Hedge Fund Performance Persistence and Mixed Trading Strategies

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Abstract

We examine US hedge funds' performance persistence and mixed-trading strategies across both different economic and market conditions for 1990-2014. We use parametric and non-parametric models and we examine hedge fund persistence in various aspects. During "good" times there is smoothness in hedge fund (risk-adjusted) returns whereas during "bad" times this smoothness disappears. With respect to the market benchmark, with a few exceptions, there is no performance persistence. Concerning the persistence within each group of strategy, for "good" times we found persistence up to one year whereas for "bad" times we found up to six months. There is strong evidence that the persistence is driven mainly by the top performers, and recessions are harsher than down regimes for hedge fund persistence. Finally, we constructed mixed trading strategies and we introduce the zero investment portfolio "momentrarian" strategy that can bring conditional high excess returns to investors.

Keywords: *hedge funds, performance persistence, mixed-trading strategies, momentrarian*

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1 Introduction

Investors very often rely on hedge fund past performance expecting that it is stable over time and that some fund managers outperform their peers. There is strong evidence that there is at least short term performance (e.g. Agarwal and Naik, 2000a; Harri, and Brosen, 2004; Eling, 2009; Joenvaara, Kosowiski, and Tolonen, 2012; Hentati-Kaffel and Peretti, 2015). However there are studies (e.g. Jagannathan, Malakhov, and Novikov, 2010; Ammann, Huber, and Schumid, 2013) that challenge the above studies showing that there is long term persistence (over a year). Nevertheless, further research is needed to verify the results of these recent studies. There is evidence (Bares, Gibson, and Gyger, 2003; Eling, 2009) that some non-directional strategies (e.g. Merger Arbitrage, Convertible Arbitrage strategies) present more persistence than directional strategies (e.g. Long Only and Short Bias strategies). More details concerning the nature of the fund persistence are still emerging such as the difference in persistence between different hedge fund strategies and between different fund characteristics such as size (Joenvaara, Kosowski and Tolonen, 2012), age (Meredith, 2007), fees (Amenc and Martellini, 2003) or flow restrictions (Bae and Yi, 2012).

Another important issue is that there is evidence (e.g. Bollen and Pool, 2006; Agarwal, Daniel, and Naik, 2011; Itzhak, Franzoni, Landlier and Moussawi, 2013) that illiquidity and smoothing returns are widespread. This is because some fund managers invest in illiquid assets or manage their prices (returns). Hence, researchers should take into consideration more advanced econometric methods so as to capture these smoothing techniques used by fund managers. Last but not least, there are differences in studies due to industry heterogeneity and authors use different databases, time periods and methodologies as well. However, there are some consistent trends and patterns that reveal useful dimensions about hedge fund behaviour.

Although the above studies are important in explaining hedge funds performance in terms of persistence, there is however a need to examine hedge fund performance persistence in a more comprehensive way by making a distinction between the different types of performance and not only focusing in one only type of persistence (e.g. persistence within each strategy). Furthermore, there is need to examine the impact of different market conditions in hedge fund performance persistence focusing on specific region(s). In our study we use the term multiple business cycles and different market conditions (these are not limited to one only

recession/growth period or financial event) and we focus on North America funds[3] as this is the most important region for hedge funds in economic terms. Therefore, our study fills a gap in the literature. We make a distinction between multiple business cycles and different market conditions as they do not coincide necessarily, having different implications (as we see later in our empirical analysis) in hedge fund behaviour. Furthermore we investigate hedge funds at the strategy level and we examine different types of persistence using several parametric and non-parametric tests. Another gap in the literature is the lack of the examination of different trading strategies based on persistence and spreads of top/bottom performers that investors or fund of fund managers can exploit so as to gain higher returns. In this study we deal with various mixed trading strategies (investment styles) that can help fund managers achieving higher returns. We also introduce the term "momentrarian strategy" that is a combination of a momentum and contrarian strategy under specific conditions, as discussed later in section 2.1.

We have some important findings that contribute to the academic literature beyond those that agree with other authors above in terms of short term persistence (e.g. Harri and Brorsen, 2004; Eling, 2009; Joenvaara, Kosowski, and Tolonen, 2012; Hentati-Kaffel, and Peretti, 2015) or that some strategies appear to be more consistent than others (e.g. Eling, 2009; Brown and Goetzmann, 2003; Hari and Brorsen, 2004): First, using a regression based parametric approach, non-directional and semi-directional strategies have on average smoother returns compared to directional strategies, however during stressful market there is a negative impact on the smoothness for all hedge fund strategies. When considering risk-adjusted returns the smoothness weakens even more in all cases. Second, using CPR tests and Chi-square tests, we found that there is little or no persistence of hedge funds against the market benchmark. Only a few strategies such as Long Short, Multi-strategy, and Long Short seem to present some performance persistence against the market during "good" market conditions. Third, when examining persistence within strategies, we found that there is persistence up to one year, however, during stressful market conditions there is quarterly persistence (with a few exceptions that provide semi-annual persistence). Fourth, the persistence, on average, is attributed mainly to top performers and less to bottom performing funds. Often, there are reversals in bottom performers as fund managers are pressurized to deliver higher returns; otherwise they will go out of business. Furthermore, during stressful market conditions, the persistence is reduced dramatically for hedge fund strategies. Fifth, we created a framework of using various zero

[3] These are funds that invest primarily in the North America region.

investment trading strategies that can utilize differences in spreads between top and bottom performing funds among different strategies. We found that a momentum trading strategy is, on average, the most efficient within “good” market conditions whereas momentrarian is, on average, the most efficient during stressful market conditions.

Our study makes important contributions to the literature and to investors as well. We have revealed aspects that have not been examined before. More specifically, we are the first that we make a clearly distinction between different aspects of performance persistence and we examine each of these aspects, at strategy level, within multiple business cycles and different market conditions, as these two different states do not coincide necessarily, having different implications for hedge funds (e.g. it seems that recessions periods are, on average, fiercer in terms of hedge fund performance persistence compared with down regimes). Investors know what to expect from different strategies in terms of performance persistence. Past performance is no guide to the future; however, most investors in their capital allocation process rely on past performance. One more contribution is that we are the first to develop a framework of using zero investment trading strategies that utilize the differences in spreads between top and bottom performing hedge funds. These mixed or synthetic trading strategies can be a guide to investors allowing them for potential higher returns, outperforming market returns. Last but not least, we executed a systematic database merging and cleaning process that can be considered as a guide for future studies.

Investors can benefit from our findings as they are able to know what to expect from different strategies in terms of performance persistence. Although past performance is no guide to the future, most investors, in their capital allocation process, rely on funds’ past records. This implies that investors expect performance to be stable over time and that some fund managers provide better performance compared to their peers. Our study provides a comprehensive investigation of hedge fund performance persistence allowing investors to implement mixed trading strategies utilizing spreads between top and bottom performers of different hedge fund strategies. Financial government authorities can benefit by better understanding hedge funds in terms of their persistence and risks, in case there is any need for closer monitoring or a change in the legal framework.

The remainder of this paper is as follows: First we present our methodology describing our theoretical framework and our data. Secondly, we proceed to our empirical analysis by

presenting some key statistics, our regime switching model, our performance persistence analysis at strategy level, and our mixed trading strategies. Then we have some robustness tests. Lastly, we present our conclusions providing a summary of our findings and some opportunities for further research.

2 Methodology

In this section we present our theoretical framework along with our data.

2.1 Theoretical framework

In this section we present, first, the framework of the predefined and undefined structural breaks conditional on different states of the market. Within this framework we examine hedge fund performance persistence in terms of returns and risk-adjusted returns to investors. Secondly, we present the methods used in order to detect performance persistence. Third, we present several trading strategies that includes a *momentrarian* trading strategy which is a combination of momentum and contrarian strategies so the investor or fund of funds manager can have higher returns in her portfolio.

We model hedge fund returns and risk adjusted returns using pre-defined structural breaks that depend on the growth and recession periods of multiple business cycles[4]. Hence, this approach takes into consideration variables (dependant or non-dependant) that belong to a particular stage of the economy.

$$F(x) = \begin{cases} x_{i0}, & S_0 \\ x_{i1}, & S_1 \end{cases} \qquad \text{where } x_i \text{ returns for different } i = 1,\ldots n \text{ months} \tag{1}$$

$$\text{Where the } S_{state} = \begin{cases} S_0, \ when\ we\ are\ in\ growth\ period \\ S_1, \ when\ we\ are\ in\ recession\ period \end{cases} \tag{2}$$

Beyond pre-defined structural breaks we use non-defined structural breaks that are specified by a statistical stochastic process using a Markov regime-switching model (Hamilton, 1989, 1990).

[4] We used the officially business cycles denoted by the National Bureau of Economic Research (NBER) and the Economic Cycle Research Institute (ECRI). The growth periods are: 01/1990-07/1990, 04/1991-03/2001, 12/2001-12/2007 and 07/2009-03/2014, and the recession periods are: 08/1990-03/1991, 04/2001-11/2001, and 01/2008 06/2009.

Similar to other authors such Meligkotsidou and Vrontos (2014) and Teulon, Guesmi and Jebri (2014) who measured the structural breaks of hedge fund returns and volatility, we use the Wilshire 5000TRI including dividends, represented by two different states: up regime and down regime, with a 24 year period[5] under examination.

The Markov switching approach gives possible outcomes that lie in *m* states of the world, denoted s_i, *i*=1,2,…,*m*, corresponding to *m* regimes. In our study, we will assume two regimes, *m*=1 or *m*=2. Therefore if s_1=1 the process is in regime 1 at time *t*, and if s_t=2, the process is in regime 2 at time *t*. The movements of the state variable between regimes are governed by the Markov process and are uncontrollable. That Markov property can be declared as:

$$P[\alpha < y_t \leq b\ |y_1, y_2, \dots, y_{t-1}|] = P[\alpha < y_t \leq b|y_{t-1}] \quad (3)$$

The above equation denotes that the probability distribution of the state of any time t depends only on the state at time t-1, only.

Hamilton's (1989) most basic model encompass an unobserved state variable, named z_t, that is theorized to evaluate according to a first order Markov process:

$$prob[z_t = 1|z_{t-1} = 1|] = p_{11} \quad (4)$$

$$prob[z_t = 2|z_{t-1} = 2|] = p_{22} \quad (5)$$

$$prob[z_t = 2|z_{t-1} = 1|] = 1 - p_{11} \quad (6)$$

$$prob[z_t = 1|z_{t-1} = 2|] = 1 - p_{22} \quad (7)$$

Where p_{11} and p_{22} stand for the probability of being in regime one, given that the system was in regime one during the previous period, and the probability of being in regime two, given that the system was in regime two during the previous period, respectively. Therefore, $1 - p_{11}$ defines the probability that y_i will change from state one in period t-1 to stage two in period t, and $1 - p_{22}$ defines the probability of a shift from state two to state one between times t-1 and t. Under this specification, z_t evolves as an AR(1) process:

[5] The time period under examination is divided in to up regimes (01/1990-06/1990, 11/1990-10/2000, 10/2002-05/2008, 03/2009-03/2014) and down regimes (07/1990-10/1990, 11/2000-09/2002, 06/2008-02/2009).

$$z_t = (1 - p_{11}) + \rho z_{t-1} + \eta_t \quad (8)$$

Where $\rho = p_{11} + p_{22} - 1$

The Markov switching approach suggests that, there can be multiple shifts from one set of behaviour to another. In this framework, the observed return series can be expressed as:

$$y_t = \mu_1 + \mu_2 z_t + (\sigma^2{}_1 + \varphi z_t)½ u_t \quad (9)$$

Where, $u_t \sim N(0,1)$. The expected values and variances of the series are μ_1 and $\sigma^2{}_1$, accordingly in state one, and $(\mu_1 + \mu_2)$ and $\sigma^2{}_1 + \varphi$ respectively in state two. The variance in state two is also defined as $\sigma^2{}_2 = \sigma^2{}_1 + \varphi$. The unknown parameters of the model $\mu_1, \mu_2, \sigma^2{}_1, \sigma^2{}_2, p_{11}, p_{22}$ are calculated using maximum likelihood.

The transition probabilities are best expressed in a matrix in case where there are *m* states. Thus:

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1m} \\ p_{21} & p_{22} & \cdots & p_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ p_{m1} & p_{m2} & \cdots & p_{mm} \end{bmatrix} \quad (10)$$

Where $p_{i,j}$ is the probability of moving from regime *i* to regime *j*. Due to the fact that, at any given time, the variable must be in one of the *m* states, it must be true that:

$$\sum_{j=1}^{m} P_{i,j} = 1 \; \forall i \quad (11)$$

A vector of current state probabilities is then expressed as

$$\pi_t = [\pi_1 \; \pi_2 \; \ldots \; \pi_m] \quad (12)$$

Where π_t is the probability that the variable *y* is currently in state *i*. Given π_t and *P*, the probability that the variable y will be in a given regime next period can be forecast by using:

$$\pi_{t+1} = \pi_t P \quad (13)$$

In order to examine hedge funds at a strategy level we form portfolios of hedge funds according to their strategy (total 11 strategy portfolios). In our study we examine hedge fund performance persistence in terms of smoothness (how constant are their raw and risk-adjusted returns), against the market benchmark and within strategy groups (hedge funds) over quarterly, semi-annual, and annual intervals[6].

Performance persistence - Methods

In general, there are two statistical approaches (Agarwal and Naik, 2000a) when examining performance persistence: two-period and multi-period statistical approaches. In the first approach two consecutive time units are examined (e.g. months) whereas in the second approach more than two consecutive periods are examined. This is known as a Kolmogorov-Smirnov test. In our study we use the traditional two-period framework. This is because we examine persistence within multiple business cycles and market conditions and we have not enough available observations for the stressful market conditions that is needed for the multi-period framework.

Within the two-period framework as a nonparametric approach the contingency-table methods are based on the construction of tables of winners and losers. Winners are funds whose performance is higher than the median of all funds within the same group or benchmark, whereas losers are funds whose performance is lower than the median. Funds that are winners (WW) or losers (LL) in both time units are persistent. Funds that are winners in the first period and losers in the second are denoted WL or LW, contrarily. In this framework we have conducted as a primary test the cross-product ratio (CPR) and as secondary the Chi-square statistic so as to detect the performance persistence. This is because the CPR is stricter than the Chi-square test and is able to capture the positive or negative manner of the persistence.

The cross-product ratio (CPR) test is the ratio of funds that present persistence to the funds that do not (Agarwal and Naik, 2000b).

$$CPR = (WL * LL)/(WL * LW) \quad (14)$$

[6] These are the most common time horizons examined in the literature. We do not use time horizons of more than a year due to limited observations during stressful market conditions. The numbers of observations for recessions and down regimes are 34 and 36, respectively. Hence, at the yearly time horizon we would have only three observations.

The null hypothesis in this setting means that there is persistence where the CPR is equal to one. Under this, it is expected that the each of the four categories (WL, LL, WL, and LW) will have 25% of the funds under consideration. The statistical significance of the CPR can be tested using the standard error $a * \ln(CPR)$ of the natural logarithm of CPR that is given by

$$\sum \ln(CRP) = \sqrt{\frac{1}{WW} + \frac{1}{LL} + \frac{1}{WL} + \frac{1}{LW}} \quad (15)$$

The resulting Z-statistic is the ratio of the natural logarithm of the CPR to the standard error of the natural logarithm[7].

In the Chi-square test (see Park and Staum, 1998) the observed frequency distribution of WW, LL, WL, and LW is compared to the expected frequency distribution.

$$x^2 = \frac{(WW-D1)^2}{D1} + \frac{(WL-D2)^2}{D2} + \frac{(LW-D3)^2}{D3} + \frac{(LL-D4)^2}{D4} \quad (16)$$

Where $D1 = {(WW + WL) * (WW + LW)}/{N}$, $D2 = {(WW + WL) * (WL + LL)}/{N}$,

$D3 = {(LW + LL) * (WW + LW)}/{N}$ and $D4 = {(LW + LL) * (WL + LL)}/{N}$; N is the number of funds. Following the chi-square distribution with one degree of freedom, a critical value x^2 (chi-square) greater than 3.84 (6.64) indicates a significance at the 5% (1%) confidence level.

Within the two-period framework as a parametric approach we use the regression-based parametric model (Brown, Goetzmann, Ibbotson, 1999) where we regress funds' returns (and risk adjusted returns) during the current period against the returns (or risk adjusted returns) during the previous period. As risk adjusted measures we use the Sharpe[8] ratio and the Information[9] ratio. A positive significant slope coefficient indicates performance persistence. This says that a hedge fund (or group) that did well in a specific period tend to do well in the

[7] Corresponding to the standard normal distribution, a value greater than 1.96 (2.58) indicates a significance level at 5% (1%) confidence level.

[8] For each month, we computed the Sharpe ratio which is the portfolio return minus the risk free return divided by the standard deviation of the portfolio return. $Sharpe\ Ratio = (\overline{R}_p - \overline{R}_f) / \sigma_p$, (Sharpe, 1994).

[9] For each month, we computed the Information ratio which is the portfolio return minus the benchmark (Wilshire 5000TRI, including dividends) return divided by the standard deviation of the excess market returns. $Information\ Ratio = \overline{(R_P - R_B)}/\sigma(R_P - R_B)$, (Goodwin, 1998).

subsequent period and vice-versa. In other words, there are no high fluctuations in the returns. The statistical significance of the slope can be tested using the t-statistic[10]. As we mentioned, we use the regression-based parametric model so as to examine the smoothness of returns for each hedge fund strategy.

$$R_t = a + b(R_{t-1}) + \varepsilon_i \quad (17)$$

Within the multi-period framework a Kolmogorov-Smirnov goodness-of-fit-test (Agarwal and Naik, 2000a) is applied, where a series of wins and losses are constructed for each fund and we compare the observed frequency distribution with the theoretical frequency distribution of more than two consecutive wins and losses. For example, under the null hypothesis of no persistence the theoretical (or expected) probability of observing WWW and LLL or WWWW and LLLL is one-eighth and one-sixteenth, respectively. By using the two sample Kolmogorov-Smirnov test we check whether the observed distribution is statistically different from the theoretical distribution. As we have already mentioned, we use the traditional two-period framework because during stressful market conditions we do not have enough available observations to examine the persistence in the multi-period framework (e.g. three or four consecutive periods).

Last but not least we use the portfolio construction approach by forming initial winners P1 and losers P10 and tracking their performances for the next period denoted by P1* and P10*. We examine the relation of P1 versus P1*, and the relation of P10 versus P10*. Then we examine the relation between P1* against the average within the same strategy and the relation of P10* against the average in the same strategy as well. We use parametric and non-parametric correlation tests such as the Pearson and the Spearman correlation tests for more robust results. The Spearman correlation test is the Pearson's correlation coefficient on the ranks of the data.

