

# 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 strategy group, for “good” times we find persistence up to one year whereas for “bad” times 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 construct 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 Schmid, 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). Details concerning the nature of the fund persistence continue to emerge, such persistence varying 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) and 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 has a significant effect and the smoothing of returns is 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 the smoothing techniques used by fund managers. Last but not least, there are differences in studies due to industry heterogeneity and authors also use different databases, time periods and methodologies. 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 a need to examine hedge fund performance persistence in a more comprehensive way by drawing a distinction between the different types of performance and not only focusing on one only type of persistence (e.g. persistence within each strategy). Furthermore, there is a need to examine the impact of different market conditions in hedge fund performance persistence focusing on specific region(s). In our study we use multiple business cycles and different market conditions (not limited to only one recession/growth period or financial event) and we focus on North America funds (funds that invest primarily in the North

America region) 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) for 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 “momentarian strategy” that is a combination of a momentum and contrarian strategy under specific conditions, as discussed later in section 2.1.

We have several 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 are 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 conditions there is a negative impact on 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 present some performance persistence against the market during “good” market conditions. Third, when examining persistence within strategies, we find that there is persistence up to one year, however, during stressful market conditions there is quarterly persistence (with a few exceptions that show semi-annual persistence). Fourth, 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. During stressful market conditions persistence reduces dramatically. Fifth, we created a framework using various zero investment trading strategies that utilizes 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 momentum is, on average, the most efficient during stressful market conditions.

Our study makes important contributions to the literature and to investors as well, revealing aspects that have not been examined before. We are the first to make a clear 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. These two different states do not coincide necessarily, having different implications for hedge funds. For example it seems that recessions periods are, on average, fiercer in terms of hedge fund performance persistence compared with down regimes. Investors will know from now on what to expect from different strategies in terms of performance persistence. Past performance is a poor guide to the future; nevertheless, most investors in their capital allocation process rely on past performance. Another 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 execute a systematic database merging and cleaning process that can be considered as a models 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 governance 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 perform robustness tests.

Finally, 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. Second, 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<sup>3</sup>. Hence, this approach takes into consideration variables (dependant or non-dependant) that belong to a particular stage of the economy.

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

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

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

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<sup>3</sup> We used the official 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.

Wilshire 5000TRI including dividends, represented by two different states: up regime and down regime, with a 24 year period<sup>4</sup> under examination.

The Markov switching approach gives possible outcomes that lie in  $m$  states of the world, denoted  $s_i, i=1,2,\dots,m$ , 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:

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

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<sup>4</sup> 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).

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:

$$y_t = \mu_1 + \mu_2 z_t + (\sigma^2_1 + \varphi z_t)^{1/2} u_t \quad (9)$$

Where,  $u_t \sim N(0,1)$ . The expected values and variances of the series are  $\mu_1$  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:

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

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:

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

A vector of current state probabilities is then expressed as

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

Where  $\pi_t$  is the probability that the variable  $y$  is currently in state  $i$ . Given  $\pi_t$  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 – see the data section). 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. 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<sup>5</sup>.

### **Performance persistence - Methods**

As Agarwal and Naik, 2000a said, in general there are two statistical approaches () when examining performance persistence: two-period and multi-period 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 do not have enough available observations for the stressful market conditions to consider a 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).

$$CPR = (WL * LL)/(WL * LW) \tag{14}$$

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

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<sup>5</sup> 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.

25% of the funds under consideration. The statistical significance of the CPR can be tested using the standard error  $\alpha * \ln(CPR)$  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.

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.

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

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  $\chi^2$  (chi-square) greater than 3.84 (6.64) indicates 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 ratio and the Information ratio. 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.  $Sharpe\ Ratio = (\bar{R}_p - \bar{R}_f) / \sigma_p$ , (Sharpe, 1994). Similarly, 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). A positive significant slope coefficient indicates performance persistence. This says that a hedge fund (or group) that did well in a specific period tends to do well in the subsequent period. In other words, there are no

high fluctuations in the returns. The statistical significance of the slope can be tested using the t-statistic. As we mentioned, we use the regression-based parametric model so as to examine the smoothness of returns for each hedge fund strategy.

$$R_t = a + b(R_{t-1}) + \varepsilon_i \quad \text{where } R \text{ are fund's returns} \quad (17)$$

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 expected probabilities of observing WWW or LLL and WWWW or 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.

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 three 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 persistence, we focus more on raw returns. However, we also include risk-adjusted returns in our analysis computing the Sharpe ratio and Information ratio cross-sectionally 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. 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<sup>6</sup>. 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<sup>7</sup>. We then examine the relationship between initially top (bottom) ranked portfolios against the subsequent performance in the next time period of the same portfolios. Finally 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.

### **“Momentum” trading style**

We know from the academic literature that the momentum (e.g. Jegadeesh and Titman, 1993) and contrarian (e.g. DeBondt and Thaler, 1990) trading strategies produce significant excess returns to investors. In this paper, we introduce the term *momentarian* which denotes an investment style (or trading strategy) that utilizes the momentum (MOMEN-) and the contrarian (-

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<sup>6</sup> Due to the fact that our data length concerning the various horizons under consideration (e.g. quarterly, semi-annual, annual) does not always match, and we want to exploit as many observations as we can, 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).

<sup>7</sup> A positive and significant slope means that the spread is smooth, in other words the distance between top and bottom performers is not random (not having high fluctuations).

TRARIAN) trading strategies to maximize returns. We are the first to we present a trading style that is a combination of these two trading styles that can bring conditional higher returns than just exploiting one of these strategies. In Table 1, we present a framework with the possible actions when using momentum and contrarian trading strategies. These possible actions may refer to 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 past winners and short 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.

As it can be seen from Table 1, the above trading strategies can work horizontally (e.g. implementing in parallel two separate zero investment portfolios – one momentum and the other contrarian) denoted as a horizontal *momentrarian* trading strategy. The other case is a vertical *momentrarian* strategy (using a combination of a momentum and contrarian strategy). 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 (please see 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). There are two basic momentrarian strategies: high and low returns exploitation.

|                                  |                    |  |  |                                 |
|----------------------------------|--------------------|--|--|---------------------------------|
| Momentrarian Trading (high rtns) | Momentum Trading   | Hedge funds, A : High Recent Returns<br>Action: Buy then Sell        | Hedge funds, B : Low Recent returns<br>Action: Short-Sell then Buy | Momentrarian Trading (low rtns) |
|                                  | Contrarian Trading | Hedge funds, C : High Earlier Returns<br>Action: Short-Sell then Buy | Hedge funds, D : Low Earlier Returns<br>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)<sup>8</sup>. 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 sufficient and robustness, we take into 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<sup>9</sup>, on a monthly basis.

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<sup>8</sup> 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 the fund whose performance trends are poorer at  $t-1$ , as it is a sign that the contrarian effect starts to take 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 starts to take 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.

<sup>9</sup> This period includes three business cycles that covers the longest possible time. The majority of the databases for commercial use are available from early/mid 1990 with a few exceptions such as the EurekaHedge and BarclayHedge databases that came earlier. Our dataset contains dead funds prior to 1994, thus we do have this kind

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 have minimized the survivorship and instant history biases by including in our sample dead/ceased reporting funds and eliminating the first 12 monthly returns of each hedge fund. Also, we adjust outliers by implementing a “winsorizing” technique<sup>10</sup>. 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.

We assume the strategies used are those that fund managers reported in these databases<sup>11</sup>. 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)<sup>12</sup>.

### 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.

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of survivorship bias. In our robustness tests at the end of the paper we have an out-of-sample test with a holdback dataset for validation purposes.

<sup>10</sup> 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 terms.

<sup>11</sup> 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 bound to operate according to the strategy described in the *offering memorandum*.

<sup>12</sup> We describe some hedge fund strategies: the *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 used by other hedge fund strategies. *CTA* refers to Commodity Trading Advisors funds, which make an extensive use of systematic trading or use derivatives and commodity trading.

### 3.1 Basic Statistics and regimes

In this section we provide basic statistics of raw returns for each of the 11 strategies as shown in Table 2 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 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 with 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, 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. 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      |

We implement our analysis taking into consideration different business cycles and market conditions. We remind readers that within the 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 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). The average monthly MAI (excess risk free) return for down regimes is -3.69% whereas for recessions it is -1.03%.

