Hedge Funds: Theory and Performance[1]

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I. Introduction

Hedge funds are a class of investment products which have developed to make optimal use of manager skill. The last decade has experienced dramatic growth in the hedge fund industry due to a number of factors. These include historically high risk-adjusted returns relative to other investments, the relaxation of regulatory constraints on hedge-fund investment and the growth of global markets and opportunities for skill-based investing. This primer is an introduction to hedge funds and their role in an investment portfolio. We provide a theoretical background for the value proposition of hedge fund management, a discussion of the risks peculiar to hedge funds, a review of the different fund styles and evidence on their historical performance. Finally, we address the potential role of hedge funds in a diversified portfolio with long-term performance goals.

As we show, the theory of hedge funds is closely related to the theory of asset pricing itself. In fact, hedge funds can be viewed as playing an essential role in the daily process of price discovery in the global capital markets. Asset pricing theory provides a useful foundation for assessing the skill of the manager and the role of the fund in an investment portfolio. Despite the variety of different styles pursued by hedge fund managers, we argue that all hedge fund managers essentially share a common value proposition. All seek to exploit temporary mispricings in the value of marketable securities. This quest takes hedge fund managers to the frontiers of asset markets, where the valuation of securities is not well understood by all participants. Successful hedge fund managers specialize in markets for which they have a comparative informational or technical advantage.

Hedge funds pursue strategies that we will term "arbitrage in expectations," or *expectational arbitrage*. That is, they seek to provide a positive expected return on capital with a minimal exposure to systematic sources of risk by "hedging away" exposure to traditional asset

classes typically held in the investment portfolio. This is significantly different from the behavior of the traditional asset manager, and it has important implications for return and risk measurement, as well as the evaluation of the role of the hedge fund in the investment portfolio.

In the next section we provide some useful background on hedge funds. In section 3 we develop a theory of hedge fund management drawn from the theory of asset pricing. Section 4 discusses key issues that distinguish hedge funds. Section 5 focuses on the risks distinctive to hedge funds. Section 6 examines the variety of hedge fund styles, the potential of each for adding value to the portfolio and the types of risks they represent. In section 7 we discuss the metrics used to evaluate hedge fund performance. In section 8 we examine the historical performance of hedge funds over the past decade with an eye to what history reveals about their future potential. Section 9 discusses the role of hedge funds in the investment portfolio. Section 10 briefly concludes the primer and points out important areas for future discussion.

II. What is a Hedge Fund?

For our purposes, hedge funds are investment companies that actively trade in marketable securities. What makes their legal structure unusual for U.S. investors is that they are not regulated by the United States Investment Company Act of 1940 which established the modern structure of mutual funds. Because of this, they have much broader flexibility than mutual funds. Mutual funds have restrictions on the types of securities they can hold, the degree to which their portfolios may be concentrated in a single security, the percentage they may hold of any one firm and the amount of leverage they may take. Mutual funds are not allowed to hold shares of other mutual funds, or to offer managers asymmetric performance contracts and they are required to offer daily pricing and liquidity to investors and to publically report their security holdings on a quarterly basis.

While all of these restrictions have some merit, they significantly restrict manager strategies. By electing not to qualify as regulated investment companies, hedge funds have considerable freedom in their investment policies and freedom from disclosure that might put them at a strategic disadvantage. However, they pay for this freedom with limits on their ability to market their services. Before 1996, hedge funds could only accept 99 U.S. investors. This constraint was relaxed funds to 499 qualified U.S. investors, although most successful managers have offshore funds that allow an unlimited number of non-U.S. accounts. Offshore funds are generally organized as limited liability corporations while domestic funds are often structured as limited partnerships.

The distinctive feature of hedge funds is that they are structured to allow nearly pure bets on managerial skill. Unlike a typical mutual fund whose returns are mostly a function of the performance of an asset class, hedge funds returns are almost entirely a function of the manager's ability to identify and capture transitory trading opportunities. The efficiency of the worlds capital markets makes trading on mispricing a highly specialized skill. Hedge fund managers typically develop focused knowledge of particular markets, securities and institutions.

For example, event-driven arbitrage managers focus on M&A activity – their expertise is at evaluating the probability of the outcomes of merger announcements. Distressed security managers are expert on the intricacies of the bankruptcy code. Quantitative trading funds generate value through proprietary statistical arbitrage models. Relative value funds trade offsetting long-short positions in securities that are close economic substitutes. Fixed income funds typically exploit subtle differences in forward rates implied by current bond prices or differntial values arising from liquidity or credit considerations. Mortgage backed security specialists provide value through their ability to correctly forecast the re-financing behavior homeowners, and their skill at evaluating different components of complex mortgage-backed securities. Derivatives managers use option-

pricing models to evaluate deviations in the market price of options and convertible bonds from fundamental values. Global macro managers trade in the international currency and securities markets in anticipation of fundamental shifts in national macro-economic policies. In fact, it is difficult to find a security or market that hedge funds do not trade. Despite this variety of specialized styles, we show in the next section that virtually all hedge fund strategies can be evaluated from the perspective of a strikingly simple theoretical model.

III. A Theory of Hedge Funds

In order to understand hedge funds' arbitrage in expectations, a baseline model of correct security pricing is essential. Much research in financial economics over the past three decades has focused on the development of equilibrium models of asset prices – that is, logical frameworks for understanding the relative values of stocks, bonds and derivative securities. What basic factors keep the share price of Mobile Oil from wandering far away from the share price of Shell, despite the firms being close economic substitutes? Why should investors demand very nearly the same yield for a nine-year bond as a ten-year bond? The most powerful reason is arbitrage. When prices deviate too far from their equilibrium values, asset pricing theory tells us that astute investors – arbitrageurs looking for bargains – will step in and buy up the underpriced assets, driving them back to their correct relative values. The simple absence of obvious arbitrage opportunities is the key force in the Arbitrage Pricing Theory [APT] as a tool for estimating the expected return on securities demanded by investors in equilibrium. We use this as the basis of our analysis because it is so well suited to hedge funds and because it is consistent with all other pricing frameworks for risk and return.

In the modern world of liquid global capital markets, hedge funds have become the primary agents enforcing equilibrium prices – finding and exploiting deviations from relative value, and driving prices back to equilibrium. To understand the source of hedge fund profits we use an example that will illustrate where hedge fund profits come from and how they are realized.

III.1 Arbitrage Pricing: Risk Exposure

The arbitrage pricing theory and related models rely on the idea that there are few fundamental sources of risk in the economy, and that investors will demand compensation in the form of expected return for bearing these risks. These risks include pure stock market risk, such as the daily fluctuation of the S&P 500, and other fundamental risks such as exposure to inflation or interest rate shocks. Surprisingly, potential shocks specific to the company – like the risk of management turnover, matter relatively little in comparison. Most well-structured investment portfolios are sufficiently diversified to reduce exposure to the company-specific risks however none is completely insured against the "macro-shocks" we associate with fluctuations in the business cycle.

Equity asset pricing models, such as the arbitrage pricing theory and empirical applications of the APT such as Fama and French (1993) use linear factor models that describe the exposure of individual securities to macro-risk factors. That is, the expected return of a security is proportional to its exposure to these non-diversifiable sources of economic risk. For equities, this is often referred to as a beta model. A stock's beta with respect to a given factor quantifies its risk exposure.

III.2 Arbitrage Pricing: an example

Consider a simple, single factor model that estimates a market beta for a given security. The expected excess return of this stock over treasury bills is a linear function of its beta and the equity

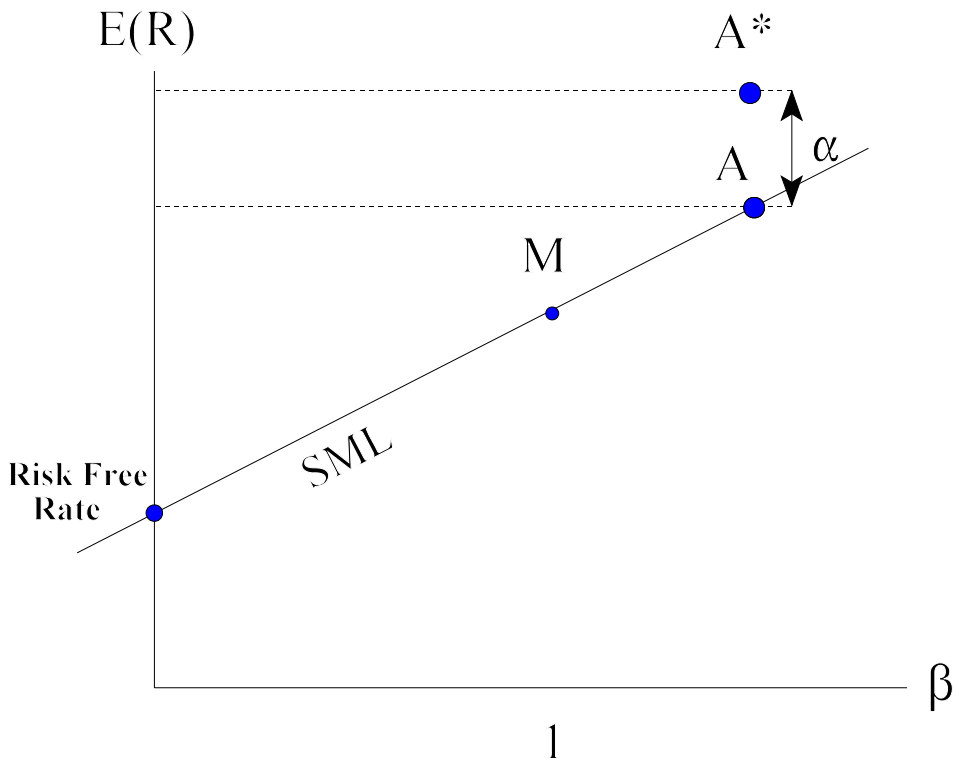

Figure 1

risk premium i.e. the average expected excess return of equities over treasury bills. Figure 1 represents this graphically.