Aspects of performance persistence

Contrary to earlier studies, we measure 3 different aspects of performance persistence. The first aspect is the smoothness (uniform consistency or fluctuation from one period to the next) of the returns and risk adjusted returns for hedge funds groups at strategy level. As absolute performance is the most important element in the hedge fund industry when examining

[10] Corresponding to the standard normal distribution, a value greater than 1.96 (2.58) indicates a significance level at 5% (1%) confidence level (two-tailed test).

persistence, we focus more on raw returns. However, we also include risk-adjusted returns in our analysis, (Sharpe ratio and Information ratio were computed cross-sectional using funds at the strategy and fundamental level, for each time period) as some strategies are more risky whereas others attempt to offer more stable returns. We use the regression based parametric model described before. The second aspect is measuring the out(under)performance of hedge funds returns against a specific benchmark which is the market index. In other words we want to determine whether hedge funds consistently provide higher (or lower) returns against the market index (Wilshire 5000TRI, including dividends). This is examined at a strategy level and we use the CPR and Chi-square tests described in the previous section. The third aspect is the examination of persistence at a fund level. More specifically, we take into consideration funds that belong to the same strategy. Our objective is to examine whether fund winners (losers) continue to be fund winners (losers) in the next period. In order to fulfil our objectives we form ranked portfolios of funds that are rebalanced every subsequent period. We follow a decile classification similar to other authors (e.g. Carhart, 1997; Capocci, 2007). Each period (quarterly, semi-yearly, yearly) all funds within a specific group (e.g. strategy) are ranked in ten equally weighted portfolios (D1 [highest]…D10 [lowest]) based on their previous period results. The portfolios are held until the next period and then rebalanced again. Funds that disappear are included in their equally-weighted average until their death, then the portfolio weights are adjusted appropriately[11]. After this, we examine the spread between the first ranked and the last ranked portfolios and we implement the regression based parametric model so as to examine the smoothness of the underlying spread[12]. Afterwards, we examine the relation between initially top (bottom) ranked portfolios against the subsequent performance in the next time period of the same portfolios. Then we compare the returns of the subsequent performances (top or bottom initially ranked portfolios) with the average of all funds within the same strategy, according to the tests mentioned in the previous section.

"Momentrarian" trading style

[11] Due to the fact that our data length concerning the various horizons under consideration (e.g. quarterly, semi-annual, annual) does not always match necessarily, and we want to exploit as many observations as we can, as a general principle, we exclude data-months where the missing values are more than 50%. For example, in the yearly analysis within recessions, the third year consists of ten months/observations that are available. On the contrary, in the yearly analysis within growth periods, we excluded the last five months/observations because the missing data (seven months/observations) were greater than the 50% required (12 months/observations).

[12] A positive and significant slope means that the spread is smooth, in other words the distance between top and bottom performers is not random.

We know from the academic literature about momentum (e.g. Jegadeesh and Titan, 1993) and contrarian (e.g. DeBondt and Thaler, 1990) investment styles (or trading strategies) producing significant excess returns to investors. In this paper, we introduce the term *momentrarian* which denotes an investment style (or trading strategy) that utilize the momentum (MOMEN-) and the contrarian (-TRARIAN) trading strategies so as investors or fund of fund managers having higher returns. We are the first that we present a trading style that is combination of these two trading styles that can bring conditional higher returns than just exploiting one of these (as presented in our empirical section). This mixed trading strategy can bring returns to equal or higher than a simple momentum or contrarian trading strategy. In Table 1, we present a framework with the possible actions when using momentum and contrarian investment styles (or trading strategies). These possible actions may refer to (different) securities, financial indices or hedge funds, as in our case. We use periods of quarterly, semi-yearly, and yearly (similar to our performance persistence examination). Hence, an investor when using trading strategies at the hedge fund level has the following four cases: The first case (A) is the momentum trading concerning top performers; the second case (B) is the (reverse) momentum trading concerning the bottom performers. The third case (C) is the contrarian strategy concerning the top performers; the fourth case (D) is the (reverse) contrarian strategy with the bottom performers. We know from the literature that the momentum strategy can be a zero investment portfolio that is long in past winners and short in past losers. Similarly, the contrarian strategy can be a zero investment portfolio short in (early) past winners and long in (early) past losers. According to the literature (e.g. Jegadeesh and Titman, 1993) the momentum effect lasts for a few months (e.g. up to a year). Hence beyond this time period we should expect the contrarian effect to dominate.

The above trading strategies can work horizontally in parallel (e.g. two zero investment portfolios – one momentum and the other contrarian) denoted as a horizontal *momentrarian* trading strategy. The other case is a vertical *momentrarian* strategy (in parallel or not, as explained later). For the vertical *momentrarian* trading strategy the implementation seems more difficult as in order to have zero investment portfolios the period should be the same for the momentum and the contrarian trading, although in different time intervals (as presented in the next example).

Table 1: Basic Trading Strategies

This table provides the basic trading strategies which are momentum (horizontal), contrarian (horizontal),

and the momentrarian (vertical).

Momentrarian Trading (high rtns)	Momentum Trading	Hedge funds, A : High Recent Returns Action: Buy then Sell	Hedge funds, B : Low Recent returns Action: Short-Sell then Buy	Momentrarian Trading (low rtns)
	Contrarian Trading	Hedge funds, C : High Earlier Returns Action: Short-Sell then Buy	Hedge funds, D : Low Earlier Returns Action: Buy then Sell	

A simple example of a vertical *momentrarian* (involving high returns exploitation) strategy is: At time *t*, select and buy a hedge fund (A) whose returns at *t*-1 (e.g. last year) are high (compared to other funds). Also, select and short-sell another hedge fund (C) whose returns at *t*-2 (e.g. two years before) were higher (compared to other funds)[13]. At time *t*+1 (e.g. one year, ahead) sell hedge fund (A) and buy hedge fund (C). Then, at time *t*+1, we rebalance our portfolio, repeating the above initial process, and so on.

A similar example could be used in the other vertical momentrarian (involving low return exploitation). At time *t*, select and short-sell a hedge fund (B) whose returns at *t*-1 (e.g. last year) are low (compared to other funds). Also, select and buy another hedge fund (D) whose returns at *t*-2 (e.g. 2 years before) are low (compared to other funds). At time *t*+1 (e.g. one year, ahead) buy hedge fund (B) and sell hedge fund (D). Afterwards, at time *t*+1, we rebalance our portfolio, repeating the above initial process, and so on.

In section 3.4 we take into consideration the above framework and we reveal *momentrarian* trading styles that can bring substantially higher returns to investors. We implement this strategy along with the momentum and the contrarian trading strategies. Moreover, we implement these trading strategies at different business cycles or market conditions for even higher investors' returns. Later, in order to test our study for sufficiently and robustness, we take into

[13] In practice, when the fund manager wants to apply the momentrarian strategy (involving high returns exploitation) and has to select between e.g. two similar funds (C) whose returns are higher at t-2 (years before) compared to other funds, she can choose fund whose performance trends are poorer at t-1, as it is a sign that the contrarian effect starts to takes place and at t+1 fund's returns will be relatively low. This applies accordingly in the next example of the momentrarian strategy (involving low returns exploitation) when considering two similar (D) funds. In this case the fund manager should choose the fund whose performance trends are better at t-1, as it is a sign that the contrarian effect start to takes place and at t+1 fund's returns will be relatively high. Last but not least, our framework covers many variations of the above strategies with different time periods of forming/holding portfolios that an investor can choose. However for simplicity reasons we focus on specific equal forming/holding horizons of portfolios for momentum strategies (being accordance with our fund persistence analysis) and one year forming with holding one, two and three years for contrarian and momentrarian strategies .

consideration fund redemption fees (lockups), and we perform a sub-period analysis with a holdback period.

2.2 Data

In our analysis we combine and use three hedge fund databases (one with live/dead funds, one with live funds and one with dead funds) from two database vendors. These are BarclayHedge and EurekaHedge covering the period from January 1990 to March 2014[14], on a monthly basis. As far as we know, this is the longest period under examination in a hedge fund study. We proceed to a strict merging and cleaning process (e.g. withdrawing records containing consecutive returns of zero, N/A and null) and we selected funds (live and dead) that invest mainly in the North America region counting for 7,541. We discarded outliers by implementing a "winsorizing" technique[15]. Our eventual dataset consists of 6,373 funds. We have to mention that contrary to many other authors that do not provide full details of their merging and database cleaning processes, our merging and elimination of duplicates algorithms can be regarded as benchmarks in the literature. Because of space limitations, elements of all these procedures are available on request from the authors.

In this paper, we adopt the strategies that fund managers reported in these databases[16]. We implement a mapping between database strategies that has been used by other authors (e.g. Joenvaara, Kosowski and Tolonen, 2012) using these two databases. Hence, we end up with eleven hedge fund strategies: Short Bias (SB), Long Only (LO), Sector (SE), Long Short (LS), Event Driven (ED), Multi Strategy (MS), Others (OT), Global Macro (GM), Relative Value (RV), Market Neutral (MN) and CTAs (CT)[17].

[14] We include three business cycles so as our analysis being more comprehensive covering the longest possible time period. The majority of the databases for commercial are available from early/mid 1990 with a few exceptions such as the used EurekaHedge and BarclayHedge databases that came earlier. Our dataset contains dead funds prior to 1994 thus we do have this kind of survivorship bias. In our robustness tests at the end of the paper we have an out-of-sample with a holdback dataset for validation purposes.

[15] We ranked hedge funds returns (for every month) having percentiles (null values were excluded). Afterwards, these returns (extreme outliers) that were below to 0.5% were designated return value equal to that represented in the 0.5% percentile. Returns above to 99.5% were assigned value equal to that represented in the 99.5% percentile. The returns are net-of-fee in percentage.

[16] In the hedge fund industry and literature, there is no universal classification scheme for hedge funds' strategies. Despite the fact that fund managers may change their investment style over time, they are legally bind to operate according to the *offering memorandum* that describes the fund, its strategy, how it trades and operates, and details of the firm.

[17] We describe some hedge fund strategies: *Others* strategy contains hedge funds that may use different styles/tools (e.g. PIPES, Close-Ended), or even allocations (e.g. start-ups financed by venture capitals) that are not commonly

3 Empirical analysis

In this section we proceed from basic statistics about hedge fund strategies and market classification to broader categories of the hedge fund strategies, and give details of the regime switches we arrived at.

3.1 Basic statistics

In this section we provide basic statistics of raw returns for each of the 11 strategies. In Table 2 we provide basic statistics on the raw returns of the eleven hedge fund strategies[18]. For each specific strategy there is a representative-average time series of its relevant (equally weighted) hedge funds. We can discern that some strategies (e.g. Sector, Long Short, Others, CTA) deliver high monthly mean returns (at least 1.1%) and are more aggressive than non-directional strategies (e.g. Event Driven, Market Neutral). On the contrary, some strategies (e.g. Short Bias) deliver low monthly mean returns (0.1%). In general, directional strategies have more volatile returns than non-directional strategies. An exception is the CTA strategy.

Table 2: Raw Returns by Strategy

This table presents the basic statistics of monthly raw returns for each hedge fund strategy.

Strategy	Mean	Standard Deviation	Strategy	Mean	Standard Deviation
Short Bias	0.050%	5.197	Others	1.349%	1.091
Long Only	0.999%	3.437	Global Macro	0.934%	2.017
Sector	1.151%	3.259	Relative Value	0.821%	1.238
Long Short	1.125%	2.663	Market Neutral	0.525%	0.874
Event Driven	0.937%	1.839	CTA	1.184%	3.415
Multi Strategy	1.062%	1.713			

In the spirit of Bali, Brown and Caglayan (2011), we classify fund strategies by dividing them into directional, semi-directional and non-directional strategies. The classification is based on

used by other hedge fund strategies. *CTA* refers to Commodity Trading Advisors funds that make an extensive use of systematic trading or use derivatives and commodity trading.

[18] In order to minimize survivorship and instant history biases we include in our sample, dead/ceased reporting funds and we eliminate the first 12 monthly returns of each hedge fund.

funds' correlation with the market index Wilshire 5000TRI, including dividends. Since this index captures almost all firms within the U.S. economy, it is more representative of the whole market compared to the S&P. In Table 3 we present the correlation of each strategy and its relevant classification. The most directional strategies are at the top of the table as opposed to the most non-directional strategies lie at bottom of the table. It is not surprising that, SB (Short Bias) has a large negative correlation to the market index of -0.924. The market neutral strategy MN has a very low correlation of 0.059. CT (CTAs) has a very low correlation to market index as well (0.048), although not significantly different from zero.

Table 3. Hedge Fund Market Correlation and Classification

This table describes for each strategy the correlation with the Wilshire 5000TRI including dividends for the whole period under examination (01/1990-03/2014). As ranking criterion we used the correlation with the market index, corresponding from extreme directional strategies (Short Bias) to extreme non-directional strategies (CTAs). Each strategy is a representative-average time series of all the relevant hedge funds. We observe that all correlations are significantly different from zero at the 0.1% level except for CTAs, with a t-statistic of 0.739 and a p-value of 0.46.

Directional Strategies	Code	Coefficient	Std. Error
Short Bias	SB	-0.924	0.042
Long Only	LO	0.707	0.023
Sector	SE	0.637	0.026
Long Short	LS	0.550	0.019
Semi-Directional Strategies			
Event Driven	ED	0.338	0.019
Multi Strategy	MS	0.271	0.021
Others	OT	0.232	0.018
Global Macro	GM	0.223	0.026
Non-Directional Strategies			
Relative Value	RV	0.211	0.015
Market Neutral	MN	0.059	0.013
CTAs	CT	0.048	0.048

3.2 Regime switching model

We implement our analysis taking into consideration different business cycles and market conditions. We remind our reader that within January 1990 to March 2014 period there are three official business cycles. Hence the period under examination is divided into growth periods (01/1990-07/1990, 04/1991-03/2001, 12/2001-12/2007 and 07/2009-03/2014) and to recession periods (08/1990-03/1991, 04/2001-11/2001 and 01/2008-06/2009). Regarding the different market conditions, the Markov Switching process determines regimes based on the mean and volatility of the Wilshire 5000TRI. In order to compare the two different stages with business

cycles we selected two regimes: up regimes 01/1990-06/1990, 11/1990-10/2000, 10/2002-05/2008 and 03/2009-03/2014) and down regimes (07/1990-10/1990, 11/2000-09/2002 and 06/2008-02/2009)[19].

3.3 Performance persistence

In this section we examine hedge funds performance persistence at strategy level within multiple business cycles and different market conditions. In more detail, we first examine the smoothness of the returns[20], then the persistence with respect to the market index, and then the persistence within each strategy themselves.

3.3.1 Smoothness of returns

Growth periods

In Table 4 we present the results for the growth period under examination using the regression based parametric method. Concerning the raw returns, we can observe that the majority of the hedge funds strategies present smoothness in their returns and, on average, non-directional (except from the CTA strategy) and semi-directional strategies have more consistent returns compared to the directional strategies (except from the Short Bias strategy). Regarding the Sharpe ratio, the situation is almost the same compared to the raw returns. However, some strategies such as Other, Global Macro and CTA suffer more compared to the others. On average, non-directional (except CTA) and semi-directional strategies (except Global Macro) have more consistent returns compared to the directional strategies (except Short Bias). Regarding the information ratio, we can observe that almost all hedge fund strategies have poor results in term of smoothness. One exception is the Long Short strategy that presents consistency at semi-annual and annual horizons.

[19] We inform the reader that the average monthly MAI (excess risk free) return for down regimes is -3.69% whereas for recessions is -1.03%.
[20] We examine the smoothness at quarterly, semi-annual, and annual horizon by computing the average return within each time period.

Table 4. Hedge Fund Smoothness at Strategy Level – Growth Periods

This table shows the results of the regression-based parametric model for raw returns (RR), the Sharpe ratio (SR), and the Information ratio (IR), during growth periods. A positive and significant slope coefficient indicates performance persistence. This suggests that a hedge fund (or group) that did well in a specific period tend to do well in the subsequent period and vice-versa. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. For space reasons, we present only coefficients followed by the t-statistics in parentheses.

	Time Horizon - RR			Time Horizon - SR			Time Horizon - IR		
Strategy	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual
Short Bias	-0.114	0.060	-0.082	0.168	0.198	0.634**	0.109	0.198	0.720**
	(-1.077)	(0.393)	(-0.351)	(1.575)	(1.360)	(3.609)	(1.004)	(1.355)	(4.567)
Long Only	0.241*	0.474**	0.553*	0.222*	0.444**	0.619**	0.054	(2.273)	(2.110)
	(2.268)	(3.422)	(2.765)	(2.026)	(3.117)	(3.341)	(0.488)	0.366*	0.384
Sector	0.279**	0.543**	0.453*	0.323**	0.519**	0.529*	0.097	0.366*	0.384
	(2.665)	(4.165)	(2.248)	(3.124)	(3.843)	(2.701)	(0.913)	(2.576)	(0.129)
Long Short	0.322**	0.532**	0.597**	0.299**	0.462**	0.509*	0.265*	0.296	0.570*
	(3.112)	(4.028)	(3.235)	(2.862)	(3.283)	(2.476)	(2.484)	(1.986)	(2.744)
Event Driven	0.578**	0.661**	0.805**	0.604**	0.649**	0.748**	0.102	0.178	0.289
	(6.467)	(5.646)	(5.983)	(6.897)	(5.414)	(4.764)	(0.932)	(1.147)	(1.258)
Multi-Strategy	0.712**	0.763**	0.760**	0.518**	0.612**	0.582**	-0.250*	-0.214**	-0.005
	(9.315)	(7.622)	(5.310)	(5.496)	(4.945)	(4.091)	(-2.364)	(-4.790)	(-0.059)
Other	0.786**	0.850**	0.843**	-0.001	0.596**	0.606**	-0.120	0.147	0.380
	(11.892)	(10.490)	(7.138)	(-0.007)	(8.723)	(9.019)	(-0.948)	(0.764)	(1.330)
Global Macro	0.411**	0.571**	0.524**	0.340**	0.457**	0.366	0.111	0.298	0.191
	(4.146)	(4.499)	(2.990)	(3.093)	(3.121)	(1.619)	(0.963)	(1.897)	(0.804)
Relative Value	0.718**	0.796**	0.871**	0.675**	0.735**	0.840**	0.015	0.227	0.311
	(9.425)	(8.301)	(7.732)	(8.310)	(6.755)	(6.314)	(0.132)	(1.478)	(1.288)
Market Neutral	0.744**	0.771**	0.758**	0.472**	0.419**	0.620**	0.029	0.317*	0.472
	(10.181)	(7.827)	(5.257)	(4.885)	(2.885)	(3.368)	(0.264)	(2.107)	(2.079)
CTA	0.185	0.448**	0.708**	0.030	0.080	0.382	-0.007	0.085	0.445
	(1.766)	(3.342)	(4.530)	(0.286)	(0.547)	(1.851)	(-0.063)	(0.557)	(1.869)

Recession periods

In Table 5 we present the results during recession periods. We observe that all hedge fund strategies present no consistency in their raw returns. There are some exceptions such as Long Only, and Market Neutral Strategy presenting significant consistent at annual horizons. Regarding the risk adjusted returns, and more specific the Sharpe ratio and the Information ratio all hedge funds have poor results. There are a few exceptions such as the CTA and the Long Bias that provide some consistence at semi-annual only horizons.