### 3.2 Performance persistence

In this section we examine hedge funds' performance persistence at strategy level within multiple business cycles and different market conditions. We first examine the smoothness of

the returns, then the persistence with respect to the market index, and finally the persistence within each strategy. We examine the smoothness at quarterly, semi-annual, and annual horizon by computing the average return within each time period.

### 3.2.1 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. On average non-directional (except for the CTA strategy) and semi-directional strategies have more consistent returns than the directional strategies (except for the Short Bias strategy). Regarding the Sharpe ratio, the situation is almost the same as for 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 than directional strategies (except Short Bias). Regarding the information ratio, 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.

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

This table shows the results of the regression-based parametric model (equation 17) 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.

| Strategy     | RR - Time Horizon  |                    |                    | SR - Time Horizon  |                    |                    | IR - Time Horizon |                   |                    |
|--------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|--------------------|
|              | Quarterly          | Semi-Annual        | Annual             | Quarterly          | Semi-Annual        | Annual             | Quarterly         | Semi-Annual       | Annual             |
| Short Bias   | -0.114<br>(-1.077) | 0.060<br>(0.393)   | -0.082<br>(-0.351) | 0.168<br>(1.575)   | 0.198<br>(1.360)   | 0.634**<br>(3.609) | 0.109<br>(1.004)  | 0.198<br>(1.355)  | 0.720**<br>(4.567) |
| Long Only    | 0.241*<br>(2.268)  | 0.474**<br>(3.422) | 0.553*<br>(2.765)  | 0.222*<br>(2.026)  | 0.444**<br>(3.117) | 0.619**<br>(3.341) | 0.054<br>(0.488)  | 0.366*<br>(2.273) | 0.384<br>(2.110)   |
| Sector       | 0.279**<br>(2.665) | 0.543**<br>(4.165) | 0.453*<br>(2.248)  | 0.323**<br>(3.124) | 0.519**<br>(3.843) | 0.529*<br>(2.701)  | 0.097<br>(0.913)  | 0.366*<br>(2.576) | 0.384<br>(0.129)   |
| Long Short   | 0.322**<br>(3.112) | 0.532**<br>(4.028) | 0.597**<br>(3.235) | 0.299**<br>(2.862) | 0.462**<br>(3.283) | 0.509*<br>(2.476)  | 0.265*<br>(2.484) | 0.296<br>(1.986)  | 0.570*<br>(2.744)  |
| Event Driven | 0.578**<br>(6.467) | 0.661**<br>(5.646) | 0.805**<br>(5.983) | 0.604**<br>(6.897) | 0.649**<br>(5.414) | 0.748**<br>(4.764) | 0.102<br>(0.932)  | 0.178<br>(1.147)  | 0.289<br>(1.258)   |

|                |                     |                     |                    |                    |                    |                    |                     |                      |                    |
|----------------|---------------------|---------------------|--------------------|--------------------|--------------------|--------------------|---------------------|----------------------|--------------------|
| Multi-Strategy | 0.712**<br>(9.315)  | 0.763**<br>(7.622)  | 0.760**<br>(5.310) | 0.518**<br>(5.496) | 0.612**<br>(4.945) | 0.582**<br>(4.091) | -0.250*<br>(-2.364) | -0.214**<br>(-4.790) | -0.005<br>(-0.059) |
| Other          | 0.786**<br>(11.892) | 0.850**<br>(10.490) | 0.843**<br>(7.138) | -0.001<br>(-0.007) | 0.596**<br>(8.723) | 0.606**<br>(9.019) | -0.120<br>(-0.948)  | 0.147<br>(0.764)     | 0.380<br>(1.330)   |
| Global Macro   | 0.411**<br>(4.146)  | 0.571**<br>(4.499)  | 0.524**<br>(2.990) | 0.340**<br>(3.093) | 0.457**<br>(3.121) | 0.366<br>(1.619)   | 0.111<br>(0.963)    | 0.298<br>(1.897)     | 0.191<br>(0.804)   |
| Relative Value | 0.718**<br>(9.425)  | 0.796**<br>(8.301)  | 0.871**<br>(7.732) | 0.675**<br>(8.310) | 0.735**<br>(6.755) | 0.840**<br>(6.314) | 0.015<br>(0.132)    | 0.227<br>(1.478)     | 0.311<br>(1.288)   |
| Market Neutral | 0.744**<br>(10.181) | 0.771**<br>(7.827)  | 0.758**<br>(5.257) | 0.472**<br>(4.885) | 0.419**<br>(2.885) | 0.620**<br>(3.368) | 0.029<br>(0.264)    | 0.317*<br>(2.107)    | 0.472<br>(2.079)   |
| CTA            | 0.185<br>(1.766)    | 0.448**<br>(3.342)  | 0.708**<br>(4.530) | 0.030<br>(0.286)   | 0.080<br>(0.547)   | 0.382<br>(1.851)   | -0.007<br>(-0.063)  | 0.085<br>(0.557)     | 0.445<br>(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 that present significant consistency at annual horizons. Regarding the Sharpe ratio and the Information ratio all hedge funds have low consistency results. There are a few exceptions such as CTA and Long Bias that provide some consistency at semi-annual horizons.

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

This table shows the results of the regression-based parametric model (equation 17) 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.

| Strategy   | Time Horizon - RR |                    |                    | Time Horizon - SR |                    |                    | Time Horizon - IR  |                    |                    |
|------------|-------------------|--------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
|            | Quarterly         | Semi-Annual        | Annual             | Quarterly         | Semi-Annual        | Annual             | Quarterly          | Semi-Annual        | Annual             |
| Short Bias | 0.073<br>(0.251)  | -0.533<br>(-1.129) | 0.357<br>(0.258)   | 0.285<br>(0.927)  | 0.433<br>(1.196)   | -0.001<br>(-0.075) | 0.329<br>(1.058)   | 0.393*<br>(3.456)  | -0.002<br>(-0.164) |
| Long Only  | 0.080<br>(0.255)  | -0.748<br>(-1.705) | 3.451*<br>(4.788)  | 0.057<br>(0.168)  | -0.065<br>(-0.119) | -0.748<br>(-1.128) | 0.007<br>(0.084)   | -0.184<br>(-1.568) | -0.030<br>(-0.070) |
| Sector     | 0.176<br>(0.511)  | -0.437<br>(-0.775) | -0.125<br>(-0.227) | 0.196<br>(0.597)  | -0.194<br>(-0.335) | -0.216<br>(-1.267) | -0.038<br>(-0.122) | -0.421<br>(-0.950) | 0.846<br>(1.126)   |
| Long Short | 0.141<br>(0.413)  | -0.712<br>(-1.346) | -0.090<br>(-0.136) | 0.062<br>(0.193)  | -0.825<br>(-1.599) | -0.224<br>(-0.490) | 0.106<br>(0.302)   | -0.489<br>(-0.985) | 1.853<br>(1.622)   |

