Multi-Period Performance Persistence Analysis of Hedge Funds

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Abstract

Since hedge funds specify significant lockup periods, we investigate persistence in the performance of hedge funds using a multi-period framework in which the likelihood of observing persistence by chance is lower than that in the traditional two-period framework. Under the null hypothesis of no manager skill (no persistence), the theoretical distribution of observing wins or losses follows a binomial distribution. We test this hypothesis using the traditional two-period framework and compare the findings with the results obtained using our multi-period framework. We examine whether persistence is sensitive to the length of return measurement intervals by using quarterly, half-yearly and yearly returns. We find maximum persistence at quarterly horizon indicating that persistence among hedge fund managers is short-term in nature. It decreases as one moves to yearly returns and this finding is not sensitive to whether returns are calculated on a pre- or post-fee basis suggesting that the intra-year persistence finding is not driven by the way performance fees are imputed. The level of persistence in the multi-period framework is considerably smaller than that in the two-period framework with virtually no evidence of persistence using yearly returns under the multi-period framework. Finally persistence, whenever present, seems to be unrelated to whether the fund took directional bets or not.

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I. Introduction

It is now well known that the traditional active strategies such as investing in mutual funds, on average, underperform passive investment strategies. The few mutual fund managers who successfully beat the passive strategies tend to move into the arena of "alternative" investments and start their own hedge funds. Hedge funds seek to deliver high absolute returns and typically have features such as hurdle rates, incentive fees with high watermark provision which help in a better alignment of the interests of managers and the investors. This has caused many investors following traditional active-passive strategies to seriously consider replacing the traditional active part of their portfolio with alternative investment strategies.

The inclusion of hedge funds in a portfolio can potentially result in better risk-return tradeoffs due to the low correlation between hedge fund returns and the returns on the traditional asset classes like equities, bonds, currencies, etc. (see Fung and Hsieh (1997), Agarwal and Naik (2000a)). However, question arises as to whether hedge funds are able to add value consistently? This is an important issue in the context of hedge funds because unlike the traditional mutual funds, investment in hedge funds involves a significant lockup period. This implies that the investors need to have sufficient information about the performance of hedge funds over a long period before committing

their money to hedge funds[1]. Moreover, as hedge funds exhibit a much higher attrition rate compared to mutual funds (see Brown et. al. (1999) and Liang (2000)), the issue of performance persistence becomes especially important in the case of hedge funds.

This paper contributes to our understanding of persistence among hedge funds in two important ways. First, it examines whether the nature of persistence in the performance of hedge funds is of short-term or long-term in nature. Our understanding of the nature of persistence among hedge funds is largely due to Brown et al (1999) who use annual returns of offshore hedge funds. They find virtually no persistence in their sample. In contrast, this paper employs a new database covering offshore as well as onshore hedge funds, and examines persistence using high frequency data over longer time period. It is possible that hedge fund managers exhibit differential degree of persistence at different return horizons, an issue investigated to some extent in mutual funds literature[2]. Therefore, we examine both short-term and long-term persistence in the performance of hedge funds by investigating their pre-fee and post-fee returns over quarterly, half-yearly and yearly intervals[3].

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[1] As hedge funds are refrained from advertising about their own performance, the investors have to generate their own information and conclusions about whether the funds that have done well in the past will continue to do so in the future.

[2] For performance persistence studies in the mutual fund literature, see Brown and Goetzmann (1995), Carhart (1997), Elton, Gruber and Blake (1996), Goetzmann and Ibbotson (1994), Grinblatt and Titman (1989, 1992), Gruber (1996), Hendricks et al (1993) and Malkiel (1995).

[3] Given the limited history of hedge fund returns, it is not possible to examine 3-5 yearly performance as done in the case of mutual funds.

Second, unlike the existing literature, which restricts attention to performance over two consecutive periods, we also study persistence by examining the series of wins and losses for two, three and more consecutive time periods. This allows a direct examination of extent of multi-period persistence, which is essential before locking up investment over significantly long periods of time. Under the null hypothesis of no manager skill (which implies no persistence), the probability of winning and losing in each period equals a half and is independent of the return horizon. We test this null hypothesis for different hedge funds individually and collectively over two, three and more consecutive periods. Since the likelihood of observing a series of wins or losses due to chance is much less than observing two consecutive wins or losses in a two-period framework, the multi-period framework is able to discriminate better between persistence due to chance and persistence due to manager skill. We compare and contrast the findings from our multi-period analysis with those obtained from the traditional two-period analysis on a pre-fee and post-fee basis.

We conduct this investigation using data provided by Hedge Fund Research Inc. (henceforth HFR) which covers returns earned by hedge funds from January 1982 to December 1998 period. HFR data set provides information about hedge funds both living and dead, and is known to have lower attrition rate compared to other databases such as TASS (see Liang (2000)). The lower attrition rate in HFR suggests that it includes fewer number of funds that fail as compared to other databases. This potentially exacerbates survivorship bias related problem in studies that employ HFR database. We try to mitigate

the problem of spurious inferences caused by survivorship related issues *a la* Brown et. al. (1992, 1999) by including data on both, the living as well as the dead hedge funds. They show that survival induced persistence "anomalies" are mitigated, at least in part, by the use of appraisal ratio. We therefore examine persistence using alphas as well as appraisal ratios.

Using net-of-fee returns, we find that the extent of persistence is highest at the quarterly horizon and decreases as we move to yearly horizon. This continues to remain true with pre-fee returns as well suggesting that our finding of intra-year persistence is not driven by the imputation of performance fee. It is important to note that even if there exists some persistence at the quarterly level, it would be difficult for investors to take advantage of it due to significantly long lockup periods. It is also important to bear in mind that fact that most hedge funds only put out audited returns on an annual basis – so some of the apparent intra-year persistence may be caused by stale valuations. In any case, persistence at the quarterly but not at the annual horizon among the hedge funds stands in sharp contrast to the results in Hendricks et al (1993) who find that in mutual funds, persistence is highest at the two year horizon. We observe that the level of persistence in the multi-period framework is considerably smaller than that in the two-period framework. Finally, we find that persistence, whenever present, is unrelated to the type of strategy (directional or non-directional) followed by the fund.

