DOES HEDGE FUND PERFORMANCE PERSIST? OVERVIEW AND NEW EMPIRICAL EVIDENCE

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ABSTRACT

The purpose of this paper is to provide an overview and new empirical evidence on hedge fund performance persistence, which has been a controversial issue in the academic literature in the last years. In the first step we review recent studies and put them into a joint evaluation of hedge fund performance persistence. In the second step we use the methodological framework developed in the overview to present new empirical evidence. We provide a more accurate picture of hedge fund performance persistence. We find different levels of performance persistence depending on the statistical methodology and the hedge fund strategy. We thus conclude that the use of different methodologies is the main reason for the confusing, mixed results found in literature. Furthermore, we conclude that persistence is related to the type of strategy.

Keywords: Performance Measurement, Performance Persistence, Hedge Funds

1 Introduction

Most investment products contain the warning that past performance is not an indicator for future returns. Nevertheless, most investors allocate capital to different funds on basis of their track record, which implies that they expect performance to be stable over time and that they expect some fund managers to provide better performance than others. Finding these fund managers and investing in their funds is the key motivation for measurement of performance persistence.

Hedge funds seem to be an ideal object to look for performance persistence and manager skill. Unlike mutual funds, hedge funds do not track a benchmark but rather seek to exploit mispricings and to provide absolute returns (see Brown et al. (1999)). Thus, analyzing performance persistence for mutual fund managers, who follow traditional benchmark tracking strategies, makes less sense than for hedge fund managers, as mutual fund managers have less opportunity than hedge fund managers to display differential skills. Nevertheless, the issue of performance persistence has been extensively studied for traditional mutual funds, e.g. by Grinblat and Titman (1992), Brown and Goetzmann (1995), and Carhart (1997). Most of these studies confirm that traditional strategies such as investing in mutual funds on average under-

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perform passive investment strategies and that hardly any performance persistence can be found with traditional mutual funds (see Droms (2006) for an overview).

This situation might be different with hedge funds, as the few fund managers who have beaten passive strategies tend to move to alternative investments and start their own hedge fund (see Agarwal and Naik (2000a)). For that reason hedge fund performance persistence has captured a great deal of attention. However, in contrast to articles on performance persistence for traditional mutual funds, these studies give a confusing picture. There are many different results, which may be produced by different databases, investigation periods, performance measures, and statistical methodologies. For example, Agarwal and Naik (2000a) consider 746 funds from the hedge fund research database between 1982 and 1998 and find performance persistence at quarterly horizons. Brown et al. (1999) consider 399 funds from the US Offshore Funds Directory between 1989 and 1995 and find no evidence of persistence in hedge fund performance at yearly horizon. The heterogeneity of these studies precludes a broad and clear picture of hedge fund performance persistence. What is missing is an overview of performance measures, statistical methodologies and results.

The first goal of this paper is to provide such an overview. We will give insights into 25 studies on hedge fund performance persistence by summarizing the databases, performance measures, statistical methodologies, and results. The second goal of this paper is to use the methodological framework developed in the overview to present new empirical evidence of hedge fund performance persistence. For this we consider the Center for International Securities and Derivatives Markets (CISDM) database, which is one of the largest hedge fund databases ever analyzed for this purpose. It contains data on 4,165 hedge funds and 2,021 funds of hedge funds. We will analyze the years 1996 through 2005, which is advantageous for two reasons. First, the results will not suffer as much from the survivorship and backfilling biases that plague much of the older hedge fund research.[1] Second, this time period contains bullish as well as bearish markets; many other studies are limited to the analysis of bullish markets.[2] Thus, this paper will give a broad and unbiased evaluation of hedge fund performance persistence.

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[1] Major hedge fund data vendors did not cover dissolved funds before 1994. Hedge fund data before 1994 is thus not reliable and should not be used in academic research. For this reason, Capocci and Hübner (2004) decided to exclude the largest part of their hedge fund data from 1984 to 2000 in their study of hedge fund performance. The unreliability of data before 1994 is also discussed by Fung and Hsieh (2000), Liang (2000), and Ammann and Moerth (2005).

[2] Although many hedge funds do not use trend-following strategies, Capocci et al. (2005) found that the market phase may influence the results. For that reason it seems favorable to have bullish as well as bearish market phases in the investigation.

In the empirical part, we provide the following new insights. First, we find differences in results, depending on the methodology used to assess performance persistence. Regression-based tests and the Hurst exponent provide clear evidence of performance persistence while correlation- and contingency-table-based tests deliver a mixed picture. With the multi period Kolmogorov/Smirnov test we even find no persistence. We thus conclude that the use of different methodologies is one of the key reasons for the unsteady results found in literature. Second, we find large differences in results depending on the hedge fund strategy. With Convertible Arbitrage and Emerging Markets hedge funds we find very high levels of persistence, but Equity Long Only hedge funds provide low levels of persistence. Therefore, we conclude that persistence is related to the type of hedge fund strategy followed. Finally, we find very similar results comparing measures used to assess performance persistence like, e.g., raw returns, alphas, and appraisal ratios. The use of different performance measures is thus not the reason for the conflicting results found in performance persistence literature.

The remainder of this paper is organized as follows. Section 2 is the overview of 25 studies on hedge fund performance persistence. Section 3 is the empirical examination of hedge fund performance persistence. The results of the study are summarized in Section 4.

2 Literature Review on Hedge Fund Performance Persistence

Before measuring performance persistence, many questions need to be answered: Which hedge fund database should be considered? How many funds should be regarded? Which investigation period should be chosen? How should this time period be divided up? Which measure should be considered? Which methodology should be used to assess statistical significance?

Having all these questions in mind, we give an overview of 25 academic studies on hedge fund performance persistence. Table 1 summarizes the main features of these studies.[3] The first column gives the authors. The second and third columns display the database and the number of funds considered. The fourth and fifth columns show the investigation period and the time horizon. Columns six and seven present the performance measures and the statistical methodology. Finally, in column eight the result of the studies are summarized. The rest of this section is subdivided by the columns listed in Table 1.

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[3]   See Gehin (2004), Henn and Meier (2004), Schneeweis et al. (2002), Gregoriou et al. (2002), and Gupta et al. (2003) which all provide smaller overviews on a subset of these studies.

Table 1: Studies on hedge fund performance persistence

Authors	Database	Number of Funds	Investigation Period	Time Horizon (Months)	Performance Measure	Statistical Methodology	Result
Agarwal et al. (2005)	CISDM, HFR, MSCI, TASS	7535	1994-2002	12	return	chi square, regression	persistence at yearly horizon
Agarwal and Naik (2000a)	HFR	746	1982-1998	3, 6,12	alpha, appraisal ratio	cross product ratio, chi square, regression, Kolmogorov/Smirnov	persistence at quarterly horizon
Agarwal and Naik (2000b)	HFR	167	1995-1998	3	alpha, appraisal ratio	cross product ratio, regression	persistence at quarterly horizon
Amenc et al. (2003)	CSFB/Tremont indices	9	1994-2000	1	return	regression, Hurst	persistence at monthly horizon
Baquero et al. (2005)	TASS	1797	1994-2000	3, 12, 24	return, alpha	none (descriptive comparison of rankings)	persistence at quarterly and yearly horizon, but not at two-year horizon
Barès et al. (2003)	Financial Risk Management	4934	1992-2000	1, 3, 6, 12	return, alpha	descriptive comparison of rankings, t-statistic	persistence at monthly and quarterly horizon
Boyson and Cooper (2004)	TASS	1659	1994-2000	3	alpha	t-statistic	persistence at quarterly horizon
Brown and Goetzmann (2003)	TASS	1295	1992-1998	12	return	regression	no persistence at yearly horizon
Brown et al. (1999)	US Offshore Funds Directory	399	1989-1995	12	return, alpha, appraisal ratio	regression	no persistence at yearly horizon
Capocci et al. (2005)	MAR, HFR, TASS	2894	1994-2002	12	alpha	t-statistic	no persistence at yearly horizon
Capocci and Hübner (2004)	HFR, MAR	2796	1988-1995	12	alpha	t-statistic	no persistence at yearly horizon
Chen and Passow (2003)	TASS, HFR	76 (only LSE)	1990-2002	12	alpha	regression	no persistence at yearly horizon
De Souza and Gokcan (2004)	HFR	314	1997-2002	24, 36	return, standard deviation, Sharpe ratio	cross product ratio, regression, Hurst	no persistence at two-and three year horizon with returns, but with risk
Edwards and Caglayan (2001)	MAR	1665	1990-1998	12, 24	alpha	cross product ratio, regression	persistence at one-year and two-year horizons
Gregoriou and Rouah (2001)	Zurich/LaPorte	(n/a)	1988-1999	12	alpha	descriptive comparison of rankings	no persistence at yearly horizon
Harri and Brorsen (2002)	LaPorte	1209	1977-1998	1, 2, 3, … to 24	return, information ratio, Sharpe ratio, alpha	Spearman, regression	persistence at all horizons
Henn and Meier (2004)	EurekaHegde	1217	1994-2004	1, 3, 12	return	cross product ratio	persistence at monthly, quarterly and yearly horizon
Herzberg and Mozes (2003)	HedgeFund.net, Altvest, Spring Mountain Capital	3300	1995-2001	12	return, Sharpe ratio, max. draw. standard deviation, correlation	Rank Information Coefficient	no persistence at yearly horizon with returns, but with risk
Jagannathan et al. (2006)	HFR	2141	1996-2003	36	alpha	regression	persistence at three-year horizon
Kat and Menexe (2002)	TASS	324	1994-2001	36	Mean, standard deviation, skewness, kurtosis, correlation	cross product ratio, regression	no persistence at three-year horizon with returns, but with the higher mo.
Koh et al. (2003)	EurekaHegde, AsiaHedge	3810 (only Asian funds)	1999-2003	1, 2, 3, 6, 9, 12	return, alpha	cross product ratio, chi square, Kolmogorov/Smirnov	persistence at monthly and quarterly but not at yearly horizon
Kosowski et al. (2006)	TASS, HFR, MAR, MSCI	5533	1990-2002	12	alpha	regression, bootstrap approach, Bayesian approach	persistence at yearly horizon
Kouwenberg (2003)	Zurich (MAR)	2614	1995-2000	36	return, alpha, Sharpe ratio	chi square	persistence at three-year horizon
Malkiel and Saha (2005)	TASS	2065	1996-2003	12	returns	chi square	no persistence at yearly horizon
Park and Staum (1998)	TASS	n/a	1986-1997	12	appraisal ratio	chi square, Spearman	persistence at yearly horizon

This table reports the main characteristics and results for 25 studies on hedge fund performance persistence between 1998 and 2005. Column 1 gives the authors, column 2 the considered database, column 3 the number of funds, column 4 the investigation period, column 5 the time horizon, column 6 the performance measures, column 7 the statistical methodology, and column 8 the results. Abbreviations: CISDM: Center for International Securities and Derivatives Markets, CSFB: Credit Suisse First Boston, HFR: Hedge Fund Research, LSE: Long/Short-Equity, MAR: Managed Account Reports, MSCI: Morgan Stanley Capital International, TASS: Tremont Advisory Shareholders Services.

2.1 Database and Number of Funds

It is documented in literature that there are differences between hedge fund databases.[4] For that reason it is a relevant question, which database to consider in the empirical study. There are three main hedge fund database providers, which are mostly used in academic studies: Managed Account Reports (MAR, contains 4200 active and 2000 inactive funds at present), Hedge Fund Research (HFR, 6000 active and 3500 inactive funds), and Tremont Advisory Shareholders Services (TASS, 3900 active and 2400 inactive funds). These three databases have also been used in combination: E.g. Ackermann et al. (1999) and Capocci and Hübner (2004) used a combination of HFR and MAR, whereas Chen and Passow (2003) use a combination of TASS and HFR. Moreover, some smaller databases have been subject of performance persistence studies. For example, Brown et al. (1999) collect hedge fund data from the US Offshore Funds Directory and Koh et al. (2003) consider the EurekaHegde and Asia-Hedge database.