The vertical axis is the dimension of expected return for the security, the horizontal axis is the exposure of the security to fluctuations in the market factor. In the figure, the market portfolio, perhaps an S&P 500 index fund, is represented by M. M rests on a line extending through the riskless rate of return i.e. T-bills. In fact, this line represents all the feasible positions achievable by holding a combination of the market portfolio and treasury bills. For example, in this picture, it is possible to achieve a higher rate of expected return by borrowing money at the riskless rate and buying more shares of M. This moves the portfolio to M* which has a higher beta. This line is called the security market line or SML for short and it is the benchmark for assessing whether an asset or a fund or a manager can add value.

Security A is a high-beta asset and it, too, lies on the SML. Although it has higher risk, i.e. a higher exposure to the market factor, it also has a commensurately higher rate of expected return. Why, exactly, does A plot on the security market line and not above or below it? The answer is that hedge funds step in to take advantage of the mispricing.

III.3 Hedge Funds and Arbitrage Pricing

The APT relies on the ability of investors to understand the systematic risk of securities and their willingness to uncover and exploit deviations from the security market line. Hedge funds are in the business of searching for opportunities represented in figure 1 by A*. This opportunity is actually called an "arbitrage in expectations," because a positive profit on the investment is expected but not guaranteed. A hedge fund manager who buys shares in A* receives a higher expected rate of return than a portfolio with the equivalent risk exposure to the market factor, A. The more of A* he buys, the greater the expected profit from the purchase.

In an active and liquid securities market, this opportunity will quickly attract other investors, either because they spot the same mispricing, or because a manager's own buying activity alerts others to the security. The increased demand for shares of A* by hedge funds should eventually drive the price higher and the expected return lower – back to its equilibrium value A, at which time the fund manager will sell shares in A* and realize a profit. The arbitrage pricing theory argues that the existence, or even the potential existence, of hedge fund operators will keep security prices close to their equilibrium values. They are essential players in the capital market, willing to step in quickly to exploit deviations from the pricing model. In practice, the speed with which the hedge fund operators act, and the capital at their command, both affect the degree and duration of deviations from the security market line.

III.4 The 'Hedge' in Hedge Funds

Notice in this example that the hedge fund manager increases profits by buying more shares of the underpriced security. The purchase of these shares has some undesirable features, however. For every share of A* he buys, he also adds to his beta risk. His expected return includes two components – the expected return of A – the fairly priced security, and the spread between A and A* – commonly termed his alpha. The hedge fund manager's problem is how to invest in mispricing opportunities – alphas – without investing in A. The solution to this problem was the brainchild of Alfred Winslow Jones, the founder of the hedge fund industry.

Jones was a polymath – a prominent sociologist with a Columbia University Ph.D. , who was asked by *Fortune* magazine in the 1940's to write an article on new developments in Wall Street investing. By the time his article appeared in 1949, Jones had already become one of the street's most creative innovator – he founded his own fund in 1949, the A.W. Jones Company, that had

virtually all of the characteristics of a modern hedge fund – a "skill-based" strategy to exploit mispricing, incentive fee compensation and one additional structural feature. Jones proposed the novel idea of "hedging" purchases of underpriced securities by selling short other shares. He put the 'hedge' in hedge funds and in fact the term was first applied to his firm, when later journalists can to study how Mr. Jones became such a successful investor.

In the example in Figure 1, hedging is equivalent to shorting one share of security A for each share of A* purchased. This has two important effects. First, the beta risk of the A' shares are now completely hedged by the negative beta exposure of the shorted A shares. Thus, the net exposure of the hedge fund to the market factor is zero. Second, shorting shares of securities generates capital – capital that can be used to buy more shares in the undervalued asset! The hedging strategy is a self-financing portfolio that eliminates bets on the fully priced assets and instead maximizes exposure to managerial skill i.e. alpha.

Hedge fund managers are commonly referred to as *absolute return* managers. The example shows why. After hedging out the market risk, the hedge fund manager's benchmark is the rate of return on the riskless portfolio – treasury bills. Thus, a well-hedged hedge fund should be evaluated by its absolute return above the benchmark of the riskless rate, rather that relative to the performance of any given asset class.

Although hedge funds invest in virtually every security in the world, their value proposition is based upon the skill of the manager in identifying positive alpha opportunities and financing these opportunities with positions that hedge away systematic factor exposures. While asset pricing models used by hedge funds may range from a simple, single factor linear model to complex, high tech, multi-factor, non-linear time-varying frameworks estimated by super-computers, to just plain good judgement, the basic principle of betting on skill, not asset class behavior, is the same. this

perspective can help identify who is a hedge fund manager and who is not. Funds calling themselves hedge funds but who take bets on systematic factors to capture the factor risk premium are not entirely skill-based funds and they should not be evaluated by their absolute returns.

IV. Key Issues

The theoretical development above tells us a number of things about hedge funds and their value proposition. First, the value of any hedge fund rests almost completely on the manager's skill in identifying opportunities arising from the mispricing of publically traded securities relative to securities of comparable risk. Second, the value of a hedge fund, at least in its pure form, does not derive from a passive long position in an asset class, but from a market neutral investment. Third, hedge funds are best adapted to new and "imperfect" capital markets where methods of valuation are not well developed by others and where research and quantitative analysis may provide a comparative advantage. Finally, theory suggests that arbitrage in expectations will be competitive, and that hedge funds will have strategic considerations, beginning with the need for secrecy about strategies and positions. These strategic considerations help understand why hedge funds may forego the benefits of operating as regulated investment companies by conventional definitions.

IV.1 Relative Valuation

There has been much debate over the past few years about whether the stock market is over or under-valued. Experts disagree whether the current level of stock prices is justified by the present value of future dividends investors expect to receive. This disagreement essentially about the *absolute* level of equity prices, as opposed to relative price levels. Most hedge fund strategies are based instead on the *relative valuation* of securities.

Relative value strategies are typically unaffected by whether or not the market as a whole deviates from fundamental values. In the simple example, the expected return of A* makes it attractive relative to the expected return of A. A divergence in their relative values thus represents an opportunity for hedge funds managers under the assumption that, in the long run, two securities that are close economic substitutes should sell for the same price. A relative value strategy can be thought of as a bet on convergence in the prices of closely related securities.

Relative valuation is used by managers to identify opportunities for purchase or sale of individual securities as well as for the purchase and sale of baskets of securities. Our example above worked because there were two securities A and A*, both with the same risk characteristics. But if stock A did not exist for comparison, a levered position in the market portfolio M could be sold short to hedge and finance the purchase of A*. Even more sophisticated examples could be constructed – for example A could be "synthesized" by holding a stock with a higher beta and a stock with a lower beta, giving a portfolio with a systematic risk exactly equal to that of A*. As we show below, there are a number of hedge fund styles that essentially exploit deviations in relative valuation.

IV. 2 Market Neutrality

Another key difference between hedge funds and traditional asset classes is market neutrality. In the above example, an investment in a traditional asset class is equivalent to the purchase of shares in the market portfolio M, for which the investor expects to earn the equity risk premium. Indeed, a pure index fund investment completely eliminates any expectation of any return above the security market line. While most managed asset class portfolios seek to add some measure of positive alpha, much of their performance will be explained by the returns of the asset

class itself. When small stocks go down in a given year, for instance, most small cap stock managers will have bad years. Not because they are poor managers, but because they have a large positive exposure to that asset class.

By contrast, a perfectly hedged equity hedge fund will be relatively unaffected by positive or negative swings in the stock market. This neutrality is similar to that of an "overlay" strategy that seeks to enhance the expected portfolio return without altering its systematic risk characteristics in any way. Market neutrality is an important advantage in volatile market conditions. Hedge fund managers typically shine in down market years because they have hedged away systematic equity risk. However, while hedge funds, at least in theory, do not add to the systematic risk of an investment portfolio, they may add volatility, since the alpha is only in expectation and not certain.

IV. 3 Imperfect Markets

Opportunities for arbitrage in expectations are rare in markets that are well understood by participants. This does not mean that all securities are everywhere and always correctly priced, however. The securities markets are never in perfect equilibrium – they just tend that way, due to the activities of arbitrageurs. Well-known deviations from "correct" prices include the closed end fund discount. The prices of closed end funds are persistently lower than the equivalent portfolio of shares in the underlying securities. In this case and others like it, however, high transactions costs or other institutional barriers typically prevent profitable exploitation. Despite the apparent lack of major deviations from relative value, some hedge funds operate in highly liquid, efficient and well-functioning markets. This may be because they face lower transactions or financing costs than other participants. Even when the mispricing is a few basis points, some hedge funds may be skillful enough at trading that they profit from high-volume, low margin arbitrage in expectations.

The other extreme are hedge funds that operate in relatively inefficient markets in which the basis for security valuation is uncertain and research and specialized knowledge and experience provide a comparative advantage. Research may take many different forms, from high-tech quantitative models of statistical arbitrage to fundamental valuation based on a sophisticated knowledge of a particular industry. We can expect hedge funds to be active in any newly created market because it is precisely the exotic, novel, complex securities markets in which research provides the greatest advantage. Thus, some hedge funds specialize in "fringe" securities – complex derivatives, emerging market debt, convertible debt and high tech equities.