Rest of the paper is organized as follows. Section II provides the sample description and classifies it into directional and non-directional hedge fund strategies. Section III

describes how pre-fee returns are computed and examines the persistence on a pre-fee and post-fee basis in the traditional two-period framework using both parametric and non-parametric techniques. Section IV tests for multi-period persistence by comparing the observed frequency distribution of wins and losses against a theoretical distribution under the null hypothesis of no persistence. Section V concludes with suggestions for future research.

II. Classification of Hedge Funds

Although the term 'hedge fund' originated from the equally long and short strategy employed by managers like Alfred Winslow Jones, the new definition of hedge funds covers a multitude of different strategies. Unlike the traditional investment arena, since there does not exist a universally accepted norm to classify the different strategies, we segregate them into two broad categories: 'Non-Directional' and 'Directional'. Hedge fund strategies exhibiting low correlation with the market are classified as non-directional (also commonly referred to as market-neutral), while those having high correlation with the market are classified as directional[4]. We further divide these two main categories into ten popular strategies (see Appendix A for details) and examine persistence in the performance of hedge funds following each of these strategies[5].

[4] Note that the non-directional strategies are neutral only to the first moment, i.e., expected returns. They are not neutral to the second moment, as in volatile periods convergence is not always obtained and arbitrage based strategies can make losses.

[5] Agarwal and Naik (2000b) find that these strategies exhibit significantly different risk exposures towards different asset class factors, and these risk exposures are broadly consistent with their stated investment

Table I provides the description of the sample in terms of the number of funds in each of the strategies, the time period spanned by each strategy, the number of dead funds during the sample period, average and median number of funds per period for each hedge fund strategy. Since the incentive fee is typically worked out based on calendar year return, we select January to December period for computing annual returns, January-June and July-December for computing semi-annual returns, and January-March, April-June, etc. for computing quarterly returns. For our investigation using quarterly, half-yearly and yearly data, we use returns of 746, 716 and 586 hedge funds respectively spanning the period of January 1982 to December 1998. In general, as we increase the investment horizon the number of funds within a particular strategy decreases. This is primarily because the funds need to have returns for at least two periods before they can be included in the sample.

We select the first complete period (quarter, half-year or year) after the birth of a fund for the purpose of our investigation. In case of death of a fund, we include returns till the end of the fund. We have 27 (15 and 13) dead funds out of a total of 746 (716 and 586) funds using quarterly (half-yearly and yearly) returns. The attrition rate, defined as the percentage of dead funds in the total number of funds, is 3.62%, 2.10% and 2.22% using quarterly, half-yearly and yearly returns, which is consistent with an average annual attrition rate of 2.17% in HFR database reported by Liang (1999) during 1993-97. This attrition rate is much lower than the annual attrition rate of about 14% for offshore hedge

objectives.

funds during 1987-96 reported by Brown, Goetzmann and Ibbotson (1999) and 8.3% in TASS database during 1994-98 as reported by Liang (1999).

Having described the sample period and characteristics, we now proceed with the examination of persistence in the traditional two-period framework using parametric and non-parametric tests.

III. Parametric and Non-parametric Tests of Persistence

It is well known that different hedge fund strategies involve significantly different risk-return tradeoffs. Therefore, it may not be prudent to compare the performance of a hedge fund manager following a given strategy with another manager following a different strategy. We know from Brown et al. (1999) that the existence of 'style factor' can lead to reversals in the persistence phenomenon because of the differences in the levels of systematic risk across managers. This is especially relevant in the case of hedge funds, which are exposed to significantly different levels of risk depending on whether they follow directional or non-directional strategies[6]. We, therefore, examine the issue of performance persistence *within* individual hedge fund strategies. Specifically, we compare

[6] See Brown and Goetzmann (1995) for the importance of relative risk adjustment. They find that the relative risk-adjusted performance of mutual funds persists from year to year but the absolute performance measured by alphas does not. In a recent working paper, Agarwal and Naik (2000c) estimate the alpha against a comprehensive benchmark consisting of passive and option-based strategies.

the return of a hedge fund following a particular strategy with the average return earned by all the hedge funds pursuing that strategy.

We follow Brown et al (1995, 1999) and compare the performance measures in the current period on the performance measures in the previous period. We employ two performance measures: the alpha and the appraisal ratio. We define alpha as the return of a hedge fund using a particular strategy minus the average return for all hedge funds following the same strategy. It is well known that different hedge funds employ different degrees of leverage to scale up their alphas[7]. However, this also scales up the volatility of their returns - a fact that may not be captured by just looking at the alphas. Therefore, we also use a second measure called the appraisal ratio. This is defined as the alpha divided by the residual standard deviation resulting from a regression of the hedge fund return on the average return of all the hedge funds following that strategy. The appraisal ratio accounts for the differences in the volatility of returns and is leverage-invariant. Therefore, we also use the appraisal ratios to investigate the extent of persistence in the performance.

To investigate the issue of persistence in two-period framework, we use regression-based (parametric) and contingency-table-based (non-parametric) methods. We conduct all the tests at quarterly, half-yearly and yearly intervals using alphas as well as appraisal ratios. For the regression-based parametric method, we regress the alphas (appraisal ratios) during current period on the alphas (appraisal ratios) during the previous period. A

[7] This effect has been shown analytically by Park and Staum (1998).

positive significant slope coefficient on past alpha (appraisal ratio) suggests that a hedge fund that did well in a given period did well in the subsequent period and vice-versa.

