Dimensional Fund Advisors: A Deeper Look At The Performance
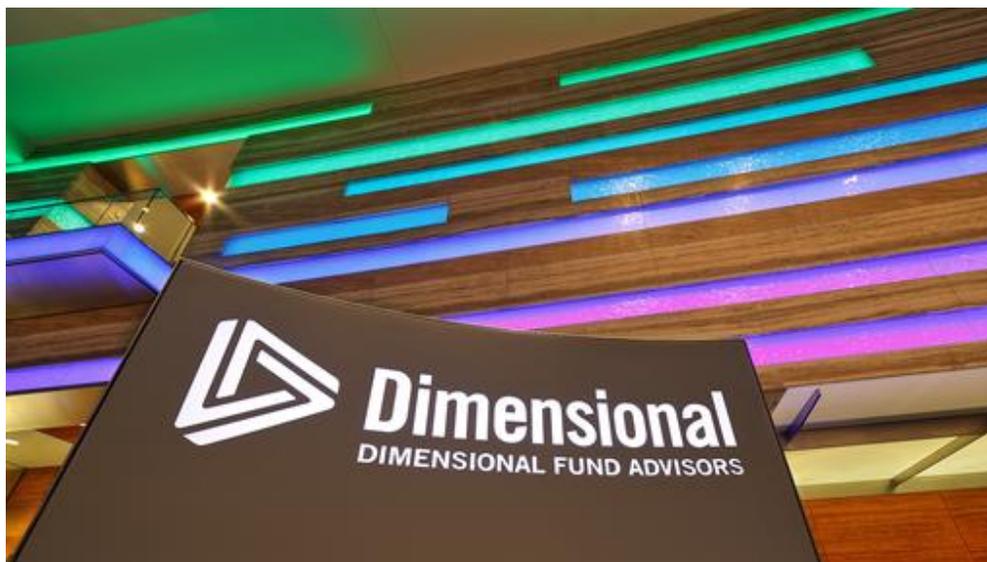
Mark Hebner and Murray Coleman

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As many of our readers know, we don't think highly of any form of active investing. In particular, we see more harm than good coming from investment products and strategies put forward by members of the actively managed funds industry.

Such fund companies specialize in trying to identify mispriced securities in relatively concentrated portfolios. These managers operate with a hope of trying to beat an underlying index. But a host of fact-based independent research by top-drawer academics -- ranging from Nobel Laureates Eugene Fama and Harry Markowitz to William Sharpe and Myron Scholes, to name just a few -- raise red flags about the wisdom of such an investment thesis.

Along with this growing body of independent third-party academic research, we've undertaken several studies of our own digging into the historical performances of active management. All of this evidence leads IFA's investment committee to a resounding conclusion: These active funds on the whole have failed to deliver on the value proposition they profess, which is to reliably outperform a risk-comparable benchmark.

As a result, our wealth advisors remain concerned that non-passive investors are being put in less-advantageous financial positions by trying their hands at active management.

Although our portfolio management and research team has analyzed some of the largest active mutual fund families in the industry, it does beg the question: "What about Dimensional Fund Advisors, the family that IFA most frequently advises its clients to own?"

This is a good topic because it allows us to educate our investors about the basic philosophical differences between the approaches taken by the actively managed firms and Dimensional Fund Advisors (DFA).

Simply put, those differences can be summarized by stating that markets work, diversification reduces risk and certain company characteristics explain returns. Here are further explanations of these ideas:

Financial markets are efficient. Current market prices fully incorporate available information and forecasts. Future prices reflect random and unexpected new information. That process is borne out as a result of millions of traders engaged in "price discovery," e.g. the natural give-and-take of negotiations as provided by the very economic structure of how free markets work. In other words, an investor's best estimate of current pricing is the best estimate of the "fair" price, expressed for investment purposes as the price agreed upon between both sides of any exchange. From this fair pricing mechanism, investors are able to expect a fair return on average (and over risk-appropriate periods of time). Also worth noting: Any range of short-term returns relative to the average is commensurate with the risk of the investment.

Risk and return are inseparable. Although there is no such thing as return without risk, not all risks are equally rewarded. Long-term historical risk and return data informs the investment selection process, and index portfolios seek to capture the historical risk factors that have appropriately compensated investors for risks taken. These include market, size, value and profitability for equity as well as term and default for fixed-income.

Diversification is essential. Diversification within and among asset classes, and over extended periods of time, reduces risk in security selection and market timing errors, allowing investors to improve the probability of capturing the returns offered by global financial markets.

Structure explains performance. The returns of diversified portfolios can be explained by the exposure to the various risk factors. Therefore, investors can design diversified portfolios that target those risk factors and avoid the high costs, errors and risks of active management that have been harmful to investor's financial success.

Advisor Advantage. There are distinct measurable benefits to enlisting the services of a passively-oriented advisor, including investor behavior modification, appropriate asset allocation, disciplined rebalancing, tax loss harvesting, asset location and glide path risk reduction over time.

Fair Prices Equal Fair Returns. In competitive capital markets, investors should expect to pay a *fair price* for securities based on their risks, expected returns and the uncertainties of those returns. The more uncertainty of achieving that expected return, the lower the price buyers should be willing to pay. The future monthly returns on a diversified portfolio approximate a [normal distribution](#) or bell curve and our best estimation of that expected return is the very long-term historical average based on those fair prices that were obtained in publicly traded markets. In essence, when you are selecting an index portfolio of a certain risk level, you are accepting a future distribution of outcomes, which on a monthly basis approximate a bell curve.

Dimensional Fund Advisors accepts this basic premise that markets are fairly pricing securities based on the risks associated with them (i.e. markets work) and therefore accept market prices and market returns. Their active counterparts believe that free markets aren't most of the time performing the basic function of setting fair prices. As a result, active managers believe they can identify securities to buy at "undervalued" prices as well as time markets in order to avoid holding "overvalued" assets. As Rex Sinquefeld [cleverly put it](#), "so who still believes market don't work? Apparently it is only the North Koreans, the Cubans and the active managers."

Dimensions of Expected Stock and Bond Returns

Is there only one type of risk investors are considering? Acutally, there are multiple dimensions of risk associated with stock and bond markets. Academics have identified multiple factors including size, value, profitability, capital investment, default and term as the driving forces behind stock and bond returns.

Think of these factors as the components of the engine in your car. Like your car's ability to perform, the driving force behind stock and bond returns are these factors that are being considered by investors and are therefore (consciously or subconsciously) being embedded into stock and bond prices.

This is extremely important to understand because it's going to explain the discrepancies that we see when examining performance of both actively managed mutual funds and even their passive counterparts. It also allows us to explain the outperformance of Dimensional's strategies against well-known index fund competitors such as Vanguard.

When comparing index funds to indexes, the analysis is more about the differences in indexes (factor exposures) rather than the existence of alpha (selecting stocks or bonds from within a benchmark). This is what makes Dimensional different -- its portfolio managers create their own Dimensional indexes that include different tilts to the dimensions of returns (such as size, value and profitability).

Then, they implement their indexes in their funds with rules that minimize market impact costs, minimize taxes in tax-managed funds, screen for social and sustainability factors and screen for float considerations and momentum.

So when we see positive (or negative) differences in real-time Dimensional fund returns, the next step is to look at the longer period index data on the factors that distinguish the index fund from the Morningstar assigned benchmark.

Once that takes place, longer-term data more frequently supports Dimensional's factor tilts, even though the shorter-term data might not show the premiums (i.e., excess returns of one factor as compared to another). This is where it becomes difficult for investors because they prefer to see the premiums on a consistent basis, where you might see 10- to 20-years where the premium wasn't available in the data.

That's why IFA's advisors warn that when comparing indexes, unfortunately, live fund data is rarely enough data to draw conclusions.
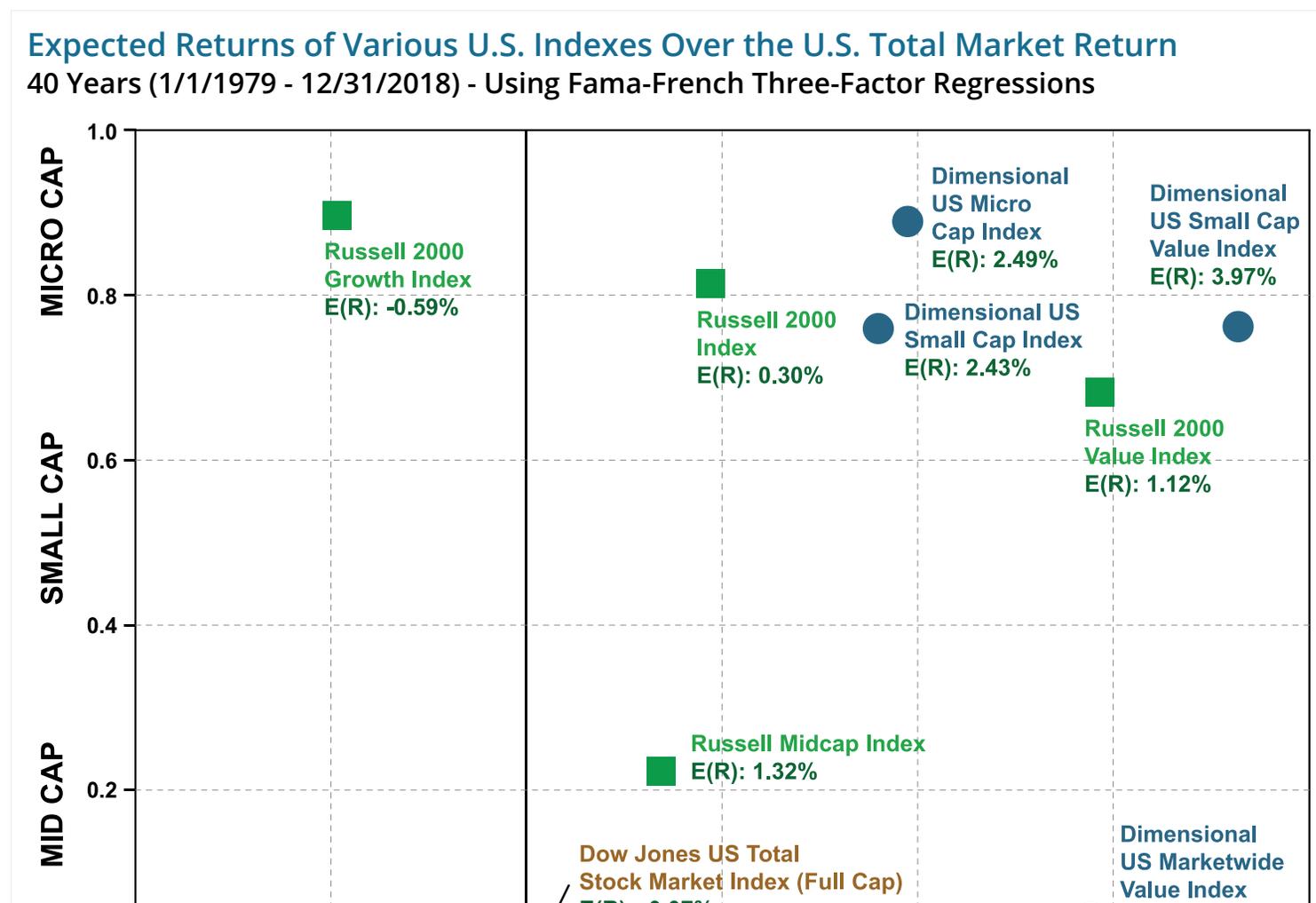
The chart below illustrates the difference among Russell Indexes and Dimensional Indexes over 40 years (1979 through 2018), which starts from the inception dates of some Russell indexes.
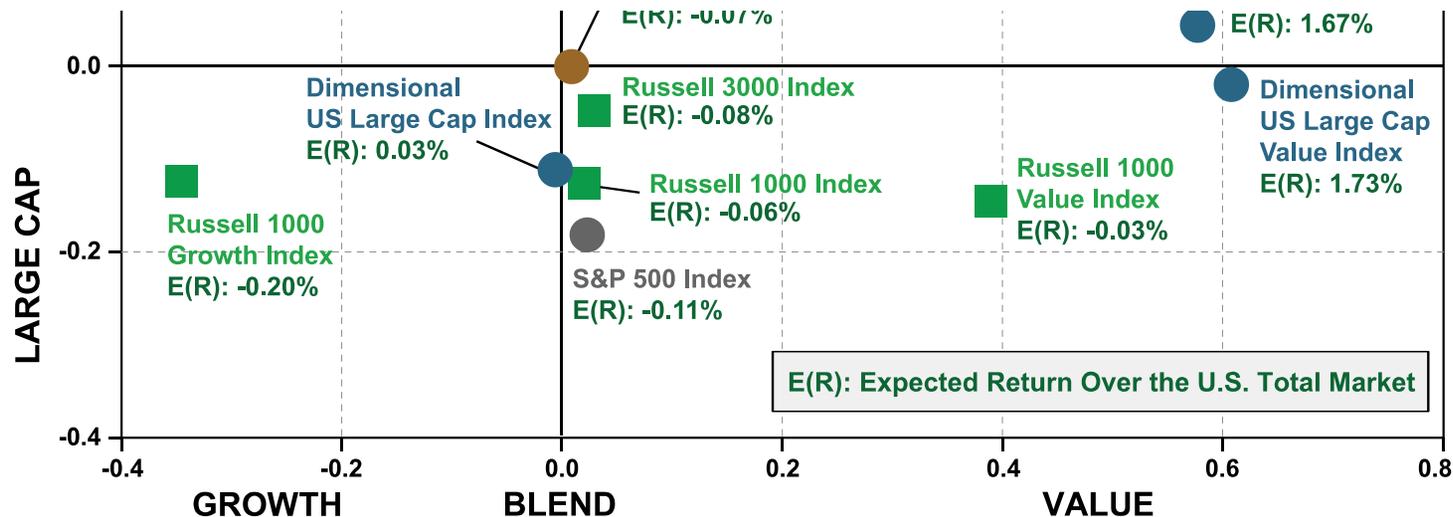
The scales on this chart are important to understand. On the y-axis you have a scale of company size, with 0 representing the average company size of a total market index fund, 1.0 representing a micro cap company and -0.4 representing a mega cap company. The x-axis scale represents a book to market ratio, which is a value quantification. On the left side are growth companies and on the right side are value companies.

For investors in stock index funds, this might be one of the most important charts to understand. It explains that when an index is tilted towards small and value, the 40-year excess expected annualized return over the total market's gain was 1.12%. Meanwhile, on the opposite end of the size/value spectrum, such a comparison showed a large growth index had a *negative* expected annualized return of -0.20%.

This type of an analysis using a popular benchmarking family is another piece of evidence giving IFA's investment committee confidence that an index with a smaller and more value tilted design is preferred to a larger and less-value tilted one. Data over an even longer period also supports that small and value tilts had higher returns in U.S. markets. But let's not stop there.

Not all indexes are the same. Digging even deeper, look at the Russell 2000 Value Index's excess expected annualized return versus the total market's return over such an extended period (1979 through 2018). This index tracks U.S. small-cap value stocks. So does the Dimensional U.S. Small Cap Value Index. But it produced 3.97% in expected excess annualized return over that of the total market as compared to the other index's 1.12%. (Note the example of how excess expected returns are calculated in the graphic below.)

Expected Returns of Various U.S. Indexes Over the U.S. Total Market Return
40 Years (1/1/1979 - 12/31/2018) - Using Fama-French Three-Factor Regressions

Russell 2000 Growth Index
E(R): -0.59%

Dimensional US Micro Cap Index
E(R): 2.49%

Dimensional US Small Cap Value Index
E(R): 3.97%

Russell 2000 Index
E(R): 0.30%

Dimensional US Small Cap Index
E(R): 2.43%

Russell 2000 Value Index
E(R): 1.12%

Russell Midcap Index
E(R): 1.32%

Dow Jones US Total Stock Market Index (Full Cap)

Dimensional US Marketwide Value Index

E(R): -0.07%

E(R): 1.67%

0.0

**Dimensional
US Large Cap Index
E(R): 0.03%**

**Russell 3000 Index
E(R): -0.08%**

**Dimensional
US Large Cap
Value Index
E(R): 1.73%**

**Russell 1000
Value Index
E(R): -0.03%**

**Russell 1000 Index
E(R): -0.06%**

LARGE CAP

**Russell 1000
Growth Index
E(R): -0.20%**

-0.2

**S&P 500 Index
E(R): -0.11%**

E(R): Expected Return Over the U.S. Total Market

-0.4

-0.4 -0.2 0.0 0.2 0.4 0.6 0.8

GROWTH   **BLEND**   **VALUE**

Risk Premium Values:	Example Asset:	Example Calculation for Dimensional US Small Cap Value Index:		
40 Years (1/1/1979-12/31/2018)	Dimensional US Small Cap Value Index	Beta * (Avg. Market Premium)	1.04 X (7.82) =	+ 8.11
		Size Loading * (Avg. Size Premium)	0.76 X (1.54) =	+ 1.17
Market minus T-Bill = 7.82	Beta = 1.04	Value Loading * (Avg. Value Premium)	0.72 X (2.98) =	+ 2.14
Size Effect = 1.54	Size Loading = 0.76	Regression Error Term		+ 0.37
Value Effect = 2.98	Value Loading = 0.72	Minus Market Premium		- 7.82
		Excess Expected Return over the Total Market Return = 3.97		

Based on our review of long-term data, there has been an excess return for exposure to these risk factors. These are referred to as: the U.S. Equity Premium (Risk of the Total Market Minus Risk Free 30 day T-Bill); the U.S. Value Premium (High Book to Market Minus Low Book to Market); and the U.S. Size Premium (Small Companies Minus Big Companies).