It is noteworthy that the number of funds contained in the hedge fund databases and analyzed within performance persistence studies is rapidly rising in the last years. While most older study up to the year 2000 do not analyze more than 1000 funds, the recent study by Kosowski et al. (2006) combines TASS, HFR and MAR with the new MSCI database leading to the largest dataset used for academic research to date. It contains 6,392 live and 2,946 dead funds.

2.2 Investigation Period and Time Horizon

There is no clear answer in the literature to the question which investigation period to choose to measure performance persistence. There are studies with very short investigation periods of only three years (see Agarwal and Naik (2000b)), but also studies with very long time periods of up to 21 years (see Harri and Brorsen (2002)). In the mean the 25 studies considered in this literature overview have an investigation period of 8.5 years with an median of 7 years.

Choosing the investigation period, there are some important aspects which should be kept in mind. First, as mentioned in the introduction it might not be meaningful to consider returns prior to 1994 because of the survivorship and backfilling bias in hedge fund returns (see Liang (2000)). Second, it is important not to consider too long time periods, as hedge fund managers typically do not work for more then one decade with the same hedge fund (see Boyson

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[4] E.g., Liang (2000) finds significant differences in fund returns, attrition rate, and survivorship bias in the TASS and HFR database.

and Cooper (2004)). This is problematic because most studies measure the fund performance but not that of the underlying manager since they cannot control for a change in the fund management. As performance persistence is mostly associated with the special skills of a fund manager it is difficult to identify skillful managers especially if the investigation period is very long. Therefore, we recommend not to consider a time period of more than 10 years and to choose returns not older than 1994.

Another important aspect is the choice of time horizon. It clearly makes a difference whether yearly, quarterly, or monthly returns are considered. For example, Harri and Brorsen (2000) compare persistence for a horizon of 1 month up to 24 month and find large differences in significance levels of persistence. The same result is found by Henn and Meier (2004) and Koh et al. (2003). We will reconsider this aspect in the discussion of the main results (see Section 2.5)

2.3 Measure

A wide range of measures is used to analyze hedge fund performance persistence. In Table 2 these measures are broken down into five groups: Return, risk, higher moments, correlation and risk-adjusted performance.

Table 2: Measures for testing performance persistence

Measure	Return	Risk/Higher Moments/ Correlation	Risk-Adjusted Performance	
			Information ratio/Sharpe ratio/ Appraisal ratio	Alpha
Considered in	*only post-fee:* Agarwal et al. (2005) Amenc et al. (2003) Baquero et al. (2005) Barès et al. (2003) Brown and Goetzmann (2003) De Souza and Gokcan (2004) Harri and Brorsen (2002) Henn and Meier (2004) Herzberg and Mozes (2003) Kat and Menexe (2002) Kouwenberg (2003) Malkiel and Saha (2005) *post-fee and pre-fee:* Brown et al. (1999) Koh et al. (2003)	*standard deviation:* De Souza and Gokcan (2004) Herzberg and Mozes (2003) Kat and Menexe (2002) *maximum drawdown:* Herzberg and Mozes (2003) *skewness:* Kat and Menexe (2002) *kurtosis:* Kat and Menexe (2002) *Correlation:* Herzberg and Mozes (2003) Kat and Menexe (2002)	*Information ratio:* Harri and Brorsen (2002) *Sharpe ratio:* De Souza and Gokcan (2004) Harri and Brorsen (2002) Herzberg and Mozes (2003) *Appraisal ratio:* Agarwal and Naik (2000a) Agarwal and Naik (2000b) Brown et al. (1999) Park and Staum (1998)	*hedge fund style adjusted:* Agarwal and Naik (2000a) Agarwal and Naik (2000b) Baquero et al. (2005) Barès et al. (2003) Boyson and Cooper (2004) Brown et al. (1999) *market-adjusted:* Capocci et al. (2005) Capocci and Hübner (2004) Chen and Passow (2003) Edwards and Caglayan (2001) Gregoriou and Rouah (2001) Harri and Brorsen (2002) Koh et al. (2003) Kosowski et al. (2006) Kouwenberg (2003) *hedge fund style- and market-adjusted:* Jagannathan et al. (2006)

This table reports the measures used to search for performance persistence within 25 studies between 1998 and 2005. In line 1 the measures are broken down into five groups (Return, risk, higher moments, correlation and risk-adjusted performance). The risk-adjusted performance measures can be further broken down into Information ratio, Sharpe ratio, Appraisal ratio, and Alpha. The second line gives the authors.

The first group are raw return based measures. While most studies concentrate on post fee returns, Brown et al. (1999) and Koh et al. (2003) also analyze pre-fee returns. Fee consideration can provide additional information about the fund manager's performance because there is a difference between a fund that has a gross return of 10% and a net return of 5%, and a fund that has a gross return of 20% and a net return of 5%.

Two risk measures are analyzed in performance persistence literature. The standard deviation measures the total risk of an investment, which gives both the positive and negative deviations of the returns from the expected value. The maximum drawdown of a fund is the maximum possible loss incurred over a given investment period. Furthermore, higher moments, like, e.g., skewness and kurtosis and correlations with stock and bond markets were included in performance persistence studies.

The most important measures to analyze performance persistence are risk-adjusted performance measures. These measures can be divided in four sub-measures: The information ratio, the Sharpe ratio, alpha based measures and the appraisal ratio. The information ratio measures the relationship between the funds return and its standard deviation (see Goodwin (1998)). The Sharpe ratio considers the relationship between the excess return (return minus the risk-free interest rate) and the standard deviation of the returns (see Sharpe (1966)). Alpha is the intercept of the regression of several market factors on the hedge fund excess returns. It is often criticized because it can be manipulated by leveraging the fund return. A related measure that is leverage invariant is the appraisal ratio, which is the relationship between alpha and the residuals standard deviation of the above mentioned regression. While it is easy to define information ratio, Sharpe ratio, and appraisal ratio, it is necessary to take a closer look at the underlying market factors for the alpha based measures. This is done in Table 3.

Alpha was introduced by Jensen (1968) in the context of a single index model as a regression of the capital market excess return on the fund excess return. This single factor modelling can be extended to a multi factor framework in order to improve the portion of variance explained by the regression. One example is the Fama and French (1993) model with two additional factors for size (SMB, small minus big) and the ratio of book-to-market (HML, high minus low book to price ratio). Other extensions are the international Fama and French (1998) model with an international book-to-market factor (used, e.g., by Capocci and Hübner (2004)), and the model of Carhart with a momentum factor (used, e.g., by Capocci et al. (2005)).

Table 3: Definition of alpha

Authors	Number of factors	Factors
Agarwal and Naik (2000a)	1	average return of all the funds using the same strategy
Agarwal and Naik (2000b)	1	average return of all the funds using the same strategy
Baquero et al. (2005)	1	Tremont hedge fund style indices
Barès et al. (2003)	8	hedge fund style factors obtained by a principal component analysis
Boyson and Cooper (2004)	19	▪ 6 traditional indices: US Dollar, Gold, Commodities, CRSP Value Weighted, LB Aggregate Bond, LB 30 Year US Treasury ▪ Fama and French (1993) + Carhart (1997): HML, SMB, Momentum ▪ 10 CSFB/Tremont indices
Brown et al. (1999)	1	Tremont hedge fund style indices
Capocci et al. (2005)	11	▪ Jensen (1968) + Fama and French (1998) + Carhart (1997): MER (all NYSE, AMEX and Nasdaq stocks), SMB, HML, IHML, Momentum ▪ Agarwal and Naik (2004): Lehman BAA Corp. Bond, MSCI World excluding US, LB US Aggregate Bond, Salomon World Government, Goldman Sachs Commodity ▪ JP Morgan Emerging Market Bond
Capocci and Hübner (2004)	11	▪ Jensen (1968) + Fama and French (1998) + Carhart (1997): MER (all NYSE, AMEX and Nasdaq stocks), SMB, HML, IHML, Momentum ▪ Agarwal and Naik (2004): Lehman BAA Corp. Bond, MSCI World excluding US, LB US Aggregate Bond, Salomon World Government, Goldman Sachs Commodity ▪ JP Morgan Emerging Market Bond
Chen and Passow (2003)	4	▪ Jensen (1968) + Fama and French (1993): ER (Russel 3000), HML, SMB ▪ Agarwal and Naik (2004): Goldman Sachs Commodity Index
Edwards and Caglayan (2001)	6	model similar to that of Fama and French (1993, 1995, 1996) ▪ Jensen (1968) + Fama and French (1993): MER (S&P 500), HML, SMB ▪ WML (winner minus loosers), TERM (a long-term government bond portfolio minus the 1-month-lagged 30-day T-bill return), DEF (monthly return on a portfolio of long-term corporate bonds minus the monthly return on a portfolio of long-term government bonds)
Gregoriou and Rouah (2001)	1	▪ Jensen (1968): MER (S&P 500 and MSCI, separately)
Harri and Brorsen (2002)	8	style analysis similar to Sharpe (1992) and Fung and Hsieh (1997) ▪ three equity classes: S&P500, MSCI World excluding US, and MSCI emerging markets ▪ two bond indices: a government bond index and a corporate bond index ▪ Cash (1-month eurodollar deposit), gold, currency
Jagannathan et al. (2006)	3	▪ Jensen (1968): MER (CRSP) ▪ Self reported style index J from HFR ▪ Additional style index K from HFR
Koh et al. (2003)	7	▪ Asian equity factor (broken down into an Asia ex Japan factor and a Japan factor) ▪ Asian bond factor ▪ US equity factor ▪ Fama and French (1993) + Carhart (1997): SMB, HML, momentum
Kosowski et al. (2006)	7	seven-factor model developed by Fung and Hsieh (2004) ▪ S&P 500 return minus risk free rate ▪ Wilshire small cap minus large cap return ▪ change in the constant maturity yield of the 10-year Treasury ▪ change in the spread of Moody's Baa minus the 10-year Treasury ▪ bond primitive trend following strategy ▪ currency and commodities
Kouwenberg (2003)	3	style adjusted: portfolio of S&P 500, Nasdaq and Option Selling Strategies

This table reports the definition of alpha within 16 studies on hedge fund performance persistence. Column 1 gives the authors, column 2 the number of factors considered database, and column 3 the factors itself. Abbreviations: AMEX: American Stock and Options Exchange, CRSP: Center for Research in Security Prices, ER: excess return, HML: high minus low book to price ratio, IHML: international high minus low book to price ratio, LB: Lehman Brothers, NYSE: New York Stock Exchange, MER: market excess return, SMB: small minus big.

A number of researchers have stressed the importance of considering hedge fund specific style factors in a study of hedge fund performance (see, e.g., Fung and Hsieh (1997), Brown et al. (1999)). Thus, many model includes common risk factors but also hedge fund style factors. The style factors usually are hedge fund indices (e.g., the Tremont indices, Brown et al. (1999)) or an average return of all the funds using the same strategy in a database (Agarwal and Naik (2000a)).

2.4 Statistical Methodology

The issue of performance persistence can be examined through various statistical approaches. Agarwal and Naik (2000a) distinguish between two period and multi period approaches. In the first case the total investigation period is divided into equal parts, whereas in the second case the investigation period is further broken down. The statistical methodologies which build upon the two period framework can be further distinguished in non parametric and parametric approaches. To the first group of non parametric approaches belong the contingency table-based cross product ratio test and chi square test, the correlation-based rank information coefficient test, Spearman's rank correlation test, and the Hurst test. The parametric approach is a linear regression. In the multi-period framework a Kolmogorov/Smirnov test can be applied. Table 4 gives an overview of statistical methodologies for testing performance persistence.

