EVALUATION OF DIMENSIONAL FUND ADVISORS INDICES

Dimensional Fund Advisors is a highly regarded mutual fund company. Utilizing their Matrix Book data in our portfolio optimization system, the plans were noticeably better, with higher projected income for the same risk.

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The Data for Forecasts

IBBOTSON'S SBBI YEARBOOK

A popular source of data among advisors is Ibbotson's Stocks, Bonds, Bills, and Inflation Yearbook (SBBI). It was published each year and included historical returns of a few asset classes as well as inflation. One of the benefits of Ibbotson's data is that it starts in 1926. The advantage of a long historical track record is that it improves our understanding the underlying system.

For example, suppose one wishes to understand the probability that a disfigured coin will turn up heads when flipped. One could create an experiment in which the coin is flipped ten times, and the percentage of heads can be used as an estimate of the probability that the coin will come up heads in any future flip. Only flipping 10 flips means the estimate can only be 0%, 10%, 20%, and so on up to 100%. Obviously, this is pretty imprecise since the answer can only be in 10% increments.

Suppose after ten flips, the coin was heads seven times, or 70% of the time. Does this mean the coin is actually going to come up heads with a 70% probability in the future? Almost certainly not. The actual probability of heads could easily be anywhere between 40% and 90%. However, if you flip the coin 10,000 times, and the coin comes up heads 7,000 times, the actual probability of heads is very likely between 69% and 71%. The more data we have, the more accurate our understanding underlying system.

The same is true for investing. The more data we have, the more precise our understanding of the underlying behavior of the market[1]. The SBBI provided market data during several tumultuous periods, including the great depression, World War II, the Korean, Vietnam, and Cold Wars, the abandonment of the

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[1] Some might argue that the markets are not stationary. Laws and norms change over time so that the business climate and market behavior will be different today than it was 70 years ago. The data from 70 years ago will mislead us about future returns.

This is true, however, all of these changes are random and unpredictable. They too are a part of the random system. In fact, there are millions of unpredictable contributions to market performance. For example, a trader that isn't feeling well one day might forego purchasing some shares in favor of going home early. Those shares may trade lower because of his illness. Similarly, the government may introduce regulations to a class of companies that will reduce profitability and productivity. Several decades later, those regulations may be reversed.

All of these factors are unpredictable and can be treated as random variables, the sum of which is factored into the market behavior. Hence, the market can be treated as stationary, especially for long-term forecasting. *Plus ça change, plus c'est la même chose.*

dollar gold base, the oil embargo, and so on. Of course, having 900 years of data would be better than about 90 years, but 90 years is far better than the 20 or 30 years of data that many people base their forecasts on.

Having a solid long-term set of data for investment decisions is a gold mine, so the SBBI is a reasonable foundation for long-term forecasting and portfolio optimization.

DIMENSIONAL FUND ADVISORS

Dimensional Fund Advisors (DFA) is a highly regarded mutual fund company. They may have more Nobel prizes among their founders and directors than any other company, although we have not checked. Their funds are only sold through institutions, such as 401(k) plans, or select advisors and are not sold directly to individuals. DFA bases their funds on "factors", such as company size, price-to-book, and profitability. They have been very successful and have rapidly grown since their inception.

