. The opportunity set then changes as the efficient frontier shifts to more equity allocations and the return for risk trade-off flattens out. Given that the small cap return and return/risk premia declined and the US small caps and US large cap equity assets look very close in risk and return space, it is somewhat surprising that we find that the US small cap assets are still strongly preferred in the efficient frontier portfolios that are unconstrained. Most importantly, the international assets that were dominant in the earlier period are dramatically reduced in frontier portfolios in the latter out of sample period.

The risk-equivalent efficient frontier portfolio is selected to match the risk-level of the diversified 60/40 portfolio with EAFE in local currency since it is the most efficient over this particular timeframe. This portfolio shown in Figure 21 allocates roughly 60 percent to equity and 40 percent to fixed income, where it was slightly higher in equity weight over the earlier data period. Rather than the intermediate-term government bond allocation that occurred in the 1970–1994 MVO analysis, all fixed income is now allocated to long-term government bonds. Even though the corporate bonds look more efficient than government on a standalone basis, the lower correlation of the government bonds in the presence of equity assets appears to be the primary driver of this allocation. The corporate bonds do make a showing in the lower risk portfolios with no equity assets.

The optimizer goes to the full constraint threshold of 50 percent of US large cap for the US small cap allocation in this Moderate SC Constraint analysis. The international equities do not receive any allocation in the efficient portfolio that is equivalent risk level. Overall, the diversified straw man portfolio for the last 25+ years in Figure 22 looks less efficient than over the earlier timeframe in terms of the Sharpe Ratio, and thus, further away from the efficient frontier. This is due to the inefficiency of the international equities over the 1995–2020 timeframe and the substantial allocation that the portfolio gives to this asset class.

FIGURE 21

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | | | 5.00 | 15.00 | 15.00 | 5.00 | 25.00 | | 10.00 | 25.00 |
| 60 Equity / 40 Fixed Income EAFE LCL | | | 5.00 | 15.00 | 15.00 | 5.00 | | 25.00 | 10.00 | 25.00 |
| 60/40 Equivalent Risk Efficient Frontier Portfolio | | | | 40.28 | | | | | 19.91 | 39.81 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 22

| 1995–2020 | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | 9.33 | 8.79 | 10.43 | 0.89 |
| 60 Equity / 40 Fixed Income EAFE LCL | 9.25 | 8.76 | 9.98 | 0.93 |
| Last 25+ 60/40 Equivalent Risk Efficient Frontier Portfolio | 10.80 | 10.31 | 9.96 | 1.08 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 23

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| P0 SC Constrained | 91.02 | | | | 4.75 | 4.23 | | | | |
| P0 Moderate Constraint | 91.02 | | | | 4.75 | 4.23 | | | | |
| P0 SC Unconstrained | 91.02 | | | | 4.75 | 4.23 | | | | |
| P25 SC Constrained | | | 26.21 | 35.58 | 0.22 | 17.91 | | 3.71 | | 16.37 |
| P25 Moderate Constraint | | | 30.80 | 33.08 | | 11.00 | | | 8.37 | 16.74 |
| P25 SC Unconstrained | | | 30.40 | 36.55 | | 3.00 | | | 30.06 | |
| P50 SC Constrained | | | | 44.62 | | | | | | 55.38 |
| P50 Moderate Constraint | | | | 40.28 | | | | | 19.91 | 39.81 |
| P50 SC Unconstrained | | | | 40.93 | | | | | 59.07 | 0.00 |
| P75 SC Constrained | | | | 20.70 | | | | | | 79.30 |
| P75 Moderate Constraint | | | | 17.98 | | | | | 27.34 | 54.68 |
| P75 SC Unconstrained | | | | 20.19 | | | | | 74.57 | 5.23 |
| P99 SC Constrained | | | | 1.52 | | | | | | 98.48 |
| P99 Moderate Constraint | | | | | | | | | 30.00 | 70.00 |
| P99 SC Unconstrained | | | | 3.55 | | | | | 86.56 | 9.90 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

The various risk points along the efficient frontier in Figure 23 are equally informative. The international equities do not make a showing in the minimum risk portfolio as they did in the 1970–1994 MVO analysis, where they now appear to be displaced by high yield bonds. The only place where international equities have an efficient frontier portfolio allocation is in the P25 portfolio when US small cap is constrained to zero. In that case, the MSCI EAFE in hedged local currency terms receives a small allocation that is approximately an 18.5 percent relative weight of the roughly 20 percent total equity allocation.

