

Morgan Stanley & Co. Incorporated **Martin Leibowitz**  
Martin.Leibowitz@morganstanley.com  
+1 (1)212 761 7597

**Anthony Bova**  
Anthony.Bova@morganstanley.com  
+1 (1)212 761 3781

May 13, 2009

## Portfolio Strategy

### Return Targets and Percentile Fans

We use multiple-percentile “fans” for different equity mixtures to provide a simultaneous view of the prospects for reaching return targets and for satisfying prescribed risk limits.

**A minimum objective for any risk-taking is to surpass the return available from a “risk-free” alternative (or more pragmatically, a very low risk one).** For a given equity return/risk ratio, there is a certain “characteristic probability” of surpassing this minimal objective that is the same for every equity/cash mixture and every risk-free rate — and it is surprisingly low (e.g., 60%) over a 1-year horizon. Higher return targets require accepting a minimum level of beta risk even for success probabilities below the characteristic probability.

**Longer-term horizons are the key to generating significant probabilities of achieving even modest return targets.** However, for certain targets, longer-term horizons may also increase the required minimum beta. In contrast, limits on short-term volatility call for a maximum beta risk on a year-by-year basis.

**A range of feasible beta values is defined by this combination of a maximum for risk constraint and a minimum for return objectives.** Under some specifications, this beta range may be quite tight (or possibly even non-existent!). In this paper, the feasible beta values (e.g. 0.53) closely approximate the equity sensitivity of most individual and institutional portfolios (even those with the highest level of diversification).

**These findings suggest that allocations should incorporate a return-seeking core that is long-term oriented and can accommodate a relatively high level of short-term risk.**

#### Recent Reports

| Title  | Date         |
|--|--------------|
| Portfolio Strategy: Minimum Target and Maximum Shortfall Risks<br>Martin Leibowitz / Anthony Bova                              | Apr 21, 2009 |
| Portfolio Strategy: Portfolio Liquidity and Fund-Level Betas<br>Martin Leibowitz / Anthony Bova                                | Feb 26, 2009 |
| Portfolio Strategy: Portfolio Liquidity<br>Martin Leibowitz / Anthony Bova   | Jan 13, 2009 |
| Portfolio Strategy: Diversification Performance: Under Stress (2008) and Over the Long Term<br>Anthony Bova / Martin Leibowitz | Nov 10, 2008 |
| Portfolio Strategy: The Endowment Model: Theory and More Experience<br>Martin Leibowitz / Anthony Bova                         | Oct 9, 2008  |
| Portfolio Strategy: The “Endowment Model”: Theory and Experience<br>Martin Leibowitz / Anthony Bova                            | Aug 20, 2008 |
| Portfolio Strategy: Risk-Equivalent Allocations Under Taxation<br>Martin Leibowitz / Anthony Bova                              | Jul 8, 2008  |
| Portfolio Strategy: Stress Beta Pathways<br>Martin Leibowitz / Anthony Bova  | Jun 4, 2008  |
| Portfolio Strategy: Generalizations of the Active 130/30 Extension Concept<br>Martin Leibowitz / Anthony Bova                  | Apr 29, 2008 |

Morgan Stanley does and seeks to do business with companies covered in Morgan Stanley Research. As a result, investors should be aware that the firm may have a conflict of interest that could affect the objectivity of Morgan Stanley Research. Investors should consider Morgan Stanley Research as only a single factor in making their investment decision.

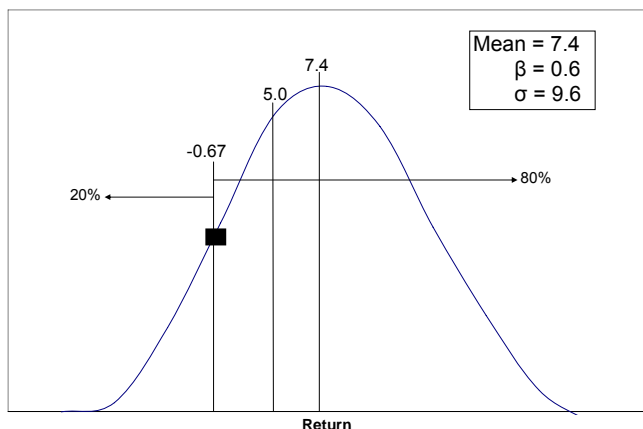
**For analyst certification and other important disclosures, refer to the Disclosure Section, located at the end of this report.**

## Return Targets and Percentile Fans

### Percentiles in Return/Beta Space

This study focuses on a basic cash/equity model with hypothetical rates of 5% for risk-free cash, 4% for the equity premium over cash, and an equity volatility of 16%. A 60% equity/40% cash portfolio would then have an expected one-year return of 7.4% and a volatility of 9.6%. Exhibit 1 depicts the distribution of outcomes for this 0.60 beta portfolio.

Exhibit 1  
**Probability Distribution for 60/40 Portfolio (Beta = 0.6)**



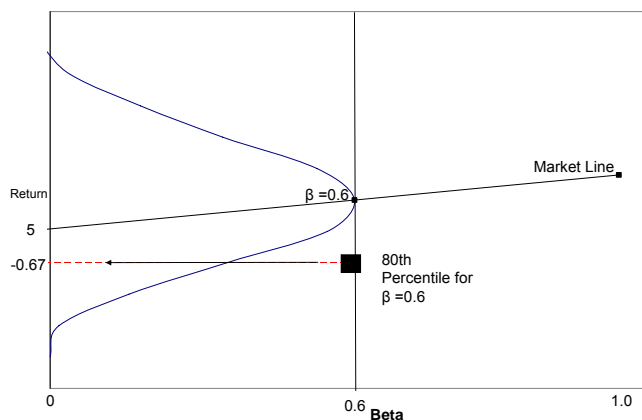
Source: Morgan Stanley Research

This 60% equity portfolio has an 80% probability of surpassing a return level of -0.67%. Since our focus is on the probability of exceeding various thresholds, it is useful to express percentiles in an inverted fashion, e.g., the -0.67% level will be referred to as the 80<sup>th</sup> percentile.

Exhibit 2 plots the “market line” of expected returns against beta values for different equity/cash mixtures. The equity market line begins at the risk-free rate of 5% and extends to 9% for a 100% equity portfolio with a beta=1.

This distribution in Exhibit 1 can be rotated and plotted against the 0.60 beta point on this equity market line. This distribution is centered on the 7.4% expected return of the 0.6 beta portfolio. Using our revised definition, the 80<sup>th</sup> “percentile” is located at -0.67%.

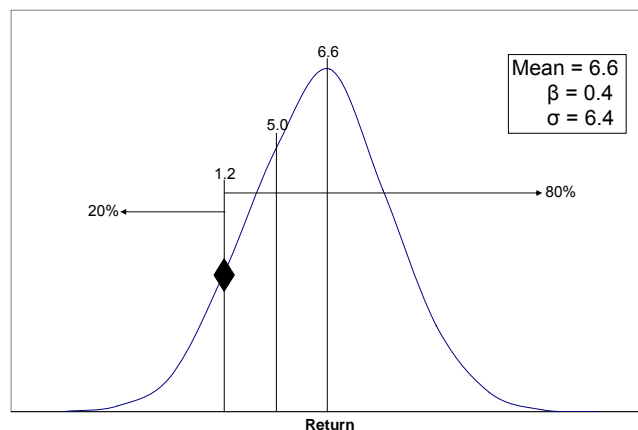
Exhibit 2  
**80<sup>th</sup> Percentile in Return/Beta Space (Beta = 0.6)**



Source: Morgan Stanley Research

A 40/60 portfolio with a lower 0.4 beta will naturally have a lower volatility (6.4%) and a reduced expected return (6.6%). With this narrower distribution, the 80<sup>th</sup> percentile now falls at the higher line of 1.2%.