Table 5. Hedge Fund Smoothness at Strategy Level - Recession Periods

This table shows the results of the regression-based parametric model for raw returns (RR), the Sharpe ratio (SR), and the Information ratio (IR), during recessions. A positive and significant slope coefficient indicates performance persistence. This suggests that a hedge fund (or group) that did well in a specific period tend to do well in the subsequent period and vice-versa. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. For space reasons, we present only coefficients followed by the t-statistics in parentheses.

	Time Horizon - RR			Time Horizon - SR			Time Horizon - IR		
Strategy	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual
Short Bias	0.073	-0.533	0.357	0.285	0.433	-0.001	0.329	0.393*	-0.002
	(0.251)	(-1.129)	(0.258)	(0.927)	(1.196)	(-0.075)	(1.058)	(3.456)	(-0.164)
Long Only	0.080	-0.748	3.451*	0.057	-0.065	-0.748	0.007	-0.184	-0.030
	(0.255)	(-1.705)	(4.788)	(0.168)	(-0.119)	(-1.128)	(0.084)	(-1.568)	(-0.070)
Sector	0.176	-0.437	-0.125	0.196	-0.194	-0.216	-0.038	-0.421	0.846
	(0.511)	(-0.775)	(-0.227)	(0.597)	(-0.335)	(-1.267)	(-0.122)	(-0.950)	(1.126)
Long Short	0.141	-0.712	-0.090	0.062	-0.825	-0.224	0.106	-0.489	1.853
	(0.413)	(-1.346)	(-0.136)	(0.193)	(-1.599)	(-0.490)	(0.302)	(-0.985)	(1.622)
Event Driven	0.206	-0.822	0.116	0.260	-0.686	-0.326	0.077	-0.362	0.041
	(0.541)	(-1.478)	(0.096)	(0.746)	(-1.106)	(-0.514)	(0.236)	(-0.824)	(0.038)
Multi-Strategy	0.138	-0.4551	-0.006	0.181	-0.576	0.243	-0.283	-0.717	0.527
	(0.381)	(-0.709)	(-0.065)	(0.492)	(-0.779)	(0.352)	(-1.014)	(-1.500)	(0.414)
Other	0.276	-0.039	0.282	-0.254	0.332	0.899	0.120	0.032	0.671
	(0.831)	(-0.075)	(1.043)	(-0.716)	(0.448)	(0.976)	(0.314)	(0.059)	(1.746)
Global Macro	0.129	0.844	0.824	0.124	0.589	1.075	0.167	0.974	1.529
	(0.381)	(2.216)	(5.812)	(0.318)	(0.713)	(1.125)	(0.449)	(1.238)	(7.158)
Relative Value	0.028	-0.666	0.215	0.024	-0.570	1.253	-0.053	-0.352	0.929
	(0.085)	(-1.190)	(0.546)	(0.090)	(-1.144)	(9.045)	(-0.151)	(-0.658)	(0.836)
Market Neutral	0.183	-0.177	0.704*	-0.149	-0.569	1.716	-0.025	-0.663	0.360
	(0.977)	(-0.726)	(3.499)	(-0.554)	(-1.163)	(0.382)	(-0.083)	(-1.422)	(0.222)
CTA	0.004	0.747	0.909	0.011	0.940*	1.036	0.027	-0.433	0.156
	-0.018	(2.523)	(2.917)	(0.044)	(4.531)	(2.532)	(0.082)	(-0.814)	(0.134)

Up regimes

In Table 6, during up regimes almost all hedge fund strategies (except Short Bias and CTAs) present consistency in their returns for al horizons. Moreover, on average, non-directional and semi-directional strategies have higher return consistency for the underlying time horizons compared to the directional strategies. Regarding the risk-adjusted returns and more specifically the Sharpe ratio, CTA, Other and Global Macro strategies are affected more in terms of

persistence. Concerning the Information ratio, similar to the growth periods, all hedge fund strategies present poor results in terms of persistence.

Table 6. Hedge Fund Smoothness at Strategy Level – Up Regimes

This table shows the results of the regression-based parametric model for raw returns (RR), the Sharpe ratio (SR), and the Information ratio (IR), during up regimes. A positive and significant slope coefficient indicates performance persistence. This suggests that a hedge fund (or group) that did well in a specific period tend to do well in the subsequent period and vice-versa. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. For space reasons, we present only coefficients followed by the t-statistics in parentheses.

	Time Horizon - RR			Time Horizon - SR			Time Horizon - IR		
Strategy	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual
Short Bias	0.112	-0.135	-0.244	0.163	0.042	0.185	0.199	0.071	0.260
	(1.067)	(-0.894)	(-1.095)	(1.507)	(0.267)	(1.009)	(1.852)	(0.452)	(1.501)
Long Only	0.371**	0.409**	0.539*	0.257*	0.504**	0.648**	0.020	0.223	0.093
	(3.639)	(2.863)	(2.710)	(2.388)	(3.705)	(3.498)	(0.227)	(1.743)	(0.475)
Sector	0.425**	0.511**	0.615**	0.343**	0.538**	0.689**	-0.035	0.126	0.196
	(4.282)	(3.818)	(3.849)	(3.325)	(4.054)	(4.335)	(-0.330)	(0.831)	(0.786)
Long Short	0.407**	0.516**	0.611**	0.278*	0.506**	0.562**	0.017	0.253	0.298
	(4.059)	(3.872)	(3.577)	(2.635)	(3.740)	(2.908)	(0.155)	(1.697)	(1.214)
Event Driven	0.604**	0.589**	0.636**	0.577**	0.641**	0.658**	-0.066	0.152	0.307
	(6.897)	(4.673)	(3.656)	(6.438)	(5.333)	(3.764)	(-0.602)	(0.988)	(1.331)
Multi-Strategy	0.721**	0.708**	0.726**	0.662**	0.691**	0.662**	0.085	0.138**	0.004
	(9.505)	(6.420)	(4.959)	(7.975)	(5.993)	(3.984)	(0.774)	(3.683)	(0.066)
Other	0.717**	0.865**	0.862**	0.002	0.615**	0.627**	-0.143	-0.119	0.631
	(9.492)	(11.162)	(7.959)	(0.033)	(9.739)	(9.295)	(-1.117)	(-0.598)	(1.785)
Global Macro	0.397**	0.478**	0.560**	0.340**	0.465**	0.360	0.118	0.292	0.144
	(3.950)	(3.520)	(3.007)	(3.050)	(3.146)	(1.541)	(1.008)	(1.826)	(0.579)
Relative Value	0.729**	0.691**	0.759**	0.724**	0.751**	0.793**	-0.099	0.134	0.327
	(9.661)	(6.068)	(5.676)	(9.481)	(7.077)	(5.621)	(-0.907)	(0.867)	(1.253)
Market Neutral	0.616**	0.713**	0.840**	0.408**	0.431**	0.645**	0.142	0.252	0.330
	(7.127)	(6.598)	(6.537)	(4.055)	(3.031)	(3.477)	(1.307)	(1.667)	(1.571)
CTA	0.128	0.563**	0.594**	-0.001	0.141	-0.046	0.124	0.085	0.003
	(1.204)	(4.634)	(3.304)	(-0.002)	(0.975)	(-0.205)	(1.170)	(0.552)	(0.012)

Down regimes

In table 7 we present the results during down regimes. Almost all hedge fund strategies present non raw return consistency. One exception is the Market Neutral Strategy that is consistent in all time horizons, and CTA that is only on quarterly basis. As far as the risk-adjusted returns are

concerned and more specifically the Sharpe ratio almost all hedge fund strategy do not provide smooth returns. There are some exceptions such as the Short Bias and CTA strategy that provides return consistency on quarterly basis and the Market Neutral that provide on yearly basis. Information ratio results, during down regimes are poor in terms of smoothness. However, there are a few strategies such as Sector, Long Short, Event Driven that present consistency at semi-annual period whereas other strategies such as Short Bias, Global Macro and CTA present consistency on quarterly horizons.

Table 7. Hedge Fund Smoothness at Strategy Level – Down Regimes

This table shows the results of the regression-based parametric model for raw returns (RR), the Sharpe ratio (SR), and the Information ratio (IR), during down regimes. A positive and significant slope coefficient indicates performance persistence. This suggests that a hedge fund (or group) that did well in a specific period tend to do well in the subsequent period and vice-versa. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. For space reasons, we present only coefficients followed by the t-statistics in parentheses.

	Time Horizon - RR			Time Horizon - SR			Time Horizon - IR		
Strategy	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual	Quarterly	Semi-Annual	Annual
Short Bias	0.364	0.419	0.600	0.487**	0.007	0.127	0.512**	0.056	0.160
	(1.582)	(1.170)	(0.634)	(3.348)	(0.059)	(0.491)	(3.193)	(0.380)	(0.441)
Long Only	0.208	0.277	0.225	0.156	0.348	0.924	0.439	0.379	1.076
	(0.773)	(0.487)	(0.103)	(0.504)	(0.784)	(0.377)	(1.252)	(0.611)	(9.627)
Sector	0.008	0.757	1.401	-0.080	0.352	0.940	0.630	1.119*	1.384
	(0.027)	(1.260)	(0.757)	(-0.307)	(0.922)	(0.887)	(1.858)	(3.961)	(1.119)
Long Short	0.174	0.681	0.148	0.187	0.440	0.221	0.518	1.294**	1.512
	(0.600)	(1.064)	(0.034)	(0.672)	(0.982)	(0.104)	(1.597)	(5.616)	(3.716)
Event Driven	0.301	1.293	-3.749	0.404	0.579	-5.262	0.023	0.925**	0.930
	(1.005)	(1.373)	(-0.722)	(1.455)	(0.958)	(-8.776)	(0.070)	(4.757)	(9.132)
Multi-Strategy	0.004	1.011	-0.291	0.124	0.133	0.125	0.202	0.176	0.316
	(0.012)	(1.458)	(-0.183)	(1.046)	(1.143)	(0.430)	(1.577)	(1.074)	(0.922)
Other	-0.180	0.301	0.133	0.127	0.186	-0.819	0.626	0.339	1.035
	(-0.605)	(0.586)	(0.193)	(0.379)	(0.321)	(-0.870)	(1.870)	(0.649)	(7.618)
Global Macro	-0.094	0.383	0.479	0.169	0.415	1.613	1.184*	0.540	1.642
	(-0.513)	(1.946)	(9.891)	(0.443)	(0.741)	(5.200)	(2.382)	(1.077)	(2.190)
Relative Value	-0.024	-0.126	-1.770	0.296	-0.088	-0.678	0.272	1.109**	1.429
	(-0.081)	(-0.221)	(-3.297)	(1.418)	(-0.364)	(-4.336)	(0.822)	(7.079)	(11.340)
Market Neutral	0.535*	0.508*	0.515**	0.190	0.077	0.406*	0.260	0.583	0.825
	(2.660)	(4.179)	(9.120)	(0.885)	(0.470)	(4.883)	(1.042)	(1.354)	(0.776)
CTA	0.521*	0.267	0.359	0.393*	0.193	0.175	0.579*	0.660	0.648
	(3.097)	(1.497)	(0.962)	(2.387)	(1.085)	(0.376)	(2.495)	(2.074)	(0.686)

To sum up, we observe that during "good" market conditions almost all hedge fund strategies present return consistency on quarterly, semi-annual and annual horizons. This situation weakens when we take into consideration risk-adjusted returns. When we take into consideration stressful market conditions almost all hedge fund strategies present poor results in their return smoothness. Furthermore recession periods have a greater negative impact on hedge fund strategies' smoothness compared to down regimes. This is because down regimes (that characterized by low market returns with high volatility) affect a lot funds' performance in terms of poor but relatively constant returns. On average, non-directional and semi-directional strategies present higher consistency in their returns. From the above it seems that during "good" times fund managers present return consistency (or massage their returns more efficiently) compared to stressful market conditions as it is more difficult to have smooth returns. Our findings are close to the literature such as Getmansky, Lo and Makarov (2004) and Eling (2009) who observed serial correlation for hedge fund strategies and especially for those that invest in illiquid assets[21].

3.3.2 Persistence against the market benchmark

In this section we examine hedge funds' raw returns persistence against the market benchmark (Wilshire 5000TRI, including dividends). In other words we examine whether hedge funds are able to outperform (or underperform) the market, consistently. We use three time horizons: annual, semi-annual, and quarterly. In order to consider persistence the CPR test and the Chi-square test are used. The CPR should be significantly greater than one if we are to conclude that there is performance persistence[22]. Moreover, depending on the ratio WW/LL we can discuss about the out- or under-performance versus the market.

Growth periods

In Table 8, using the CPR test, we observe that only a few strategies such as Long Short (annual), Multi-strategy (semi-annually), and Long Short (quarterly) are able to present performance persistence against the market (although underperforming). The Chi-square test

[21] We have tested for autocorrelation for one, two, four, six, and twelve months and some strategies such as Relative Value, and Market Neutral present autocorrelation even at the 12-month horizon. The results are not presented here for space reasons but are available on request from the authors.

[22] After we have computed the CPR, we examine whether it is greater than one. If it is less than one, this means instantly that there is no persistence; hence we do not proceed further to hypothesis tests. The CPR test is stricter than the Chi-square test.

examines the difference in the observed versus the expected frequencies[23]. Using this test, Short Bias (annual, semi-annual, quarterly), Market Neutral (annual, semi-annual, quarterly), and Relative Value (annual) present persistence versus the market index. Although there are some strategies that perform better than the markets nevertheless, using two different tests these results are not significant. In other words both test showed that none of the strategies present persistence with respect to the market (in a positive or negative manner)[24].

Table 8. Persistence against Benchmark

This table shows the results of CPR and the chi-square statistics during growth regimes. A significant CPR statistic indicates persistence whereas a WW/LL greater (less) than one indicates outperformance (underperformance) against the market index (Wilshire 5000TRI, including dividends). A chi-square less than 0.05 indicates significant persistence against the market index. At CPR, * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 a two-tailed statistic test. At annual horizon we used the t-statistic whereas at the semi-annual and quarterly horizon we used the z-statistic.

	annual, (t-stat)			semi - annual, (t-stat)			quarterly, (z-stat)		
Strategy	CPR	WW/LL	Ch-Sqr P	CPR	WW/LL	Ch-Sqr P	CPR	WW/LL	Ch-Sqr P
Sort Bias	2.33	0.07	0.00	2.86	0.21	0.00	1.01	0.31	0.00
Long Only	5.00	1.80	0.19	2.39	1.89	0.14	1.66	1.29	0.51
Sector	3.50	1.17	0.57	2.14	1.27	0.57	2.03	1.17	0.38
Long Short	9.33*	0.88	0.16	3.04	0.59	0.12	2.47*	0.86	0.20
Event Driven	3.00	0.44	0.22	0.68	-	0.92	1.15	1.00	0.99
Multi-Strategy	8.33	0.50	0.06	4.86*	0.71	0.06	1.66	0.78	0.51
Other	1.50	0.83	0.94	2.14	0.79	0.57	1.14	0.83	0.92
Global Macro	2.50	0.30	0.08	1.33	0.35	0.10	1.35	0.70	0.55
Relative Value	0.69	-	0.01	1.17	0.26	0.02	0.82	-	0.11
Market Neutral	3.75	0.07	0.00	1.86	0.12	0.00	0.94	-	0.00
CTA	1.50	0.83	0.94	0.64	-	0.66	0.96	-	0.05

Recession periods

Within the recession period due to the fact that we have relatively few observations, we use descriptive statistics as presented in Table 9 concerning the performance persistence of the strategies against the market benchmark. Similar to the growth period, we use three time horizons: annual, semi-annual, and quarterly. Concerning the annual period all strategies present

[23] A drawback of the Chi-square test in this case is that it cannot capture the proportion of winners and losers contrary to the CPR test. Hence, we consider the CPR test more powerful. However, we believe that it is better to use more than one test, for more robust results.

[24] An exception is the Multi Strategy that presents weakly significant persistence for the annual and semi-annual time horizon using both tests.

two or three wins against zero or one loss in terms of frequencies. However, during the semi-annual period the non-persistence is more common among all hedge fund strategies compared to persistence. The same is applied for the quarterly horizon for all hedge fund strategies. An exception is the Long Only strategy that presents six cases of persistence (WW and LL) against four of non-persistence (WL and LW).

Table 9. Persistence against Benchmark

This table shows information about hedge fund performance persistence against the market benchmark (Wilshire 5000TRI, including dividends) for recessions. During stressful market conditions, due to the low number of available observations, we provide descriptive figures for all hedge fund strategies at annual, semi-annual, and quarterly time horizon.

	annual		semi- annual				quarterly			
Strategy	W	L	WW	LL	WL	LW	WW	LL	WL	LW
Sort Bias	2	1	2	0	2	1	4	1	3	2
Long Only	2	1	1	0	2	2	4	2	2	2
Sector	3	0	2	0	2	1	5	0	3	2
Long Short	2	1	2	0	2	1	4	1	3	2
Event Driven	2	1	0	0	3	2	4	1	3	2
Multi-Strategy	2	1	0	0	3	2	4	1	3	2
Other	3	0	2	0	2	1	4	1	3	2
Global Macro	2	1	2	0	2	1	4	1	3	2
Relative Value	2	1	2	1	1	1	4	1	3	2
Market Neutral	2	1	2	0	2	1	4	1	3	2
CTA	2	1	2	0	2	1	4	1	3	2

Up regimes

In Table 10, we proceed our analysis towards hedge fund returns persistence against the market benchmark during up regimes. Using the CPR test, none of the strategies show persistence against the benchmark, over all time horizons. As we have already mentioned, the Chi-square test examines the difference of the observed versus the expected frequencies. Some strategies such as Short Bias, Global Macro, or Market Neutral show significant persistence over these time horizons. However, we have to mention that there is no confirmation from the two tests

about performance persistence. Hence we can conclude that no strategies present persistence against the market benchmark.

Table 10. Persistence against Benchmark

This table shows the results of CPR and the chi-square statistics during up regimes. A significant CPR statistic indicates persistence whereas a WW/LL greater (less) than one indicates outperformance (underperformance) against the market index (Wilshire 5000TRI, including dividends). A chi-square less than 0.05 indicates significant persistence against the market index. At CPR, * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 a two-tailed statistic test. At annual horizon we used the t-statistic whereas at the semi-annual and quarterly horizon we used the z-statistic.

	annual, (t-stat)			semi - annual, (t-stat)			quarterly, (z-stat)		
Strategy	CPR	WW/LL	Ch-Sqr P	CPR	WW/LL	Ch-Sqr P	CPR	WW/LL	Ch-Sqr P
Sort Bias	0.75	-	0.01	0.19	-	0.00	0.78	-	0.00
Long Only	0.44	-	0.85	1.47	0.92	0.92	0.56	-	0.61
Sector	3.50	0.86	0.57	1.78	1.00	0.84	0.99	-	0.94
Long Short	0.84	-	0.66	1.58	0.32	0.02	1.00	-	0.25
Event Driven	2.00	0.50	0.49	1.67	0.60	0.46	0.50	-	0.16
Multi-Strategy	3.67	0.27	0.02	2.08	0.37	0.03	1.40	0.64	0.37
Other	0.44	-	0.85	0.69	-	0.37	1.20	0.83	0.90
Global Macro	0.40	-	0.05	1.17	0.19	0.00	0.67	-	0.01
Relative Value	1.69	0.33	0.22	0.45	-	0.10	0.68	-	0.00
Market Neutral	0.69	-	0.01	0.26	-	0.00	0.45	-	0.00
CTA	0.16	-	0.31	0.82	-	0.27	0.71	-	0.03

Down regimes

We move now to the down regimes. Unfortunately, we have relatively few observations thus (similar to recessions) we use descriptive statistics in Table 11. Regarding the annual period all strategies present three wins against zero losses in terms of frequencies. Similar results apply for the semi–annual period. As far as the quarterly time horizon is concerned, all hedge fund strategies also present persistence in term of wins against losses (as we have already mentioned, we measure frequencies).