Table 4: Methodologies for testing performance persistence

Period	Methodological Basis	Test (Statistic)	Used in
Two Period	contingency table-based (non parametric)	cross product ratio test (Z-statistic)	Agarwal and Naik (2000a) Agarwal and Naik (2000b) Brown et al. (1999) DeSouza and Gokcan (2004 Edwards and Caglayan (2001) Henn and Meier (2004) Kat and Menexe (2002) Koh et al. (2003)
		chi square test (X^2-statistic)	Agarwal et al. (2005) Agarwal and Naik (2000a) Koh et al. (2003) Kouwenberg (2003) Malkiel and Saha (2005) Park and Staum (1998)
	correlation-based (non parametric)	rank information coefficient (Fisher T-statistic)	Herzberg and Mozes (2003)
		Spearman rank correlation test (Fisher T-statistic)	Harri and Brorsen (2002) Park and Staum (1998)
	(non parametric)	Hurst exponent (D-statistic)	Amenc et al. (2003) De Souza and Gokcan (2004)
	regression-based (parametric)	cross-sectional regression (t-statistic)	Agarwal et al. (2005) Agarwal and Naik (2000a) Agarwal and Naik (2000b) Amenc et al. (2003) Barès et al. (2003) Boyson and Cooper (2004) Brown et al. (1999) Brown and Goetzmann (2003) Capocci et al. (2005) Capocci and Hübner (2004) Chen and Passow (2003) De Souza and Gokcan (2004) Edwards and Caglayan (2001) Harri and Brorsen (2002) Jagannathan et al. (2006) Kat and Menexe (2002) Kosowski et al. (2006)
Multi Period		Kolmogorov/Smirnov test	Agarwal and Naik (2000a) Koh et al. (2003)

This table reports the statistical methodology within 25 studies on hedge fund performance persistence. The first column subdivides the methodologies into two-period and multi-period measures. Within the two period framework we can further distinguish in non parametric and parametric approaches (second column). The third column displays seven tests for performance persistence. The last column gives the authors of the studies, where the methodology is applied.

Cross Product Ratio Test

The contingency table-based methods are based on the construction of tables of winners and losers. Winners are funds whose performance is higher than the median return of all funds following the same strategy over this period, and losers are funds whose performance is lower than the median performance of all funds following the same strategy. Persistent are those funds that are winners (WW) and losers (LL) in both periods. Against it, winners during the first period which are losers during the second period will be denoted WL and LW in the opposite case. The cross product ratio (CPR) test (also called log-odds ratio test; see, e.g., Agarwal and Naik (2000a)) is the ratio of the funds that persist to the fund which did not persist:

$$CPR = \frac{WW \cdot LL}{WL \cdot LW}.$$

(1)

CPR is equal to 1 in the null hypothesis of no persistence, i.e., each of the four categories WW, LL, WL and LW represent 25% of all funds. The statistical significance of CPR can be tested using the standard error $\alpha_{ln(CPR)}$ of the natural logarithm of CPR. The resulting Z-statistic is the ratio of the natural logarithm of the CPR to the standard error of the natural logarithm. Corresponding to the standard normal distribution, a value greater than 1.96 (2.58) indicates significant persistence at 5% (1%) confidence level:

$$Z = \frac{\ln(CPR)}{\alpha_{\ln(CPR)}} = \frac{\ln(CPR)}{\sqrt{\dfrac{1}{WW} + \dfrac{1}{WL} + \dfrac{1}{LW} + \dfrac{1}{LL}}}.$$

(2)

Chi-Square Test

With the chi-square test (see, e.g., Park and Staum (1998)) the observed frequency distribution of WW, WL, LW, and LL is compared with the expected frequency distribution:

$$\chi^2 = \sum_{i=1}^{I} \frac{\left(O_i - E_i\right)^2}{E_i},$$

(3)

where O_i is the observed number of funds ($i=1,..., I$) in each case of the contingency table, and E_i is the expected number of funds in each case. Following the chi square distribution with one degree of freedom, a value of χ^2 greater than 3.84 (6.64) indicates significant persistence at 5% (1%) confidence level.

Rank Information Coefficient

The rank information coefficient (*RIC*, used by Herzberg and Mozes (2003)) measures the correlation between the value of a given variable for a period 1 (e.g., the prior month) and its value for a period 2 (e.g., the subsequent month). The statistical significance of the rank information coefficient can be tested using the Fisher T-Statistic:

$$T_{RIC_i} = \sqrt{N_i - 2}\, \frac{RIC_i}{\sqrt{1 - RIC_i^2}}\,.$$ (4)

with *N* as number of returns of fund i. Corresponding to the T-distribution, a value greater than 1.96 (2.58) indicates significant persistence at 5% (1%) confidence level.

Spearman Rank Correlation Test

With Spearman's rank correlation test (see Park and Staum (1998)) performance rankings are compared for different time periods. In case of persistence the correlation between the rankings of two consecutive periods should be near one, while a correlation coefficient of zero indicates the absence of persistence. The statistical significance of the Spearman rank correlation coefficient can again be tested using the Fisher T-Statistic described in equation (4)

Hurst Exponent

The Hurst exponent (used by De Souza and Gokcan (2004)) has the advantage that it is not related to an assumption on the return distribution. It measures whether a (positive or negative) trend persists or mean reverts. The Hurst exponent is calculated as:

$$H_i = \ln(R_i / \sigma_i) / \ln(N_i / 2)\,,$$ (5)

with *R* as the range of the cumulative deviations from the mean return and σ_i as the standard deviation of the returns. The Hurst exponent directly indicates the managers that persistently display positive or negative returns. A Hurst exponent between 0 and 0.5 indicates reverse persistence. An exponent of 0.5 indicates random performance. An exponent between 0.5 and 1 indicates positive persistence. We calculate the t-statistic using the annualized standard de-

viation (σ_{ann}) to evaluate statistical significance of the Hurst-exponent. Corresponding to the T-distribution, a value greater than 1.96 (2.58) indicates significant persistence at 5% (1%) confidence level:

$$T_{H_i} = \frac{H_i - 0.5}{\sigma_{ann_i} / \sqrt{N_i}}.$$

(6)

Cross-sectional Regression

For the regression-based parametric method (see Agarwal and Naik (2000a)) the measurement value during the current period is regressed on the measurement value of the previous period. A positive significant slope coefficient indicates performance persistence. The statistical significance of the slope can be tested using the t-statistic. Corresponding to the standard normal distribution, a t-value greater than 1.96 (2.58) indicates significant persistence at 5% (1%) confidence level:

$$r_t = \alpha + \beta \cdot r_{t-1}$$

(7)

Kolmogorov/Smirnov Test

With the Kolmogorov/Smirnov goodness of fit test (used by Koh et al. (2003)), the traditional two-period framework is extended to a multi-period approach, because this might bring more robust results. A series of wins and losses for each fund is constructed and the observed frequency distribution is compared with the theoretical frequency distribution of two or more consecutive wins and losses. For example, under the null hypothesis of no persistence, the theoretical probability of WWW and LLL is one-eighth and that of WWWW and LLLL is one-sixteenth. Using the two-sample Kolmogorov/Smirnov goodness of fit test, we check whether the observed distribution is statistically different from the theoretical distribution. With O_i as the observed number of funds in each case of the contingency table, and E_i as the expected number of funds in each case and I as number of all funds we calculate (a value greater than $1.22/\sqrt{I}$ ($1.92/\sqrt{I}$) indicates significant persistence at 5% (1%) confidence level):

$$KS = \max\left(O_i / I - E_i / I\right)$$

(8)

12

2.5 Results

Table 5 summarizes the results of the 25 studies. "↑" indicates that performance persistence was found, while "↓" indicates no performance persistence. "-" means that the time horizon was not analyzed.

Table 5: Results

Authors	Time horizon in month					
	1	3	6	12	24	36
Agarwal et al. (2005)	-	-	-	↑	-	-
Agarwal and Naik (2000a)	-	↑	↑	↑	-	-
Agarwal and Naik (2000b)	-	↑	-	-	-	-
Amenc et al. (2003)	↑	-	-	-	-	-
Baquero et al. (2005)	-	↑	-	↑	↓	-
Barès et al. (2003)	↑	↑	↓	↓	-	-
Boyson and Cooper (2004)	-	↑	-	-	-	-
Brown and Goetzmann (2003)	-	-	-	↓	-	-
Brown et al. (1999)	-	-	-	↓	-	-
Capocci et al. (2005)	-	-	-	↓	-	-
Capocci and Hübner (2004)	-	-	-	↓	-	-
Chen and Passow (2003)	-	-	-	↓	-	-
De Souza and Gokcan (2004)	-	-	-	-	↓	↓
Edwards and Caglayan (2001)	-	-	-	↑	↑	-
Gregoriou and Rouah (2001)	-	-	-	↓	-	-
Harri and Brorsen (2002)	↑	↑	↑	↑	↑	-
Henn and Meier (2004)	↑	↑	-	↑	-	-
Herzberg and Mozes (2003)	-	-	-	↓	-	-
Jagannathan et al. (2006)	-	-	-	-	-	↑
Kat and Menexe (2002)	-	-	-	-	-	↓
Koh et al. (2003)	↑	↑	↑	↓	-	-
Kosowski et al. (2006)	-	-	-	↑	-	-
Kouwenberg (2003)	-	-	-	-	-	↑
Malkiel and Saha (2005)	-	-	-	↓	-	-
Park and Staum (1998)	-	-	-	↑	-	-
Total	5 ↑	8 ↑	3 ↑ 1 ↓	8 ↑ 10 ↓	2 ↑ 2 ↓	2 ↑ 2 ↓

This table reports the results for 25 studies on hedge fund performance persistence. The first column gives the authors and the second the results. We distinguish between six time horizons (from 1 to 36 months). "↑" indicates that performance persistence was found, while "↓" indicates no performance persistence. "-" means that the time horizon was not analyzed.

The main results of hedge fund performance persistence studies can be summarized as follows: First, short-term persistence for horizons of up to six months is reported by nearly all authors. Second, evidence for longer horizons is mixed, as the studies come to conflicting conclusions. For example, at the annual horizon there are eight studies which find performance persistence, while ten studies reject the hypotheses of persistence in hedge fund performance. Agarwal and Naik (2000a), Harri and Brorsen (2002) report persistence both for short and for long-term horizon. However, both mention that the return persistence significance levels weakens as one lengthens the measurement horizons.

We conclude that there is persistence in hedge fund performance at short horizons of up to six months. But the longer the time horizon the lower is the significance of performance persistence. Furthermore, the following results of the studies can be highlighted:

- First, it was analyzed whether it are winners or losers that persist. Agarwal and Naik (2000a) find that persistence is driven mostly by losers. But against it, the level of persistence found by Edwards and Caglayan (2001) holds among both winners and losers.

- There is also no consensus in the literature, whether the fund strategy is a driver of persistence. Agarwal and Naik (2000a) find that persistence is not related to the type of strategy followed. However, following Brown and Goetzmann (2003) and Harri and Brorsen (2004) persistence of fund returns has a lot to do with the style of fund management.

- It was also discussed whether survivorship bias might influence the results. Malkiel and Saha (2005) find no persistence if all funds are considered, but slightly more persistence if dead funds are dropped from the database. This is in line with Capocci and Hübner (2004). They assume that the small degree of performance persistence they found from 1985 to 1993 is due to the absence of dissolved funds.

- The two-period framework was compared to the multi-period framework. Agarwal and Naik (2000a) find that the level of persistence observed in a multi-period framework is considerably smaller than that observed under the traditional two-period framework.

- Some fund and managerial characteristics were identified as drivers of persistence. Agarwal et al. (2005) find that hedge funds with greater managerial incentives (e.g., larger incentive fee) and higher degree of managerial flexibility (e.g., longer lockup period) provide superior performance. Boyson and Cooper (2004) show that young, past good managers outperform old, past poor managers.

- Finally, many authors discussed reasons for persistence: One possible reason for short-term performance persistence could be that monthly returns are smoothed out, either due to holding illiquid securities or managed returns (see Henn and Meier (2004)). Barès et al. (2003) and Jagannathan et al. (2006) attach short-term persistence to the hot hands effect documented in mutual fund literature (see Hendricks et al. (1993)). This effect means that the securities held by funds that had better performance during one year realize superior returns the following year.

We thus can identify a main tenor in the literature concerning short term-persistence, but also many conflicting results concerning long term-persistence and other characteristics. The following empirical study will shed light on these issues.

3 Empirical Evidence on Hedge Fund Performance Persistence

The literature study gives a heterogeneous picture of hedge fund performance persistence. The large differences in results may be produced by different databases, investigation periods, performance measures, and statistical methodologies. To get a more accurate picture of hedge fund performance persistence, we will use the whole framework discussed in the overview and present new empirical evidence on all tests and measures.

