Measuring Mutual Fund Performance

The ability to reliably measure investment performance has become increasingly important given the rapid proliferation of financial products and the unprecedented increase in the public ownership of mutual funds over the past 20 years. Throughout the 1980's and 1990's, the size and scope of the mutual fund industry has increased almost exponentially, with more than a ten-fold increase in the number of mutual funds available to investors, and a twenty-five-fold increase in mutual fund assets.[1] By the end of 1997, investors could choose from roughly 6,800 equity, bond and income, and money market funds, and the analysis, evaluation, and rating of such funds had become a significant business for firms such as Morningstar, Inc. and Lipper Analytical Services.

The measurement of the performance of mutual funds serves a number of critical purposes. Investment advisors and private and professional investors rely on performance measurement to make portfolio allocation decisions. Companies that offer 401(k) plans to their employees require performance assessments in deciding which investment alternatives to offer their employees. Mutual funds themselves need to measure their performance in order to evaluate and compensate the professional investment managers who work for them. And mutual fund boards of directors are instructed to consider the performance of a mutual fund in the negotiation of fees with management companies. In all of these instances, the ability to sensibly measure the performance of a given fund is crucial.

In this note, we examine various methods of measuring mutual fund performance. We specifically outline two types of approaches: one that is based on a fund's exposure to broad market risk factors and one that is based on its overall level of risk. Then we examine the process by which the influential mutual fund rating service, Morningstar, Inc., calculates its star ratings. We also apply the approaches to a variety of Fidelity funds to demonstrate the effect of using different metrics to measure fund performance (see **Exhibit 1**).

Historical Versus Future Returns

To the extent that a mutual fund's past performance can serve as a reliable indicator of the skill of its manager, the measurement and assessment of the historical returns of funds becomes a useful tool in determining an investment strategy. The assumption that past and future performance are related, is a

[1] "Mutual Fund Factbook," Investment Company Institute, 1997.

Charles M. Williams Fellow Markus F. Mullarkey and Professor André F. Perold prepared this note as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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contentious one, however, as numerous academic studies have demonstrated that a fund's past performance is only weakly correlated (if at all) with its future performance.[2]

Nonetheless, investors seem to rely heavily on past performance as an indicator of investment management skill. For example, in 1995 The Wall Street Journal reported that almost 90% of the new money that flowed into stock funds went to funds whose historical performance had received a four-star or five-star Morningstar rating.[3] This pattern is confirmed by academic findings that indicate that mutual fund consumers disproportionately invest in funds with strong prior-year returns (particularly among funds in the top 20th percentile in prior-year performance).[4]

Total Returns

A basic measure of a fund's return is its average total return over a standard holding period (one year, for example). Total return consists of investment income (such as dividends or coupon interest payments) plus capital gains or losses (the appreciation or depreciation in the price of the fund's shares over the time period). Load fees (such as front-end sales charges and brokerage fees) and other administrative charges are also often reported.

In addition, returns are increasingly being reported on an after-tax, as well as a before-tax, basis. However, after-tax returns are difficult to calculate in practice, as the appropriate tax rate to apply to a fund's total return varies depending on an investor's tax bracket and state of residence, the fund's distribution policies, and the investor's holding period and cost basis.

Arithmetic versus Geometric Averaging

In calculating and reporting historical performance over a given period, returns are usually averaged. In practice, this is typically done in terms of a fund's compounded annualized return. For example, if a fund has achieved a cumulative five year return of 60%, it's annualized compounded return is 9.9% (given by the following: $(1.60)^{1/5} - 1.00$). This is a geometric average return. However, for the purposes of investment decision-making, it is more appropriate to use the arithmetic average of the fund's historical returns over short time intervals such as daily, weekly, or monthly periods (i.e., the sum of the individual interval returns divided by the number of such intervals in a year). The arithmetic average is then annualized by multiplying this number by the number of days, weeks, or months in a year. To a first order approximation, the arithmetic average is higher than the geometric average by $\frac{1}{2}\sigma^2$, where both averages are calculated over the same observation frequency (e.g., daily, weekly, or monthly),

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[2] Michael Jensen pioneered the area of mutual fund performance measurement in his article "The Performance of Mutual Funds in the Period 1945-64" (*Journal of Finance,* 23 (2), May, 1968). The study found that funds on average were not able to outperform a buy the market and hold policy, and that individual fund returns were not better than would be expected by random chance. This finding was particularly striking in that Jensen studied fund returns before accounting for fund expenses. Since that time, numerous studies have updated and refined this type of analysis, and debate continues as to the ability of funds to generate persistent, market-adjusted outperformance. Specific articles include: "The Persistence of Mutual Fund Performance" (Mark Grinblatt and Sheridan Titman, *Journal of Finance,* 47 (5), December, 1992), "Hot Hands in Mutual Funds: Short-Run Persistence of Relative Performance, 1974-1988" (Darryll Hendricks, Jayendu Patel, and Richard Zeckhauser, *Journal of Finance,* 48 (1), March, 1993), "On Persistence in Mutual Fund Performance" (Mark M. Carhart, *Journal of Finance,* 52 (1), March, 1997), and "Measuring Mutual Fund Performance with Characteristic-Based Benchmarks" (Kent Daniel, Mark Grinblatt, Sheridan Titman, and Russ Wermers, *Journal of Finance,* 52 (3), July, 1997).

