The Dimensions of Stock Returns: 2002 Update

By Truman A. Clark
Vice President
Dimensional Fund Advisors Inc.
April 2002

An ongoing objective of financial research is to explain the behavior of stock returns. Factors are sought that explain both differences among the returns of individual stocks in any given time period and the variation of stock returns through time. If a factor does both, it is said to explain the common variation of returns. In addition, if a factor is related to non-diversifiable risk and possesses explanatory power independent of other factors, the factor is considered a "dimension" of stock returns.

Fama and French (1992) found that two factors related to company size and book-to-market ratio (BtM) together explain much of the common variation of stock returns and that these factors are related to risk. Small cap stocks have higher average returns than large cap stocks, and high BtM (or "value") stocks have higher average returns than low BtM (or "growth") stocks. Based on Fama and French's findings, size and BtM are dimensions of stock returns.[1]

Fama and French also investigated a market factor. A market factor is needed to distinguish stocks from fixed income securities, and it is important in explaining the variation of stock returns through time. But, among stocks in a given time period, differences in their sensitivities to the market factor are unrelated to differences in their average returns, so the market factor is not a dimension of stock returns.

The Fama/French results have important implications for domestic equity portfolio design. Large capitalization growth stocks constitute large portions of traditional "market-like portfolios" based on indexes such as the S&P 500, the Russell 3000 and the Wilshire 5000. Domestic equity portfolios with greater commitments to small cap stocks and value stocks offer higher average returns than conventional market-like portfolios.

Size and BtM also are dimensions of international and emerging markets stock returns. This confirms Fama and French's interpretation of size and BtM effects as rewards for bearing risk that cannot be eliminated by diversification.

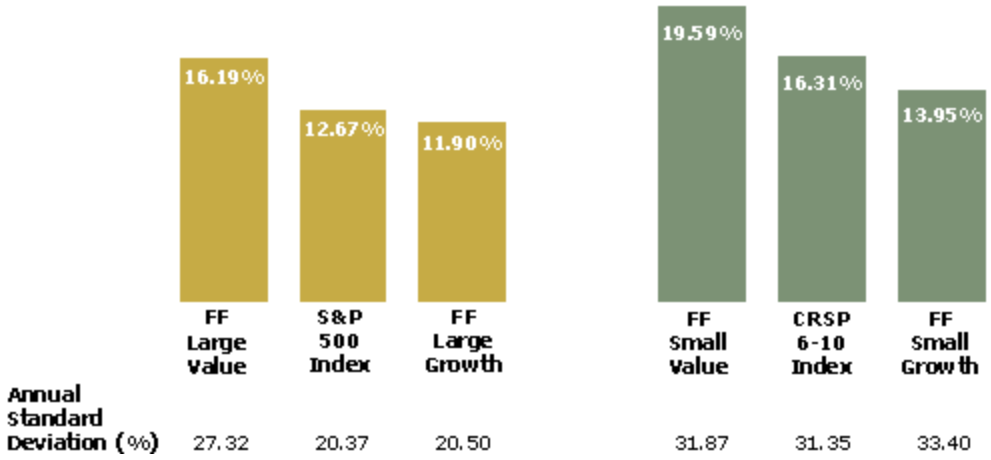
The implications for global equity allocation are significant. The MSCI EAFE index is the international equivalent of the S&P 500—a composite dominated by large cap growth stocks. For American investors with large core holdings of S&P 500 stocks, EAFE may provide less diversification benefits than other international equity portfolios. Dimensional recommends that most investors use international and emerging markets small cap and value stocks for global diversification.

Risk and Return

Figure 1 shows arithmetic averages and standard deviations of the 1927-2001 annual returns of four asset class portfolios. Stocks are grouped by size (large and small) and BtM (low and high) to form these asset class portfolios. For reference, statistics also are shown for two market indexes: the S&P 500 (a composite of large cap stocks) and the CRSP 6-10 (a composite of small cap stocks).

Figure 1

US Equities
Arithmetic Average Rates of Return
Annual Data: 1927-2001



Value and growth data courtesy of Fama/French.
S&P data courtesy of © Stocks, Bonds, Bills and Inflation Yearbook™, Ibbotson Associates, Chicago (annually updated works by Roger C. Ibbotson and Rex A. Sinquefield).
CRSP data courtesy of the Center for Research in Security Prices, University of Chicago.