An important consideration for investors is the likelihood that these risk "premiums" are actually zero (i.e., there is no premium) despite a historical mean that is positive. The starting point is calculating a t-stat for each premium return series as outlined in the bar charts and data below. The blue bars indicate a positive excess return for the factor premium and the red bars indicate a negative factor premium. The t-stats, as shown in the bottom section of the chart, are all considered statistically significant (i.e., greater than 2), and we can almost be 99% sure that all three risk premiums are positive, with only the size premium (Small Cap minus Large Cap) t-stat being marginally lower than the required 2.6 for a 99% level of significance.

The Return Differences of Total US Market minus 30-day T-Bill
91 Years (1/1/1928 - 12/31/2018)

Total US Market had a positive difference in 62 out of 91 years (68.1%)
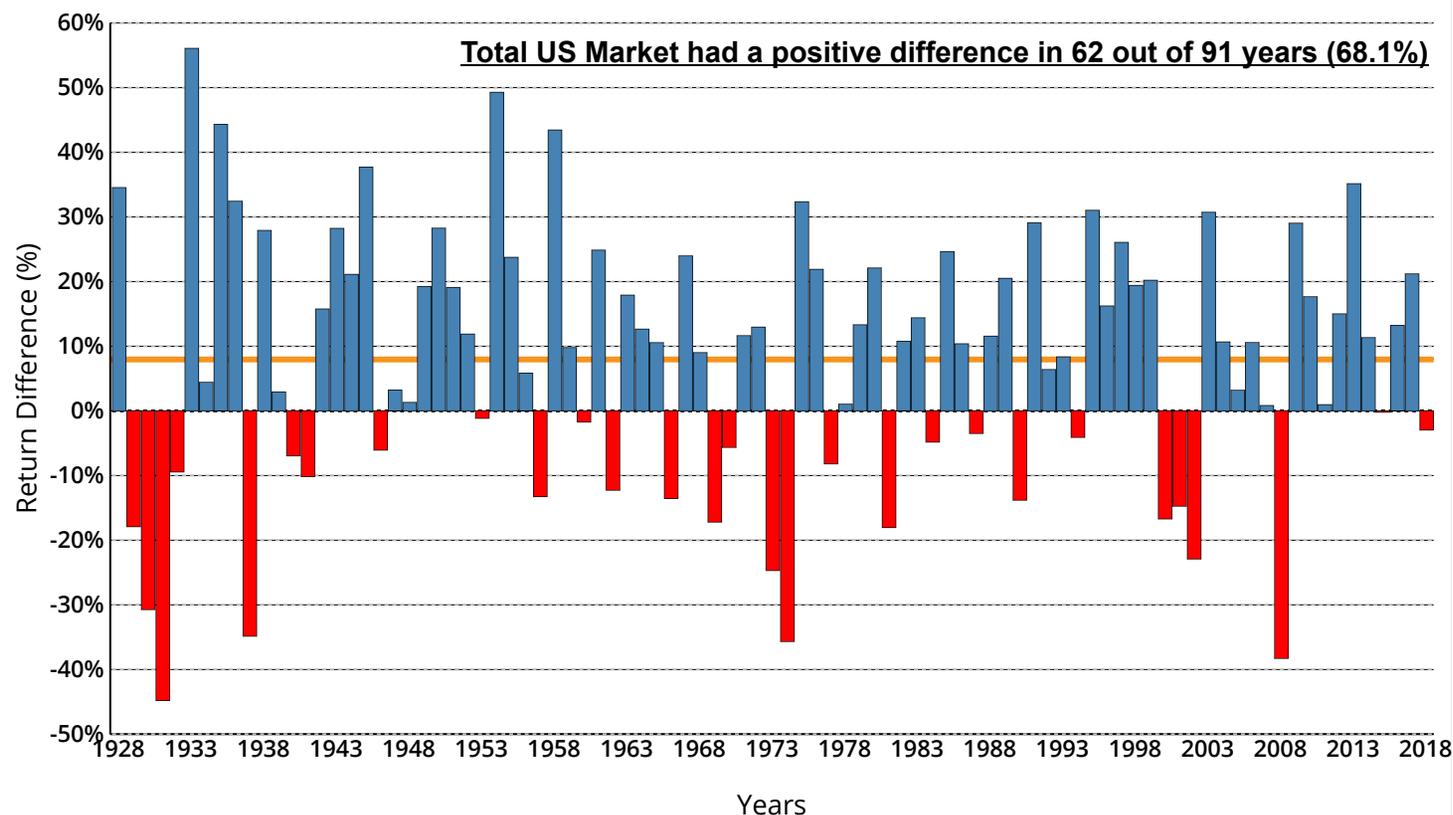
Minimum Track Record to	— Average Difference: 8.24%	t-Statistic: 3.91
Indicate Difference (t-stat > 2): 24 Yrs	Standard Deviation of Alpha: 20.11	(a t-stat of >2 = 95% confidence of difference)

Source: DFA Returns 2.0 Fama and French Data. Past performance does not guarantee future results. Performance figures may contain both live and HYPOTHETICAL back-tested data. All data, including performance data, is provided for illustrative purposes only, it does not represent actual performance of any client portfolio or account and it should not be interpreted as an indication of

such performance. IFA utilizes "standard deviation" as a quantification of risk, see the definition in the IFA glossary. The t-statistic is define in the glossary. © 2020 Index Fund Advisors, Inc. (IFA.com)

The Return Differences of US Small Cap Stocks minus US Large Cap Stocks
### 91 Years (1/1/1928 - 12/31/2018)

US Small Cap Stocks had a positive difference in 47 out of 91 years (51.6%)

Minimum Track Record to	—— Average Difference: 4.05%	t-Statistic: 2.45
Indicate Difference (t-stat > 2): 61 Yrs	Standard Deviation of Alpha: 15.8	(a t-stat of >2 = 95% confidence of difference)

Past performance does not guarantee future results. Performance figures may contain both live and HYPOTHETICAL back-tested data. All data, including performance data, is provided for illustrative purposes only, it does not represent actual performance of any client portfolio or account and it should not be interpreted as an indication of such performance. IFA utilizes "standard deviation" as a quantification of risk, see the definition in the IFA glossary. The t-statistic is defined in the glossary. Source: DFA Returns 2.0 © 2020 Index Fund Advisors, Inc. (IFA.com)

The Return Differences of US Small Value Index minus US Large Growth Index

91 Years (1/1/1928 - 12/31/2018)

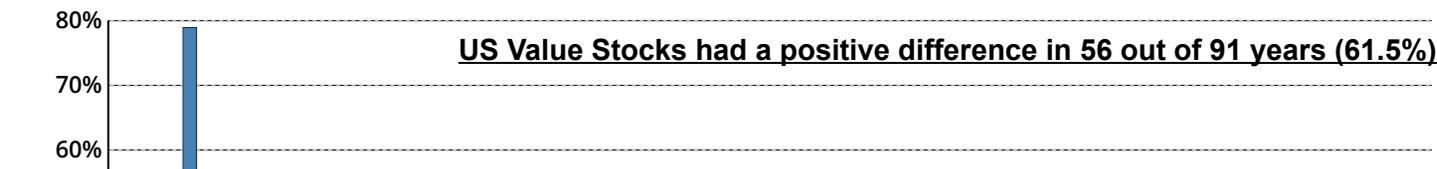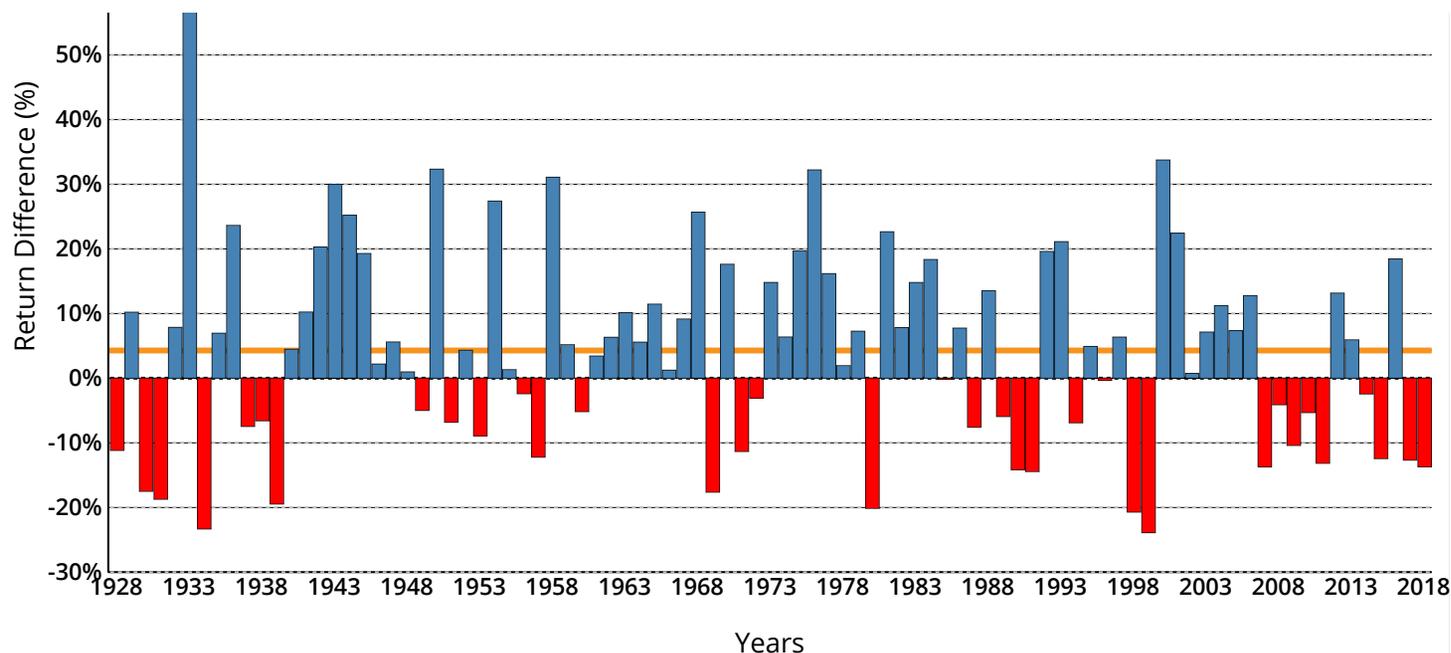**US Small Value Index had a positive difference in 51 out of 91 years (56.0%)**
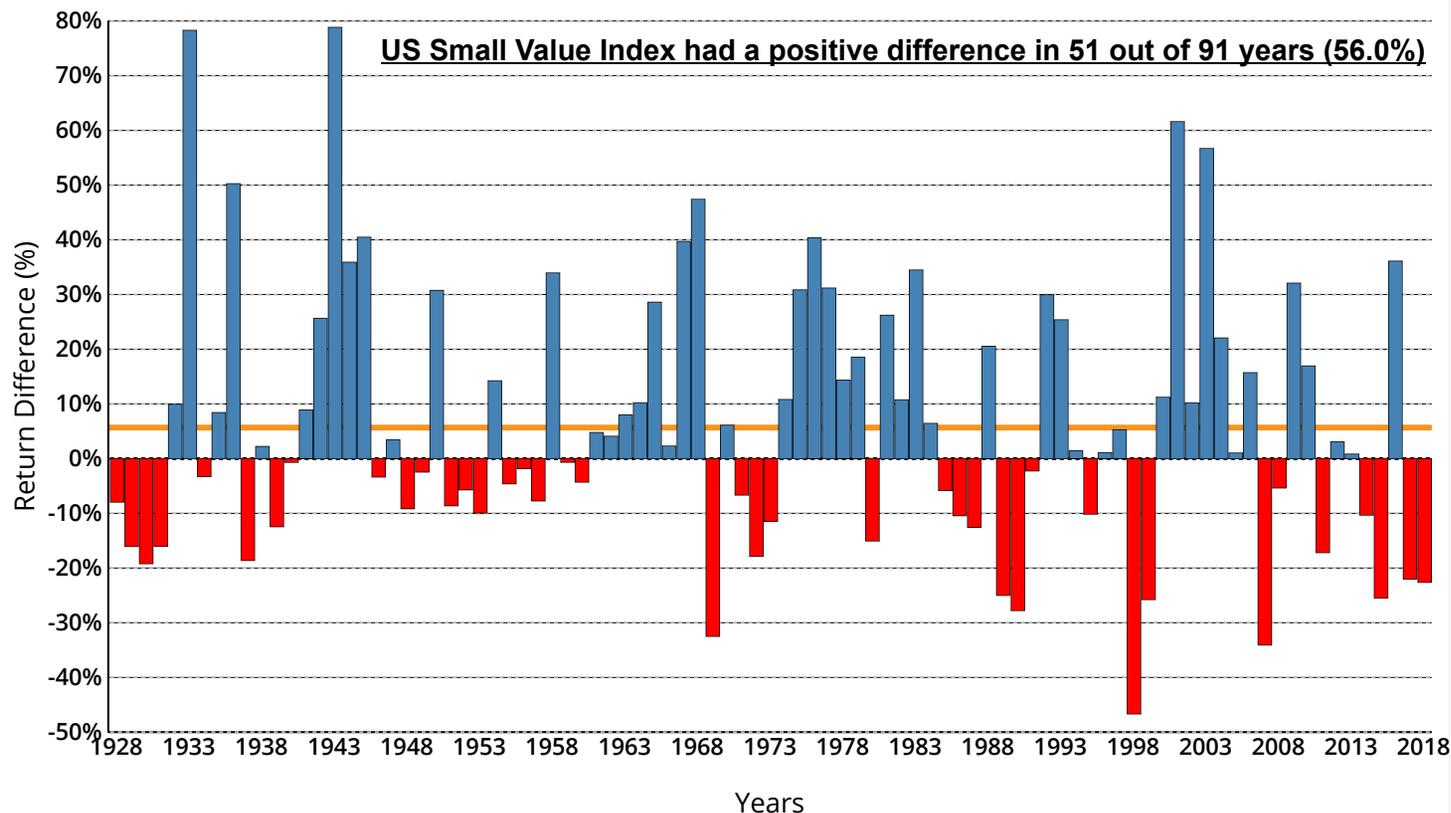
Minimum Track Record to Indicate Difference (t-stat > 2): 52 Yrs	Average Difference: 6.68%	t-Statistic: 2.65
	Standard Deviation of Alpha: 24.1	(a t-stat of >2 = 95% confidence of difference)

Past performance does not guarantee future results. Performance figures may contain both live and HYPOTHETICAL back-tested data. All data, including performance data, is provided for illustrative purposes only, it does not represent actual performance of any client portfolio or account and it should not be interpreted as an indication of such performance. IFA utilizes "standard deviation" as a quantification of risk, see the definition in the IFA glossary. The t-statistic is defined in the glossary. Source: DFA Returns 2.0 © 2020 Index Fund Advisors, Inc. (IFA.com)

The Return Difference of US Value Stocks minus US Growth Stocks
91 Years (1/1/1928 - 12/31/2018)

US Value Stocks had a positive difference in 56 out of 91 years (61.5%)

Minimum Track Record to	──── Average Difference: 4.7%	t-Statistic: 2.74
Indicate Difference (t-stat > 2): 48 Yrs	Standard Deviation of Alpha: 16.36	(a t-stat of >2 = 95% confidence of difference)

Past performance does not guarantee future results. Performance figures may contain both live and HYPOTHETICAL back-tested data. All data, including performance data, is provided for illustrative purposes only, it does not represent actual performance of any client portfolio or account and it should not be interpreted as an indication of such performance. IFA utilizes "standard deviation" as a quantification of risk, see the definition in the IFA glossary. The t-statistic is defined in the glossary. Source: DFA Returns 2.0 © 2020 Index Fund Advisors, Inc. (IFA.com)

Fees & Expenses

Let's get into the actual data. We examined funds offered by Dimensional Fund Advisors that Index Fund Advisors recommends to its clients. There are many other funds from Dimensional that are either duplications of existing asset classes or funds that IFA does not think will add incremental value to a globally diversified portfolio.

The costs we examine include expense ratios, front end (A), deferred (B) and level (C) loads, and 12b-1 fees (there are no loads or 12b-1 fees in Dimensional's funds). These are considered the "hard" costs that investors incur. Prospectuses, however, do not reflect the trading costs associated with mutual funds. Commissions and market impact costs are real costs associated with implementing a particular investment strategy and can vary depending on the frequency and size of the trades taken by portfolio managers.

We can estimate the costs associated with an investment strategy by looking at its annual turnover ratio. For example, a turnover ratio of 100% means that the portfolio manager turns over the entire portfolio in one year. This is considered an active approach and investors holding these funds in taxable accounts will likely incur a higher exposure to tax liabilities such as short and long term capital gains distributions than those incurred by passively managed funds.

The table below details the hard costs, as well as the turnover ratios, for 28 mutual funds offered by Dimensional Fund Advisors that IFA utilizes in their IFA Index Portfolios. You can search this page for a symbol or name by using Control F in Windows or Command F on a Mac. Then click the link to see the Alpha Chart. Also remember that this is what is considered an in-sample test, the next level of analysis is to do an out-of-sample test.