Table 11. Persistence against Benchmark

This table shows information about hedge fund performance persistence against the market benchmark (Wilshire 5000TRI, including dividends) for down regimes. During stressful market conditions, due to the low number of available observations, we provide descriptive figures for all hedge fund strategies at annual, semi-annual, and quarterly time horizon.

	annual	semi- annual	quarterly

Strategy	W	L	WW	LL	WL	LW	WW	LL	WL	LW
Sort Bias	3	0	5	0	0	0	7	0	2	2
Long Only	3	0	4	0	1	0	8	0	1	2
Sector	3	0	5	0	0	0	8	1	1	1
Long Short	3	0	5	0	0	0	7	0	2	2
Event Driven	3	0	5	0	0	0	7	0	2	2
Multi-Strategy	3	0	5	0	0	0	7	0	2	2
Other	3	0	5	0	0	0	7	0	2	2
Global Macro	3	0	5	0	0	0	6	1	2	2
Relative Value	3	0	5	0	0	0	7	0	2	2
Market Neutral	3	0	5	0	0	0	6	1	2	2
CTA	3	0	5	0	0	0	6	1	2	2

To sum up, during "good" time conditions for some strategies (e.g. Long Short and Multi - Strategy) there is weak evidence that there is persistence with respect to the market within the underlying time horizons. For all the other strategies it is clear that there is no persistence. However, during stressful market conditions, there is some evidence that strategies present some persistence against the market benchmark (unfortunately we have relatively few available observations so we cannot calculate statistical significance). Recessions, affect hedge fund persistence against the market benchmark fiercer compared to down regimes as funds continue to outperform the market during down regimes. We remind the reader that we are referring to raw returns, only. To our knowledge, we are the first that we examine hedge funds returns against the market index.

3.3.3 Persistence within each strategy

In this section we proceed further and we examine hedge fund performance persistence within each group of the 11 strategies. More specific, our objective is to examine whether fund winners (losers) continue to be fund winners (losers) in the next time unit (in terms of raw returns). Hence, we form ranked portfolios of funds that are rebalancing every subsequent period (quarterly, semi-annual, and annual). Afterwards, we take the spread between the first ranked and the last ranked portfolios and we implement the regression based parametric model so as to examine the smoothness of the underlying spread. We present the results of whether top

performers continue to be top performers and bottom performers continue to be bottom performers.

3.3.3.1 Growth periods

Quarterly

In Table 12 we compare the performance of the top performers (P1*) or losers (P10*) with that of the average of all hedge funds. It is important to clarify the distinction between P1 versus P1* and P10 versus P10*. P1 are the ex-ante best performer portfolios and more specifically funds that we formed based on best past performance (e.g. quarterly, semi-annual, annual). P1* are that of ex-post portfolios and more specifically the previous P1 after one time period (e.g. quarterly, semi-annual, annual). Similar rules apply to P10. We observe that the monthly spread between top performers P1* and the average of all funds is positive for more than half hedge fund strategies and significant[25] as well. Short Bias, Sector, Global Macro, Market Neutral, and CTAs strategies have positive but insignificant spreads. The highest is from Relative Value (0.88%, monthly) and the lowest from Long Short (0.49%, monthly). Concerning the bottom performers P10* we observe that for all hedge fund strategies the spread is negative and in most cases significant. Short Bias and CTA strategies have positive spread but are insignificant. The highest (in terms of absolute value - negative) and most significant spread is from the Other strategy (-0.51%, monthly) and the lowest (in terms of absolute value - negative) is from Event Driven (-0.16%, monthly). We mentioned that we compared the ex-ante best performers portfolios (P1) with that of ex-post (P1); we found that on the Other and Relative strategies there is positive and significant correlation (using the Spearman and Pearson statistics). This means that the persistence for these two strategies (their spreads are the highest) is driven by the top performers. In other words, the top performers are performing extremely well. We mentioned also that we also compared the ex-ante bottom performers' portfolios (P10) with that of ex-post (P10); we found that there is significant negative correlation for Global Macro and Relative Value strategies. This means that, despite the reversals, the bottom performers continue to be poor performers especially, for the Relative Value strategy.

[25] Significantly different from zero. We used a two-tailed t-test at 0.05 and 0.01 levels.

Table 12. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies on a quarterly basis during growth periods. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spr. P1-P1*	3.71%	-0.014	-0.125	Spd P1-P1*	3.32%	0.090	-0.070	Spd P1-P1*	5.22%	0.036	-0.162	Spd P1-P1*	4.03%	0.125	-0.113
P1	4.34%			P1	5.25%			P1	6.79%			P1	5.69%		
P1*	0.62%			P1*	1.93%			P1*	1.57%			P1*	1.66%		
Spd P10-P10*	-4.09%	-0.145	-0.206	Spd P10-P10*	-2.99%	-0.067	-0.099	Spd P10-P10*	-4.59%	0.123	0.041	Spd P10-P10*	-3.90%	0.024	-0.133
P10	-3.85%			P10	-2.11%			P10	-3.69%			P10	-3.02%		
P10*	0.24%			P10*	0.89%			P10*	0.90%			P10*	0.88%		
Spd P1*-Avg	0.52%			Spd P1*-Avg	0.65%**			Spd P1*-Avg	0.28%			Spd P1*-Avg	0.49%*		
Spd P10*-Avg	0.14%			Spd. P10*-Avg	-0.40%*			Spd P10*-Avg	-0.39%			Spd P10*-Avg	-0.28%**		
Event Driven	Return	Spearman	Pearson	**Multi Strategy**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	2.63%	0.185	-0.034	Spd P1-P1*	2.80%	0.126	0.144	Spd P1-P1*	2.91%	0.353**	0.237	Spd P1-P1*	3.90%	-0.069	-0.128
P1	4.34%			P1	4.58%			P1	4.81%			P1	4.81%		
P1*	1.71%			P1*	1.78%			P1*	1.90%			P1*	0.91%		
Spd P10-P10*	-2.52%	0.001	0.004	Spd P10-P10*	-2.60%	0.063	-0.172	Spd P10-P10*	-2.94%	-0.04	-0.139	Spd P10-P10*	-3.57%	-0.187	-0.315*
P10	-1.59%			P10	-1.79%			P10	-2.41%			P10	-2.88%		
P10*	0.93%			P10*	0.81%			P10*	0.53%			P10*	0.69%		
Spd P1*-Avg	0.62%**			Spd P1*-Avg	0.66%*			Spd P1*-Avg	0.85%**			Spd P1*-Avg	0.16%		
Spd P10*-Avg	-0.16%**			Spd P10*-Avg	-0.28%			Spd P10*-Avg	-0.51%*			Spd P10*-Avg	-0.07%		
Relative Value	Return	Spearman	Pearson	**Market Neutral**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	1.90%	0.307**	0.309**	Spd P1-P1*	2.30%	0.153	-0.084	Spd P1-P1*	5.72%	-0.011	-0.073				
P1	3.68%			P1	3.00%			P1	7.18%						
P1*	1.78%			P1*	0.70%			P1*	1.46%						
Spd P10-P10*	-2.16%	-0.161	-0.292**	Spd P10-P10*	-2.18%	-0.007	-0.04	Spd P10-P10*	-5.51%	-0.164	-0.201				
P10	-1.55%			P10	-1.82%			P10	-4.11%						
P10*	0.61%			P10*	0.36%			P10*	1.41%						
Spd P1*-Avg	0.88%**			Spd P1*-Avg	0.15%			Spd P1*-Avg	0.32%						
Spd P10*-Avg	-0.29%*			Spd P10*-Avg	-0.20%			Spd P10*-Avg	0.26%						

Semi-annual

In Table 13 we examine whether top performers continue to be top performers and bottom performers continue to be bottom performers on a semiannual basis. In other words we examine P1* and P10*. The majority of the hedge fund strategies demonstrate significant persistence for top performers. The exception is the Short Bias, Long Only, Global Macro, and the CTA strategies. The highest significant spread of the top performers P1* and the average of all funds within the specific strategy is Other (1.01%, monthly) and the lowest is from the Market Neutral strategy (0.37%, monthly). Regarding the bottom performers (P10*), there are many strategies that have significant spreads compared to the average within the specific strategy. The highest (in absolute values - negative) spread is from the Other strategy (-0.96%, monthly) and the lowest (in absolute values - negative) is from the Market Neutral strategy (-0.36%, monthly). When we compare the P1 with the P1* portfolios we observe that Other and Relative Value have positive and significant correlations meaning that, especially for the Other strategy, top performers continue to perform extremely well. Comparing the P10 and P10* in most cases there are negative correlations although in the Relative Value strategy it is significantly different from zero. This means that there are reversals within poorly performing funds.

Table 13. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus average, and P10* versus average. These are for all hedge fund strategies, at semi-annual basis, during growth periods. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearma	Pearson
Spd P1-P1*	2.75%	0.170	0.321	Spd P1-P1*	2.87%	0.157	0.070	Spd P1-P1*	4.19%	-0.038	-0.047	Spd P1-P1*	3.21%	-0.093	-0.18
P1	3.67%			P1	4.51%			P1	5.74%			P1	4.83%		
P1*	0.92%			P1*	1.64%			P1*	1.55%			P1*	1.62%		
Spd P10-P10*	-2.94%	-0.010	-0.196	Spd P10-P10*	-2.50%	-0.089	-0.071	Spd P10-P10*	-3.64%	0.098	0.243	Spd P10-P10*	-3.04%	-0.006	0.058
P10	-3.04%			P10	-1.70%			P10	-3.06%			P10	-2.29%		
P10*	-0.10%			P10*	0.79%			P10*	0.58%			P10*	0.75%		
Spd P1*-Avg	0.84%			Spd P1*- Avg	0.38%			Spd P1*- Avg	0.28%			Spd P1*- Avg	0.48%*		
Spd P10*- Avg	-0.19%			Spd P10*- Avg	-0.47%*			Spd P10*- Avg	-0.69%			Spd P10*- Avg	-0.40%*		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearma	Pearson
Spd P1-P1*	2.13%	0.028	-0.280	Spd P1-P1*	1.93%	0.121	0.093	Spd P1-P1*	2.24%	0.221	0.403*	Spd P1-P1*	2.61%	0.162	0.148
P1	3.82%			P1	3.92%			P1	4.28%			P1	3.81%		
P1*	1.69%			P1*	2.00%			P1*	2.04%			P1*	1.19%		
Spd P10-P10*	-1.65%	-0.165	-0.152	Spd P10-P10*	-2.22%	0.191	0.173	Spd P10-P10*	-1.82%	0.071	0.136	Spd P10-P10*	-3.04%	0.029	-0.238
P10	-1.12%			P10	-1.31%			P10	-1.75%			P10	-2.18%		
P10*	0.53%			P10*	0.92%			P10*	0.07%			P10*	0.86%		
Spd P1*- Avg	0.62%**			Spd P1*- Avg	0.9%**			Spd P1*- Avg	1.01%**			Spd P1*- Avg	0.47%		
Spd P10*- Avg	-			Spd P10*- Avg	-0.17%			Spd P10*- Avg	-0.96%**			Spd P10*- Avg	0.14%		
Relative Value	Return	Spearman	Pearson	**Market**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	1.62%	0.395**	0.371*	Spd P1-P1*	1.62%	0.298	0.062	Spd P1-P1*	4.47%	-0.140	-0.202				
P1	3.27%			P1	2.56%			P1	5.98%						
P1*	1.65%			P1*	0.94%			P1*	1.51%						
Spd P10-P10*	-1.74%	-0.048	-0.342*	Spd P10-P10*	-1.47%	0.014	-0.069	Spd P10-P10*	-4.09%	0.163	0.042				
P10	-1.17%			P10	-1.26%			P10	-2.60%						
P10*	0.57%			P10*	0.21%			P10*	1.50%						
Spd P1*- Avg	0.76%**			Spd P1*- Avg	0.37%*			Spd P1*- Avg	0.30%						
Spd	-0.33%			Spd P10*- Avg	-0.36%*			Spd P10*- Avg	0.28%						

Yearly

In Table 14 we examine persistence on an annual basis. Concerning the top performers (P1* hedge funds), their spreads in relation to the average funds within the same strategy are positive for almost all hedge funds strategies. The only exception is from Market Neutral and the CTA strategies although this (negative) difference is not significantly different from zero. For the rest, the highest significant spread is from Short Bias (1.01%, monthly) and the lowest from the Long Only strategy (0.44%, monthly). Regarding the worst performing funds, we observe that their spreads in relation to the average funds within the same strategy is negative, although only for the Relative Value strategy is it significantly different from zero (-0.43%, monthly). When we compare the P1 with the P1* portfolios we observe that the Long only strategy has significant negative correlations meaning that, although P1* perform well above the average, there is reversal when compared with the P1. Similarly, comparing the P10 and P10* there are no significant correlations within bottom performers.

Table 14. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus average, and P10* versus average. These are for all hedge fund strategies, at annual basis, during growth periods. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	2.42%	0.086	0.002	Spd P1-P1*	2.27%	-0.519*	-0.575**	Spd P1-P1*	3.15%	-0.217	-0.271	Spd P1-P1*	2.67%	-0.426	-0.276
P1	3.42%			P1	3.98%			P1	5.03%			P1	4.07%		
P1*	1.00%			P1*	1.71%			P1*	1.88%			P1*	1.40%		
Spd P10-P10*	-	-0.060	0.055	Spd P10-P10*	-2.21%	0.005	-0.219	Spd P10-P10*	-3.06%	0.060	-0.369	Spd P10-P10*	-2.67%	0.052	-0.312
P10	-			P10	-1.42%			P10	-2.12%			P10	-1.72%		
P10*	0.40%			P10*	0.79%			P10*	0.94%			P10*	0.94%		
Spd P1*-Avg	1.01%			Spd P1*-Avg	0.44%*			Spd P1*-Avg	0.59%			Spd P1*-Avg	0.29%		
Spd P10*- Avg	0.41%			Spd P10*- Avg	-0.47%			Spd P10*- Avg	-0.35%			Spd P10*- Avg	-0.17%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	1.90%	0.048	0.044	Spd P1-P1*	1.98%	-0.074	0.072	Spd P1-P1*	2.33%	0.050	0.016	Spd P1-P1*	2.77%	-0.318	-0.244
P1	3.41%			P1	3.38%			P1	3.89%			P1	3.49%		
P1*	1.52%			P1*	1.40%			P1*	1.56%			P1*	0.72%		
Spd P10-P10*	-	0.200	-0.128	Spd P10-P10*	-2.00%	-0.164	-0.234	Spd P10-P10*	-1.70%	0.222	0.220	Spd P10-P10*	-2.40%	0.318	-0.277
P10	-			P10	-0.77%			P10	-1.39%			P10	-1.80%		
P10*	0.87%			P10*	1.23%			P10*	0.31%			P10*	0.60%		
Spd P1*- Avg	0.46**			Spd P1*- Avg	0.29%			Spd P1*- Avg	0.58%			Spd P1*- Avg	0.08%		
Spd P10*- Avg	-0.19			Spd P10*- Avg	0.12%			Spd P10*- Avg	-0.68%			Spd P10*- Avg	-0.04%		
Relative Value	Return	Spearman	Pearson	**Market**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	1.57%	0.279	0.285	Spd P1-P1*	1.95%	0.104	-0.247	Spd P1-P1*	3.78%	0.221	-0.011				
P1	3.08%			P1	2.26%			P1	2.23%						
P1*	1.51%			P1*	0.31%			P1*	-1.54%						
Spd P10-P10*	-	-0.021	-0.395	Spd P10-P10*	-1.75%	0.064	0.065	Spd P10-P10*	-3.71%	0.108	-0.037				
P10	-			P10	-0.98%			P10	-5.23%						
P10*	0.46%			P10*	0.77%			P10*	-1.52%						
Spd P1*- Avg	0.63%			Spd P1*- Avg	-0.26%			Spd P1*- Avg	-0.42%						
Spd P10*- Avg	-			Spd P10*- Avg	0.21%			Spd P10*- Avg	-0.41%						

3.3.3.2 Recession periods

Quarterly

We turn our focus towards recessions. In Table 15 we present our results. Concerning top performing hedge funds the spreads between the top performers P1* and the average is for the majority of hedge fund strategies positive, although not significant. The only exception is from the Relative Value strategy that is weakly significant (0.98%, monthly). Similar results are for spreads between bottom performers P10* and the average which is negative in all strategies, although not significant. The only exception is from the CTA strategy with significantly positive spread (2.36%, monthly). When we compare the P1 with the P1* portfolios we observe that only the Relative Value Strategy demonstrates high significant positive correlation between them. This means that top performers continue to perform extremely well. Similar results are seen when we compare P10 and P10* where there are no significant correlations within bottom performers.