The efficient frontier portfolios become relatively undiversified at higher risk levels, with only three asset classes present and which become just two asset classes when US small cap is constrained to zero. Clearly, over this particular timeframe, the US equity assets are dominant over the international equities even in the context of a diversified asset opportunity set, as well as on the standalone basis that we examined earlier.

FIGURE 24: 1995–2020 MVO ANALYSIS

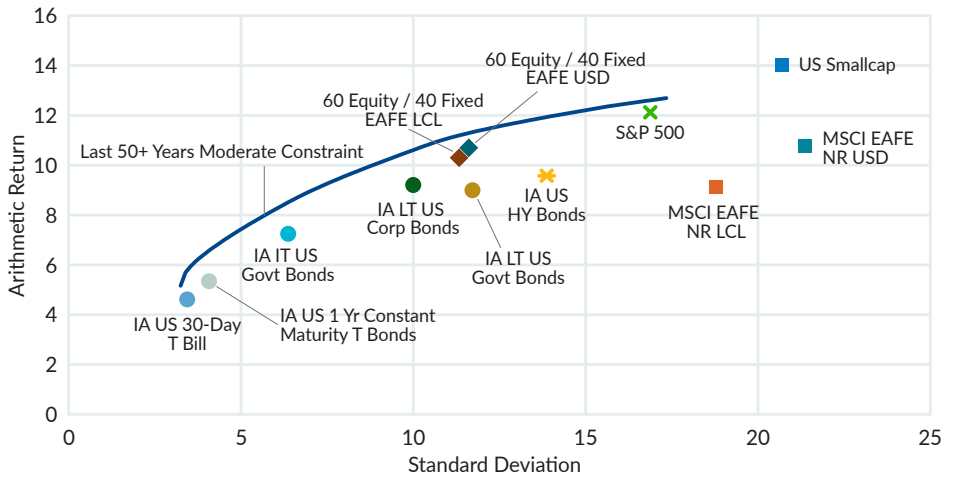
| Asset mix | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | 9.33 | 8.78 | 10.48 | 0.89 |
| 60 Equity / 40 Fixed Income EAFE LCL | 9.25 | 8.76 | 10.00 | 0.93 |
| 1995–2020 Efficient Frontier Portfolio | 10.80 | 10.31 | 9.98 | 1.08 |
| 1970–1994 Efficient Frontier Portfolio | 8.59 | 7.92 | 11.62 | 0.74 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

Not surprisingly, our out of sample risk-equivalent efficient frontier portfolio from 1970–1994 does not generate a good showing. The comparison of these statistics is shown in Figure 24. The portfolio from the earlier MVO analysis that was risk equivalent to the diversified 60/40 portfolio is now substantially more volatile and is no longer close to risk equivalent. It is far below the efficient frontier with a Sharpe Ratio that is below the diversified portfolio in either USD or local currency, as well as the 1995–2020 efficient frontier portfolio.

Of course, the data over each sub-period that we have utilized in our MVO analyses is just historical data. Even though there is a time sequence to the data, they are equally valid data sets in some respects. A random sampling approach of annual data could sample from either data set, thus mixing the results. Given enough sampling, one simulation of fifty draws could completely invert the annual order that was observed historically in time sequence! We can't say with any certainty what the next 25 years will look like in terms of returns and covariance for our asset classes. Perhaps 25 years is not enough of a data window because obviously it results in two very different sets of inputs. Therefore, it might prove useful to look at an MVO analysis for the entire 1970–2020 data set, because it incorporates all of the available data on an equal-weighted basis, even though it does not provide for any an out of sample test.

FIGURE 25: 1970–2020 | EFFICIENT FRONTIER




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

## 1970–2020 MVO ANALYSIS

The efficient frontier over this timeframe appears to be relatively smooth and "less humped" than that observed over the 1995–2020 period. Initially, the US long-term corporate bonds appear more efficient that the US government long-term bonds once again, but in the prior MVO analysis we observed how the lower correlations drove most allocations to the government. Also, even with the long-term data incorporating the underlying 1970–1994 data with nearly equal weight to the 1995–2020 underlying data (25 versus 26 years), the international equity assets still appear far from the frontier in either dollar or local currency terms.