Name	Ticker	Turnover Ratio %	Prospectus Net Expense Ratio	Asset Category
DFA International Social Cor Eq Instl	DSCLX	8	0.33	International Equity
DFA Global Real Estate Securities Port	DFGEX	3	0.24	Real Estate Equity
DFA Intl Sustainability Core 1	DFSPX	8	0.37	International Equity
DFA US Sustainability Core 1	DFSIX	4	0.25	U.S. Equity
DFA US Social Core Equity 2 Portfolio	DFUEX	9	0.28	U.S. Equity
DFA CA Short-Term Municipal Bond I	DFCMX	39	0.22	Muni Fixed Income
DFA Emerging Markets Social Core Port	DFESX	11	0.53	International Equity
DFA International Core Equity I	DFIEX	4	0.3	International Equity
DFA US Core Equity 2 I	DFQTX	5	0.22	U.S. Equity
DFA Emerging Markets Core Equity I	DFCEX	4	0.52	U.S. Equity
DFA Tax-Managed US Eq	DTMEX	8	0.22	U.S. Equity
DFA US Targeted Value I	DFFVX	23	0.37	U.S. Equity
DFA Tax-Managed International Value	DTMIX	21	0.53	International Equity

DFA Tax-Managed US Small Cap	DFTSX	11	0.47	U.S. Equity
DFA Tax-Managed US Marketwide Value	DTMMX	7	0.37	U.S. Equity
DFA Tax-Managed US Targeted Value	DTMVX	14	0.44	U.S. Equity
DFA Emerging Markets Value I	DFEVX	21.16	0.54	International Equity
DFA Emerging Markets Small Cap I	DEMSX	15	0.7	International Equity
DFA International Small Company I	DFISX	22	0.53	International Equity
DFA Two-Year Global Fixed-Income I	DFGFX	81	0.17	Global Fixed Income
DFA International Small Cap Value I	DISVX	23	0.68	International Equity
DFA Emerging Markets I	DFEMX	8	0.47	International Equity
DFA International Value I	DFIVX	17	0.43	International Equity
DFA US Large Cap Value I	DFLVX	15	0.27	U.S. Equity
DFA US Small Cap I	DFSTX	13	0.37	U.S. Equity
DFA Five-Year Global Fixed-Income I	DFGBX	67	0.27	Global Fixed Income
DFA Short-Term Government I	DFFGX	34	0.19	U.S. Fixed Income
DFA One-Year Fixed-Income I	DFIHX	68	0.17	U.S. Fixed Income

Consider the investment objectives, risks, and charges and expenses of the Dimensional funds carefully before investing. For this and other information about the Dimensional funds, please read the prospectus carefully before investing. Prospectuses are available at us.dimensional.com

On average, an investor who utilized an equity strategy from Dimensional experienced a 0.41% expense ratio. Similarly, an investor who utilized a bond strategy from Dimensional experienced a 0.20% expense ratio. The average turnover ratios for equity and bond strategies from Dimensional were 11.92% and 57.80%, respectively. This implies an average holding period of about 20.76 months for bond funds and 8.39 years for equity funds. (The higher turnover associated with Dimensional's bond funds is due to the majority of them being short-term in nature with variable-terms and associated credit strategies employed.)

Factor Gap

Remember those driving factors of stock and bond returns that we mentioned above? Discrepancies between passively managed fund returns and a benchmark can be attributed to differences in "factor exposures." As a result, we have identified these discrepancies in the charts below as Factor Gaps.

We have included below Alpha charts for 28 Dimensional funds that are utilized in various implementations of IFA Index Portfolios. (See below after this report's conclusion.)

Dimensional's equity funds are smaller and more value oriented, so underperformance relative to their benchmark is due to these factor premiums not being positive for the time period examined. The size, value, or profitability premiums are not positive for all time periods. This is because there is risk associated with these premiums. If they were always positive, the price would reflect that and then there wouldn't be any risk and the premiums would become zero.

Dimensional's fixed income funds were created to complement DFA's equity funds. When looking at the Factor Gap (i.e., Alpha) between DFA's fixed income funds and their Morningstar-assigned benchmarks, underperformance can be attributed to Dimensional's bond portfolios tending to hold higher credit-quality and lower duration bonds than their assigned benchmarks.

Not All Index Funds Are Created Equal

When investors finally embrace a passive approach to investing they often falsely believe that all passive investing is the same and that the lowest fee will result in the highest return.

Dimensional's ability to better target the driving forces behind stock returns allows them to have outperformed other index funds. This can also be displayed in a comparison of Dimensional's performance against a similar fund offered by Vanguard. The chart below shows you historical performance of Dimensional versus Vanguard. The time period is limited by the inception dates of the funds.

Vanguard vs Dimensional Fund Advisors - Select Mutual Fund Comparisons
21 Years and 5 Months (1/1/1999 - 5/31/2020)

	Small Value	Small Value	Small Cap	Small Cap	Large Value	Large Value	Large Blend	Large Blend	Small Value	Small Cap	Large Value	Large Value	Small Cap	Large Value	Large Blend	Large Blend
Expense Ratio	0.51%	0.07%	0.35%	0.05%	0.26%	0.05%	0.08%	0.04%	0.64%	0.52%	0.39%	0.37%	0.67%	0.51%	0.43%	0.14%
Book to Market	1.22	0.78	0.68	0.54	0.72	0.52	0.33	0.33	1.82	0.99	1.43	0.91	1.15	1.59	0.73	0.63
Wtd Avg Mkt Cap	$1.55B	$3.05B	$1.78B	$3.80B	$54.7B	$81.0B	$126.B	$126.B	$0.90B	$1.28B	$19.8B	$32.3B	$0.66B	$8.84B	$22.3B	$22.7B
Standard Deviation	21.4%	19.1%	20.5%	19.8%	18.1%	15.3%	15.0%	15.0%	18.2%	17.3%	18.9%	17.4%	22.6%	24.0%	21.2%	22.1%
#of Holdings	993	853	2,067	1,346	339	338	508	516	2,042	4,330	576	158	4,153	2,465	1,243	4,180

Wtd Avg Mkt Cap = Weighted Average Market Capitalization ($ Billion). *Data in DFA US Large Company includes DFLCX (closed fund) from 1/99-9/99 and DFUSX from 10/99-Present. **DISVX, DFISX, DEMSX and DFEVX are in this comparison to show the diversification available from DFA into small and value in International and Emerging Markets. There are no comparable passively managed Vanguard mutual funds for these asset classes. All Vanguard funds are Admiral Share Class (lowest fee share class), except the International Value Fund (VTRIX), which is an Investor Share Class (higher fee) and is actively managed by 3 firms. This chart starts in 1999 because it is the first full year of data for VSIAX-5/98, DFEVX-4/98, and DEMSX which was launch in 3/98. VFIAX inception on 11/13/2000, alternative share class used for prior period. VSMAX inception on 11/13/2000, alternative share class used for prior period. VSIAX inception 09/27/2011, alternative share class used for prior period . VEMAX inception 06/23/2006, alternative share class used for prior period. Past performance does not guarantee future results. Performance figures may contain both live and HYPOTHETICAL back-tested data. All data, including performance data, is provided for illustrative purposes only, it does not represent actual performance of any client portfolio or account and it should not be interpreted as an indication of such performance. IFA utilizes "standard deviation" as a quantification of risk, see the definition in the IFA glossary. Fund returns are shown net of mutual fund fees and include the reinvestment of dividends and capital gains. However, the performance data does not include the deduction of IFA's advisory fees, transaction costs, taxes or any other expenses, which would reduce returns by those amounts. Dimensional Fund Advisors' (DFA) funds generally have had greater exposure to small cap stocks and value stocks (higher book to market ratios) than similar mutual funds. Over long periods, small cap and value indexes have had higher returns than large and growth companies and that may be an explanation for the higher risks and returns of the DFA funds. © 2020 Index Fund Advisors, Inc. (IFA.com)

As you can see, in almost every asset class Dimensional has outperformed Vanguard, even with higher expense ratios. Why?

In the table attached to the above bar chart ("Vanguard vs Dimensional Fund Advisors - Select Mutual Fund Comparisons"), there are five different categories that include: Book-to-Market (a value metric); Weighted Average; Market Capitalization and Standard Deviation.

The higher the Book-to-Market ratio, the more the fund is exposed to the value factor. Weighted Average Market Capitalization is a measure of exposure to the size factor. The smaller this number, the greater the exposure to the size factor (small and micro cap stocks).

You can see that Dimensional consistently had a higher Book-to-Market Ratio and a smaller Weighted Average Market Capitalization. In other words, they have been better at targeting the known dimensions of expected stock returns. This has led to their outperformance against Vanguard while still maintaining robust diversification (# of holdings).

Conclusion

When investors ask us about Dimensional's "alpha," it presents a great opportunity to educate investors on the fact that Dimensional doesn't try to generate an "alpha" in the traditional sense of security selection. This is in contrast to the entire active investment community, which is seeking alpha by selecting the "best stocks or bonds."

In our analyses of actively managed mutual fund firms, we find that virtually all active funds, (when considering statistical significance of the alphas), have not been able to reliably deliver alpha and have falsely attributed their positive alphas as a repeatable skill, as opposed to chance outcomes. In our opinion, Dimensional shows us a keen sensitivity to this lack or absence of alpha, as well as a heightened understanding of important strides being made in academic research on risk factors. Together, these attributes provide our investors with return patterns that are different over time than we've been able to find elsewhere.

This, among many other reasons, is why Index Fund Advisors advises clients to invest in Dimensional funds.

# DFA Emerging Markets Small Cap's (DEMSX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): 18 Yrs	Average Alpha: 3.47%	t-Statistic: 1.99
	Standard Deviation of Alpha: 7.40%	(a t-stat of >2 = 97.5% confidence of skill)

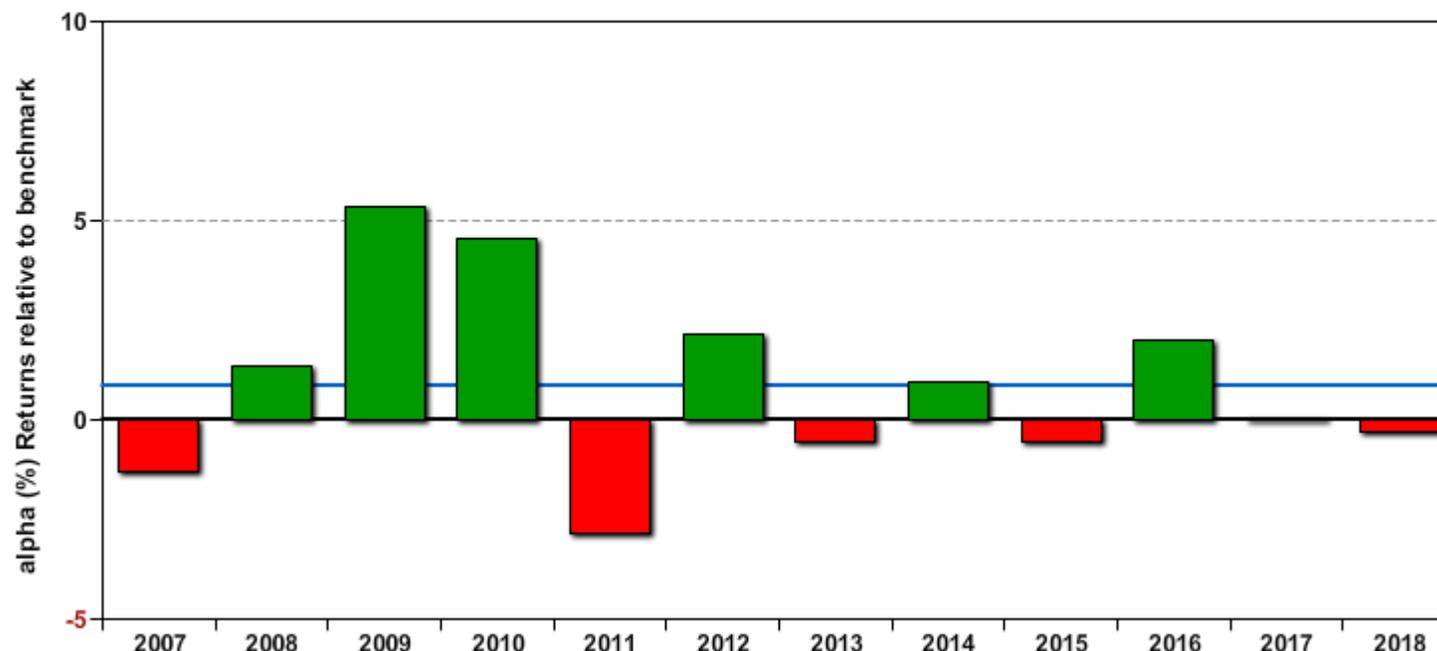**FUND: DFA Emerging Markets Small Cap (DEMSX) | BENCHMARK: MSCI EM NR USD**
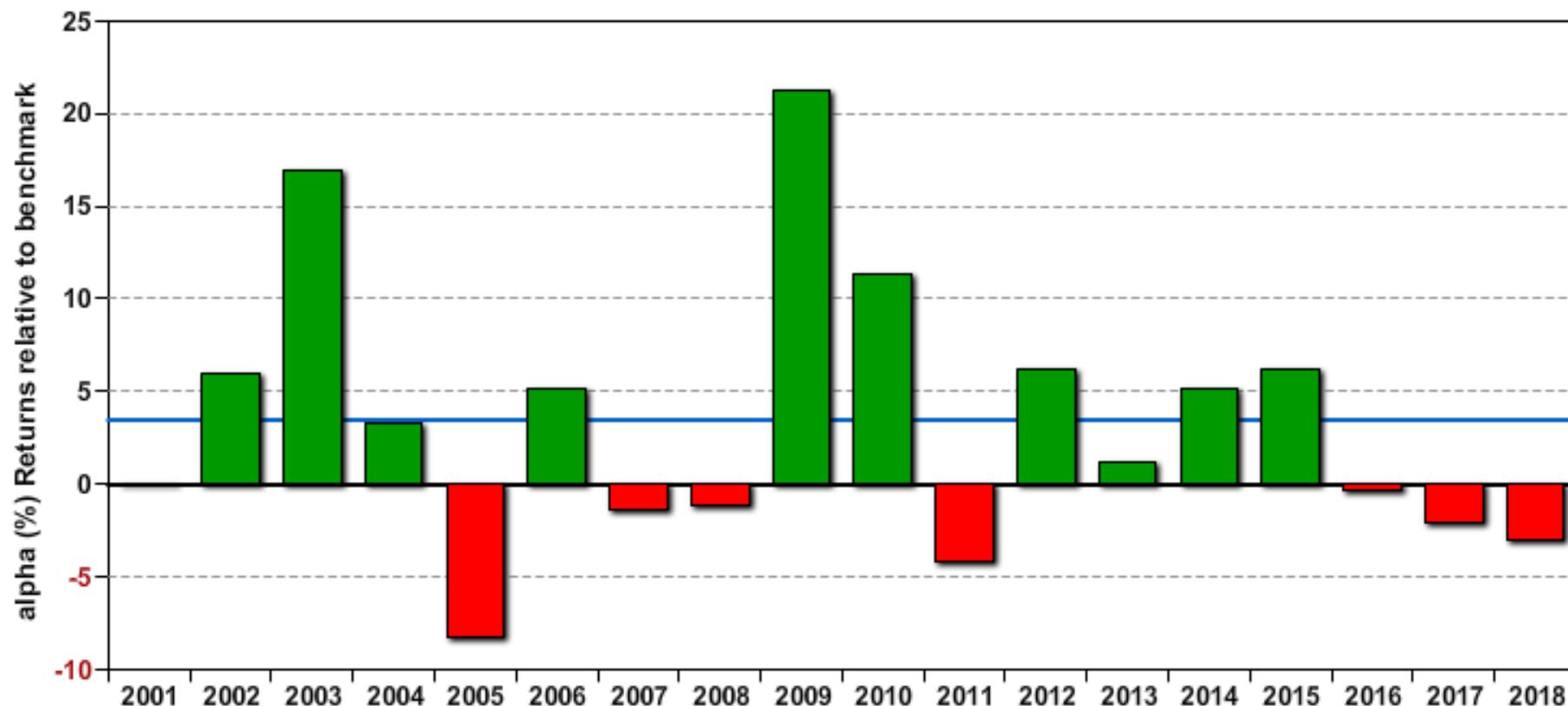
DFA Emerging Markets Core Equity's (DFCEX) Alpha Relative to Its Benchmark
13 Years (1/1/2006 - 12/31/2018)

| Minimum Track Record to | —— Average Alpha: | 0.80% | t-Statistic: | 1.24 |
| Indicate Skill (t-stat > 2): **34 Yrs** | Standard Deviation of Alpha: | **2.35%** | (a t-stat of >2 = 97.5% confidence of skill) | |