[3] Wall Street Journal, April 5, 1995.

[4] See Erik R. Sirri and Peter Tufano, "Costly Search and Mutual Fund Flows," forthcoming publication in the *Journal of Finance*, 1998.

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and σ is the standard deviation of the fund's daily, weekly, or monthly returns. In practice, this can be a large difference. For example, if σ=20% per annum, the annualized arithmetic average exceeds the annualized geometric average by roughly 2% per annum.

Alpha

The goal of most performance measurement approaches is to determine a fund's alpha (α), the amount by which the fund has outperformed or underperformed its investment benchmark. Determining the appropriate benchmark is usually the most difficult part of performance measurement. A benchmark is typically chosen so as to represent investments with a similar level of risk as the fund, and to represent the universe of investments from which the fund manager chose the fund's holdings.

The difference between total return and alpha is illustrated in the following example. Consider two funds: an equity fund and a long-term, high-grade bond fund. The equity fund returned 20% per annum over the three years ending December 31, 1997, while the bond fund returned 13% per annum. From a naive total return perspective, the equity fund had better performance. However, equities in general (as represented by the Standard & Poor's 500 index) returned 28.0% per annum over the same period, while long-term, high-grade bonds returned 10.7% per annum (as represented by the Lehman Government/Corporate index). In this case, the bond fund outperformed its benchmark, while the equity fund failed to do so. As a result, the bond fund has a higher alpha, as is shown below:

Comparison of Investment Performance

	Risk	Return		Risk	Return
Equity Fund	Equities	20.0%	Bond Fund	Interest Rates	13.0%
S&P 500 index	Equities	28.0%	Lehman Gov't/Corp index	Interest Rates	10.7%
Alpha (α)		-8.0%	Alpha (α)		+2.3%

In practice, benchmarks for funds are often customized more narrowly than with an entire asset class (e.g., with bond investments of a particular maturity range; foreign or large- or small-capitalization equities; or in particular economic sectors, geographic areas, or industries). Morningstar, for example, uses a variety of comparisons for each of the funds it rates: (1) each is compared on a basic level to the return one could earn by investing in U.S. Treasury bills; (2) each is placed in one of four broad asset classes and compared to other funds in that asset class; (3) each is placed in one of 44 more narrow categories based on the fund's holdings and compared with other funds in that category; and (4) each is compared to the benchmark performance index (of 21 different potential indexes) that best fits the fund's risk profile.

The appropriate risk characteristics of a given fund can be difficult to determine. For example, a fund tends to be classified based on its investment objectives (as described in the fund's prospectus) rather than on the actual investments or performance of the fund. Because of this, there is often potential for misclassification. If an equity growth fund had a significant amount of its portfolio invested in utilities, for example, comparing it to a benchmark consisting of other "growth" funds could lead to a significant misstatement of the fund's performance due to the income-oriented nature of utility stocks. Also, the risk characteristics of funds often change over time,[5] which requires the benchmark to be periodically reevaluated and revised.

[5] William F. Sharpe, for example, demonstrated that the exposure of Fidelity's Magellan fund to growth and small stocks shifted substantially during the 1980's — "Asset Allocation: Management Style and Performance," *Journal of Portfolio Management*, Winter, 1992, p. 7-19.

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Risk-Adjusted Return

"Risk-adjusted return" refers to measurement of a fund's alpha with respect to a benchmark whose risk is quantitatively matched with that of the fund being evaluated. In this sense, it is just an extension of the process outlined above. It is an important refinement in that it permits adjustments for leverage and exposures to various types of risk factors.

The two most widely-used measurements of a fund's risk are its beta (β) and its standard deviation of returns — sigma (σ). A fund's beta is measured with respect to a given risk factor (e.g., overall stock market movements) and represents the fund's exposure to that risk. It measures the extent to which that factor will affect the value of the fund. A fund's sigma, on the other hand, reflects the total risk of the fund, and includes not only the fund's exposure to a given risk factor, but also the idiosyncratic, residual risk that is unique to the fund.

Using Beta to Measure Risk-Adjusted Returns

As noted above, beta measures a fund's exposure to a given risk factor. A simple example of how this can be used to measure risk-adjusted performance is to consider two funds, both of which invest a portion of their assets in the S&P 500 index and the remainder in Treasury bills (the risk free asset).[6] Suppose Fund A invests 70% in the S&P 500 index and 30% in Treasury bills, and Fund B invests 50% in each. If the S&P 500 index returned 28.0% per annum and Treasury bills returned 5.4% per annum, then the returns of the two funds would be as follows:

Comparison of Fund Returns

S&P 500 index total return	28.0%	
Treasury bill return	5.4%	
	Fund A	**Fund B**
% in the S&P 500 index	70%	50%
% in Treasury bills	30%	50%
Total return[1]	21.2%	16.7%

[1]Calculated as: (% in S&P × S&P return) + (% in Bills × Treasury bill return).