3.1 Data

We received data on 6,186 funds between January 1996 and December 2005 from the Center for International Securities and Derivatives Markets (CISDM). The CISDM database has been subject of many academic studies (for the properties of this database, see, e.g., Edwards and Caglayan (2001), Kouwenberg (2003), Capocci and Hübner (2004)).[5] The database contains 4,165 hedge funds and 2,021 funds of hedge funds. Depending on the strategy the database can be broken down into 22 hedge fund strategy and 7 funds of funds strategy groups.[6]

We deleted 27 funds that appeared twice in the database and one fund that only reports returns on a quarterly basis. This reduces our sample to 4,143 hedge funds and 2,015 funds of hedge funds. We require all funds to have at least 24 monthly returns, because this is the minimum to calculate meaningful performance measures (see Ackermann et al. (1999), Gregoriou (2002), Capocci and Hübner (2004).[7] Eliminating those 1,844 funds with less than 24 monthly returns reduces our sample to 2,936 hedge funds and 1,378 funds of hedge funds.

Like other hedge fund databases, the CISDM database suffers from survivorship bias. There are two common definitions for survivorship bias: the difference in fund returns between the surviving funds and the dissolved funds (see Ackermann et al. (1999)) and the difference between the returns of the survived funds and all funds (see Liang (2000)). We use the definition of Liang (2000) and find a survivorship bias of 0.08% per month with hedge funds (see

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[5]   The CISDM database is the former Managed Account Research (MAR) database. In 2001 the database was sold to Zurich Capital Markets, which gifted the database to the CISDM.

[6]   Due to insufficient number of funds we combined the hedge fund strategies Capital Structure Arbitrage, Market Timing, Option Arbitrage, Other Relative Value, and Regulation D to the new hedge fund strategy Other and the funds of funds strategies Conservative, Invest Funds in Parent Companies, and Opportunistic to the new funds of funds strategy Other. In the emprical part we thus consider 18 hedge fund strategy and 5 funds of funds strategy groups.

[7]   Fung and Hsieh (1997) and Liang (1999) even eliminated funds with less than 36 monthly returns, which would reduce our sample to 2,319 hedge funds and 1,058 funds of hedge funds. As a robustness test, we conducted the performance measurement with at least 36 monthly returns and found robust results.

Table A1 in the appendix for detailed calculations), which is comparable to other values found in the literature (see, e.g., Ackermann et al. (1999) and Liang (2000)). The fact that compared to hedge funds the attrition rate and the survivorship bias are lower with funds of hedge funds is well documented in literature (see Liang (2000)). In our sample survivorship bias for funds of hedge funds only amounts to 0.02% (see Table A1).

In case that new funds are added into a database, historical returns are backfilled, which may also cause an upward bias in performance measurement results. We follow Brown et al. (1999), Fung and Hsieh (2000), and Capocci and Hübner (2004) and calculate backfilling bias by stepwise deleting the first 12, 24, 36, 48, and 60 months of returns (see Table A2 in the appendix for calculations). The monthly return of the portfolio which invests in all funds is 1.03 for hedge funds and 0.68 for funds of funds. Eliminating the first 12 months of returns for each fund reduces the return about 0.18 for hedge funds and 0.03 for funds of funds. These values are again comparable to other values in the literature. For example, Fung and Hsieh (2000) find that backfilling bias is noticeably lower with funds of funds than with hedge funds. However, we cannot confirm the finding of Capocci and Hübner (2004) that backfilling bias is bigger the longer the estimation period is.

We compare hedge funds and fund of hedge funds with the passive benchmark indices used as market factors in alpha measurement literature (see Table 3). The equity market proxy is the value-weighted portfolio of all NYSE, Amex and Nasdaq stocks used in Fama and French (1993) and Carhart (1997). Furthermore, the MSCI World excluding US, the MSCI Emerging Markets, Fama and French's (1993) factors for size (SML) and book-to-market (HML), and Carhart's (1997) momentum factor are used as passive equity benchmark indices. Bonds are represented by the Lehman US Aggregate Bond, the JP Morgan Global Government Bond, the JP Morgan Emerging Market Bond, and the Lehman BAA Corporate Bond Index. Finally, we use the JPM US Cash 1 Month Index and the Goldman Sachs Commodity Index as passive benchmark indices for currencies and commodities.

3.2 Descriptive Statistics and Performance Measurement

Descriptive statistics and performance measurement results for the 4,314 funds and the passive strategy indices are presented in Table 6. The analyzed funds are subdivided by the strategy group in the first column. The second, third and fourth column displays the number of funds, subdivided in all, living, and dead funds. Columns five to eight show the first four moments of the return distribution (mean value, standard deviation, skewness, and excess

kurtosis). Column 9 shows the results of the Jarque-Bera test, which are displayed as the portion of funds for which the assumption of normally distributed returns must be rejected at 5% significance level. Mean excess returns are calculated in column 10 using the one-month Treasury bill rate provided by Ibbotson Associates. The Sharpe ratio (column 11) is computed as the mean excess return divided by the standard deviation.

In addition to raw returns and to the Sharpe ratio we analyze two performance measurement models and the resulting alpha values. The first version of alpha (α_m) is market adjusted and very similar to the combined model presented by Capocci and Hübner (2004). For each fund it is calculated as the intercept of a regression of the returns of the 12 benchmark indices displayed in Table 6 on the funds excess returns. The second version of alpha (α_{ms}) is market and hedge fund style adjusted. The market factors for the alpha calculation are again the 12 benchmark indices. For calculation of the hedge fund style factor we follow Agarwal and Naik (2000a) and use the average return of the funds following the same strategy. The two versions of alpha and the associated R2 are displayed in colums 12 to 15 of Table 6.[8]

The performance measurement results show significant evidence of superior hedge fund performance over long periods of time. The highest mean return of all strategies was achieved by Sector (1.38%) followed by funds that have no strategy description (1.23%) and Emerging Markets (1.26%). Strategies that offer the lowest mean return are Short Bias (0.43%), Fixed Income Arbitrage (0.51%), and Equity Market Neutral (0.61%). The mean return of all hedge funds in the database is 1.03%, while funds of hedge funds only achieve 0.68%. However, compared to the benchmark indices hedge funds as well as funds of hedge funds provide quite high returns.

Taking the investment risk into account through the Sharpe ratio, there are other strategies offering the best trade-off between risk and return: Fixed Income – MBS (0.32), followed by Other (0.32) and Relative Value Multi Strategy (0.31). The lowest Sharpe ratio is obtained by Short Bias (0.02). But again most funds provide a very high Sharpe ratio compared to the benchmark indices, which can be taken as evidence of superior hedge fund performance.

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[8]   The full performance measurement results are displayed in Table A3 of the appendix. The Fama & French factors for size (SMB) and book-to-market (HML) are highly significant for most hedge funds and funds of funds.

Table 6: Descriptive statistics and Performance Measurement

	Number of funds			Returns					Mean Excess Return	Sharpe ratio	market adjusted model		market and style adjusted model	
	Total	Liv-ing	Dead	Mean (%)	St. Dev. (%)	Skew.	Exc. Kurt.	Jarque Bera (%)			α_m	R^2_m	α_{ms}	R^2_{ms}
A. Hedge funds (2,936 funds)														
Convertible Arbitrage	159	82	77	0.82	2.13	-0.17	2.86	0.58	0.56	0.26	0.16***	0.37	-0.30***	0.44
Distressed Securities	113	66	47	1.14	3.64	0.11	3.14	0.64	0.87	0.24	0.79***	0.49	-0.29	0.56
Emerging Markets	257	137	120	1.21	7.05	-0.32	5.20	0.61	0.92	0.13	0.97***	0.56	-0.77***	0.60
Equity Long Only	57	33	24	1.19	6.43	-0.04	0.84	0.37	0.94	0.15	0.48**	0.68	-0.45	0.70
Equity Long/Short	1109	512	597	1.14	5.09	0.25	2.40	0.52	0.87	0.17	0.34***	0.53	-0.47***	0.57
Equity Market Neutral	164	92	72	0.61	2.74	0.13	2.72	0.44	0.38	0.14	0.16**	0.43	-0.04	0.47
Event Driven Multi Strategy	120	85	35	1.04	3.14	-0.11	3.11	0.63	0.81	0.26	0.68***	0.48	0.09	0.55
Fixed Income	65	55	10	0.69	1.71	-0.13	1.37	0.34	0.49	0.29	0.24***	0.56	0.07	0.59
Fixed Income – MBS	54	32	22	0.91	2.10	-1.51	15.69	0.87	0.67	0.32	0.76***	0.25	0.64***	0.29
Fixed Income Arbitrage	111	51	60	0.51	2.13	-0.84	6.53	0.67	0.25	0.12	0.56***	0.41	0.03	0.45
Global Macro	142	67	75	0.86	4.80	0.16	2.34	0.49	0.57	0.12	0.16	0.45	-0.25	0.48
Merger Arbitrage	104	37	67	0.70	2.00	-0.32	3.72	0.72	0.41	0.20	0.14	0.38	-0.11	0.41
Multi Strategy	47	43	4	1.00	2.89	0.25	2.43	0.51	0.80	0.28	0.51***	0.37	0.03	0.46
No Strategy	47	15	32	1.23	3.69	0.12	2.05	0.64	0.95	0.26	0.69***	0.46	-0.01	0.52
Other	36	28	8	1.01	2.48	0.78	3.06	0.75	0.79	0.32	0.14	0.42	0.12	0.45
Relative Value Multi Strategy	61	51	10	0.90	1.71	0.02	5.46	0.61	0.80	0.31	0.41***	0.37	0.09	0.44
Sector	257	108	149	1.38	7.06	0.44	3.35	0.56	1.10	0.16	0.51***	0.57	-0.36***	0.61
Short Bias	33	11	22	0.43	6.84	0.11	1.68	0.39	0.12	0.02	0.81***	0.66	0.57**	0.67
All funds	2936	1505	1431	1.03	4.53	0.05	3.28	0.55	0.77	0.17	0.44***	0.50	-0.30***	0.54
B. Funds of Funds (1,378 funds)														
Market Neutral	41	41	0	0.64	1.51	-0.48	2.28	0.46	0.43	0.29	0.07	0.61	-0.20	0.70
Multi Strategy	832	779	53	0.70	1.70	-0.19	2.19	0.43	0.50	0.29	-0.01	0.49	-0.16*	0.62
No Strategy	336	50	286	0.64	2.86	-0.34	3.81	0.55	0.32	0.11	-0.02	0.59	-0.18***	0.70
Other	33	33	0	0.68	1.78	-0.33	0.54	0.27	0.51	0.29	0.09	0.63	-0.13	0.71
Single Strategy	136	130	6	0.71	1.85	-0.16	2.62	0.45	0.53	0.28	0.25	0.59	-0.06	0.69
All funds	1378	1033	345	0.68	2.00	-0.24	2.59	0.46	0.46	0.23	0.08	0.59	-0.10	0.68
C. Passive strategy indice														
Equity														
Market proxy				0.86	4.66	-0.67	0.43		0.56	0.12				
MSCI World ex US				0.62	4.31	-0.52	0.37		0.33	0.08				
MSCI Emerging Markets				0.81	6.87	-0.91	2.06		0.51	0.07				
Fama & French SMB				0.29	4.35	0.73	5.79		-0.01	0.00				
Fama & French HML				0.46	3.96	0.02	1.84		0.16	0.04				
Momentum				0.86	5.75	-0.63	3.85		0.57	0.10				
Bonds														
Lehman US Aggregate				-0.03	1.09	-0.63	0.65		-0.33	-0.30				
JPM Global Gov. Bond				0.44	1.87	0.36	0.14		0.14	0.07				
JPM Emerging Markets Bond				1.11	4.11	-2.90	18.52		0.82	0.20				
Lehman BAA Corporate				-0.01	1.59	-0.12	0.28		-0.31	-0.20				
Currency														
JPM US Cash 1Month				0.34	0.16	-0.26	-1.54		0.04	0.24				
Commodity														
Goldman Sachs Commodity				0.95	6.17	0.10	-0.27		0.65	0.11				

This table shows the number of funds (subdivided in all, living, and dead funds, column 2, 3, and 4), the first four moments of the return distribution (mean value, standard deviation, skewness, and excess kurtosis, column 5 to 8), the portion of funds for which the assumption of normally distributed returns must be rejected at the 5% significance level (Jarque-Bera test, column 9), mean excess returns (column 10) using the one-month Treasury bill rate, the Sharpe ratio (column 11), average age (column 12), average annual management fee (column 13), average annual incentive fee (column 14), and average minimum investment (column 15) for the funds in our database of 2,936 hedge funds (Panel A., broken down into 22 strategies) and 1,378 funds of funds (Panel B., broken down into 7 strategies). The table also reports the first for moments and the Jarque-Bera test results for the passive strategy indices (Panel C.).