FUND: DFA Emerging Markets Core Equity (DFCEX) | BENCHMARK: MSCI EM NR USD
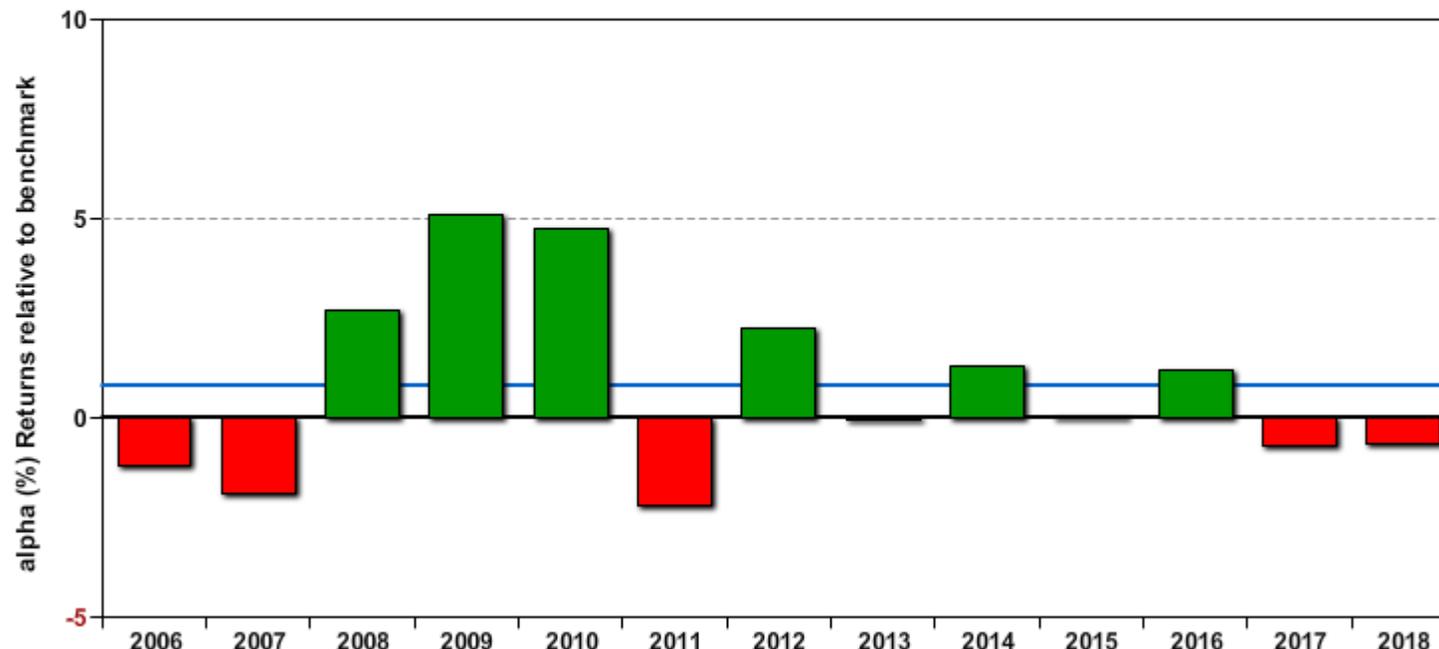
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DFA California Short-Term Municipal Bond I's (DFCMX) Alpha Relative to Its
11 Years (1/1/2008 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	── Average Alpha: **-0.81%** Standard Deviation of Alpha: **0.71%**	t-Statistic: **-3.74** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA California Short-Term Municipal Bond I (DFCMX) | BENCHMARK: BBgBarc Municipal 3 Yr 2-4 TR USD
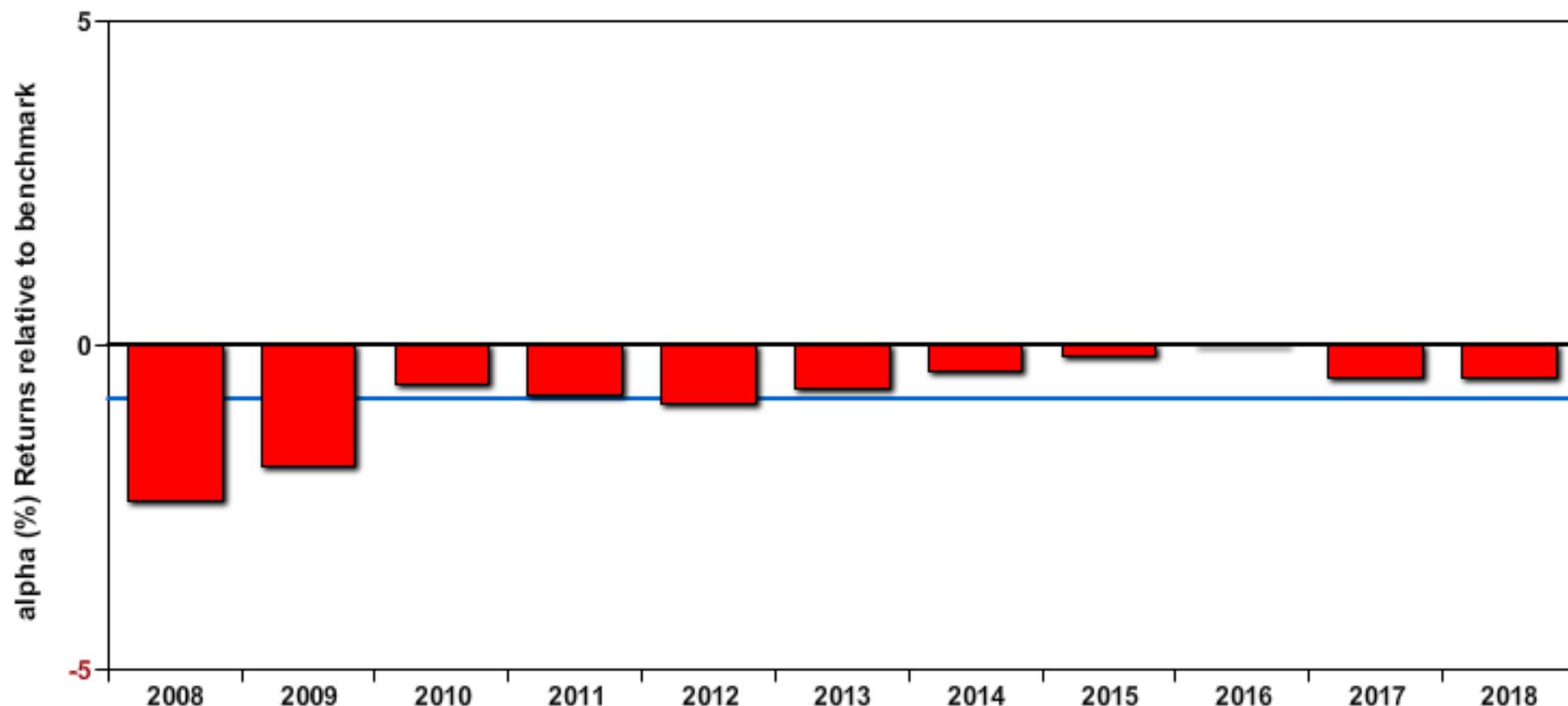
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DFA Emerging Markets's (DFEMX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	— Average Alpha: **-0.37%** Standard Deviation of Alpha: **3.23%**	t-Statistic: **-0.49** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Emerging Markets (DFEMX) | BENCHMARK: MSCI EM NR USD
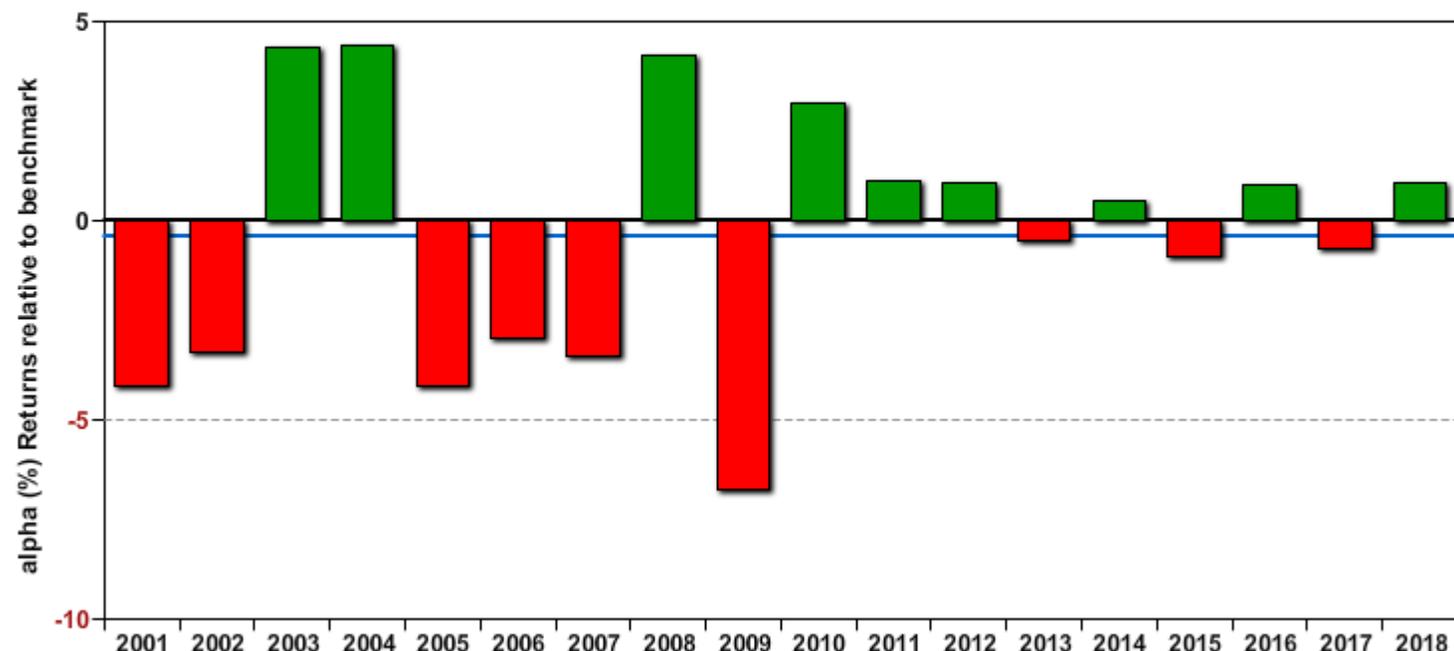
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DFA Emerging Markets Social Core Equity's (DFESX) Alpha Relative to Its

12 Years (1/1/2007 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **28 Yrs**	— Average Alpha: **0.89%** Standard Deviation of Alpha: **2.36%**	t-Statistic: **1.31** (a t-stat of >2 = 97.5% confidence of skill)	

FUND: DFA Emerging Markets Social Core Equity (DFESX) | BENCHMARK: MSCI EM NR USD

DFA Emerging Markets Value's (DFEVX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **19 Yrs**	— Average Alpha: **3.34%**	t-Statistic: **1.96**
	Standard Deviation of Alpha: **7.21%**	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Emerging Markets Value (DFEVX) | BENCHMARK: MSCI EM NR USD
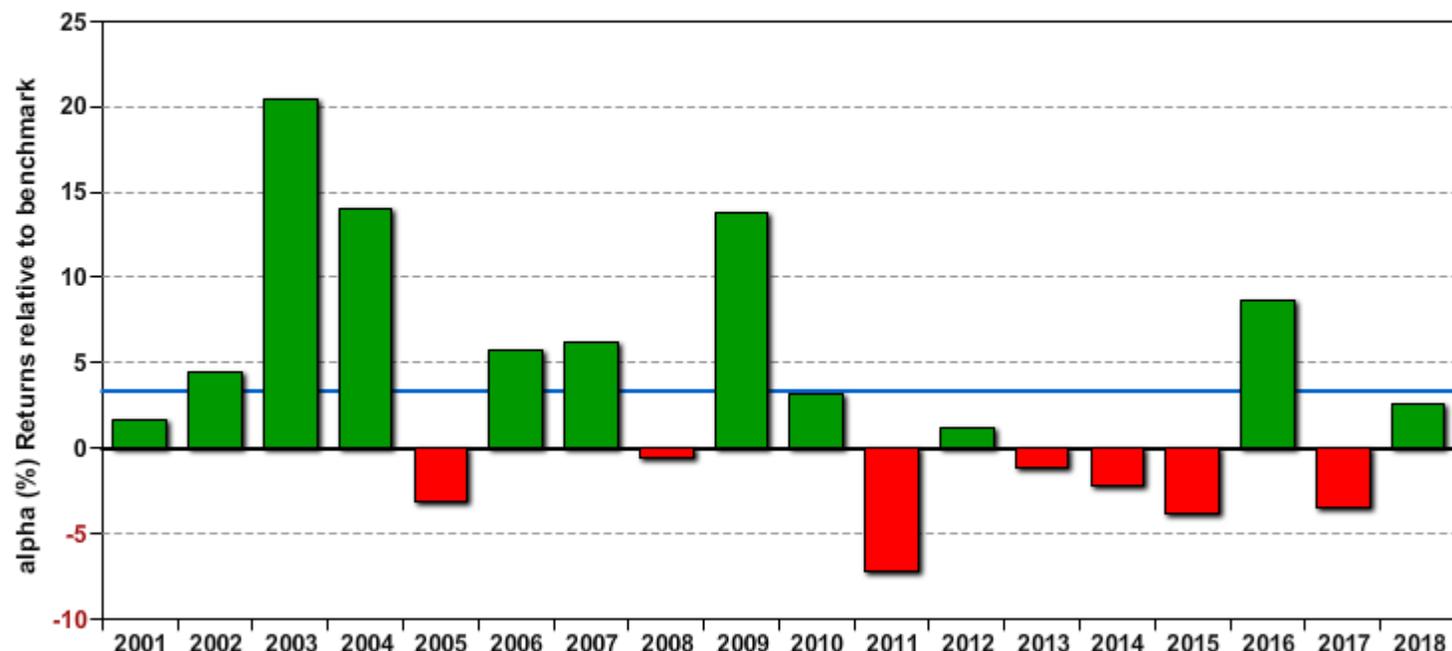
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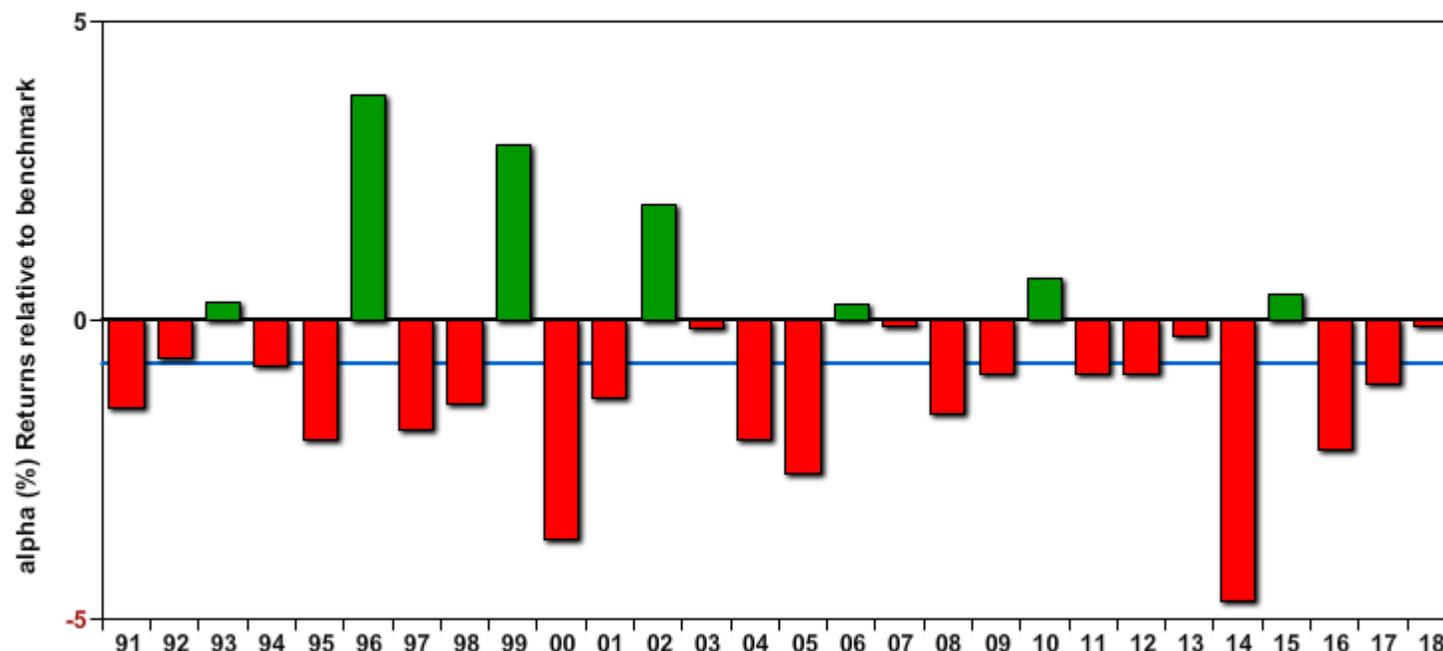
DFA Short Term Government's (DFFGX) Alpha Relative to Its Benchmark
31 Years (1/1/1988 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **98 Yrs**	── Average Alpha: **0.37%** Standard Deviation of Alpha: **1.81%**	t-Statistic: **1.12** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Short Term Government (DFFGX) | BENCHMARK: BBgBarc US Govt 1-3 Yr TR USD
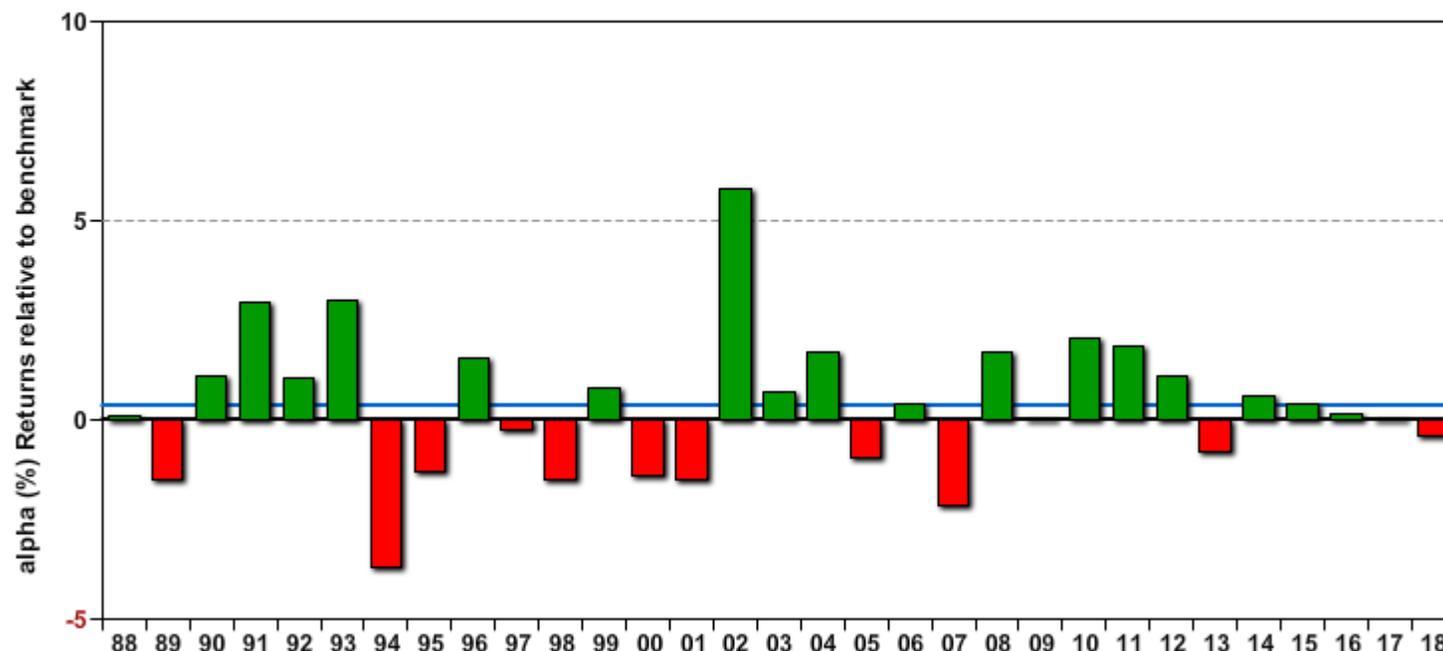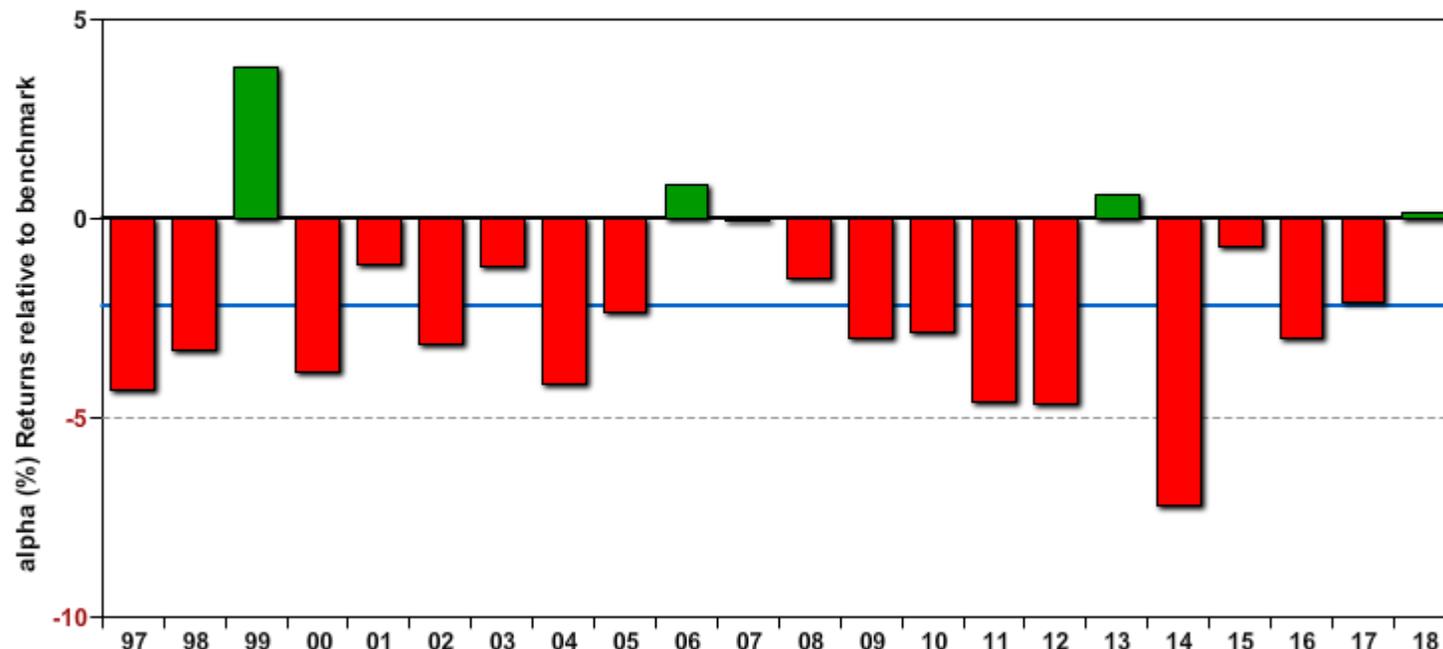