For the non-parametric method, we construct a contingency table of winners and losers where a fund is a winner if the alpha of that fund is greater than the median alpha of all the funds following the same strategy in that period otherwise it is a loser. Persistence in this context relates to the funds that are winners in two consecutive periods (quarterly, half-yearly or yearly as the case may be) denoted by WW, or losers in two consecutive periods, denoted by LL. Similarly, winners in first period and losers in the second period are denoted by WL and LW denotes the reverse. In this framework, we use both cross-product ratio (CPR) and Chi-square statistic to detect persistence. CPR defined as $(WW*LL)/(WL*LW)$, captures the ratio of the funds which show persistence in performance to the ones which do not. The null hypothesis in this setting represents lack of persistence for which the CPR equals one. In other words, when there is no persistence, one would expect each of the four categories denoted by WW, WL, LW and LL to have 25% of the total number of funds. We determine the statistical significance of the CPR by using the standard error of the natural logarithm of the CPR given by (see Christensen (1990))

$$\sigma_{\ln(CPR)} = \sqrt[2]{\frac{1}{WW} + \frac{1}{WL} + \frac{1}{LW} + \frac{1}{LL}}$$

We also conduct a Chi-square test comparing the observed frequency distribution of *WW, WL, LW* and *LL* for each hedge fund with the expected frequency distribution. In a recent paper, Carpenter and Lynch (1999) study the specification and power of various

persistence tests. They find that the Chi-square test based on the number of winners and losers is well specified, powerful and more robust to the presence of survivorship bias compared to other test methodologies. In our study, we aggregate combinations of winners and losers (*WW, WL, LW* and *LL)* across ten different hedge fund strategies. We compute the Chi-square statistic as

$(WW-D1)^2/D1+(WL-D2)^2/D2+(LW-D3)^2/D3+(LL-D4)^2/D4$ where

$$D1 = (WW+WL)*(WW+LW)/N,\ D2 = (WW+WL)*(WL+LL)/N,$$

$$D3 = (LW+LL)*(WW+LW)/N \text{ and } D4 = (LW+LL)*(WL+LL)/N.$$

We test this statistic at 5% level corresponding to the critical value of Chi-square statistic of 3.84 corresponding to the Chi-square distribution with one degree of freedom.

Since fees are imputed, but not paid intra-year, such imputation can potentially influence persistence measure at the quarterly and half-yearly horizons[8]. We therefore conduct persistence tests on a pre-fee basis as well. Towards that end, we estimate the performance fee paid to each fund at the end of each year based on the fee schedule, hurdle rate and high watermark provision[9]. We add back a twelfth of this each month for the past year to arrive at the pre-fee returns. We repeat all our tests with pre-fee returns and contrast the findings with those observed using post-fee returns reported in the HFR database.

[8] We thank the referee and the editor for bringing this to our attention.

[9] Out of a maximum of 746 funds we use for this study, 616 have a high watermark provision and 119 have a hurdle rate. Hurdle rate is typically the T-Bill or the Eurodollar rate. We also adjust for the management fee that ranges from 1% to 2%.

We conduct the parametric and non-parametric tests for each hedge fund strategy separately. For the overall persistence results, we aggregate the information on all hedge funds in each time period. For the sake of brevity we report in Table II the percentage of cases where statistically significant persistence was observed in each hedge fund strategy on pre-fee basis and on post-fee basis[10]. These results are based on both alphas (see Panel A) and appraisal ratios (see Panel B) computed using quarterly, half-yearly and yearly returns. We find that, in general, the regression based parametric tests indicate a greater extent of persistence compared to the non-parametric (CPR and Chi-square) tests. Interestingly, the Chi-square test which Carpenter and Lynch (1999) find to be well specified, powerful and more robust indicates higher extent of persistence as compared to that observed with tests based on CPR. We also find that the extent of persistence is sensitive to the return measurement interval. In particular, persistence decreases as the return measurement interval increases. Finally, the extent of persistence does not seem to be related to whether the fund took directional bets or followed an arbitrage based strategy.

Brown et al (1999) examine persistence among offshore hedge funds using annual returns. They consider the possibility that performance persists on a pre-fee basis and that managers can extract their full value-added through fees. To test this proposition, they compare persistence on a pre-fee basis with that on a post-fee basis and find similar results. Our results on an annual basis using both onshore and offshore funds over a

[10] A Z-statistic of 1.96 corresponds to significance at 5% level.

longer time period confirm this finding. Interestingly, we find that extent of persistence at quarterly and half-yearly level is higher on a pre-fee basis compared to that observed on a post-fee basis which is consistent with the possibility suggested by Brown et al (1999) mentioned above. However, since we continue to observe a comparable level of persistence on a pre-fee and post-fee basis at quarterly and half-yearly intervals, it suggests that the intra-year persistence observed on a post-fee basis is not driven by the way the performance fee is imputed.

Having examined the extent of persistence in a two-period framework, we proceed with multi-period analysis.

IV. Multi-Period Tests of Persistence

In this section, we extend our investigation from the traditional two-period framework to a multi-period framework. Towards that end, we construct a series of wins and losses for each hedge fund and compare the observed frequency distribution with the theoretical frequency distribution of two and more consecutive wins and losses. For example, under the null hypothesis of no persistence, the theoretical probability of observing *WWW* and *LLL* equals one-eighth while that of observing *WWWW* and *LLLL* equals one-sixteenth, and so on. We illustrate this using annual returns in Chart I that shows the theoretical and observed frequency distributions of consecutive wins and losses

of non-directional strategies, directional strategies and the overall sample based on alphas and appraisal ratios[11].

We employ the two-sample Kolmogrov-Smirnov (K-S) test to check if the observed distribution of wins and losses is statistically different from the theoretical distribution. We report the results of the K-S test in Table III based on alphas and appraisal ratios in Panels A, B and C for quarterly, half-yearly and yearly post-fee returns respectively. We show in bold face (italic face) the cases where we find persistence significant at 5% (10%) level.

Table III highlights three interesting features. First, the extent of persistence decreases as the return measurement interval increases. For example, at 5% level of significance, there are four cases of persistence in losers and one case of persistence among winners based on quarterly appraisal ratios. When we increase the return interval to half-year, we find only one case of persistence in losers and none among winners while with yearly return interval, there is no evidence of persistence in either winners or losers. Second, whenever some persistence is observed, it seems to be driven more by losers than by winners. This is similar to our earlier findings in the case of the two-period framework. Once again, directional and non-directional funds seem to exhibit similar degree of

[11] We repeat this with quarterly and half-yearly returns as well. We find that the best performance corresponds to 21, 12 and 9 consecutive wins based on quarterly, half-yearly and yearly returns while the corresponding numbers for worst performance are 22, 18 and 12 consecutive losses. This suggests that there are a few very good managers and a few very poor managers.

persistence. Finally, the level of persistence based on multi-period performance measure is considerably smaller than that observed under a two-period framework with no evidence of persistence at the yearly return horizon even at the 10% level. This is because, unlike the traditional two-period test, our multi-period test involves tracking the history of series of successes and failures of *individual* hedge funds throughout the sample period. This significantly reduces the likelihood of observing large number of consecutive wins or losses due to chance factor and therefore has more power to discriminate between the chance and the skill factors.