| Event Driven   | 0.206<br>(0.541)  | -0.822<br>(-1.478)  | 0.116<br>(0.096)   | 0.260<br>(0.746)   | -0.686<br>(-1.106) | -0.326<br>(-0.514) | 0.077<br>(0.236)   | -0.362<br>(-0.824) | 0.041<br>(0.038) |
|----------------|-------------------|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------------------|
| Multi-Strategy | 0.138<br>(0.381)  | -0.4551<br>(-0.709) | -0.006<br>(-0.065) | 0.181<br>(0.492)   | -0.576<br>(-0.779) | 0.243<br>(0.352)   | -0.283<br>(-1.014) | -0.717<br>(-1.500) | 0.527<br>(0.414) |
| Other          | 0.276<br>(0.831)  | -0.039<br>(-0.075)  | 0.282<br>(1.043)   | -0.254<br>(-0.716) | 0.332<br>(0.448)   | 0.899<br>(0.976)   | 0.120<br>(0.314)   | 0.032<br>(0.059)   | 0.671<br>(1.746) |
| Global Macro   | 0.129<br>(0.381)  | 0.844<br>(2.216)    | 0.824<br>(5.812)   | 0.124<br>(0.318)   | 0.589<br>(0.713)   | 1.075<br>(1.125)   | 0.167<br>(0.449)   | 0.974<br>(1.238)   | 1.529<br>(7.158) |
| Relative Value | 0.028<br>(0.085)  | -0.666<br>(-1.190)  | 0.215<br>(0.546)   | 0.024<br>(0.090)   | -0.570<br>(-1.144) | 1.253<br>(9.045)   | -0.053<br>(-0.151) | -0.352<br>(-0.658) | 0.929<br>(0.836) |
| Market Neutral | 0.183<br>(0.977)  | -0.177<br>(-0.726)  | 0.704*<br>(3.499)  | -0.149<br>(-0.554) | -0.569<br>(-1.163) | 1.716<br>(0.382)   | -0.025<br>(-0.083) | -0.663<br>(-1.422) | 0.360<br>(0.222) |
| CTA            | 0.004<br>(-0.018) | 0.747<br>(2.523)    | 0.909<br>(2.917)   | 0.011<br>(0.044)   | 0.940*<br>(4.531)  | 1.036<br>(2.532)   | 0.027<br>(0.082)   | -0.433<br>(-0.814) | 0.156<br>(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 all 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 Sharpe ratio, CTA, Others and Global Macro strategies show the least persistence. Concerning the Information ratio, similar to the growth periods, almost all hedge fund strategies present no persistence.

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

This table shows the results of the regression-based parametric model (equation 17) 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.

| Strategy   | Time Horizon - RR  |                    |                    | Time Horizon - SR  |                    |                    | Time Horizon - IR  |                  |                  |
|------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|------------------|------------------|
|            | Quarterly          | Semi-<br>Annual    | Annual             | Quarterly          | Semi-<br>Annual    | Annual             | Quarterly          | Semi-<br>Annual  | Annual           |
| Short Bias | 0.112<br>(1.067)   | -0.135<br>(-0.894) | -0.244<br>(-1.095) | 0.163<br>(1.507)   | 0.042<br>(0.267)   | 0.185<br>(1.009)   | 0.199<br>(1.852)   | 0.071<br>(0.452) | 0.260<br>(1.501) |
| Long Only  | 0.371**<br>(3.639) | 0.409**<br>(2.863) | 0.539*<br>(2.710)  | 0.257*<br>(2.388)  | 0.504**<br>(3.705) | 0.648**<br>(3.498) | 0.020<br>(0.227)   | 0.223<br>(1.743) | 0.093<br>(0.475) |
| Sector     | 0.425**<br>(4.282) | 0.511**<br>(3.818) | 0.615**<br>(3.849) | 0.343**<br>(3.325) | 0.538**<br>(4.054) | 0.689**<br>(4.335) | -0.035<br>(-0.330) | 0.126<br>(0.831) | 0.196<br>(0.786) |

| <b>Table 6 cont'</b> |         |          |         |          |         |          |          |          |         |
|----------------------|---------|----------|---------|----------|---------|----------|----------|----------|---------|
| 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 no raw returns consistency. One exception is the Market Neutral Strategy that is consistent in all time horizons, and CTA that is, but only on a quarterly basis. As far as the Sharpe ratio is concerned almost no hedge fund strategies 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 a 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 (equation 17) 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.

| Strategy | Time Horizon - RR |             |        | Time Horizon - SR |             |        | Time Horizon - IR |             |        |
|----------|-------------------|-------------|--------|-------------------|-------------|--------|-------------------|-------------|--------|
|          | Quarterly         | Semi-Annual | Annual | Quarterly         | Semi-Annual | Annual | Quarterly         | Semi-Annual | Annual |
|          |                   |             |        |                   |             |        |                   |             |        |

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

To sum up, we observe that during “good” market conditions almost all hedge fund strategies present returns consistency on quarterly, semi-annual and annual horizons. This situation weakens when we take into consideration risk-adjusted returns, although still mostly significant. When we take into consideration stressful market conditions almost all hedge fund strategies present mostly no 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 are characterized by low market returns with high volatility) affect a lot of 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<sup>13</sup>.

### **3.2.2 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<sup>14</sup>. Depending on the ratio WW/LL we can discuss 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 examines the difference in the observed versus the expected frequencies<sup>15</sup>. 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 tests show that none of the strategies present persistence with respect to the market (in a positive or negative manner)<sup>16</sup>.

#### **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

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<sup>13</sup> 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.

<sup>14</sup> 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.

<sup>15</sup> A drawback of the Chi-square test in this case is that unlike the CPR test, it cannot capture the proportion of winners and losers. 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.

<sup>16</sup> An exception is the Multi Strategy that presents weakly significant persistence for the annual and semi-annual time horizon using both tests.

(Wilshire 5000TRI, including dividends). A chi-square less than 0.05 indicates significant persistence against the market index. For CPR, \* denotes significance at  $P < 0.05$  and \*\* denotes significance at  $P < 0.01$  using a two-tailed statistic test. At annual horizon we used the t-statistic (due to low number of observations) whereas at the semi-annual and quarterly horizon we used the z-statistic.

| Strategy       | annual, (t-stat) |       |          | semi - annual, (z-stat) |       |          | quarterly, (z-stat) |       |          |
|----------------|------------------|-------|----------|-------------------------|-------|----------|---------------------|-------|----------|
|                | CPR              | WW/LL | $\chi^2$ | CPR                     | WW/LL | $\chi^2$ | CPR                 | WW/LL | $\chi^2$ |
| Short Bias     | 2.33             | 0.07  | 22.00**  | 2.86                    | 0.21  | 23.33**  | 1.01                | 0.31  | 14.15**  |
| Long Only      | 5.00             | 1.80  | 4.80     | 2.39                    | 1.89  | 5.43     | 1.66                | 1.29  | 2.29     |
| Sector         | 3.50             | 1.17  | 2.00     | 2.14                    | 1.27  | 2.00     | 2.03                | 1.17  | 3.05     |
| Long Short     | 9.33*            | 0.88  | 5.20     | 3.04                    | 0.59  | 5.81     | 2.47*               | 0.86  | 4.65     |
| Event Driven   | 3.00             | 0.44  | 4.40     | 0.68                    | -     | 0.48     | 1.15                | 1.00  | 0.13     |
| Multi-Strategy | 8.33             | 0.50  | 7.60     | 4.86*                   | 0.71  | 7.33     | 1.66                | 0.78  | 2.29     |
| Other          | 1.50             | 0.83  | 0.40     | 2.14                    | 0.79  | 2.00     | 1.14                | 0.83  | 0.51     |
| Global Macro   | 2.50             | 0.30  | 6.80     | 1.33                    | 0.35  | 6.19     | 1.35                | 0.70  | 2.11     |
| Relative Value | 0.69             | -     | 10.80*   | 1.17                    | 0.26  | 10.19*   | 0.82                | -     | 6.06     |
| Market Neutral | 3.75             | 0.07  | 26.80**  | 1.86                    | 0.12  | 31.33**  | 0.94                | -     | 25.54**  |
| CTA            | 1.50             | 0.83  | 0.40     | 0.64                    | -     | 1.62     | 0.96                | -     | 7.75     |

## Recession periods

Within recession periods, 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 two or three wins against zero or one loss in terms of frequencies. However, during the semi-annual period 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). Hence, during recessions hedge funds present almost no persistence against the market benchmark.

