HELSINKI SCHOOL OF ECONOMICS (HSE)
Department of Accounting and Finance

PERSISTENCE AND PREDICTABILITY IN HEDGE FUND PERFORMANCE

Finance
Master's thesis
Jenni Juokslahti
Fall 2004

Approved by the Council of the Department 7 / 9 2004 and awarded the grade good 70 points

KTT Vesa Puttonen KTT Sami Torstila

HELSINKI SCHOOL OF ECONOMICS
Jenni Juokslahti

ABSTRACT
August 25, 2004

PERSISTENCE AND PREDICTABILITY IN HEDGE FUND PERFORMANCE

Purpose of the study
The purpose of this study is to examine the performance persistence and predictability of hedge fund indexes. More specifically, performance persistence and return predictability are investigated separately for all hedge fund investment strategies.

This study contributes to the current knowledge of hedge fund predictability being the first to take into account the stance of monetary policy, using Federal Reserve's discount rate changes as a measure of restrictive and expansive monetary policies. Therefore, one of the study objectives includes the examination of whether hedge fund performance varies according to the monetary environment.

Data
This study uses nine CSFB/Tremont hedge fund indexes over the ten-year period from January 1994 through December 2003. The empirical study also employs three business variables used in past return predictability studies, and other variables such as, equity, volume, and volatility indexes to measure the many dimensions of financial risk. In addition, changes in Federal Reserve's discount rate are used to distinguish the stance of monetary policy. Hedge fund indexes are gathered from the TASS Management database and other variables from the Datastream service and internet. The study uses monthly index returns with a total of 120 monthly observations.

Results
The results from examining persistence of hedge fund returns show evidence of very short-term persistence with the biggest effect observed in the first month.

The results from examining predictability of hedge fund performance indicate that there are common economic variables that have forecast power on the following indexes: Convertible Arbitrage, Emerging Markets, Equity Market Neutral, Event Driven and Fixed Income Arbitrage.

Results show evidence that hedge fund volatility varies according to the monetary environment. The difference in volatility between periods of restrictive and expansive monetary policy is statistically significant. This finding is important as it can be used in making investment decisions due to the ex ante nature of the monetary policy variable. However, surprisingly changes in the monetary environment have no effect on hedge fund returns.

Keywords
Hedge fund returns, persistence, predictability, monetary policy, discount rate, DIR variable.

HELSINGIN KAUPPAKORKEAKOULU
Jenni Juokslahti

TIIVISTELMÄ
25 Elokuuta, 2004

PERSISTENCE AND PREDICTABILITY IN HEDGE FUND PERFORMANCE

Tutkimuksen tarkoitus
Tämän tutkimuksen tarkoituksena on tutkia hedge rahasto –indeksien ennustettavuutta ja tuottojen persistenssiä eli "jatkuvuutta". Persistenssiä ja ennustettavuutta tutkitaan erikseen kaikissa hedge rahastoille tyypillisissä sijoitusstrategiaryhmissä.

Tämä Pro gradu –tutkielman kontribuutio olemassa olevaan kirjallisuuteen on rahapolitiikan tilan huomioiminen ennustettavuustutkimuksessa. Se on tiedettävästi ensimmäinen hedge rahasto –aineistolla suoritettu tutkimus, joka ottaa rahapolitiikan tilan huomioon käyttämällä hyväksi Federal Reserven koron muutoksia rahapolitiikan tilan määrittämisessä. Yksi tutkimuksen tavoitteista onkin tutkia hedge rahastojen tuottoja ja volatiliteettiä eri rahapolitiikan tilojen vallitessa.

Aineisto
Tutkimuksessa käytetään yhdeksää CSFB/Tremont hedge rahasto –indeksiä vuosilta 1994-2003. Empiirisessä osassa käytetään myös aikaisemmista ennustettavuustutkimuksista tuttuja muuttujia kuvaamaan erilaisia riskejä. Lisäksi, Federal Reserven koron muutosta käytetään kuvaamaan rahapolitiikan tilaa. Hedge rahasto –indeksit on saatu TASS tietokannasta ja muut muuttujat Datastream tietokannasta sekä internetistä. Tutkimuksessa käytetään kuukausittaisia tuottoja ja havaintojen lukumäärä on yhteensä 120.

Tulokset
Tutkimustulosten mukaan hedge rahastojen tuotoissa on havaittavissa lyhytaikaista persistenssiä ja suurin vaikutus on edellisen kuukauden tuotoilla.

Ennustettavuustutkimustulosten mukaan tutkimuksessa käytetyillä muuttujilla voidaan osittain ennustaa seuraavien indeksien tuottoja: Convertible Arbitrage, Emerging Markets, Equity Market Neutral, Event Driven ja Fixed Income Arbitrage.