Since for large samples the binomial distribution can be approximated by normal distribution, we conduct a Kolmogorov-Smirnov test comparing the distribution of consecutive wins and losses of hedge funds with a normal distribution. As before, we conduct this test based on alphas and appraisal ratios separately for quarterly, half-yearly and yearly post-fee returns. We report the results in Table IV. Persistence in this framework is captured by the observed distribution being significantly different from a normal distribution.

Overall the results exhibit somewhat higher level of persistence than that observed in Table III. However, we continue to observe the same interesting features. First, the extent of persistence decreases as the return measurement interval increases. Second, whenever persistence is observed, it is mainly attributable to losers continuing to be losers. However, we find evidence of a few good managers who consistently outperform their peers over long periods indicating the importance of manager selection exercise in the

context of hedge funds. Third, both non-directional and directional funds exhibit similar degree of persistence. Finally, the level of persistence based on multi-period performance measure is considerably smaller than that observed under a two-period framework with virtually no evidence of persistence at the yearly return horizon.

We repeat these multi-period tests using pre-fee returns and find virtually identical results[12]. For the test reported in Table III, in case of quarterly pre-fee returns, we find 7 cases of significance (at 5% level) as compared to 5 cases with post-fee returns. For half-yearly and yearly pre-fee (post-fee) returns, the number of significant cases is 4 (3) and 0 (0) respectively. The corresponding number of significant cases for the test reported in Table IV are 19 (20), 6 (7) and 0 (0) for quarterly, half-yearly and yearly pre-fee (post-fee) returns respectively. In general, similar to the two-period tests, the extent of persistence is marginally higher with pre-fee returns compared to post-fee returns.

V. Concluding Remarks

This paper investigated the extent of pre- and post-fee performance persistence exhibited by hedge funds during January 1982 to December 1998 using the traditional two-period framework and contrasted the findings with those observed using a multi-period framework. It also examined whether the persistence observed was sensitive to whether returns were measured over quarters (short-horizon) or over years (long-horizon). This is particularly important in the case of hedge funds that specify significant

[12] These results are available from authors upon request.

lockup periods. Finally, it also investigated whether the way in which the performance fee is imputed affects the degree of persistence observed among hedge funds.

It found three interesting patterns using both pre-fee and post-fee returns. First, there exists considerable amount of persistence at quarterly horizon. It reduces as one moves to yearly returns indicating that persistence among hedge fund managers is primarily short-term in nature. This is in sharp contrast to the findings in the mutual fund literature, which show that two years is about the horizon of persistence. However, it is important to bear in mind the fact that hedge funds stipulate significant lockup periods. This may make it difficult for investors to take advantage of the short-term persistence observed in the data[13]. Second, persistence does not seem to be related to the type of strategy followed by the fund, i.e., both directional and non-directional funds exhibited similar degree of persistence. Finally, the level of persistence observed in a multi-period framework is considerably smaller than that observed under the traditional two-period framework, with virtually no persistence at the yearly return level in the multi-period framework.

Performance persistence over long periods is an important area of future research. Since entry and exit into active management involves non-trivial costs and since learning about manager skill takes time, selecting the right manager becomes a very important issue. This is especially so in case of hedge funds as they specify significant lock-up periods. As avenues of future research, it would be interesting to examine whether

[13] Our finding of short-term persistence may be attributable, to some extent, to stale valuations resulting from annual reporting of audited statements by hedge funds.

performance persistence is related to characteristic features of hedge funds such as size, lockup period, incentive fees, etc.[14]. It would also be interesting to see whether multi-period analysis of mutual funds exhibits significantly different patterns compared to the ones observed with hedge funds.

[14] Recently, Ackermann, McEnally & Ravenscraft (1999) study the relationship between characteristic features and performance of hedge funds and find that incentive fees explains the higher performance partly.

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Appendix A

Non-directional Strategies: These strategies do not depend on the direction of any specific market movement and are commonly referred to as 'market neutral' strategies. These are usually designed to exploit short term market inefficiencies and pricing discrepancies between related securities while hedging out as much of the market exposure as possible. Due to the reduced liquidity inherent in many such situations, they frequently run smaller pools of capital than their counterparts following directional strategies. Included in this group are the following strategies:

1. Fixed Income Arbitrage - A strategy having long and short bond positions via cash or derivatives markets in government, corporate and/or asset-backed securities. The risk of these strategies varies depending on duration, credit exposure and the degree of leverage employed.
2. Event Driven - A strategy which hopes to benefit from mispricing arising in different events such as merger arbitrage, restructurings etc. Manager takes a position in an undervalued security that is anticipated to rise in value because of events such as mergers, reorganizations, or takeovers. The main risk in such strategies is non-realization of the event.
3. Equity Hedge - A strategy of investing in equity or equity-like instruments where the net exposure (gross long minus gross short) is generally low. The manager may invest globally, or have a more defined geographic, industry or capitalization focus. The risk primarily pertains to the specific risk of the long and short positions.
4. Restructuring - A strategy of buying and occasionally shorting securities of companies under Chapter 11 and/or ones which are undergoing some form of reorganization. The

securities range from senior secured debt to common stock. The liquidation of financially distressed company is the main source of risk in these strategies.

5. Event Arbitrage - A strategy of purchasing securities of a company being acquired, and shorting that of the acquiring company. The risk associated with such strategies is more of a "deal" risk rather than market risk.
6. Capital Structure Arbitrage - A strategy of buying and selling different securities of the same issuer (e.g. convertibles/common stock) seeking to obtain low volatility returns by arbitraging the relative mispricing of these securities.

Directional Strategies: These strategies hope to benefit from broad market movements. Some popular directional strategies are:

1. Macro - A strategy that seeks to capitalize on country, regional and/or economic change affecting securities, commodities, interest rates and currency rates. Asset allocation can be aggressive, and leverage and derivatives may be utilized. The method and degree of hedging can vary significantly.
2. Long - A strategy which employs a "growth" or "value" approach to investing in equities with no shorting or hedging to minimize inherent market risk. These funds mainly invest in the emerging markets where there may be restrictions on short sales.
3. Hedge (Long Bias) - A strategy similar to equity hedge with significant net long exposure.
4. Short - A strategy that focuses on selling short over-valued securities, with the hope of repurchasing them in the future at a lower price.