Table 15. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, on a quarterly basis, during recessions. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	4.32%	-0.214	-0.006	Spd P1-P1*	9.38%	0.433	0.335	Spd P1-P1*	8.87%	-0.200	0.004	Spd P1-P1*	7.06%	0.225	0.229
P1	6.47%			P1	7.87%			P1	8.95%			P1	7.48%		
P1*	2.15%			P1*	-1.51%			P1*	0.08%			P1*	0.42%		
Spd P10-P10*	-6.13%	0.143	0.057	Spd P10-P10*	-6.41%	-0.083	0.133	Spd P10-P10*	-8.41%	0.173	0.101	Spd P10-	-7.51%	0.027	0.094
P10	-6.45%			P10	-7.42%			P10	-8.34%			P10	-7.39%		
P10*	-0.31%			P10*	-1.01%			P10*	0.06%			P10*	0.12%		
Spd P1*-Avg	1.77%			Spd P1*-Avg	-0.89%			Spd P1*-Avg	-0.42%			Spd P1*-	0.03%		
Spd P10*-Avg	-0.70%			Spd P10*-Avg	-0.39%			Spd P10*-Avg	-0.44%			Spd P10*-	-0.26%		
Event Driven	Return	Spearman	Pearson	**Multi Strategy**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global**	Return	Spearman	Pearson
Spd P1-P1*	5.42%	0.382	0.519	Spd P1-P1*	3.93%	0.321	0.153	Spd P1-P1*	6.41%	0.250	0.190	Spread P1-	7.56%	-0.200	-0.299
P1	5.78%			P1	5.31%			P1	7.27%			P1	8.41%		
P1*	0.36%			P1*	1.38%			P1*	0.85%			P1*	0.86%		
Spd P10-P10*	-3.72%			Spd P10-P10*	-4.03%	-0.006	-0.040	Spd P10-P10*	-6.50%	-0.567	-0.383	Spd P10-	-5.53%	-0.550	0.286
P10	-5.22%			P10	-4.64%			P10	-6.33%			P10	-5.06%		
P10*	-1.50%	-0.291	0.011	P10*	-0.61%			P10*	0.17%			P10*	0.47%		
Spd P1*-Avg	0.33%			Spd P1*-Avg	1.21%			Spd P1*-Avg	0.40%			Spd P1*-	0.20%		
Spd P10*-Avg	-1.53%			Spd P10*-Avg	-0.78%			Spd P10*-Avg	-0.29%			Spd P10*-	-0.19%		
Relative Value	Return	Spearman	Pearson	**Market Neutral**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	3.94%	0.818**	0.653*	Spd P1-P1*	3.96%	0.418	0.332	Spd P1-P1*	8.98%	-0.082	0.245				
P1	5.49%			P1	3.69%			P1	8.80%						
P1*	1.55%			P1*	-0.27%			P1*	-0.18%						
Spd P10-P10*	-4.48%	-0.105	-0.309	Spd P10-P10*	-3.06%	0.227	0.035	Spd P10-P10*	-10.50%	-0.009	0.070				
P10	-4.82%			P10	-3.33%			P10	-7.81%						
P10*	-0.34%			P10*	-0.27%			P10*	2.69%						
Spd P1*-Avg	0.98%			Spd P1*-Avg	-0.47%			Spd P1*-Avg	-0.51%						
Spd P10*-Avg	-0.22%			Spd P10*-Avg	-0.48%			Spd P10*-Avg	2.36%*						

Semi-annual

In Table 16 we present our results on a quarterly basis. Regarding the top performers (P1*), their spreads in relation to the average within the specific strategy, are for the majority of hedge fund strategies positive, although not significant. The only exception is the CTA strategy with significantly negative spread equal to -3.60%, monthly. Similar results are seen for spreads between bottom performers P10* and the average which is negative in all strategies although not significant. The only exception is from the CTA strategy with a significantly positive spread (3.04%, monthly). This means that for P1 and P10 of the CTA strategy there is not only a lack of performance persistence but there are significant reversals when comparing these portfolios with the average fund within the same strategy. When we compare the P1 with the P1* portfolios we observe that there is no significant correlation between them, although in most cases it is positive. Similar results are seen when we compare P10 and P10*, where there are no significant correlations within bottom performers. The only exception is from Market Neutral where there is a significant negative correlation, meaning that bottom performers P10* tend to reverse in their performance but still they underperform compared to the average within this strategy.

Table 16. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, at semi-annual basis, during recessions. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	5.29%	0.500	0.254	Spd P1-P1*	4.72%	-0.200	0.082	Spd P1-P1*	8.80%	0.500	0.652	Spd P1-P1*	5.01%	0.300	0.733
P1	7.05%			P1	3.28%			P1	7.93%			P1	5.23%		
P1*	1.76%			P1*	-1.45%			P1*	-0.88%			P1*	0.22%		
Spd P10-P10*	-7.86%	-0.900*	-0.943	Spd P10-P10*	-8.00%	-0.800	-0.924	Spd P10-P10*	-7.87%	-0.100	-0.519	Spd P10-P10*	-7.83%	-0.100	-0.700
P10	-5.78%			P10	-6.89%			P10	-8.14%			P10	-6.60%		
P10*	2.08%			P10*	1.12%			P10*	-0.28%			P10*	1.22%		
Spd P1*-Avg	-1.81%			Spd P1*-Avg	0.20%			Spd P1*-Avg	-0.72%			Spd P1*-Avg	0.28%		
Spd P10*-Avg	-0.06%			Spd P10*-Avg	2.76			Spd P10*-Avg	-0.12%			Spd P10*-Avg	1.28%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	6.51%	0.700	0.740	Spd P1-P1*	3.57%	0.500	0.288	Spd P1-P1*	4.52%	-0.200	0.354	Spd P1-P1*	6.50%	0.400	0.471
P1	5.07%			P1	4.06%			P1	5.20%			P1	7.85%		
P1*	-1.43%			P1*	0.49%			P1*	0.68%			P1*	1.35%		
Spd P10-P10*	-5.29%	-0.500	-0.745	Spd P10-P10*	-5.44%	-0.500	-0.832	Spd P10-P10*	-6.50%	-0.400	-0.822	Spd P10-P10*	-6.25%	-0.200	-0.565
P10	-4.28%			P10	-4.53%			P10	-5.48%			P10	-4.09%		
P10*	1.01%			P10*	0.91%			P10*	1.02%			P10*	2.16%		
Spd P1*-Avg	-1.44%			Spd P1*-Avg	0.30%			Spd P1*-Avg	0.64%			Spd P1*-Avg	0.48%		
Spd P10*-Avg	1.00%			Spd P10*-Avg	0.72%			Spd P10*-Avg	0.98%			Spd P10*-Avg	1.29%		
Relative Value	Monthly	Spearman	Pearson	**Market**	Monthly	Spearman	Pearson	**CTAs**	Monthly	Spearman	Pearson				
Sprd P1-P1*	3.74%	0.300	0.225	Spd P1-P1*	2.46%	0.101	0.334	Spd P1-P1*	10.19%	0.200	0.379				
P1	4.05%			P1	3.08%			P1	7.53%						
P1*	0.31%			P1*	0.62%			P1*	-2.67%						
Spd P10-P10*	-3.87%	-0.500	-0.471	Spd P10-P10*	-2.60%	-0.900*	-0.887*	Spd P10-P10*	-11.26%	0.700	0.764				
P10	-4.52%			P10	-2.81%			P10	-7.28%						
P10*	-0.65%			P10*	-0.22%			P10*	3.98%						
Spd P1*-Avg	0.06%			Spd P1*-Avg	0.45%			Spd P1*-Avg	-3.60%*						
Spd P10*-Avg	-0.91%			Spd P10*-Avg	-0.38%			Spd P10*-Avg	3.04%*						

Annual

We finish our analysis for recessions by presenting in Table 17, our results on annual basis. We observe that the spread between P1* and the average of funds within the specific strategy varies between positive and negative. The largest positive is from the Long Only strategy (1.83%, monthly) and the largest negative is from the Sector and Other strategy (-2.56%, monthly). P1 and P1* spreads for all strategies are relatively high. The largest is from the Short Bias strategy (10.70%, monthly) and the smallest is from the Multi Strategy (2.56%, monthly). P10 and P10* spreads for all strategies are negative. The largest (in terms of absolute value) is from CTA (-7.31%, monthly) and the smallest is from the Multi Strategy (-0.29%, monthly). It seems that during recessions, there is not yearly performance persistence among hedge fund strategies.

Table 17. Persistence within Strategies – Winners/Losers

This table shows descriptive statistics for spreads between top P1 versus P1* and P10 versus P10* performers, and spreads between P1* versus average, and P10* versus average. These are for all hedge fund strategies on an annual basis during recessions. P1* and P10* are ex-post portfolios of P1 and P10, respectively. The returns are average monthly.

Short Bias	Return	**Long Only**	Return	**Sector**	Return	**Long Short**	Return
Spread P1-P1*	10.70%	Spread P1-P1*	3.52%	Spread P1-P1*	5.67%	Spread P1-P1*	4.40%
P1	9.11%	P1	3.89%	P1	4.39%	P1	3.97%
P1*	-1.60%	P1*	0.38%	P1*	-1.29%	P1*	-0.43%
Spread P10-P10*	-6.68%	Spread P10-P10*	-2.60%	Spread P10-P10*	-4.77%	Spread P10-P10*	-3.93%
P10	-5.78%	P10	-5.59%	P10	-8.55%	P10	-6.21%
P10*	0.90%	P10*	-2.99%	P10*	-3.78%	P10*	-2.28%
Spread P1*- Average	-1.04%	Spread P1*- Average	1.83%	Spread P1*- Average	-0.07%	Spread P1*- Average	0.41%
Spread P10*- Average	1.45%	Spread P10*- Average	-1.54%	Spread P10*- Average	-2.56%	Spread P10*- Average	-1.44%
Event Driven	Return	**Multi Strategy**	Return	**Other**	Return	**Global Macro**	Return
Spread P1-P1*	4.12%	Spread P1-P1*	2.56%	Spread P1-P1*	3.92%	Spread P1-P1*	4.18%
P1	3.18%	P1	2.92%	P1	4.75%	P1	6.07%
P1*	-0.94%	P1*	0.36%	P1*	0.83%	P1*	1.89%
Spread P10-P10*	-2.55%	Spread P10-P10*	-0.29%	Spread P10-P10*	-1.42%	Spread P10-P10*	-3.05%
P10	-4.88%	P10	-3.17%	P10	-3.90%	P10	-3.28%
P10*	-2.33%	P10*	-2.89%	P10*	-2.48%	P10*	-0.23%
Spread P1*- Average	-0.02%	Spread P1*- Average	0.92%	Spread P1*- Average	0.76%	Spread P1*- Average	1.18%
Spread P10*- Average	-1.41%	Spread P10*- Average	-2.33%	Spread P10*- Average	-2.56%	Spread P10*- Average	-0.94%
Relative Value	Return	**Market Neutral**	Return	**CTAs**	Return		
Spread P1-P1*	2.97%	Spread P1-P1*	4.37%	Spread P1-P1*	6.97%		
P1	3.81%	P1	2.75%	P1	5.72%		
P1*	0.84%	P1*	-1.63%	P1*	-1.25%		
Spread P10-P10*	-1.39%	Spread P10-P10*	-2.77%	Spread P10-P10*	-7.31%		
P10	-5.49%	P10	-2.74%	P10	-4.86%		
P10*	-4.10%	P10*	0.03%	P10*	2.45%		
Spread P1*- Average	1.16%	Spread P1*- Average	-1.65%	Spread P1*- Average	-2.27%		
Spread P10*- Average	-4.66%	Spread P10*- Average	0.01%	Spread P10*- Average	1.44%		

3.3.3.3 Up regimes

Quarterly

In Table 18 we investigate whether top performers continue to be top performers and bottom performers continue to be bottom performers. Regarding the top performers (P1*), their spreads in relation to the average within the same strategy is for the majority of cases significantly positive. There are some exceptions such as Global Macro, CTAs, and Market Neutral where the spreads are not significantly different from zero. Similar results are seen for spreads between the bottom P10* performers and the average which are negative in all strategies, although not significant. This means that the bottom performers do not differ significantly from the average hedge fund within the same strategy. When we compare the P1 with the P1* portfolios, we observe that for almost half of the strategies there is significantly positive correlation. For some strategies such as the Multi Strategy and the Relative Value this correlation is relatively high. Similar results are seen when we compare P10 and P10*. Many strategies have significantly negative correlations such as the Long Short, Other and CTA strategies, meaning that there is a reverse in bottom performers even though they perform poorly compared to the average fund in the same strategy.

Table 18. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1* P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, quarterly basis, during up regimes. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	3.14%	0.040	0.125	Spd P1-P1*	3.27%	0.175	0.267*	Spd P1-P1*	4.70%	0.348	0.201	Spd P1-P1*	3.88%	0.165	0.254*
P1	3.71%			P1	5.49%			P1	6.88%			P1	5.91%		
P1*	0.57%			P1*	2.22%			P1*	2.18%			P1*	2.03%		
Spd P10-P10*	-3.34%	-0.009	-0.007	Spd P10-P10*	-3.15%	-0.230*	-0.188	Spd P10-P10*	-4.76%	-0.180	-0.103	Spd P10-P10*	-4.01%	-0.211	-0.349**
P10	-3.68%			P10	-1.88%			P10	-3.38%			P10	-2.82%		
P10*	-0.34%			P10*	1.26%			P10*	1.38%			P10*	1.19%		
Spd P1*-Avg	0.77%*			Spd P1*-Avg	0.75%*			Spd P1*-Avg	0.64%*			Spd P1*-Avg	0.68%**		
Spd P10*-Avg	-0.15%			Spd P10*-Avg	-0.21%			Spd P10*-Avg	-0.16%			Spd P10*-Avg	-0.16%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	2.73%	0.143	0.374**	Spd P1-P1*	2.76%	0.353**	0.373**	Spd P1-P1*	3.18%	0.143	0.068	Spd P1-P1*	4.76%	0.141	0.165
P1	4.61%			P1	4.66%			P1	5.17%			P1	5.33%		
P1*	1.88%			P1*	1.90%			P1*	1.98%			P1*	0.57%		
Spd P10-P10*	-2.56%	-0.052	-0.105	Spd P10-P10*	-3.13%	0.083	0.118	Spd P10-P10*	-3.57%	-0.155	-0.329**	Spd P10-P10*	-4.65%	-0.181	-0.298**
P10	-1.66%			P10	-1.70%			P10	-2.55%			P10	-2.94%		
P10*	0.90%			P10*	1.44%			P10*	1.02%			P10*	1.72%		
Spd P1*-Avg	0.7%**			Spd P1*-Avg	0.71%**			Spd P1*-Avg	0.87%*			Spd P1*-Avg	-0.31%		
Spd P10*-Avg	-0.28%			Spd P10*-Avg	0.24%			Spd P10*-Avg	-0.09%			Spd P10*-Avg	0.83%*		
Relative	Return	Spearman	Pearson	**Market**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	1.96%	0.460**	0.550**	Spd P1-P1*	2.37%	0.213	0.082	Spread P1-P1*	5.66%	-0.112	-0.100				
P1	3.90%			P1	3.01%			P1	7.00%						
P1*	1.94%			P1*	0.64%			P1*	1.34%						
Spd P10-P10*	-2.06%	-0.052	-0.012	Spd P10-P10*	-2.21%	0.041	-0.045	Sprd P10-P10*	-5.15%	-0.318**	-0.234*				
P10	-1.39%			P10	-1.77%			P10	-3.97%						
P10*	0.67%			P10*	0.44%			P10*	1.18%						
Spd P1*-Avg	0.97%**			Spd P1*-Avg	0.09%			Spd P1*-Avg	0.28%						
Spd P10*-Avg	-0.31%			Spd P10*-Avg	-0.11%			Spd P10*-Avg	0.12%						

Semi-annual

In Table 19 we present our results, on a semi-annual basis. Concerning top performers (P1*), their spreads with the average is for the majority of hedge fund strategies significantly positive. Regarding the spreads between bottom performers P10* and the average, this is negative in almost all strategies but is not significant. The only exception is from the Relative Value and the CTA strategies which are negative and positive, respectively. In the first case this means that bottom performers' funds consistently underperform the average within the Relative Value strategy whereas in the second case bottom performers outperform the average, meaning there is a reversal. When we compare the P1 and P1* portfolios, the correlations between them are not significant except for the Other and Relative Value strategies which are significantly positive. This implies that top performer funds continue to perform extremely well. When we compare P10 and P10* only the Long Short, Global Macro, and Relative Value strategies demonstrate significantly negative correlation, meaning that there is a reversal in bottom performers even though they perform poorly compared to the average fund in the same strategy, as in case with the Relative Value strategy.

Table 19. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, semi-annual basis, during up regimes. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	2.74%	0.197	0.038	Spd P1-P1*	2.92%	0.023	0.102	Spd P1-P1*	3.56%	0.088	0.098	Spd P1-P1*	3.04%	0.079	0.145
P1	2.91%			P1	4.71%			P1	5.91%			P1	4.90%		
P1*	0.17%			P1*	1.79%			P1*	2.35%			P1*	1.87%		
Spd P10-P10*	-2.87%	0.085	0.165	Spd P10-P10*	-2.71%	-0.284	-0.368*	Spd P10-P10*	-3.68%	-0.112	0.053	Spd P10-P10*	-3.02%	-0.223	-0.347*
P10	-2.99%			P10	-1.25%			P10	-2.41%			P10	-1.89%		
P10*	-0.12%			P10*	1.46%			P10*	1.27%			P10*	1.13%		
Spd P1*-Avg	0.43%			Spd P1*-Avg	0.36%			Spd P1*-Avg	0.82%**			Spd P1*-Avg	0.54%		
Spd P10*-Avg	0.14%			Spd P10*-Avg	0.03%			Spd P10*-Avg	-0.27%			Spd P10*-Avg	-0.19%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	2.24%	-0.144	0.123	Spd P1-P1*	2.18%	0.069	-0.139	Spd P1-P1*	3.09%	0.428**	0.347*	Spd P1-P1*	3.24%	-0.205	-0.139
P1	3.89%			P1	3.85%			P1	4.72%			P1	4.29%		
P1*	1.65%			P1*	1.67%			P1*	1.62%			P1*	1.05%		
Spd P10-P10*	-2.28%	0.008	-0.269	Spd P10-P10*	-2.14%	0.224	0.102	Spd P10-P10*	-2.68%	0.115	0.094	Spd P10-P10*	1.16%	-0.322	-0.425*
P10	-1.22%			P10	-1.01%			P10	-1.88%			P10	1.16%		
P10*	1.06%			P10*	1.13%			P10*	0.80%			P10*			
Spd P1*-Avg	0.51*			Spd P1*-Avg	0.52%*			Spd P1*-Avg	0.54%*			Spd P1*-Avg	0.21%		
Spd P10*-Avg	-0.08			Spd P10*-Avg	-0.03%			Spd P10*-Avg	-0.28%			Spd P10*-Avg	0.32%		
Relative Value	Return	Spearman	Pearson	**Market**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	1.84%	0.467**	0.505**	Spd P1-P1*	1.97%	0.230	0.096	Spd P1-P1*	4.66%	0.124	0.187				
P1	3.47%			P1	2.55%			P1	5.73%						
P1*	1.63%			P1*	0.58%			P1*	1.06%						
Spd P10-P10*	-1.59%	0.036	-0.308*	Spd P10-P10*	-1.81%	0.236	0.132	Spd P10-P10*	-4.20%	-0.094	-0.103				
P10	-1.00%			P10	-1.35%			P10	-2.75%						
P10*	0.59%			P10*	0.46%			P10*	1.45%						
Spd P1*-Avg	0.67%**			Spd P1*-Avg	0.04%			Spd P1*-Avg	2.14%**						
Spd P10*-Avg	-			Spd P10*-Avg	-0.08%			Spd P10*-Avg	2.53%**						

Annual

Regarding persistence on annual basis in Table 20 we demonstrate our results. Concerning the top performers P1*, their spreads with the average, for specific strategies such as the Long Only, Event Driven, Multi Strategy and Relative Value the spread is positive and significantly different from zero. Regarding the spreads between the bottom performers P10* and the average, only the Relative Value strategy presents a negative spread that is a significantly different from zero. This means that worst performing funds consistently underperform the average within the strategy. When we compare the P1 with the P1* portfolios and more specifically their correlation, only the Relative Value strategy presents significant results (positive correlation). When we compare P10 and P10* only the Sector Strategy presents significant negative correlation, meaning that there is a reversal in the worst performers.