## 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.

| Strategy | annual |   | semi- annual |    |    |    | quarterly |    |    |    |
|----------|--------|---|--------------|----|----|----|-----------|----|----|----|
|          | W      | L | WW           | LL | WL | LW | WW        | LL | WL | LW |

|                |   |   |   |   |   |   |   |   |   |   |
|----------------|---|---|---|---|---|---|---|---|---|---|
| Short 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 look at 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 but only using the  $\chi^2$  test. However, we have to mention that there is no confirmation from the two tests of 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 (due to low number of observations) whereas at the semi-annual and quarterly horizon we used the z-statistic.

| Strategy   | annual, (t-stat) |       |          | semi - annual, (t-stat) |       |          | quarterly, (z-stat) |       |          |
|------------|------------------|-------|----------|-------------------------|-------|----------|---------------------|-------|----------|
|            | CPR              | WW/LL | $\chi^2$ | CPR                     | WW/LL | $\chi^2$ | CPR                 | WW/LL | $\chi^2$ |
| Short Bias | 0.75             | -     | 12.71**  | 0.19                    | -     | 18.67**  | 0.78                | -     | 20.48**  |

| Long Only      | 0.44 | -    | 0.80   | 1.47 | 0.92 | 0.48   | 0.56 | -    | 1.81    |
|----------------|------|------|--------|------|------|--------|------|------|---------|
| Sector         | 3.50 | 0.86 | 2.00   | 1.78 | 1.00 | 0.86   | 0.99 | -    | 0.38    |
| Long Short     | 0.84 | -    | 1.60   | 1.58 | 0.32 | 9.62*  | 1.00 | -    | 4.10    |
| Event Driven   | 2.00 | 0.50 | 2.40   | 1.67 | 0.60 | 2.57   | 0.50 | -    | 5.14    |
| Multi-Strategy | 3.67 | 0.27 | 9.60*  | 2.08 | 0.37 | 9.24*  | 1.40 | 0.64 | 3.14    |
| Other          | 0.44 | -    | 0.80   | 0.69 | -    | 3.14   | 1.20 | 0.83 | 0.57    |
| Global Macro   | 0.40 | -    | 7.76*  | 1.17 | 0.19 | 15.33* | 0.67 | -    | 10.57*  |
| *              |      |      |        |      |      | *      |      |      |         |
| Relative Value | 1.69 | 0.33 | 4.40   | 0.45 | -    | 6.19   | 0.68 | -    | 13.71** |
| Market Neutral | 0.69 | -    | 10.80* | 0.26 | -    | 23.14* | 0.45 | -    | 20.10** |
| CTA            | 0.16 | -    | 3.60   | 0.82 | -    | 3.90   | 0.71 | -    | 9.67*   |

## Down regimes

We move now to the down regimes. Unfortunately, we have relatively few observations, so 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. Hence, during recessions hedge funds present some persistence against the market benchmark.

## 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.

| Strategy       | annual |   | semi- annual |    |    |    | quarterly |    |    |    |
|----------------|--------|---|--------------|----|----|----|-----------|----|----|----|
|                | W      | L | WW           | LL | WL | LW | WW        | LL | WL | LW |
| Short 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  |

| <b>Table 11 cont'</b> |   |   |   |   |   |   |   |   |   |   |
|-----------------------|---|---|---|---|---|---|---|---|---|---|
| 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 more fiercely than 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 to examine hedge funds returns against the market index.

### **3.2.3 Persistence within each strategy**

In this section we proceed further and examine hedge fund performance persistence within each of the 11 strategies. Our objective is to examine whether fund winners (losers) continue to be fund winners (losers) in the next time period (in terms of raw returns). Hence we form ranked portfolios of funds that we rebalance every subsequent period (quarterly, semi-annually, and annually). We then take the spread between the first ranked and the last ranked portfolios and 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.

#### **3.2.3.1 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<sup>17</sup> 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 compare the ex-ante best performers portfolios (P1) with that of ex-post (P1\*); we find 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 also compare the ex-ante bottom performers' portfolios (P10) with that of ex-post (P10); we find 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.

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<sup>17</sup> 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return   | Spearman | Pearson  | <b>Long Only</b>      | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | Return   | Spearman | Pearson |
|-----------------------|----------|----------|----------|-----------------------|---------|----------|---------|---------------|---------|----------|---------|---------------------|----------|----------|---------|
| Spd 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%** |          |         |
| <b>Event Driven</b>   | Return   | Spearman | Pearson  | <b>Multi Strategy</b> | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | 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%   |          |         |
| <b>Relative Value</b> | Return   | Spearman | Pearson  | <b>Market Neutral</b> | Return  | Spearman | Pearson | <b>CTAs</b>   | 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 Others (1.01%, monthly) and the lowest is for 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return | Spearman | Pearson | <b>Long Only</b> | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | Return  | Spearman | 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%* |          |         |
| <b>Event Driven</b>   | Return | Spearman | Pearson | <b>Multi</b>     | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | Return  | Spearman | 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%   |          |         |
| <b>Relative Value</b> | Return | Spearman | Pearson | <b>Market</b>    | Return  | Spearman | Pearson | <b>CTAs</b>   | 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 P10*-Avg          | -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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return  | Spearman | Pearson | <b>Long Only</b> | Return | Spearman | Pearson  | <b>Sector</b> | Return | Spearman | Pearson | <b>Long Short</b>   | 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*          | -3.04%  | -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                   | -2.64%  |          |         | 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% |          |         |
| <b>Event Driven</b>   | Return  | Spearman | Pearson | <b>Multi</b>     | Return | Spearman | Pearson  | <b>Other</b>  | Return | Spearman | Pearson | <b>Global Macro</b> | 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*          | -1.72%  | 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                   | -0.85%  |          |         | 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% |          |         |
| <b>Relative Value</b> | Return  | Spearman | Pearson | <b>Market</b>    | Return | Spearman | Pearson  | <b>CTAs</b>   | 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*          | -1.39%  | -0.021   | -0.395  | Spd P10-P10*     | -1.75% | 0.064    | 0.065    | Spd P10-P10*  | -3.71% | 0.108    | -0.037  |                     |        |          |         |
| P10                   | -0.94%  |          |         | 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% |          |         |                     |        |          |         |

### **3.2.3.2 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 for 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 for 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return | Spearman | Pearson | <b>Long Only</b>      | Return | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b> | 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% |          |         |
| <b>Event Driven</b>   | Return | Spearman | Pearson | <b>Multi Strategy</b> | Return | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global</b>     | 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% |          |         |
| <b>Relative Value</b> | Return | Spearman | Pearson | <b>Market Neutral</b> | Return | Spearman | Pearson | <b>CTAs</b>   | 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 semi-annual 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 a significantly negative spread equal to -3.60%, monthly. Similar results are seen for spreads between bottom performers P10\* and the average which are negative in all strategies although not significant. The only exception is for 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 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return  | Spearman | Pearson | <b>Long Only</b> | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | 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%  |          |         |
| <b>Event Driven</b>   | Return  | Spearman | Pearson | <b>Multi</b>     | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | 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%  |          |         |
| <b>Relative Value</b> | Monthly | Spearman | Pearson | <b>Market</b>    | Monthly | Spearman | Pearson | <b>CTAs</b>   | Monthly | Spearman | Pearson |                     |        |          |         |
| Spd 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 an 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 no yearly performance persistence among hedge fund strategies.

**Table 17. Persistence within Strategies – Winners/Losers**

This table shows descriptive only statistics (due to the low number of observations) 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.

| <b>Short Bias</b>     |        | Return               | <b>Long Only</b>      |                      | Return | <b>Sector</b>        | Return | <b>Long Short</b> | 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% |                   |                     |  |        |
| <b>Event Driven</b>   |        | Return               | <b>Multi Strategy</b> |                      | Return | <b>Other</b>         |        | Return            | <b>Global Macro</b> |  | 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% |                   |                     |  |        |
| <b>Relative Value</b> |        | Return               | <b>Market Neutral</b> |                      | Return | <b>CTAs</b>          |        | 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%  |                      |        |                   |                     |  |        |

### ***3.2.3.3 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 strongly significant. 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>   | Return  | Spearman | Pearson | <b>Long Only</b> | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson  | <b>Long Short</b>   | 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%  |          |          |
| <b>Event Driven</b> | Return  | Spearman | Pearson | <b>Multi</b>     | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson  | <b>Global Macro</b> | 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%** |          |          |
| <b>Relative</b>     | Return  | Spearman | Pearson | <b>Market</b>    | Return  | Spearman | Pearson | <b>CTAs</b>   | 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  | Spd 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 are 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 for 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 is 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return  | Spearman | Pearson | <b>Long Only</b> | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | 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% |          |         |
| <b>Event Driven</b>   | Return  | Spearman | Pearson | <b>Multi</b>     | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | 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     | -0.039% |          |         | Spd P10*-Avg  | -0.28%  |          |         | Spd P10*-Avg        | 0.32%  |          |         |
| <b>Relative Value</b> | Return  | Spearman | Pearson | <b>Market</b>    | Return  | Spearman | Pearson | <b>CTAs</b>   | 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**