Table I. Sample Description

The table below shows the sample period, total number of funds during the sample period, average number of funds per period and median number of funds per period for each of the ten different hedge fund strategies pursued by hedge funds from January 1982 to December 1998.

Hedge fund strategy	Quarterly returns					Half-Yearly returns					Yearly returns				
	Period	Total funds	Dead funds	Average funds/period	Median funds/period	Period	Total funds	Dead funds	Average Funds/period	Median funds/period	Period	Total funds	Dead funds	Average funds/period	Median funds/period
Fixed Income Arbitrage	93Q1-98Q4	25	2	10.3	11.0	93I-98II	22	0	9.8	10.0	93-98	12	0	8.2	9.5
Event Driven	83Q1-98Q4	63	1	21.7	14.0	83I-98II	61	0	21.3	14.0	83-98	56	0	20.4	14.0
Equity Hedge	82Q1-98Q4	223	7	57.5	21.0	82I-98II	213	4	56.0	20.5	82-98	174	4	51.5	19.0
Restructuring	89Q1-98Q4	34	0	18.0	15.0	89I-98II	34	0	17.7	15.0	89-98	31	0	16.7	14.0
Event Arbitrage	84Q1-98Q4	31	2	11.9	9.0	84I-98II	28	0	11.7	9.0	84-98	26	0	11.3	9.0
Capital Structure Arbitrage	88Q3-98Q4	57	2	21.6	18.0	88II-98II	57	2	25.9	18.0	89-98	37	1	18.9	15.5
Non-Directional		433	14	115.9	53.0		415	6	113.2	51.5		336	5	104.5	47.0
Macro	84Q3-98Q4	59	3	19.0	12.5	84II-98II	52	1	18.6	12.0	85-98	38	1	17.6	12.5
Long	89Q2-98Q4	41	0	14.0	9.0	89II-98II	40	0	13.8	9.0	90-98	27	0	12.2	9.0
Hedge (Long Bias)	82Q2-98Q4	200	10	65.1	45.0	82II-98II	196	8	65.0	45.0	83-98	174	7	63.6	45.5
Short	88Q3-98Q4	13	0	6.4	5.0	88II-98II	13	0	6.4	5.0	89-98	11	0	6.3	5.5
Directional		313	13	93.7	62.0		301	9	93.3	62.0		250	8	89.8	62.5
Overall		746	27	208.2	113.0		716	15	203.7	111.5		586	13	189.0	105.0

Table II. Two-period Performance Persistence of Hedge Fund Strategies on pre-fee and post-fee basis for different return measurement intervals

The table below shows the summary of percentage of cases exhibiting statistically significant persistence in performance of the ten different hedge fund strategies from January 1982 to December 1998. We employ both the parametric (regression-based) and non-parametric (contingency-table-based) methods using Alpha and Appraisal Ratio. The results show the persistence at quarterly, half-yearly and yearly intervals on both pre-fee and post-fee basis . Alpha is defined as the return of the fund manager using a particular strategy minus the average return on all the funds using the same strategy in that period. Appraisal Ratio is defined as alpha divided by the standard errors of the residuals from the regression of the fund return on the average return of all the funds following that strategy in that period. For contingency table, Winners and Losers are determined by comparing the appraisal ratios of individual fund managers to those of the median manager within each strategy in each period. WW and LL denote winners and losers in two consecutive periods, LW denotes Losers in the first period & Winners in the second period & WL denotes the reverse. The Cross-Product Ratio (CPR) and Chi-square statistic computed as per Section III. All figures are in percentage where the figures in brackets refer to the results on a pre-fee basis.

Panel A: Based on Alphas

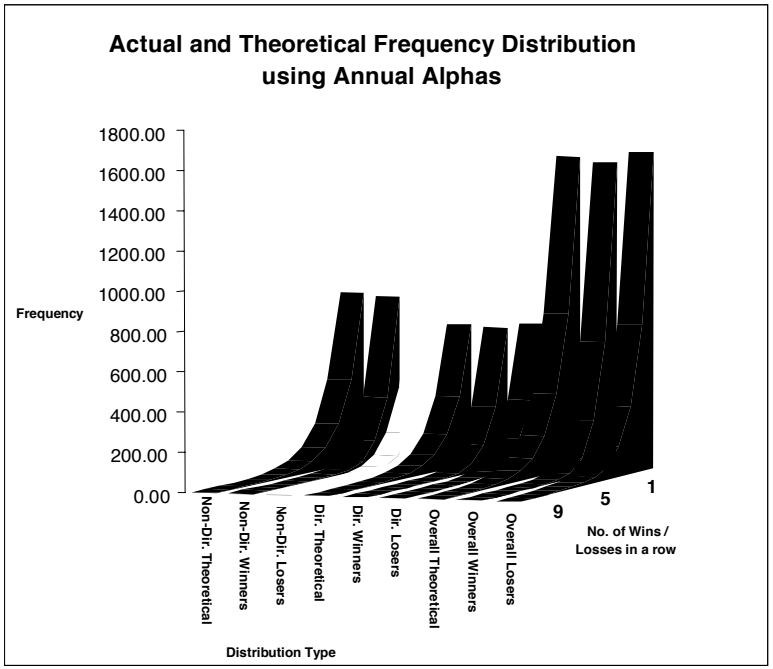
Hedge fund strategy	Quarterly returns			Half-Yearly returns			Yearly returns		
	Parametric	Non-parametric		Parametric	Non-parametric		Parametric	Non-parametric	
		CPR	Chi-sq.		CPR	Chi-sq.		CPR	Chi-sq.
Fixed Income Arb	17 (17)	4 (4)	17 (17)	18 (18)	0 (0)	0 (0)	20 (20)	0 (20)	20 (20)
Event Driven	14 (14)	8 (6)	16 (14)	16 (19)	6 (10)	10 (10)	13 (20)	20 (7)	20 (13)
Equity Hedge	24 (24)	7 (12)	21 (24)	15 (15)	15 (12)	24 (24)	19 (19)	13 (6)	19 (6)
Restructuring	21 (21)	8 (8)	23 (18)	21 (21)	5 (5)	21 (16)	33 (33)	11 (0)	11 (0)
Event Arbitrage	5 (7)	0 (0)	22 (25)	7 (7)	0 (0)	17 (14)	0 (0)	0 (0)	0 (0)
Capital Structure Arb	27 (29)	7 (5)	12 (10)	40 (40)	20 (25)	25 (35)	22 (22)	22 (22)	33 (33)
Non-Directional	31 (33)	21 (24)	31 (36)	15 (15)	15 (18)	21 (24)	19 (19)	25 (19)	31 (31)
Macro	11 (11)	4 (4)	18 (18)	14 (14)	0 (0)	11 (11)	8 (8)	15 (0)	23 (8)
Long	13 (16)	11 (11)	24 (24)	6 (6)	11 (6)	17 (17)	25 (25)	25 (25)	25 (25)
Hedge (Long Bias)	20 (20)	14 (17)	21 (21)	25 (25)	13 (13)	19 (19)	27 (27)	13 (13)	13 (13)
Short	7 (7)	0 (0)	22 (24)	10 (10)	0 (5)	20 (20)	0 (0)	0 (0)	33 (33)
Directional	27 (27)	18 (21)	26 (27)	38 (38)	13 (16)	16 (22)	27 (33)	20 (20)	20 (21)
Overall	34 (34)	24 (27)	34 (36)	30 (33)	27 (30)	36 (42)	25 (25)	25 (19)	31 (25)