Controlling for differences in BtM by comparing large cap value to small cap value and comparing large cap growth to small cap growth, *small cap stocks had higher average returns than large cap stocks.*[2] Controlling for differences in size by comparing large cap growth to large cap value and comparing small cap growth to small cap value, *value stocks had higher average returns than growth stocks.* The higher average returns of small cap and value stocks represent rewards for bearing risk.

If standard deviation were a complete measure of risk, average returns would increase as standard deviations increase. Controlling for differences in BtM, a direct relation between average returns and standard deviations is found when large cap stocks are compared to small cap stocks. But, controlling for differences in size, a discrepancy appears. Small growth stocks had a lower average return and a higher standard deviation than small value stocks. Since greater standard deviations are not consistently associated with higher average returns, *standard deviation is not a reliable measure of risk.*

Size, Book-to-Market and Earnings

Seeking a risk-based explanation for the relations of size and BtM to average returns, Fama and French (1995) investigated the behavior of the earnings of stocks grouped by size and BtM. Measuring profitability by the ratio of annual earnings to book value of equity, Figure 2 illustrates the evolution of profitability over long periods before and after stocks are classified by size and BtM. BtM is associated with persistent differences in profitability. On average, low BTM stocks are more profitable than high BtM stocks of similar size for at least five years before and after portfolio formation. Low BtM indicates sustained high earnings that are characteristic of firms that are growing and financially robust. High BtM indicates protracted low earnings that are typical of firms experiencing financial distress.

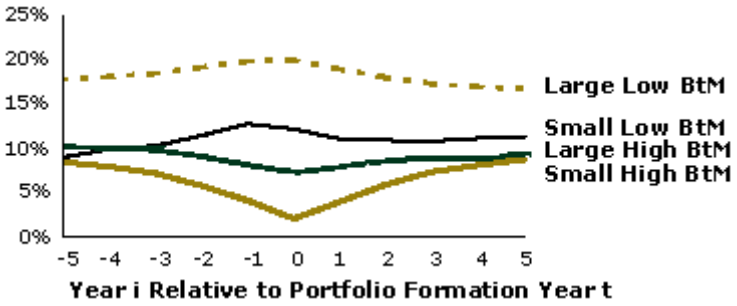
Figure 2 also shows that profitability is related to firm size. Controlling for differences in BtM, the earnings of small cap stocks are lower than those of large cap stocks for at least five years before and after portfolio formation.

The patterns observed in Figure 2 indicate that small stocks and value stocks are subject to ongoing earnings pressure. Size and BtM appear to be indicators of exposure to fundamental risk factors related to financial distress.[3]

Figure 2

Earnings on Book Equity
E(t+i+1) / B(t+1)

Portfolios Formed at End of Year t: 1963-2000



For each portfolio formation year t = 1963-2000, the ratios are calculated for t+i, i=-5,...,5. The ratio for t+i is then averaged across portfolio formation years t. E(t+i+1) is earnings before extraordinary items but after interest, depreciation, taxes and preferred dividends for the fiscal year ending in calendar year t+i+1. B(t+i) is book common equity plus balance sheet deferred taxes for the fiscal year ending in calendar year t+i.

Data courtesy of Fama/French.

Expected Returns and the Cost of Capital

Financial markets channel funds from suppliers of capital to users of capital. Expected returns are the rewards investors anticipate for supplying capital. Investors require a higher rate of return (or risk premium) for bearing greater risk. Risk is something that investors collectively shun and that cannot be eliminated by diversification.

The cost of capital is the price users of capital must pay to obtain financing. Competition forces users of capital to bid higher prices to obtain funding for more risky ventures.

In equilibrium, the expected rate of return and the cost of capital are determined jointly as the price at which the demand for and supply of capital are equal. In financial markets that function efficiently, investors only receive risk premiums for bearing risk. As risk increases, the expected rate of return and the cost of capital increase.

High BtM and small size often indicate companies that are experiencing some degree of financial distress. On average, they have higher costs of capital because they tend to be riskier than companies with low BtM and large market capitalization. The higher average returns of small stocks and value stocks reflect compensation for exposure to non-diversifiable risk factors.

The Three-Factor Model

The findings of Fama and French suggest that much of the variation in stock returns is explained by three systematic risk factors.

- The **market factor** measured by the returns of stocks minus the returns of Treasury bills (or XRMKT).
- The **size factor** measured by the returns of small stocks minus the returns of big stocks (or SMB).
- The **value factor** measured by the returns of high-BtM stocks minus the returns of low-BtM stocks (or HML).