IV.4 Strategic Considerations

The hedge fund industry is highly competitive. Mispricings, once discovered, will disappear if chased by sufficient capital. As a result, the lack of public disclosure by hedge funds reflects their strategic advantage. The more hedge funds disclose about their strategy, their performance and their trades, the more they are subject to "reverse engineering" by their competitors. The requirement that mutual funds disclose holdings quarterly and price shares daily is a major problem for hedge funds. For investors, the lack of security-level information is both a blessing and a curse. The blessing is that the disclosure barrier allows the fund to maintain its relative informational advantage. The curse is that it is difficult to evaluate the fund's risk characteristics.

V. Hedge Fund Risk

While many risks of hedge funds are similar to those of other investment companies, there are a few that are fundamentally different. Since a pure hedge fund strategy has virtually no systematic (or asset class) risk, all of the risk relates to the manager's alpha. the alpha and the risk

associated with it can be broken into two parts. First, the model that identifies it could be wrong. This is called "model risk." Second, the process by which the long position and the hedge converge to create value is an inherent source of risk. A spread that looks like an attractive arbitrage in expectations looks even more attractive when it widens. But, as it widens, the hedge loses money. This is called "convergence risk."

V.1 Model Risk

Relative security valuation depends critically on the ability to reliably identify securities or portfolios as close economic substitutes. Whatever the exact nature of the model, the crucial feature is whether it fully accounts for the systematic risk of the underpriced security and the position used to hedge it. In the example, A* plotted above the security market line due to mispricing . However, suppose there were another source of risk that the single beta model failed to capture. Suppose there were in fact two dimensions of risk, beta 1 and beta 2. If A* happened to have a high exposure to factor 2, and A had no exposure to factor 2, then A* would command a higher expected return than A in equilibrium. Thus, the challenge of the hedge fund manager is to determine whether an observed discrepancy between the price of two securities is due to incorrect evaluation of risk by the market, or his own omission of risk factors in the expected return model. The classic example of this is the so-called "Peso problem." Foreign exchange traders frequently noticed that long positions in the Mexican peso regularly yielded positive returns. The explanation for this mysterious "premium" for holding pesos suddenly became clear when the Peso was devalued. Even though devaluation occurred only one in a great many years, it was still a risk for which the market commanded a premium in expected return. Speculators in the peso who believed they were exploiting a market imperfection were merely collecting insurance premiums each month

for bearing the risk of a sudden devaluation. Even a well-tested model of foreign exchange, unless it included a rare devaluation event, would have incorrectly suggested a potential for arbitrage in expectations.

V.2 Convergence Risk

Even when the valuation model is correct, a hedge fund is potentially exposed to position risk. For example, sometimes prices diverge before they converge. The forces that led to the initial gap in the prices of the long and short positions may strengthen before they abate. In this circumstance, the fund confronts short term losses, while still anticipating long term gains due to eventual equilibration in prices. Short term losses can be a major risk to the ability to maintain a profitable position. In fact, short term decreases in the value of securities may lead to margin calls by brokers that trigger liquidation. Perhaps the most famous case of position risk is Long Term Capital Management. It was widely reported that the firm bet heavily on the convergence in the prices of two different types of bonds. When bond prices diverged, the firm apparently had insufficient capital to avoid bankruptcy. Ultimately bond prices did converge, but the LTCM creditors, not the original investors, were the ultimate beneficiaries. In fact, it is useful to think of assets in hedge funds as simply a margin account that is used as security for taking long and short positions in traded securities. Convergence risk increases with the probability of a margin call.

The LTCM case highlights the potential for prices or economically equivalent assets to diverge before they converge. Even if a relative valuation model is absolutely correct and the firm has no uncertainty about the ability to maintain its position, there is still uncertainty about when convergence will occur. Because of the time value of money, slowly converging positions are less profitable than rapidly converging positions. Unless the investment has some specified date on which the cash flows from the long and short positions occur to offset each other, there is no guarantee that the market prices will equilibrate soon. Figure 2 illustrates convergence. The manager expects to earn the price differential between A and A* through the convergence in the expected returns of the two securities. However, the process by which the expected returns converge is uncertain.

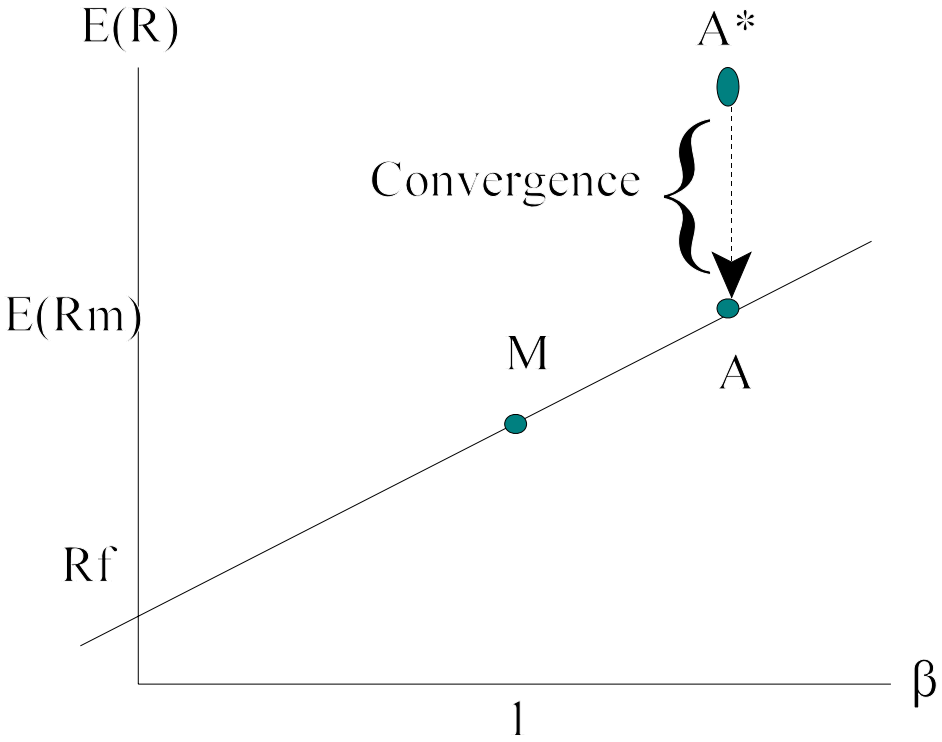

Figure 2

V.4 Fund of Funds

Traditional investment portfolios are sufficiently diversified across securities so that security-specific risk is minimized, and systematic risk – i.e. factor risk – is the predominant source of uncertainty. Individual hedge funds cannot necessarily diversify in this manner. At any given time, mispricings may be plentiful or they may be few. Thus, there is no guarantee that the security-specific risk may be diversified away by spreading capital across a large number of "deals." Nor is there any guarantee when convergence on any particular position will occur. Unfortunately, when managers try to diversify across opportunities within their funds, they are naturally tempted to stray farther from their areas of specialization. By their very nature, hedge fund managers are "niche" specialists and straying can be dangerous.

One approach to reducing model risk and convergence risk this is for investors to diversify across different hedge funds and hedge fund strategies to eliminate the idiosyncratic risk at the investor portfolio level. Unlike mutual fund, hedge funds may take positions in shares of another investment company. One type of hedge fund company, called a *fund-of-funds* is actually designed as a diversified portfolio of other hedge funds. The fund of funds can diversify at the portfolio level, spreading the model risks and convergence risks across various managers and styles. As such, it is an important potential tool in the implementation of a hedge fund investment strategy.

VI. Hedge Fund Styles

Because they specialize is so many different securities and markets, hedge funds can only be approximately classified. In fact, the issue of style identification is an interesting and evolving problem in the hedge fund industry, because the styles themselves follow common patterns that have

implications for portfolio performance. There are a number of common hedge fund style classifications used in the industry. These can be generally divided into three groups: *relative value* arbitrage, *event-driven* arbitrage and *inter-temporal* arbitrage strategies. While these provide a useful conceptual framework for hedge fund style definitions, research suggests that the risk and return characteristics of these strategies shift through time. Most importantly, not all funds in each style share the same risk characteristics. As a result, style indices constructed from these categories are unlikely to provide accurate risk-adjusted return benchmarks.

VI.1 Relative Value Strategies

Managers pursue relative value strategies in a number of different securities markets: equity, fixed income and derivatives. While the valuation models differ across asset classes, the principles of relative value arbitrage are the same across markets.

VI.1.i Equities

Long-short equity managers seek to identify and exploit mispriced common stocks – securities that are either over-priced or under-priced relative to others in the equity universe. They hold portfolios of offsetting positions which ideally have little or no systematic risk as measured by an equity factor model such as the APT or the CAPM. One of the most enduring long-short equity strategies is *pairs-trading*. Pairs managers identify two stocks whose prices tend to move together. When relative values of the two stocks diverge, pairs traders take a long position in the lower priced stock and a short position in the higher priced stock, which they unwind once the prices converge. Academic analysis of pairs trading suggests that it has been historically profitable, and fits the

classic definition of a market-neutral strategy.[2] Pairs trading is the simplest kind of long-short equity strategy because it requires no pricing model to evaluate pricing deviations. Quantitative, model-based methods are widely used to develop more sophisticated long-short hedge portfolios. For example, s*tatistical arbitrage* managers use software based on the APT and related factor models to calculate the systematic risk exposure of individual stocks use proprietary models to determine the alpha of each security. Managers take long positions in securities with positive alphas and offset them with short positions in securities with negative alphas. These positions are often, but not always, balanced to achieve a net market neutral exposure. Positions change as individual securities realize their positive or negative alpha potential.