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DFA US Targeted Value's (DFFVX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **25 Yrs**	── Average Alpha: **1.82%** t-Statistic: **1.69**
	Standard Deviation of Alpha: **4.56%** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Targeted Value (DFFVX) | BENCHMARK: Russell 2000 Value TR USD
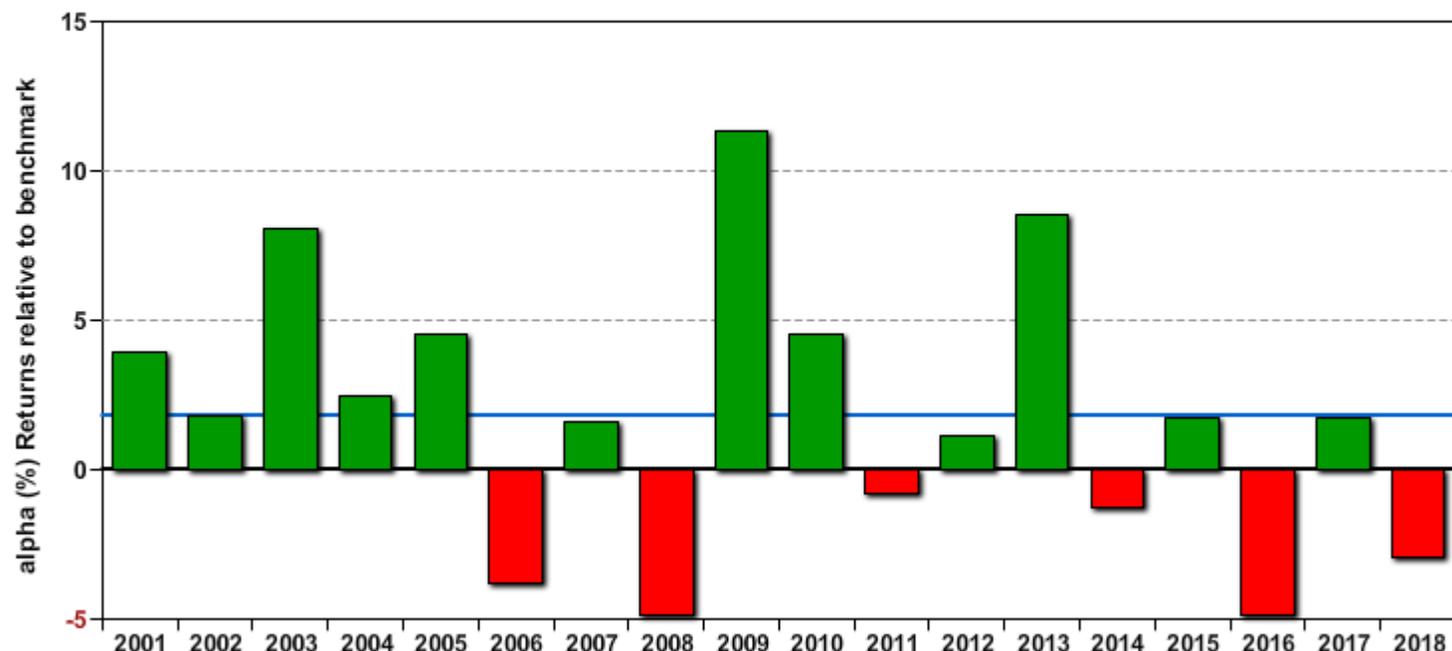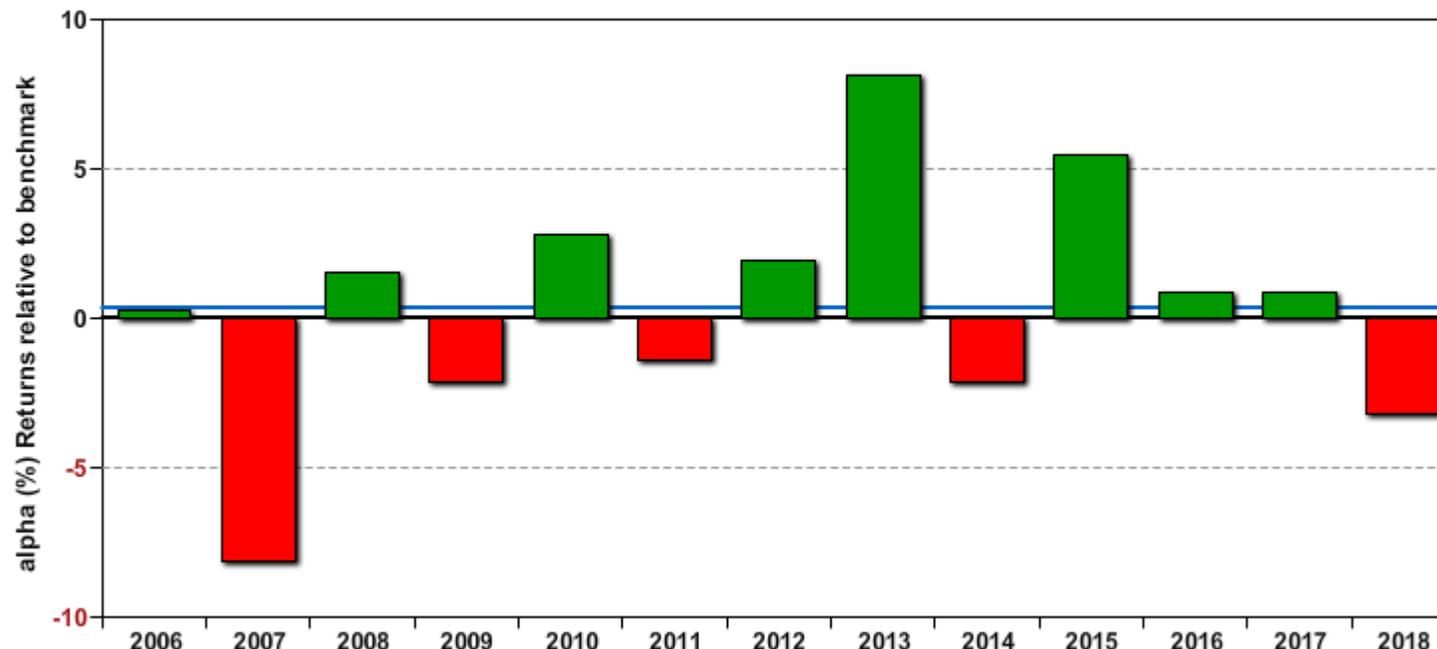

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DFA Five-Year Global Fixed Income's (DFGBX) Alpha Relative to Its Benchmark
28 Years (1/1/1991 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	── Average Alpha: **-0.72%** t-Statistic: **-2.17**
	Standard Deviation of Alpha: **1.76%** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Five-Year Global Fixed Income (DFGBX) | BENCHMARK: BBgBarc Global Aggregate TR Hdg USD

DFA Global Real Estate Securities's (DFGEX) Alpha Relative to Its Benchmark
10 Years (1/1/2009 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	—— Average Alpha: **-0.13%** Standard Deviation of Alpha: **0.60%**	t-Statistic: **-0.66** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Global Real Estate Securities (DFGEX) | BENCHMARK: S&P Global REIT TR USD
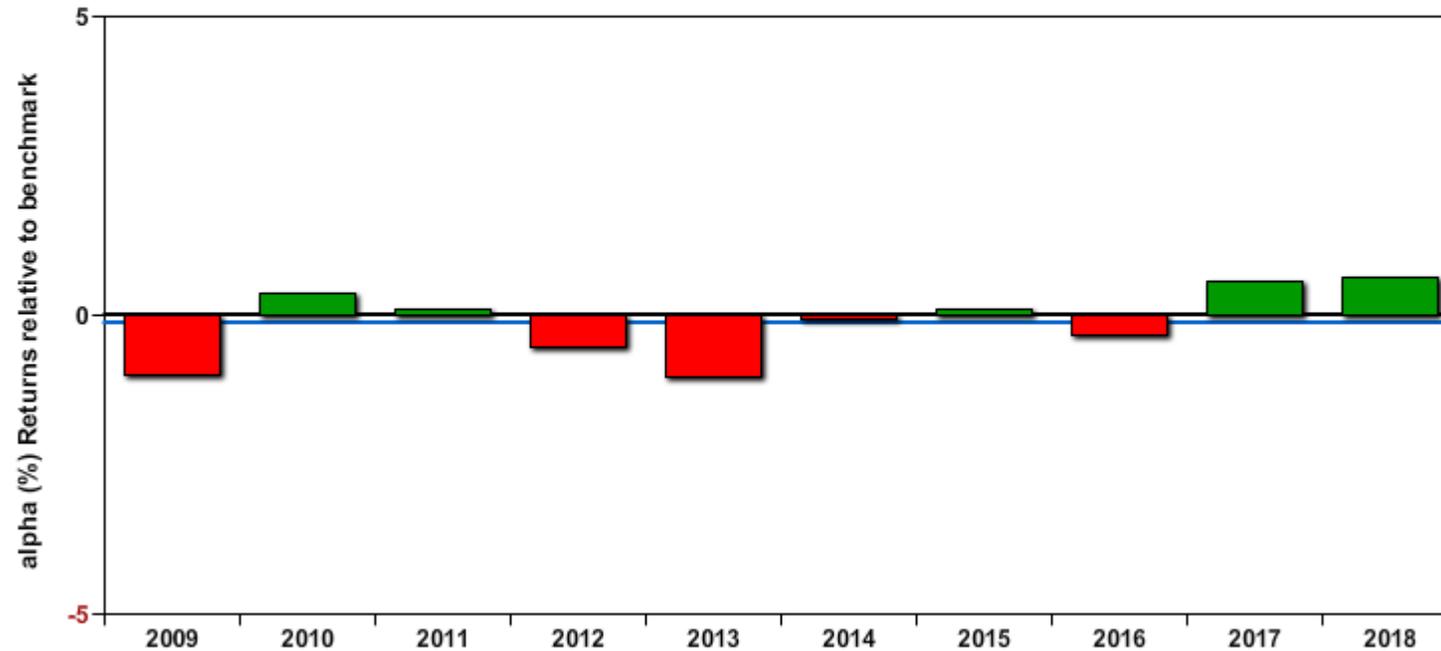
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DFA Two-Year Global Fixed Income's (DFGFX) Alpha Relative to Its Benchmark
22 Years (1/1/1997 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	— Average Alpha: **-2.18%** Standard Deviation of Alpha: **2.39%**	t-Statistic: **-4.28** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Two-Year Global Fixed Income (DFGFX) | BENCHMARK: BBgBarc Global Aggregate TR Hdg USD

DFA International Core Equity Portfolio's (DFIEX) Alpha Relative to Its Benchmark
13 Years (1/1/2006 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **496 Yrs**	— Average Alpha: **0.36%** t-Statistic: **0.32** Standard Deviation of Alpha: **4.05%** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA International Core Equity Portfolio (DFIEX) | BENCHMARK: MSCI ACWI Ex USA NR USD

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DFA One-Year Fixed Income's (DFIHX) Alpha Relative to Its Benchmark
20 Years (1/1/1999 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	── Average Alpha: **-0.08%** Standard Deviation of Alpha: **0.38%**	t-Statistic: **-0.96** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA One-Year Fixed Income (DFIHX) | BENCHMARK: BBgBarc Govt/Corp 1 Yr Duration TR USD
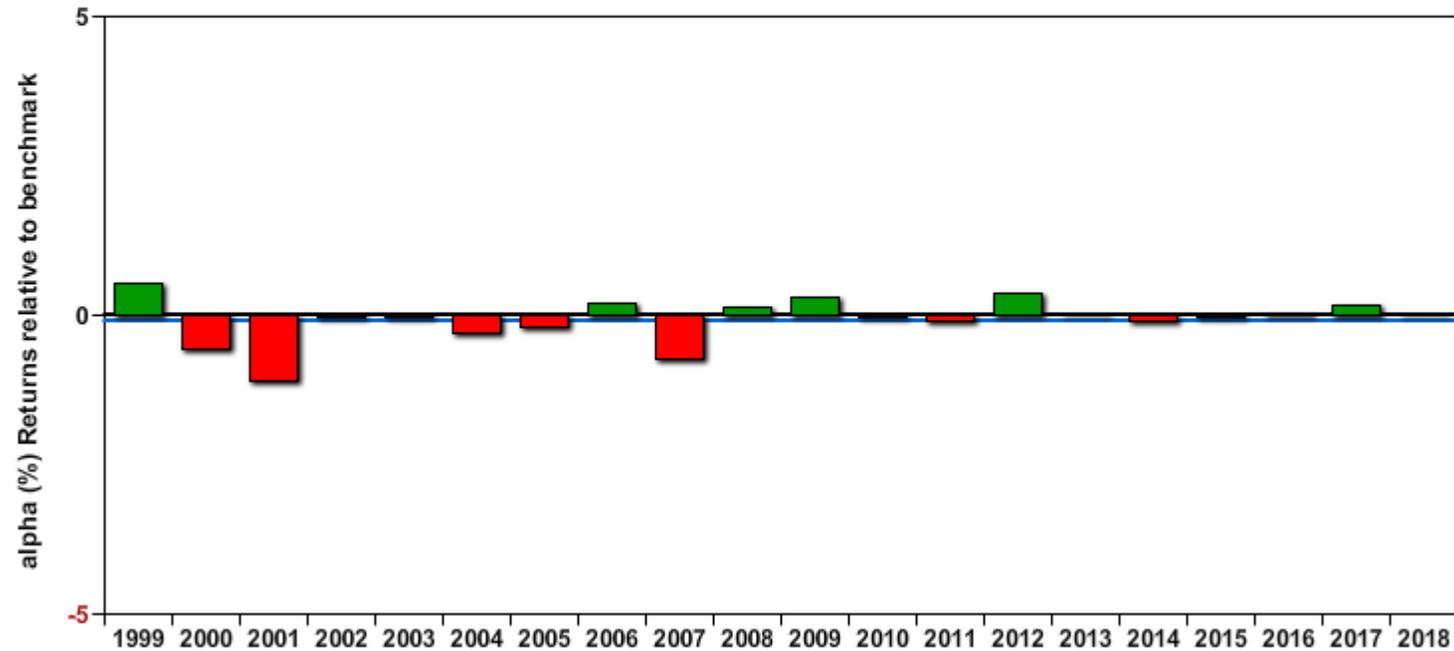
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DFA International Small Company's (DFISX) Alpha Relative to Its Benchmark
22 Years (1/1/1997 - 12/31/2018)

| Minimum Track Record to Indicate Skill (t-stat > 2): **102 Yrs** | — Average Alpha: **1.01%** t-Statistic: **0.93** |
| Standard Deviation of Alpha: **5.13%** (a t-stat of >2 = 97.5% confidence of skill) |