Risk adjustment of these total returns is straightforward as the risk of both funds is comprised solely of the risk of the S&P 500 index. Because Fund A is 70% exposed to the risk of the S&P 500 index, its beta with respect to the S&P 500 index is 0.70. Similarly, the beta of Fund B is 0.50. Knowing these betas, we can create benchmark returns for funds A and B as follows:

$$\text{Benchmark Return}_{\text{Fund}} = \beta \times \text{Return}_{\text{S\&P 500 index}} + (1-\beta) \times \text{Return}_{\text{Treasury bills}}$$

$$= \text{Return}_{\text{Treasury bills}} + \beta \times (\text{Return}_{\text{S\&P 500 index}} - \text{Return}_{\text{Treasury bills}})^{7}$$

Note that this formulation of a fund's benchmark return is similar to the formula for expected return given by the capital asset pricing model (CAPM). It is in fact identical when the fund's beta is calculated with respect to the market portfolio. It is important to note, however, that the usefulness of this technique can apply to benchmarks based on any risk factor (or combination of risk factors), whether or not the CAPM correctly describes expected returns.

[6] This example assumes that both funds rebalance their portfolios to maintain their targeted proportions, and that the returns on the S&P 500 index and on Treasury bills are expressed in terms of annualized arithmetic averages.

[7] This formula holds only for arithmetically-averaged returns, and not for geometrically-averaged returns.

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Once the benchmark has been defined, funds' returns can be compared on a risk-adjusted basis as follows:

Comparison of Investment Performance

S&P 500 index total return	28.0%	
Treasury bill return	5.4%	
	Fund A	**Fund B**
Fund beta (β)	0.70	0.50
Benchmark return:		
$\text{Return}_{\text{Treasury bills}} + \beta \times (\text{Return}_{\text{S\&P 500 index}} - \text{Return}_{\text{Treasury bills}})$	21.2%	16.7%
Actual fund return	21.2%	16.7%
Fund alpha (α)	0.0%	0.0%

Thus, while Fund A had a higher total return than Fund B, the two funds had the same risk-adjusted returns — their alphas are both zero. The alphas are both zero because neither fund manager actively manages the fund's assets.

In this example, we know the funds' betas by construction. Often, however, betas must be estimated statistically. One method for estimating a fund's beta is to regress the historical returns of the fund (in excess of the risk-free return) on the returns of the risk factor (also in excess of the risk-free rate). Such a regression will fit the best linear approximation of the relationship between the returns of the fund and the risk factor (see **Exhibit 2**). The slope of this line, the fund's beta, is the fund's exposure to the risk.

Consider the results of the following regressions between the monthly returns of Fidelity's Growth & Income Fund and Contrafund, and the monthly returns on the S&P 500 index, over the three-year period ending December 31, 1997:

Regression Results

	Fidelity Growth & Income Fund	**Fidelity Contra-fund**
Fund alpha (α) - annualized	0.5%	1.4%
Fund beta (β)	0.87	0.79
Fund sigma (σ)	10.1%	11.3%
Standard deviation of unexplained returns (σ_{residual})	2.2%	6.9%
Regression R^2	0.95	0.63

σ_{residual} is that portion of a fund's overall variation that is not explained by the regression between the fund's returns and the returns of the risk factor. It is related to the fund's beta and sigma as follows:

$$(\sigma_{\text{fund}})^2 = (\beta_{\text{fund vs. risk factor}})^2 \times (\sigma_{\text{risk factor}})^2 + (\sigma_{\text{residual}})^2$$

This can also be stated in reference to the R^2 measure associated with the regression between the fund's returns and the returns of the risk factor as follows:

$$(\sigma_{\text{residual}})^2 = (\sigma_{\text{fund}})^2 \times (1\text{-Regression } R^2)$$

Once the beta is estimated, a benchmark return can be calculated as above, and a fund's performance can be measured as follows:

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Comparison of Investment Performance (3 years ending December 31, 1997)

S&P 500 index total return	28.0%	
Treasury bill return	5.4%	
	Fidelity Growth & Income Fund	**Fidelity Contra-fund**
Fund beta (β)	0.87	0.79
Benchmark return:		
$\text{Return}_{\text{Treasury bills}} + \beta \times (\text{Return}_{\text{S\&P 500 index}} - \text{Return}_{\text{Treasury bills}})$[1]	25.2%	23.3%
Actual fund return	25.7%	24.7%
Fund alpha (α)	0.5%	1.4%

[1] Numbers may not add exactly due to rounding.

In this example, while the Fidelity Growth & Income Fund experienced higher returns (25.7% vs. 24.7%), the Fidelity Contra Fund can be considered more attractive because of its higher alpha (1.4% vs. 0.5%).