The data in Figure 26 looks very similar to the risk-equivalent efficient frontier output from 1995–2020. The return and risk data in Figure 27 show higher returns and higher volatilities relative to those from the 1995–2020 MVO set, as the longer-term higher inflationary and higher nominal return data is averaged in. The straw man portfolios look relatively efficient vis-à-vis the efficient portfolio—more so than in the 1995–2020 MVO analysis. There is a very slight optimizer preference for the unhedged portfolio, but we deem the hedged and unhedged 60/40 portfolio options to be largely equivalent in Sharpe Ratio terms. Of course, there is some cost that must be assumed for currency hedging and the optimal hedging choice consistent with this long-term input data set might depend on the particular investor time horizon.

FIGURE 26

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | | | 5.00 | 15.00 | 15.00 | 5.00 | 25.00 | | 10.00 | 25.00 |
| 60 Equity / 40 Fixed Income EAFE LCL | | | 5.00 | 15.00 | 15.00 | 5.00 | | 25.00 | 10.00 | 25.00 |
| 60/40 Equivalent Risk Efficient Frontier Portfolio | | | | 38.59 | | | | | 20.47 | 40.94 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 27

| 1970–1994 | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | 10.70 | 10.03 | 11.61 | 0.92 |
| 60 Equity / 40 Fixed Income EAFE LCL | 10.29 | 9.65 | 11.32 | 0.91 |
| Full Period 60/40 Equivalent Risk Efficient Frontier Portfolio | 11.30 | 10.64 | 11.65 | 0.97 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 28

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| P0 SC Constrained | 88.52 | | | | 7.32 | 3.45 | 0.72 | | | |
| P0 Moderate Constraint | 88.52 | | | | 7.32 | 3.45 | 0.72 | | | |
| P0 SC Unconstrained | 88.52 | | | | 7.32 | 3.45 | 0.72 | | | |
| P25 SC Constrained | | | 63.04 | 6.43 | | 3.04 | 4.34 | | | 23.16 |
| P25 Moderate Constraint | | | 67.22 | 4.42 | | | 3.06 | | 8.44 | 16.87 |
| P25 SC Unconstrained | | | 69.54 | 4.25 | | | 4.00 | | 15.89 | 6.32 |
| P50 SC Constrained | | | | 42.55 | 5.93 | 2.21 | 1.45 | | | 47.85 |
| P50 Moderate Constraint | | | 1.09 | 47.24 | 3.53 | | | | 16.05 | 32.10 |
| P50 SC Unconstrained | | | 5.53 | 48.16 | 2.96 | | 2.15 | | 34.58 | 6.62 |
| P75 SC Constrained | | | | 19.63 | | | | | | 80.37 |
| P75 Moderate Constraint | | | | 22.49 | | | | | 25.84 | 51.67 |
| P75 SC Unconstrained | | | | 35.24 | | | | | 64.76 | 0.00 |
| P99 SC Constrained | | | | | | | | | | 100.00 |
| P99 Moderate Constraint | | | | | | | | | 30.00 | 70.00 |
| P99 SC Constrained | | | | 16.22 | | | | | 83.78 | |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

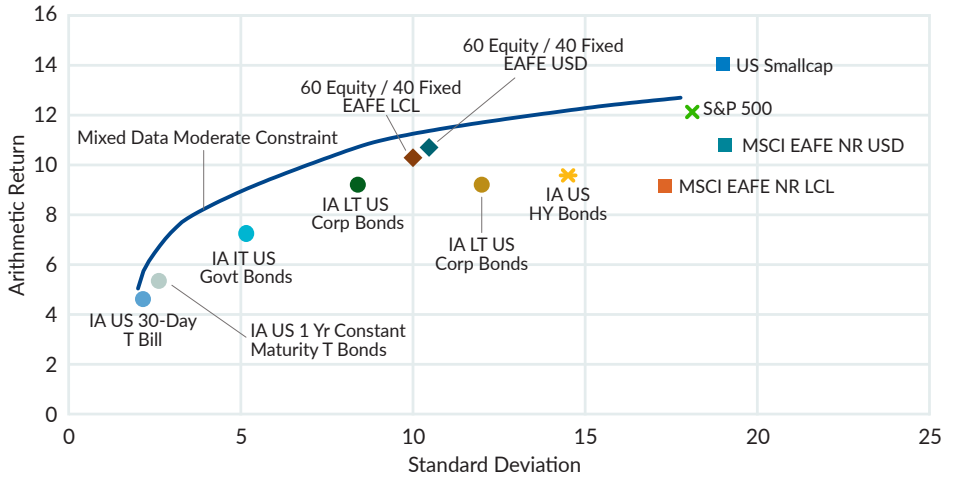
Figure 28 shows the efficient frontier portfolios at the various risk points along the frontier. International equities make a modest showing in the P25 portfolio, when US small cap is either fully constrained or unconstrained, at just over 15 percent relative equity weight. There is a very minimal allocation in the P50 portfolios with the same constraint sets. International equities do not receive any weight in the higher equity allocation portfolios. The unhedged international equities are preferred in these allocations where there is an international equity allocation.