FUND: DFA International Small Company (DFISX) | BENCHMARK: MSCI World Ex USA SMID NR USD
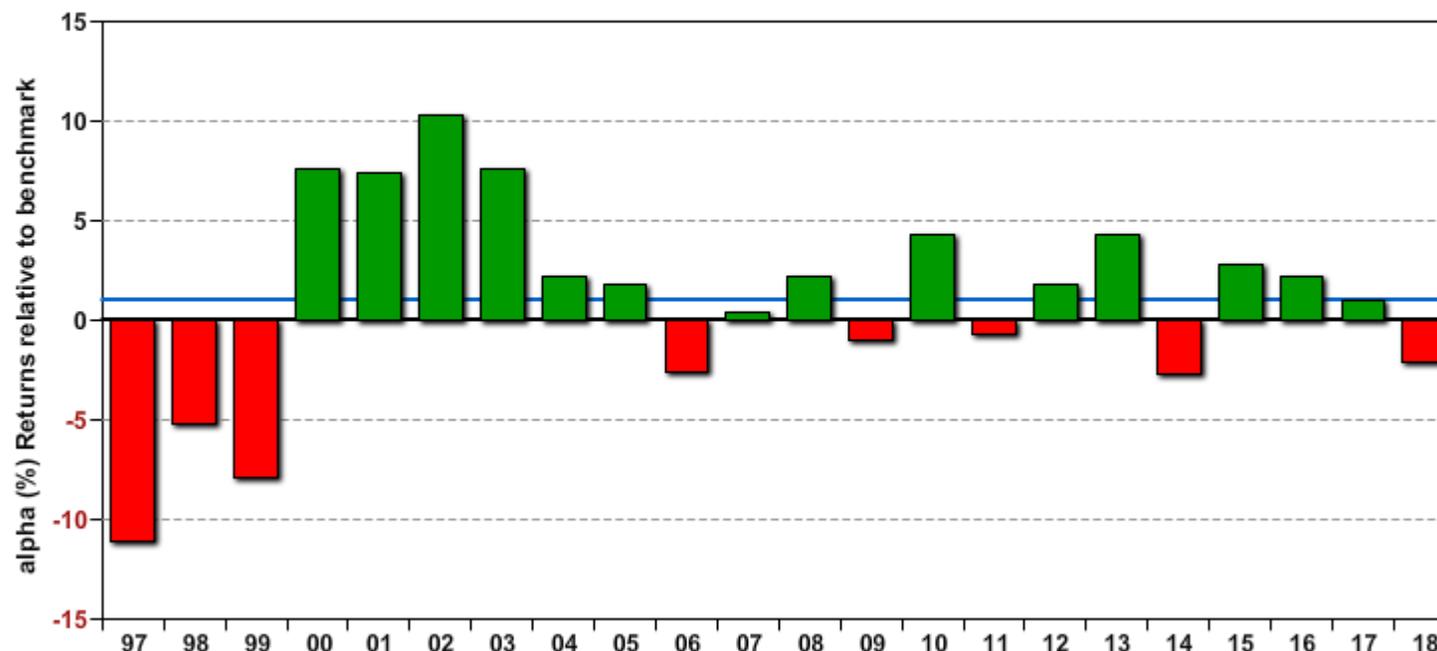
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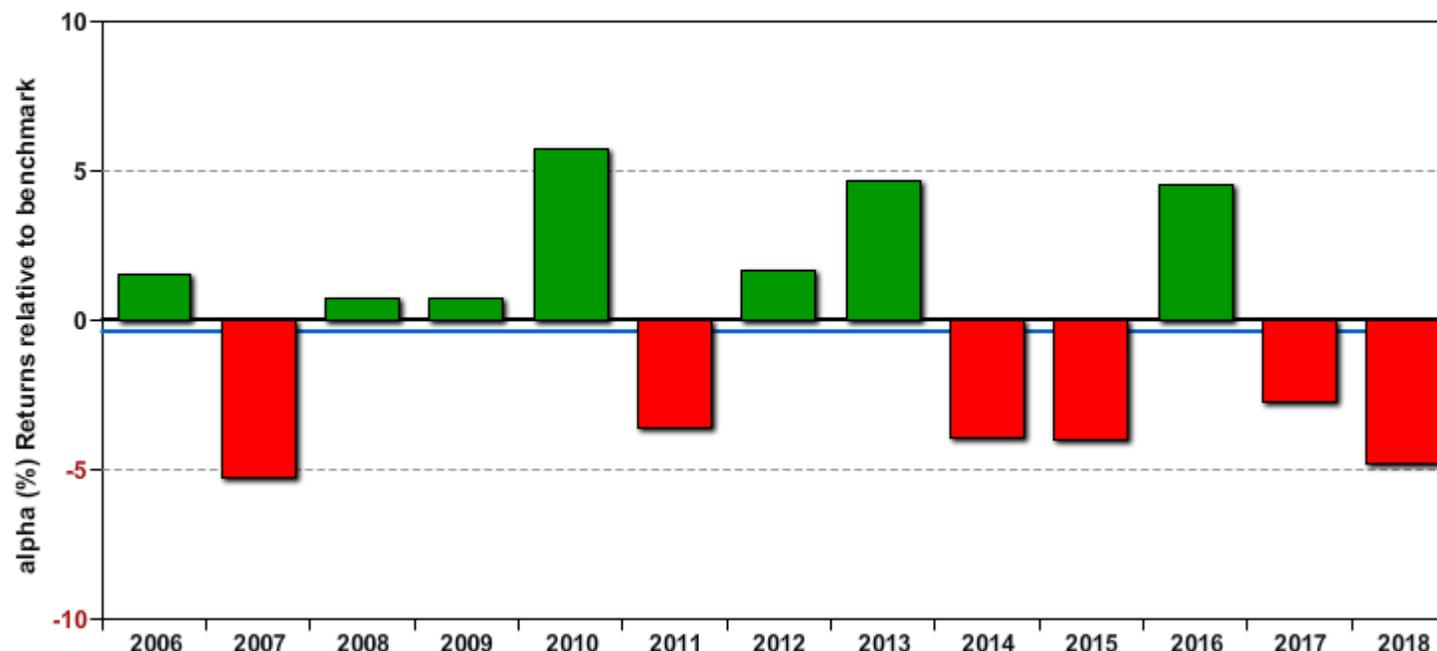
DFA International Value's (DFIVX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to	── Average Alpha: **0.95%**	t-Statistic: **1.11**
Indicate Skill (t-stat > 2): **59 Yrs**	Standard Deviation of Alpha: **3.63%**	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA International Value (DFIVX) | BENCHMARK: MSCI ACWI Ex USA Value NR USD
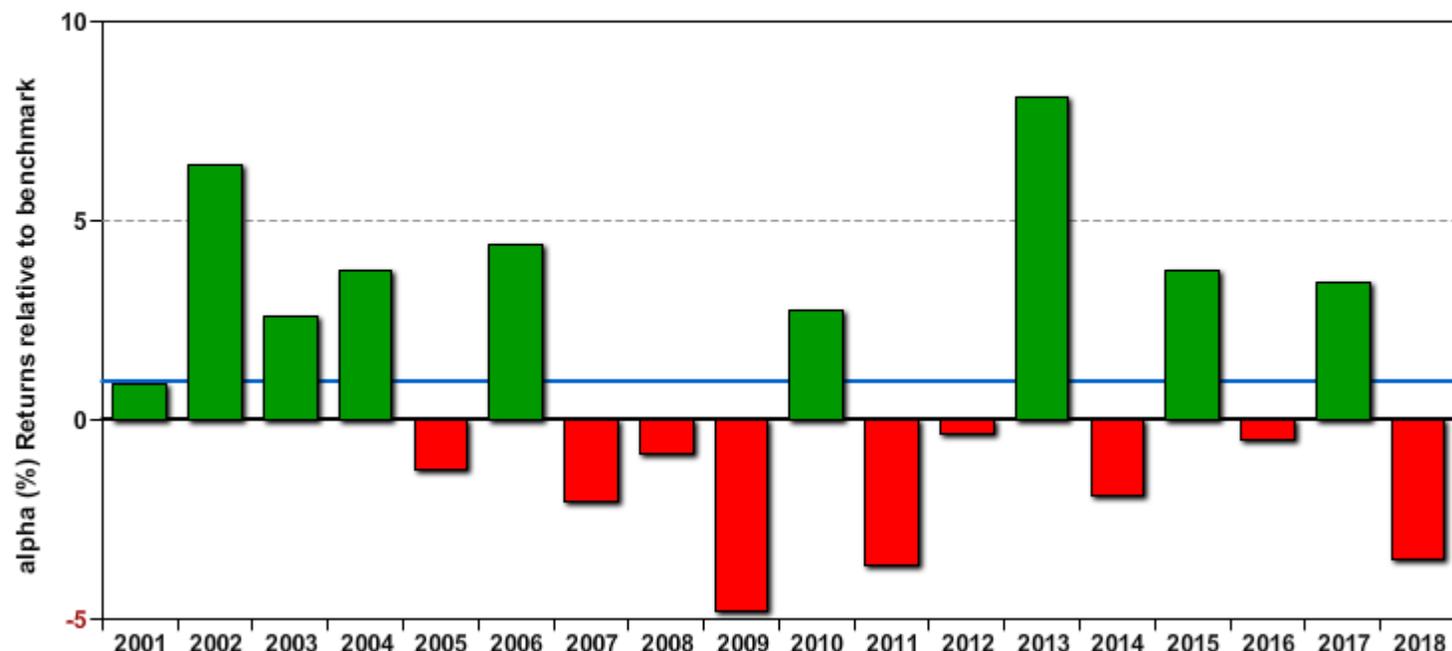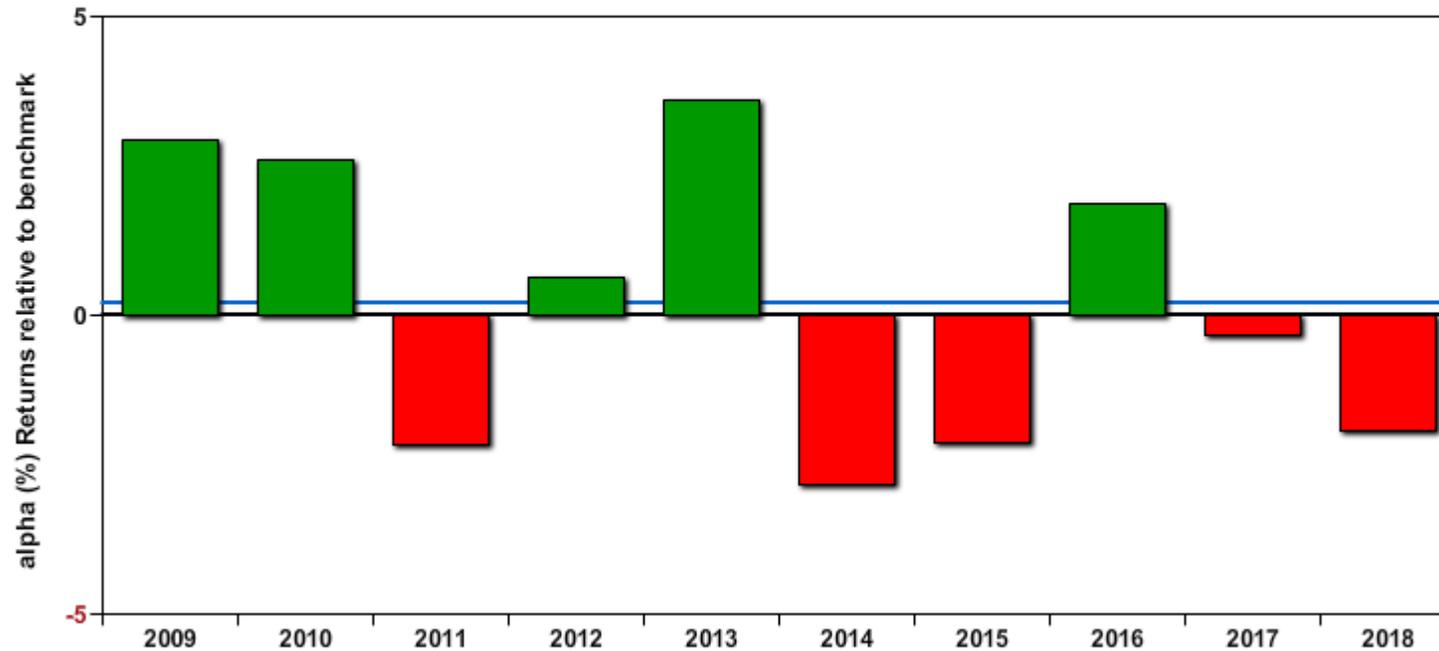

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DFA US Large Cap Value's (DFLVX) Alpha Relative to Its Benchmark

25 Years (1/1/1994 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **116 Yrs**	—— Average Alpha: **0.85%** Standard Deviation of Alpha: **4.56%**	t-Statistic: **0.93** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Large Cap Value (DFLVX) | BENCHMARK: Russell 1000 Value TR USD
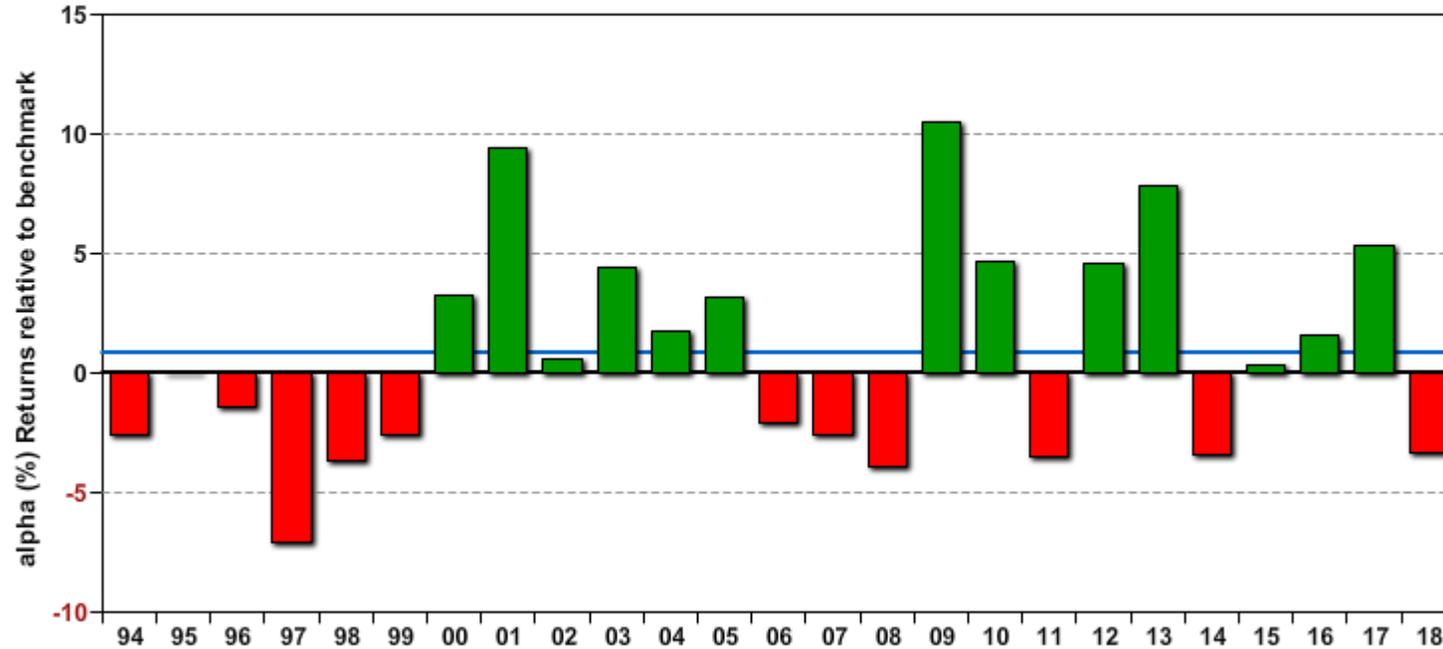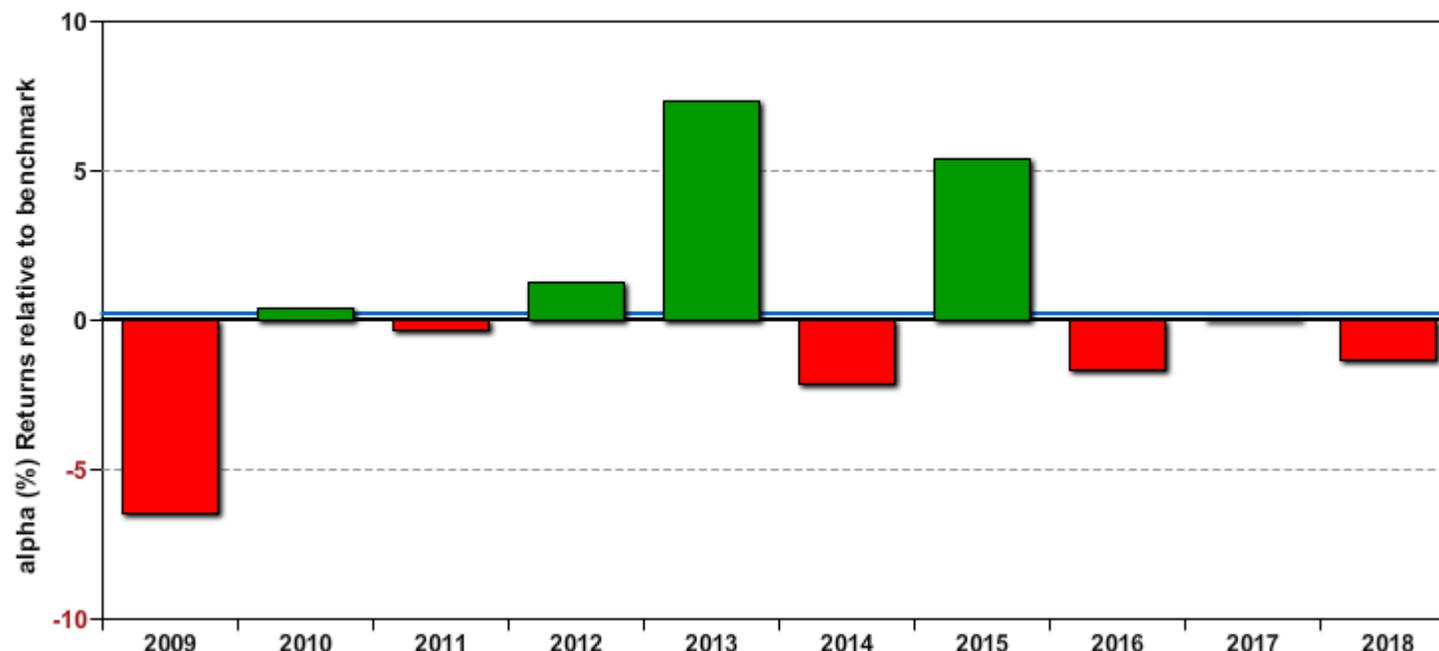