They also publish a Matrix Book with historical returns for some indexes they have created based on their factors. The annual data go back to 1928. However, one cannot invest in an index – an index is simply a list of companies or bonds, not a fund. Fortunately, DFA created funds that target the performance of those indices.
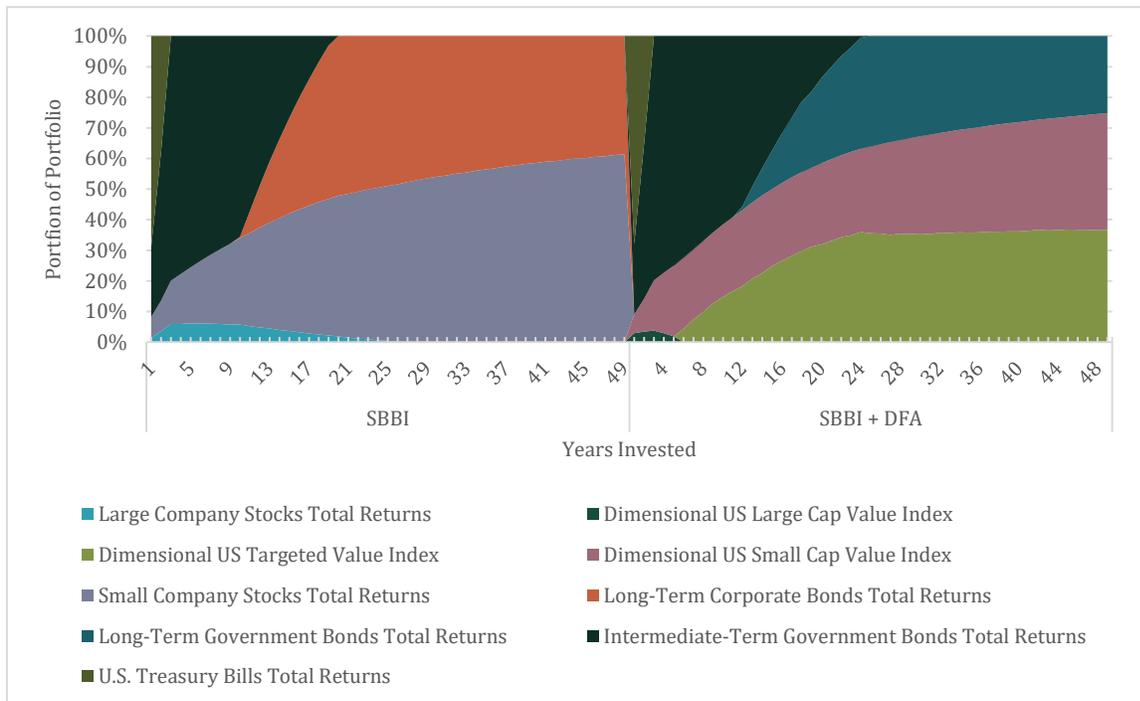
DFA Versus SBBI

By combining SBBI's and DFA's data, a new set of portfolio optimizations can be calculated with more investment choices. Incidentally, a good optimization algorithm is pretty selective and will tend to narrow investment selection to only a few highest quality choices. In fact, it's pretty easy to spot an un-optimized portfolio. If a portfolio has more than a handful of funds, it may have been created using the Blutarsky[2] method of fund selection. See example at right.

QUANTATIVE COMPARISON

The chart below shows the optimal asset allocations using SBBI's data on the left half of the chart compared with the right half showing the optimizations using SBBI and DFA's data combined. The x-axis is the years that the money in question will be invested. The y-axis is the portion of the portfolio. If one were to look at a thin vertical slice on the left side of the left chart, one would see the optimal allocation for a 1-year investment using only the SBBI indices. Looking at the right side of the left chart, one would see the optimal allocation for an investment that will be held for 50-years.

Legend:
- Large Company Stocks Total Returns
- Dimensional US Large Cap Value Index
- Dimensional US Targeted Value Index
- Dimensional US Small Cap Value Index
- Small Company Stocks Total Returns
- Long-Term Corporate Bonds Total Returns
- Long-Term Government Bonds Total Returns
- Intermediate-Term Government Bonds Total Returns
- U.S. Treasury Bills Total Returns

[2] *Animal House*, 1978

Given 7 choices of indices in the SBBI data, the optimization algorithm used six and threw out one (the long-term government bond index). Given 14 choices of indices in the SBBI + DFA optimization, the optimizer selected only six. This behavior is not unusual. Given many choices, the optimizer generally tends to be fairly selective.
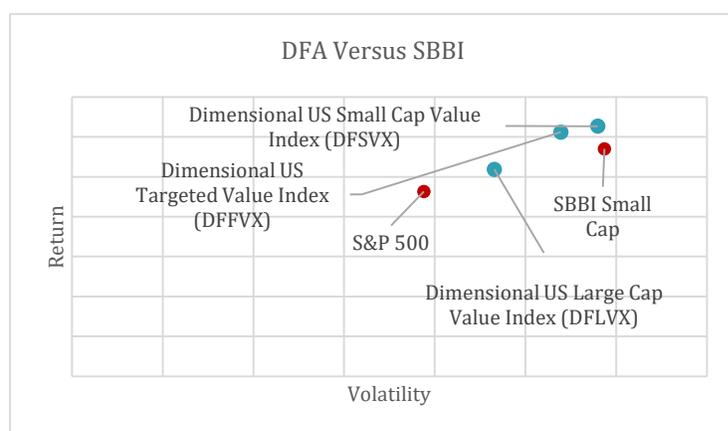
There are interesting similarities between the two. First, the bonds are shown on the top of the two charts looking a bit like the comb of a rooster. The US Treasury index is used only for very short investments, less than three years. Between three and ten years, the intermediate-term bonds are chosen. Beyond 10-13 years, the long-term bonds begin to be favored. In a sense, the optimizer is building a bond ladder. In other words, money that will be used within a short-term are put into short-term bonds, money to be used within an intermediate-term are put into intermediate-term bonds, and so on. This is a common practice within the industry.