Panel B: Based on Appraisal Ratios

Hedge fund strategy	Quarterly returns			Half-Yearly returns			Yearly returns		
	Parametric	Non-parametric		Parametric	Non-parametric		Parametric	Non-parametric	
		CPR	Chi-sq.		CPR	Chi-sq.		CPR	Chi-sq.
Fixed Income Arb	39 (35)	4 (4)	26 (26)	55 (55)	18 (0)	36 (36)	40 (40)	0 (0)	20 (20)
Event Driven	29 (33)	13 (17)	22 (25)	42 (42)	13 (16)	19 (23)	27 (33)	20 (13)	20 (13)
Equity Hedge	18 (19)	9 (12)	22 (24)	21 (21)	15 (15)	24 (27)	25 (25)	13 (0)	19 (6)
Restructuring	28 (28)	5 (3)	10 (8)	21 (21)	11 (5)	21 (11)	11 (11)	11 (11)	22 (22)
Event Arbitrage	8 (9)	2 (2)	25 (25)	3 (10)	0 (0)	17 (17)	0 (0)	0 (0)	0 (0)
Capital Structure Arb	32 (34)	10 (10)	17 (12)	35 (35)	20 (35)	35 (45)	33 (22)	22 (22)	44 (44)
Non-Directional	55 (57)	25 (24)	36 (33)	39 (39)	15 (24)	27 (33)	25 (25)	19 (18)	44 (38)
Macro	28 (28)	9 (7)	23 (23)	32 (32)	0 (7)	18 (18)	38 (46)	8 (8)	15 (15)
Long	24 (24)	13 (8)	26 (21)	28 (28)	17 (6)	17 (17)	25 (25)	13 (13)	25 (25)
Hedge (Long Bias)	29 (30)	17 (15)	26 (24)	31 (31)	13 (19)	19 (25)	27 (33)	13 (13)	13 (13)
Short	12 (15)	2 (2)	34 (34)	10 (10)	0 (10)	25 (35)	22 (22)	0 (0)	22 (33)
Directional	41 (45)	29 (27)	41 (38)	44 (44)	13 (16)	19 (19)	33 (40)	20 (20)	20 (21)
Overall	51 (52)	33 (33)	42 (42)	45 (45)	27 (27)	36 (42)	38 (38)	19 (19)	25 (25)

Chart I. Theoretical and Observed Frequency Distribution of Series of Wins and Losses of Hedge Fund Strategies using yearly Data

The chart below shows the frequency distribution of a series of wins and losses employing two performance measures, Alphas and Appraisal Ratios, using yearly net-of-fee returns for the ten different strategies pursued by 586 hedge funds from January 1982 to December 1998. Alpha is defined as the return of the fund manager using a particular strategy minus the average return on all the funds using the same strategy. Appraisal Ratio is defined as alpha divided by the standard errors of the residuals from the regression of the fund return on the average return of all the funds following that strategy. Winners and Losers are determined by comparing the alphas and appraisal ratios of individual fund managers to those of the median manager within each strategy in each period.



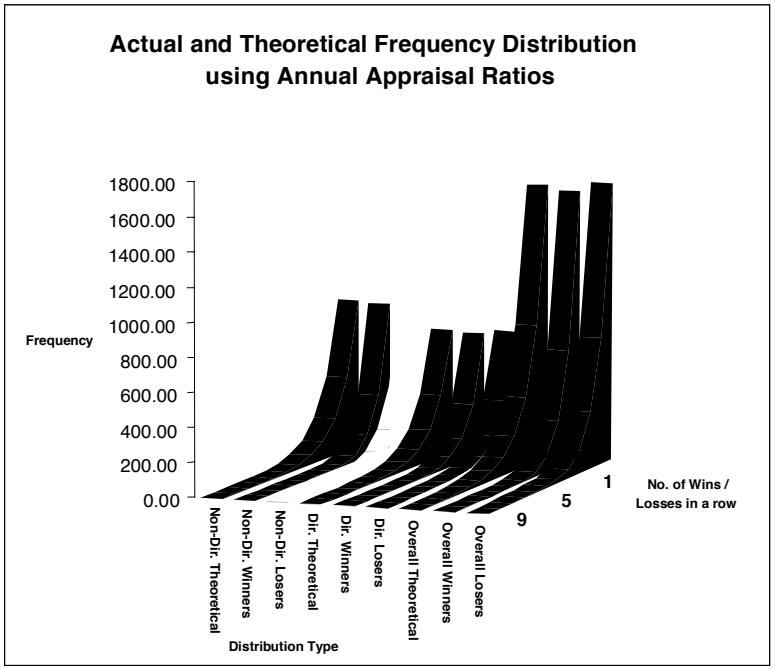


Table III. Kolmogrov-Smirnov Test for Multi-period Persistence in Performance of Hedge Fund Strategies

The table below shows the results of the two-sided Kolmogrov-Smirnov test without making any distributional assumptions about the theoretical distribution of the series of wins and losses for the ten hedge fund strategies. Panel A (B and C) shows the results for the quarterly (half-yearly and yearly) net-of-fee returns of hedge funds from January 1982 to December 1998. Bold (Italic) face indicates that the actual distribution of wins/losses is significantly different from the theoretical distribution at 5% (10%) level signifying multi-period persistence in the performance.