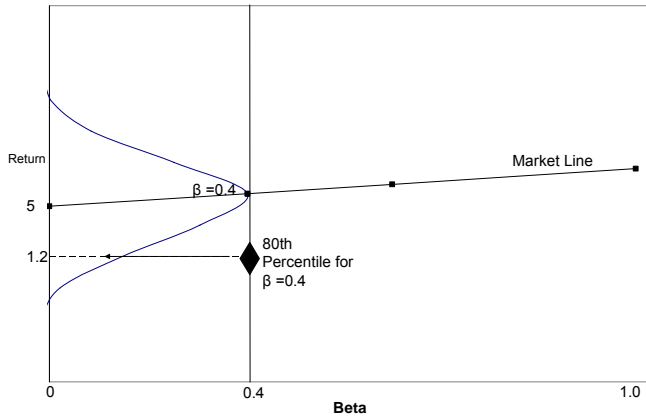
Exhibit 3  
**Probability Distribution for 40/60 Portfolio (Beta = 0.4)**



Source: Morgan Stanley Research

Once again, the distribution can be rotated and plotted against the equity market line (Exhibit 4).

Exhibit 4  
**80<sup>th</sup> Percentile in Return/Beta Space (Beta = 0.4)**



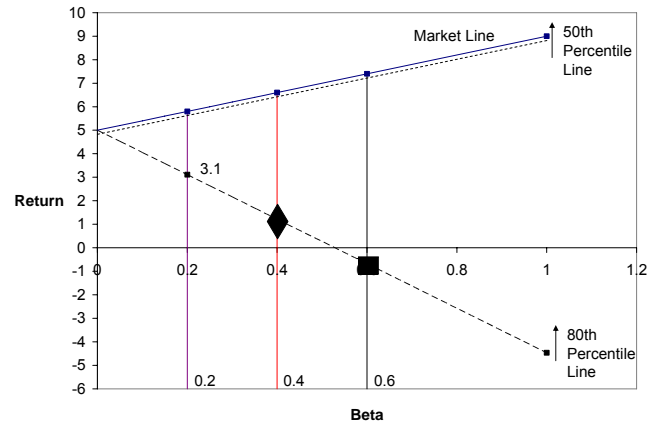
Source: Morgan Stanley Research

### The Percentile Fan

Exhibits 1-4 depict the 80<sup>th</sup> percentiles for two specific portfolios of stock/cash mixes of 60/40 and 40/60, respectively. In Exhibit 5, a straight line is drawn between these two points. In the Appendix, it is demonstrated how any point on this line can be interpreted as the 80<sup>th</sup> percentile for every return distribution defined by a beta value along the horizontal axis. Thus, a beta of 0.2 corresponds to a return of 3.1% on this line, indicating that a 20/80 portfolio would have this value as its 80<sup>th</sup> percentile.

Exhibit 5 also indicates how the market line itself can be interpreted as the 50<sup>th</sup> percentile line. The 50<sup>th</sup> and 80<sup>th</sup> percentile lines both intersect the 0-beta axis at the 5% cash rate. At 0-beta, the portfolio consists of 100% cash, so there is a 100% probability of realizing the cash rate and all the percentiles collapse into a single point.

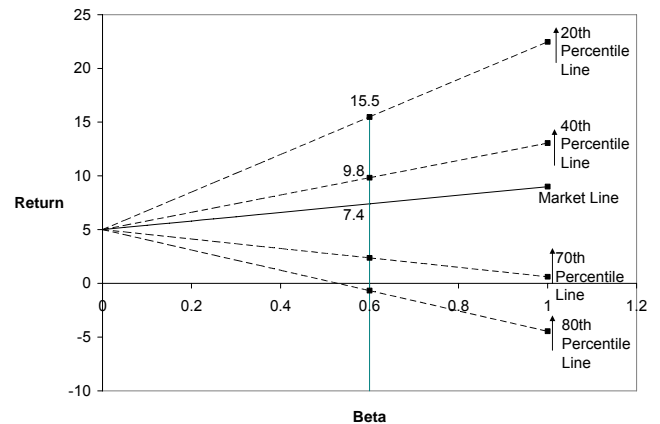
Exhibit 5  
**The 80<sup>th</sup> Percentile Line**



Source: Morgan Stanley Research

Exhibit 6 now adds percentile lines of 20%, 40% and 70%. Focusing on a beta = 0.6, there is a 20% chance of exceeding 15.5% and a 40% chance of exceeding 9.8%. Not surprisingly, these percentile “fans” are symmetric around the market line, i.e., the angle from the market line to 20<sup>th</sup> percentile is the same as the angle to the 80<sup>th</sup> percentile line. This underscores the point that these percentile fans are associated with a specific set of market assumptions and the corresponding market line. Risk premiums that are greater than our assumed 4% would rotate this entire percentile fan upward in a counterclockwise situation.

Exhibit 6  
**The Percentile “Fan”**



Source: Morgan Stanley Research

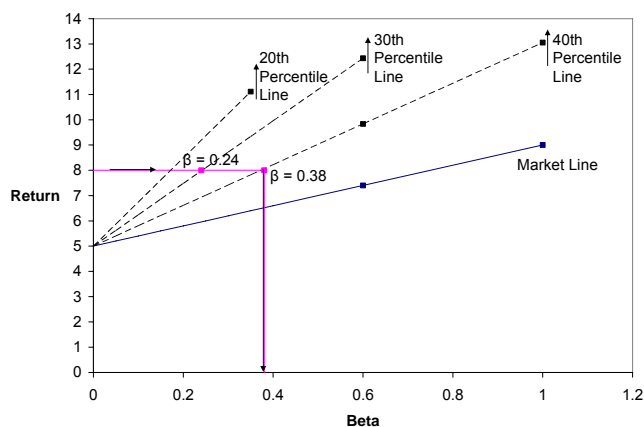
The wide spread of the percentile lines in Exhibit 6 dominates the modest upward slope of the market line. It should also be emphasized that the fan structure depicted in Exhibit 6 represents a one-year time horizon. Over such a short time period, it should be no surprise that the expected returns derived from the 4% equity premium are overshadowed by the much larger 16% volatility, especially at the higher beta values.

With our definition of percentiles and our adoption of a normal distribution, percentiles higher than 50% imply thresholds below the expected return. Consequently, all such greater-than-50<sup>th</sup> percentile lines fall below the market line in Exhibit 6, while all lower-than-50<sup>th</sup> percentile lines lie above the market line.

### Minimum/Maximum Betas for Return Targets

The percentile fans can be useful for an investor seeking a specific return target. For example, suppose an investor targets an 8% return with a probability of at least 40%. In Exhibit 7, the beta must be extended beyond the 20<sup>th</sup> and 30<sup>th</sup> percentile lines until it reaches the 40<sup>th</sup> percentile line at a beta of 0.38. Lower portfolio betas would lead to lower probabilities of achieving the 8% target. Thus, to achieve the stated target of an 8% return with a 40% probability, a minimum beta of 0.38 is required.