One impetus for our sub-period analysis was to look at the substantial variation in inputs, but also to identify any secular data trends. Many investors might choose to simply incorporate the long-term, equal weighted data as represented by this analysis. Another option that we explore in the next MVO analysis employs the long horizon return data, but also utilizes the later volatility and correlation dataset alongside in an attempt to account for the secular trends in covariance.

## MIXED DATA MVO ANALYSIS

Not surprisingly, the efficient frontier shown in Figure 29 looks like a cross between the 1995–2020 MVO frontier and the 1970–2020 MVO frontier. The risk-equivalent 60/40 efficient frontier portfolio for this mixed set of inputs is shown in Figure 30. It is selected to match the risk level of the diversified 60/40 straw man portfolio with MSCI EAFE NR local, as that hedged currency portfolio has the slightly higher Sharpe Ratio. The efficient frontier portfolio is the same asset allocation as that generated from the 1995–2020 period. The return and volatility characteristics, which are different, are shown in Figure 31. The resulting relative efficiency of the diversified portfolios also rests in between the results of the 1995–2020 MVO and the 1970–2020 MVO.

FIGURE 29: MIXED DATA | EFFICIENT FRONTIER




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

FIGURE 30

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | | | 5.00 | 15.00 | 15.00 | 5.00 | 25.00 | | 10.00 | 25.00 |
| 60 Equity / 40 Fixed Income EAFE LCL | | | 5.00 | 15.00 | 15.00 | 5.00 | | 25.00 | 10.00 | 25.00 |
| 60/40 Equivalent Risk Efficient Frontier Portfolio | | | | 40.28 | | | | | 19.91 | 39.81 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 31

| Mixed data | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|
| 60 Equity / 40 Fixed Income EAFE USD | 10.70 | 10.16 | 10.46 | 1.02 |
| 60 Equity / 40 Fixed Income EAFE LCL | 10.29 | 9.79 | 10.00 | 1.03 |
| Mixed Data 60/40 Equivalent Risk Efficient Frontier Portfolio | 11.24 | 10.75 | 9.97 | 1.13 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 32

| Portfolio | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | IA US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| P0 SC Constrained | 91.02 | | | | 4.75 | 4.23 | | | | |
| P0 Moderate Constraint | 91.02 | | | | 4.75 | 4.23 | | | | |
| P0 SC Unconstrained | 91.02 | | | | 4.75 | 4.23 | | | | |
| P25 SC Constrained | | | 22.41 | 35.86 | 3.82 | 12.09 | 16.94 | | | 8.88 |
| P25 Moderate Constraint | | | 33.83 | 28.75 | 1.18 | 5.16 | 5.16 | | 8.64 | 17.28 |
| P25 SC Unconstrained | | | 36.55 | 29.81 | | | | | 33.64 | |
| P50 SC Constrained | | | | 44.62 | | | | | | 55.38 |
| P50 Moderate Constraint | | | | 40.28 | | | | | 19.91 | 39.81 |
| P50 SC Unconstrained | | | | 40.93 | | | | | 59.07 | |
| P75 SC Constrained | | | | 20.70 | | | | | | 79.30 |
| P75 Moderate Constraint | | | | 17.98 | | | | | 27.34 | 54.68 |
| P75 SC Unconstrained | | | | 20.89 | | | | | 79.11 | |
| P99 SC Constrained | | | | 1.52 | | | | | | 98.48 |
| P99 Moderate Constraint | | | | | | | | | 30.00 | 70.00 |
| P99 SC Unconstrained | | | | 4.90 | | | | | 95.10 | |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

The frontier position portfolios at various risk levels are shown in Figure 32. The P0 minimum risk, P50 and P75 portfolios are identical or nearly identical as those shown in the 1995–2020 MVO analysis. The most interesting and informative set in many regards is the P25 suite of portfolios. There are two surprises that we observe. First, the relative equity weight allocation to international equities is higher for two of these portfolios (SC Constrained and Moderate SC Constraint) than was observed in either the 1995–2020 MVO analysis or the 1970–2020 MVO analysis. Where US Small Cap is constrained, the allocation to international equity is substantially higher than to US large cap equity. Second, the optimizer prefers the unhedged international equity even though it is slightly less efficient on a standalone basis.

