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Multi-Period Performance Persistence Analysis of Hedge Funds

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Abstract

Since hedge funds specify significant lock-up 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 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 the quarterly horizon indicating that persistence among hedge fund managers is short term in nature.

I. Introduction

It is now well known that 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 and incentive fees with high watermark provisions that help to better align the interests of managers and 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

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the returns on the traditional asset classes like equities, bonds, and currencies (see Fung and Hsieh (1997), Agarwal and Naik (2000a)). However, the question arises as to whether hedge funds are able to consistently add value. This is an important issue in the context of hedge funds because, unlike traditional mutual funds, an investment in hedge funds involves a significant lock-up 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 them.[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 short term or long term in nature. Our understanding 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 a longer time period. It is possible that hedge fund managers exhibit differential degrees 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]

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 the extent of multi-period persistence, which is essential before locking up investments 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 one-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 better able to discriminate 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

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

[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 three- to five-year performance as done in the case of mutual funds.

1982 to December 1998. The HFR data set provides information about hedge funds both living and dead, and is known to have a lower attrition rate compared to other databases such as TASS (see Liang (2000)). The lower attrition rate in HFR suggests that it includes fewer funds that fail as compared to other databases. This potentially exacerbates a survivorship bias-related problem in studies that employ the 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 living as well as dead hedge funds. They show that survival-induced persistence "anomalies" are mitigated, at least in part, by the use of an appraisal ratio. We, therefore, examine persistence using alphas as well as appraisal ratios.

Using net-of-fee returns, we find that persistence is highest at the quarterly horizon and decreases as we move to the yearly horizon. This continues with pre-fee returns as well, suggesting that our finding of intra-year persistence is not driven by the imputation of a performance fee. It is important to note that, even if some persistence exists at the quarterly level, it would be difficult for investors to take advantage of it due to significantly long lock-up periods. It is also important to bear in mind 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 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.

The 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 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 in the traditional investment arena, no universally accepted norm exists to classify the different strategies. Thus, 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]

[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.

We further divide these two main categories into 10 popular strategies (see the Appendix for details) and examine persistence in the performance of hedge funds following each of these strategies.[5]

Table 1 describes 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, and the 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 the January–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 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 our investigation. In the case of a fund's death, we include returns till the fund ends. 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 the HFR database reported by Liang (2000) during 1993–1997. This attrition rate is much lower than the annual attrition rate of about 14% for offshore hedge funds during 1987–1996 reported by Brown, Goetzmann and Ibbotson (1999) and 8.3% in the TASS database during 1994–1998 as reported by Liang (2000).

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 a "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 the re-

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

[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.

TABLE 1

Sample Description

	Quarterly Returns					Half-Yearly Returns					Yearly Returns				
Hedge Fund Strategy	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

The table 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 10 different hedge fund strategies pursued by hedge funds from January 1982 to December 1998.

turn of a hedge fund following a particular strategy with the average return earned by all 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 performance.

To investigate the issue of persistence in a 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 the current period on the alphas (appraisal ratios) during the previous period. A positive significant slope coefficient on a 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 the first period and losers in the second period are denoted by WL; LW denotes the reverse. In this framework, we use both a cross-product ratio (CPR) and a Chi-square statistic to detect persistence. CPR defined as $(WW*LL)/(WL*LW)$ captures the ratio of the funds that show persistence in performance to the ones that 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))

$$\sigma_{\ln(\mathrm{CPR})} = \sqrt{\frac{1}{WW} + \frac{1}{WL} + \frac{1}{LW} + \frac{1}{LL}}.$$

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

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

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 when compared to other test methodologies. In our study, we aggregate combinations of winners and losers (WW, WL, LW, and LL) across 10 different hedge fund strategies. We compute the Chi-square statistic as

$$(\mathrm{WW} - D1)^2/D1 + (\mathrm{WL} - D2)^2/D2 + (\mathrm{LW} - D3)^2/D3 + (\mathrm{LL} - D4)^2/D4,$$

where
$$D1 = (\mathrm{WW} + \mathrm{WL}) * (\mathrm{WW} + \mathrm{LW})/N,$$
$$D2 = (\mathrm{WW} + \mathrm{WL}) * (\mathrm{WL} + \mathrm{LL})/N,$$
$$D3 = (\mathrm{LW} + \mathrm{LL}) * (\mathrm{WW} + \mathrm{LW})/N \quad \text{and}$$
$$D4 = (\mathrm{LW} + \mathrm{LL}) * (\mathrm{WL} + \mathrm{LL})/N.$$

We test this statistic at the 5% level, corresponding to the critical value of a 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. Toward 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 one-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.