Exhibit 7  
**The Minimum Beta for an 8% Target with 40% Probability**

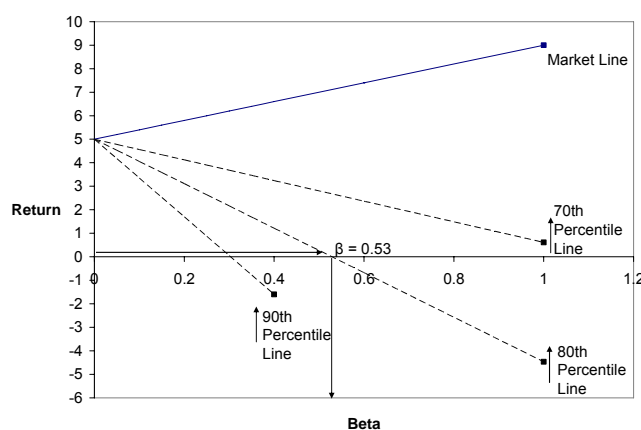


Source: Morgan Stanley Research

In the preceding example, the 8% target return was above the 5% risk-free rate. In contrast, risk constraints typically specify both a threshold well below the cash rate, together with a high probability that returns do not fall below this “shortfall” limit. For example, in Exhibit 8, the specified shortfall limit is set at a

0% return with at least an 80% probability. As the beta extends along this 0% horizontal threshold, it proceeds through the overly stringent 90<sup>th</sup> percentile line in order to reach the “last acceptable” 80<sup>th</sup> percentile line at a beta of 0.53. Higher betas would lead to unacceptably low probabilities. This suggests that 0.53 is the maximum beta that will allow for an 80% probability of positive returns.

Exhibit 8  
**The Maximum Beta for 0% Shortfall Limit with 80% Probability**



Source: Morgan Stanley Research

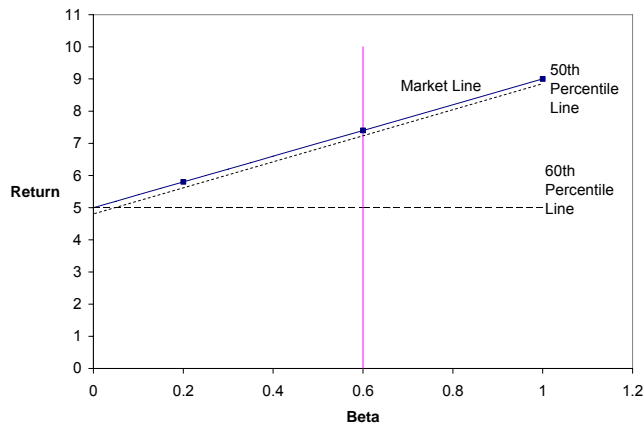
### The “Characteristic Probability” of Exceeding the Risk-Free Rate

Since the 5% risk-free rate can be achieved with 100% assurance, a key reason for accepting beta risk is to improve upon this cash rate. Every line in return/beta space that emanates from the cash-rate point can be interpreted as reflecting some percentile value. This interpretation specifically includes the horizontal line that starts at 5%.

In Exhibit 9, this horizontal line is shown as being equivalent to a 60<sup>th</sup> percentile line. This suggests that for a return minimum of 5%, the probability remains constant at 60% for all positive beta values. In other words, for this particular set of market parameters, every portfolio mixture has this same 60% chance of exceeding the 5% cash rate.

Exhibit 9

## The Characteristic Probability



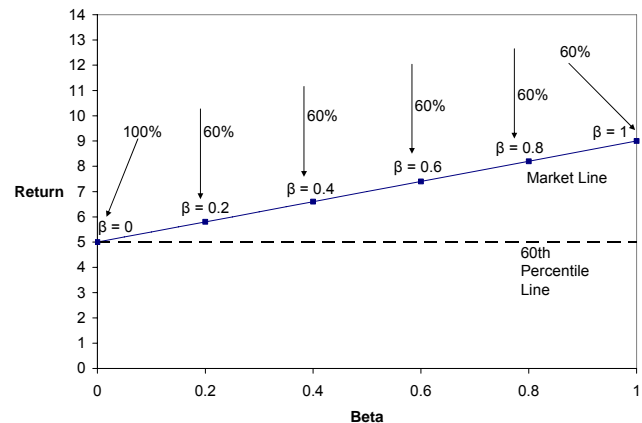
Source: Morgan Stanley Research

As depicted schematically in Exhibit 10, a 0-beta portfolio (i.e., 100% cash) provides 100% assurance of achieving the 5% rate. However, any move off this solid cash pedestal into the more turbulent region of positive betas, and the probability immediately drops from 100% to 60% — no matter how small or how large the equity percentage! Any  $\beta > 0$  equity position has the same balance of return and risk, so that all equity percentages have this same 60% probability of exceeding the 5% risk-free rate.

This fixed 60% probability is determined solely by our assumed 0.25 ratio of equity return premium (4%) to volatility (16%). There is no dependence on the actual level of the risk-free rate. For example, a higher return/risk ratio of 0.40 would lead to a 65% probability of beating the risk-free rate, again for any equity/cash mixture. Thus, this horizontal percentile value serves as a “characteristic probability” attached to the equity return/risk ratio. As such, it can be viewed as a baseline incentive to incur any of the equity risk associated with a specific set of market assumptions.

Exhibit 10

## Probability of Matching or Exceeding 5% Risk-Free Rate



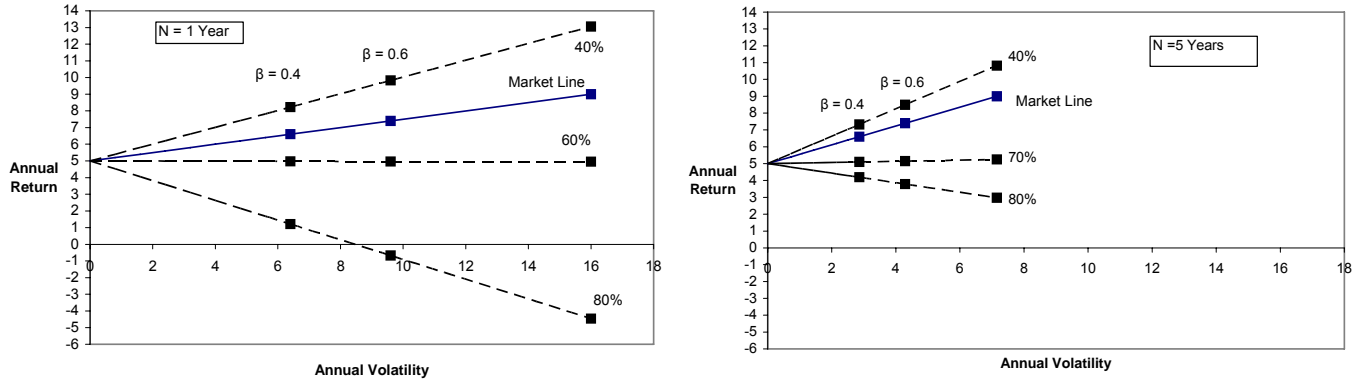
Source: Morgan Stanley Research

## Multi-Year Horizons

The analysis thus far has focused on a one-year time horizon. However, the percentile lines can also be useful when looking at multi-year periods. Exhibit 11 plots the return/risk percentile fans for 1 and 5 year periods, but now with the annualized volatility as the horizontal axis. The one-year timeframe is subject to tremendous volatility and therefore generates a wide range of outcomes. As the time period increases, the annualized expected return remains approximately the same (ignoring compounding or volatility drag effects), while the annualized volatility decreases by the square root of the number of years. With lower annualized volatilities over a 5-year horizon, the equity market line and the associated percentile lines rise in slope and contract in length. For example, for the horizontal percentile, the characteristic probability for exceeding the 5% cash rate can be seen to increase from 60% to 70% as one moves from a 1-year to a 5-year horizon.