VI.1.ii Fixed-Income

Fixed-income arbitrage funds invest in the entire array of debt instruments, foreign exchange futures, interest rate derivatives, interest-rate swaps and mortgage-backed securities. The classic fixed-income arbitrage fund seeks to capture differences in the implied forward rates among economically equivalent securities or portfolios. Hedges for a particular over-valued or under-valued bond may involve complex combinations of swaps, derivatives and foreign exchange instruments. The models underlying these positions are typically highly quantitative, proprietary asset pricing models derived from academic research on yield curves such as the path-dependent

[2] See Evan Gatev,William N. Goetzmann, and K. Geert Rouwenhorst, 1999, "Pairs Trading, the Performance of a Relative Value Arbitrage Strategy," Working Paper, International Center for Finance, Yale School of Management.

Heath-Jarrow Morton[3] model or the risk-based factor models such as the Cox-Ingersoll-Ross model,[4] both of which provide a theoretical framework for evaluating the relative prices and relative hedge requirements of default-free bonds of differing maturities. These models allow fund managers to express mispricing opportunities in terms of such factors as volatility mispricing, undervalued tax-effects and liquidity differentials.

Fixed income funds also focus on the evaluation of corporate or sovereign credit risk, speculating on the convergence in prices of securities with similar default risk characteristics. Distressed debt funds have a comparative advantage in understanding the implications of the bankruptcy code for creditors. Emerging market funds speculate in the relative credit risk of countries. Theoretical models for credit-risk valuation are less developed than those for riskless debt. This in fact may be the basis for firms specializing explicitly in this arena.

One class of relative-value fixed income hedge funds specialize in the evaluation of mortgage-backed securities [MBS]. As with other fixed income relative value arbitrage, MBS strategies are model-based. These models typically incorporate the refinancing option implicit in mortgage-backed securities and their derivatives. In addition, they are often estimated on empirical data about refinancing behavior, since people do not always behave as theory would suggest. The comparative advantage of an MBS fund is its ability to more accurately estimate the pre-payment rate.

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[3]Heath D, Jarrow WR, Morton A, 1992, "Bond Pricing and the Term Structure of Interest Rates – A New Methodology for Contingent Claims Valuation."*Econometrica* 60: (1) 77-105.

[4]Cox JC, Ingersoll JE, Ross SA, 1985, "An Inter-temporal General Equilibrium Model of Asset Prices," Econometrica 53: (2) 363-384 and Cox JC, Ingersoll JE, Ross SA, 1985," A Theory of the Term Structure of Interest Rates," *Econometrica* 53: (2) 385-407.

Convertible-bond arbitrageurs represent yet another group of fixed-income relative value hedge funds. As with mortgage-backed securities, it has long been known that convertible bonds may not actually be converted at optimal times.[5] In addition, since they are "hybrid" securities resembling both bonds and stocks, the potential exists for their mispricing. Some managers specialize in the purchase of under-valued mortgage-backed securities, while hedging them with appropriate short positions in the equity and other debt of the firm.

VI.1.iii Derivatives

Derivatives funds trade in options on equities, debt and futures as well as securities such as warrants and convertible bonds. Derivative funds are the only relative-value players whose activities closely approximate true arbitrage, rather than arbitrage in expectations. This is because equity derivatives such as puts and calls are truly "redundant" assets in the market. Their payoffs can be exactly matched by dynamic positions in the underlying shares and treasuries. When derivatives are mispriced, they are almost perfectly hedgeable. Option contracts typically have expiration dates. Thus, there is a specific date upon which the long and short positions in the portfolio are destined to converge. Perhaps the most well-known relative-value derivatives strategy is *index arbitrage*. Since the introduction of futures on the S&P 500 and other equity indexes beginning in the 1980's, relative-value arbitrageurs have traded the futures against their equivalent basket of underlying securities. When S&P 500 futures rise in value relative to the price of the underlying stocks, relative value arbitrageurs sell futures short and buy the underlying shares. In fact, computer-driven trading arose in part because of the need to simultaneously trade an entire

[5]Ingersoll, J. E. Jr., 1977, "Contingent Claims Valuation of Convertible Securities,"*Journal of Financial Economics*, 4: (3) 289-322

basket of dozens or hundreds of stocks while making the offsetting futures trades. With the rapid development of index futures for non-U.S. markets, index arbitrage has become a global strategy.

VI.2 Event-Driven Strategies

Event-driven strategies represent a distinct set of hedge fund strategies that differ from relative-value arbitrage. These are typically positions are motivated corporate or sovereign events. These events may be corporate mergers or acquisitions, currency devaluations, positive or negative news items affecting securities, revisions in widely held index funds or the issuance of new securities. As with relative-value arbitrage funds, event-driven managers seek to hedge the systematic risk of their positions, and concentrate their capital commitment on the alpha that derives from temporary deviations of security prices from relative value.

VI.2.i Risk Arbitrage

Risk arbitrageurs take positions in stocks following merger or tender offer announcements. Typically, stocks of companies involved in mergers or acquisitions trade at a discount to the announced terms of the deal, reflecting market-wide uncertainty about whether the deal will actually be consummated. Risk arbitrageurs take long positions in shares of acquired firms in anticipation of earning the difference between the deal value and the current discounted market price. They offset this with short market positions, or short positions in the acquiring firm in the case of stock -for-stock mergers. In addition, risk arbitrageurs seek to exploit mispricings in contingency terms of mergers. For example, guarantees offered to shareholders of acquiring firms against declines in the value of acquiring firm shares have the feature of a put option which can be valued and hedged. Thus, successful risk arbitrageurs have a relative advantage in evaluating the probability of deal

completions Although some risk-arbitrage may be model-based – particularly that related to derivatives – much of the specialized talent of risk arbitrageurs involves detailed knowledge of anti-trust precedent, understanding of the respective managements of the two firms and familiarity with industry specialists who know the likelihood of deal completion.

VI.2.ii Institutional Event Arbitrage

There are a few regular events that appear to provide opportunities for exploitation by hedge fund managers. Among these are compositional changes in index funds and changes in on-the-run bonds to off-the-run bonds. Both of these opportunities are likely due to the preference by institutional investors for particular types of securities. For example, in order to minimize tracking error, S&P index funds are bound to buy stocks that are brought on to the S&P 500. Academic research shows that arbitrageurs can and do exploit the anticipated demand shocks for these securities buy buying in advance of additions and shorting in anticipation of index deletions. In similar fashion, institutions are know to prefer buying newly issued bonds, called "on-the-run." As a result, the prices of these bonds are high relative the seasoned securities that precisely match their cash flows, some managers exploit this differential, in anticipation of convergence in value once a bonds is "off-the-run."

VI.2.iii Special Situations

A number of opportunistic, (sometimes called *special situations*) hedge funds explicitly trade on perceived temporary deviations in security value, often associated with new events. News items about companies often contain information relevant to their value. Certain managers specialize in estimating and trading upon this value-relevant information. Sometimes this involves

exploiting apparent over-reaction of the market to a piece of news, other times it involves acting early on a news that others' may understand as significant. While opportunistic funds often specialize in equities, there is an opportunistic feature to many fixed income strategies as well. Interest rates respond to decisions by the Federal Reserve which are typically based upon macro-economic trends. Opportunistic fixed income funds often shift exposures to interest rates in response to macro-economic news and in anticipation of Fed decisions. This kind of speculation, however is more of the nature of directional bets on interest rates, and not a truly hedged investment. As such this type of manager would more properly below in the third and next major category of hedge funds.

VI.3 Tactical Strategies

Tactical managers are one group of hedge funds that do not neatly fit the hedge fund theory proposed in the analysis. Tactical managers take educated bets on the short-term trends of various assert classes. As such, they have fluctuating exposures to systematic risk factors. Their added value lies in their ability to accurately forecast the future movement of a given market. In effect, their strategy is to move opportunistically along the SML rather than search for positive or negative alpha positions at a risk point on the SML. This inter-temporal variation in factor exposures makes tactical managers particularly difficult to evaluate with traditional performance measures.

VI.3.i Global Macro

The most widely recognized tactical hedge funds are global macro funds, like those created by George Soros. Macro funds take directional bets on international currency, equity and debt markets. A recent study of global macro-managers around the time of the Asian currency crisis of

1997[6] shows that the currency exposures of the top macro funds in the three years preceding the crisis changed practically on a weekly basis. Thus, the value proposition of a global macro manager is different from that of a relative-value manager or even and event-driven manager. The tactical manager offers timing skill. The tactical fund is never market-neutral, however the strategy cannot be simply replicated with passive investment in traditional assets because the exposures change rapidly.

VI.3.ii Market Trend/Timing

Statistical relationships between security returns and historical patterns in security price movements are the basis for a wide range of market-timing strategies used by fund managers. Timers might strictly be thought of as managers who move in and out of a single market, however there are a wide variety of related strategies which may involve changing allocations across a number of different markets. Although tactical managers often appear in stylistic classification of hedge funds, they are not fundamentally different than tactical asset allocation manager or timers. The difference in primarily due to organizational form rather than the substance of what they do.

VI.3.iii Directional

A large class of managers in the hedge fund industry intentionally takes unhedged, temporary directional bets on asset classes, or on sub-classes of assets. For example, a directional fixed income fund may change their exposure to long bonds depending upon the outlook for interest rate changes. Directional equity hedge fund managers may vary their exposure to small cap stocks

[6]Stephen J. Brown, William N. Goetzmann and James M. Park, 2000, "Hedge Funds and the Asian Currency Crisis," *journal of Portfolio Management*, 26(4), Summer, pages 95-101.

or value stocks. As with timers, the difference between directional managers and active long fund managers is a matter of degree, rather than substance.