While some investors might be more concerned with central tendencies of the return distribution (mean value, standard deviation), others may care more about the extreme values. For these investors it is interesting to consider skewness, excess kurtosis and the results of the

Jarque-Bera test. The returns of most hedge funds and funds of funds are not normally distributed. The rejection rate for the Jarque-Bera test varies between 27% with Other Funds of Funds and 87% with Fixed Income – MBS. For the whole database it is 55% for hedge funds and 46% for funds of funds.

Considering alpha we find strong evidence of superior hedge fund performance for the market adjusted model, as 15 of 18 strategies achieve significant positive alphas. We find no evidence of superior funds of funds performance. The average R^2_{ma} varies between 0.25 for Fixed Income-MBS and 0.68 for Equity Long Only, making the model quite powerful for some hedge fund strategies. R^2 is even higher looking at the market and strategy adjusted model. It varies between 0.29 for Fixed Income-MBS and 0.71 for Other Funds of Funds. Alpha is significant lower in this model. There are only two hedge funds strategies that achieve significant positive alphas. These are Fixed Income – MBS and Short Bias.

3.3 Measurement of Performance Persistence

In the performance persistence study we analyze six time horizons (monthly, bimonthly, quarterly, half-yearly, yearly, and two-yearly horizon), six performance measures (raw returns, Sharpe ratio, two versions of alpha, and the two associated appraisal ratios), and seven statistical methodologies (cross product ratio test (CPR), chi square test (CS), rank information coefficient (RIC), Spearman rank correlation test (SRC), Hurst exponent test (HE), cross sectional regression (CSR), and Kolmogorov/Smirnov test (KS)).

We present the results on different aggregation levels, in order to focus on different aspects of performance persistence. The first focus is on the different methodologies (see Table 7), the second focus is on differences in hedge fund strategies (see Table 8) and the third focus is on the different performance measures used to assess performance persistence (see Table 9).

In Table 7, we first compare the methodologies used in performance persistence analysis. We focus on raw returns as performance measure and we compare the results of the seven methodologies for different time horizons (the results for the other performance measures are displayed in Table A4 in the appendix). In the Table we show the percentage of cases exhibiting statistically significant performance persistence.

Table 7: Comparison of Methodologies

Time horizon (months)	1	2	3	6	12	24
A. Hedge funds (2,936 funds)						
CPR	28.10	28.91	28.92	31.29	29.63	18.06
CHI	35.71	35.03	34.76	34.50	36.42	29.17
RIC	37.39	40.49	36.75	41.23	41.36	33.33
SRC	36.83	39.83	37.46	45.32	44.44	33.33
Hurst	94.63	90.65	81.89	75.62	42.39	19.40
CSR	52.45	44.61	41.15	29.99	24.90	20.77
KS	9.32	7.95	7.60	8.95	9.03	9.26
Average	42.06	41.07	38.36	38.13	32.60	23.33
B. Funds of Funds (1,378 funds)						
CPR	29.41	30.51	31.28	40.00	33.33	25.00
CHI	40.34	40.34	38.97	42.11	42.22	30.00
RIC	41.68	44.07	39.49	47.37	46.67	40.00
SRC	38.15	38.98	37.44	51.58	46.67	35.00
Hurst	95.93	93.20	84.30	75.04	47.31	27.99
CSR	61.99	56.96	56.98	49.60	38.65	27.07
KS	21.02	20.00	15.79	20.00	20.00	6.67
Average	46.93	46.29	43.46	46.53	39.26	27.39

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A.) and 1,378 funds of funds (Panel B.). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis. The tests employed include cross product ratio (CPR), chi square (CHI), the Rank Information Coefficient (RIC), Spearman rank correlation (SRC), Hurst, cross sectional regression (CSR), and Kolmogorov/Smirnov (KS).

In Table 7 we find high levels of short-term persistence for horizons of up to six months with most of the tests. We also find that the persistence significance levels weaken as one lengthens the measurement horizons. This basically confirms the findings presented in Section 2.5. Consider the cross sectional regression (CSR) with hedge funds as an example. At monthly horizon, one out of two funds (52.45%) exhibits statistically significant performance persistence. However, for the annual and bi-annual horizon only 24.90% and 20.77% of all funds show significant persistence. An exception is the Kolmogorov/Smirnov test with hedge funds where the relatively low level of persistence remains at 9%. However, with funds of funds it also declines and is only 6.67% at the two-year horizon. Comparable results can be found for the Sharpe ratio and the alpha-based measures (see Table A4 in the appendix).

However, comparing the results we find that the levels of significance strongly differ depending on the methodology. Considering the panel of hedge funds at monthly horizon, the regression-based tests (CSR) and the Hurst exponent provide clear evidence of performance persistence; the portion of significant cases is above 50%. Correlation based tests (RIC and SRC) and contingency table based tests (CPR and Chi) deliver a more mixed picture; the portion of significant results varies between 28.10% (CPR) and 37.39% (RIC). With the multi-period Kolmogorov/Smirnov we find hardly performance persistence; the percentage of cases exhibiting statistically significant performance persistence is only 9.32%. We thus conclude that the use of different methodologies is one of the main drivers for the confusing, mixed results found in literature. We also confirm the findings of Agarwal/Naik (2000a) that the level of

persistence observed in a multi-period framework is considerably smaller than that observed under the two-period framework.

Our second step is to analyze differences in hedge fund strategies. In Table 8 we again focus on raw returns and show the percentage of cases exhibiting statistically significant performance persistence for 23 strategy groups (the results for the other performance measures are displayed in Table A5 of the appendix). In this Table the results are aggregated above the different methodologies presented in the last Table.

Table 8: Comparison of Hedge Fund Strategies

Time horizon (month)	1	2	3	6	12	24
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	56.95	50.96	45.19	51.05	52.09	23.33
Distressed Securities	43.38	40.70	34.89	39.39	19.26	15.13
Emerging Markets	52.70	48.97	48.40	41.19	46.06	34.77
Equity Long Only	26.87	29.10	22.45	23.81	16.70	25.12
Equity Long/Short	46.27	43.89	40.13	36.40	36.02	25.09
Equity Market Neutral	38.03	39.15	34.77	34.85	14.66	5.16
Event Driven Multi Strategy	48.15	42.74	41.75	43.74	22.97	24.28
Fixed Income	35.99	37.97	37.73	33.52	24.95	9.98
Fixed Income – MBS	49.34	52.81	49.11	48.15	33.71	32.20
Fixed Income Arbitrage	49.25	49.79	47.39	41.42	38.55	6.54
Global Macro	32.65	34.94	30.46	29.12	35.11	22.84
Merger Arbitrage	39.34	39.04	37.51	42.51	39.62	40.68
Multi Strategy	34.27	35.75	31.11	25.76	24.90	32.86
No Strategy	38.36	40.36	35.26	33.56	35.92	14.23
Other	39.14	36.49	38.50	28.74	30.80	22.65
Relative Value Multi Strategy	47.75	40.63	43.61	49.26	32.12	19.45
Sector	47.53	48.96	46.33	54.00	55.90	53.75
Short Bias	31.19	26.93	25.92	29.85	27.38	11.90
All Funds	42.06	41.07	38.36	38.13	32.60	23.33
B. Funds of Funds (1,378 funds)						
Market Neutral	41.58	42.35	45.00	48.45	42.97	12.20
Multi Strategy	57.99	58.48	52.89	65.57	55.26	39.53
No Strategy	54.40	54.38	49.45	53.77	49.74	27.03
Other	32.50	29.70	25.74	24.26	20.04	30.00
Single Strategy	48.19	46.57	44.23	40.59	28.32	28.18
All Funds	46.93	46.29	43.46	46.53	39.26	27.39

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A., subdivided in 18 strategies) and 1,378 funds of funds (Panel B., subdivided in 5 strategies). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis.

We find large differences in results depending on the hedge fund strategy. With hedge funds following the Convertible Arbitrage or the Emerging Markets strategy we find very high levels of persistence, but with Other Funds of Funds and Equity Long Only hedge funds the levels of significance are considerably smaller. We thus follow Brown and Goetzmann (2003) and Harri and Brorsen (2004) and conclude that persistence is related to the type of hedge fund strategy followed. It is also interesting that Merger Arbitrage and Sector hedge funds retain their high levels of significance, while with most other strategies the significance level decreases as one lengthens the measurement horizon.

Finally, we compare the performance measures used to asses performance persistence. The results presented in Table 9 are aggregated for all the methodologies presented in Table 7 and all hedge fund strategies presented in 8.

Table 9: Comparison of Measures

Time horizon (months)	1	2	3	6	12	24
A. Hedge funds (2,936 funds)						
Return	42.06	41.07	38.36	38.13	32.60	23.33
Excess return	39.78	38.97	36.59	37.23	32.50	25.30
Sharpe ratio	33.97	34.77	33.44	36.66	35.75	33.80
α_m	34.72	34.55	32.03	33.64	28.90	20.86
AR_m	33.76	34.66	32.49	37.58	36.76	33.92
α_{ms}	36.02	36.24	34.23	36.75	30.68	21.57
AR_{ms}	34.73	34.89	33.53	37.76	35.29	35.84
Average	36.43	36.45	34.38	36.82	33.21	27.80
B. Funds of Funds (1,378 funds)						
Return	46.93	46.29	43.46	46.53	39.26	27.39
Excess return	44.01	42.84	40.36	43.56	37.72	29.77
Sharpe ratio	37.96	38.03	39.82	43.58	44.25	36.00
α_m	37.87	37.85	34.95	41.72	29.93	25.05
AR_m	36.06	38.37	38.71	45.10	44.69	36.01
α_{ms}	42.43	41.39	39.76	42.67	37.96	26.20
AR_{ms}	36.40	37.94	37.01	43.71	40.36	39.11
Average	40.24	40.39	39.15	43.84	39.17	31.36

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A.) and 1,378 funds of funds (Panel B.). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis using seven different performance measures: raw returns, the Sharpe ratio (SR), two versions of alpha and the two associated versions of appraisal ratio (AR).

Comparing the performance measures, we find only small differences in the levels of significance. Considering hedge fund returns at monthly horizon as an example, the significance levels varies between 33.76% with the market adjusted appraisal ratio and 42.06% with returns. We again find that the persistence significance levels weaken as one lengthens the measurement horizons. The only exeption is that the level of significance remains very stable with the appraisal ratios. However, overall it seems that the level of hedge fund performance persistence is not related to the choice of performance measures.

4 Conclusion

The purpose of this paper was to review recent studies on hedge fund performance persistence and to provide new empirical evidence on this widely discussed topic. We find a large number of different studies which give a quite confusing picture. There are many different results, which might be produced by different databases, performance measures, and statistical methodologies. While most authors find short-term persistence for horizons of up to six months, the return persistence significance levels weakens as one lengthens the measurement horizons.

To get a more accurate picture of persistence in hedge fund performance we empirically investigate 4,314 hedge funds from the CISDM database. We find short-term persistence for horizons of up to six months. We also find that the persistence significance levels are lower the longer the time horizon is. These findings thus confirm the main tenor reported in literature. Moreover, we could identify the key driver for the confusing, mixed results found in parts of the literature, as we find large differences depending on the methodology used to assess performance persistence. Using regression-based tests and the Hurst exponent we find clear evidence of performance persistence, but correlation- and contingency-table-based provide a mixed picture. With the multi period Kolmogorov/Smirnov test we even find hardly persistence. We thus conclude that the use of different methodologies is one of the main drivers for the confusing, mixed results found in literature.