One deduction that we can derive from this observation is that the frontier portfolios can be relatively sensitive to small variations in the inputs, which is not surprising. Combining data from two different analyses that were not particularly favorable to international equities resulted in a distinct international equity preference under at least one set of conditions (i.e., SC Constrained). We use very straightforward historical data inputs or combinations thereof; however, a robust optimization that varies the inputs randomly—consistent with the variation observed over our sub-periods for example— or else, some other means of incorporating error bars, likely would result in some sampled outcomes that prefer international equities. That being said, a strong argument could be made for greater weighted sampling from the later covariance data. Overall, this later data tended to lessen the relative attractiveness of the international equities for US-based investors versus the earlier data set.

For completeness, we performed another analysis that is not displayed in the paper that combined the 1970–1994 returns with the 1995–2020 volatilities and correlations. That combination essentially presumes US equity underperformance relative to international equities, as occurred over the earlier 1970–1994 period, along with lower volatility and higher correlations among equity assets as was experienced over the later 1995–2020 period.

Not surprisingly, this set of inputs resulted in a general preference for international assets for US-based investors.

FIGURE 33

| 1970 to 1994 | IA US 30-Day T Bill | IA US 1 Yr Constant Maturity T Bonds | IA IT US Govt Bonds | IA LT US Govt Bonds | IA LT US Corp Bonds | IA US HY Bonds | MSCI EAFE NR USD | MSCI EAFE NR LCL | US Small Cap | S&P 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| Corporate DB Liability | | | | | 100.00 | | | | | |
| 60 Equity / 40 Fixed Income EAFE USD | | | | | 40.00 | | 25.00 | | 10.00 | 25.00 |
| 60 Equity / 40 Fixed Income EAFE LCL | | | | | 40.00 | | | 25.00 | 10.00 | 25.00 |
| Fist 25 Surplus Efficient Frontier Portfolio | | | | | 38.48 | | 22.01 | | 13.17 | 26.34 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

FIGURE 34

| Asset mix | Expected Surplus | Expected Surplus Ratio | Expected Funding Ratio | Surplus Standard Deviation | Arithmetic Mean | Geometric Mean | Standard Deviation | Sharpe Ratio |
|---|---|---|---|---|---|---|---|---|
| Corporate DB Liability | $0 | 0.0000 | 1.0000 | 0.00 | 9.89 | 9.22 | 11.56 | 0.86 |
| 60 Equity / 40 Fixed Income EAFE USD | $2,288,387 | 2.2884 | 1.0208 | 9.95 | 12.18 | 11.36 | 12.92 | 0.94 |
| 60 Equity / 40 Fixed Income EAFE LCL | $1,527,026 | 1.5270 | 1.0139 | 9.56 | 11.42 | 10.60 | 12.87 | 0.89 |
| Fist 25 Surplus Efficient Frontier Portfolio | $2,353,885 | 2.3539 | 1.0214 | 10.03 | 12.24 | 11.42 | 13.02 | 0.94 |

Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations

## Overview of surplus optimization analyses and their results

Another type of analysis that we performed, but are not fully displayed in this paper, are surplus optimizations(SO), where a liability target is designated. In general, this approach is meant to mimic a defined benefit framework, where the liability is defined as mirroring US long-term corporate bonds. We utilize similar 60/40 diversified portfolios as risk bogeys for the sake of consistency, even though many defined benefit allocations might be skewed more to fixed income. The only difference with these portfolios relative to the MVO analyses is that the entire 40 percent fixed income allocation is to US long-term corporate bonds. The SO portfolio sets are displayed in Figure 33. We set an initial asset portfolio value of $100 million and an initial liability of $100 million for a funded ratio of 1.0. We set the risk-equivalent efficient frontier portfolio to have roughly the same surplus standard deviation as the more efficient of the two diversified 60/40 portfolios. We analyze the expected surplus, funded ratio and surplus standard deviation based on a 20-year forecast horizon.