The major bond difference between the SBBI and SBBI+DFA bond optimizations is that the long-term corporate bonds are preferred in the SBBI optimization, whereas the long-term government bonds are preferred in the DFA optimization.

The stock selection is completely different. The SBBI optimization selects a small portion of the large cap, S&P 500 fund for some short-term investments and then utilizes the small cap stocks as the bulk of the stock portion. When the DFA indices are added to the mix, the two SBBI stock indices are removed in favor of three DFA indices. The large cap value replaces the S&P 500, but it's weighting is reduced. The SBBI small cap index is replaced by the DFA US Small Cap Value and US Targeted Value indices.

STATISTICS

What advantages do the DFA indices have over SBBI's? It is sometimes difficult to decipher the optimization preferences since there are complex interactions that the optimizer weighs (e.g. correlation coefficient matrices, variance weighting, etc.), but there is one easy to spot reason. This chart below shows the historical volatility and average return of the three optimizer selected DFA stock indices as well as two rejected SBBI stock indices. Given all other variables being equal, the best index will be toward the upper left. The SBBI Small Cap index is clearly beaten by the DFA US Small Cap Value Index and the Targeted Value Index. Both DFA funds have higher returns with less volatility – they are above and to the left of the SBBI index.

DFA Versus SBBI

The S&P 500 is also rejected in favor of the DFA Large Cap Value Index, but the reason is less clear from this chart. The

DFA fund has higher returns, but it also has higher volatility. Regardless, neither optimization set considers the large cap sector to be very useful and the two large cap indices are never more than 6% of the allocation.

A 65-YEAR-OLD RETIREE PLAN PERFORMANCE

Statistics are all well and good, but it's hard to picture the advantage by simply looking at numbers. The figure at right shows the relative planned annual inflation adjusted income from two plans that provide 40 years of income from a single lump investment. Such plans might be appropriate for a 65-year-old retired couple.

The two plans are identical except one uses the SBBI indices while the other uses both SBBI and DFA indices. We can see that adding the DFA indices improves the planned income by about 5%. So, a $100,000 planned income from the SBBI indices is increased to $105,000 when the DFA indices are added to the mix.

The planned income represents a highly likely income. In this example there is an 85% probability that actual income will be above the planned income and a 15% probability that the income will be below the planned income. In a sense, it represents a lowball estimate of what the future income will be.