We also find large differences in results depending on the hedge fund strategy. Convertible Arbitrage and Emerging Markets hedge funds provide very high levels of persistence, but regarding equity long only hedge funds we find low levels of persistence. We thus conclude that persistence is related to the type of hedge fund strategy. Finally, we find very similar results comparing different measures used to assess performance persistence, such as raw returns, alphas, and appraisal ratios. We conclude that the use of different performance measures is not the reason for the conflicting results found in performance persistence literature.

The current state of literature and our empirical findings indicate that there is short-term persistence, but no long-term persistence in hedge fund performance. However, the problem with short-term persistence in hedge fund returns is that this cannot be profitably exploited by hedge fund investors due to significant lock-up periods as well as entry and exit cost. Future research should thus concentrate on new methodologies to analyze long-term performance persistence in hedge fund returns. As shown in our literature overview, there are a large number of studies that concentrate on short-term and mid-term performance persistence of up to one year. But for the two-year and three-year horizon there is less empirical evidence to date. However, current research such as Jagannathan et al. (2006) and Kosowski et al. (2006) provide interesting new insights into long-term persistence by using new, sophisticated methodologies. Therefore, long-term persistence in hedge fund performance might be a promising area of research in the coming years.

Appendix

Table A1: Attrition rate and survivorship bias

Year	Attrition rate				Survivorship Bias: Return of			
	Start (No.)	Entry (No.)	Dissolution (No.)	Attrition Rate (%)	All Funds (%)	Surviving Funds (%)	Dissolved Funds (%)	Survivorship Bias (%)
A. Hedge funds (2,936 funds)							Ø 0.08	
1996	889	240	45	5.06	1.76	1.83	-0.26	0.07
1997	1084	344	117	10.79	1.66	1.71	0.55	0.05
1998	1311	306	181	13.81	0.35	0.52	-2.07	0.17
1999	1436	335	207	14.42	2.71	2.84	0.58	0.13
2000	1564	291	172	11.00	0.79	0.85	-0.55	0.06
2001	1683	312	211	12.54	0.52	0.62	-1.28	0.10
2002	1784	358	225	12.61	0.06	0.15	-1.41	0.09
2003	1917	313	234	12.21	1.62	1.67	0.58	0.05
2004	1996	363	264	13.23	0.82	0.87	0.08	0.05
2005	2095	309	310	14.80	0.83	0.88	0.07	0.05
B. Funds of Funds (1,378 funds)							Ø 0.02	
1996	308	60	9	2.92	1.30	1.32	0.61	0.02
1997	359	96	18	5.01	1.38	1.40	0.41	0.02
1998	437	87	35	8.01	0.04	0.07	-1.00	0.03
1999	489	118	33	6.75	1.93	1.95	0.63	0.02
2000	574	119	43	7.49	0.69	0.71	0.14	0.02
2001	650	184	55	8.46	0.42	0.45	-0.59	0.03
2002	779	223	33	4.24	0.13	0.14	-0.35	0.01
2003	969	243	47	4.85	0.97	0.98	0.31	0.01
2004	1165	336	92	7.90	0.59	0.60	0.29	0.01
2005	1409	184	111	7.88	0.62	0.63	0.30	0.01

This table reports attrition rate and survivorship bias for our sample of 2,936 hedge funds and 1,378 funds of funds. In Panel A attrition rate is calculated in column 5 as the number of dissolved funds (column 4) divided by the number of funds at the beginning of the year (column 2). In Panel B survivorship bias is calculated in column 9 as the difference between the return of the survived funds (column 7) and the return of all funds (column 6).

Table A2: Backfilling bias

Year	Mean monthly return	Difference	Total number of funds	Average number of funds per month
A. Hedge Funds (2,936 funds)				
All months	1.03		2936	1525
Without first 12 months	0.85	0.19	2936	1368
Without first 24 months	0.65	0.38	2859	1089
Without first 36 months	0.65	0.38	2348	831
Without first 48 months	0.63	0.40	1822	621
Without first 60 months	0.73	0.31	1444	454
B. Funds of Funds (1,378 funds)				
All months	0.68		1378	720
Without first 12 months	0.65	0.03	1378	594
Without first 24 months	0.67	0.02	1324	464
Without first 36 months	0.62	0.06	1042	349
Without first 48 months	0.60	0.08	802	258
Without first 60 months	0.60	0.08	604	189

This table reports backfilling bias for our sample of 2,936 hedge funds and 1,378 funds of funds. We estimate backfilling bias by stepwise deleting the first months of returns. The backfilling bias is calculated in column 3 as the difference between the average monthly return of the portfolio which invests in all funds each month and the average monthly return of these funds after deleting the first 12, 24, 36, 48, and 60 months of returns.

Table A3: Performance measurement results

1. Market Adjusted Model

	Alpha	MKT	MSCI WxUS	MSCI EM	F&F SMB	F&F HML	MOM	LUS AGG	JPM GGB	JPM EMB	LBAA Corp.	JPM USC	GSC	R2	+	0	-
A. Hedge Funds (2,936 funds)																	
Convertible Arbitrage	0.16***	0.01	0.01	0.00	0.12***	0.02	-0.04***	-0.56***	-0.01	0.08***	0.36***	4.84***	0.01***	0.37	7	92	1
Distressed Securities	0.79***	0.16***	0.10***	0.03	0.29***	0.25***	-0.01	-0.70***	0.01	-0.05	0.59***	-8.10*	-0.01	0.49	28	72	0
Emerging Markets	0.97***	0.00	0.02	0.47***	0.17***	0.10***	0.12***	0.18	-0.39***	0.09**	0.23	-2.44	0.04***	0.56	11	89	0
Equity Long Only	0.48**	0.40***	0.19**	0.16***	0.23***	0.01	0.00	0.20	-0.13	-0.05	0.10	-2.24	0.02*	0.68	9	89	2
Equity Long/Short	0.34***	0.26***	0.09***	0.08***	0.20***	0.06***	0.02**	-0.03	-0.10***	-0.03**	0.09	5.78***	0.03***	0.53	4	95	1
Equity Market Neutral	0.16**	0.08***	-0.02	0.02	0.05***	0.05**	0.03	0.18	-0.01	0.01	-0.08	3.57**	0.01	0.43	4	95	1
Event Driven Multi Strategy	0.68***	0.17***	0.04	0.08***	0.22***	0.13***	-0.05**	-0.07	-0.03	-0.07**	0.20***	-4.02	-0.01	0.48	21	79	0
Fixed Income	0.24***	-0.03	0.09***	0.03**	0.14***	0.13***	-0.08**	-0.12	-0.05	0.06	0.22***	0.00	0.00	0.56	11	89	0
Fixed Income – MBS	0.76***	0.04	-0.06**	0.03**	0.03	0.01	0.02**	-0.08	-0.08*	-0.05**	0.26***	0.90	0.00	0.25	31	69	0
Fixed Income Arbitrage	0.56***	-0.05***	0.06***	0.02	0.09***	0.12***	0.01	-0.16	-0.17***	-0.01	0.20*	-2.87	-0.02*	0.41	14	86	0
Global Macro	0.16	0.03	0.07*	0.12***	0.15***	0.07*	-0.03	0.46***	-0.19**	0.01	0.05	9.60**	0.02*	0.45	8	91	1
Merger Arbitrage	0.14	0.18***	-0.01	-0.01	0.09***	0.08***	0.00	-0.04	0.03	0.02	-0.01	1.98	0.00	0.38	1	98	1
Multi Strategy	0.51***	0.22***	-0.05	0.02	0.10***	0.10*	0.00	0.47**	0.01	-0.01	-0.32***	-2.27	0.06***	0.37	19	81	0
No Strategy	0.69***	0.15***	0.05	0.10**	0.13***	-0.04	0.00	0.61***	-0.20***	-0.06	-0.22	13.05	0.00	0.46	6	94	0
Other	0.14	0.06	-0.02	0.00	0.02	-0.03	-0.01	-0.21	0.07	0.07*	-0.05	7.72	0.00	0.42	19	81	0
Relative Value Multi Strategy	0.41***	-0.03	0.05*	0.04**	0.08***	0.07***	-0.01	-0.14**	-0.03	0.01	0.12**	4.40**	0.01*	0.37			
Sector	0.51***	0.54***	-0.02	-0.01	0.29***	-0.08*	0.08***	-0.34	0.02	0.09***	0.15	6.93***	0.06***	0.57	4	96	1
Short Bias	0.81***	-0.62***	-0.04	0.06**	-0.27***	0.29***	-0.08	0.48	0.01	-0.08	-0.26	-1.83	-0.05***	0.66	0	100	0
All funds	0.44***	0.17***	0.05***	0.09***	0.17***	0.06***	0.02***	-0.04	-0.09***	0.00	0.13***	3.31 ***	0.02***	0.50	8	91	1
B. Funds of Funds (1,378 funds)																	
Market Neutral	0.07	-0.18***	0.17***	0.19***	0.14***	0.07	0.01	0.19	0.07*	-0.27***	0.17***	0.19	0.02**	0.61	54	8	38
Multi Strategy	-0.01	-0.06	0.08***	0.08***	0.09***	0.03	0.01	0.01	0.06**	-0.03	0.05	0.36	0.01***	0.49	34	29	37
No Strategy	-0.02	-0.03**	0.11***	0.12***	0.11***	0.08***	0.01***	0.13***	-0.01	-0.10***	0.07***	0.55***	0.01***	0.59	39	22	39
Other	0.09	-0.21***	0.20***	0.19***	0.13***	0.07	-0.01	0.20**	-0.01	-0.20***	0.11***	-0.24	0.01*	0.63	52	12	36
Single Strategy	0.25	-0.23	0.29***	0.11**	0.08***	-0.07	0.02***	0.11	-0.15	-0.04	0.10	-0.24	0.00	0.59	50	0	50
All funds	0.08	-0.01	0.12***	0.10***	0.11***	0.02	0.03***	0.16***	-0.06**	-0.09***	0.06*	0.23	0.02***	0.59	46	15	39