Hedge Fund Strategy	Alphas				Appraisal Ratios			
	Wins		Losses		Wins		Losses	
	2-sided K-S Stat	p-value	2-sided K-S Stat	p-value	2-sided K-S Stat	p-value	2-sided K-S Stat	p-value
Panel A: **Based on Quarterly Data**								
Fixed Income Arbitrage	0.9806	0.2928	0.6124	0.8475	0.9806	0.2928	*1.2780*	0.0763
Event Driven	0.5884	0.8793	*1.3333*	0.0571	**1.6973**	0.0063	**1.6973**	0.0063
Equity Hedge	0.8575	0.4624	0.8575	0.4624	0.8575	0.4624	0.8575	0.4624
Restructuring	0.2357	1.0000	0.4083	0.9963	0.4714	0.9794	0.4083	0.9963
Event Arbitrage	0.5884	0.8793	0.5884	0.8793	0.9129	0.3790	0.4083	0.9963
Capital Structure Arb	1.0955	0.1815	*1.2374*	0.0936	1.2057	0.1092	*1.2374*	0.0936
Non-Directional	0.6860	0.7344	1.0000	0.2710	1.2344	0.0950	**1.3887**	0.0423
Macro	0.2357	1.0000	0.7559	0.6172	1.2005	0.1120	**1.8091**	0.0029
Long	0.2357	1.0000	0.6396	0.8079	1.0000	0.9674	0.6396	0.8079
Hedge (Long Bias)	0.2041	1.0000	0.5477	0.9251	1.0000	0.2710	1.1356	0.1517
Short	0.2500	1.0000	0.5000	0.9640	0.2500	1.0000	0.2357	1.0000
Directional	0.2041	1.0000	0.7303	0.6604	1.0000	0.2710	**1.5076**	0.0212
Overall	0.6860	0.7344	0.8333	0.5026	*1.2344*	0.0950	*1.3568*	0.0504
Panel B: **Based on Half-yearly Data**								
Fixed Income Arbitrage	0.2673	1.0000	0.5000	0.9640	0.5000	0.9640	0.5345	0.9375
Event Driven	0.2357	1.0000	0.4472	0.9883	0.2236	1.0000	0.4714	0.9794
Equity Hedge	0.2132	1.0000	0.9129	0.3790	0.2132	1.0000	1.0607	0.2109
Restructuring	0.2357	1.0000	0.2500	1.0000	0.2357	1.0000	0.5345	0.9375
Event Arbitrage	0.2673	1.0000	**1.5435**	0.0171	0.6396	0.8079	**1.6667**	0.0077
Capital Structure Arb	0.5000	0.9640	0.6708	0.7591	0.5000	0.9640	0.6708	0.7591
Non-Directional	0.2132	1.0000	1.2005	0.1120	0.2132	1.0000	*1.3333*	0.0571
Macro	0.6124	0.8475	0.6124	0.8475	0.6124	0.8475	0.9806	0.2928
Long	0.5774	0.8928	0.6708	0.7591	0.5774	0.8928	0.6708	0.7591
Hedge (Long Bias)	0.5000	0.9640	0.4083	0.9963	0.5000	0.9640	0.2236	1.0000
Short	0.2673	1.0000	0.6708	0.7591	0.2673	1.0000	0.6708	0.7591
Directional	0.2041	1.0000	0.4083	0.9963	0.2041	1.0000	0.5884	0.8793
Overall	0.2041	1.0000	1.0290	0.2408	0.2041	1.0000	1.1667	0.1315
Panel C: **Based on Yearly Data**								
Fixed Income Arbitrage	0.3162	1.0000	0.5774	0.8928	0.3162	1.0000	0.5774	0.8928
Event Driven	0.4714	0.9794	0.2673	1.0000	0.5774	0.8928	0.2887	1.0000
Equity Hedge	0.5345	0.9375	0.8165	0.5320	0.2887	1.0000	0.8165	0.5320
Restructuring	0.5000	0.9640	0.3162	1.0000	0.5000	0.9640	0.3162	1.0000
Event Arbitrage	0.5774	0.8928	0.4714	0.9794	0.5774	0.8928	0.4714	0.9794
Capital Structure Arb	0.3536	1.0000	0.2887	1.0000	0.3536	1.0000	0.3162	1.0000
Non-Directional	0.2357	1.0000	0.2041	1.0000	0.7500	0.6272	0.4083	0.9963
Macro	0.2500	1.0000	0.2673	1.0000	0.2500	1.0000	0.6708	0.7591
Long	0.3162	1.0000	0.2887	1.0000	0.3162	1.0000	0.2887	1.0000
Hedge (Long Bias)	0.2887	1.0000	0.4472	0.9883	0.5345	0.9375	0.4472	0.9883
Short	0.3162	1.0000	0.8018	0.5587	0.3162	1.0000	0.5345	0.9375
Directional	0.7500	0.6272	0.4472	0.9883	0.7500	0.6272	0.2236	1.0000
Overall	0.7071	0.6994	0.2041	1.0000	0.7500	0.6272	0.4083	0.9963

Table IV. Kolmogrov-Smirnov Normality Test for Multi-period Persistence

The table below shows the results of the one-sample Kolmogrov-Smirnov test to compare the observed frequency distribution of a series of wins & losses for the hedge fund strategies with a normal distribution. Panel A (B &C) shows the results for the quarterly (half-yearly & yearly) net-of-fee returns of hedge funds from January 1982 to December 1998. N indicates the total of wins & losses for all the funds following a strategy. Bold (Italic) face indicates that the observed distribution of wins/losses is significantly different from the normal distribution at 5% (10%) level signifying persistence. Asy. Sig. And MC Sig. stand for asymptotic & Monte-Carlo significance respectively.