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DFA US Core Equity 2 Portfolio's (DFQTX) Alpha Relative to Its Benchmark

13 Years (1/1/2006 - 12/31/2018)

Minimum Track Record to		
Indicate Skill (t-stat > 2): **N/A**	— Average Alpha: **-0.37%**	t-Statistic: **-0.34**
	Standard Deviation of Alpha: **3.89%**	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Core Equity 2 Portfolio (DFQTX) | BENCHMARK: Russell 1000 TR USD

DFA US Sustainability Core Equity 1's (DFSIX) Alpha Relative to Its Benchmark

10 Years (1/1/2009 - 12/31/2018)

Minimum Track Record to	Average Alpha: 0.21%	t-Statistic: 0.28
Indicate Skill (t-stat > 2): 510 Yrs	Standard Deviation of Alpha: 2.42%	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Sustainability Core Equity 1 (DFSIX) | BENCHMARK: Russell 1000 TR USD

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DFA Int'l Sustainability Core Equity's (DFSPX) Alpha Relative to Its Benchmark
10 Years (1/1/2009 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **978 Yrs**	─── Average Alpha: **0.25%** t-Statistic: **0.20** Standard Deviation of Alpha: **3.89%** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Int'l Sustainability Core Equity (DFSPX) | BENCHMARK: MSCI ACWI Ex USA NR USD

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DFA US Small Cap's (DFSTX) Alpha Relative to Its Benchmark
26 Years (1/1/1993 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **28 Yrs**	—— Average Alpha: **1.35%** Standard Deviation of Alpha: **3.56%**	t-Statistic: **1.94** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Small Cap (DFSTX) | BENCHMARK: Russell 2000 TR USD
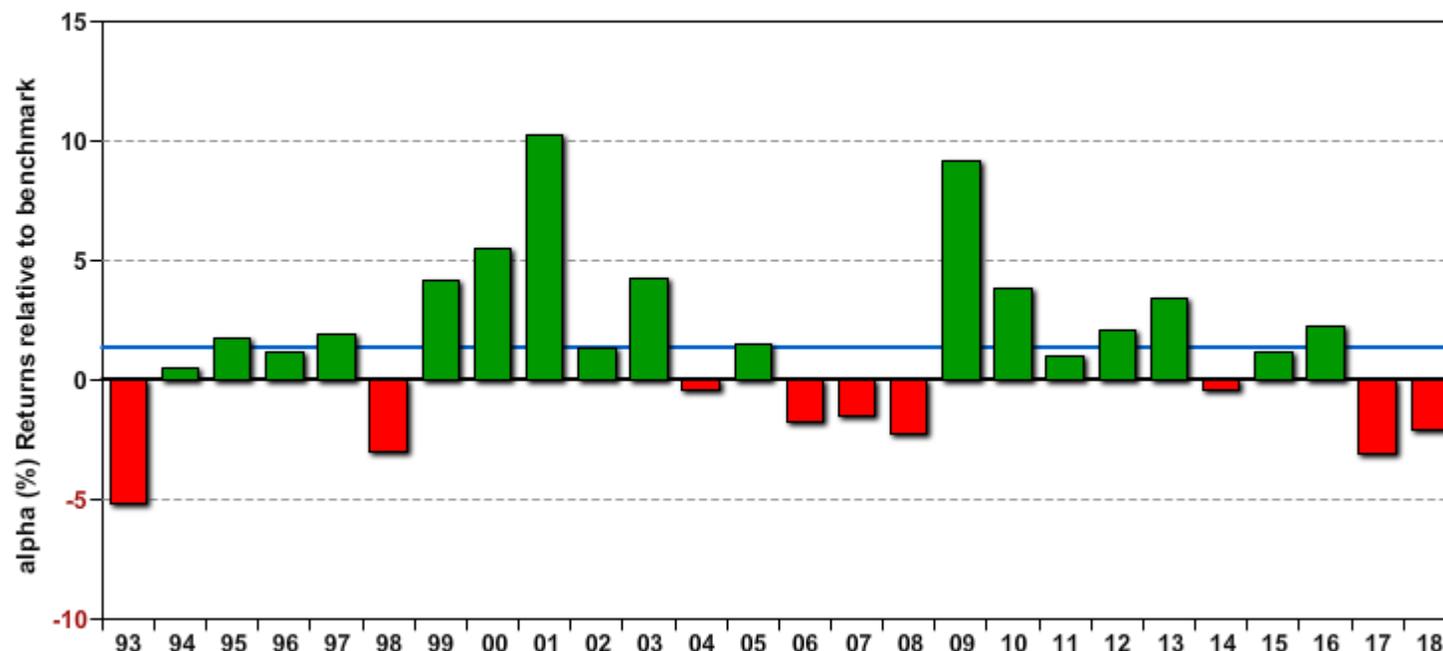
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DFA Tax-Managed US Small Cap's (DFTSX) Alpha Relative to Its Benchmark
20 Years (1/1/1999 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **32 Yrs**	—— Average Alpha: **1.40%** Standard Deviation of Alpha: **3.97%**	t-Statistic: **1.58** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Tax-Managed US Small Cap (DFTSX) | BENCHMARK: Russell 2000 TR USD
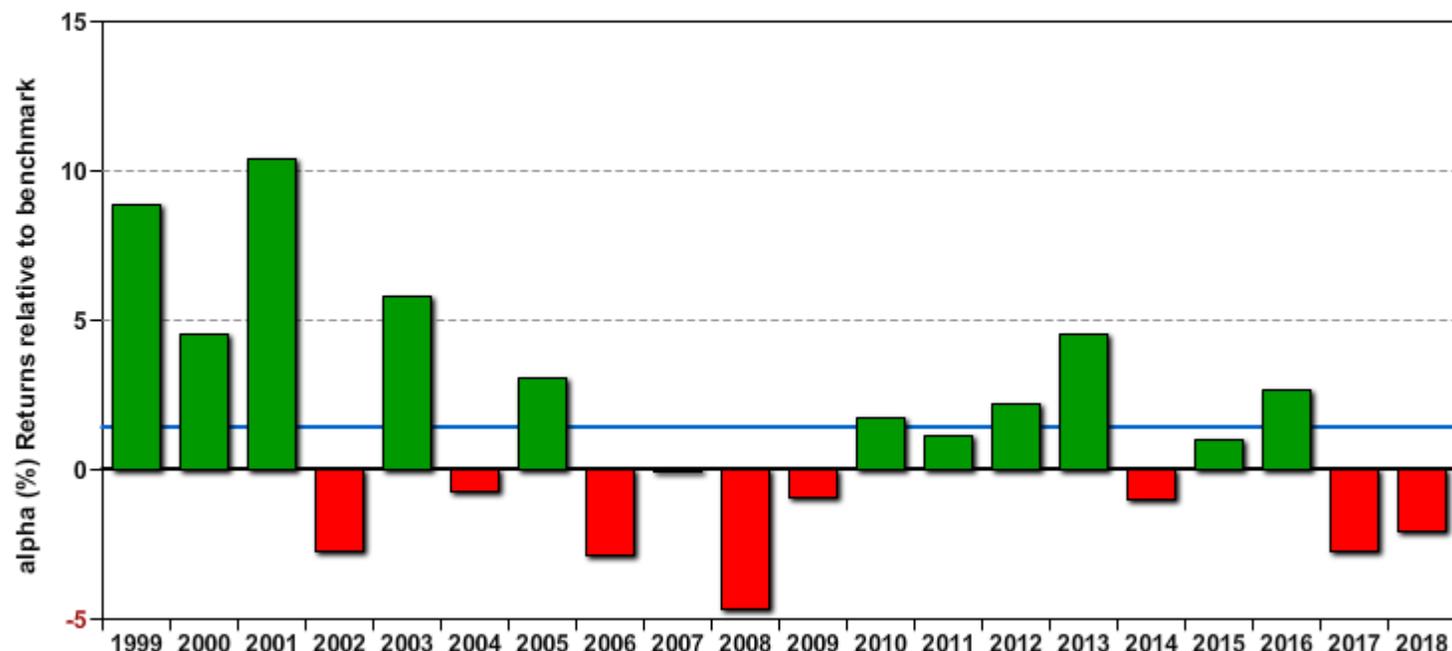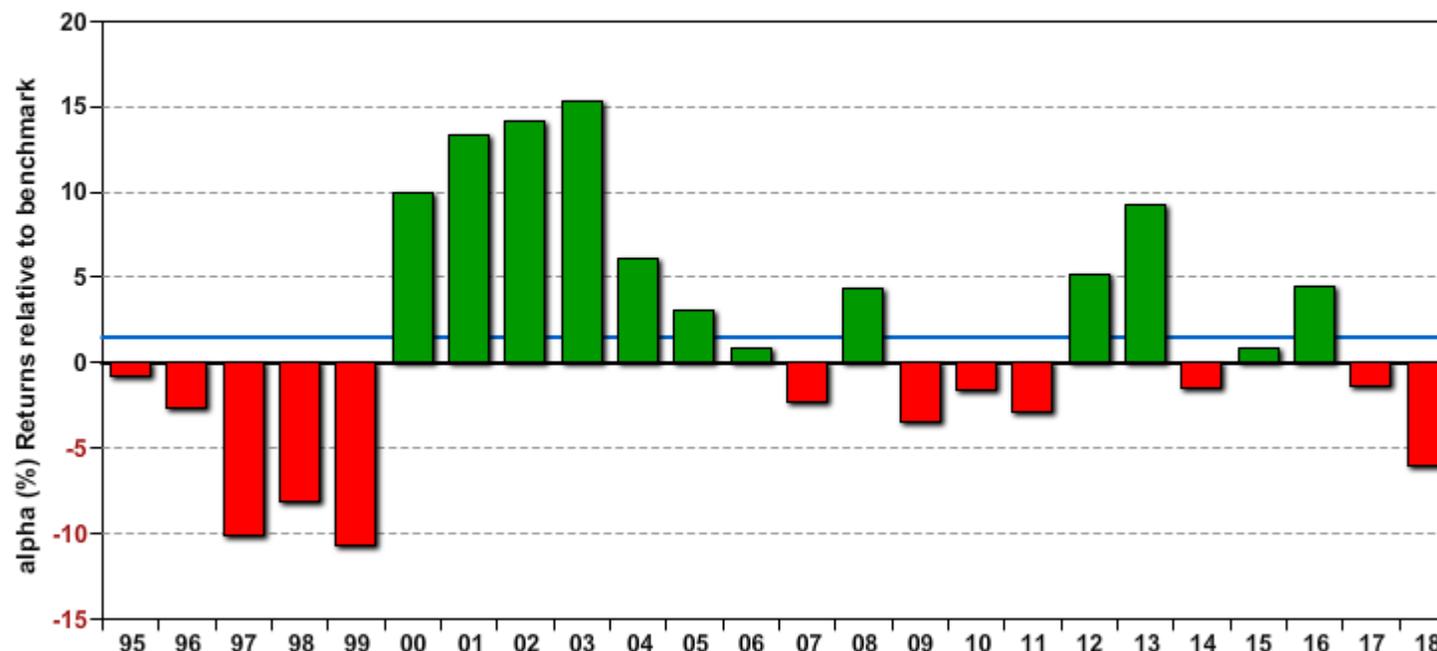

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DFA US Social Core Equity 2's (DFUEX) Alpha Relative to Its Benchmark

11 Years (1/1/2008 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **N/A**	—— Average Alpha: **-0.45%** Standard Deviation of Alpha: **4.47%**	t-Statistic: **-0.34** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA US Social Core Equity 2 (DFUEX) | BENCHMARK: Russell 1000 TR USD
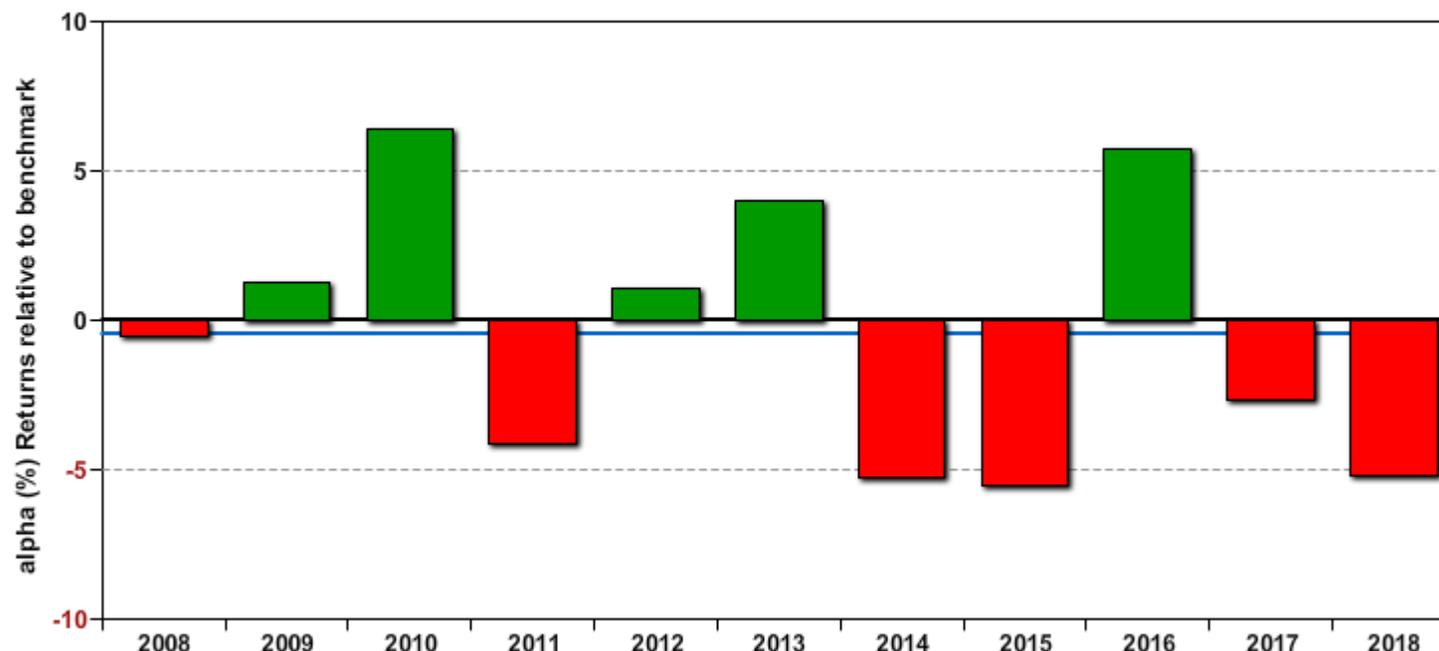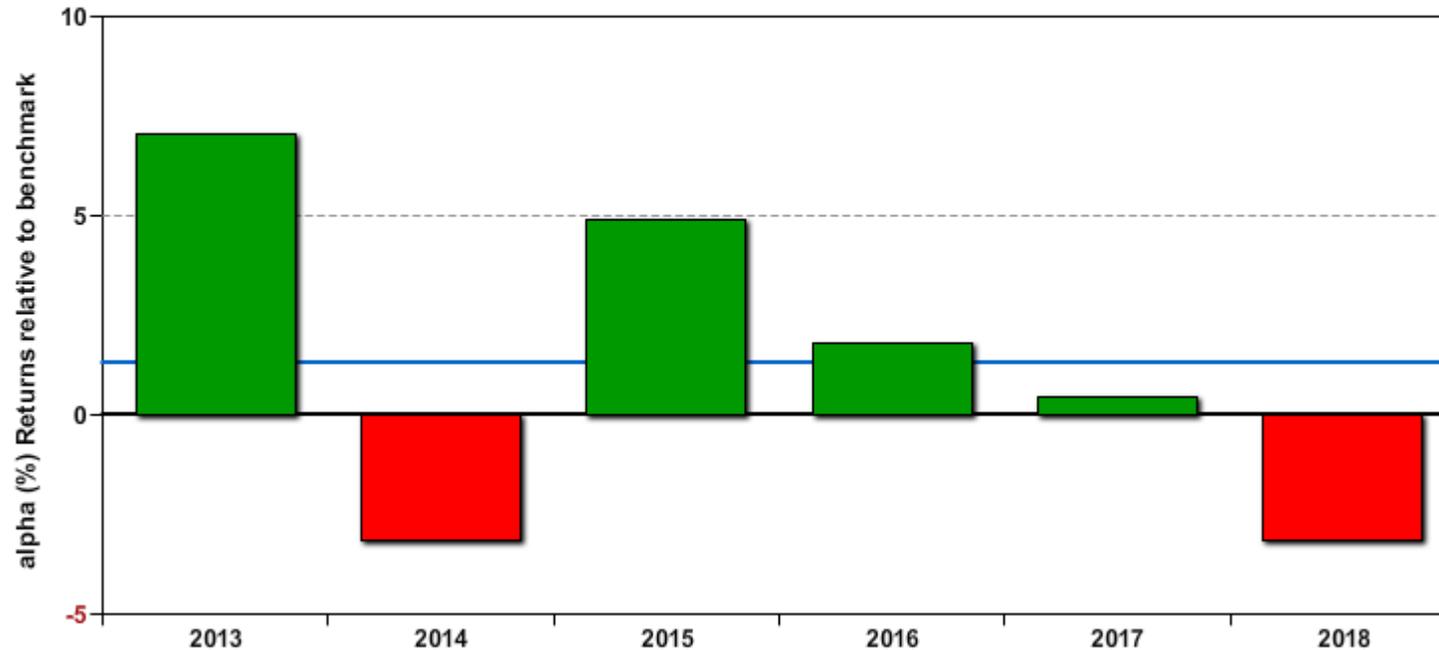