Exhibit 11

## Horizon Effects in Return/Volatility Space: 1 and 5 Years



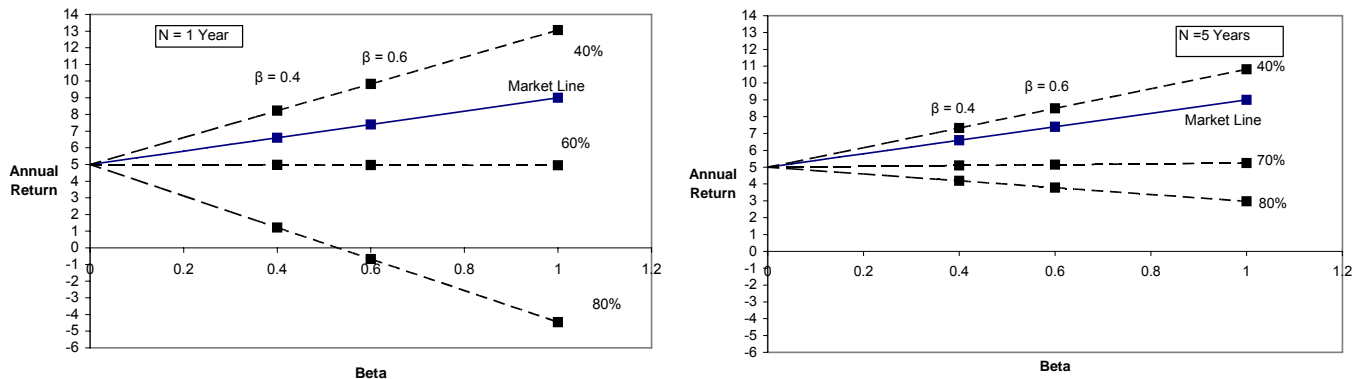
Source: Morgan Stanley Research

It is not uncommon for investors to have shorter horizons for setting risk limits while accepting longer time frames for return generation [1-2]. The effect of maintaining a fixed beta posture year after year may be better envisioned by reverting to the

return/beta framework shown in Exhibit 12. As the time horizon lengthens, the percentile fan compresses around a market line which remains invariant.

Exhibit 12

## Horizon Effects in Return/Beta Space: 1 and 5 Years



Source: Morgan Stanley Research

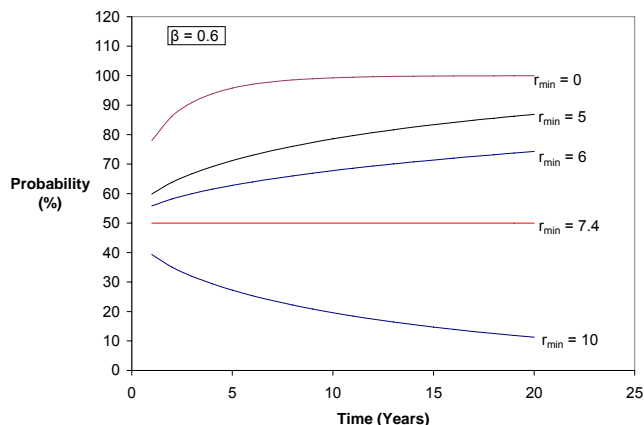
With a beta that is sufficiently high relative to the return target, longer time horizons lead to an increasing probability of success. For example, for a fixed beta of 0.6, the probability of returns above 0% increases from 78% for 1 year to 96% for 5 years, and 99% for 10 years. Similarly, the probability of surpassing the 5% risk-free rate is 60%, 71% and 79% for 1, 5 and 10-year horizons. However, the expected returns for a 0.6 beta portfolio is 7.4%, and the probability of exceeding this value is 50% for one year — and remains right at 50% for ever longer time horizons as well. As illustrated in Exhibit 13, once we move to return targets above the 7.4% expected return, the

success probability actually declines with time. Thus, for a 10% target, a 0.6 beta portfolio leads to declining success probabilities of 39%, 27% and 20% for 1, 5 and 10 years, respectively.

All these results follow from the tightening of the theoretical distribution of annualized returns over longer time horizons.

Exhibit 13

## Success Probabilities Over Time



Source: Morgan Stanley Research

### Beta Regimes

A related effect of the fan compression with longer horizons is that low minimum betas may need to be increased. For example, in Exhibit 7, it was shown that a minimum beta of 0.38 was needed for a 40% probability of obtaining an 8% target return. If the horizon is stretched to 5 years, the same 40% probability would now require a minimum beta of 0.52. Together with Exhibit 8's risk-based maximum beta of 0.53 for a positive return over 1 year, this 5-year minimum beta implies an extremely narrow beta range — from a minimum of 0.52 to a maximum of 0.53.

Although this example is strictly hypothetical, it is interesting to note that the typical beta value for US institutional portfolios actually does lie in the 0.55 to 0.65 range [3-4]. Moreover, the total volatility of such funds is generally projected to be around 10%, with the beta factor accounting for over 90% of this volatility. Indeed, it is quite striking the extent to which all funds, even across a wide range of diversified allocations, cluster around this 0.60 beta value and 10% volatility. One possible explanation might be that funds set their risk limits — either explicitly or implicitly — to assure a high probability of returns above some common shortfall limit.

When the target is stated as a spread above or below the cash rate, the actual cash level becomes irrelevant and the probabilities only depend on the equity premium and volatility assumptions. Thus, with the same 4% premium and 16% volatility, one will always have a 60% probability of exceeding the cash rate, whether it is 5%, 6% or 2%. However, the probability will be different for different return/risk ratios. Thus,

an 8% premium/32% volatility (i.e., the same 0.25 ratio as 4%/16%) will provide the same 1-year 60% probability of returns over the cash rate, while a 6%/16% ratio would lead to a higher 1-year probability of 70%.

### Shortfall Lines

Thus far, we have focused on the percentile lines that essentially describe the probability distribution for a given beta portfolio. As repeatedly emphasized, these percentile fans are derived from a specific set of market assumptions. An alternative approach is to specify a minimum return with a given probability and ask what combinations of expected return and volatility satisfy this constraint.

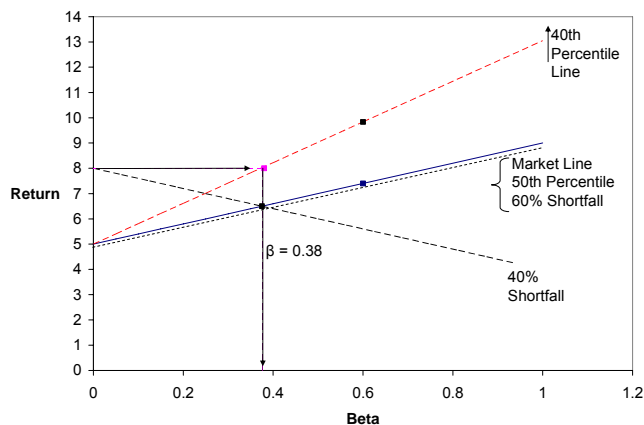
As shown in the Appendix, one can draw such a “shortfall line” where all return/risk combinations above the line satisfy the constraint, while all combinations below the line do not. The specified minimum return acts as the shortfall line's point of origin on the vertical axis. The slope is determined by the required probability. It should be noted that a given shortfall line applies to all combinations of expected return and volatility, i.e., unlike the line in the percentile fan, a shortfall line is not tied to a given market line.