However, the median income projection represents a more typical income level. There is a 50% probability that the future income will be above the median projected level and a 50% probability that it will be below the median projection. The median projected level is not used in the planning process except to show a reasonably likely upside potential of the plan. One might think of the median income as the typical income levels of people who invested in such a plan at various times since 1928.
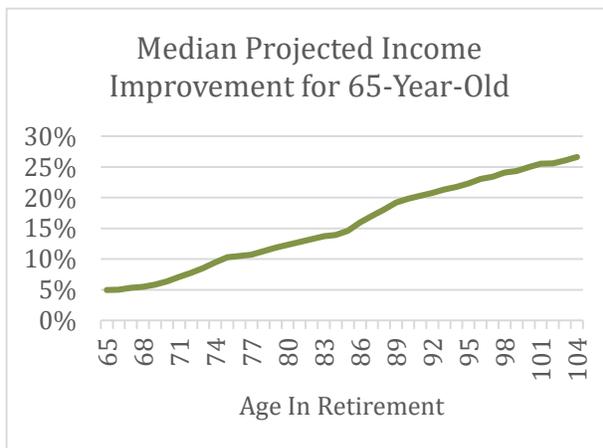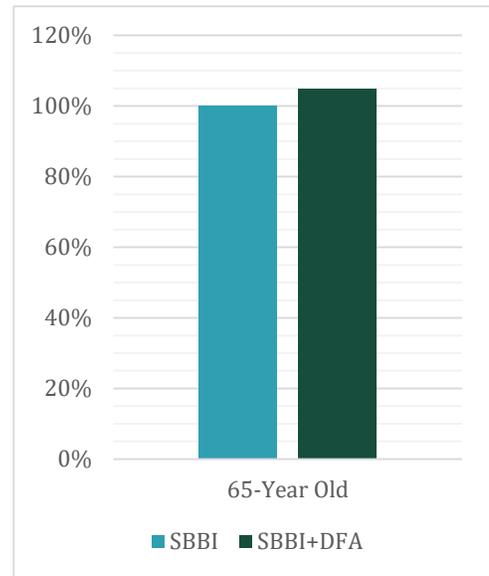
The figure on the left shows the improvement in median projected income that DFA provides. The DFA indices offer about a 5% improvement at the beginning of the retirement, but by mid-retirement, the projected median income is 14% higher. By the end of the 40 years, the projection is 27% more. This variation over time is due to the higher growth that the DFA funds have provided in the past. The longer the funds are held, the more growth opportunity.

For example, an SBBI optimized plan for such a retiree would provide $100,000 planned income for 40 years, but the median income in mid-retirement would be $209,000. Adding DFA funds, the planned income is $105,000 and the median projected income at age 84 is $238,000. This median projected income is increased by about $19,000 for that year.

This does not guarantee that the DFA indices will outperform the SBBI indices in the future. Far from it. It simply indicates that the odds appear favorable that the DFA funds will outperform over the long run. Even if DFA funds are likely to outperform, there will be future situations in which they will not outperform.

40- AND 50-YEAR-OLD RETIREE PLANS PERFORMANCES

The section above described a plan suitable for a 65-year-old couple, but the younger the investor, the better the apparent advantage of DFA. From this chart we can see that the planned annual income from a lump investment at age 40 and at age 50 will result in significantly higher planned incomes from adding DFA indices to the mix.

The 50-year-old will see the planned income improve by 13% whereas the 40-year-old will have a 20% increase in planned income. The actual results will vary, since this scenario assumes the money is *all* invested at age 40 or age 50. Many people have some money saved at age 40 or 50, but they will probably continue to save until they retire. Each year, successive contributions will get less potential improvement from the DFA indices. As stated in the previous section, by age 65 the DFA indices only provide a 5% improvement for any new money being contributed. Nonetheless, the money invested at age 40 and 50 will produce 13% and 20% higher likely income.
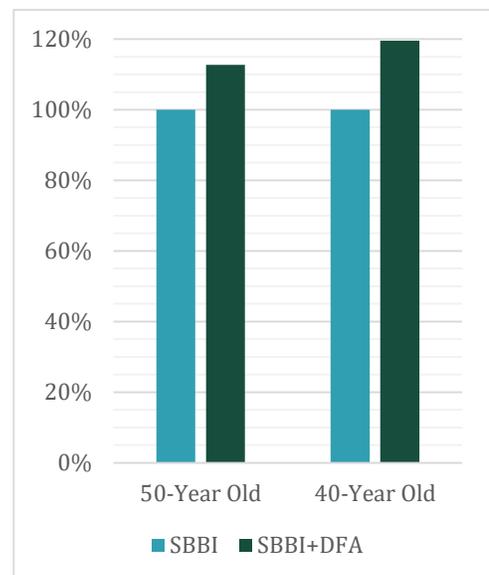
A plan for a 50-year-old that projects $100,000 per year in income using SBBI indices will increase to $113,000 when DFA is added. Similarly, for a 40-year-old, the planned income will increase to $120,000.

The chart at right shows how much the median projected income will improve throughout retirement. For 40-year-old investor planning on retiring at age 65, the median projected income is 37% higher in the first year of retirement when DFA indices are used. Later in the retirement, the median projected income approaches 60% higher. For the 50-year-old, the improvements range from 20% to a little more than 40%.