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DFA International Small Cap Value's (DISVX) Alpha Relative to Its Benchmark
24 Years (1/1/1995 - 12/31/2018)

Minimum Track Record to		▬ Average Alpha: **1.48%**	t-Statistic: **1.00**
Indicate Skill (t-stat > 2): **96 Yrs**		Standard Deviation of Alpha: **7.27%**	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA International Small Cap Value (DISVX) | BENCHMARK: MSCI World Ex USA SMID NR USD

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DFA International Social Core Equity's (DSCLX) Alpha Relative to Its Benchmark
6 Years (1/1/2013 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **40 Yrs**	— Average Alpha: **1.32%** t-Statistic: **0.77**
	Standard Deviation of Alpha: **4.18%** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA International Social Core Equity (DSCLX) | BENCHMARK: MSCI ACWI Ex USA NR USD
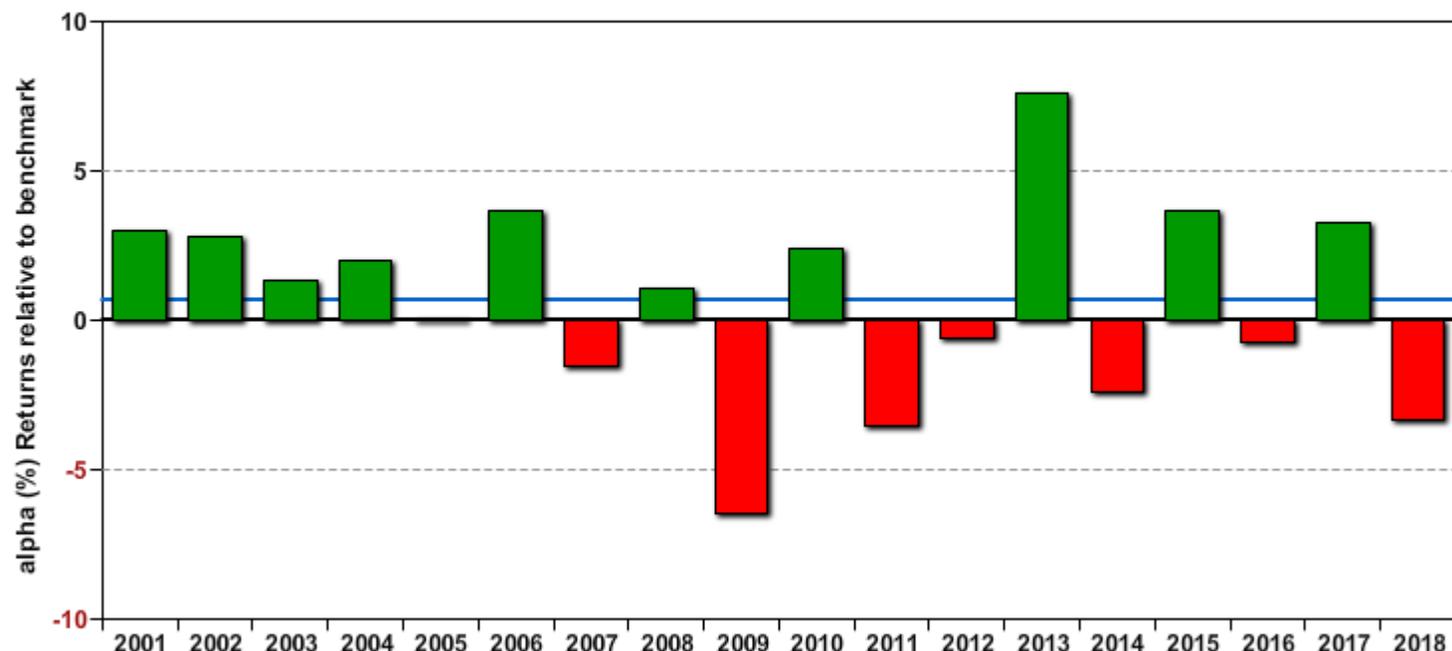

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DFA Tax-Managed US Equity's (DTMEX) Alpha Relative to Its Benchmark
17 Years (1/1/2002 - 12/31/2018)

Minimum Track Record to	⎯⎯ Average Alpha: **-0.49%**	t-Statistic: **-1.23**
Indicate Skill (t-stat > 2): **N/A**	Standard Deviation of Alpha: **1.66%**	(a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Tax-Managed US Equity (DTMEX) | BENCHMARK: Russell 1000 TR USD
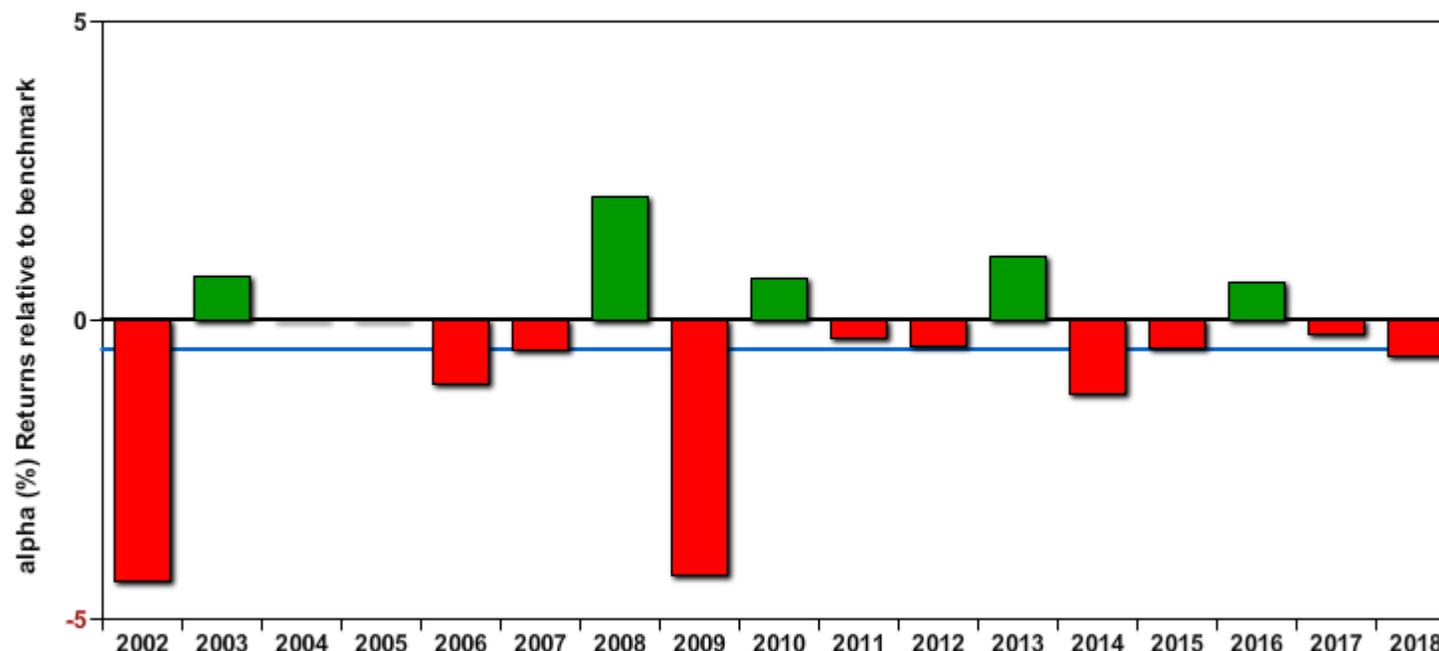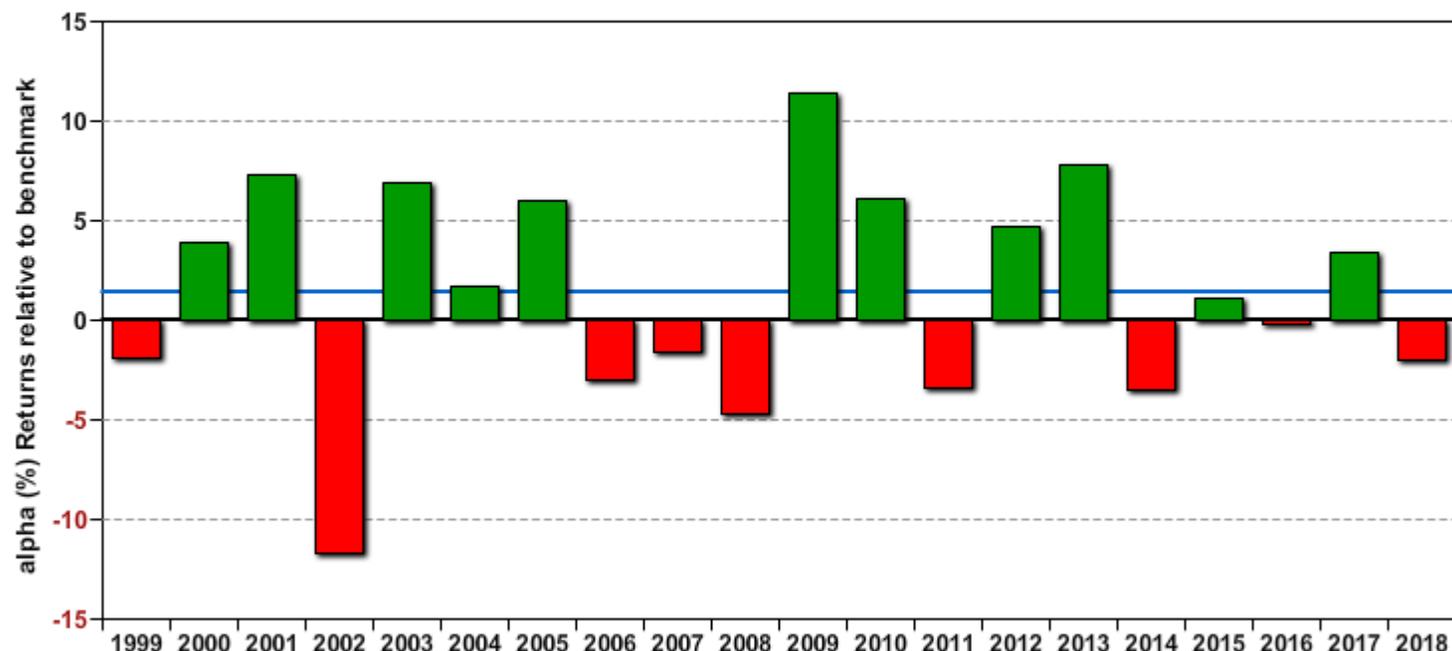

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DFA Tax-Managed International Value's (DTMIX) Alpha Relative to Its Benchmark
18 Years (1/1/2001 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **100 Yrs**	— Average Alpha: **0.67%** Standard Deviation of Alpha: **3.35%**	t-Statistic: **0.85** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Tax-Managed International Value (DTMIX) | BENCHMARK: MSCI ACWI Ex USA Value NR USD

DFA Tax-Managed US Marketwide Value's (DTMMX) Alpha Relative to Its
20 Years (1/1/1999 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **62 Yrs**	— Average Alpha: **1.40%** Standard Deviation of Alpha: **5.53%**	t-Statistic: **1.13** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Tax-Managed US Marketwide Value (DTMMX) | BENCHMARK: Russell 1000 Value TR USD
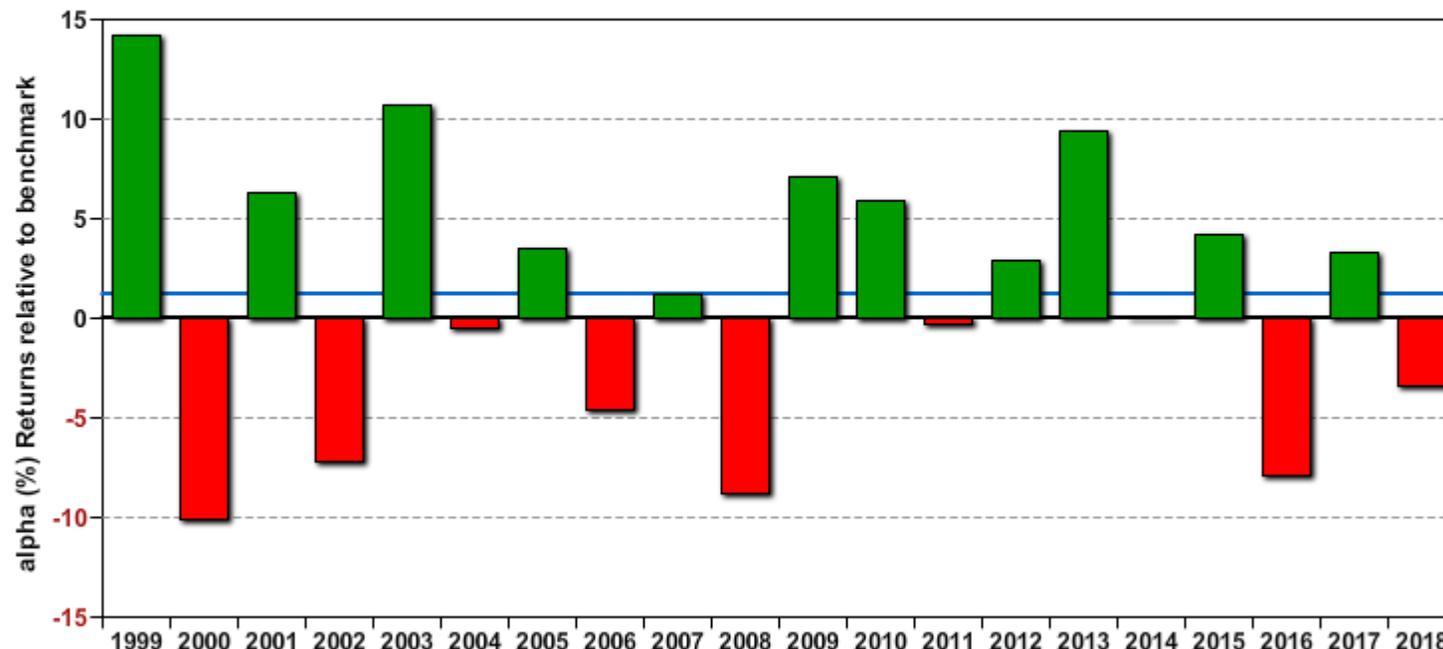

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DFA Tax-Managed US Targeted Value's (DTMVX) Alpha Relative to Its Benchmark
20 Years (1/1/1999 - 12/31/2018)

Minimum Track Record to Indicate Skill (t-stat > 2): **112 Yrs**	— Average Alpha: **1.28%** Standard Deviation of Alpha: **6.79%**	t-Statistic: **0.84** (a t-stat of >2 = 97.5% confidence of skill)

FUND: DFA Tax-Managed US Targeted Value (DTMVX) | BENCHMARK: Russell 2000 Value TR USD

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Another point worth keeping in mind is depicted in the figure below. It shows the formula to determine the t-stat for a fund. Our investment committee warns investors against trusting or relying on data relating to alpha or averge returns without t-stat calculations.

How to Calculate a t-statistic for Any Data Set

Enter the Average, Standard Deviation and Sample Size (Number of Observations) to calculate the t-stat.
A t-stat of 2 indicates that the average is statistically significant and that you can be 97.5% confident that the average did not occur by chance. With a t-stat of 2, there is still a 2.5% probability that that the true value of the average is zero.

$$t = \frac{\overline{x} \times \sqrt{n}}{s}$$

$\overline{x}$ Average:	
s Standard Deviation:	
n Sample:Size:	
	Calculate
t t-stat:	

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Below is a figure showing the formula used to calculate the number of years needed for a t-stat of 2. We first determine the excess return over a benchmark (the alpha), then

determine the regularity of the excess returns by calculating the standard deviation of those returns. Based on these two numbers, we can then calculate how many years we

need (sample size) to support the manager's claim of skill.

Number of Years Needed for a Statistically Significant Alpha

Enter Average Excess Return (Alpha) and Standard Deviation of the Alpha to calculate for Number of Years Needed for t-stat of 2. A t-stat of 2 is needed to be 97.5% confident that the excess return (alpha) is not zero.

$$n = \left(\frac{s \times t}{\overline{x}} \right)^2$$

$\overline{x}$ Average Excess Return (Alpha):	
s Standard Deviation of Alpha:	
t t-stat:	2
	Calculate
n Number of Years Needed for a t-stat of 2:	

t stat of 2.

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