The three-factor model hypothesizes a linear relation between the excess returns of a portfolio (or stock) and the premiums of the three factors:
$RP(t) - RF(t) = a + b \cdot [RM(t) - RF(t)] + s \cdot SMB(t) + h \cdot HML(t) + e(t)$
$RP(t)$ is the total rate of return of a portfolio in month t. $RF(t)$ is the return of a one-month Treasury bill. $RM(t)$ is the total rate of return of the stock market. $SMB(t)$ is the size factor premium, and $HML(t)$ is the

value factor premium. Monthly departures from the model's predictions (or errors) are represented by $e(t)$, and they are assumed to vary randomly about an expected value of zero.

Using monthly data for the period January 1992 through December 2001, parameters of the model for two indexes and four portfolios were estimated by **regression** methods (Table 1). The slope coefficients (b, s and h) measure a portfolio's sensitivity to each factor.

- Sensitivity to the market factor (b): The estimates of b are close to 1.00 for the S&P 500, the Russell 3000 and the DFA Large Cap Value Portfolio. The DFA Small Cap Portfolio, Micro Cap Portfolio and Small Value Portfolio are less sensitive to overall market movements. Relative to the market, these small-cap stock portfolios behave like a portfolio composed roughly of 85 percent stocks and 15 percent bonds.[4]
- Sensitivity to the size factor (s): The S&P 500 and Russell 3000 are predominantly large-cap stock indexes, and their excess returns are negatively related to the size factor. The DFA Large Cap Value Portfolio's sensitivity to the size factor is effectively zero. The three DFA small-cap portfolios have strong, positive sensitivities to the size factor.
- Sensitivity to the value factor (h): The DFA Micro Cap Portfolio's sensitivity to the value factor is effectively zero. The estimated value sensitivities of the other five portfolios are positive, and the value sensitivities of the DFA Large Cap Value and Small Cap Value Portfolios are much greater than the others.

Table 1

Three-Factor Model Estimates
Monthly Data: 1992-2001

	a	b	s	h	Adjusted R-squared
S&P 500 Index	0.03	1.00	-0.17	0.05	0.989
	0.75	*0.10*	*-15.20*	*5.22*	
Russell 3000 Index	-0.01	1.00	-0.05	0.04	0.997
	-0.32	*-0.18*	*-8.09*	*7.75*	
DFA Small Cap Portfolio	0.05	0.88	0.90	0.10	0.953
	0.42	*-4.17*	*28.92*	*3.36*	
DFA Micro Cap Portfolio	0.28	0.81	1.09	0.04	0.918
	1.74	*-4.50*	*23.74*	*0.86*	
DFA Large Value Portfolio	0.00	1.08	0.04	0.61	0.836
	0.01	*1.83*	*0.73*	*13.56*	
DFA Small Value Portfolio	0.24	0.84	0.81	0.39	0.911
	1.88	*-4.80*	*22.21*	*11.65*	

t-statistics are in *italics*. For the market sensitivity coefficient, the null hypothesis is b=1. For the other coefficients, the null hypothesis is that each equals zero. Underlined type indicates statistical significance at the .01 level (2-tailed).

The intercept of each regression (a) measures the average excess return that is not explained by the three factors. In each case, the intercept is indistinguishable from zero indicating that the model explains all of the average excess return.
As indicated by the adjusted R-squared statistics, the model explains at least 90 percent of the variance of the excess returns of five of the six portfolios. For the DFA Large Cap Value Portfolio, the model explains more than 80 percent of the variance.

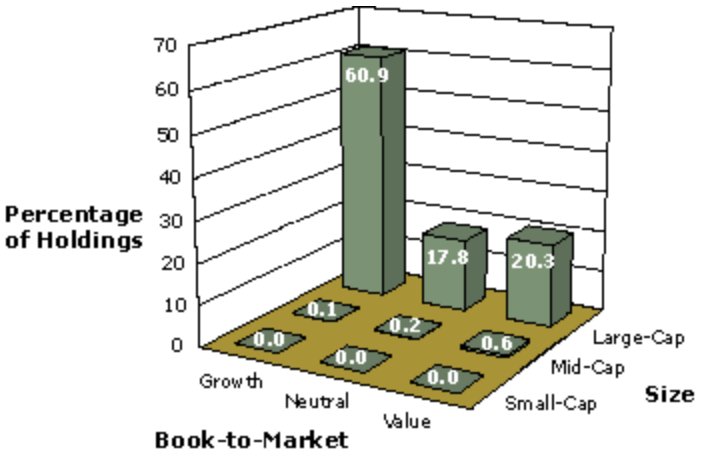
Portfolio Engineering

Many investors commit high proportions of their domestic equity holdings to portfolios resembling the S&P 500, Russell 3000 or other market-like proxies. Large cap growth stocks are the dominant holdings of the S&P 500 (Figure 3) and the Russell 3000 (Figure 4). As a result, market-like proxies are poor