Our expectation is that when there is a domestic liability to defease that the likely allocation to international assets will be less than in the absence of such considerations, all else being equal. It is very straight-forward for a pension fund, where the value of the accumulated and projected benefit obligations (ABO and PBO, respectively) and the required contribution scheme is clearly defined. The same would be true in theory, however, for US-based retirees with dollar-based cash income needs where the risk bogey becomes a series of zero coupons matching the cash outflows. Therefore, this analysis is relevant for defined contribution retirees, as well.

In this paper, we focus on 1970–1994 timeframe that most favored the international equities in the MVO framework because the results and comparison with the MVO results are the most informative. We find that the international equities receive less allocation in the SO (Surplus Optimization) framework. Comparing the risk-equivalent frontier portfolio results in Figure 33 from the 1970–1994 SO analysis versus the comparable results in Figure 17 from the 1970–1994 MVO analysis, the allocation to international equities was reduced from 30.64 percent to 22.01 percent when a domestic liability target is included. The allocation is still substantial, but substantially less than in the asset only MVO framework. The relative international equity weight drops to just under 36 percent, which is roughly consistent with a neutral global developed market weighting, whereas in the MVO framework, there was a substantial overweight in this regard.

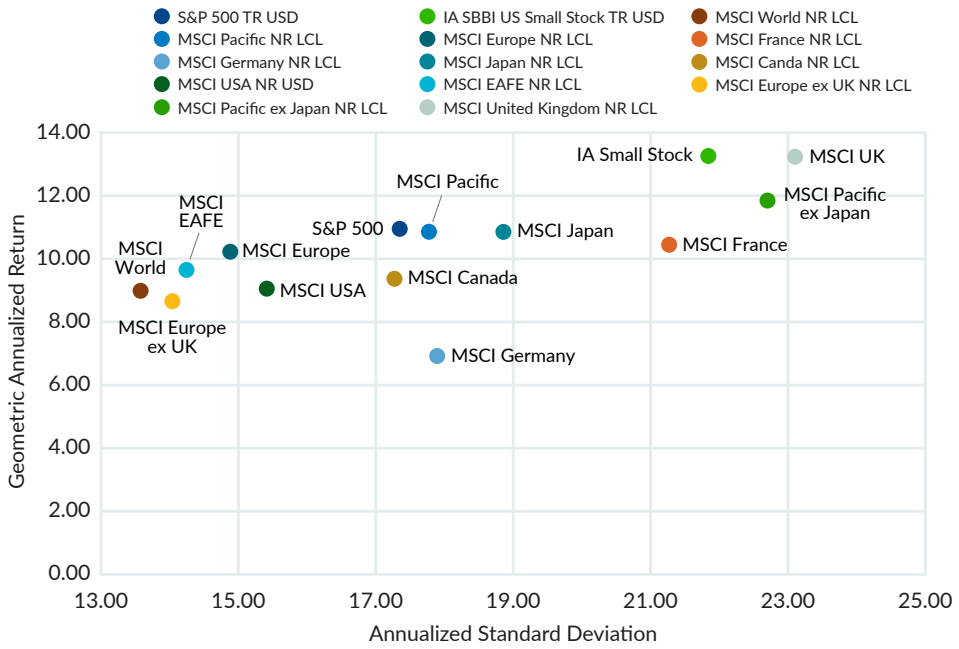
The surplus and surplus volatility characteristics are shown in Figure 34, along with the mean, standard deviation and Sharpe Ratio data relevant in an asset-only framework. As was the case in the MVO framework utilizing the 1970–1994 data set, the diversified 60/40 straw man portfolio is relatively efficient. This can be seen in a comparison of the expected funding ratios.

We also performed the SO analyses utilizing the 1995–2020 data set and full period 1970–2020 data set. Not surprisingly, as an international equity allocation did not show up in the risk-equivalent portfolios for the asset-only MVO analyses, the same was true for the respective SO analyses. International equities are not favored and we chose not display these results. We can only evaluate the relative change in moving to a liability-relative framework when there is an international equity allocation to evaluate. In general, we can conclude that where data supports an allocation to international equities, the optimal allocation is lower when US liabilities are included in the analyses for US-based investors.