Note, however, that the standard deviation of the unexplained returns of the Contrafund is much higher than that for the Growth & Income Fund (from the table on the preceding page), so that the benchmark return constructed for the Contrafund is potentially less meaningful than that constructed for the Growth & Income Fund. If the unexplained risk is diversifiable, idiosyncratic risk, investors should not require a return for it, and its exclusion from Contrafund's benchmark is appropriate.[8] If the unexplained risk is a market-priced, systematic risk, however, not incorporating it in the benchmark will mis-state Contrafund's alpha. For example, if Contrafund invested in long-term bonds *and* equities, but its beta is calculated only with respect to equity risk (i.e., ignoring interest-rate risk), the benchmark return will be too low, and the alpha too high. In this case, Contrafund's benchmark should be adjusted to incorporate both types of systematic risk. This is accomplished by simultaneously regressing its returns against as many risk factors as are necessary. The resulting betas are then incorporated into a benchmark return as follows:

$$\text{Benchmark Return} = \text{Return}_{\text{Risk free}} + \beta_1(\text{Return}_1 - \text{Return}_{\text{Risk free}}) + \ldots + \beta_n(\text{Return}_n - \text{Return}_{\text{Risk free}})$$

This multi-factor approach is particularly important in the case of mutual funds, as they can (and often do) retain exposure to multiple asset classes such as equities, bonds, foreign exchange, etc.[9]

Using Sigma to Measure Risk-Adjusted Returns – The Sharpe Ratio

A popular alternative to using betas to adjust for risk, and perhaps the simplest approach to measuring risk-adjusted return, is to compare funds on the basis of their returns relative to total risk — sigma (σ). The Sharpe Ratio is one approach to doing this. It measures a fund's excess return over Treasury bills per unit of total risk:

$$\text{Sharpe Ratio}_{\text{Fund}} = (\text{Return}_{\text{Fund}} - \text{Return}_{\text{Risk-free}})/\sigma_{\text{Fund}}$$

Revisiting our earlier example of the two funds, Fund A and Fund B, which both invest only in the S&P 500 index and cash, we see that the funds have identical Sharpe Ratios as a result of the fact that

[8] The rationale for this statement is akin to the rationale underpinning the capital asset pricing model (i.e., that investors only require compensation for undiversifiable risk, and will freely bear other risks).

[9] William F. Sharpe points out in the study referenced above that even funds with relatively specific investment goals (utility funds, for example) are exposed to the risk of a number of different asset classes.

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both generate the same return per unit of risk (i.e., the S&P 500 index's return in excess of Treasury bills divided by the S&P 500 index's level of risk):

Comparison of Investment Performance

Treasury bill return		5.4%	
	S&P 500 index	**Fund A**	**Fund B**
Actual return	28.0%	21.2%	16.7%
Excess return over Treasury bills	22.6%	15.8%	11.3%
Standard deviation of returns (σ)[1]	11.3%	7.9%	5.7%
Sharpe Ratio	2.0	2.0	2.0

[1]Since both funds invest only in the S&P 500 index, the funds' sigmas are equal to the market sigma multiplied by the percentage of the fund's portfolio that is invested in the market.

This process can also be applied to the actual funds we examined above. Based on their Sharpe Ratios, the Growth & Income Fund can be considered more attractive than the Contrafund:

Comparison of Investment Performance

Treasury bill return		5.4%
	Fidelity Growth & Income Fund	**Fidelity Contra-fund**
Actual fund return	25.7%	24.7%
Excess returns over the risk free rate	20.3%	19.3%
Standard deviation of returns (σ)[1]	10.1%	11.3%
Sharpe Ratio	2.0	1.7

[1]To annualize the standard deviation of monthly returns, the monthly standard deviation was multiplied by the square root of twelve.

The use of the Sharpe Ratio has gained wide acceptance among academics and practitioners because of its ease in application as outlined above. Also, its calculation uses metrics which are easily observable (at least in hindsight), and are therefore perhaps more transparent. [10]

However, using Sharpe Ratios as the only measure of a fund's risk-adjusted return has a critical drawback. Specifically, it only evaluates an individual fund's performance in isolation, and it ignores the degree to which fund risk can be diversified by holding the fund in combination with other investments. That is, the total risk of the fund is not equal to the incremental risk the fund generates in an investor's overall portfolio.

The Risk Adjusted Performance (RAP) Measure

Another way to measure a fund's risk-adjusted return using sigma is to calculate its Risk-Adjusted Performance (RAP) measure as suggested by Modigliani and Modigliani.[11] Similar to the Sharpe Ratio, the RAP is based on the fund's return, the standard deviation of the returns, and the risk-free rate-of-return. The RAP adjusts the fund's returns to capture the return an investor would have earned in a particular period if the fund's returns had been diluted or leveraged to match a benchmark

[10] W.F. Sharpe, "The Sharpe Ratio," *The Journal of Portfolio Management*, Fall, 1994.

[11] F. Modigliani & L. Modigliani, "Risk-Adjusted Performance," *The Journal of Portfolio Management*, 23 (2), Winter, 1997.