VII. Hedge Fund Performance

Because the hedge fund industry is skill-based, reliable methods of measuring manager performance, style performance and asset class performance are vital. Much recent academic and industry research has focused on the performance measurement issue. Perhaps the most striking aspect of this problem is how really difficult it is. There is no official list of hedge funds in the United States and no official clearinghouse for information about them. The size of the industry is only a guess, based upon incomplete current information.

VII.1 Data Issues - Survivorship Bias

For many years, high quality data about hedge fund performance was simply unavailable. The constraints of the Investment Company Act of 1940 prevented funds from publically advertising or soliciting investors. Many funds conservatively interpreted this as a constraint on publicly reporting their performance or sharing information with data vendors. As result, only in the past decade have many funds been willing and able to report results. Furthermore, only in the past few years have data vendors become aware of the need to consistently collect and maintain performance records – including those of funds that have disappeared. For example, it was common until the mid-1990's for vendors to only maintain records for currently operating funds, or to gather data on funds requested by their clients by "backfilling" performance records. As a consequence, records of defunct managers simply were not saved. This failure to maintain records of poor performers leads to a severe "survival-bias."

When the losers are dropped from sample, the index is dramatically biased upwards. [7] Measures of the annual attrition rate for hedge funds are as high as 20%[8]. Recent research[9] shows that this high attrition rate biases hedge fund indices by as much as 2% to 3% per year. In other words, the historical benchmarks used to evaluate individual hedge fund track records may simply be wrong. This gravely affects portfolio optimization procedures that rely upon biased hedge fund indices and consequently may severely misrepresent their value to investors.

A more subtle problem induced by survivorship bias is difficulty in individual manager selection. We have found that when funds with different volatilities are compared to each other, and the sample of funds is subject to attrition, then the riskier funds may appear to be the better funds *ex post*.[10] Without a bias-free database, you may believe you are selecting funds with higher alphas when you are really selecting funds with higher volatility who simply got lucky and survived. One approach for reducing this bias is to use the appraisal ratio, which is just α/σ where α is the measured alpha and σ is the residual standard deviation of fund returns. Unfortunately, while this reduces the bias it doesn't eliminate it, and performance measurement remains difficult.

Given the serious difficulties posed by data limitations, the challenge in the hedge fund industry is, first, to develop measures of individual manager skill that have a minimal sensitivity

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[7] Stephen J. Brown, William N. Goetzmann and Stephen A. Ross, 1995, "Survival," *Journal of Finance*, July.

[8] Brown, Goetzmann and Ibbotson, 1999, Op.cit.

[9] James M. Park, Stephen J. Brown and William N. Goetzmann, 1999m "Performance Benchmarks and Survivorship Bias for Hedge Funds and Commodity Trading Advisors," *Hedge Fund News* August. and Bing Liang, 2000, "Hedge Funds: The Living and the Dead," *Journal of Financial and Quantitative Analysis*, 35(3) September, pages 309-326

[10]Stephen J. Brown, William N. Goetzmann, Roger G. Ibbotson and Stephen A. Ross, 1992, "Survivorship Bias in Performance Measures," *Review of Financial Studies*, December.

to survival bias and second, to create basic measures of individual and aggregate performance that are not subject to survival bias and backfilling bias.[11]

VII.2 Skill Metrics

Hedge fund performance measurement demands an approach that captures differences in the manager skill, and does not reward the manager for returns generated by systematic risk exposure. There are three common skill metrics used to evaluate hedge fund managers. They are the *Sharpe ratio*, the *alpha* and the *information ratio.* Each has limitations and advantages. Of the three, our past research suggest that the information ratio provides some protection against the misleading effects of survival bias, while controlling for linear exposures to systematic risk. Its drawbacks are the for long manager histories to verify skill with a high level of certainty and an inability to capture manager timing ability.

VII.3 Sharpe Ratio

Developed by Professor William Sharpe as a measure of the risk-adjusted return to mutual funds, the Sharpe ratio is now widely used in the investment management industry to adjust excess manager performance by the volatility of returns. The calculation of the Sharpe ratio is simple and intuitive. The historical average of a manager's total return in excess of the treasury-bill return is divided by the volatility of that return. Thus the Sharpe ratio is a reward-to-risk measure. The problems with it as a hedge fund metric are two-fold. First, it does not differentiate returns

[11] See William Fung and David A. Hsieh, 2000, "Performance Characteristics of Hedge Funds and Commodity Funds: Natural vs. Spurious Biases," *Journal of Financial and Quantitative Analysis*, 35(3) pages 291-308, Summer. They find that fund-of-fund returns are actually a more accurate measure of aggregate hedge fund performance than use of biased vendor data.

according to whether they derive from market-neutral strategies or from systematic factor exposures. Thus it cannot determine whether the manager is truly hedged. Second, recent research has suggested that the Sharpe ratio may be "gamed" by the clever use of derivatives. Given that hedge fund managers have no restrictions on their use of derivative securities, this is an undesirable property.

VII.4 Manager Alpha

The manager alpha is the average performance the hedge fund manager in excess of the treasury bill rate, once the amount due to systematic factor exposures has been subtracted. The manager's benchmark becomes the security market line shown in Figure 1. A perfectly hedged manager who beats the treasury bill rate will have positive alpha. An imperfectly hedged manager will have the hurdle raised by the systematic risk exposure. The advantage of using manager alpha as a performance metric is that it controls explicitly for systematic risk exposure. The limitations of it are two-fold. First, if the manager's track record comes from a survival-biased database, the average return is possibly biased upwards. The greater the volatility of the fund, in fact, the greater the likely bias. The systematic risk correction fails to account for this problem. Second, the estimation of the factor model, particularly for equities is confounded by managers who change their factor exposures through time. In fact, research suggests that managers with timing skills can actually appear to have negative alphas when their timing activity is ignored.[12]

[12]Dybvig PH, Ross SA, 1985," Differential Information and Performance Measurement Using a Security Market Line,"*Journal of Finance* 40: (2) 383-399 and Dybvig PH, Ross SA, 1985,"The Analytics of Performance Measurement Using A Security Market Line," *Journal of Finance,* (2) 401-416.

VII.5 Information Ratio

The information ratio [IR] or *appraisal ratio* is a useful innovation to the alpha that at least partially helps adjust for some survival effects. The IR scales the manager alpha by the alpha's statistical uncertainty – its *standard error*. This has two benefits. First, the IR becomes, in effect, a quality-adjusted alpha – more commonly called the t-statistic of the alpha. If the statistical uncertainty associated with a positive historical alpha is high, then the IR will be low. Managers that reliably deliver positive alpha – even if it small in magnitude – will have a high information ratio. The second major advantage is a relative robustness with respect to survivorship bias. In previous research we have found that the survival bias is highest for relatively risky funds – funds that take large non-systematic bets. This relative riskiness is statistically equivalent to alpha risk. Scaling alpha by alpha risk to make the IR means that funds more subject to survival bias will have a lower performance metric than those that are not.

VIII. Historical Performance

In this section we report industry performance based on ten years worth of annual performance data using one of the better hedge fund databases.[13] Our research, and that of other hedge fund analysts, suggests that, while the database is not entirely free from survival and backfill problems, it has less survival and backfill biases than most others. While the common intuition in data collection is that more is better, survival-biases mean that this intuition is wrong. Merging biased data with non-biased data results in a database of lower value for purposes of financial analysis.

[13] We use the commercially available TASS database.

Because of the issue of survivorship and related possible biases, we divide our analysis of hedge fund performance into three historical periods. Tables 2, 3 and 4 report summary statistics for indices constructed from the monthly after-fee returns in the hedge fund database.[14] The first table uses data over the period before the systematic collection of hedge fund dat: 2/1977 to 12/1988. This precedes the beginning of most efforts at collecting comprehensive hedge fund data sources. Table 3 uses data over the period 1989 to 1994, the period before which the current database began to save data of defunct funds, but a period of emerging attention to hedge funds by investors. Table 4 covers the period from 1994 through May, 2000, during which the database developer began to systematically save data from defunct funds. Even taken together, these three periods are relatively short for the evaluation of the long-term benefits and risks of hedge fund investing.

VIII.1 Industry Trends

While the database we use covers an unknown fraction of the global hedge fund assets under management, it provides at least a partial picture of the growth of the industry over the past 24 years. The database reports $136 billion in hedge fund assets in spring of 2000. This is slightly more than the assets reported by alternative sources[15] but certainly less than the total pool of hedge fund assets in the world and less still than the amount of capital devoted to arbitrage in expectations, through other vehicles ranging from individual investment to institutional proprietary trading operations. One interesting trend is the decrease in the relative scale of global macro funds. Some of the top

[14] Since most performance fees are calculated quarterly or annually, the monthly returns are really only an estimate formed by imputing a fee to a monthly return. This potentially distorts the mean and variance of the series.

[15] The Offshore Funds Directory reports $118 Billion as of year-end 1999.

global macro funds have shut down or dramatically reduced their size and strategies over the past year. Thus, a once dominant style is less relevant in the range of hedge fund activities than it once was. The trends in relative value arbitrage goes the other way – it has grown faster than other styles in recent years. Variations in the capital committed to different styles is not surprising, since hedge funds by their very nature operate under shifting opportunities for profit. Certain types of arbitrage may be available for periods of time and then disappear with the increased efficiency or competition within a market. Indeed this makes it problematic to take average historical returns for any given style as reliable forecasts for the future.