Table 20. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1* P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, at annual basis, during up regimes. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	2.46%	-0.064	-0.207	Spd P1-P1*	2.32%	-0.120	-0.003	Spd P1-P1*	3.53%	-0.099	0.061	Spd P1-P1*	2.81%	-0.019	0.048
P1	2.70%			P1	4.25%			P1	5.57%			P1	4.51%		
P1*	0.24%			P1*	1.93%			P1*	2.04%			P1*	1.70%		
Spd P10-P10*	-3.32%	-0.130	-0.173	Spd P10-P10*	-1.97%	-0.376	-0.410	Spd P10-P10*	-3.28%	-0.370	-0.474*	Spd P10-P10*	-2.71%	-0.156	-0.228
P10	-2.97%			P10	-0.92%			P10	-1.89%			P10	-1.53%		
P10*	0.35%			P10*	1.05%			P10*	1.39%			P10*	1.19%		
Spd P1*-Avg	0.43%			Spd P1*-Avg	0.54%*			Spd P1*-Avg	0.57%			Spd P1*-Avg	0.36%		
Spd P10*-Avg	0.54%			Spd P10*-Avg	-0.33%			Spd P10*-Avg	-0.07%			Spd P10*-Avg	-0.16%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	1.98%	-0.052	0.041	Sprd P1-P1*	1.93%	-0.114	0.036	Spd P1-P1*	2.96%	0.286	0.173	Spd P1-P1*	3.11%	0.135	0.140
P1	3.48%			P1	3.47%			P1	4.29%			P1	3.86%		
P1*	1.51%			P1*	1.54%			P1*	1.33%			P1*	0.75%		
Spd P10-P10*	-1.81%		-0.374	Spd P10-P10*	-2.30%	0.196	0.118	Spd P10-P10*	-2.19%	0.154	0.149	Spd P10-P10*	-2.50%	-0.094	-0.240
P10	-0.86%		-0.242	P10	-1.03%			P10	-1.54%			P10	-1.28%		
P10*	0.95%			P10*	1.27%			P10*	0.65%			P10*	1.22%		
Spd P1*-Avg	0.38%**			Spd P1*-Avg	0.46%*			Spd P1*-Avg	0.26%			Spd P1*-Avg	-0.07%		
Spd P10*-Avg	-0.18%			Spd P10*-Avg	0.18%			Spd P10*-Avg	-0.42%			Sprd P10*-Avg	0.40%		
Relative Value	Monthly	Spearman	Pearson	**Market**	Monthly	Spearman	Pearson	**CTAs**	Monthly	Spearman	Pearson				
Spd P1-P1*	1.78%	0.640**	0.674**	Spd P1-P1*	1.58%	-0.048	-0.040	Spd P1-P1*	3.56%	0.065	0.024				
P1	3.37%			P1	2.16%			P1	4.85%						
P1*	1.59%			P1*	0.57%			P1*	1.29%						
Spd P10-P10*	-1.41%	-0.145	-0.216	Spd P10-P10*	-2.44%	0.011	0.013	Spd P10-P10*	-3.49%	-0.013	-0.023				
P10	-0.75%			P10	-1.93%			P10	-2.32%						
P10*	0.65%			P10*	0.51%			P10*	1.17%						
Spd P1*-Avg	0.64%**			Spd P1*-Avg	0.03%			Spd P1*-Avg	0.19%						
Spd P10*-Avg	-0.29%*			Spd P10*-Avg	-0.04%			Spd P10*-Avg	0.07%						

3.3.3.4 Down regimes

Quarterly

In this sub-section, we focus on down regimes. In Table 21 present our results. Regarding the top performers P1*, and their spreads with the average, the majority of the hedge fund strategies present positive spreads, although they are not significant. The Relative Value strategy presents significant spread equal to 0.76% monthly (the Event Driven has weakly a significant positive spread). Regarding the spreads between the bottom performers P10* and the average, almost all hedge fund strategies present negative spread, although they are not significant. When we compare the P1 with the P1* portfolios and more specifically their correlations, only the Long Only and Event Driven strategies present significantly positive correlations. When we compare P10 and P10* we have mixed results of positive and negative correlations, although they are not significantly different from zero.

Table 21. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, at quarterly basis, during down regimes. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	8.34%	-0.048	-0.049	Spd P1-P1*	5.57%	0.636*	0.403	Spd P1-P1*	6.37%	-0.509	-0.502	Spd P1-P1*	5.90%	0.309	0.125
P1	9.94%			P1	4.63%			P1	5.55%			P1	5.38%		
P1*	1.59%			P1*	-0.94%			P1*	-0.83%			P1*	-0.52%		
Spd P10-P10*	-5.63%	0.001	-0.258	Spd P10-P10*	-6.20%	-0.188	-0.081	Spd P10-P10*	-6.67%	-0.145	-0.204	Spd P10-P10*	-6.11%	0.036	0.001
P10	-3.35%			P10	-8.79%			P10	-11.04%			P10	-8.72%		
P10*	2.28%			P10*	-2.60%			P10*	-4.38%			P10*	-2.62%		
Spd P1*-Avg	-1.12%			Spd P1*-Avg	0.65%			Spd P1*-Avg	0.60%			Spd P1*-Avg	0.36%		
Spd P10*-Avg	-0.43%			Spd P10*-Avg	-1.00%			Spd P10*-Avg	-2.94%			Spd P10*-Avg	-1.74%		
Event Driven	Return	Spearman	Pearson	**Multi**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	3.31%	0.618*	0.718*	Spd P1-P1*	0.50%	0.467	0.305	Spd P1-P1*	4.78%	0.055	-0.271	Spd P1-P1*	5.52%	-0.167	-0.109
P1	3.97%			P1	0.50%			P1	4.53%			P1	6.76%		
P1*	0.66%			P1*				P1*	-0.24%			P1*	1.24%		
Spd P10-P10*	-4.18%	0.300	0.157	Spd P10-P10*	-3.48%	-0.309	-0.192	Spd P10-P10*	-5.80%	-0.442	-0.345	Spd P10-P10*	-6.98%	0.050	0.124
P10	-5.72%			P10	-5.35%			P10	-5.95%			P10	-6.28%		
P10*	-1.54%			P10*	-1.87%			P10*	-0.15%			P10*	0.70%		
Spd P1*-Ag	1.34%			Spd P1*-Avg	0.78%			Spd P1*-Avg	-0.30%			Spd P1*-Avg	0.88%		
Spd P10*-Avg	-0.87%			Spd P10*-Avg	-1.58%			Spd P10*-Ag	-0.20%			Spd P10*-Avg	0.33%		
Relative Value	Return	Spearman	Pearson	**Market**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	3.17%	0.491	0.324	Spd P1-P1*	3.01%	0.445	0.223	Spd P1-P1*	8.97%	0.309	0.347				
P1	3.98%			P1	3.84%			P1	9.08%						
P1*	0.81%			P1*	0.83%			P1*	0.11%						
Spd P10-P10*	-4.47%	-0.227	-0.246	Spd P10-P10*	-3.81%	0.300	0.399	Spd P10-P10*	-6.45%	-0.564	-0.423				
P10	-5.44%			P10	-3.56%			P10	-5.06%						
P10*	-0.97%			P10*	0.24%			P10*	1.39%						
Spd P1*-Avg	0.76%*			Spd P1*-Avg	0.54%			Spd P1*-Avg	-1.23%						
Spd P10*-Avg	-1.01%			Spd P10*-Avg	-0.05%			Spd P10*-Avg	0.05%						

Semi-annual

In Table 22 concerning the top performers P1*, and their spreads with the average, the majority of the hedge fund strategies present positive spread, although this is not significant (some strategies such as Sector, Long Short, and Relative Value provide results weakly significantly different from zero). Regarding the spreads between the bottom performers P10* and the average, almost all hedge fund strategies present negative spreads, although these are not significant (some strategies such as Sector, Long Short, and Market Neutral present results weakly significantly different from zero). When we compare the P1 with the P1* portfolios and more specifically their correlations, in all cases, except for the CTA strategy, there is positive correlation and for some strategies such as the Sector, Long Short and Long Only these are significant different from zero. When we compare P10 and P10* we have mixed results of positive and negative correlations, although they are not significantly different from zero. However, the Other and the Market Neutral strategies present results significantly different from zero.

Table 22. Persistence within Strategies – Winners/Losers

This table shows average (avg) monthly returns of spreads (spd) between top P1 versus P1*, P10 versus P10* performers, spreads between P* versus the average, and P10* versus the average. These are for all hedge fund strategies, at semi-annual basis, during down regimes. * denotes significance at P < 0.05 and ** denotes significance at P <0.01 (two-tailed tests). P1 and P10 are ex-ante best performer and worst performer portfolios, respectively. P1* and P10* are ex-post portfolios of P1 and P10, respectively. Spearman and Pearson represent the relevant correlation coefficients.

Short Bias	Return	Spearman	Pearson	**Long Only**	Return	Spearman	Pearson	**Sector**	Return	Spearman	Pearson	**Long Short**	Return	Spearman	Pearson
Spd P1-P1*	6.02%	0.200	0.033	Spd P1-P1*	3.18%	0.900*	0.825	Spd P1-P1*	4.10%	0.998**	0.964**	Spd P1-P1*	0.14%	0.900*	0.902*
P1	9.46%			P1	3.18%			P1	4.53%			P1	0.14%		
P1*	3.44%			P1*				P1*	0.43%			P1*			
Spd P10-P10*	-3.47%	0.600	-0.002	Spd P10-P10*	-3.46%	0.400	-0.251	Spd P10-P10*	-5.42%	-0.100	-0.024	Spd P10-P10*	-3.91%	0.200	0.184
P10	-1.60%			P10	-7.49%			P10	-10.77%			P10	-7.85%		
P10*	1.87%			P10*	-4.03%			P10*	-5.35%			P10*	-3.94%		
Spd P1*-Avg	0.42%			Spd P1*-Avg	-0.01%			Spd P1*-Avg	1.80%			Spd P1*-Avg	1.07%		
Spd P10*-Avg	-1.14%			Spd P10*-Avg	-2.52%*			Spd P10*-Avg	-3.98%			Spd P10*-Avg	-3.01%		
Event Driven	Return	Spearman	Pearson	**Multi Strategy**	Return	Spearman	Pearson	**Other**	Return	Spearman	Pearson	**Global Macro**	Return	Spearman	Pearson
Spd P1-P1*	3.26%	0.600	0.412	Spd P1-P1*	3.25%	0.700	0.713	Spd P1-P1*	2.90%	0.600	0.435	Spd P1-P1*	4.44%	0.300	0.669
P1	3.12%			P1	3.59%			P1	3.40%			P1	6.68%		
P1*	-0.14%			P1*	0.34%			P1*	0.50%			P1*	2.24%		
Spd P10-P10*	-2.38%	0.400	0.214	Spd P10-P10*	-3.64%	-0.700	-0.029	Spd P10-P10*	-2.27%	0.900*	0.755	Spd P10-P10*	-3.92%	-0.100	-0.070
P10	-5.14%			P10	-5.51%			P10	-4.77%			P10	-5.21%		
P10*	-2.77%			P10*	-1.87%			P10*	-2.50%			P10*	-1.30%		
Spd P1*-Avg	0.61%			Spd P1*-Avg	0.70%			Spd P1*-Avg	0.55%			Spd P1*-Avg	1.69%		
Spd P10*-Avg	-2.02%			Spd P10*-Avg	-1.50%*			Spd P10*-Avg	-2.44%			Spd P10*-Avg	-1.84%		
Relative Value	Return	Spearman	Pearson	**Market Neutral**	Return	Spearman	Pearson	**CTAs**	Return	Spearman	Pearson				
Spd P1-P1*	3.56%	0.300	0.479	Spd P1-P1*	2.37%	0.800	0.445	Spd P1-P1*	8.11%	-0.100	-0.315				
P1	0.83%			P1	3.31%			P1	7.64%						
P1*				P1*	0.94%			P1*	-0.48%						
Spd P10-P10*	-3.06%	-0.100	-0.327	Spd P10-P10*	-2.94%	0.700	0.879*	Spd P10-P10*	-7.82%	-0.100	-0.195				
P10	-5.17%			P10	-3.57%			P10	-2.78%						
P10*	-2.11%			P10*	-0.63%			P10*	5.04%						
Spd P1*-Avg	0.80%			Spd P1*-Avg	0.68%			Spd P1*-Avg	-1.29%						
Spd P10*-Avg	-2.14			Spd P10*-Avg	-0.88%			Spd P10*-Avg	-0.31%						

Annual

In Table 23, we observe that the spread between P1* and the average of funds within the specific strategy varies to positive and negative. The largest positive is from the Global Macro strategy (2.59%. monthly) and the largest negative is from the Global Macro strategy (-3.64%, monthly). P1 and P1* spreads for all strategies are relatively high. The largest is from the Long Only strategy (5.01%, monthly) and the smallest is from the CTA (1.82%, monthly). P10 and P10* spreads for all strategies are negative. The largest (in terms of absolute value) is from CTA (-4.34%, monthly) and the smallest is from the Global Macro (-0.28%, monthly).

Table 23. Persistence within Strategies – Winners/Losers

This table shows descriptive statistics results for spreads between top P1versus P1* and P10 versus P10* performers, and spreads between P* versus average, and P10* versus average. These are for all hedge fund strategies, on an annual basis during down regimes. P1* and P10* are ex-post portfolios of P1 and P10, respectively. The returns are average monthly.

Short Bias	Return	**Long Only**	Return	**Sector**	Return	**Long Short**	Return
Spread P1-P1*	2.83%	Spread P1-P1*	5.01%	Spread P1-P1*	4.02%	Spread P1-P1*	3.84%
P1	6.94%	P1	2.49%	P1	3.78%	P1	3.39%
P1*	4.11%	P1*	-2.52%	P1*	-0.24%	P1*	-0.45%
Spread P10-P10*	-3.00%	Spread P10-P10*	-1.62%	Spread P10-P10*	-3.53%	Spread P10-P10*	-2.97%
P10	-1.65%	P10	-5.68%	P10	-8.17%	P10	-6.17%
P10*	1.35%	P10*	-4.07%	P10*	-4.64%	P10*	-3.20%
Spread P1*-Average	1.08%	Spread P1*-Average	-0.28%	Spread P1*-Average	1.46%	Spread P1*-Average	0.85%
Spread P10*-Average	-1.68%	Spread P10*-Average	-1.82%	Spread P10*-Average	-2.94%	Spread P10*-Average	-1.91%
Event Driven	Return	**Multi Strategy**	Return	**Other**	Return	**Global Macro**	Return
Spread P1-P1*	2.48%	Spread P1-P1*	3.36%	Spread P1-P1*	3.49%	Spread P1-P1*	4.55%
P1	-2.11%	P1	3.19%	P1	3.12%	P1	7.50%
P1*		P1*	-0.17%	P1*	-0.37%	P1*	2.95%
Spread P10-P10*	-1.89%	Spread P10-P10*	-2.87%	Spread P10-P10*	-2.45%	Spread P10-P10*	-0.28%
P10	-3.86%	P10	-5.07%	P10	-3.63%	P10	-3.55%
P10*	-1.97%	P10*	-2.20%	P10*	-1.18%	P10*	-3.28%
Spread P1*-Average	-2.75	Spread P1*-Average	0.32%	Spread P1*-Average	-0.29%	Spread P1*-Average	2.59%
Spread P10*-Average	-2.61	Spread P10*-Average	-1.70%	Spread P10*-Average	-1.10%	Spread P10*-Average	-3.64%
Relative Value	Return	**Market Neutral**	Return	**CTAs**	Return		
Spread P1-P1*	2.50%	Spread P1-P1*	2.21%	Spread P1-P1*	1.82%		
P1	2.86%	P1	2.60%	P1	4.86%		
P1*	0.36%	P1*	0.39%	P1*	3.04%		
Spread P10-P10*	-1.49%	Spread P10-P10*	-2.24%	Spread P10-P10*	-4.34%		
P10	-3.42%	P10	-2.46%	P10	-3.03%		
P10*	-1.93%	P10*	-0.22%	P10*	1.31%		
Spread P1*-Average	0.50%	Spread P1*-Average	0.12%	Spread P1*-Average	1.69%		
Spread P10*-Average	-1.80%	Spread P10*-Average	-0.49%	Spread P10*-Average	-0.04%		

To sum up, we examined whether top performers continue to be top performers and bottom performers continue to be bottom performers (in technical terms we examined P1* and P10*). During "good" market conditions many strategies such as the Event Driven, Relative Value, or Multi Strategy funds, present persistence up to one year. Some other strategies such as the Sector and Other present persistence up to a half year. Some other strategies such as Short Bias and Long Only present persistence on a quarterly basis. In most cases the persistence was driven by the top performers that continue to perform extremely well. Also, in most cases there were reversals in bottom performers. This implies that there is fierce competition among bottom performers to be at least average in terms of performance; otherwise the fund will go out of business. It is known that there are high attrition rates in the hedge fund industry; hence funds that are underperforming in one time period push their managers to do their best to reverse their performance. During stressful market conditions, the persistence reduces dramatically for all hedge fund strategies. Some strategies such as Event Driven and Relative Value present quarterly persistence and some such as CTA semi-annual persistence[26].

Our results confirm earlier studies (e.g. Agarwal and Naik, 2000a; Eling, 2009; Joenvaara, Kosowski, and Tolonen, 2012; Hentati-Kaffel, and Peretti, 2015) that there is short term persistence. However, in our study we proceed further, by confirming our initial hypothesis that that persistence depends also on the different business cycles and the different market conditions. More specifically there is a negative impact concerning the spreads between top P1 and bottom P10 performers and their performance persistence. Also we showed evidence that some directional strategies (e.g. Relative Value) present more persistence than non-directional strategies (e.g. Short Bias or Long Only). Nevertheless the difference in persistence is mainly related to the type of strategy each fund follows. There are some studies such as Kosowski, Naik and Teo (2007), Jagannathan, Malakhov and Novikov (2010), and Amman, Huber and Schmid (2013) that indicated persistence beyond one year. Our study examined persistence up to one year due to the limitation of data availability, especially during stressful market conditions. Our study revealed that the persistence is driven mainly by the top performers, a finding that agrees

[26] We examined also the spreads between top P1 and bottom P10 performing funds across all hedge fund strategies for "good" and "bad" market conditions. During "good" times we found persistence in spreads up to an annual basis. During "bad" times we found persistence in spreads on a quarterly basis whereas for the semi-annual period many strategies such as the Short Bias, Other, Global Macro and Relative Value do not provide persistence in the spreads. For the annual period we found no persistence in spreads among hedge fund strategies. It seems that during stressful market conditions there is fiercer completion among fund managers thus making more difficult for sustainable outperformance against its pairs. In all market conditions, on average, directional strategies present higher spreads between top P1 and bottom P10 fund performers, compared to semi or non-directional strategies. We do not provide detailed results here for space reasons but these are available upon request from the authors.

with Jagannathan, Makakhov and Norvikov (2010), as we noticed reversals in bottom performers in most cases. Other authors (e.g. Capocci, 2007) suggest that bad performance is more likely to persist than good performance. This is intuitive as, in general, it is easier to identify fund characteristics that result in poor performance (e.g. high expense ratios, high turnover ratios, high trading costs) compared identifying the secrets of successful stock picking. However, if there were a consistency in poor performance these bottom performers would soon be out of business unless they reversed their performance.