Hedge rahastojen tuottojen volatiliteetti vaihtelee rahapolitiikan tilan mukaan. Tämä vaihtelu on tilastollisesti merkittävää. Tulos on merkittävä myös muuttujan ex ante luonteen takia, joka mahdollistaa volatiliteetin vaihtelun huomioonottamisen sijoituspäätöksissä. Yllättävänä tuloksena voidaan kuitenkin pitää sitä, että rahapolitiikalla ei ole vaikutusta itse tuottoihin.

Avainsanat
Hedge rahasto, tuotot, persistenssi, ennustettavuus, rahapolitiikka, DIR muuttuja.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Background and motivation

Although hedge funds date back to 1949, when Alfred Jones created his first hedge fund, over the past few years especially wealthy private investors have shown great interest in hedge funds. As a result, the number of funds has increased dramatically. Since the late 1980s the number of hedge funds has risen by more than 25% per year, and the growth rate of hedge fund assets has been even more rapid (Ackermann et al, 1999). It is estimated that currently there are around 6,000 hedge funds with an estimated $500 billion in capital, and most institutional investors appear to be moving toward holding hedge funds in their portfolios.

The consensus now in empirical finance is that the expected returns of traditional assets, such as stocks and bonds, are to some extent predictable. But little is known about the return predictability of alternative investment instruments, such as hedge funds, partially due to a limited amount of academic literature regarding hedge fund return predictability.

There are several empirical studies that suggest that a significant amount of asset return variation is related to monetary policy. Studies in this area have been made using traditional assets such as stocks, bonds, and futures, but nothing is known concerning hedge fund performance.

1.2 Objectives of the study

This thesis has three objectives. First, to examine whether hedge fund returns persist, and if they do, determine whether performance persistence varies according to different strategies. Second, to examine whether common economic variables can predict hedge fund index returns, and if they can, which particular hedge fund strategies can be forecast. Third, to examine the effect of

monetary policy in the predictive model, and whether hedge fund performance varies with the stance of monetary policy.

Figure 1 illustrates more precisely how the objectives are divided into primary and secondary ones, and how these secondary objectives are set depending on the outcome of the findings concerning the primary objectives.

FIGURE 1
Research Objectives

This figure illustrates the research objectives. It further shows how secondary objectives are conditional to primary ones.

	Primary Objective		Secondary Objective
Performance Persistence	To examine whether hedge fund returns persist.	**If they do**	To examine whether persistence vary according to different strategies.
Predictability	To examine whether common economic variables can predict hedge fund returns.	**If they can**	To examine whether predictability vary according to different strategies and whether the forecast variables' slope coefficients have common sign across different strategy groups.
Effect of Monetary Policy	To examine whether hedge fund performance vary according to the stance of monetary policy.	**If it does**	To discuss how investors could take the effect of monetary policy into account.

1.3 Data used in this study

This study uses nine CSFB/Tremont hedge fund indexes that are built from the TASS and CSFB/Tremont databases, which track more than 3,000 funds. The indexes used are Convertible Arbitrage, Dedicated Short Bias, Emerging Markets, Equity Market Neutral, Event Driven, Fixed Income Arbitrage, Global Macro, Long/Short Equity, and Managed Futures.

The empirical study also employs three business cycle variables used in past return predictability studies, and other variables such as equity, volume, and volatility indexes to measure the many dimensions of financial risk. These variables are mainly gathered from the Datastream Service with the exception of two indexes from the Internet. In addition, one dummy variable is used to distinguish the stance of monetary policy. More specifically, the stance of monetary policy is determined by the changes of the Federal Reserve's discount rate.

The study covers a ten-year period from January 1994 though December 2003 and uses monthly index returns with a total of 120 monthly observations.

1.4 Contribution of the study

This study uses variables that are already common in the literature of return predictability. However, this is the first hedge fund study that takes into account the stance of monetary policy, using Federal Reserve's discount rate changes as a measure of restrictive and expansive monetary policies. The difference in performance under different monetary policies will be investigated in more detail by measuring both returns and volatility.

Moreover, the ten-year study period 1994-2003 is long enough to cover exceptional years for hedge funds; it covers poor years such as 1994 when Federal Reserve increased interest rates significantly, and 1998 when interest rate spreads jumped after Russia's default, but it also covers

the millennium's IT bubble. Therefore, the time horizon of the study is sufficiently long to interpret persistence and predictability.

1.5 Structure of the study

Chapter 1 is an introduction to the rest of the thesis that is structured as follows. Chapter 2 reviews existing literature. It introduces the terminology and different hedge fund investment strategies as well as gives an overview of previous hedge fund studies, and it also presents potential biases in hedge fund databases. Moreover, previous performance persistence and return predictability studies are presented in Chapter 2. Chapter 3 presents the hypotheses and methodology used in the empirical study, and Chapter 4 describes the data. Chapter 5 analyses the study results, and finally Chapter 6 summarizes the thesis.