Hedge Fund Strategy	N	Alphas						Appraisal Ratios					
		Wins			Losses			Wins			Losses		
		K-S Z-Stat	Asy. Sig.	MC Sig.	K-S Z-Stat	Asy. Sig.	MC Sig.	K-S Z-Stat	Asy. Sig.	MC Sig.	K-S Z-Stat	Asy. Sig.	MC Sig.
Panel A: **Based on Quarterly Data**													
Fixed Income Arb	297	1.02	0.25	0.21	1.04	0.23	0.19	0.95	0.33	0.27	0.97	0.30	0.25
Event Driven	1510	1.08	0.19	0.16	**1.39**	0.04	0.03	*1.32*	0.06	0.05	**1.35**	0.05	0.04
Equity Hedge	4351	**1.48**	0.03	0.02	**1.42**	0.04	0.03	**1.45**	0.03	0.02	**1.40**	0.04	0.03
Restructuring	837	0.74	0.64	0.56	1.05	0.22	0.18	0.75	0.63	0.55	1.03	0.24	0.20
Event Arbitrage	773	*1.21*	0.11	0.09	*1.18*	0.13	0.10	1.04	0.23	0.19	0.99	0.29	0.24
Capital Structure Arb	1020	1.09	0.19	0.15	1.16	0.14	0.11	1.09	0.19	0.16	1.16	0.14	0.11
Non-Directional	8788	**1.39**	0.04	0.03	**1.43**	0.03	0.03	**1.53**	0.02	0.02	**1.54**	0.02	0.02
Macro	1216	0.84	0.48	0.41	1.12	0.16	0.13	**1.32**	0.06	0.05	**1.56**	0.02	0.01
Long	627	0.85	0.47	0.39	0.91	0.39	0.32	0.83	0.50	0.43	0.89	0.41	0.35
Hedge (Long Bias)	4804	1.02	0.25	0.21	*1.26*	0.09	0.06	**1.35**	0.05	0.04	**1.44**	0.03	0.02
Short	296	0.87	0.43	0.35	0.74	0.65	0.56	0.82	0.51	0.43	0.85	0.46	0.39
Directional	6943	1.03	0.24	0.20	*1.24*	0.09	0.07	**1.38**	0.05	0.04	**1.61**	0.01	0.01
Overall	15731	**1.40**	0.04	0.03	**1.43**	0.03	0.03	**1.54**	0.02	0.02	**1.60**	0.01	0.01
Panel B: **Based on Half-yearly Data**													
Fixed Income Arb	140	0.67	0.77	0.68	0.63	0.83	0.76	0.70	0.72	0.64	0.55	0.93	0.87
Event Driven	755	0.79	0.57	0.50	0.80	0.55	0.48	0.84	0.49	0.42	0.77	0.59	0.52
Equity Hedge	2112	1.09	0.18	0.15	**1.31**	0.06	0.05	1.10	0.18	0.14	**1.36**	0.05	0.04
Restructuring	387	0.89	0.41	0.35	0.78	0.58	0.51	0.84	0.48	0.41	0.68	0.74	0.65
Event Arbitrage	379	0.72	0.68	0.59	*1.27*	0.08	0.06	1.06	0.21	0.17	**1.32**	0.06	0.05
Capital Structure Arb	496	0.71	0.70	0.62	0.80	0.55	0.47	0.70	0.71	0.64	0.76	0.62	0.54
Non-Directional	4269	1.04	0.23	0.19	**1.36**	0.05	0.04	1.02	0.25	0.21	**1.42**	0.04	0.03
Macro	590	1.12	0.17	0.14	0.95	0.32	0.28	1.10	0.18	0.15	0.99	0.28	0.24
Long	312	0.68	0.75	0.66	0.88	0.43	0.36	0.67	0.76	0.67	0.85	0.46	0.40
Hedge (Long Bias)	2363	0.76	0.60	0.53	1.05	0.22	0.18	0.76	0.61	0.54	0.91	0.38	0.32
Short	147	0.64	0.81	0.73	0.88	0.43	0.36	0.62	0.84	0.77	0.81	0.53	0.46
Directional	3412	1.12	0.17	0.14	1.03	0.24	0.20	1.11	0.17	0.14	1.11	0.17	0.13
Overall	7681	1.11	0.17	0.14	**1.38**	0.05	0.04	1.10	0.18	0.15	**1.44**	0.03	0.02
Panel C: **Based on Yearly Data**													
Fixed Income Arb	49	0.56	0.91	0.84	0.56	0.91	0.85	0.56	0.91	0.84	0.56	0.91	0.85
Event Driven	326	0.92	0.36	0.30	0.65	0.80	0.72	0.67	0.76	0.67	0.65	0.80	0.72
Equity Hedge	879	0.79	0.56	0.47	1.17	0.13	0.10	0.69	0.72	0.63	1.18	0.12	0.10
Restructuring	167	0.95	0.33	0.27	0.62	0.84	0.75	0.88	0.43	0.35	0.62	0.84	0.75
Event Arbitrage	170	0.70	0.70	0.61	0.81	0.53	0.46	0.73	0.65	0.55	0.85	0.46	0.39
Capital Structure Arb	190	0.50	0.97	0.91	0.62	0.84	0.76	0.50	0.97	0.91	0.52	0.95	0.89
Non-Directional	1781	0.97	0.31	0.25	1.16	0.14	0.11	0.87	0.44	0.37	*1.20*	0.11	0.09
Macro	248	0.82	0.52	0.44	0.64	0.81	0.73	0.79	0.57	0.49	0.88	0.42	0.36
Long	110	0.55	0.93	0.86	0.59	0.87	0.80	0.51	0.96	0.90	0.54	0.93	0.88
Hedge (Long Bias)	1045	0.67	0.77	0.68	1.00	0.28	0.23	0.74	0.64	0.54	1.00	0.27	0.22
Short	63	0.49	0.97	0.93	0.61	0.85	0.78	0.54	0.94	0.88	0.70	0.71	0.62
Directional	1466	0.81	0.52	0.45	0.98	0.30	0.24	0.79	0.56	0.49	0.98	0.29	0.24
Overall	3247	0.95	0.33	0.26	1.15	0.15	0.12	0.83	0.50	0.42	*1.17*	0.13	0.10