Returning now to the 1-year horizon, Exhibit 14 shows a 40% shortfall line for an 8% return. This shortfall line intersects the equity market line at the same beta of 0.38 that was seen earlier in Exhibit 7.

While Exhibit 14 demonstrates the consistency between the shortfall and the percentile approach, it should again be emphasized that unlike the percentiles, which rotate around the assumed market line, the shortfall line is independent of the market model.

Exhibit 14

## 40<sup>th</sup> Percentile and 40% Shortfall Lines



Source: Morgan Stanley Research

Every straight line in expected return/risk space represents a shortfall line for some probability of achieving some minimum threshold. And the market line itself represents a shortfall line where the risk-free rate is taken as the minimum threshold. As with all shortfall lines, the associated probability is determined by the line's slope. For our market model (e.g., in Exhibit 9), the associated shortfall probability is 60% — the same characteristic 60% probability given by the horizontal percentile line. In other words, the market line's shortfall interpretation and the horizontal percentile line reflect the same 60% characteristic probability that any equity/cash mixture will be able to exceed the risk-free rate.

### Alpha Cores and Stress Betas

In practice, portfolios are more complex than our two-asset model. A typical institutional fund will have multiple sources of risk and return that may include a variety of diversifying asset classes, more granularities within the equity component itself, a better yielding structure for the "lower-risk alternatives" than just cash, a whole spectrum of active management and hedging strategies, etc. Each such component will contribute some (hopefully positive) measure of expected return, risk, and a correlation with all the other components.

However, most asset classes (and most active strategies) have some degree of correlation with equities, and this correlation is additive in nature. The net result is that at the fund level, the beta sensitivity to domestic equities remains the overwhelmingly dominant source of risk, even for highly diversified allocations with minimal direct equity exposure. Commonly used return estimates (and certain historical evidence) suggest that the benefit from a typical diversification

is to be found not in lower short-term volatility, but in higher expected return [5]. Indeed, as noted earlier, most diversified funds seen in practice appear to have the same fund-level 0.55-0.65 betas as the more traditional 60/40 funds.

The beta dominance allows allocations to be approximately modeled as having only two key sources of risk and return: 1) the fund-level beta sensitivity, and 2) a theoretical "alpha" core that provides an expected return — and a source of volatility risk — beyond that which can be directly ascribed to the benchmark equity.

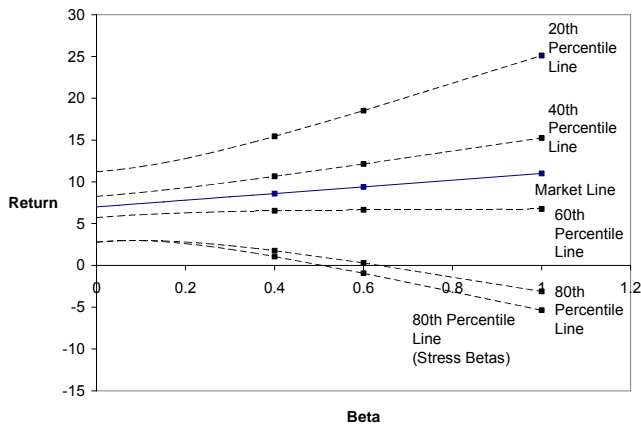
Any alpha core with a positive return/risk ratio and beta-independence could clearly help achieve return targets that would be problematic under the basic equity/cash model. However, there are certainly many issues regarding the expected net return and statistical characteristics of the various components comprising such an alpha core.

The inclusion of such an alpha core would materially alter the shape of the percentile fan. The addition of an increment of expected return would raise the market line (now a "market curve") above the earlier risk-free rate. At the same time, the total portfolio volatility would now depend on the alpha volatility as well as the beta-based volatility. Since these two volatility sources combine as sum-of-squares, the portfolio's total volatility would no longer be linear in beta. Instead of a straight line, a fixed-percentile value would now lead to a fan of percentile curves as the beta is varied.

Exhibit 15 depicts this 1-year percentile fan for portfolios that incorporate an alpha core with an assumed incremental return of 2% and a beta-independent volatility of 5%. In contrast to the basic equity/cash model, the 60<sup>th</sup> percentile curve now lies above the risk-free rate. At a beta of 0.6, the alpha portfolio provides returns that exceed the risk-free rate with a probability of 66% for 1-year and 82% for 5-year horizons, compared with the equity/cash model's 60% and 71% for the corresponding time periods.

Exhibit 15

## An Alpha Core Percentile Fan



Source: Morgan Stanley Research

The multi-asset structure of an alpha core can also present special problems. In “normal times,” the 60/40 fund and diversified allocations both have similar fund-level betas. However, in severe market declines, correlations generally tighten [6-8]. In the multi-asset structure of an alpha portfolio, these increasing correlations can raise the beta sensitivity to stress levels — at just the wrong time! Because of these “stress beta” effects, it is the diversified portfolios that ironically turn out to be more vulnerable to seriously adverse markets than simple two-asset funds. Exhibit 15 attempts to illustrate this stress beta effect as a more stringent 80<sup>th</sup> percentile curve that would result from a 25% correlation tightening.

Thus, while a productive alpha core may offer the prospect of improved return targets (and more divergent outcomes over the long term), it comes at the potential cost of more severe short-term risk under extreme markets.

### Implications

These results support the argument that reasonable return objectives call for a long-term approach combined with the fortitude to accept relatively high levels of year-by-year volatility risk.

At the same time, these strong findings should be tempered by recognizing the very basic nature of our equity/cash models, which exclude many important considerations such as compounding, reversion to the mean, volatility drag, fat tails and/or asymmetric distributions, etc. Also, while the assumed premium/volatility values are close to those used in many allocation studies, some investors may feel that these values should be dramatically higher (or lower) under various market

conditions. Finally, it should be recognized that all expected return models tend to be fundamentally long-term in nature.

Subject to these caveats, our analysis leads to the following key takeaways:

- 1) The probability of exceeding the risk-free rate over a one-year period is surprisingly low, regardless of how much beta risk is taken.
- 2) In order to achieve a reasonable probability of reaching even modest return targets, a long-term investment horizon is needed.
- 3) However, even over the long term, a significant probability for achieving decent return targets requires accepting a sufficiently high minimum beta risk.
- 4) Short-term risk constraints set a maximum beta limit.
- 5) The combination of a maximum risk-based beta and a target-based minimum beta defines a beta regime, which might be quite tight (or sometimes even non-existent!)
- 6) The tight 0.52-0.53 beta range found in our example roughly approximates the 0.55-0.65 beta values widely seen in practice.
- 7) To achieve reasonable return targets within the framework of a standard market model, allocations may need to incorporate a return-seeking core that is seriously long-term oriented, and yet able to accommodate relatively high levels of year-by-year volatility.
- 8) Positive alpha returns from diversifying assets, better-yielding low risk alternatives, and active strategies can also help in achieving reasonable return targets over the long run, but with a potentially greater vulnerability to stress risks in severely adverse markets.