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level of volatility. This is accomplished by hypothetically blending shares of the fund with lending or borrowing at the risk-free rate to achieve a benchmark level of risk such as that of the S&P 500 index. Under this process, funds with greater volatility than the benchmark are combined with cash, while funds with less volatility are leveraged. The RAP measure can be stated mathematically as follows:

$$\text{Risk Adjusted Performance}_{\text{Fund}} = (\sigma_{\text{Benchmark}}/\sigma_{\text{Fund}})\text{Return}_{\text{Fund}} + (1 - \sigma_{\text{Benchmark}}/\sigma_{\text{Fund}})\text{Return}_{\text{Risk-free}}$$

Returning to our previous example, we can evaluate the performance of Fidelity's Growth & Income Fund and Contrafund using the RAP methodology as follows:

Comparison of Investment Performance

S&P 500 index total return	28.0%	
Treasury bill return	5.4%	
S&P 500 index sigma (σ)	11.3%	
	Fidelity Growth & Income Fund	**Fidelity Contra-fund**
Actual fund return	25.7%	24.7%
Fund sigma (σ)	10.1%	11.3%
Hypothetical portfolio[1]		
% in fund	111.7%	100.0%
% in cash[2]	-11.7%	0.0%
Sigma of hypothetical portfolio[3]	11.3%	11.3%
RAP (return of hypothetical portfolio)	28.1%	24.7%

[1]The hypothetical portfolio is constructed so as to have a sigma equal to the sigma of the S&P 500 index. This is accomplished by blending the fund with excess cash or leverage to dampen or magnify the fund's volatility of returns.

[2]A negative cash position in the hypothetical portfolio represents levering a fund's returns by borrowing at the risk-free rate.

[3]The sigma of the hypothetical portfolio equals the fund's sigma multiplied by the hypothetical portfolio's percentage investment in the fund.

According to the RAP measure, the Growth & Income Fund had better performance than the Contrafund, and the Growth & Income Fund slightly outperformed the S&P 500 index.

While the RAP approach represents a different calculation than the Sharpe Ratio, it will rank funds in exactly the same way as the Sharpe Ratio, provided that the fund returns are adjusted to the same benchmark level of volatility. This is because the RAP measure is linearly related to a fund's Sharpe Ratio. Specifically, the RAP and Sharpe Ratio of a given fund are related according to:

$$\text{RAP}_{\text{Fund}} = \text{Return}_{\text{Risk-free}} + \text{Sharpe Ratio}_{\text{Fund}} \times \sigma_{\text{Benchmark}}$$

This can be seen in **Exhibit 3**, where the funds' annualized returns are graphed relative to the annualized standard deviation of their monthly returns.

The Morningstar Rating System

Morningstar's rating system was created in 1984 to distill the large amount of mutual fund data the company collected into a practical, simple-to-understand rating that investors could use as a first step in making investment decisions. The star system was not meant to be prescriptive in that it wasn't

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designed to predict future fund performance. As originally conceived, the rating system would take in broad measures of a fund's historical performance, and mathematically calculate a rating for the fund by comparing the fund's relative performance with other funds in the same asset class (see **Exhibit 4** for a sample calculation of a representative fund's rating).[12] Relative performance was measured in terms of return and risk as follows: [13]

Cumulative excess returns A fund's cumulative return would be calculated over the past three years, five years, and ten years, depending on the amount of data that was available.[14] Morningstar calculated fund returns net of the total costs assessed to the fund as a result of management fees, distribution fees, etc. The inclusion of *all* the expenses related to investing in the fund was one of the first ways Morningstar set itself apart from others in the industry. Cumulative returns were calculated as follows:

Cumulative Return = [Product (1 + Monthly Return)] * (1 - Load Factor)

where:

Cumulative Return = the cumulative value of $1 invested in the fund

Monthly Return = the fund's monthly return including investment of income and additions to and distributions from the fund

Load Factor = the maximum front-end load fees, applicable deferred loads, and applicable redemption fees for an investment in the fund

Cumulative excess returns were calculated by subtracting the cumulative return on Treasury bills from the cumulative return of the fund.

Risk A fund's risk also would be assessed on a past three-year, five-year, and ten-year basis. Morningstar's measure of risk averaged the amount by which the fund under-performed Treasury bills in each month.[15] This was a somewhat unconventional measure of risk, as most in the industry associated fund risk with either the volatility of the fund's returns or the fund's exposure to fluctuations in the market as a whole (the fund's beta).

Relative Performance Morningstar then calculated the *relative* performance of the fund as follows: Relative risk was defined as the ratio of a fund's risk to the average risk of all funds in its asset class. Relative return was defined as the ratio of a fund's cumulative excess return to a benchmark return, where the benchmark return was the larger of the cumulative return of Treasury bills and the average cumulative excess return of funds in the fund's asset class. The benchmark return was the same for all funds in the asset class. A fund's risk-adjusted return was calculated by subtracting its relative risk from its relative return:

Risk-adjusted Return = Relative Return - Relative Risk

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[12] See HBS Case No. 298-140, *Morningstar, Inc.*, for a more detailed treatment of Morningstar's business and an overview of the controversy surrounding its rating system.

[13] Much of the analysis and understanding of Morningstar's rating system is based on work carried out by Willam F. Sharpe at Stanford University. See *http://www-sharpe.stanford.edu/stars1.htm* for more details.

[14] Morningstar had a policy of only rating funds for which they had 36 months of data available. All such funds would receive a three-year star rating, and consequently an overall star rating. For obvious reasons, however, only funds with 60 and 120 months of available data would receive five-year and ten-year star ratings.

[15] If the fund outperformed T-bills in a given month, the "under-performance" was measured as zero.