The question of how hedge fund capital flows affect returns is an important subject for research. Our asset pricing model framework suggests that absolute dollar profits may be more relevant as a measure of hedge fund investing rather than percentage returns per year. This is because of the assumption that, as arbitrage capital flows towards an arbitrage in expectations, the price responds by moving towards equilibrium value. As a result, when the pool of arbitrage capital is large, returns are expected to be smaller. In fact, research suggests that successful managers tend to take *less* external capital, perhaps because it dilutes returns.[16]

An important issue illuminated by the trends in Table 1 is whether the growth of the hedge fund industry as a whole will diminish future returns to arbitrage in expectations. While theory suggests the industry has diminishing returns to scale, it does so under the assumption of the constant scale of asset markets. In fact, the world capital markets have been growing dramatically over the past decade, not just in size but in variety. One way to read recent upward trends in hedge

[16] William N. Goetzmann, Jonathan Ingersoll Jr and Stephen A. Ross, 1999, "High Water Marks," International Center for Finance, Yale School of Management Working Paper Series.

fund growth is as a response to the opportunities presented by the market growth and liberalization of cross-border investment. Given the documented tendency of hedge fund operators to resist the dilution of returns, we should take the current scale of the hedge fund universe as endogenous. Never-the-less, the size of the industry relative to the assets it trades in may be a relevant ratio in forecasting future hedge fund industry performance.

VIII.2 Return Calculations

The returns for each index are equal-weighted across the funds extant in a particular category at any given time. Equal-weighting is chosen because our goal is to examine the performance of hedge fund managers in general. Value-weighted indices, while useful for measuring how the average dollar invested in the industry performed, will typically be weighted towards a few, large funds. In particular, the Soros funds were relatively large in the early period of the sample. Hence the global macro style would be disproportionately represented in a value-weighted index. In addition, unlike traditional asset classes where the capitalization is well-estimated, the hedge funds for which we observe return data may only be a small sample relative to the capital invested in non-reporting funds, and non-reporting funds may not have the same kind of distribution across styles as those in the TASS database. Equal-weighting means we do not presume that the observed capital distribution across styles is representative of the actual capital distribution across styles.

We report several statistics for each category: arithmetic mean, geometric mean, standard deviation, Sharpe ratio, manager alpha and the information ratio. Alpha is based on a single factor asset pricing model. The systematic risk factor is the S&P 500. It is expressed in a positive or negative percentage per month. The t-statistic of alpha [information ratio] measures the probability that it differs from zero.

The table first divides the hedge fund universe into fund of funds and single manager funds. Funds of funds hold shares in single manager funds. There are apparent differences in the historical performance of each which will be discussed below. Below the aggregate measures, we report the performance of sub-categories according to strategies investment strategies pursued by funds. These categories are not mutually exclusive. For example, a fund might use both technical and fundamental techniques to evaluate market neutral strategies. In this case, it might be included in three different indices. The final classification is style. These are more likely to be mutually exclusive classifications of funds.

VIII.3 Mean returns

The most striking evidence across the three tables is the difference in hedge fund performance through time. Mean returns are 30% in the first period, 17% in the second period and 14% in the third period. One possible explanation for this difference is backfilling and survival bias. Since hedge fund data vendors were not active over most of this period, Table 2 is almost certainly based upon backfilled fund information, drawn from managers who were successful. The second period, reported in Table 3, may not be backfilled, but it is still likely to have been subject to survival bias. The return differential between the second and third tables is certainly consistent with academic estimates of the magnitude of the survival bias: 2 ½ % to 3%, and suggests that Table 4 is more likely to provide reasonable estimates of mean return. For example, the arithmetic mean return of 13.99% for the equal-weighted TASS portfolio from January, 1994 to May, 2000 is fairly close to the Brown, Goetzmann, Ibbotson [BGI] estimate of 13.27% for the period 1989 through 1995. This comparison is instructive, because the BGI estimate, while not entirely free of survivor bias was constructed by following all funds in an annual database during the 1989 - 1995 period.

Notice that the estimate of TASS equal-weighted average returns in Table 3 for the 1989 - 1993 period was significantly higher 4% or so. This might, of course, be due their coverage of different time periods, but the mean return for the fund-of-fund index is 13.04% – very close to the BGI estimate. This is a strong argument for using the fund-of-funds index as a indicator of the true return to hedge fund investing. The article by Fung and Hsieh cited above agues that, because funds of funds actually hold real positions in investable hedge funds, managers cannot "erase" track records of poor performers that drop out of sample. As such, they are less subject to bias.

VIII.4 Sharpe Ratio

The simplest form of risk adjustment for manager returns is the Sharpe ratio. We calculate the Sharpe ratio as the ratio of the excess monthly fund returns over treasury bills, divided by the monthly standard deviation. We have found in previous research that scaling by the volatility in this way provides a partial adjustment for survival biases because of the correlation of the survival bias to volatility.[17] Notice that the Sharpe ratio for the fund of funds index ranges from .31 to .39, even though the mean returns vary dramatically. This suggests that the reward to risk ratio for hedge fund investment has remained surprisingly constant over the entire period, when total risk is used as the control.

VIII.5 Alpha and Information Ratio

How have hedge funds fared at delivering alpha? Alpha, calculated with respect to the S&P 500 as the source of systematic risk, is reported in each table. Consistent with backfilling bias,

[17] For details of this, see Stephen J. Brown, William N. Goetzmann, Roger G. Ibbotson and Stephen A Ross, 1997, "Comment: The J Shape of Performance Persistence Given Survival Bias," *Review of Economics and Statistics,* Spring.

hedge fund alphas are much higher for the pre-1989 period. The t-statistic of alpha ,i.e. the information ratio, scales alpha by its standard error. When this correction is applied (in the final column of the tables) we find that bias in the first table is potentially mitigated – t-statistics of Jensen's alpha in Tables 2 and 3 are fairly similar. Table 4 has the lowest t-statistics, with the fund of fund values since 1994 being negative – although not statistically significantly so. This evidently reflects secular trends in the risk-adjusted return of one major class of hedge fund - Fixed income directional funds. It is tempting to conclude that the 1998 collapse of Long Term Capital, or firms doing similar trades, adversely affected funds of funds.

VIII.6 Strategies

Each table breaks out aggregate returns by sub-indices according to strategies used by the managers. These correspond to the basic styles of fund management discussed above and would at first glance appear to be a valuable break-down of performance. No so. In fact, the strategy breakdown clearly indicates the difficulty in using self-reported strategies to differentiate funds. Despite apparently fundamental differences in strategies, virtually all the long term annualized means and standard deviations for the various strategy categories are close to each other. Without further analysis of the individual styles, this would appear to indicate that the various strategies are close economic substitutes for each other in the investment portfolio. In fact, this is probably not the case – it is simply due to the failure of the managers to actually report what they are doing, or perhaps to over-report what they are doing. It would seem that most funds check several different strategy boxes, arguably because of strategic concerns.

One interesting exception is the Event-driven category. It is the smallest class of strategies in the database, with 154 managers identifying themselves as event-driven and includes M&A risk

arbitrageurs.. The small number suggests that it is likely to be more focused than other strategies, and hence may be a fair representation of the performance of the style of event-driven managers. The performance of this class has been strong since 1989, with alpha t-statistics of 5. As we see in te following style analysis, some – but not all – of this is accompanied with exposure to systematic risk factors.

VIII.7 Styles

The styles classification does somewhat better at meaningfully distinguishing groups. Notice that the risk-return characteristics of the styles differs in cross-section, with the fixed income directional style having a lower risk and return profile and the US equity hedged style having a higher risk and return profile. The pattern is roughly consistent across the three tables, suggesting that the seven different styles offer alternative benefits to the investment portfolio. Table 5 below shows the correlation of the monthly returns of the TASS styles. The correlation matrix shows that the correlations between traditional asset classes and the styles is typically non-zero. The correlations of most fund styles is positive with the market factor, with the exception of the short-sellers who have a negative beta by definition).

Table 6 reports the systematic risk exposure of the aggregate indices and the style indices. For each series, we use all available time-series observations in a linear regression that uses a set of independent variables corresponding to systematic risk factors that influence the stock and bond markets. We have two stock factors – the U.S. equity premium and the premium of small stock returns in excess of large stock returns. Both have been shown to be important factors in asset pricing models. Our two bond factors are a default premium, measured as the return differential between long term government and corporate bonds, and an horizon premium, measured as the

differential between returns of long term bonds and t-bills.[18] Because we use all available data, the intercept terms, which typically correspond to alphas, are typically positive. This is due to the use of data from early periods. The various data biases have little effect on beta estimates, however so we can be relatively confident of our estimates of hedge fund systematic risk exposures.

The constellation of systematic risk exposures help characterize the source of profits for each major fund style, on average. Notice that only one group conforms well to the theoretical "market-neutral" posture of hedge funds as zero-beta, market neutral assets – the Relative Value style. Although it has a positive correlation to movements in the stock market, it has a much lower volatility than the market as a whole, resulting in a lower sensitivity to stock market fluctuations.

In contrast, Hedged U.S. Equity funds are not exactly well hedged. They have a beta of .68 on the U.S. equity premium and a small stock beta of .46 – both of which are highly significant. Thus, we can surmise that on average, most of the funds in this class are mostly long small and large cap equities – hedging if it exists must only be partial. This is important information for performance evaluation, because it suggests that it is not necessarily appropriate to benchmark managers in this category against an absolute return standard. Given their positive factor exposure, an equity benchmark – or at least a blended benchmark – makes more sense.