### References:

- 1) Leibowitz, Martin L., Lawrence N. Bader and Stanley Kogelman. “Return Targets and Shortfall Risks”, Irwin Professional Publishing, 1996.
- 2) Leibowitz, Martin L. and Anthony Bova. “Minimum Target and Maximum Shortfall Risks.” *Portfolio Strategy Note*, April 22, 2009
- 3) Leibowitz, Martin L. and Anthony Bova. “Allocation Betas.” *Financial Analysts Journal*, July/August 2005
- 4) Leibowitz, Martin L. and Anthony Bova. “Gathering Implicit Alphas in a Beta World.” *Journal of Portfolio Management*, Spring 2007
- 5) Leibowitz, Martin L. and Anthony Bova. “Diversification Performance and Stress-Betas.” *The Journal of Portfolio Management*, Spring 2009
- 6) Leibowitz, Martin L. and Anthony Bova. “Stress Betas and Correlation Tightening.” *Portfolio Analysis Note*, December 10, 2007

7) Leibowitz, Martin L. and Anthony Bova. "Stress Risks within Asset and Surplus Frameworks." *Portfolio Analysis Note*, January 14, 2008

8) Leibowitz, Martin L. and Anthony Bova. "Stress Beta Pathways." *Portfolio Analysis Note*, June 4, 2008

## Appendix

The market model consists of a risk-free rate  $y$ , an equity risk premium  $r_e$ , and an equity volatility  $\sigma_e$ . The equity/cash portfolio with an equity fraction  $\beta$  then has an expected return  $R$ ,

$$R = y + \beta r_e \quad \beta \geq 0$$

and a volatility  $\sigma$ ,

$$\sigma_\beta = \beta \sigma_e$$

For a given distribution of returns (assumed to be normal in this paper), the  $p^{\text{th}}$  percentile can be expressed as  $k_p$  units of standard deviation to the left of the mean. For a given beta value  $\beta$ , this would imply a  $p^{\text{th}}$  percentile return  $r_p$ ,

$$\begin{aligned} r_p &= R - k_p \sigma_\beta \\ &= y + \beta r_e - k_p \beta \sigma_e \\ &= y + \beta (r_e - k_p \sigma_e) \\ &= y + \beta \sigma_e (SR_e - k_p) \end{aligned}$$

where  $SR_e$  is the Sharpe Ratio  $\left( \frac{r_e}{\sigma_e} \right)$  for the equity market line.

The “percentile fan” consists of the percentile lines traced out in return/beta space as  $\beta$  varies.

Alternatively, percentiles can be plotted against the volatility  $\sigma_\beta$

$$r_p = y + \sigma_\beta (SR_e - k_p)$$

where  $\sigma_\beta$  ranges from  $0 \leq \sigma_\beta \leq \sigma_e$

The case where  $k_p = SR_e$  for  $\beta > 0$  deserves special mention. This condition defines a horizontal line  $r_p = y$  emanating from the cash rate  $y$ . For a given market model with its assumed Sharpe Ratio,  $SR_e$ , there will be one probability  $p$  derived from the  $k_p = SR_e$  relationship. This  $p$  value can be interpreted as the probability that a portfolio with a positive equity fraction  $\beta$  will be able to exceed the risk-free rate. Moreover, this same probability  $p$  will apply to all beta values ( $\beta > 0$ ) along the entire market line. In other words, each set of market assumptions has a characteristic probability  $p$  that any equity portfolio — regardless of the exact mixture — will provide returns above the risk-free rate.

From the above equation, one can see that this characteristic probability  $p$  is determined only by the Sharpe Ratio. Thus, as long as the risk premium and the volatility lead to the same Sharpe Ratio, one will have the same characteristic probability of besting the cash rate — whatever that cash rate may be.

Multi-year horizons can be simplistically modeled (ignoring compounding and “volatility drag”) by treating all returns as annualized and reducing the annualized volatility by a factor of  $(1/\sqrt{N})$  where  $N$  is the number of years. The percentile lines then take the form,

$$\begin{aligned} r_p &= y + \beta \left[ r_e - k_p \frac{\sigma_e}{\sqrt{N}} \right] \\ &= y + \beta \left( \frac{\sigma_e}{\sqrt{N}} \right) \left[ (SR_e) \sqrt{N} - k_p \right] \end{aligned}$$

In this case, the characteristic probability  $p$  is defined by

$$k_p = \sqrt{N} (SR_e)$$

so that this probability rises with a lengthening investment horizon.

The expression

$$k_p \left( \frac{\sigma_e}{\sqrt{N}} \right)$$

becomes smaller as  $N$  increases, which leads to a compression of the percentile fan around the basic market line, which remains invariant. In the limit, for very long horizons (where this simple model surely does not hold), all percentile lines will converge on the market line itself. Thus, the return for a given beta portfolio should theoretically converge towards the expected return associated with its beta position. In other words, over the long-term, a given return target will be hypothetically achievable only by beta values having expected returns that match or exceed the target level.

An alternative approach to the multi-year horizon is to view percentiles using the annualized volatility as the horizontal axis. The annualized volatility  $\sigma(\beta, N)$  corresponding to a  $\beta$  portfolio over  $N$  years is

$$\sigma(\beta, N) = \frac{(\beta \sigma_e)}{\sqrt{N}}$$

so that

$$\begin{aligned}
 r_p &= y + \beta \left[ r_e - k_p \left( \frac{\sigma_e}{\sqrt{N}} \right) \right] \\
 &= y + \frac{\sqrt{N} \sigma(\beta, N)}{\sigma_e} \left[ r_e - k_p \left( \frac{\sigma_e}{\sqrt{N}} \right) \right] \\
 &= y + \sigma(\beta, N) \left[ \sqrt{N} (SR_e) - k_p \right]
 \end{aligned}$$

Where  $\sigma(\beta, N)$  now has the more limited range,

$$0 \leq \sigma(\beta, N) \leq \left( \sigma_e / \sqrt{N} \right)$$

In this formulation, the larger Sharpe Ratio term increases the slope of the market line while the tightened  $\sigma(\beta, N)$  range comprises the percentile fan around the higher market line. This framework has the advantage that multiple horizons can be plotted on the same diagram, providing a view of both the rising market line and the associated fan compression.

Shortfall lines are a related concept. Unlike the percentile lines described above, a shortfall line only specifies a minimum return threshold  $T$  that is to be achieved with a desired probability  $p$ . For a given  $\sigma_\beta$ , the expected return  $R$  that will achieve  $T$  with probability  $p$  is

$$\begin{aligned}
 R &= T + k_p \sigma_\beta \\
 &= T + k_p \beta \sigma_e
 \end{aligned}$$

Shortfall lines can be generated for any threshold  $T$  and any required probability  $p$

A given market line,

$$\begin{aligned}
 R &= y + \beta r_e \\
 &= y + \sigma_\beta (SR_e)
 \end{aligned}$$

will have an intersection with a shortfall line at a point where the beta portfolio can satisfy the shortfall constraint. This intersection point may also serve as a maximum beta for threshold risks (below the risk-free rate) or a minimum beta for return targets (above the risk-free rate).

For a threshold  $T$ , this intersection can be found by setting

$$\begin{aligned}
 R &= y + \beta r_e \\
 &= T + k_p \beta \sigma_e
 \end{aligned}$$

or

$$T = y + \beta[r_e - k_p \sigma_e]$$

which has the same value as the  $p^{\text{th}}$  percentile line at the beta value  $\beta$ , i.e.,

$$r_p = y + \beta[r_e - k_p \sigma_e]$$

from the earlier expression for the  $p^{\text{th}}$  percentile lines. Thus, a shortfall line's intersection with the market line coincides with the  $p^{\text{th}}$  percentile line for a target return  $T$ .

One particular shortfall line is especially notable — the market line itself — where

$$T = y$$

and so

$$\begin{aligned} R &= T + \beta r_e && \text{(market line)} \\ &= T + k_p \beta \sigma_e && \text{(} p^{\text{th}} \text{ shortfall line at } T = y) \end{aligned}$$

This equality implies that

$$k_p \beta \sigma_e = \beta r_e$$

or for all  $\beta > 0$

$$\begin{aligned} k_p &= \left( \frac{r_e}{\sigma_e} \right) \\ &= SR_e \end{aligned}$$

Thus, from viewing the market line as a shortfall line, every equity mixture, i.e., ( $\beta > 0$ ) turns out to have the same  $p^{\text{th}}$  probability of exceeding the risk-free rate  $T = y$ .