portfolio structures for investors seeking exposure to the size and/or value factors. Investors can get such exposure by increasing their relative holdings of small cap and/or value stocks.

Figure 3

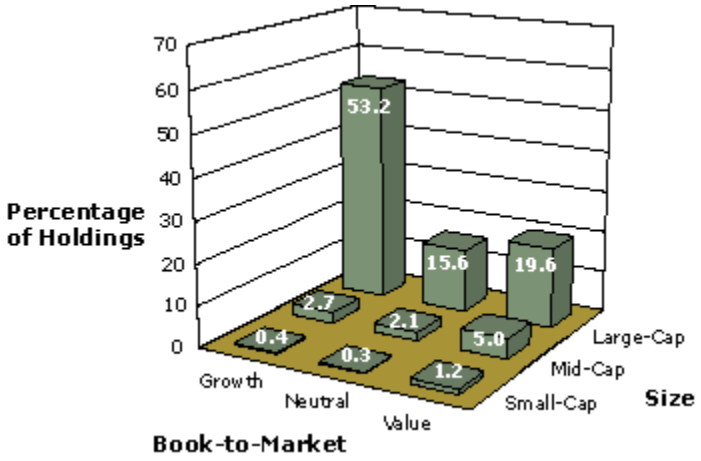
Size and BtM Composition of the S&P 500 Index
December 31, 2001



S&P data courtesy of © Stocks, Bonds, Bills and Inflation Yearbook™, Ibbotson Associates, Chicago (annually updated works by Roger C. Ibbotson and Rex A. Sinquefield).

Figure 4

Size and BtM Composition of the Russell 3000 Index
December 31, 2001



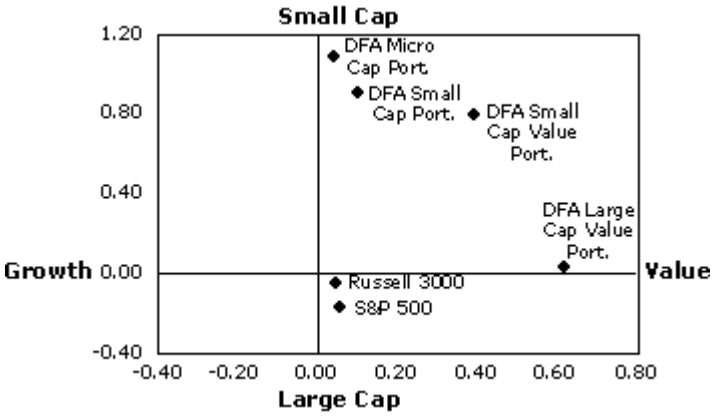
Russell data courtesy of Russell Analytic Services.

Figure 5 is a scatter plot of the size (*s*) and value (*h*) coefficients of five of the portfolios reported in Table 1. Each DFA asset class portfolio is carefully designed to provide concentrated exposures to the size and/or value factors. For diversification purposes, each asset class portfolio includes many stocks that have specific size and BtM characteristics. The asset class portfolios can be used as building blocks for structured portfolios providing targeted exposures to the size and/or value factors. To illustrate, let the S&P 500 serve as an initial core portfolio.

- Increased size exposure can be obtained with the Small Cap, Micro Cap and Small Cap Value funds.
- Increased value exposure can be obtained with the Large Cap Value and Small Cap Value funds.

Figure 5

Estimated Portfolio Sensitivities: Size and Value



S&P data courtesy of © Stocks, Bonds, Bills and Inflation Yearbook™, Ibbotson Associates, Chicago (annually updated works by Roger C. Ibbotson and Rex A. Sinquefield).
Russell data courtesy of Russell Analytic Services.