2. Market and Strategy Adjusted Model

	Alpha	MKT	MSCI WxUS	MSCI EM	F&F SMB	F&F HML	MOM	LUS AGG	JPM GGB	JPM EMB	LBAA Corp.	JPM USC	GSC	HF	R2	+	0	-
A. Hedge Funds (2,936 funds)																		
Convertible Arbitrage	-0.30***	-0.09***	-0.05***	-0.07***	-0.01	-0.01	-0.05***	-0.64***	0.05**	0.08***	0.34***	2.08	-0.01	0.77***	0.44	10	84	6
Distressed Securities	-0.29	-0.01	0.02	-0.14***	0.04	0.19***	-0.02	-0.69***	0.14**	-0.01	0.37**	-11.3***	-0.04***	1.31***	0.56	19	73	8
Emerging Markets	-0.77***	-0.40***	-0.06	0.28***	-0.22***	0.02	0.09***	0.17	-0.05	0.09*	-0.13	-11.9***	-0.04***	1.89***	0.60	10	79	11
Equity Long Only	-0.45	0.17	0.10	0.04	0.03	-0.05	-0.04	0.15	0.05	-0.05	-0.05	-6.29	-0.02	1.22***	0.70	5	84	11
Equity Long/Short	-0.47***	0.04*	0.05***	-0.03***	0.03*	0.02	-0.01	-0.14*	0.06**	-0.05***	0.03	0.61	0.00	1.07***	0.57	4	88	9
Equity Market Neutral	-0.04	0.03	-0.05	0.00	0.02	0.04	0.01	0.17	0.01	-0.01	-0.08	3.11*	0.00	0.27***	0.47	6	89	5
Event Driven Multi Strategy	0.09	0.03	-0.02	-0.03	0.06*	0.10***	-0.06***	-0.11	0.04	-0.08***	0.12*	-6.72***	-0.03***	1.04***	0.55	13	77	11
Fixed Income	0.07	-0.04	0.05	-0.01	0.08***	0.12***	-0.08***	-0.18	-0.03	0.08	0.21***	0.02	-0.01	0.32***	0.59	11	80	9
Fixed Income – MBS	0.64***	-0.01	-0.05*	0.02	0.00	0.01	0.01	-0.10	-0.07	-0.07***	0.27***	-0.62	0.00	0.21***	0.29	31	69	0
Fixed Income Arbitrage	0.03	-0.14***	0.03*	-0.03*	-0.03	0.09***	0.01	-0.17	-0.04	0.00	0.09	-4.35*	-0.04***	0.50***	0.48	21	73	6
Global Macro	-0.25	-0.12*	0.12	0.08	0.08	0.07	-0.05	0.54***	-0.13	-0.03	-0.07	6.02	0.00	0.44**	0.48	7	87	6
Merger Arbitrage	-0.11	0.11***	-0.02	-0.04	0.03	0.06***	0.00	-0.03	0.07	0.02	-0.08	0.08	-0.02	0.32***	0.41	6	91	3
Multi Strategy	0.03	0.07	-0.12*	-0.09	-0.07	0.07	-0.02	0.37*	0.05	-0.03	-0.36***	-8.47*	0.03**	1.18***	0.46	11	87	2
No Strategy	-0.01	0.03	0.00	0.07	0.02	-0.08	-0.02	0.60***	-0.04	-0.08*	-0.26	15.67	-0.03	0.53*	0.52	11	89	0
Other	0.12	0.07	-0.01	0.00	0.03	-0.01	-0.01	-0.36	0.03	0.05	0.06	9.04	0.01	0.04	0.45	22	69	8
Relative Value Multi Strategy	0.09	-0.11***	0.02	-0.02	-0.01	0.05**	-0.02***	-0.19***	0.01	0.00	0.10**	2.40	0.00	0.57***	0.44	16	80	3
Sector	-0.36***	0.25***	-0.02	-0.09***	0.14***	-0.11***	0.04*	-0.51**	0.18***	0.02	0.17	1.10	0.02*	1.06***	0.61	3	90	7
Short Bias	0.57**	-0.64***	-0.04	0.05*	-0.29***	0.28***	-0.08	0.51	0.06	-0.07	-0.31	-0.79	-0.05***	0.04	0.67	3	94	3
All funds	-0.30***	-0.01	0.01	0.00	0.01	0.03***	0.00	-0.11***	0.04***	-0.01	0.04	-0.88	-0.01***	0.94***	0.54	8	85	8
B. Funds of Funds (1,378 funds)																		
Market Neutral	-0.20	-0.20***	0.01	0.04	-0.07**	-0.01	0.03***	0.07	0.12***	-0.17***	0.08*	-0.63	0.00	1.16***	0.70	29	21	50
Multi Strategy	-0.16*	-0.13**	0.00	-0.02	-0.04	0.00	0.00	-0.03	0.08***	0.00	-0.02	-0.47	-0.01*	0.84***	0.62	24	34	41
No Strategy	-0.18***	-0.11***	0.02***	0.00	-0.05***	0.03***	0.01***	0.06***	0.01	-0.06***	0.01	-0.46***	0.00***	0.96***	0.70	25	23	52
Other	-0.13	-0.24***	0.08	0.07**	-0.03	0.02	0.00	0.14*	0.02	-0.14***	0.03	-0.89*	0.00	0.96***	0.71	36	15	48
Single Strategy	-0.06	-0.28	0.18	-0.04	-0.10*	-0.11*	0.02***	0.17	-0.17	0.00	-0.05	-0.73	-0.02	1.19***	0.69	50	0	50
All funds	-0.10	-0.07***	0.04*	-0.01	-0.04***	-0.02	0.03***	0.12	-0.05**	-0.05***	-0.01	-0.60***	0.00	0.94***	0.68	37	10	54

This table shows the performance measurement results for the market adjusted model (Part 1) and the market + strategy adjusted model (Part 2) for the 2,936 hedge funds (Panel A., broken down into 22 strategies) and 1,378 funds of funds (Panel A., broken down into 7 strategies). *** (**,*): significance at 1% (5%, 10%)-level.

Table A4: Comparison of Methodologies

Time horizon (months)	1	2	3	6	12	24
Excess Returns						
A. Hedge funds (2,936 funds)						
CPR	28.10	29.00	29.20	32.16	30.86	23.61
CHI	35.71	35.22	35.04	35.67	37.65	30.56
RIC	37.39	40.40	36.89	41.23	41.36	34.72
SRC	36.83	40.02	37.46	45.03	46.30	38.89
Hurst	94.45	90.18	82.37	75.61	44.56	18.53
CSR	36.67	30.00	27.85	22.29	17.72	17.84
KS	9.32	7.95	7.31	8.64	9.03	12.96
Average	39.78	38.97	36.59	37.23	32.50	25.30
B. Funds of Funds (1,378 funds)						
CPR	29.41	29.83	31.79	35.79	31.11	35.00
CHI	40.34	40.00	38.46	38.95	40.00	35.00
RIC	41.68	44.07	39.49	47.37	46.67	40.00
SRC	38.15	38.98	37.44	50.53	48.89	40.00
Hurst	96.92	93.01	86.21	77.00	47.53	28.42
CSR	40.55	33.63	32.80	34.17	29.82	23.33
KS	21.02	20.34	16.32	21.11	20.00	6.67
Average	44.01	42.84	40.36	43.56	37.72	29.77
Sharpe Ratio						
A. Hedge funds (2,936 funds)						
CPR	33.61	34.84	34.62	39.47	40.12	27.78
CHI	38.28	38.79	37.89	41.81	41.36	37.50
RIC	54.25	60.36	60.11	71.64	71.60	77.78
SRC	48.88	53.58	51.42	62.57	60.49	54.17
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	52.44	44.61	41.15	29.99	24.90	20.84
KS	10.36	11.21	8.92	11.11	11.81	18.52
Average	33.97	34.77	33.44	36.66	35.75	33.80
B. Funds of Funds (1,378 funds)						
CPR	38.15	36.61	40.51	44.21	51.11	30.00
CHI	44.03	41.69	46.15	48.42	53.33	30.00
RIC	49.24	54.92	54.36	66.32	64.44	75.00
SRC	49.58	50.51	53.33	63.16	62.22	70.00
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	61.99	56.96	56.98	49.60	38.65	27.03
KS	22.71	25.52	27.37	33.33	40.00	20.00
Average	37.96	38.03	39.82	43.58	44.25	36.00
α_m						
A. Hedge funds (2,936 funds)						
CPR	28.10	28.34	27.49	30.41	27.16	25.00
CHI	35.67	34.93	34.19	33.63	34.57	34.72
RIC	37.39	39.92	36.32	38.30	37.04	31.94
SRC	36.83	39.74	35.90	42.69	43.83	34.72
Hurst	89.75	85.46	76.18	78.27	47.44	11.05
CSR	5.97	5.30	5.53	4.16	4.61	4.90
KS	9.32	8.14	8.63	8.02	7.64	3.70
Average	34.72	34.55	32.03	33.64	28.90	20.86
B. Funds of Funds (1,378 funds)						
CPR	29.41	29.83	28.21	36.84	26.67	25.00
CHI	40.34	41.02	36.92	41.05	35.56	30.00
RIC	41.68	41.69	39.49	43.16	40.00	40.00
SRC	38.15	39.32	36.41	52.63	37.78	40.00
Hurst	93.39	91.72	85.44	89.78	53.08	11.33
CSR	1.13	0.64	0.31	1.90	1.43	2.37
KS	21.02	20.69	17.89	26.67	15.00	26.67
Average	37.87	37.85	34.95	41.72	29.93	25.05

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A.) and 1,378 funds of funds (Panel B.). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis. The tests employed include cross product ratio (CPR), chi square (CHI), the Rank Information Coefficient (RIC), Spearman rank correlation (SRC), Hurst, cross sectional regression (CSR), and Kolmogorov/Smirnov (KS).

Table A4: Comparison of Methodologies (continued)

Time horizon (months)	1	2	3	6	12	24
AR_m						
A. Hedge funds (2,936 funds)						
CPR	33.24	35.59	32.76	40.35	41.98	34.72
CHI	38.28	39.55	37.75	43.57	45.68	43.06
RIC	53.03	59.60	56.55	73.39	67.28	70.83
SRC	48.65	52.64	49.72	63.74	63.58	56.94
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	52.44	44.61	41.15	29.99	24.90	20.77
KS	10.64	10.63	9.50	12.04	13.89	11.11
Average	33.76	34.66	32.49	37.58	36.76	33.92
B. Funds of Funds (1,378 funds)						
CPR	35.63	38.31	41.03	49.47	51.11	30.00
CHI	41.01	44.07	45.13	51.58	53.33	35.00
RIC	46.22	54.92	52.31	67.37	62.22	75.00
SRC	46.39	47.12	49.23	62.11	60.00	65.00
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	61.99	56.96	56.98	49.60	38.65	27.07
KS	21.19	27.24	26.32	35.56	47.50	20.00
Average	36.06	38.37	38.71	45.10	44.69	36.01
α_{ms}						
A. Hedge funds (2,936 funds)						
CPR	28.10	29.57	29.34	35.96	32.72	19.44
CHI	35.67	35.88	35.61	38.60	37.65	30.56
RIC	37.39	40.40	37.75	41.52	40.12	34.72
SRC	36.83	40.21	37.18	45.32	44.44	30.56
Hurst	95.06	91.28	84.77	78.22	43.73	21.30
CSR	9.72	7.84	6.90	6.82	4.97	7.01
KS	9.32	8.52	8.04	10.80	11.11	7.41
Average	36.02	36.24	34.23	36.75	30.68	21.57
B. Funds of Funds (1,378 funds)						
CPR	29.41	30.17	31.28	37.89	37.78	25.00
CHI	40.34	41.02	39.49	41.05	42.22	25.00
RIC	41.68	43.05	40.00	46.32	46.67	40.00
SRC	38.15	38.64	37.44	51.58	48.89	35.00
Hurst	96.83	91.01	89.09	80.51	54.72	22.92
CSR	29.58	25.82	25.78	20.24	15.45	8.79
KS	21.02	20.00	15.26	21.11	20.00	26.67
Average	42.43	41.39	39.76	42.67	37.96	26.20
AR_{ms}						
A. Hedge funds (2,936 funds)						
CPR	34.97	35.50	35.47	38.60	33.95	37.50
CHI	40.71	40.30	39.74	42.69	39.51	43.06
RIC	54.01	59.51	57.26	73.39	72.22	70.83
SRC	49.21	53.39	50.57	66.67	66.05	58.33
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	52.44	44.61	41.15	29.99	24.90	20.77
KS	11.77	10.92	10.53	12.96	10.42	20.37
Average	34.73	34.89	33.53	37.76	35.29	35.84
B. Funds of Funds (1,378 funds)						
CPR	36.81	36.95	36.41	47.37	42.22	45.00
CHI	42.52	42.71	41.03	50.53	48.89	45.00
RIC	45.38	54.24	52.31	65.26	60.00	70.00
SRC	46.89	47.80	50.77	62.11	57.78	60.00
Hurst	0.00	0.00	0.00	0.00	0.00	0.00
CSR	61.99	56.96	56.98	49.60	38.65	27.07
KS	21.19	26.90	21.58	31.11	35.00	26.67
Average	36.40	37.94	37.01	43.71	40.36	39.11

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A.) and 1,378 funds of funds (Panel B.). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis. The tests employed include cross product ratio (CPR), chi square (CHI), the Rank Information Coefficient (RIC), Spearman rank correlation (SRC), Hurst, cross sectional regression (CSR), and Kolmogorov/Smirnov (KS).