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, Table 2 reports the percentage of cases where statistically significant persistence was observed in each hedge fund strategy on both a pre-fee and 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 that Carpenter and Lynch (1999) find to be well specified, powerful, and more robust indicates a higher extent of persistence when 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.

[8]We thank William Goetzmann (the referee) and Stephen Brown (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%.

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

TABLE 2

Two-Period Performance Persistence of Hedge Fund Strategies on Both the Pre-Fee and Post-Fee Basis for Different Return Measurement Intervals

	Quarterly Returns			Half-Yearly Returns			Yearly Returns		
	Parametric	Non-Parametric		Parametric	Non-Parametric		Parametric	Non-Parametric	
Hedge Fund Strategy		CPR	Chi-Sq.		CPR	Chi-Sq.		CPR	Chi-Sq.
Panel A. Based on Alphas									
Fixed Income Arbitrage	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 Arbitrage	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									
Fixed Income Arbitrage	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 Arbitrage	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)

The table shows the summary of percentage of cases exhibiting statistically significant persistence in performance of the 10 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 the 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 the 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 and Winners in the second period and 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.

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 longer time period confirm this finding. Interestingly, we find that the extent of persistence at the quarterly and half-yearly levels 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). 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.

IV. Multi-Period Tests of Persistence

In this section, we extend our investigation from the traditional two-period framework to a multi-period framework. Toward 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. We illustrate this in Figure 1 using annual returns that show 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 3, based on alphas and appraisal ratios in Panels A, B, and C for quarterly, half-yearly, and yearly post-fee returns, respectively. We show by * (**) the cases where we find persistence significant at the 5% (10%) level.

Table 3 highlights three interesting features. First, the extent of persistence decreases as the return measurement interval increases. For example, at the 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-yearly, we find only one case of persistence in losers and none among winners, while with the 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 a similar degree of persistence. Finally, the level of persistence based on a 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 a large

[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.

TABLE 3

Kolmogrov-Smirnov Test for Multi-Period Persistence in Performance of Hedge Fund Strategies

	Alphas				Appraisal Ratios			
	Wins		Losses		Wins		Losses	
Hedge Fund Strategy	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 Arbitrage	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 Arbitrage	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
	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 Arbitrage	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

The table 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 10 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. * (**) indicates that the actual distribution of wins/losses is significantly different from the theoretical distribution at the 5% (10%) level signifying multi-period persistence in the performance.

FIGURE 1

Theoretical and Observed Frequency Distribution of Series of Wins and Losses of Hedge Fund Strategies Using Yearly Data

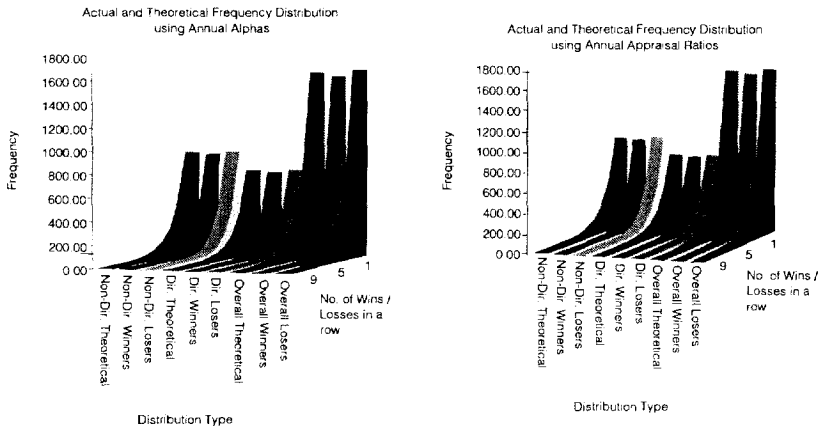

Figure 1 shows the frequency distribution of a series of wins and losses employing two performance measures, Alphas and Appraisal Ratios, using yearly net-of-fee returns for the 10 different strategies pursued by 586 hedge funds from January 1982 to December 1998. Alpha is defined as the return of the 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.

number of consecutive wins or losses due to the chance factor and, therefore, has more power to discriminate between the chance and the skill factors.