We demonstrate our results regarding persistence on an annual basis in Table 20. Concerning the top performers P1\*, and 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 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return   | Spearman | Pearson | <b>Long Only</b> | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | 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% |          |         |
| <b>Event Driven</b>   | Return   | Spearman | Pearson | <b>Multi</b>     | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | Return | Spearman | Pearson |
| Spd P1-P1*            | 1.98%    | -0.052   | 0.041   | Spd 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   | -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%  |          |         | Spd P10*-Avg        | 0.40%  |          |         |
| <b>Relative Value</b> | Monthly  | Spearman | Pearson | <b>Market</b>    | Monthly | Spearman | Pearson | <b>CTAs</b>   | 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%   |          |         |                     |        |          |         |

### **3.2.3.4 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, most hedge fund strategies present positive spreads, although they are not significant. The Relative Value strategy presents a significant spread equal to 0.76% monthly (and the Event Driven has a weakly significant positive spread). Regarding the spreads between the bottom performers P10\* and the average, almost all hedge fund strategies present negative spreads, although they are not significant. When we compare the P1 with the P1\* portfolios 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return | Spearman | Pearson | <b>Long Only</b> | Return | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | 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% |          |         |
| <b>Event Driven</b>   | Return | Spearman | Pearson | <b>Multi</b>     | Return | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | 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*-Avg  | -0.20%  |          |         | Spd P10*-Avg        | 0.33%  |          |         |
| <b>Relative Value</b> | Return | Spearman | Pearson | <b>Market</b>    | Return | Spearman | Pearson | <b>CTAs</b>   | 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 hedge fund strategies present positive spreads, 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 (but 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 in all cases except for the CTA strategy, there is positive correlation. 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 so as to examine whether top (bottom) performers continue to be top (bottom) performers.

| <b>Short Bias</b>     | Return | Spearman | Pearson | <b>Long Only</b>      | Return  | Spearman | Pearson | <b>Sector</b> | Return  | Spearman | Pearson | <b>Long Short</b>   | 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% |          |         |
| <b>Event Driven</b>   | Return | Spearman | Pearson | <b>Multi Strategy</b> | Return  | Spearman | Pearson | <b>Other</b>  | Return  | Spearman | Pearson | <b>Global Macro</b> | 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% |          |         |
| <b>Relative Value</b> | Return | Spearman | Pearson | <b>Market Neutral</b> | Return  | Spearman | Pearson | <b>CTAs</b>   | 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 from positive to negative. The largest positive is for the Global Macro strategy (2.59%, monthly) and the largest negative is for 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 CTA (1.82%, monthly). P10 and P10\* spreads for all strategies are negative. The most negative is from CTA (-4.34%, monthly) and the least negative is from Global Macro (-0.28%, monthly).

**Table 23. Persistence within Strategies – Winners/Losers**

This table shows descriptive only statistics (due to the low number of observations) for spreads between top P1 versus 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.

| <b>Short Bias</b>     | Return | <b>Long Only</b>      | Return | <b>Sector</b>       | Return | <b>Long Short</b>   | 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% |
| <b>Event Driven</b>   | Return | <b>Multi Strategy</b> | Return | <b>Other</b>        | Return | <b>Global Macro</b> | 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% |
| <b>Relative Value</b> | Return | <b>Market Neutral</b> | Return | <b>CTAs</b>         | 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 and Multi Strategy funds present persistence up to one year. Some other strategies such as the Sector and Other present persistence up to half a 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 show semi-annual persistence<sup>18</sup>.

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 assumption 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 show evidence that some non-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 indicate persistence beyond one year. Our study examines persistence up to one year due to the limitation of data availability, especially during stressful market conditions. Our study reveals that the persistence is driven mainly by the top performers,

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<sup>18</sup> 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 their 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 it more difficult for sustainable outperformance against its peers. 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.

a finding that agrees 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 consistency in poor performance these bottom performers would soon be out of business unless they reversed their performance.

### ***3.3 Mixed trading strategies***

In this section we discuss trading strategies based on our persistence analysis at section 3.2.3 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 subsections (3.3.1 and 3.3.2) we demonstrate to the reader the theoretical optimal implementation of the eight different trading strategies, so that the reader can rationalize these strategies. We expect that strategies with higher persistence compared to other strategies and strategies with high spreads between top and bottom performers can be used by investors for high returns. Indeed we show later that some strategies that appear more common in our examples (e.g. Other, Sector, Short Bias, Relative Value) in general present these characteristics. We explain this with the suggestion that these strategies may demand excessively high skills from fund managers such as investing in 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 time periods at quarterly, semi-annual, and annual. 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 zero investment momentum trading 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 that 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 a longer period (e.g. two or three years). The second is when the investor selects different hedge fund strategies for a longer period (e.g. two or three years) as well. We use longer holding periods than the previous momentum trading strategy so as to capture the contrarian effect.

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 focusing on the top performing funds' spreads; the second sub strategy is the momentrarian involving low return exploitation focusing on the worst performing funds' spreads. Both sub strategies are on an annual basis involving P1\* and P10\* that are held for one, two or three years (please see the trading examples in section 2.1). We do not take into consideration quarterly or semi-annual periods because the contrarian effect does not work in these "short" periods.

### **3.3.1 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 12- 14 presented in section 3.2.3 (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 is 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.

| <b>Short Bias</b>     | Quarterly |       |       | Semi-yearly |       |              | Yearly |      |       | Two Years |       |              | Three Years |      |       | <b>Sector</b>         | Quarterly |      |  | Semi-yearly |  |  | Yearly |  |  | Two Years |  |  | Three Years |  |  |
|-----------------------|-----------|-------|-------|-------------|-------|--------------|--------|------|-------|-----------|-------|--------------|-------------|------|-------|-----------------------|-----------|------|--|-------------|--|--|--------|--|--|-----------|--|--|-------------|--|--|
|                       |           |       |       |             |       |              |        |      |       |           |       |              |             |      |       |                       |           |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| P1*                   | 0.62      | 0.92  | 1.00  | 0.43        | 0.43  | -0.33        | P1*    | 1.93 | 1.64  | 1.71      | 1.33  | 1.76         | P1*         | 1.57 | 1.55  | 1.88                  | 1.30      | 0.51 |  |             |  |  |        |  |  |           |  |  |             |  |  |
| P10*                  | 0.24      | -0.10 | 0.40  | 1.07        | -1.12 | P10*         | 0.89   | 0.79 | 0.79  | 1.46      | 1.07  | P10*         | 0.90        | 0.58 | 0.94  | 1.34                  | 0.97      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| Spd P1*-P10*          | 0.38      | 1.03  | 0.60  | -0.64       | 0.79  | Spd P1*-P10* | 1.05   | 0.85 | 0.92  | -0.13     | 0.69  | Spd P1*-P10* | 0.68        | 0.97 | 0.94  | -0.04                 | -0.46     |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| <b>Long Short</b>     | Quarterly |       |       | Semi-yearly |       |              | Yearly |      |       | Two Years |       |              | Three Years |      |       | <b>Multi Strategy</b> | Quarterly |      |  | Semi-yearly |  |  | Yearly |  |  | Two Years |  |  | Three Years |  |  |
| P1*                   | 1.66      | 1.62  | 1.40  | 1.38        | 1.44  | P1*          | 1.71   | 1.69 | 1.52  | 1.27      | 1.11  | P1*          | 1.78        | 2.00 | 1.40  | 1.32                  | 0.91      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| P10*                  | 0.88      | 0.75  | 0.94  | 1.18        | 0.80  | P10*         | 0.93   | 0.53 | 0.87  | 1.13      | 1.17  | P10*         | 0.84        | 0.92 | 1.23  | 1.25                  | 0.76      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| Spd P1*-P10*          | 0.78      | 0.88  | 0.46  | 0.20        | 0.63  | Spd P1*-P10* | 0.79   | 1.17 | 0.65  | 0.14      | -0.06 | Spd P1*-P10* | 0.97        | 1.08 | 0.17  | 0.07                  | 0.14      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| <b>Other</b>          | Quarterly |       |       | Semi-yearly |       |              | Yearly |      |       | Two Years |       |              | Three Years |      |       | <b>Global Macro</b>   | Quarterly |      |  | Semi-yearly |  |  | Yearly |  |  | Two Years |  |  | Three Years |  |  |
| P1*                   | 1.90      | 2.04  | 1.56  | 0.91        | 0.47  | P1*          | 0.91   | 1.19 | 0.72  | 0.53      | 0.28  | P1*          | 1.78        | 1.65 | 1.51  | 1.15                  | 0.93      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| P10*                  | 0.53      | 0.07  | 0.31  | 1.03        | 0.37  | P10*         | 0.69   | 0.86 | 0.60  | 0.64      | 0.68  | P10*         | 0.61        | 0.57 | 0.46  | 0.90                  | 0.63      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| Spd P1*-P10*          | 1.37      | 1.97  | 1.25  | -0.12       | 0.10  | Spd P1*-P10* | 0.22   | 0.34 | 0.12  | -0.11     | -0.40 | Spd P1*-P10* | 1.17        | 1.09 | 1.05  | 0.25                  | 0.30      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| <b>Market Neutral</b> | Quarterly |       |       | Semi-yearly |       |              | Yearly |      |       | Two Years |       |              | Three Years |      |       | <b>CTAs</b>           | Quarterly |      |  | Semi-yearly |  |  | Yearly |  |  | Two Years |  |  | Three Years |  |  |
| P1*                   | 0.70      | 0.94  | 0.31  | 0.81        | 0.58  | P1*          | 1.46   | 1.51 | -1.54 | -1.26     | -0.44 | P1*          | 1.46        | 1.51 | -1.54 | -1.26                 | -0.44     |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| P10*                  | 0.36      | 0.21  | 0.77  | 0.61        | 0.82  | P10*         | 1.41   | 1.50 | -1.52 | -0.93     | -1.15 | P10*         | 1.41        | 1.50 | -1.52 | -0.93                 | -1.15     |      |  |             |  |  |        |  |  |           |  |  |             |  |  |
| Spd P1*-P10*          | 0.35      | 0.73  | -0.46 | 0.19        | -0.24 | Spd P1*-P10* | 0.05   | 0.02 | -0.02 | -0.33     | 0.71  | Spd P1*-P10* | 0.05        | 0.02 | -0.02 | -0.33                 | 0.71      |      |  |             |  |  |        |  |  |           |  |  |             |  |  |