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Morningstar Ratings Morningstar would then rank the funds in a given asset class by this risk-adjusted return, and use the ranking to determine funds' three-year, five-year, and ten-year star ratings according to the following table:

Table 1 Distribution of Morningstar three year, five year, and ten year star ratings

Rating	Percentage of Funds
★★★★★	Top 10%
★★★★	Next 22.5%
★★★	Next 35%
★★	Next 22.5%
★	Bottom 10%

A fund's overall star rating was a combination of its three-year, five-year, and ten-year star ratings based on how many years of data were available. To calculate the overall rating, Morningstar averaged the number of three-year, five-year, and ten-year stars a fund received according to the weights in **Table 2** below, and rounded this average to the nearest whole number of stars:

Table 2 Components of Morningstar's overall star rating

	Weights:		
Ratings Available	3-year rating	5-year rating	10-year rating
3-year only	100%		
3-year and 5-year	40%	60%	
3-year, 5-year, and 10-year	20%	30%	50%

Other Measures In addition to three-year, five-year, and ten-year star ratings and the overall star rating, Morningstar calculated a category rating that compared a fund's performance to that of other funds in its narrow investment category (see **Exhibit 5** for a list of Morningstar's 44 fund categories). Morningstar also provided a number of other measures of fund performance including many of the most widely-used performance metrics such as funds' alphas, betas, and Sharpe Ratios.[16] In addition, Morningstar developed a specialized alpha and beta for each fund by regressing the fund's returns on twenty-one Morningstar-selected indexes. The results of the regression that generated the highest R^2 were reported as the fund's "best fit" alpha and beta.

[16] Domestic and international equity fund alphas and betas were calculated with respect to the Standard & Poor's 500 Index, while taxable and municipal bond fund alphas and betas were calculated with respect to the Lehman Brothers Aggregate Bond Index.

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Conclusion

In this note, we have examined different metrics of mutual fund performance, and we have shown how the choice of methodology can lead to potentially large differences in a fund's performance assessment. **Exhibit 1** illustrates this by measuring the performance of twelve Fidelity funds according to the various methods described in this note. Understanding the advantages and disadvantages of each methodology is a critical first step in understanding mutual fund performance.

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Exhibit 1 Performance data for twelve Fidelity funds — January, 1995 - December, 1997. The data have been annualized for comparison purposes.

Performance Metrics	Magellan	Low Price Stock	Contra-fund	Growth & Income	World-wide	Japan	SE Asia	Natural Gas	American Gold	Biotech	Financial Services	Utilities
Total return[1]	22.9%	23.9%	24.7%	25.7%	12.4%	-6.8%	-6.3%	17.5%	-2.1%	21.4%	35.3%	22.3%
Alpha vs. the S&P 500 Index	-3.5%	7.6%	1.4%	0.5%	-7.8%	-28.3%	-40.6%	3.9%	-17.9%	0.3%	5.0%	3.3%
Beta vs. the S&P 500 Index	0.93	0.48	0.79	0.87	0.66	0.71	1.28	0.36	0.46	0.69	1.10	0.60
Customized benchmark	S&P 500 index	Barra/ S&P Value index	S&P 500 index	S&P 500 index	World-wide equities index	Japanese equity index	SE Asian equities index	Natural gas equities index	Index of American gold equities	Index of biotech equities	Index of financial services equities	Index of utilities equities
Customized alpha	-3.5%	7.9%	1.4%	0.5%	-2.8%	4.5%	5.8%	-9.7%	0.1%	4.9%	-1.9%	4.5%
Customized beta	0.93	0.57	0.79	0.87	0.78	0.84	1.17	1.14	0.82	0.59	0.96	0.75
Standard deviation of returns	12.3%	8.9%	11.3%	10.1%	10.6%	18.0%	24.0%	17.6%	31.4%	16.8%	14.0%	9.3%
Sharpe Ratio	1.4	2.1	1.7	2.0	0.7	-0.7	-0.5	0.7	-0.2	1.0	2.1	1.8
Risk adjusted perf (RAP) [2]	21.5%	28.7%	24.7%	28.1%	12.9%	-2.6%	-0.1%	13.2%	2.7%	16.2%	29.5%	25.9%

Ranking among the 12 Funds	Magellan	Low Price Stock	Contra-fund	Growth & Income	World-wide	Japan	SE Asia	Natural Gas	American Gold	Biotech	Financial Services	Utilities
Total return[1]	5	4	3	2	9	12	11	8	10	7	1	6
Alpha vs. the S&P 500 Index	8	1	5	6	9	11	12	3	10	7	2	4
Customized alpha	11	1	6	7	10	4	2	12	8	3	9	5
Sharpe Ratio	6	2	5	3	9	12	11	8	10	7	1	4
Risk-adjusted performance (RAP)	6	2	5	3	9	12	11	8	10	7	1	4
Morningstar Rating	★★★★	★★★★★	★★★★	★★★★★	★★★★	★★	★★	★	★★	★★	★★★★★	★★★★

Source: Datastream, Fidelity Investments, Morningstar, and casewriter calculations

[1] Annualized arithmetic average of monthly returns.

[2] The RAP calculations assume a benchmark level of volatility of 11.3% p.a., equal to that of the S&P 500 over the three years ending December 31, 1997.