Consider the 40-year-old who has invested enough to provide a $100,000 planned income in retirement with an SBBI plan. His median projected income at age 84 is $471,000, representing a reasonable upside potential. By adding the DFA funds, his planned income is $120,000 and his median projected income at age 84 is $691,000, an increase of $220,000.

Median Projected Income Improvement

X-axis: Age In Retirement (65 to 104)
Y-axis: 0% to 60%
Legend: 40-Year-Old, 50-Year-Old
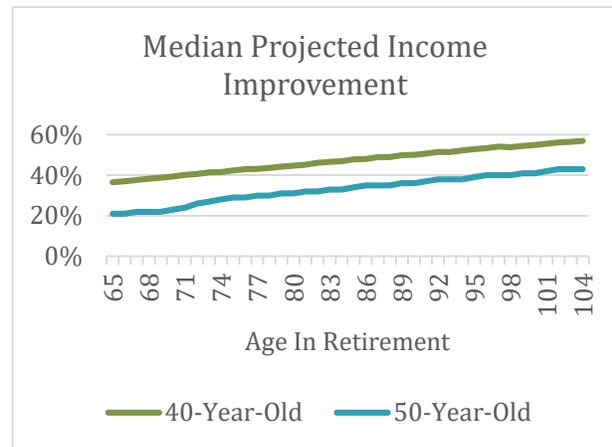
Summary

By introducing DFA indices into our mix of fund offerings, the planned income shows significant improvement. While all clients will benefit, the younger the investor, the more their potential improvement. A 40-year-old's planned income is improved 20%, while a 50-year-old's is improved 13%, as shown at right. A 65-year-old will see a 5% improvement in planned income.
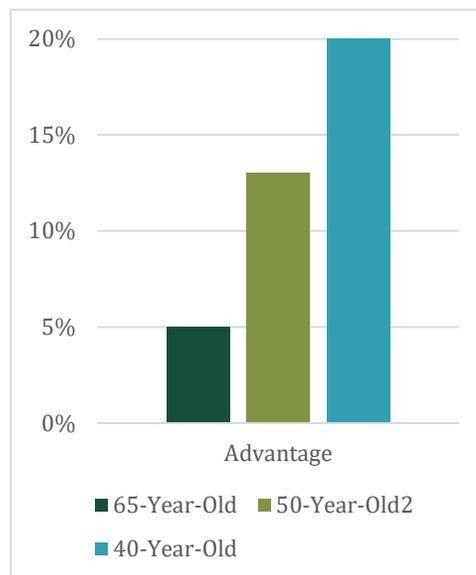
The improvement in the median projected income is even more dramatic. As shown below, for 65-year-olds, the improvement is about 14% midway into the retirement, and for the 50- and 40-year-olds, the improvement is 33% and 47%, respectively. By the end of retirement, the improvement ranges from 27% to 57%.

Clearly the DFA funds provide significant opportunities for our clients. The higher mean return with lower volatility of two of the DFA funds make them significantly better choice than the traditional small cap index. These funds lead to higher planned incomes as well as higher projected median incomes. This double benefit makes including DFA funds into our clients' portfolios an easy choice.
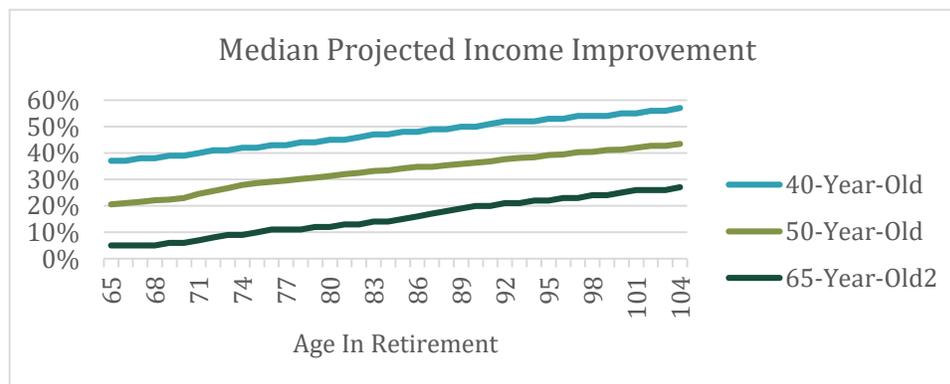
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