## Conclusion

We ran numerous MVO analyses encompassing different historical capital market inputs. The very long-term historical data in an asset-only framework does not suggest an allocation to international equity anywhere near the level consistent with a neutral global weighting framework for US-based investors that is often espoused. A fifty-year timeframe is a fairly long horizon and longer than the horizon for the average investor. Real equity returns and equity risk premia tend to be relatively stable over such long horizons, but maybe fifty years is not long enough for complete mean

FIGURE 35: **GLOBAL EQUITY MARKET COMPARISON | 1970–2020 LOCAL CURRENCY**




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

reversion in equity returns across countries. Figure 35 shows the MSCI country return data for the full 1970–2020 period in local currency and Figure 36 in US dollars, where earlier we looked at that same data over the two distinct sub-periods.

There is some variation in country returns when examined in risk and return space in local currency terms, as evidenced by the slightly upward sloping trajectory similar to Figure 7. If we posit that currencies move to counterbalance differing capital market returns in one country versus another over long horizons, however, then the relatively tight return range shown in Figure 36 in a uniform currency (US dollars) makes sense. When defined in the same MSCI terms, US equities look quite similar to other countries on the return axis, although the S&P 500 still appears superior based upon the selection criteria of the S&P committee historically. The US Small Cap proxy is, of course, not comparable to the other large cap series and should be an outlier.

If the long-term returns are similar, but the volatilities and correlations differ, then the determination of the optimal portfolio with numerous assets in an opportunity set across equities and fixed income, as well as real assets, will be different than what is optimal in an equity-only MVO sense. Our 1970–2020 MVO analysis attempted to account for this with a broad asset set (although our asset set was limited by data availability). Another difference is that we utilized the S&P 500 Index proxy, which was superior in return, but the most commonly used US benchmark.

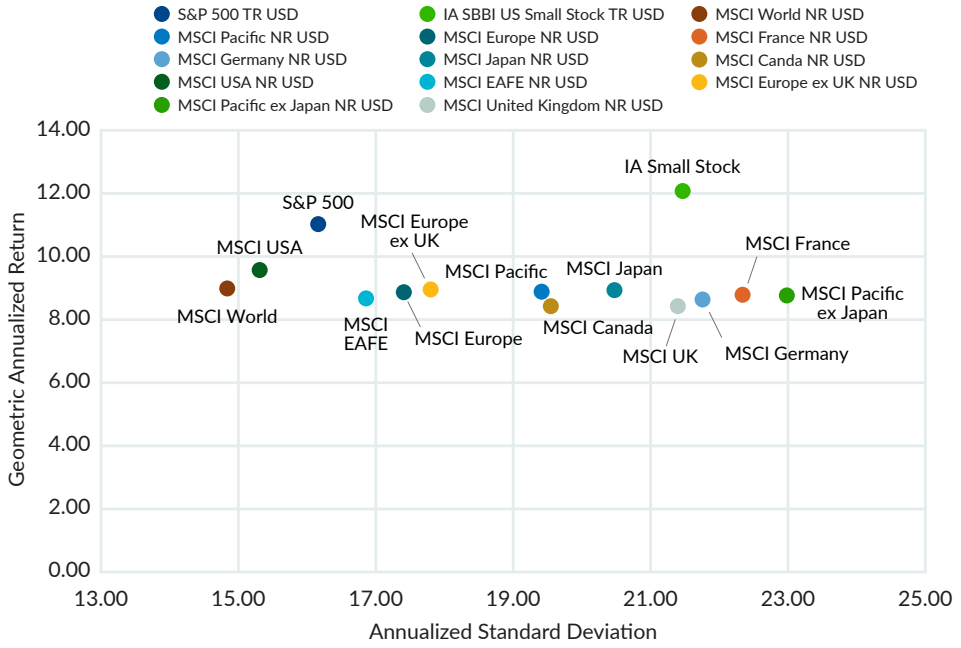
We show that optimal portfolios can vary substantially over relatively long historical horizons like the 25-year sub-periods that we employ. One data subset favors a high allocation to international equities that is above a global neutral weight and the other data subset allocates nothing at all to international

equity. Reasonable forward-looking capital market assumptions, or robust historical simulations with error bars on the inputs, are likely to include a substantial allocation to international equities. Prudent diversification arguments based upon regional shifts in in industry specialization, increasing GDP weight over time to developing markets away from developed markets, further strengthen the argument for international diversification.

Including liabilities into the equation is very insightful, however. Even over the timeframe that was most favorable to international equities (i.e., 1970 to 1994), the optimal allocation dropped substantially from an optimal overweight to international equity to a weight roughly consistent with the global weight in developed market terms. The later data set (1995 to 2020), as well as the long-term data set (1970 to 2020), resulted in below market neutral international equity allocations even in the asset-only MVO frameworks. Therefore, an allocation to international equity that is below global market neutrality may be rational and prudent based on a consideration of US-based liabilities and not be representative of an irrational equity market "home bias." That consideration is relevant for both defined benefit plans and defined contribution plan participants.