Table A5: Comparison of Hedge Fund Strategies

Time horizon (month)	1	2	3	6	12	24
Excess Returns						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	55.33	49.80	45.33	50.60	50.01	33.90
Distressed Securities	41.10	39.10	33.86	37.38	18.07	14.32
Emerging Markets	51.53	48.12	46.99	38.51	42.61	38.26
Equity Long Only	25.11	27.85	21.45	22.06	14.24	25.12
Equity Long/Short	44.27	42.50	39.12	36.51	38.51	42.10
Equity Market Neutral	35.07	36.42	32.07	36.58	19.32	4.35
Event Driven Multi Strategy	45.39	40.13	39.74	42.08	23.63	21.79
Fixed Income	32.03	35.16	34.73	30.70	29.03	8.46
Fixed Income – MBS	46.70	50.12	47.64	48.82	32.79	21.27
Fixed Income Arbitrage	46.29	46.68	45.81	41.31	44.47	6.28
Global Macro	30.44	33.00	28.45	26.20	27.36	27.43
Merger Arbitrage	35.77	37.47	35.04	40.07	40.63	42.94
Multi Strategy	33.05	33.38	29.59	25.60	24.96	32.74
No Strategy	34.62	34.98	30.70	33.85	28.96	28.47
Other	37.55	34.71	36.88	29.45	33.32	25.12
Relative Value Multi Strategy	46.11	40.31	42.29	47.86	32.40	22.91
Sector	45.86	47.35	45.42	52.15	55.68	45.10
Short Bias	29.89	24.33	23.52	30.49	28.94	14.88
All Funds	39.78	38.97	36.59	37.23	32.50	25.30
B. Funds of Funds (1,378 funds)						
Market Neutral	38.80	38.41	40.14	44.27	39.66	26.37
Multi Strategy	54.93	54.24	49.61	62.13	50.00	30.63
No Strategy	51.50	51.98	48.40	50.15	48.98	33.83
Other	29.90	26.67	23.14	22.96	21.21	29.48
Single Strategy	44.93	42.90	40.48	38.28	28.73	28.57
All Funds	44.01	42.84	40.36	43.56	37.72	29.77
Sharpe ratio						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	57.95	58.76	52.65	55.51	53.19	39.10
Distressed Securities	36.47	31.92	34.42	36.42	33.73	27.99
Emerging Markets	40.56	38.82	36.86	40.01	52.42	40.26
Equity Long Only	15.56	15.87	13.67	26.07	20.25	32.89
Equity Long/Short	33.11	40.34	32.31	41.05	46.67	55.00
Equity Market Neutral	34.07	32.15	30.54	31.65	27.55	41.42
Event Driven Multi Strategy	35.42	34.25	32.16	41.21	37.96	30.42
Fixed Income	28.79	29.83	30.70	38.71	26.37	24.11
Fixed Income – MBS	52.37	52.84	46.85	43.54	42.34	36.90
Fixed Income Arbitrage	57.33	57.26	57.27	54.77	56.01	46.69
Global Macro	20.58	17.57	18.66	27.98	24.31	35.06
Merger Arbitrage	28.88	27.03	30.78	33.35	37.10	37.27
Multi Strategy	23.53	25.65	26.24	23.53	30.85	20.30
No Strategy	27.15	38.14	37.24	35.53	36.83	25.84
Other	34.58	39.17	39.75	31.08	35.16	32.54
Relative Value Multi Strategy	39.58	37.49	37.35	41.09	22.78	16.15
Sector	32.61	42.51	37.85	47.93	60.11	56.18
Short Bias	14.99	12.14	10.16	16.34	10.45	14.29
All Funds	34.08	35.10	33.64	36.99	36.34	34.02
B. Funds of Funds (1,378 funds)						
Market Neutral	31.01	30.84	27.70	33.20	24.16	20.54
Multi Strategy	51.43	55.16	58.64	64.34	62.35	56.14
No Strategy	50.40	52.34	57.55	61.91	72.53	50.16
Other	20.42	17.87	18.20	13.46	21.11	24.29
Single Strategy	36.53	33.94	36.98	44.98	41.12	28.90
All Funds	37.96	38.03	39.82	43.58	44.25	36.00

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A., subdivided in 18 strategies) and 1,378 funds of funds (Panel B., subdivided in 5 strategies). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis.

Table A5: Comparison of Hedge Fund Strategies (continued)

Time horizon (month)	1	2	3	6	12	24
α_m						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	49.94	45.70	39.46	54.01	41.14	28.02
Distressed Securities	35.04	33.06	30.72	31.92	19.30	10.12
Emerging Markets	49.45	46.89	45.79	44.72	41.68	33.32
Equity Long Only	22.86	27.06	20.29	24.06	11.81	12.58
Equity Long/Short	41.05	41.27	36.26	32.46	35.24	31.00
Equity Market Neutral	32.29	32.27	28.72	31.12	14.78	0.99
Event Driven Multi Strategy	39.75	34.27	32.42	39.85	22.03	28.98
Fixed Income	26.76	31.98	27.41	22.54	24.47	6.06
Fixed Income – MBS	39.03	43.77	42.71	44.67	31.73	16.28
Fixed Income Arbitrage	39.99	40.28	35.24	30.83	26.91	11.49
Global Macro	27.52	28.47	27.10	28.35	23.33	20.76
Merger Arbitrage	29.45	30.90	28.49	32.25	28.34	22.39
Multi Strategy	25.45	26.58	24.73	18.76	26.42	34.28
No Strategy	28.76	30.87	27.55	27.66	28.38	27.57
Other	29.62	30.10	30.68	23.66	27.05	26.10
Relative Value Multi Strategy	36.51	30.07	32.56	43.04	31.42	8.24
Sector	43.36	44.97	45.03	47.60	54.23	38.32
Short Bias	28.16	23.34	21.42	28.02	31.88	19.05
All Funds	34.72	34.55	32.03	33.64	28.90	20.86
B. Funds of Funds (1,378 funds)						
Market Neutral	31.48	32.84	30.51	39.37	27.19	11.19
Multi Strategy	46.76	48.42	43.91	55.03	41.61	55.28
No Strategy	47.59	48.64	44.36	52.27	44.51	35.25
Other	24.70	21.61	19.68	26.30	15.91	18.07
Single Strategy	38.84	37.72	36.31	35.62	20.42	5.46
All Funds	37.87	37.85	34.95	41.72	29.93	25.05
AR_m						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	54.58	55.58	49.32	58.56	54.78	30.77
Distressed Securities	34.79	32.89	33.68	37.93	36.90	42.06
Emerging Markets	39.74	37.60	35.04	36.96	52.42	40.26
Equity Long Only	16.40	15.64	15.13	26.07	23.42	22.18
Equity Long/Short	33.29	35.67	29.61	37.27	37.78	50.94
Equity Market Neutral	33.11	32.63	29.06	36.16	22.78	36.66
Event Driven Multi Strategy	35.42	35.22	32.17	41.26	42.92	44.70
Fixed Income	27.82	27.41	28.50	31.90	26.37	13.39
Fixed Income – MBS	52.25	52.85	46.13	42.79	43.93	40.48
Fixed Income Arbitrage	56.37	55.79	56.55	59.32	61.17	20.50
Global Macro	21.30	20.96	18.30	27.98	21.14	20.78
Merger Arbitrage	28.64	28.98	28.97	34.89	46.82	44.41
Multi Strategy	23.05	23.71	25.49	19.77	29.26	20.30
No Strategy	27.27	37.41	36.90	38.66	33.46	43.70
Other	34.22	37.95	37.92	31.83	27.03	28.97
Relative Value Multi Strategy	40.07	37.00	33.32	44.09	27.54	41.15
Sector	34.29	40.81	35.27	50.90	52.37	55.02
Short Bias	14.99	15.79	13.46	20.14	21.56	14.29
All Funds	33.76	34.66	32.49	37.58	36.76	33.92
B. Funds of Funds (1,378 funds)						
Market Neutral	27.89	29.62	27.71	30.91	29.12	27.68
Multi Strategy	49.39	55.40	53.47	69.77	67.31	49.03
No Strategy	47.04	53.31	56.82	66.34	64.59	46.59
Other	20.54	18.84	17.84	14.96	24.48	24.29
Single Strategy	35.45	34.69	37.72	43.52	37.94	32.47
All Funds	36.06	38.37	38.71	45.10	44.69	36.01

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A., subdivided in 18 strategies) and 1,378 funds of funds (Panel B., subdivided in 5 strategies). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis.

Table A5: Comparison of Hedge Fund Strategies (continued)

Time horizon (month)	1	2	3	6	12	24
α_{ms}						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	51.02	46.99	42.26	56.53	53.88	35.90
Distressed Securities	35.42	34.00	29.59	34.14	12.55	6.94
Emerging Markets	47.99	44.57	44.83	41.82	38.84	36.91
Equity Long Only	23.36	26.82	21.54	22.06	12.33	10.99
Equity Long/Short	41.10	40.55	36.26	33.72	38.87	27.70
Equity Market Neutral	32.46	33.81	31.25	34.94	20.32	2.98
Event Driven Multi Strategy	40.11	34.88	34.48	44.88	22.11	19.41
Fixed Income	28.51	34.45	30.70	28.06	26.02	4.00
Fixed Income – MBS	40.35	45.14	47.08	46.92	33.26	23.94
Fixed Income Arbitrage	42.82	45.39	42.25	44.08	47.85	14.89
Global Macro	28.93	31.23	28.66	27.74	30.33	23.97
Merger Arbitrage	30.55	33.18	30.46	36.54	35.99	38.91
Multi Strategy	25.45	26.94	25.70	22.84	26.89	22.47
No Strategy	30.58	32.15	29.07	28.09	30.12	9.38
Other	37.95	36.45	36.66	29.53	17.72	34.31
Relative Value Multi Strategy	37.91	32.67	36.24	46.27	35.01	25.46
Sector	42.58	44.99	44.25	51.20	49.47	33.46
Short Bias	31.19	28.14	24.82	32.10	20.66	16.67
All Funds	36.02	36.24	34.23	36.75	30.68	21.57
B. Funds of Funds (1,378 funds)						
Market Neutral	42.63	42.35	45.66	47.40	45.20	15.71
Multi Strategy	49.99	50.99	44.82	55.81	44.87	34.46
No Strategy	52.78	52.97	50.57	56.21	51.66	36.47
Other	26.87	20.99	18.52	19.93	21.39	22.94
Single Strategy	39.89	39.65	39.25	34.01	26.69	21.40
All Funds	42.43	41.39	39.76	42.67	37.96	26.20
AR_{ms}						
A. Hedge funds (2,936 funds)						
Convertible Arbitrage	58.92	59.72	54.86	54.80	59.74	46.25
Distressed Securities	38.63	32.42	31.49	34.88	29.17	36.11
Emerging Markets	43.00	38.81	37.63	35.46	46.08	43.83
Equity Long Only	17.36	15.87	14.40	24.56	18.66	18.61
Equity Long/Short	34.37	33.24	29.60	40.32	34.60	50.94
Equity Market Neutral	34.07	32.39	29.44	33.16	38.66	35.47
Event Driven Multi Strategy	37.35	36.93	36.22	45.77	36.37	37.56
Fixed Income	25.78	27.41	29.60	28.94	24.78	9.82
Fixed Income – MBS	48.28	48.72	45.40	42.79	26.47	34.52
Fixed Income Arbitrage	55.28	54.33	55.08	52.47	48.27	38.36
Global Macro	21.54	19.03	17.92	29.53	29.27	17.21
Merger Arbitrage	30.68	36.51	37.03	40.91	41.66	61.08
Multi Strategy	23.88	26.38	25.49	22.03	30.85	27.44
No Strategy	28.59	35.22	33.19	41.63	36.63	32.98
Other	35.54	36.50	42.32	32.58	34.97	25.40
Relative Value Multi Strategy	41.39	39.43	34.07	48.65	37.07	63.77
Sector	34.41	39.83	36.76	54.07	45.23	51.45
Short Bias	16.07	15.30	13.09	17.09	16.79	14.29
All Funds	34.73	34.89	33.53	37.76	35.29	35.84
B. Funds of Funds (1,378 funds)						
Market Neutral	30.53	30.60	27.70	32.41	28.92	38.39
Multi Strategy	49.02	53.20	47.59	61.33	59.37	63.31
No Strategy	46.67	54.29	56.43	67.93	61.02	54.92
Other	20.06	17.38	17.47	15.71	22.70	17.14
Single Strategy	35.68	34.20	35.85	41.18	29.81	21.75
All Funds	36.40	37.94	37.01	43.71	40.36	39.11

This table shows the percentage of cases exhibiting statistically significant performance persistence for the sample of 2,936 hedge funds (Panel A., subdivided in 18 strategies) and 1,378 funds of funds (Panel B., subdivided in 5 strategies). We analyze performance persistence on a monthly, bi-monthly, quarterly, half-yearly, yearly, and bi-yearly basis.

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