Since the binomial distribution for large samples can be approximated by normal distribution, we conduct a K-S 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 4. Persistence in this framework is captured by the observed distribution being significantly different from a normal distribution.

Overall the results exhibit a somewhat higher level of persistence than that observed in Table 3. 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 a similar degree of persistence. Finally, the level of persistence based on a 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.

TABLE 4

Kolmogrov-Smirnov Normality Test for Multi-Period Persistence

		Alphas						Appraisal Ratios			
		Wins			Losses			Wins		Losses	
Hedge Fund Strategy	*N*	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 Arbitrage	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 Arbitrage	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 Arbitrage	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 Arbitrage	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 Arbitrage	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 Arbitrage	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

The table shows the results of the one-sample Kolmogrov-Smirnov test to compare the observed frequency distribution of a series of wins and losses for the hedge fund strategies with a normal distribution. 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. *N* indicates the total of wins and losses for all the funds following a strategy. * (**) indicates that the observed distribution of wins/losses is significantly different from the normal distribution at the 5% (10%) level signifying persistence. Asy. Sig. and MC Sig. stand for asymptotic and Monte-Carlo significance, respectively.

We repeat these multi-period tests using pre-fee returns and find virtually identical results.[12] For the test reported in Table 3, in the case of quarterly pre-fee returns, we find seven cases of significance (at the 5% level) as compared to five cases with post-fee returns. For half-yearly and yearly pre-fee (post-fee) returns, the number of significant cases is four (three) and zero (zero), respectively. The corresponding number of significant cases for the test reported in Table 4 are 19 (20), six (seven), and zero (zero) 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

We investigate the extent of pre- and post-fee performance persistence exhibited by hedge funds from January 1982 to December 1998 using the traditional two-period framework and contrast the findings with those observed using a multi-period framework. We also examine whether the persistence observed is sensitive due to returns measured over quarters (short horizon) or over years (long horizon). This is particularly important in the case of hedge funds that specify significant lock-up periods. Finally, we also investigate whether the way in which a performance fee is imputed affects the degree of persistence observed among hedge funds.

We find three interesting patterns using both pre-fee and post-fee returns. First, a considerable amount of persistence exists at the quarterly horizon. The persistence is reduced 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 funds literature, which show that two years is about the horizon of persistence. However, it is important to bear in mind that hedge funds stipulate significant lock-up 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 degrees 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 the case of hedge funds as they specify significant lock-up periods. As avenues of future research, it would be interesting to examine whether performance persistence is related to charac-

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

[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.

teristic features of hedge funds such as size, lock-up period, and incentive fees.[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.

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* is a strategy having long and short bond positions via cash or derivatives markets in government, corporate, and/or asset-backed securities. Risk varies depending on duration, credit exposure, and the degree of leverage employed.

2. *Event Driven* is a strategy that benefits from mispricing arising in different events such as merger arbitrage and restructurings. The 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 is non-realization of the event.

3. *Equity Hedge* is 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 nature of the long and short positions.

4. *Restructuring* is a strategy of buying and occasionally shorting securities of companies under Chapter 11 and/or ones that are undergoing some form of reorganization. The securities range from senior secured debt to common stock. The liquidation of financially distressed companies is the main source of risk in these strategies.

5. *Event Arbitrage* is 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 than a market risk.

6. *Capital Structure Arbitrage* is a strategy of buying and selling different securities of the same issuer (e.g., convertibles/common stock) and seeking to obtain low volatility returns by arbitraging the relative mispricing of these securities.

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

B. Directional Strategies

These strategies can gain benefit from broad market movements. Some popular directional strategies are:

1. *Macro* is 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* is a strategy that 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 emerging markets where there may be restrictions on short sales.

3. *Hedge (Long Bias)* is a strategy similar to an equity hedge with significant net long exposure.

4. *Short* is a strategy that focuses on selling short over-valued securities, with the hope of repurchasing them in the future at a lower price.

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