Directional Fixed Income funds appear to deliver as advertised. They have statistically significant directional exposures to each of the four risk factors. Their single largest exposure on average appears to be on the default premium. This is consistent with convergence strategies that are long of high yield corporate or sovereign debt. The high horizon premium loading also suggests that these funds are also betting on the upwardly-sloped yield curve. Both of these two strategies may be interpreted as "insurance" strategies. Default and yield curve risks are clearly factors that

[18]Source: Ibbotson Associates.

large segments of the investment universe wish to avoid.. Directional fixed income managers apparently step in to supply insurance to these segments. These positive factor exposures clearly argue against measuring directional fixed income manages in absolute return terms. A multi-factor risk adjustment model including a range of fixed income factors is clearly warranted for evaluating whether they add positive alpha.

Global macro managers, although widely recognized as managers who take directional bets actually have less exposure to systematic factors than one might expect. Of course the model in Table 6 does not include international factors and currencies. Nor does it allow for time variation in factor exposures. Since empirical analysis of high frequency returns from global macro managers suggests their directional bets on currencies may swing widely from week to week, our simple multi-factor model is probably an insufficient tool for risk adjustment.

There is no ambiguity about the systematic bets of short sellers. They load up with a negative sign on large and small cap stocks – as such, they would appear to be a good hedge to the entire US Equity hedge class, although their exposure to large cap stocks is particularly extreme – a negative beta of 1.2 indicates they either select high beta stocks to short, or more likely, they use margin to magnify their position.

Discretionary funds appears to be a catch-all category for equity strategies. This probably corresponds to the opportunistic style described above. The positive loading on the two equity factors suggests that equity exposure is a by-product of favorable investment opportunities. As with U.S. Equity funds, an absolute return benchmark is not entirely appropriate for this category.

In sum, our exploration of the equal-weighted return indices of seven available hedge fund styles suggests that one group of relative value funds matches our theoretical model of the value proposition for hedge fund management. To the extend that the other six groups take directional

bets, it is important to use a risk-adjustment model to put all managers on equal footing for purposes of performance evaluation. Perhaps more important is the extent to which systematic risk exposures of various fund styles influence the asset allocation process. That is the subject of the next section.

IX. Hedge Funds as Portfolio Assets

The essential feature of asset allocation for institutional and/or large individual portfolios is the combination of asset classes to achieve a satisfactory expected return with as much diversification as possible. Investment managers typically take a top-down approach to structuring portfolios, beginning with a decision about the long term allocation policy which generally involves weights on four to eight major asset classes, and then the implementation of this policy through asset-class manager relationships. For each asset class, it is generally considered prudent to diversify across securities. Indeed, the benefits of such diversification has nearly become axiomatic to the investment management process.

In the simplest terms, hedge funds add back some of the idiosyncratic risk which investment managers have so long sought to eliminate. In return, they seek to provide positive alpha. Market-neutral funds are hedge funds in their purest form – adding *only* idiosyncratic risk without shifting any of the portfolios systematic risk exposures. This neutrality has certain advantages. It can be thought of as an *overlay* on an existing portfolio that has already been optimally balanced across major asset classes. As a consequence, when used in the context of a portfolio optimization program, market-neutral investments add volatility, but they are essentially uncorrelated to other asset classes. The choice about how much to invest in a pure hedge fund thus depends upon investor risk appetite and the uncertainty about model and convergence risk. Fund of funds play a potentially important role in controlling the potential risk added by hedge funds. To the extend they spread

capital across a range of different managers and styles, they allow a diversification across positive alpha strategies that minimize the variance in return that is passed on to the investor. Once idiosyncratic risk is minimized, the attractiveness of pure market-neutral hedge funds depends almost entirely on the assessment of whether they can deliver positive alpha, and not on their correlation to other asset classes.

For funds that are not market-neutral, but whose systematic exposures can be reliably estimated, their role in the portfolio should be determined in the same manner that one evaluates the relative attractiveness of asset class. A good example are directional fixed income managers. While they do not hedge all their systematic risk, their factor exposures may estimated and their correlations to other asset classes forecast reasonably well. The attractiveness of imperfectly hedged funds to the investor will therefore depend on an their correlations to other asset classes, as well as upon expectations about the alpha they deliver.

The role of timing managers in the portfolio is more difficult to determine. Certainly, expectations about return are important, however since factor exposures change through time, correlations to other assets change as well, in unpredictable ways. Thus, the best approach to evaluating the benefits of adding timing strategies to the investment portfolio may be through careful simulations of a range of investment policies that incorporate time-varying factor betas.

X. Conclusion

Hedge funds are the subject of much current research. As arbitrageurs in expectations, they play an important role in the world's capital markets. We argue in this primer that hedge fund investment technology is based upon exploiting temporary deviations from equilibrium prices . As such, market-neutral managers are evaluated in terms of their absolute return above the risk-free

benchmark. Reliable long-term performance data for hedge funds does not exist. Even the best data sources can provide unbiased data back no more than a decade. Few portfolio managers would be comfortable evaluating long-term expected returns using such short histories.

Despite lack of long-term data, our empirical analysis suggests that hedge fund performance has exhibited periods of positive absolute and risk-adjusted returns. Using the fund of funds equal-weighted index as our best survival-bias free measure of return, we find that hedge funds returned approximately 13% per year over the 1989-1994 period and approximately 8% per year over the 1994 to 2000 period. Our analysis of the systematic risk exposures of various hedge fund styles suggests that some of this performance was due to directional bets by managers, while some was genuinely market neutral.

Table 1: Hedge Fund Industry Trends

Summary information about hedge funds categorized by strategies used and fund styles. Funds may identify with multiple categories and styles or none. Data source, TASS.

	Asset Values (in $ millions)				Number of Funds By Strategy and Category			
	Jan-77	Dec-88	Dec-92	Mar-00	Jan-77	Dec-88	Dec-92	Mar-00
Total Assets	4	4,413	20,197	136,632	1	81	303	1,221
Strategies								
Top Down	0	2,687	14,437	50,872	0	22	95	332
Bottom up	0	1,346	11,740	92,030	0	35	148	644
Market Neutral	0	5,087	2,810	39,883	0	11	52	304
Opportunity	0	23,413	10,377	61,608	0	28	115	462
Relative Value	0	7,063	5,793	33,866	0	15	70	340
Arbitrage	0	8,923	3,626	45,244	0	23	83	390
Discretionary	0	6,468	4,682	20,897	0	17	67	255
Trend Following	4	10,433	3,019	8,936	1	25	70	190
Technical	4	14,153	4,082	23,686	1	38	125	375
Fundamental	4	19,142	11,951	72,733	1	39	171	641
Styles								
U.S. Equity Hedged	0	2,127	11,587	24,634	0	18	55	211
Fixed Directional	0	1,302	784	630	0	1	3	19
Event Driven	0	3,755	8,482	14,499	0	15	34	121
Relative Value	0	0	4,302	20,437	0	0	13	142
Global Macro	0	1,968	72,625	12,491	0	3	12	20
Global Eq. Hedged	0	0	11,075	17,077	0	2	7	53
Short Seller	0	0	542	600	0	1	4	11

Table 2: Hedge Fund Performance 2/1977 - 12/1988

Annual summary statistics and performance measures for equal-weighted hedge fund indices and asset class benchmarks. Monthly data from TASS extend over the period 2/1977 to 12/1988. All may be at least partly backfilled. Benchmarks from Ibbotson Associates, TASS aggregates calculated by equal-weighting monthly returns for single manager funds and for fund-of-funds and for the two groups together. Strategies are manager investment approaches used by the fund – typically more than one strategy is applied by a fund, so these categories are not mutually exclusive. Styles represent TASS categories of funds. While not always mutually exclusive, they a have less overlap than strategies. Jensen's alpha is calculated only with respect to the S&P 500. The T-statistic of alpha is in percentage terms. Thus a value of 200 is required for rejection at traditional confidence levels.

	N Periods	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation	Sharpe Ratio	Jensen's Alpha (%)	T-stat of Alpha (%)
Benchmarks							
S&P 500 TR	143	13.9	15.37	18.35	0.11	0	0
U.S. 30 Day TBill TR	143	8.62	8.63	0.89	0	0	0
Tass Aggregates							
TassEW	143	29.46	30.91	19.87	0.35	1.37	4.02
TassEWsingle	143	30.86	32.67	22.5	0.34	1.51	3.81
TassEWFoF	132	26.99	28.28	18.4	0.33	1.00	3.86
Strategies							
Top Down	132	26.36	27.64	18.16	0.32	0.91	4.16
Bottom Up	134	25.11	26.74	20.16	0.28	0.77	3.47
Market Neutral	132	24.44	26.06	20.07	0.26	0.78	2.96
Opportunity	132	27.72	29.34	20.37	0.31	0.98	4.06
Relative Value	132	25.09	26.28	17.45	0.31	0.84	3.82
Arbitrage	132	24.67	25.98	18	0.29	0.8	3.58
Trend Following	143	29.42	32.16	27.94	0.27	1.59	3.06
Technical	143	30.99	33.4	26.23	0.3	1.65	3.42
Fundamental	143	28.2	29.31	17.01	0.38	1.24	4.53
Event Driven	134	22.41	24.76	23.49	0.21	0.6	1.92
Styles							
US Equity Hedge	87	26.64	28.1	19.38	0.32	0.83	2.85
Fixed Inc Directional	17	2.75	3.21	9.97	-0.08	-0.17	-0.24
Relative Value	NA	NA	NA	NA	NA	NA	NA
Global Macro	36	18.35	20.82	24.66	0.19	0.53	0.82
Global Equity Hedge	49	24.52	30.04	35.68	0.21	0.71	0.8
Short Seller	3	1.37	1.77	11.13	-0.14	0.1	0.07
Discretionary	132	26.54	27.78	17.95	0.33	1.02	3.58

Table 3: Hedge Fund Performance January, 1989 - January, 1993

Annual summary statistics and performance measures for equal-weighted hedge fund indices and asset class benchmarks. Monthly data from TASS extend over the period to January, 1989 - January, 1993. Data are subject to survivor bias. Benchmarks from Ibbotson Associates, TASS aggregates calculated by equal-weighting monthly returns for single manager funds and for fund-of-funds and for the two groups together. Strategies are manager investment approaches used by the fund – typically more than one strategy is applied by a fund, so these categories are not mutually exclusive. Styles represent TASS categories of funds. While not always mutually exclusive, they a have less overlap than strategies. Jensen's alpha is calculated only with respect to the S&P 500. The T-statistic of alpha is in percentage terms. Thus a value of 200 is required for rejection at traditional confidence levels.