This finding is also consistent with the horizontal percentile line described above, where

$$r_p = y$$

and again

$$k_p = SR_e$$

In other words, the horizontal percentile lines and the market line's shortfall interpretation both describe the characteristic probability of exceeding the risk-free rate for any equity mixture having a given Sharpe Ratio.

## Disclosure Section

The information and opinions in Morgan Stanley Research were prepared by Morgan Stanley & Co. Incorporated, and/or Morgan Stanley C.T.V.M. S.A. and their affiliates (collectively, "Morgan Stanley").

For important disclosures, stock price charts and rating histories regarding companies that are the subject of this report, please see the Morgan Stanley Research Disclosure Website at [www.morganstanley.com/researchdisclosures](http://www.morganstanley.com/researchdisclosures), or contact your investment representative or Morgan Stanley Research at 1585 Broadway, (Attention: Equity Research Management), New York, NY, 10036 USA.

### Analyst Certification

The following analysts hereby certify that their views about the companies and their securities discussed in this report are accurately expressed and that they have not received and will not receive direct or indirect compensation in exchange for expressing specific recommendations or views in this report: Martin Leibowitz.

Unless otherwise stated, the individuals listed on the cover page of this report are research analysts.

### Global Research Conflict Management Policy

Morgan Stanley Research has been published in accordance with our conflict management policy, which is available at [www.morganstanley.com/institutional/research/conflictolicies](http://www.morganstanley.com/institutional/research/conflictolicies).

### Important US Regulatory Disclosures on Subject Companies

The research analysts, strategists, or research associates principally responsible for the preparation of Morgan Stanley Research have received compensation based upon various factors, including quality of research, investor client feedback, stock picking, competitive factors, firm revenues and overall investment banking revenues.

Certain disclosures listed above are also for compliance with applicable regulations in non-US jurisdictions.

### STOCK RATINGS

Morgan Stanley uses a relative rating system using terms such as Overweight, Equal-weight, Not-Rated or Underweight (see definitions below). Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy, hold and sell. Investors should carefully read the definitions of all ratings used in Morgan Stanley Research. In addition, since Morgan Stanley Research contains more complete information concerning the analyst's views, investors should carefully read Morgan Stanley Research, in its entirety, and not infer the contents from the rating alone. In any case, ratings (or research) should not be used or relied upon as investment advice. An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations.

### Global Stock Ratings Distribution

(as of April 30, 2009)

For disclosure purposes only (in accordance with NASD and NYSE requirements), we include the category headings of Buy, Hold, and Sell alongside our ratings of Overweight, Equal-weight, Not-Rated and Underweight. Morgan Stanley does not assign ratings of Buy, Hold or Sell to the stocks we cover. Overweight, Equal-weight, Not-Rated and Underweight are not the equivalent of buy, hold, and sell but represent recommended relative weightings (see definitions below). To satisfy regulatory requirements, we correspond Overweight, our most positive stock rating, with a buy recommendation; we correspond Equal-weight and Not-Rated to hold and Underweight to sell recommendations, respectively.

| Stock Rating Category    | Coverage Universe |            | Investment Banking Clients (IBC) |                |                      |
|--------------------------|-------------------|------------|----------------------------------|----------------|----------------------|
|                          | Count             | % of Total | Count                            | % of Total IBC | % of Rating Category |
| <b>Overweight/Buy</b>    | <b>668</b>        | <b>30%</b> | <b>205</b>                       | <b>35%</b>     | <b>31%</b>           |
| <b>Equal-weight/Hold</b> | <b>1005</b>       | <b>45%</b> | <b>272</b>                       | <b>46%</b>     | <b>27%</b>           |
| <b>Not-Rated/Hold</b>    | <b>33</b>         | <b>1%</b>  | <b>8</b>                         | <b>1%</b>      | <b>24%</b>           |
| <b>Underweight/Sell</b>  | <b>517</b>        | <b>23%</b> | <b>108</b>                       | <b>18%</b>     | <b>21%</b>           |
| <b>Total</b>             | <b>2,223</b>      |            | <b>593</b>                       |                |                      |

Data include common stock and ADRs currently assigned ratings. An investor's decision to buy or sell a stock should depend on individual circumstances (such as the investor's existing holdings) and other considerations. Investment Banking Clients are companies from whom Morgan Stanley or an affiliate received investment banking compensation in the last 12 months.

### Analyst Stock Ratings

**Overweight (O).** The stock's total return is expected to exceed the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

**Equal-weight (E).** The stock's total return is expected to be in line with the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

**Not-Rated (NR).** Currently the analyst does not have adequate conviction about the stock's total return relative to the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

**Underweight (U).** The stock's total return is expected to be below the average total return of the analyst's industry (or industry team's) coverage universe, on a risk-adjusted basis, over the next 12-18 months.

Unless otherwise specified, the time frame for price targets included in Morgan Stanley Research is 12 to 18 months.

### Analyst Industry Views

**Attractive (A):** The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be attractive vs. the relevant broad market benchmark, as indicated below.

**In-Line (I):** The analyst expects the performance of his or her industry coverage universe over the next 12-18 months to be in line with the relevant broad market benchmark, as indicated below.

**Cautious (C):** The analyst views the performance of his or her industry coverage universe over the next 12-18 months with caution vs. the relevant broad market benchmark, as indicated below.

Benchmarks for each region are as follows: North America - S&P 500; Latin America - relevant MSCI country index or MSCI Latin America Index; Europe - MSCI Europe; Japan - TOPIX; Asia - relevant MSCI country index.

### Other Important Disclosures

Morgan Stanley produces a research product called a "Tactical Idea." Views contained in a "Tactical Idea" on a particular stock may be contrary to the recommendations or views expressed in this or other research on the same stock. This may be the result of differing time horizons, methodologies, market events, or other factors. For all research available on a particular stock, please contact your sales representative or go to Client Link at [www.morganstanley.com](http://www.morganstanley.com).

May 13, 2009  
Portfolio Strategy

For a discussion, if applicable, of the valuation methods used to determine the price targets included in this summary and the risks related to achieving these targets, please refer to the latest relevant published research on these stocks.

Morgan Stanley Research does not provide individually tailored investment advice. Morgan Stanley Research has been prepared without regard to the individual financial circumstances and objectives of persons who receive it. The securities/instruments discussed in Morgan Stanley Research may not be suitable for all investors. Morgan Stanley recommends that investors independently evaluate particular investments and strategies, and encourages investors to seek the advice of a financial adviser. The appropriateness of a particular investment or strategy will depend on an investor's individual circumstances and objectives. The securities, instruments, or strategies discussed in Morgan Stanley Research may not be suitable for all investors, and certain investors may not be eligible to purchase or participate in some or all of them.

Morgan Stanley Research is not an offer to buy or sell or the solicitation of an offer to buy or sell any security/instrument or to participate in any particular trading strategy. The "Important US Regulatory Disclosures on Subject Companies" section in Morgan Stanley Research lists all companies mentioned where Morgan Stanley owns 1% or more of a class of common securities of the companies. For all other companies mentioned in Morgan Stanley Research, Morgan Stanley may have an investment of less than 1% in securities or derivatives of securities of companies and may trade them in ways different from those discussed in Morgan Stanley Research. Employees of Morgan Stanley not involved in the preparation of Morgan Stanley Research may have investments in securities or derivatives of securities of companies mentioned and may trade them in ways different from those discussed in Morgan Stanley Research. Derivatives may be issued by Morgan Stanley or associated persons.