The compositions of four structured portfolios are shown in Table 2. Portfolio *P0* is the initial core portfolio invested entirely in the S&P 500. Portfolio *P1* provides a *size tilt* through commitments to the Small Cap and Micro Cap funds. As shown in Table 2 and Figure 6, portfolio *P1* has positive sensitivity to the size factor and only modest sensitivity to the value factor.5 Portfolio *P2* provides a *value tilt* by combining the S&P 500 and the Large Cap Value fund. *P2* has positive value sensitivity and, being composed almost entirely of large cap stocks, negative size sensitivity. Portfolios *P3* and *P4* provide both size and value tilts. Portfolio *P4* makes the biggest departures from the initial S&P 500 core and has strong positive sensitivities to both the size and value factors.

Table 2

Portfolio Engineering
Substituting Small Cap and Value Stocks for the S&P 500

Asset Class Portfolio	*P0*	*P1*	*P2*	*P3*	*P4*
S&P 500	100	70	70	40	30
DFA Small Cap Portfolio	0	20	0	20	20
DFA Micro Cap Portfolio	0	10	0	10	10
DFA Large Cap Value Portfolio	0	0	30	30	30
DFA Small Cap Value Portfolio	0	0	0	0	10
Estimated Porfolio Sensitivities					
Market (*b*)	1.00	0.96	1.03	0.98	0.97
Size (*s*)	-0.17	0.17	-0.11	0.23	0.33
Value (*h*)	0.05	0.06	0.22	0.23	0.26
Expected Risk Premium (% per year)	-0.34	0.44	0.49	1.28	1.57

S&P data courtesy of © Stocks, Bonds, Bills and Inflation Yearbook™, Ibbotson Associates, Chicago (annually updated works by Roger C. Ibbotson and Rex A. Sinquefield).

Expected risk premium does not represent actual investment performance differences but rather expected performance based on the Fama/French three-factor model.

The potential increases in expected returns due to these tilts can be estimated with the three-factor model. For purposes of illustration, it is assumed that the expected risk premiums are six percent per year for the market factor and three percent per year for both the size and value factors. Using these assumed premiums and the factor sensitivities of portfolios *P0* - *P4*, expected risk premiums are estimated relative to a pure market portfolio with unit market sensitivity (b = 1) and zero sensitivity to size (s = 0) and value (h = 0).

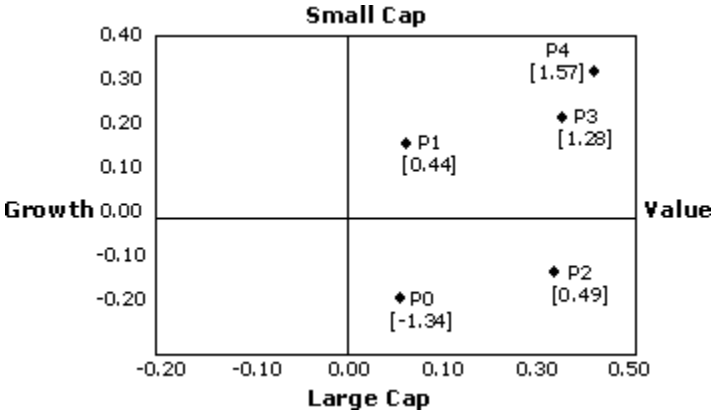
$E(premium) = (b - 1) \cdot 6 + s \cdot 3 + h \cdot 3$

The expected premiums are shown in Table 2 and Figure 6. The expected premium of *P0*, the S&P 500, is -34 basis points per year because of its negative sensitivity to the size factor. *P1*, with a size tilt, has an expected premium of 44 basis points per year (or 78 basis points more than *P0*). *P2*, with a value tilt, has an expected annual premium of 49 basis points. *P3*, with both size and value tilts, has an expected annual

premium of 128 basis points. *P4*, with stronger size and value tilts, has an expected premium of 157 basis points per year.

Figure 6

Structured Portfolios: Size and Value Sensitivities and Expected Risk Premiums



Expected annual risk premium over the market shown in brackets.