3.4 Mixed trading strategies

In this section we discuss trading strategies (based on our persistence analysis at section 3.3.3) at the hedge fund level that an investor can exploit for potential higher returns. We consider growth periods and recessions. This is because down regimes that are characterized by down market movements with high volatility are more difficult to predict or to realize instantly once they happen. Moreover, contrary to recessions (that last for a few months), down regimes primarily consist of shocks; thus any trading strategy implementation is difficult during down regimes**.** After a brief discussion of the underlying trading strategies, in the next two sub-sections (3.4.1 and 3.4.2) we demonstrate to the reader the theoretical optimal implementation of the eight different trading strategies. We perform this so as the reader being able to rationalize these strategies. Some strategies that appear more common in our examples (e.g. Other, Sector, Short Bias, Relative Value) in general present higher persistence compared to other strategies and have high spreads between top and bottom performers. We explain this in a way that these strategies may demand excessive high skills from fund managers such as investing on start-ups or private investment in public equity (Others), deep knowledge of specific sectors (Sector), better contrarian investment styles (Short Bias), or finding arbitrage opportunities (Relative Value). Subsequently, we proceed to the overall evaluation of these eight trading strategies by presenting their average performance within the different market conditions. Finally, we have some robustness tests.

Trading Strategies

We begin our analysis when dealing with growth periods and the time periods at quarterly, semi-yearly, and yearly time units. Then we proceed to recession periods. We take into

consideration three basic trading strategies: (i) momentum strategy, (ii) contrarian strategy, and (iii) momentrarian strategy.

The momentum trading (zero investment) strategy consists of two sub strategies: the first is when the investor selects one hedge fund strategy (the one with the highest spread between P1* and P10*) but within the same period (quarterly, semi-annual, annual). The second sub-strategy is when the investor uses different hedge fund strategies (so as the cross sectional spread between P1* and P10* is the highest) but again within the same period.

The contrarian (zero investment) strategy also consists of two sub strategies: the first is when the investor selects one hedge fund strategy (the one with the highest spread between P1* and P10*) for longer period (e.g. two or three years). The second is when the investor selects different hedge fund strategies for longer period (e.g. two or three years) as well.

The momentrarian (zero investment) strategy is defined as an investment style (or trading strategy) that is a combination of a momentum (MOMEN-) and contrarian (-TRARIAN) strategy by taking the appropriate long and short positions on different funds (securities or financial indices). The momentrarian strategy consists of two sub strategies: the first is the momentrarian involving high return exploitation and more specific focusing on the top performing funds' spreads; the second sub strategy is the momentrarian involving low return exploitation and particular focusing on the worst performing funds' spreads. Both sub strategies are on annual basis involving P1* and P10* that are held for one, two or three years (please see the trading examples in section 2.1).

3.4.1 During growth periods

In Table 24 we present the monthly returns (%) for top and bottom hedge fund performers, for all hedge fund strategies during growth periods. This table is derived from the tables presented in section 3.3.3.1 (persistence within strategies –winners/losers returns, of P1* and P10*). Since we found that there is short term performance persistence in hedge fund returns, investors can utilize these spreads by forming appropriate trading strategies so as to increase their returns. Our analysis when forming and constructing trading strategies are based on the performance of winners and losers.

Table 24. Spreads – Winners/Losers

This table shows results of spreads (spd) between P1* versus P10* (or ex-post spreads of P1 vs P10) of all hedge fund strategies, at quarterly, semi-annual, annual, two years, and three years. These are for all hedge fund strategies during growth periods.

Short Bias	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	0.62	0.92	1.00	0.43	-0.33
P10*	0.24	-0.10	0.40	1.07	-1.12
Spd P1*-P10*	0.38	1.03	0.60	-0.64	0.79

Long Only	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.93	1.64	1.71	1.33	1.76
P10*	0.89	0.79	0.79	1.46	1.07
Spd P1*-P10*	1.05	0.85	0.92	-0.13	0.69

Sector	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.57	1.55	1.88	1.30	0.51
P10*	0.90	0.58	0.94	1.34	0.97
Spd P1*-P10*	0.68	0.97	0.94	-0.04	-0.46

Long Short	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.66	1.62	1.40	1.38	1.44
P10*	0.88	0.75	0.94	1.18	0.80
Spd P1*-P10*	0.78	0.88	0.46	0.20	0.63

Event Driven	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.71	1.69	1.52	1.27	1.11
P10*	0.93	0.53	0.87	1.13	1.17
Spd P1*-P10*	0.79	1.17	0.65	0.14	-0.06

Multi Strategy	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.78	2.00	1.40	1.32	0.91
P10*	0.84	0.92	1.23	1.25	0.76
Spd P1*-P10*	0.97	1.08	0.17	0.07	0.14

Other	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.90	2.04	1.56	0.91	0.47
P10*	0.53	0.07	0.31	1.03	0.37
Spd P1*-P10*	1.37	1.97	1.25	-0.12	0.10

Global Macro	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	0.91	1.19	0.72	0.53	0.28
P10*	0.69	0.86	0.60	0.64	0.68
Spd P1*-P10*	0.22	0.34	0.12	-0.11	-0.40

Relative Value	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.78	1.65	1.51	1.15	0.93
P10*	0.61	0.57	0.46	0.90	0.63
Spd P1*-P10*	1.17	1.09	1.05	0.25	0.30

Market Neutral	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	0.70	0.94	0.31	0.81	0.58
P10*	0.36	0.21	0.77	0.61	0.82
Spd P1*-P10*	0.35	0.73	-0.46	0.19	-0.24

CTAs	Quarterly	Semi-yearly	Yearly	Two Years	Three Years
P1*	1.46	1.51	-1.54	-1.26	-0.44
P10*	1.41	1.50	-1.52	-0.93	-1.15
Spd P1*-P10*	0.05	0.02	-0.02	-0.33	0.71

3.4.1.1 Momentum trading

In Table 25 we present the momentum trading style when the investor uses only one strategy per time period (quarterly, semi-annually, and annually). Based on this, the investor should choose to invest in the strategy with the higher expected difference between top and bottom performers and more specific the Other strategy. Therefore, the investor should take long and short positions in the top and bottom performers accordingly to exploit the differences in spreads. For example, the investor for each time period, should take a long position on best performers (P1) and a short position on bottom performers (P10). The next time period she should adjust and rebalance the portfolio accordingly. Thus, for the quarterly period the excess market return is 0.30% on a monthly basis whereas for the semi-annual and annual periods it is 0.90% and 0.18% respectively.

Table 25. Momentum Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum momentum trading strategy during growth periods, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios.

Momentum		**Actions**		**Return**	**Excess Mt Return**
Quarterly	t	Buy P1 of OT	Short-sell P10 of OT	1.37**	0.30
	t+1	sell P1 of OT then rebalance	Buy P10 of OT then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Semi-yearly	t	Buy P1 of OT	Short-sell P10 of OT	1.97**	0.90*
	t+1	Sell P1 of OT then rebalance	Buy P10 of OT then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Yearly	t	Buy P1* of OT	Short-sell P10* of OT	1.25**	0.18
	t+1	Sell P1 of OT then rebalance	Buy P10 of OT then rebalance		
	…	…	…		

In Table 26 we present the momentum trading style when the investor uses different hedge fund strategies. The investor should choose the hedge fund strategies with the highest cross strategy spread between P1 and P10. For the quarterly period, the investor by taking long and short positions in Long Only and Short Bias of top and bottom performers respectively can have an excess market return equal to 0.63% on a monthly basis. For the semi-annual period the investor by utilizing the Other and Short Bias strategies can have an expected excess market return equal to 1.06% on a monthly basis. For the yearly period by using the Sector and CTA strategies can have an expected excess market return equal to 2.33% on a monthly basis.

Table 26. Momentum Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentum trading strategy during growth periods, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios.

Momentum		**Actions**		**Return**	**Excess Mt Return**
Quarterly	t	Buy P1 of LO	Short-sell P10 of SB	1.70**	0.63
	t+1	Sell P1 of LO then rebalance	Buy P10 of SB then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Semi-yearly	t	Buy P1 of OT	Short sell P10 of SB	2.14**	1.06*
	t+1	Sell P1 of OT then rebalance	Buy P10 of SB then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Yearly	t	Buy P1 of SE	Short sell P10 of CT	3.40**	2.33**
	t+1	Sell P1 of SE then rebalance	Buy P10 of CT then rebalance		
	…	…	….		

3.4.1.2 Contrarian trading

In Table 27 we present the contrarian trading style when the investor uses only one strategy per time period (two and three years). The investor should use the contrarian strategies for two or more years between the top and bottom performers within the hedge fund strategy with the

highest spreads between them. In the two year contrarian trading the Short Bias strategy is the most appropriate hedge fund strategy that the investor should exploit. However, we observe that although this is the best contrarian strategy, the investor receives lower returns than the market returns. Similar results are for the three year contrarian trading taking into consideration the Sector strategy.

Table 27. Contrarian Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum contrarian trading strategy during growth periods, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). Where "|" denotes the portfolio which selected based on low (P10) or high (P1) performance two years prior *t* (= 0) and "||"denotes the portfolio which selected on low (P10) or high (P1) performance three years prior *t*. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios.

Contrarian		**Actions**		**Return**	**Excess Mt Return**
2 Years	t	Buy P10 of SB|	Short sell P1 of SB|	0.64	-0.38
	t+1	Sell P10 of SB| then rebalance	Buy P1 of SB| then rebalance		
	…	…	…		
Contrarian		**Actions**		**Return**	**Excess Mt Return**
3 Years	t	Buy P10* of SE||	Short sell P1* of SE||	0.46	-0.55
	t+1	Sell P10* of SE|| then rebalance	Buy P1* of SE|| then rebalance		
	…	…	…		

In Table 28 we present the contrarian trading style where the investor utilizes more than one hedge fund strategy per time period. In this case the investor should utilize these strategies with the higher cross strategy spread. Therefore, for the two year contrarian trading, the investor by taking a long position in the bottom performing Long Only strategy and taking a short position in the top performing CTA strategy, can have an expected excess market return equal to 1.71% per month. For the three year contrarian strategy the expected excess market return is equal to 0.60%, per month.

Table 28. Contrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum contrarian trading strategy during growth periods, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). Where "|" denotes the portfolio which selected based on low (P10) or high (P1) performance two years prior *t* (= 0)

and "||"denotes the portfolio which selected on low (P10) or high (P1) performance three years prior *t*. * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios.

Contrarian		**Actions**		**Return**	**Excess Mt Return**
2 Years	t	Buy P10 of LO|	Short sell P1 of CT|	2.72**	1.71**
	t+1	Sell P10 of LO| then rebalance	Buy P1 of CT| then rebalance		
	…	…	….		
Contrarian		**Actions**		**Return**	**Excess Mt Return**
3 Years	t	Buy P10 of ED||	Short sell P1 of CT||	1.60**	0.60
	t+1	Sell P10 of ED|| then rebalance	Buy P1 of CT|| then rebalance		
	…	…	….		

3.4.1.3 Momentrarian trading (involving high return exploitation)

In Table 29 we present the momentrarian trading style, involving high return exploitation, where the investor uses only one strategy per time period (1st or 2nd order). For the 1st order case, the investor exploits the spread between the top performer at t (long position based on previous one year portfolio performance) and top performer at t-1 (short position based on prior two years portfolio performance). The highest spread is from the Others strategy, nevertheless the investor is unable to outperform the market index it provides a negative excess market return equal to -0.42% on a monthly basis. For the 2nd order case the investor exploits the spread between the top performer at t (long position based on previous one year portfolio performance) and top performer as well at t-2 (short position based on prior three years, portfolio performance). For the Others strategy the expected excess market return is 0.30%, monthly.

Table 29. High Return Momentrarian Trading Strategy – Same Strategy

This table presents the optimum momentrarian trading strategy (involving high return exploitation) during growth periods, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on high (P1) performance two years prior *t* (= 0) and "||"denotes the portfolio which selected on high (P1) performance three years prior *t*. Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 portfolios.

Momentrarian		**Actions**		**Return**	**Excess Mt Return**
1st order	t	Buy P1 of OT	Short sell P1 of OT|	0.65	-0.42

	t+1	Sell P1 of OT then rebalance	Buy P1 of OT| then rebalance		
	…	…	…		
Momentrarian		**Actions**		**Return**	**Excess Mt Return**
2nd order	t	Buy P1 of SE	Short sell P1 of SE||	1.37	0.30
	t+1	Sell P1 of SE then rebalance	Buy P1 of SE|| then rebalance		
	…	…	…		

In Table 30 we present the momentrarian trading style involving high return exploitation, where the investor uses different strategies per time period. In the 1st order case the investor should take a long position in Sector top performers (one year before) and short positions in CTA top performers (two years before); the excess market return delivered is 2.07% on monthly basis. For the 2nd order the excess market return is 1.25% on monthly basis.

Table 30. High Return Momentrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentrarian trading strategy (involving high return exploitation) during growth periods, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on high (P1) performance two years prior *t* (= 0) and "||"denotes the portfolio which selected on high (P1) performance three years prior *t*. Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 portfolios.

Momentrarian		**Actions**		**Return**	**Excess Mt Return**
1st order	t	Buy P1 of SE	Short sell P1 of CT|	3.14**	2.07**
	t+1	Sell P1 of SE then rebalance	Buy P1 of CT| then rebalance		
	…	…	…		
Momentrarian		**Actions**		**Return**	**Excess Mt Return**
2nd order	t	Buy P1 of SE	Short sell P1 of CT||	2.32**	1.25
	t+1	Sell P1 of SE then rebalance	Buy P1 of CT|| then rebalance		
	…	…	…		

3.4.1.4 Momentrarian trading (involving low return exploitation)

In Table 31 we present the momentrarian trading style, involving low return exploitation, where the investor uses only one strategy per time period (1st and 2nd order). In the 1st order case the investor exploits the spreads between bottom performers at one year before (long position) and bottom performers two years before (short position). The highest spread is from the Others strategy, nevertheless the investor is unable to outperform the market index as there is excess market returns equal to -0.35% on monthly basis. For the 2nd order there is excess market returns equal to -0.69% on monthly basis.

Table 31. Low Return Momentrarian Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum momentrarian trading strategy (involving low return exploitation) during growth periods, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on low (P10) performance two years prior *t* (= 0) and "||"denotes the portfolio which selected on low (P10) performance three years prior *t*. Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P10 portfolios.

Momentrarian		**Actions**		**Return**	**Excess Mt Return**
1st order	t	Buy P10 of OT|	Short sell P10 of OT	0.72	-0.35
	t+1	Sell P10 of OT| then rebalance	Buy P10 of OT then rebalance		
	…	…	…		
Momentrarian		**Actions**		**Return**	**Excess Mt Return**
2nd order	t	Buy P10 of CT||	Short sell P10 CT	0.38	-0.69
	t+1	Sell P10 of CT|| then rebalance	Buy P10 of CT then rebalance		
	…	…	…		

In Table 32 we present the momentrarian trading style, involving low return exploitation, when the investor uses different strategies. In the 1st order case the investor receives excess market return equal to 1.79% on a monthly basis whereas in the 2nd order case the excess market return is equal to 1.61% on a monthly basis.

Table 32. Low Return - Momentrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentrarian trading strategy (involving low return exploitation) during growth periods, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on low (P10) performance two years prior *t* (= 0) and "||"denotes the portfolio which selected on low (P10) performance three years prior *t*. Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P10 portfolios.

Momentrarian		**Actions**		**Return**	**Excess Mt Return**
1st order	t	Buy P10 of SE|	Short sell P10 of CT	2.86**	1.79**
	t+2	Sell P10 of SE| then rebalance	Buy P10 of CT then rebalance		
	…	…	…		
Momentrarian		**Actions**		**Return**	**Excess Mt Return**
2nd order	t	Buy P10 of ED||	Short sell P10 of CT	2.69**	1.61**
	t+2	Sell P10 of ED|| then rebalance	Buy P10 of CT then rebalance		
	…	…	…		

Using the above examples, we calculated the average return for each of the eight different trading styles. Overall, during "good" financial conditions, the average monthly return for zero investment quarterly, semi-annual, and annual momentum strategies (using one only hedge fund strategy) is equal to 0.71% (significant different from zero at P<0.01 – two tail test, [t-statistic 3.404]), 0.92% (significant different from zero at P<0.01 – two tail test, [t-statistic 4.610]), and 0.52% (significant different from zero at P<0.05 – two tail test, [t-statistic 2.451]), respectively. For the 2-year and 3-year contrarian strategies is 0.05% (not significant different from zero) and -0.20% (not significant different from zero), respectively. For the 1st and 2nd order momentrarian (involving high return exploitation) is 0.21% (not significant different from zero) and 0.38% (not significant different from zero), respectively. For the 1st and 2nd order momentrarian (involving low return exploitation) is 0.35% (significant different from zero at P<0.05 – two tail test, [t-statistic 2.112]) and -0.07% (not significant different from zero), respectively.

3.4.2 During recession periods

We continue our analysis during recession periods and, again, we take into consideration three basic trading strategies: (i) momentum strategy, (ii) contrarian strategy, and (iii) momentrarian strategy. Due to the low number of observations during recessions, we do not consider the three year contrarian, and the momentrarian 2nd order trading strategy.

In Table 33 we present the monthly returns (%) for top and bottom hedge fund performers, for all hedge fund strategies during recessions. This table is derived from the tables presented in section 3.3.3.2 (persistence within strategies –winners/losers returns, of P1* and P10*). Since we found that there is short term performance persistence in hedge fund returns (at least for a quarter), investors can benefit and have higher returns even during stressful market conditions.

Table 33. Spreads – Winners/Losers

This table shows results of spreads (spd) between top P1* versus P10* (or ex-post spreads of P1 vs P10) of all hedge fund strategies, at quarterly, semi-annual, annual, and two years. These are for all hedge fund strategies during recession periods.