### 3.3.1.1 Momentum trading

In Table 25 Panel A, 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 highest expected difference between top and bottom performers and more specific the Others 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.

In Table 25, Panel B 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 25. Momentum Trading Strategy – Same/Mixed Hedge Fund Strategies

This table presents the optimum momentum trading strategy during growth periods, when using one only strategy (Panel A) and different hedge fund strategies (Panel B) per time period. Return: Trading Raw Return, Excess Mkt 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. “...” denotes the same activity after each horizon ( $t+2$ ,  $t+3$ , and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios.

| <b>Panel A</b>  |     |                                 |                                 |               |                          |
|-----------------|-----|---------------------------------|---------------------------------|---------------|--------------------------|
| <b>Momentum</b> |     | <b>Actions</b>                  |                                 | <b>Return</b> | <b>Excess Mkt Return</b> |
| Quarterly       | t   | Buy P1 of OT                    | Short-sell P10 of OT            | 1.37**        | 0.30                     |
|                 | t+1 | sell P1 of OT<br>then rebalance | Buy P10 of OT then<br>rebalance |               |                          |
|                 | ... | ...                             | ...                             |               |                          |
| <b>Momentum</b> |     | <b>Actions</b>                  |                                 | <b>Return</b> | <b>Excess Mkt Return</b> |

| <b>Table 25 cont'</b> |     |                              |                              |               |                          |
|-----------------------|-----|------------------------------|------------------------------|---------------|--------------------------|
| 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 |               |                          |
|                       | ... | ...                          | ...                          |               |                          |
| <b>Momentum</b>       |     | <b>Actions</b>               |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                       | ... | ...                          | ...                          |               |                          |
| <b>Panel B</b>        |     |                              |                              |               |                          |
| <b>Momentum</b>       |     | <b>Actions</b>               |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                       | ... | ...                          | ...                          |               |                          |
| <b>Momentum</b>       |     | <b>Actions</b>               |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                       | ... | ...                          | ...                          |               |                          |
| <b>Momentum</b>       |     | <b>Actions</b>               |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                       | ... | ...                          | ....                         |               |                          |

### 3.3.1.2 Contrarian trading

In Table 26 Panel A, 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 seen for the three year contrarian trading using the Sector strategy. However, the results here are not significant.

In Table 26, Panel B 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 highest cross strategy spread. Therefore, for the two year contrarian trade, 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 26. Contrarian Trading Strategy – Same/Mixed Hedge Fund Strategies**

This table presents the optimum contrarian trading strategy during growth periods, when using one only strategy (Panel A) and different hedge fund strategies (Panel B) per time period. Return: Trading Raw Return, Excess Mkt Return: is the Return minus the market return (Wil5000TRI including dividends). “|” denotes the portfolio 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  $t$ . Where “...” denotes the same activity after each horizon ( $t+2$ ,  $t+3$ , and so on). The returns are expected average monthly returns (%) from P1 and P10 portfolios. \*\* denotes significance at  $P < 0.01$  using a two-tailed t-statistic test.

| <b>Panel A</b>    |     |                                     |                                   |               |                          |
|-------------------|-----|-------------------------------------|-----------------------------------|---------------|--------------------------|
| <b>Contrarian</b> |     | <b>Actions</b>                      |                                   | <b>Return</b> | <b>Excess Mkt Return</b> |
| 2 Years           | t   | Buy P10 of SB                       | Short sell P1 of SB               | 0.64          | -0.38                    |
|                   | t+1 | Sell P10 of SB <br>then rebalance   | Buy P1 of SB  then<br>rebalance   |               |                          |
|                   | ... | ...                                 | ...                               |               |                          |
| <b>Contrarian</b> |     | <b>Actions</b>                      |                                   | <b>Return</b> | <b>Excess Mkt Return</b> |
| 3 Years           | t   | Buy P10* of SE                      | Short sell P1* of<br>SE           | 0.46          | -0.55                    |
|                   | t+1 | Sell P10* of SE  <br>then rebalance | Buy P1* of SE  <br>then rebalance |               |                          |
|                   | ... | ...                                 | ...                               |               |                          |
| <b>Panel B</b>    |     |                                     |                                   |               |                          |
| <b>Contrarian</b> |     | <b>Actions</b>                      |                                   | <b>Return</b> | <b>Excess Mkt Return</b> |
| 2 Years           | t   | Buy P10 of LO                       | Short sell P1 of CT               | 2.72**        | 1.71**                   |
|                   | t+1 | Sell P10 of LO <br>then rebalance   | Buy P1 of CT  then<br>rebalance   |               |                          |
|                   | ... | ...                                 | ....                              |               |                          |
| <b>Contrarian</b> |     | <b>Actions</b>                      |                                   | <b>Return</b> | <b>Excess Mkt Return</b> |

| Table 26 cont' |     |                                    |                                  |        |      |
|----------------|-----|------------------------------------|----------------------------------|--------|------|
| 3 Years        | t   | Buy P10 of ED                      | Short sell P1 of CT              | 1.60** | 0.60 |
|                | t+1 | Sell P10 of ED  <br>then rebalance | Buy P1 of CT   then<br>rebalance |        |      |
|                | ... | ...                                | ....                             |        |      |

### 3.3.1.3 Momentrarian trading (involving high return exploitation)

In Table 27 Panel A, we present the momentrarian trading style, involving high return exploitation, where the investor uses only one strategy per time period (1<sup>st</sup> or 2<sup>nd</sup> order). For the 1<sup>st</sup> 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 2<sup>nd</sup> 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. Nevertheless, the results here are not significant.