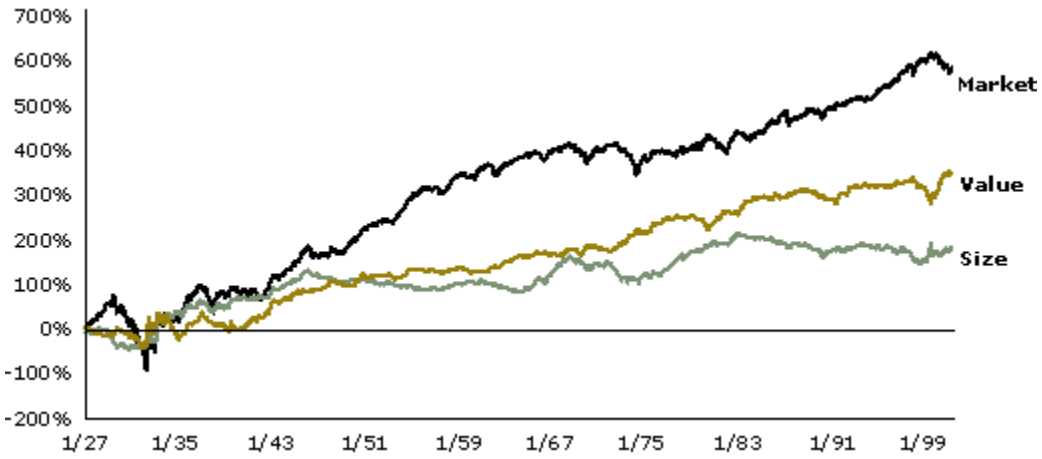
Words of Caution

Structured portfolios offer the prospect of higher long-term returns than market-like portfolios, but the expected risk premiums shown in Figure 6 are not sure things. Factor premiums vary widely and randomly. For the 1927-2001 period, the standard deviations of the annual premiums were approximately 21% per year for the market factor, 14% for the size factor and 14% for the value factor. Owing to their high variability, it may take *decades* before rewards for bearing increased size and value risk are realized.

Figure 7

Cumulative Factor Premiums

Monthly Data: July 1927-December 2001



Data courtesy of Fama/French.

Cumulative premiums for each factor are computed by adding successive monthly premiums for the period January 1927 through December 2001 (Figure 7). Although the cumulative premiums tend to rise over long periods of time, each moves erratically with lengthy episodes of downward drift. The market premium declined from December 1967 to July 1982—a period of more than 14 years. The size premium declined from December 1983 to December 2001—a period of 18 years (and still counting). The value premium declined from December 1987 to December 2000—a period of 13 years.

Structured portfolios are not appropriate for all investors. *Structured portfolios have higher expected returns because they are riskier than market-like portfolios.* Over periods of less than 20 years, structured portfolios often will have lower returns than market-like portfolios. It is only over periods of 20 years or more that it becomes more probable that structured portfolios will outperform market-like portfolios.

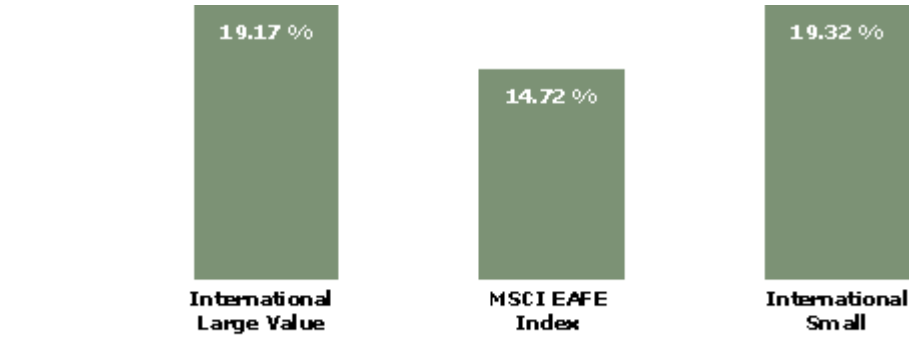
Investors with short horizons or aversion to risk should stick with market-like portfolios. Structured portfolios only make sense for investors with long time horizons and sufficient tolerance for increased risk.[6]

International and Emerging Markets Equities

Size and value effects are not confined to US equity markets. The MSCI EAFE Index represents a portfolio of international stocks from developed countries similar to the S&P 500. EAFE is composed predominantly of large cap growth stocks. During 1975-2001, international small cap stocks had a higher average return than EAFE indicating a size effect, and international large cap value stocks had a higher average return than EAFE indicating a value effect (Figure 8).[7]