Short Bias	Quarterly	Semi-yearly	Yearly	Two Years
P1*	2.15	1.76	-1.60	7.77
P10*	-0.31	2.08	0.90	2.72
Spr P1*-P10*	2.47	-0.32	-2.50	5.05

Long Only	Quarterly	Semi-yearly	Yearly	Two Years
P1*	-1.51	-1.45	0.38	-3.84
P10*	-1.01	1.12	-2.99	-1.74
Spr P1*-P10*	-0.49	-2.56	3.37	-2.10

Sector	Quarterly	Semi-yearly	Yearly	Two Years
P1*	0.08	-0.88	-1.29	-1.38
P10*	0.06	-0.28	-3.78	-0.79
Spr P1*-P10*	0.02	-0.60	2.49	-0.59

Long Short	Quarterly	Semi-yearly	Yearly	Two Years
P1*	0.42	0.22	-0.43	-1.48
P10*	0.12	1.22	-2.28	-1.20
Spr P1*-P10*	0.29	-1.00	1.85	-0.28

Event Driven	Quarterly	Semi-yearly	Yearly	Two Years
P1*	0.36	-1.43	-0.94	-4.14
P10*	-1.50	1.01	-2.33	-0.40
Spr P1*-P10*	1.86	-2.45	1.39	-3.74

Multi Strategy	Quarterly	Semi-yearly	Yearly	Two Years
P1*	1.38	0.49	0.36	-0.27
P10*	-0.61	0.91	-2.89	0.60
Spr P1*-P10*	1.99	-0.42	3.25	-0.87

Other	Quarterly	Semi-yearly	Yearly	Two Years
P1*	0.85	0.68	0.83	0.53
P10*	0.17	1.02	-2.48	-0.95
Spr P1*-P10*	0.68	-0.34	3.32	1.48

Global Macro	Quarterly	Semi-yearly	Yearly	Two Years
P1*	0.86	1.35	1.89	0.83
P10*	0.47	2.16	-0.23	0.47
Spr P1*-P10*	0.39	-0.82	2.12	0.36

Relative Value	Quarterly	Semi-yearly	Yearly	Two Years
P1*	1.55	0.31	0.84	-4.58
P10*	-0.34	-0.65	-4.10	-0.26
Spr P1*-P10*	1.89	0.96	4.94	-4.32

Market Neutral	Quarterly	Semi-yearly	Yearly	Two Years
P1*	-0.27	0.62	-1.63	-1.04
P10*	-0.27	-0.22	0.03	-0.96
Spr P1*-P10*	0.01	0.84	-1.66	-0.08

CTAs	Quarterly	Semi-yearly	Yearly	Two Years
P1*	-0.18	-2.67	-1.25	0.50
P10*	2.69	3.98	2.45	2.65
Spr P1*-P10*	-2.87	-6.64	-3.70	-2.15

3.4.2.1 Momentum trading

In Table 34 we present the momentum trading style when the investor uses only one strategy. Based on this, the investor should choose to invest in this strategy with thee higher expected difference between top and bottom performers. Therefore, for the quarterly, semi-annual and annual period the investor should take long and short positions in the top and bottom performers accordingly to exploit the differences in spreads. For the quarterly period the excess market return is 3.28% on a monthly basis whereas for the semi-annual and annual periods it is 2.67% and 5.72%, respectively.

Table 34. Momentum Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum momentum trading strategy during recessions, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios. Unfortunately, we cannot calculate statistical significance for the yearly horizon due to the low number of available observations.

Momentum		**Actions**		**Return**	**Excess Mt Return**
Quarterly	t	Buy P1 of SB	Short-sell P10 of SB	2.46	3.28
	t+1	Sell P1 of SB then rebalance	Buy P10 of SB then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Semi-yearly	t	Buy P1 of RV	Short-sell P10 of RV	0.96	2.67
	t+1	Sell P1 of RV then rebalance	Buy P10 of RV then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Yearly	t	Buy P1 of RV	Short-sell P10 of RV	4.94	5.72
	t+1	Sell P1 of RV then rebalance	Buy P10 of RV then rebalance		
	…	…	…		

In Table 35 we present the momentum trading style when the investor uses different hedge fund strategies. The investor should choose the hedge fund strategies with the highest cross strategy spread between P1 and P10. For the quarterly period, the investor by taking long and short

positions in Short Bias and Event Driven of top and bottom performers respectively can have an excess market return equal to 0.38% on a monthly basis. For the semi-annual period the investor by utilizing the Short Bias and Others strategies investors have an expected excess market return equal to -0.26% on monthly basis. For the yearly period by using the Global Macro and Relative Value strategies investors have an expected excess market return equal to 6.77% on monthly basis.

Table 35. Momentum Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentum trading strategy during recessions, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios. Unfortunately, we cannot calculate statistical significance for the yearly horizon due to the low number of available observations.

Momentum		**Actions**		**Return**	**Excess Mt Return**
Quarterly	t	Buy P1 of SB	Short-sell P10 of ED	3.66	0.38
	t+1	Sell P1 of SB then rebalance	Buy P10 of ED then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Semi-yearly	t	Buy P1 of SB	Short sell P10 of RV	2.41	-0.26
	t+1	Sell P1 of SB then rebalance	buy P10 of RV then rebalance		
	…	…	…		
Momentum		**Actions**		**Return**	**Excess Mt Return**
Yearly	t	Buy P1 of GM	Short sell P10 of RV	5.99	6.77
	t+1	Sell P1 of GM then rebalance	Buy P10 of RV then rebalance		
	…	…	…		

3.4.2.2 Contrarian trading

In the Table 36 we present the two year contrarian trading style when the investor uses one only strategy per time period. The Relative strategy is theoretical the most appropriate hedge fund strategy that the investor should exploit. We observe that the investor receives excess market returns equal to 5.10%, monthly.

Table 36. Contrarian Trading Strategy – Same Hedge Fund Industry

This table presents the optimum contrarian trading strategy during recessions, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). Where "|" denotes the portfolio which selected based on low (P10) or high (P1) performance two years prior *t* (= 0). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios. Unfortunately, we cannot calculate statistical significance for this horizon due to the low number of available observations.

Contrarian		Actions		Return	Excess Mt Return
2 Years	t	Buy P10 of RV|	Short sell P1 of RV|	4.32	5.10
	t+1	Sell P10 of RV| then rebalance	Buy P1 RV| of then rebalance		
	…	…	…		

In Table 37 we present the contrarian trading style where the investor utilizes more than one hedge fund strategy. In this case the investor should utilize these strategies with the higher cross strategy spread. Thus the investor, by taking a long position in the bottom performing Short Bias strategy and taking a short position in the top performing Relative Value strategy, can have an expected excess market return equal to 8.08% per month.

Table 37. Contrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum contrarian trading strategy during recessions, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). Where "|" denotes the portfolio which selected based on low (P10) or high (P1) performance two years prior *t* (= 0). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "…" denotes the same activity process after each horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios. Unfortunately, we cannot calculate statistical significance for this horizon due to the low number of available observations.

Contrarian		Actions		Return	Excess Mt Return
2 Years	t	Buy P10 of SB|	Short sell P1 of RV|	7.30	8.08
	t+1	Sell P10 of SB| then rebalance	Buy P1 of RV| then rebalance		
	…	…	….		

3.4.2.3 Momentrarian trading (involving high return exploitation)

In Table 38 we present the momentrarian trading style, involving high return exploitation, when the investor uses only one strategy. The investor exploits the spreads between the top performer

one year before (long position) and top performer two years before (short position). The higher spread is from the Relative strategy providing the investor with 6.20% excess market returns, on monthly basis.

Table 38. High Return - Momentrarian Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum momentrarian trading strategy (involving high return exploitation) during recessions, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on high (P1) performance two years prior *t* (= 0). Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 portfolios. Unfortunately, we cannot calculate the statistical significance for the momentrarian trading strategy due to the low number of available observations.

Momentrarian		Actions		Return	Excess Mt Return
	t	Buy P1 of RV	Short sell P1 of RV|	5.43	6.20
	t+1	Sell P1 of RV then rebalance	Buy P1 of RV| then rebalance		
	…	…	…		

In Table 39 we present the momentrarian trading style involving high return exploitation, where the investor uses different strategies. The investor should take a long position in Global Macro top performers and short positions in Relative Value top performers. The excess market return that the investor receives is 7.25% on monthly basis.

Table 39. High Return - Momentrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentrarian trading strategy (involving high return exploitation) during recessions, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on high (P1) performance two years prior *t* (= 0). Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P1 portfolios. Unfortunately, we cannot calculate the statistical significance for the momentrarian trading strategy due to the low number of available observations.

Momentrarian		Actions		Return	Excess Mt Return
	t	Buy P1 of GM	Short sell P1 of RV|	6.48	7.25

	t+1	Sell P1 of GM then rebalance	Buy P1 of RV| then rebalance	
	…	…	…	

3.4.2.4 Momentrarian trading (involving low return exploitation)

In Table 40 we present the momentrarian trading style, involving low return exploitation, where the investor uses one only strategy. The investor exploits the spreads between bottom performers (long position) and bottom performers (short position). The higher spread is from the Relative Value strategy and the investor is expected to receive excess market return equal to 4.62% on monthly basis.

Table 40. Low Return - Momentrarian Trading Strategy – Same Hedge Fund Strategy

This table presents the optimum momentrarian trading strategy (involving low return exploitation) during recessions, when using one only strategy per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on low (P10) performance two years prior *t* (= 0). Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P10 portfolios. Unfortunately, we cannot calculate the statistical significance for the momentrarian trading strategy due to the low number of available observations.

Momentrarian	Actions			Return	Excess Mt Return
	t	Buy P10 of RV|	Short sell P10 of RV	3.84	4.62
	t+1	Sell P10 of RV| then rebalance	Buy P10 of RV then rebalance		
	…	…	…		

In Table 41 we present the momentrarian trading style, involving low return exploitation, where the investor uses different strategies. In this case the investor should take long position in Short Bias bottom performers and short positions in Relative Value bottom performers. The excess market return that the investor receives is 7.60% on a monthly basis.

Table 41. Low Return - Momentrarian Trading Strategy – Mixed Hedge Fund Strategies

This table presents the optimum momentrarian trading strategy (involving low return exploitation) during recessions, when using different strategies per time period. Where, Return: Trading Raw Return, Excess Mt Return: is the Return minus the market return (Wil5000TRI including dividends). * denotes significance at P < 0.05 and ** denotes significance at P < 0.01 using a two-tailed t-statistic test. Where "|" denotes the portfolio which selected based on low (P10) performance two years prior *t* (= 0). Where "…" denotes the same activity process after each yearly horizon (*t*+2, *t*+3, and so on). The returns are expected average monthly returns (%) from P10 portfolios. Unfortunately, we cannot calculate the statistical significance for the momentrarian trading strategy due to the low number of available observations.

Momentrarian		**Actions**		**Return**	**Excess Mt Return**
	t	Buy P10 of SB|	Short sell P10* of RV	6.82	7.60
	t+1	Sell P10 of SB| then rebalance	Buy P10 of RV then rebalance		
	…	…	…		

Based on the above examples, we computed the average return for each of the eight different trading styles. Overall, during stressful market conditions, the monthly return for the zero investment momentum strategies on quarterly, semi-annual, and annual basis (using one only hedge fund strategy) is equal to 0.50% (not significant different from zero), -1.25% (not significant from zero), and 1.35% (very low number of observation to test for significance), respectively. For the 2-year contrarian strategy the return is 0.66% (very low number of observation to test for significance). For the 1st order momentrarian (high return exploitation) is 0.39% (very low number of observation to test for significance) and for the 1st order momentrarian (low return exploitation) is 1.59% (very low number of observation to test for significance).

To sum up, the main purpose of the section 3.4 is to demonstrate trading strategies and more specific the momentrartian style within a specific framework. The underlying basic trading styles help investors to form their own custom trading style that can exploit the differences between top and bottom performing funds within hedge fund strategies. We demonstrated examples of the optimum eight different trading strategies that an investor theoretically can use so as to maximize her returns. Moreover, we computed the average return for each of these eight trading strategies. As hedge fund behaviour changes during stressful market conditions hence we implemented these trading strategies during growth and recession periods, only. This is because down regimes are difficult to predict or to realize instantly once they happen. Furthermore, contrary to recessions (that last for a few months), down regimes mainly consist of shocks; thus trading strategy implementation is difficult during down regimes**.** As we

mentioned**,** we presented to the reader the application of these trading styles with specific examples by selecting the best theoretical investment choice for each particular trading strategy to maximize profit. By using the underlying trading styles on specific hedge fund strategies which present in general higher persistence compared to other strategies and have high spreads between top and bottom performers as they require excessive high skills from fund managers (e.g. Other, Sector, Relative Value) the investor can have substantial excess market returns. On average, zero investment trading strategies such as the momentum are more efficient during "good" time conditions, although cannot beat the market benchmark. On the other hand, momentrartian trading strategies are more efficient during "bad" times, and they can beat the market benchmark.

3.4.3 Robustness

In order to check for robustness for the average and optimal performance of the eight trading strategies, first, we took into consideration the redemption fees that managers may impose to investors, and second we replicate our analysis for two different sub-periods with a holdback period to examine whether the underlying strategies can make profit out-of-sample for investors.

Redemption fees

In order to compute the redemption cost by implementing the above trading strategies we proceed as follows. In our dataset 40.90% of the funds contain lockup restrictions and the (equal weighted) average redemption fee is 3.40%[27]. The maximum redemptions that are needed are four within a year for the quarterly momentum trading strategy and the minimum is one within a three year for the 3-year contrarian strategy. Hence, we compute the net return by subtracting from each trading strategy's return the average monthly redemption cost of the proportional funds that belong to the category of lockup-yes funds. We define this as:

$$AvRedCost_{monthly} = P_{lock} * RedFee * RedPer/12\ , \tag{18}$$

Where $AvRedCost_{monthy}$ is the average monthly redemption cost, P_{lock} is the proportion of funds in the sample that impose lockups, $RedFee$ is the average redemption fee for funds that

[27] The underlying average redemption fee corresponds to those funds with explicit restrictions mentioning a specific cost.

impose lockups, $RedPer$ is the redemptions per year for a given trading strategy. We divide by 12 (number of months per year) so as to standardize it.

Therefore, during "good" market conditions the average monthly cost for the quarterly, semi-annual, and annual momentum strategy becomes 0.46%, 0.23%, and 0.12%, respectively. For the 2-year and 3-year contrarian strategy the average monthly cost is 0.06%, and 0.04%, respectively. For the 1st and 2nd order momentrarian (involving high or low return exploitation) the average monthly cost becomes 0.06% and 0.04%, respectively. During "bad" market conditions the average monthly cost for quarterly, semi-annual, annual and momentrartian strategies are the same with the "good" conditions. For growth periods, all trading strategies except for the contrarian and the 2nd order momentrian (low return) continue to provide positive returns to investors. For recessions all trading strategies continue to provide positive returns to investors except for the semi-annual momentum strategy. Concerning the theoretical optimal eight different trading strategies the positive returns are still higher than the market benchmark in most cases during growths (exceptions are the contrarian strategy, the quarterly momentum using one strategy, and the momentrarian low return using one strategy) where in recessions are all positive.

Out-of-sample test

When using a holdback period in order to test whether the underlying trading strategies make profit out-of-sample, our results in generally holds. The initial historical data on which these trading strategies are tested (in-sample data) consists of the half of our data length and the other half are reserved (out-of-sample) data. During "good" market conditions the return for all trading strategies have the same sign. An exemption is the 3-year contrarian and the 2nd order momentrarian strategy. We performed the out-of-sample test during "bad" times and the semi-annual momentum strategy has the same signs contrary to the quarterly momentum. Due to limited data availability we did not examine validation beyond one year. Concerning the theoretical optimal implementation of the eight different trading strategies the majority of the sub-cases did not have differences in the sign in growth periods. During the recessions the quarterly momentum trading strategy presented the same sign contrary to the semi-annual momentum.

4 Conclusion

In this paper we deal with two important issues in the hedge fund academic literature. First, we deal with hedge fund performance persistence and secondly we deal with different hedge fund trading strategies. Concerning the performance persistence this is the first study that examines different aspects of performance persistence currently in different market conditions. Using several parametric and non-parametric tests we examine hedge fund persistence in terms of the smoothness of returns, the persistence against the market benchmark, and the persistence within each group strategy. We extended our analysis to the trading strategies; this is the first study that examines momentum and contrarian strategies when dealing with hedge fund spreads. Moreover, we are the first to introduce mixed strategies such as the momentrarian strategy (and its sub strategies) that allow investors to gain higher investment returns.

We have some important conclusions that contribute significantly to the hedge fund literature, beyond those that agree with the extant literature discussed above. Concerning hedge fund performance persistence, and more specifically the smoothness of returns we found that during "good" conditions there is smoothness in returns for almost all hedge fund strategies (an exception is the CTA and the Short Bias strategy) even for one year. This smoothness weakens however when considering risk adjusted returns. Moreover, on average, non-directional and semi-directional strategies present more smoothness in their returns compared to directional strategies. During "bad" conditions hedge fund strategies do not present smoothness in their returns. As far as persistence with respect to the market benchmark is concerned we found no persistence in the examined strategies, with a few exceptions such as the Multi-Strategy (semi-annually), the Long Short (annual), and Long Short (quarterly) which present some performance persistence against the market. We do not have any reliable evidence during stressful market conditions due to relatively few observations in data. Concerning the persistence within each strategy we found persistence for hedge funds during "good" times up to one year whereas during stressful market conditions there is a negative impact on fund persistence within each strategy. There is strong evidence that the persistence is driven mainly by the top performers as we found reversals in bottom performers in most of the cases, and recessions are fiercer than down regimes in terms of funds persistence.

Our conclusions regarding the mixed trading strategies are that an investor can outperform the market by having zero investment portfolio strategies that can exploit the differences between

top and bottom performing funds within hedge fund strategies. During “good” time conditions, on average, momentum trading strategies are the most successful strategies followed by the momentrarian trading strategies. However, during “bad” times, on average, the momentrian strategies are the most successful followed by the momentum strategies. In all market conditions the contrarian trading strategy comes third compared to the other two trading strategies. The above average results concern trading strategies that take into consideration spreads of only one strategy. When the investor takes into consideration different hedge fund strategies by exploiting the spreads of top and bottom performing funds, their average returns are even higher.

Our results are important as they enable us to better understand hedge funds’ behaviour and reveal aspects that have not been examined before. This is the first study in the literature that examines hedge fund performance persistence under different investment conditions. More specifically, we made a clear distinction between different kinds of persistence such as in terms of smoothness of (risk-adjusted) returns, persistence against the market benchmark, and persistence within each specific strategy. All these different kinds of persistence were examined using the longest dataset ever used, from 1990 to 2014. We examined persistence under different market conditions, and not isolating just one relatively short period of time containing only one financial crisis or event. Moreover, we are the first that examined mixed or synthetic trading strategies such as the momentrarian strategies allowing investors to utilize persistence in a more efficient ways.

Investors can benefit from our findings as they are able to know what to expect from different strategies in terms of performance persistence. Although past performance is no guide to the future, most investors, rely on funds’ past records in their capital allocation process. This implies that investors expect performance to be stable over time and that some fund managers provide better performance compared to their peers. Our study provides a comprehensive investigation of hedge fund performance persistence, allowing investors to implement mixed trading strategies utilizing spreads between top and bottom performers of different hedge fund strategies. Financial regulators can benefit by understanding hedge fund behaviour and knowing that there is apparently some market inefficiency in the hedge fund industry.

One limitation is that our primal focus is on hedge funds that invest in developed markets and more specifically to the North America region, due to the fact that we use three U.S. business

cycles. There is a need to examine hedge fund performance persistence using our approach for funds that invest in other regions as well (e.g. Emerging Markets). Another limitation is the limited validation of the yearly persistence during stressful market conditions due to the small number of observations during these conditions. However, it seems that during these conditions the persistence is less than semi-annual. Concerning the application of the proposed mixed or the synthetic trading strategies, we considered in our analysis lockup redemption costs; however there might be other costs (e.g. bid-ask spreads, short-selling costs) that may affect investors profits and are not captured. Due to limitation of data availability, especially during stressful market conditions, we did not considered contrarian trading strategies for two or more years.

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