Morgan Stanley and its affiliate companies do business that relates to companies/instruments covered in Morgan Stanley Research, including market making and specialized trading, risk arbitrage and other proprietary trading, fund management, commercial banking, extension of credit, investment services and investment banking. Morgan Stanley sells to and buys from customers the securities/instruments of companies covered in Morgan Stanley Research on a principal basis.

With the exception of information regarding Morgan Stanley, research prepared by Morgan Stanley Research personnel are based on public information. Morgan Stanley makes every effort to use reliable, comprehensive information, but we make no representation that it is accurate or complete. We have no obligation to tell you when opinions or information in Morgan Stanley Research change apart from when we intend to discontinue research coverage of a subject company. Facts and views presented in Morgan Stanley Research have not been reviewed by, and may not reflect information known to, professionals in other Morgan Stanley business areas, including investment banking personnel.

Morgan Stanley Research personnel conduct site visits from time to time but are prohibited from accepting payment or reimbursement by the company of travel expenses for such visits.

The value of and income from your investments may vary because of changes in interest rates or foreign exchange rates, securities prices or market indexes, operational or financial conditions of companies or other factors. There may be time limitations on the exercise of options or other rights in your securities transactions. Past performance is not necessarily a guide to future performance. Estimates of future performance are based on assumptions that may not be realized. Unless otherwise stated, the cover page provides the closing price on the primary exchange for the subject company's securities/instruments.

To our readers in Taiwan: Information on securities/instruments that trade in Taiwan is distributed by Morgan Stanley Taiwan Limited ("MSTL"). Such information is for your reference only. Information on any securities/instruments issued by a company owned by the government of or incorporated in the PRC and listed in on the Stock Exchange of Hong Kong ("SEHK"), namely the H-shares, including the component company stocks of the Stock Exchange of Hong Kong ("SEHK")'s Hang Seng China Enterprise Index; or any securities/instruments issued by a company that is 30% or more directly- or indirectly-owned by the government of or a company incorporated in the PRC and traded on an exchange in Hong Kong or Macau, namely SEHK's Red Chip shares, including the component company of the SEHK's China-affiliated Corp Index is distributed only to Taiwan Securities Investment Trust Enterprises ("SITE"). The reader should independently evaluate the investment risks and is solely responsible for their investment decisions. Morgan Stanley Research may not be distributed to the public media or quoted or used by the public media without the express written consent of Morgan Stanley. Information on securities/instruments that do not trade in Taiwan is for informational purposes only and is not to be construed as a recommendation or a solicitation to trade in such securities/instruments. MSTL may not execute transactions for clients in these securities/instruments.

To our readers in Hong Kong: Information is distributed in Hong Kong by and on behalf of, and is attributable to, Morgan Stanley Asia Limited as part of its regulated activities in Hong Kong. If you have any queries concerning Morgan Stanley Research, please contact our Hong Kong sales representatives.

Morgan Stanley Research is disseminated in Japan by Morgan Stanley Japan Securities Co., Ltd.; in Hong Kong by Morgan Stanley Asia Limited (which accepts responsibility for its contents); in Singapore by Morgan Stanley Asia (Singapore) Pte. (Registration number 199206298Z) and/or Morgan Stanley Asia (Singapore) Securities Pte Ltd (Registration number 200008434H), regulated by the Monetary Authority of Singapore, which accepts responsibility for its contents; in Australia by Morgan Stanley Australia Limited A.B.N. 67 003 734 576, holder of Australian financial services licence No. 233742, which accepts responsibility for its contents; in Korea by Morgan Stanley & Co International plc, Seoul Branch; in India by Morgan Stanley India Company Private Limited; in Canada by Morgan Stanley Canada Limited, which has approved of, and has agreed to take responsibility for, the contents of Morgan Stanley Research in Canada; in Germany by Morgan Stanley Bank AG, Frankfurt am Main, regulated by Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin); in Spain by Morgan Stanley, S.V., S.A., a Morgan Stanley group company, which is supervised by the Spanish Securities Markets Commission (CNMV) and states that Morgan Stanley Research has been written and distributed in accordance with the rules of conduct applicable to financial research as established under Spanish regulations; in the United States by Morgan Stanley & Co. Incorporated, which accepts responsibility for its contents. Morgan Stanley & Co. International plc, authorized and regulated by Financial Services Authority, disseminates in the UK research that it has prepared, and approves solely for the purposes of section 21 of the Financial Services and Markets Act 2000, research which has been prepared by any of its affiliates. Private U.K. investors should obtain the advice of their Morgan Stanley & Co. International plc representative about the investments concerned. In Australia, Morgan Stanley Research, and any access to it, is intended only for "wholesale clients" within the meaning of the Australian Corporations Act. RMB Morgan Stanley (Proprietary) Limited is a member of the JSE Limited and regulated by the Financial Services Board in South Africa. RMB Morgan Stanley (Proprietary) Limited is a joint venture owned equally by Morgan Stanley International Holdings Inc. and RMB Investment Advisory (Proprietary) Limited, which is wholly owned by FirstRand Limited.

The information in Morgan Stanley Research is being communicated by Morgan Stanley & Co. International plc (DIFC Branch), regulated by the Dubai Financial Services Authority (the DFSA), and is directed at wholesale customers only, as defined by the DFSA. This research will only be made available to a wholesale customer who we are satisfied meets the regulatory criteria to be a client.

The information in Morgan Stanley Research is being communicated by Morgan Stanley & Co. International plc (QFC Branch), regulated by the Qatar Financial Centre Regulatory Authority (the QFCRA), and is directed at business customers and market counterparties only and is not intended for Retail Customers as defined by the QFCRA.

As required by the Capital Markets Board of Turkey, investment information, comments and recommendations stated here, are not within the scope of investment advisory activity. Investment advisory service is provided in accordance with a contract of engagement on investment advisory concluded between brokerage houses, portfolio management companies, non-deposit banks and clients. Comments and recommendations stated here rely on the individual opinions of the ones providing these comments and recommendations. These opinions may not fit to your financial status, risk and return preferences. For this reason, to make an investment decision by relying solely to this information stated here may not bring about outcomes that fit your expectations.

The trademarks and service marks contained in Morgan Stanley Research are the property of their respective owners. Third-party data providers make no warranties or representations of any kind relating to the accuracy, completeness, or timeliness of the data they provide and shall not have liability for any damages of any kind relating to such data. The Global Industry Classification Standard ("GICS") was developed by and is the exclusive property of MSCI and S&P.

Morgan Stanley Research, or any portion hereof may not be reprinted, sold or redistributed without the written consent of Morgan Stanley.

Morgan Stanley Research is disseminated and available primarily electronically, and, in some cases, in printed form.

**Additional information on recommended securities/instruments is available on request.**

**The Americas**

1585 Broadway  
New York, NY 10036-8293

**United States**

Tel: +1 (1) 212 761 4000

**Europe**

20 Bank Street, Canary Wharf  
London E14 4AD

**United Kingdom**

Tel: +44 (0) 20 7 425 8000

**Japan**

4-20-3 Ebisu, Shibuya-ku  
Tokyo 150-6008

**Japan**

Tel: +81 (0) 3 5424 5000

**Asia/Pacific**

1 Austin Road West  
Kowloon

**Hong Kong**

Tel: +852 2848 5200