	N Periods	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation	Sharpe Ratio	Jensen's Alpha	T-stat of Alpha
Benchmarks							
S&P 500 TR	136	18.65	19.73	16.1	0.28	0	0
U.S. 30 Day TBill TR	136	5.24	5.24	0.47	0	0	0
Tass Aggregates							
Tass Equal Weighted	136	16.34	16.59	7.59	0.45	0.57	4.02
Tass Single Manager	136	17.46	17.72	7.94	0.48	0.64	4.36
Tass Fund of Funds	136	12.79	13.04	7.53	0.31	0.34	2.25
Strategies							
Top Down	136	17.84	18.28	10.25	0.39	0.54	3.06
Bottom Up	136	18.28	18.67	9.63	0.43	0.56	3.6
Market Neutral	136	13.92	14.01	4.54	0.58	0.51	5.59
Opportunity	136	19.16	19.51	9.09	0.48	0.68	4.39
Relative Value	136	15.56	15.77	7.08	0.45	0.47	3.93
Arbitrage	136	15.12	15.25	5.55	0.54	0.55	5.19
Trend Following	136	14.23	15.11	14.5	0.21	0.64	1.97
Technical	136	14.97	15.44	10.54	0.29	0.6	2.62
Fundamental	136	17.16	17.45	8.24	0.45	0.55	3.96
Event Driven	136	16.78	16.97	6.66	0.53	0.64	5.05
Styles							
US Equity Hedge	136	23.65	24.42	13.96	0.43	0.77	3.69
Fixed Direction	136	9.96	10.52	11.17	0.14	0.17	0.66
Relative Value	136	13.87	13.93	3.62	0.72	0.56	7.24
Global Macro	136	23.01	23.6	12.25	0.47	1.17	4.67
Global Equity Hedge	136	19.44	19.96	11.21	0.4	0.62	3.26
Short Seller	136	0.17	1.84	18.84	-0.05	0.81	2.57
Discretionary	136	16.3	16.6	8.36	0.41	0.62	3.64

Table 4: Hedge Fund Performance January, 1994 - May, 2000

Annual summary statistics and performance measures for equal-weighted hedge fund indices and asset class benchmarks. Monthly data from TASS extend over the period January, 1994 to May, 2000 This corresponds to the period for which TASS reports beginning to save "graveyard" funds. Benchmarks from Ibbotson Associates, TASS aggregates calculated by equal-weighting monthly returns for single manager funds and for fund-of-funds and for the two groups together. Strategies are manager investment approaches used by the fund – typically more than one strategy is applied by a fund, so these categories are not mutually exclusive. Styles represent TASS categories of funds. While not always mutually exclusive, they a have less overlap than strategies. Jensen's alpha is calculated only with respect to the S&P 500. The T-statistic of alpha is in percentage terms. Thus a value of 200 is required for rejection at traditional confidence levels.

	N Periods	Geometric Mean (%)	Arithmetic Mean (%)	Standard Deviation	Sharpe Ratio	Jensen's Alpha	T-stat of Alpha
Benchmarks							
S&P 500 TR	77	21.32	22.51	17.08	1.03	0.00	0.00
U.S. 30 Day TBill TR	77	4.96	4.96	0.22	0.00	0.00	0.00
Tass Aggregates							
Tass Equal Weighted	77	13.73	13.99	7.77	1.16	0.30	1.61
Tass Single Manager	77	15.41	15.66	7.66	1.40	0.43	2.39
Tass Fund of Funds	77	8.18	8.57	9.15	0.39	-0.15	-0.63
Strategies							
Top Down	76	14.18	14.72	11.27	0.87	0.15	0.57
Bottom Up	77	16.61	17.10	10.81	1.12	0.36	1.45
Market Neutral	77	10.73	10.88	5.71	1.04	0.26	1.60
Opportunity	77	16.62	17.04	10.04	1.20	0.42	1.78
Relative Value	77	12.89	13.12	7.21	1.13	0.24	1.42
Arbitrage	77	13.16	13.28	5.35	1.56	0.40	2.91
Trend Following	76	11.53	12.01	10.50	0.67	0.42	1.29
Technical	77	12.81	13.09	8.09	1.01	0.40	1.72
Fundamental	77	15.39	15.75	9.25	1.17	0.34	1.58
Event Driven	76	15.72	15.88	6.08	1.80	0.54	3.56
Styles							
US Equity Hedge	76	25.55	26.56	16.12	1.34	0.78	2.25
Fixed Direction	77	6.66	7.18	10.48	0.21	-0.17	-0.53
RelativeValue	76	13.51	13.55	3.12	2.76	0.62	6.50
Global Macro	77	10.28	10.83	11.17	0.53	0.11	0.34
Global Equity Hedge	76	16.92	17.39	10.56	1.18	0.31	1.40
Short Seller	76	-0.60	1.00	18.58	-0.21	1.01	2.42
Discretionary	77	13.35	13.60	7.56	1.14	0.30	1.60

Table 5: Correlation of Self-Reported Fund Styles and Asset Classes

Correlations calculated from monthly returns estimated over the longest common interval for each paired series. Styles are self-reported classifications in the TASS database.

U.S. LT Gvt											
U.S. LT Corp	0.95										
S&P 500	0.34	0.36									
U.S. TBill	0.07	0.07	-0.07								
MSCI EAFE	0.19	0.19	0.47	-0.07							
Discretionary	0.28	0.28	0.55	-0.05	0.34						
US Eq Hedge	0.27	0.30	0.75	-0.01	0.43	0.59					
Global Eq Hedge	0.10	0.07	0.60	0.01	0.53	0.40	0.64				
Global Macro	0.19	0.21	0.47	0.06	0.17	0.70	0.49	0.50			
Fixed Directional	0.26	0.35	0.28	-0.21	0.14	0.26	0.34	0.25	0.24		
Short Seller	-0.04	-0.14	-0.74	0.09	-0.44	-0.31	-0.79	-0.56	-0.10	-0.30	
Relative Direct	0.24	0.29	0.39	-0.09	0.27	0.24	0.42	0.44	0.25	0.41	-0.31
	LTG	**LTC**	**S&P**	**TB**	**MSC**	**DIS**	**USE**	**GLE**	**GM**	**FD**	**SSRD**

Table 6: Multi-factor Risk Exposure of Hedge Fund Aggregates and Styles

Coefficients and t-statistics from time-series regressions of hedge fund return indices on systematic risk factors. Factors include the U.S. equity premium, the premium of small stocks returns in excess of large stock returns, the return differential between long term government and corporate bonds and the differential between returns of long term bonds and t-bills. Source: Ibbotson Associates.

	Adjusted R^2	Inter-cept	*Intercept t-stat*	S&P beta	*S&P t-stat*	Small beta	*Small t-stat*	Default beta	*Default t-stat*	Horizon beta	*Horizon t-stat*
Benchmarks											
S&P 500 TR		0.01	*40.02*	1.00	*286.31*	0.00	*-0.26*	-0.01	*.-34*	0.00	*0.45*
U.S. 30 Day TBill TR		0.01	*40.01*	-0.01	*-2.07*	0.00	*-0.40*	-0.01	*-0.34*	0.00	*0.34*
Tass Aggregates											
Tass Equal Weighted	0.22	0.01	*7.89*	0.34	*7.39*	0.20	*4.36*	-0.12	*-0.54*	0.02	*0.30*
Tass Single Manager	0.14	0.02	*7.43*	0.31	*5.80*	0.18	*3.41*	-0.16	*-0.63*	0.00	*0.02*
Tass Fund of Funds	0.48	0.01	*7.30*	0.45	*12.32*	0.27	*7.38*	-0.07	*-0.44*	0.09	*1.62*
Styles											
US Equity Hedge	0.78	0.01	*10.48*	0.68	*23.08*	0.46	*15.05*	-0.01	*-0.06*	0.13	*2.44*
Fixed Direction	0.31	0.00	*2.15*	0.11	*2.09*	0.24	*4.96*	1.75	*4.22*	0.82	*5.94*
Relative Value	0.22	0.01	*13.35*	0.09	*4.10*	0.05	*3.42*	0.09	*0.59*	0.10	*1.77*
Global Macro	0.22	0.01	*5.21*	0.39	*6.46*	0.13	*2.14*	-0.11	*-0.30*	0.08	*0.54*
Global Equity Hedge	0.46	0.01	*4.31*	0.75	*11.76*	0.29	*4.54*	-1.49	*-3.81*	-0.51	*-3.33*
Short Seller	0.74	0.01	*4.92*	-1.20	*-17.07*	-0.46	*8.74*	0.11	*0.21*	0.42	*2.37*
Discretionary	0.36	0.01	*8.04*	0.38	*9.66*	0.21	*5.28*	-0.09	*-0.48*	0.13	*2.05*
Event Driven	0.55	0.01	*6.07*	0.62	*15.98*	0.36	*8.96*	-0.10	*-0.61*	0.00	*-0.02*