Figure 8

International Equities
Arithmetic Average Rates of Return
Annual Data: 1975-2001



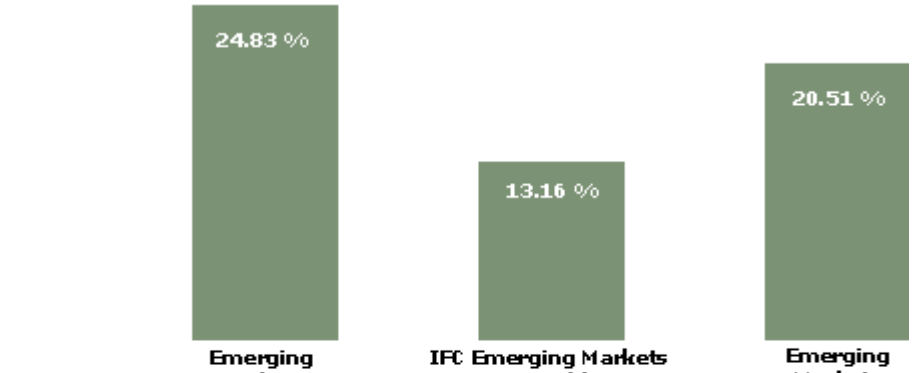
	International Large Value	MSCI EAFE Index	International Small
Annual Standard Deviation (%)	22.22	21.50	28.14

International Large Value courtesy of Fama/French prior to Dimensional's 7/93 portfolio inception.
MSCI data courtesy of Morgan Stanley Capital International.
International Small simulated by Dimensional prior to 4/86 portfolio inception.

Performance information for International Large Value and International Small are based in part on a model/backtested simulation; the performance was achieved with the retroactive application of a model designed with the benefit of hindsight; it does not represent actual investment performance. The model's investment objective is to achieve long-term capital growth. The model's performance reflects the reinvestment of dividends and other earnings, and is net of fees. There are limitations inherent in model performance. Past performance is no guarantee of future results, and there is always the risk that an investor may lose money.

Figure 9

Emerging Markets Equities
Arithmetic Average Rates of Return
Annual Data: 1989-2001



	Emerging Markets Value	IFC Emerging Markets Investables Total Return Index	Emerging Markets Small Cap
Annual Standard Deviation (%)	48.35	36.48	47.34

Emerging Markets Value data courtesy of Fama/French prior to Dimensional's 3/93 inception.
IFC data courtesy of International Finance Corporation.
Emerging Markets Small Cap data simulated by Dimensional prior to 3/98 portfolio inception.

Performance information for Emerging Markets Value and Emerging Markets Small are based in part on a model/backtested simulation; the performance was achieved with the retroactive application of a model designed with the benefit of hindsight; it does not represent actual investment performance. The model's investment objective is to achieve long-term capital growth. The model's performance reflects the reinvestment of dividends and other earnings, and is net of fees. There are limitations inherent in model performance. Past performance is no guarantee of future results, and there is always the risk that an investor may lose money.

Based on the limited amount of data available, size and value effects also appear in emerging markets. The IFC Investables Total Return Index represents a portfolio of tradable stocks in emerging markets countries that non-resident investors are permitted to own. During 1989-2001, emerging markets small cap stocks and value stocks had higher average returns than the IFC index (Figure 9).[8]

The international findings are consistent with Fama and French's interpretation of the size and value effects as rewards for bearing non-diversifiable risk. If size and value effects were related to risk factors unique to the US, forming globally diversified portfolios could eliminate them. Instead, the existence of similar size and value effects in both domestic and international stock returns demonstrates that these effects are global phenomena reflecting exposures to ubiquitous sources of risk.

Implications for Global Equity Allocation[9]

EAFE is the international equivalent of the S&P 500. EAFE returns, expressed in US dollars, are determined jointly by stock returns computed in local currencies and foreign-exchange gains or losses against the dollar. Because the two indexes contain stocks with similar size and value characteristics, it is reasonable to assume that the costs of capital of EAFE and the S&P 500 are approximately equal. If it is also assumed that currencies have zero expected returns, EAFE should have about the same expected *gross* rate of return as the S&P 500.

While their expected *gross* returns are similar, the expected *net* return of an S&P 500 portfolio will be greater than that of an EAFE portfolio due to differences in trading costs and taxes. International stocks are more costly to trade, and the dividends of international stocks are subject to foreign taxation—even when the recipients are tax-exempt in the US For example, American pension funds pay no taxes on dividends received from US firms, but they are taxed at rates of 15 to 20 percent on dividends received from many foreign companies.[10]

Many American investors rely on EAFE-like portfolios for international diversification. But given the likelihood that the S&P 500 offers a higher expected *net* rate of return and similar risk exposures, EAFE is nothing more than an expensive substitute for the S&P 500. The diversification benefits afforded by EAFE are minimal and not worth their cost.