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Exhibit 2 Rregression results for Fidelity's Growth & Income Fund and Contrafund

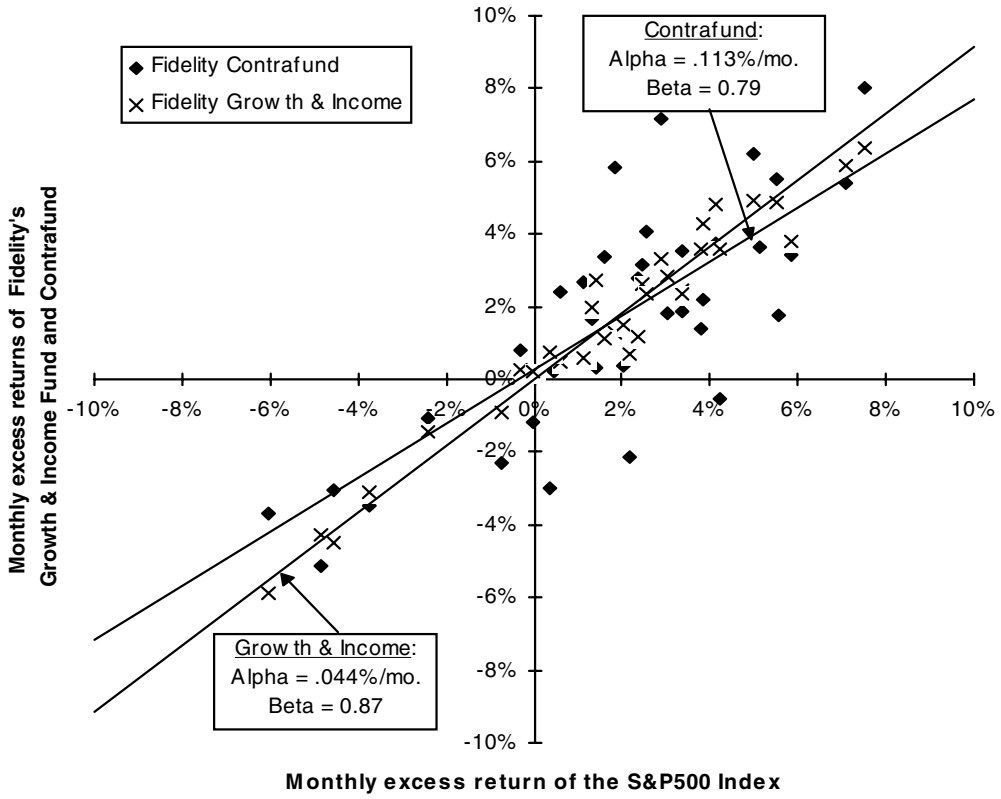

Exhibit 3 Sharpe Ratio and RAP measures for Fidelity's Growth & Income Fund and Contrafund

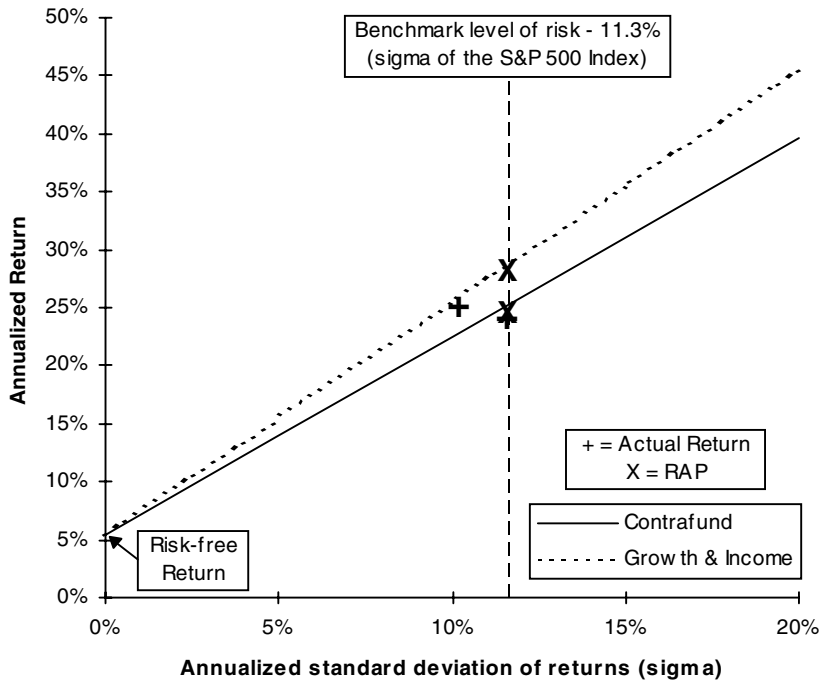

Exhibit 4 Calculation of the star rating for Fidelity's Contrafund - December 1997