The average allocation to international equity among large pension plans, as indicated in the TUCS Top Ten average from Aon Hewitt, was just under 35percent based on a public equity allocation of just over 52% as of mid-2018.[11] That weighting is roughly equivalent to a developed market framework in terms of global neutrality, but below a ACWI definitional weighting.

FIGURE 36: **GLOBAL EQUITY MARKET COMPARISON | 1970–2020 | USD**




Source: Morningstar Direct Asset Allocation Software, MSCI, Standard and Poors and Mesirow Calculations. Past performance is not indicative of future results.

Similarly, the data in Figure 37 show the average allocation of Target Date Funds (TDFs), which include all share classes in the Morningstar Direct universe, to international equity as a percentage of total equity by vintage year along with the plus one standard deviation data. The table also shows the relative percentage of emerging markets of the total non-US equity allocation. Even though most of these TDF portfolios include emerging markets in the allocation (an implicit MSCI ACWI weighting framework), the typical allocation is slightly below the global neutral framework of roughly 43% in the ACWI schema, but still above the roughly 35% of the developed markets schema.

So, we can observe that the explicit liability-driven defined benefit portfolios seem to have slightly less relative weight allocated to international equities even though this represents very large and sophisticated plans. Nevertheless, the average allocations to international equity for portfolios that are designed for US retirees with dollar-based liabilities are substantial in both cases.

They imply a set of forward-looking capital market assumptions underlying the allocations that is more akin to the 1970 to 1994 historical data set in terms of the relative balance of return, risk and correlation for international and domestic equities, as opposed to the historical data derived from the later data set of 1995 to 2020, or even the long-term historical 1970 to 2020 data set.

Of course, capital market assumptions are likely not utilizing raw historical data inputs in all cases, even though they can be informative, as with our analyses. Frameworks may utilize a global CAPM modeling framework, or something similar, producing a set of equity inputs derived from betas rather than historical premia. Higher betas for international equity versus US assets on the global portfolio could lead to higher return assumptions.

FIGURE 37

| Mean | 2065+ | 2060 | 2055 | 2050 | 2045 | 2040 | 2035 | 2030 | 2025 | 2020 | Retirement |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-US% | 36.51% | 37.07% | 37.04% | 37.14% | 37.15% | 36.94% | 36.49% | 36.20% | 36.15% | 36.15% | 36.96% |
| Emg% NonUS | 23.95% | 22.47% | 22.45% | 22.34% | 22.36% | 22.22% | 22.01% | 21.34% | 21.71% | 21.57% | 22.45% |
| **+1 SD** | **2065+** | **2060** | **2055** | **2050** | **2045** | **2040** | **2035** | **2030** | **2025** | **2020** | **Retirement** |
| Non-US% | 41.89% | 41.71% | 41.34% | 41.44% | 41.18% | 41.11% | 40.70% | 39.90% | 39.63% | 39.76% | 38.83% |
| Emg% NonUS | 26.62% | 25.31% | 25.48% | 25.45% | 25.58% | 25.63% | 25.81% | 25.58% | 26.40% | 27.04% | 29.51% |

Source: Morningstar Direct and Mesirow Calculations

Alternatively, the allocations to assets could be derived from a top-down MVO framework, or other simulation approaches, that determine aggregate asset class allocations, such as equity, fixed income, etc. Some approaches might utilize other means of determining sub-group allocations, like domestic and international equity, which might utilize the global neutral weights as a baseline and deviate from that starting point. Whatever the derivation, in a liability-related world, these allocations seem somewhat high based on the implications of our historical input MVO and SO analyses.

## About Mesirow

Mesirow is an independent, employee-owned financial services firm founded in 1937. Headquartered in Chicago, with locations around the world, we serve clients through a personal, custom approach to reaching financial goals and acting as a force for social good. With capabilities spanning Global Investment Management, Capital Markets & Investment Banking, and Advisory Services, we invest in what matters: our clients, our communities and our culture.

Mesirow Fiduciary Solutions helps the retirement plan community achieve their intended investment objectives through our institutional 3(21) and 3(38) Fiduciary Partnership Services, fiduciary technology and reporting, and customized default solutions.

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