In Table 27 Panel B, we present the momentrarian trading style involving high return exploitation, where the investor uses different strategies per time period. In the 1<sup>st</sup> order case the investor should take a long position in Sector top performers (one year before) and a short position in CTA top performers (two years before); the excess market return delivered is 2.07% on monthly basis. For the 2<sup>nd</sup> order the excess market return is 1.25% on monthly basis.

### Table 27. High Return Momentrarian Trading Strategy – Same/Mixed Strategies

This table presents the optimum momentrarian trading strategy (involving high return exploitation) during growth periods, when using one only strategy (Panel A) and different strategies (Panel B) per time period. Return: Trading Raw Return, Excess Mkt Return: is the Return minus the market return (Wil5000TRI including dividends). “|” 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  $t$ . “...” denotes the same activity after each yearly horizon ( $t+2$ ,  $t+3$ , and so on). The returns are expected average monthly returns (%) from P1 portfolios. \*\* denotes significance at  $P < 0.01$  using a two-tailed t-statistic test.

| Panel A      |         |        |                   |
|--------------|---------|--------|-------------------|
| Momentrarian | Actions | Return | Excess Mkt Return |

| <b>Table 27 cont'</b> |     |                                 |                                  |               |                          |
|-----------------------|-----|---------------------------------|----------------------------------|---------------|--------------------------|
| 1st order             | t   | Buy P1 of OT                    | Short sell P1 of OT              | 0.65          | -0.42                    |
|                       | t+1 | Sell P1 of OT<br>then rebalance | Buy P1 of OT  then<br>rebalance  |               |                          |
|                       | ... | ...                             | ...                              |               |                          |
| <b>Momentrarian</b>   |     | <b>Actions</b>                  |                                  | <b>Return</b> | <b>Excess Mkt Return</b> |
| 2nd order             | t   | Buy P1 of SE                    | Short sell P1 of SE              | 1.37          | 0.30                     |
|                       | t+1 | Sell P1 of SE<br>then rebalance | Buy P1 of SE   then<br>rebalance |               |                          |
|                       | ... | ...                             | ...                              |               |                          |
| <b>Panel B</b>        |     |                                 |                                  |               |                          |
| <b>Momentrarian</b>   |     | <b>Actions</b>                  |                                  | <b>Return</b> | <b>Excess Mkt Return</b> |
| 1st order             | t   | Buy P1 of SE                    | Short sell P1 of CT              | 3.14**        | 2.07**                   |
|                       | t+1 | Sell P1 of SE<br>then rebalance | Buy P1 of CT  then<br>rebalance  |               |                          |
|                       | ... | ...                             | ...                              |               |                          |
| <b>Momentrarian</b>   |     | <b>Actions</b>                  |                                  | <b>Return</b> | <b>Excess Mkt Return</b> |
| 2nd order             | t   | Buy P1 of SE                    | Short sell P1 of CT              | 2.32**        | 1.25                     |
|                       | t+1 | Sell P1 of SE<br>then rebalance | Buy P1 of CT   then<br>rebalance |               |                          |
|                       | ... | ...                             | ...                              |               |                          |

### **3.3.1.4 Momentrarian trading (involving low return exploitation)**

In Table 28 Panel A, we present the momentrarian trading style involving low return exploitation, where the investor uses only one strategy per time period (1<sup>st</sup> and 2<sup>nd</sup> order). In the 1<sup>st</sup> 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 the excess market returns equal -0.35% on monthly basis. For the 2<sup>nd</sup> order there are excess market returns equal to -0.69% on monthly basis. The results here are not significant.

In Table 28 Panel B, we present the momentrarian trading style involving low return exploitation, when the investor uses different strategies. In the 1<sup>st</sup> order case the investor receives excess market return equal to 1.79% on a monthly basis whereas in the 2<sup>nd</sup> order case the excess market return is equal to 1.61% on a monthly basis.

## Table 28. Low Return Momentrarian Trading Strategy – Same/Mixed Hedge Fund Strategies

This table presents the optimum momentrarian trading strategy (involving low return exploitation) during growth periods, when using one only strategy (Panel A) and different strategies (Panel B) per time period. Return: Trading Raw Return, Excess Mkt Return: is the Return minus the market return (Wil5000TRI including dividends). “|” 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  $t$ . “...” denotes the same activity after each yearly horizon ( $t+2$ ,  $t+3$ , and so on). The returns are expected average monthly returns (%) from P10 portfolios. \*\* denotes significance at  $P < 0.01$  using a two-tailed t-statistic test.

| <b>Panel A</b>      |     |                                 |                              |               |                          |
|---------------------|-----|---------------------------------|------------------------------|---------------|--------------------------|
| <b>Momentrarian</b> |     | <b>Actions</b>                  |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                     | ... | ...                             | ...                          |               |                          |
| <b>Momentrarian</b> |     | <b>Actions</b>                  |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                     | ... | ...                             | ...                          |               |                          |
| <b>Panel B</b>      |     |                                 |                              |               |                          |
| <b>Momentrarian</b> |     | <b>Actions</b>                  |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 |               |                          |
|                     | ... | ...                             | ...                          |               |                          |
| <b>Momentrarian</b> |     | <b>Actions</b>                  |                              | <b>Return</b> | <b>Excess Mkt Return</b> |
| 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 calculate 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% (significantly 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 momentarian (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 momentarian (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.

### **3.3.2 During recession periods**

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

In Table 29 we present the monthly returns (%) for top and bottom hedge fund performers, for all hedge fund strategies during recessions. This table is derived from tables 15-17 presented in section 3.2.3 (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 29. 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.

| <b>Short Bias</b>     | Quarterly |       |       |       | Semi-yearly  |       |       |       | Yearly |              |       |       | Two Years |       |                       |    |                          |               |    |
|-----------------------|-----------|-------|-------|-------|--------------|-------|-------|-------|--------|--------------|-------|-------|-----------|-------|-----------------------|----|--------------------------|---------------|----|
|                       | Q         | S     | Y     | 2Y    | Q            | S     | Y     | 2Y    | Q      | S            | Y     | 2Y    | Q         | S     | Y                     | 2Y |                          |               |    |
| P1*                   | 2.15      | 1.76  | -1.60 | 7.77  | P1*          | -1.51 | -1.45 | 0.38  | -3.84  | P1*          | 0.08  | -0.88 | -1.29     | -1.38 |                       |    |                          |               |    |
| P10*                  | -0.31     | 2.08  | 0.90  | 2.72  | P10*         | -1.01 | 1.12  | -2.99 | -1.74  | P10*         | 0.06  | -0.28 | -3.78     | -0.79 |                       |    |                          |               |    |
| Spr P1*-P10*          | 2.47      | -0.32 | -2.50 | 5.05  | Spr P1*-P10* | -0.49 | -2.56 | 3.37  | -2.10  | Spr P1*-P10* | 0.02  | -0.60 | 2.49      | -0.59 |                       |    |                          |               |    |
| <b>Long Short</b>     | Quarterly |       |       |       | Semi-yearly  |       |       |       | Yearly |              |       |       | Two Years |       |                       |    |                          |               |    |
| P1*                   | 0.42      | 0.22  | -0.43 | -1.48 | P1*          | 0.36  | -1.43 | -0.94 | -4.14  | P1*          | 1.38  | 0.49  | 0.36      | -0.27 | <b>Multi Strategy</b> | Q  | S <td>Y<td>2Y</td> </td> | Y <td>2Y</td> | 2Y |
| P10*                  | 0.12      | 1.22  | -2.28 | -1.20 | P10*         | -1.50 | 1.01  | -2.33 | -0.40  | P10*         | -0.61 | 0.91  | -2.89     | 0.60  |                       |    |                          |               |    |
| Spr P1*-P10*          | 0.29      | -1.00 | 1.85  | -0.28 | Spr P1*-P10* | 1.86  | -2.45 | 1.39  | -3.74  | Spr P1*-P10* | 1.99  | -0.42 | 3.25      | -0.87 |                       |    |                          |               |    |
| <b>Other</b>          | Quarterly |       |       |       | Semi-yearly  |       |       |       | Yearly |              |       |       | Two Years |       |                       |    |                          |               |    |
| P1*                   | 0.85      | 0.68  | 0.83  | 0.53  | P1*          | 0.86  | 1.35  | 1.89  | 0.83   | P1*          | 1.55  | 0.31  | 0.84      | -4.58 | <b>Relative Value</b> | Q  | S <td>Y<td>2Y</td> </td> | Y <td>2Y</td> | 2Y |
| P10*                  | 0.17      | 1.02  | -2.48 | -0.95 | P10*         | 0.47  | 2.16  | -0.23 | 0.47   | P10*         | -0.34 | -0.65 | -4.10     | -0.26 |                       |    |                          |               |    |
| Spr P1*-P10*          | 0.68      | -0.34 | 3.32  | 1.48  | Spr P1*-P10* | 0.39  | -0.82 | 2.12  | 0.36   | Spr P1*-P10* | 1.89  | 0.96  | 4.94      | -4.32 |                       |    |                          |               |    |
| <b>Market Neutral</b> | Quarterly |       |       |       | Semi-yearly  |       |       |       | Yearly |              |       |       | Two Years |       |                       |    |                          |               |    |
| P1*                   | -0.27     | 0.62  | -1.63 | -1.04 | P1*          | -0.18 | -2.67 | -1.25 | 0.50   |              |       |       |           |       |                       |    |                          |               |    |
| P10*                  | -0.27     | -0.22 | 0.03  | -0.96 | P10*         | 2.69  | 3.98  | 2.45  | 2.65   |              |       |       |           |       |                       |    |                          |               |    |
| Spr P1*-P10*          | 0.01      | 0.84  | -1.66 | -0.08 | Spr P1*-P10* | -2.87 | -6.64 | -3.70 | -2.15  |              |       |       |           |       |                       |    |                          |               |    |