	Return		Excess Return		Cumulative Return	
	Contrafund	3 month T-Bill	Actual	Negative	Contrafund	3 month T-Bill
Jan-95	-1.62%	0.50%	-2.11%	-2.11%	-1.62%	0.50%
Feb-95	4.03%	0.49%	3.53%	0	2.34%	0.99%
Mar-95	3.65%	0.49%	3.16%	0	6.08%	1.49%
Apr-95	4.51%	0.48%	4.03%	0	10.87%	1.98%
May-95	2.41%	0.49%	1.93%	0	13.54%	2.47%
Jun-95	6.34%	0.47%	5.87%	0	20.74%	2.95%
Jul-95	7.66%	0.47%	7.19%	0	29.99%	3.43%
Aug-95	1.32%	0.46%	0.86%	0	31.70%	3.91%
Sep-95	1.83%	0.45%	1.38%	0	34.11%	4.38%
Oct-95	-1.82%	0.45%	-2.27%	-2.27%	31.67%	4.85%
Nov-95	2.63%	0.46%	2.18%	0	35.14%	5.33%
Dec-95	0.84%	0.44%	0.41%	0	36.28%	5.79%
Jan-96	2.26%	0.43%	1.84%	0	39.36%	6.24%
Feb-96	0.61%	0.41%	0.20%	0	40.21%	6.68%
Mar-96	2.78%	0.42%	2.35%	0	44.10%	7.13%
Apr-96	3.09%	0.42%	2.67%	0	48.56%	7.58%
May-96	0.84%	0.43%	0.41%	0	49.81%	8.04%
Jun-96	-0.76%	0.44%	-1.19%	-1.19%	48.68%	8.51%
Jul-96	-4.68%	0.44%	-5.12%	-5.12%	41.72%	8.99%
Aug-96	3.81%	0.43%	3.38%	0	47.13%	9.47%
Sep-96	4.11%	0.44%	3.67%	0	53.17%	9.95%
Oct-96	3.21%	0.43%	2.78%	0	58.08%	10.42%
Nov-96	5.81%	0.43%	5.38%	0	67.26%	10.89%
Dec-96	-0.65%	0.42%	-1.07%	-1.07%	66.18%	11.35%
Jan-97	3.89%	0.43%	3.46%	0	72.64%	11.83%
Feb-97	-2.63%	0.43%	-3.05%	-3.05%	68.11%	12.31%
Mar-97	-2.60%	0.44%	-3.04%	-3.04%	63.74%	12.80%
Apr-97	2.25%	0.44%	1.81%	0	67.43%	13.30%
May-97	6.01%	0.44%	5.57%	0	77.49%	13.79%
Jun-97	4.13%	0.42%	3.71%	0	84.82%	14.27%
Jul-97	8.48%	0.43%	8.05%	0	100.49%	14.77%
Aug-97	-3.28%	0.44%	-3.72%	-3.72%	93.92%	15.27%
Sep-97	6.68%	0.42%	6.25%	0	106.87%	15.75%
Oct-97	-3.04%	0.42%	-3.46%	-3.46%	100.57%	16.24%
Nov-97	-0.16%	0.44%	-0.60%	0	100.25%	16.75%
Dec-97	2.07%	0.44%	1.63%	0	104.39%	17.27%

	Contrafund	3 month T-Bill
Overall Cumulative Return:	104.4%	17.3%
Overall Cumulative Return in Excess of Treasury Bills:	87.1%	

	Contrafund	Asset Class
Cumulative load adjusted return = Cumulative Return x (1- Load Factor):	101.3%	68.4%
Load Factor:	3.00%	
Arithmetic average of Negative Excess Returns:	-0.71%	-0.82%
# Months:	36	36

	Contrafund
Relative Return (Contrafund Return/Average Asset Class Return):	1.48
Relative Risk (Contrafund Risk/Average Asset Class Risk):	0.87
Difference (Relative Return - Relative Risk):	0.61
Percentile Among all Funds in Asset Class:	39.0%
Three-Year Star Rating:	★★★

	Contrafund
Five-Year Star Rating:	★★★★
Ten-Year Star Rating:	★★★★★
Overall Star Rating:	★★★★

Source: Morningstar

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Exhibit 5 Morningstar's mutual fund classifications

Asset Classes	Domestic Equity	International Equity	Taxable Bond	Municipal Bond
Categories	Large Value	Europe	Long-Term Government	Municipal National - Long-Term
	Large Blend	Latin America	Intermed-Term Gov't	Municipal National - Intermediate-Term
	Large Growth	Diversified Emerg Mkts	Short-Term Government	Municipal Single State - Long-Term
	Medium Value	Pacific	Long-Term Bond	Municipal Single State - Intermed-Term
	Medium Blend	Pacific ex-Japan	Intermediate-Term Bond	Municipal Bond - Short-Term
	Medium Growth	Japan	Short-Term Bond	
	Small Value	Foreign Stock	Ultra-Short Bond	
	Small Blend	World Stock	High-Yield Bond	
	Small Growth	International Hybrid	Multi-Sector Bond	
	Specialty - Precious Metals		International Bond	
	Specialty – Nat'l Resources			
	Specialty - Technology			
	Specialty - Utilities			
	Specialty - Health			
	Specialty - Financial			
	Specialty - Real Estate			
	Specialty - Communication			
	Specialty - Unaligned			
	Domestic Hybrid			
	Convertibles			

Source: Morningstar

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