Instead of EAFE, Dimensional recommends that American investors use international and emerging markets small cap and value stocks for global diversification. These asset classes have higher expected gross returns than the S&P 500 that can compensate for the higher costs and taxes of international investing.

Concluding Comments

The identification of size and value factors by Fama and French has important implications for equity portfolio design. Relative to traditional market-like portfolios, portfolios with greater exposures to the size and value factors offer higher expected long-term rates of return.

Structured portfolios can be designed that provide targeted sensitivities to the size and value factors. Dimensional's asset class portfolios can serve as building blocks for these structured portfolios.

International and emerging markets equity returns also exhibit size and value effects. For global diversification, Dimensional recommends the use of its international and emerging markets small cap and value stock funds.

Structured portfolios only make sense for investors with long time horizons and sufficient tolerance for increased risk. For the right investors, structured portfolios are promising alternatives to old-fashioned market-like portfolios.

My thanks to Jim Davis and Weston Wellington for their helpful comments.

---

[1] Fama and French (1992) examined data beginning in 1963. Davis, Fama and French (2000) investigated data from 1929 through 1963. Davis, Fama and French found evidence of similar size and value effects in this earlier period. This demonstrates that the original Fama and French findings are not unique to a particular sample period. Size and value effects are pervasive determinants of US stock returns.

[2] The higher average return of the CRSP 6-10 relative to the S&P 500 also illustrates the size effect.

[3] Size and BtM are firm characteristics that tend to be associated with fundamental risk factors, but they are not risk measures or factors themselves. Small stocks are not riskier than large stocks just because they are smaller. Value stocks are not riskier than growth stocks just because they have higher BtMs. Instead, size and BtM on average appear to be linked to fundamental risk factors that have yet to be identified. Identification of these fundamental risk factors is a challenge for future research.

[4] Although the estimated market sensitivities of the three small cap portfolios suggest similarity to stock/bond mixes, these portfolios were invested fully in equities. The model's estimated slope coefficients depend on the sample period, and they change when the sample period changes. For the sample period 1991-2000, the estimated market sensitivities were .97 for Small Cap, .87 for Micro Cap and .94 for Small Value. For the sample period 1992-2001, the estimated market sensitivities for these three portfolios were lower, as reported in Table 1.

[5] The factor sensitivities of portfolios *P1-P4* are weighted averages of the sensitivities of component portfolios. For example, *P2*'s value sensitivity (*h*=.22) equals .7 times the S&P 500's value sensitivity (.05) plus .3 times the Large Cap Value fund's value sensitivity (.61).

[6] Taxes also influence the suitability of structured portfolios for investors. Dimensional's "pure" asset-class funds often have large capital-gains distributions. This makes the pure strategies more appropriate for tax-exempt and tax-deferred accounts than for taxable accounts. Dimensional offers tax-managed versions of some of its asset-class strategies, and these funds can be used to build structured portfolios for taxable accounts. For select wealthy investors, Dimensional offers separate accounts that employ a comprehensive tax-management system to increase long-term after-tax returns.

[7] Fama and French (1998) documented the existence of a value factor in international stock returns.

[8] Different time periods were used to compute the returns statistics for domestic (Figure 1), international (Figure 8) and emerging markets (Figure 9) equities. The sample periods were determined by data availability.

[9] This section is based on the arguments and findings of Sinquefield (1996).

[10] Taxable investors receive credits for foreign taxes paid. Tax-exempt investors do not. US tax-exempt investors may petition foreign governments for return of taxes withheld, but the process of reclaiming foreign withholding taxes on dividends often is time-consuming, frustrating and expensive.

Davis, James L., Eugene F. Fama and Kenneth R. French. "Characteristics, Covariances and Average Returns: 1929-1997." *Journal of Finance* 55 (2000), 359-406.

Fama, Eugene F. and Kenneth R. French. "The Cross-Section of Expected Stock Returns." *Journal of Finance* 47 (1992), 427-65.

Fama, Eugene F. and Kenneth R. French. "Size and Book-to-Market Factors in Earnings and Returns." *Journal of Finance* 50 (1995), 131-55.

Fama, Eugene F. and Kenneth R. French. "Value versus Growth: The International Evidence." *Journal of Finance* 53 (1998), 1975-99.

Sinquefield, Rex A. "Where are the Gains from International Diversification?" *Financial Analysts Journal* 52 (1996), 8-14.