### 3.3.2.1 Trading styles

In this section we present the optimum trading styles when the investor uses only one or different hedge fund strategies per period for each of the four general trading strategies: momentum, contrarian, momentrarian involving high return exploitation, and momentrarian involving low return exploitation. Due to the fact that the findings are not significant we present an aggregate table with the results. Similar to growth periods the investor should choose the strategy(-ies) with the highest expected difference between top and bottom performers by having long and short positions appropriately (depending on the specific trading strategy). In table 30 we observe that the Relative Value, Short Bias, Global Macro, and Event Driven are the most common strategies that present the highest spread between top and bottom performer funds as non and semi-directional strategies are usually more persistent than directional strategies.

**Table 30. Trading Strategies – Same/Mixed Hedge Fund Strategies**

This table presents the optimum trading strategies for all trading styles using one only and different hedge fund strategies, during recessions. The returns are raw returns. Due to the limited data availability we computed the contrarian for two years (we cannot also calculate the statistical significance for this horizon). We calculated the first order momentrarian styles using how (HRE) or low return exploitation (LRE) due to limited data availability (we cannot also calculate the statistical significance for this horizon).

|                           | Same strategy | Return | Mixed strategies | Return |
|---------------------------|---------------|--------|------------------|--------|
| <b>Momentum trading</b>   |               |        |                  |        |
| Quarterly                 | SB            | 2.46   | SB and ED        | 3.66   |
| Semi-quarterly            | RV            | 0.96   | SB and RV        | 2.41   |
| Yearly                    | RV            | 4.94   | GM and RV        | 5.99   |
| <b>Contrarian</b>         |               |        |                  |        |
| 2 Year                    | RV            | 4.32   | SB and RV        | 7.30   |
| <b>Momentrarian (HRE)</b> |               |        |                  |        |
| 1 <sup>st</sup> order     | RV            | 5.43   | GM and RV        | 6.48   |
| <b>Momentrarian (LRE)</b> |               |        |                  |        |
| 1 <sup>st</sup> order     | RV            | 3.84   | SB and RV        | 6.82   |

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 1<sup>st</sup> order momentrarian (high return exploitation) is 0.39% (very low number of observation to test for significance) and for the 1<sup>st</sup> 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 3.3 is to demonstrate trading strategies and more specifically the momentrarian 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 can theoretically use so as to maximize her returns. As hedge fund behaviour changes during stressful market conditions, 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 very high skill levels from fund managers, (e.g. Other, Sector, Relative Value) the investor can get substantial excess market returns. On average, zero investment trading strategies such as momentum are more efficient during “good” time conditions, although they cannot beat the market benchmark. On the other hand, momentrarian trading strategies are more efficient during “bad” times, and they can beat the market benchmark although, due to the low number of observations, we cannot calculate the statistical significance.

### **3.3.3 Robustness**

In order to check for robustness for the average and optimal performance of the eight trading strategies, we first take into consideration the redemption fees that managers may impose on investors, and second we replicate our analysis for two different sub-periods with a holdback period to examine whether the underlying strategies can make out-of-sample profits 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 equally weighted average redemption fee is 3.40%<sup>19</sup>. The maximum redemptions that are needed for implementation are four within a year for the quarterly momentum trading strategy and the minimum is one within three years 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:

$$AvRedCost_{monthly} = P_{lock} * RedFee * RedPer / 12 \quad (18)$$

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

During “good” market conditions the average monthly costs for the quarterly, semi-annual and annual momentum strategy become 0.46%, 0.23%, and 0.12%, respectively. For the 2-year and 3-year contrarian strategy the average monthly costs are 0.06%, and 0.04%, respectively. For the 1<sup>st</sup> and 2<sup>nd</sup> order momentrarian (involving high or low return exploitation) the average monthly costs become 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 2<sup>nd</sup> order momentrarian (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) whereas in recessions they are all positive.

## Out-of-sample test

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<sup>19</sup> The underlying average redemption fee corresponds to those funds with explicit restrictions mentioning a specific cost.

When using a holdback period in order to test whether the underlying trading strategies make profits out-of-sample, our results generally holds. The initial historical data on which these trading strategies are tested (in-sample data) consist of half of our data length and the other half are reserved (out-of-sample) data (for “good” and “bad” times separately). During “good” market conditions the returns for all trading strategies have the same sign. Exemptions are the 3-year contrarian and the 2<sup>nd</sup> order momentrarian (low return exploitation) strategies. 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 validity beyond one year. Concerning the theoretical optimal implementation of the eight different trading strategies almost all of the sub-cases did not have differences in their signs in growth periods and the same strategies in most cases were still the best ones for the sub-periods tested. During the recessions the quarterly momentum trading strategy presented the same sign, contrary to the semi-annual momentum. Most results concerning the above (half data) returns are significant different from zero<sup>20</sup>.

## 4 Conclusion

In this paper we deal with two important issues in the hedge fund academic literature: hedge fund performance persistence and different hedge fund trading strategies by exploiting differences in hedge fund performance persistence. Concerning performance persistence this is the first study that examines different aspects of performance persistence under 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 extend 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 greater 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, 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

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<sup>20</sup> The results of our out-of-sample tests are not presented here for space reasons. These are available upon request.

for one year. This smoothness weakens but is still significant 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 no hedge fund strategies 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 having relatively few observations in the 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 every strategy. There is strong evidence that persistence is driven mainly by the top performers as we found reversals in bottom performers in most of cases, and recessions are fiercer than down regimes in terms of fund persistence.

Our conclusions regarding the mixed trading strategies are that an investor can outperform the market by having zero investment portfolio strategies that 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 momentarian trading strategies. However, during “bad” times, on average, the momentarian strategies are the most successful followed by the momentum strategies. In all market conditions the contrarian trading strategy comes third after the other two trading strategies. The above average results concern trading strategies that take into consideration the 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 make 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 are examined using the longest dataset ever used, from 1990 to 2014. We examine 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 more efficient ways.

Investors can benefit from our findings as they now 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 that utilize spreads between top and bottom performers of different hedge fund strategies. Financial regulators can benefit by better understanding hedge fund behaviour and knowing that there is apparently some market inefficiency in the hedge fund industry.

One limitation is that our focus is on hedge funds that invest in 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 persistence is at most quarterly. Concerning the application of the proposed mixed or the synthetic trading strategies, we considered 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 limitations of data availability, especially during stressful market conditions, we also did not considered contrarian trading strategies for two or more years.

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