2 LITERATURE REVIEW

Chapter 2.1 introduces several previous hedge fund studies, shows a general classification of different hedge fund investment strategies and presents in detail the three main potential biases due to the use of hedge fund database. Chapter 2.2 presents previous performance persistence studies and Chapter 2.3 reviews return predictability studies.

2.1 Hedge funds – Previous studies, strategies, and database biases

2.1.1 Overview of previous hedge fund literature

The term "hedge fund" does not have an accurate definition. A "hedge" in the financial world is a transaction that reduces risk of an investment. In many cases this definition may be misleading, as hedge funds can employ strategies with high volatility. Brooks and Kat (2002) define hedge funds as

> "pooled investment vehicles that are privately organized, administrated by professional investment managers, and not widely available to the general public."

Due to their private nature, hedge funds are subject to fewer restrictions concerning the use of leverage, short-selling, and derivatives than the more regulated vehicles such as mutual funds. Apart from the use of dynamic investment strategies, other common characteristics of hedge funds include a performance related advisory fee, which is usually 20% of annual return (Fung and Hsieh, 2000). Large minimum investment requirements, significant lock-up periods, and low correlation with the traditional asset classes are also common characteristics that distinguish hedge funds from mutual funds (Liang 2001). Moreover, while mutual fund strategies are viewed as investment styles with relative return targets, hedge fund strategies are considered investment styles with absolute return targets. In other words, whereas mutual fund performance is evaluated

relative to certain benchmarks, hedge funds are not judged by their ability to track a passive benchmark (Fung and Hsieh, 1997).

In the hedge fund literature, performance has been the most studied area. Liang (1999) shows that hedge funds offer a better risk-return trade-off compared to mutual funds as a whole, and that most hedge funds earn abnormal profits on a risk-adjusted basis. Ackermann et al. (1999) studied the investment period 1988-1995 and found that hedge funds consistently outperformed mutual funds with higher volatility. However, historically, hedge funds returns have been less volatile than stock market returns (Brown et al, 1999; Liang, 2001). For example, off-shore hedge fund returns were 13.26% with a standard deviation of 9.07% compared to the S&P500 returns of 16.47 with a standard deviation of 16.32% during 1989-1995.

Amin and Kat (2003a) studied the characteristics of hedge funds and implications for performance evaluation. They question the use of traditional performance measurement for hedge fund returns, arguing the problem which arises through the normality assumption of traditional performance measures such as, Sharpe ratio and Jensen's alpha[1]. Amin and Kat show that non-normality and non-linearity should be reckoned with when evaluating hedge fund performance, as hedge fund returns show high degrees of skewness and kurtosis. Therefore, the simplified assumption of several studies has led to the misleading conclusion that the risk-adjusted returns of hedge funds are significantly higher than those of mutual funds. Moreover, Amin and Kat show that when the whole return distribution is taken into account, there is little or no evidence of superior performance in hedge fund index returns. Brown et al. (1999) also point out that hedge funds actively shift their factor exposures, and conclude that this dynamic activity makes performance measurement difficult.

---

[1] Sharpe ratio for portfolio is $S_p = \frac{(r_p - r_f)}{\sigma_p}$, and Jensen's Alpha is $\alpha_p = r_p - [r_f + \beta_p (r_m - r_f)]$, where r_p is the average return of the portfolio, r_f is the risk-free rate, r_m is the expected market return, σ_p is the standard deviation of portfolio returns and β_p is beta of the portfolio.

2.1.2 Hedge fund investment strategies

Hedge funds are a very heterogeneous group, and in principle every fund follows its own proprietary strategy. This makes classification of hedge fund investment strategies very difficult, as the market consists of funds with very diverse activities. Furthermore, some funds are able to constantly change their strategy, or use different strategies simultaneously. The following classification is by Credit Suisse First Boston/Tremont Index LLC.

Convertible Arbitrage

This strategy is identified by hedge investing in the convertible securities of a company. A typical investment is to be long the convertible bond and short the common stock of the same company. Positions are designed to generate profits from the fixed income security as well as the short sale of stock, while protecting principal from market moves.

Dedicated Short Bias

The strategy is to maintain net short as opposed to pure short exposure. Short biased managers take short positions in mostly equities and derivatives. The short bias of a manager's portfolio must be constantly greater than zero to be classified in this category.

Emerging Markets

This strategy involves equity or fixed income investing in emerging markets around the world. Because many emerging markets do not allow short selling, nor offer viable futures or other derivative products with which to hedge, emerging market investing often employs a long-only strategy.

Equity Market Neutral

This investment strategy is designed to exploit equity market inefficiencies and usually involves being simultaneously long and short matched equity portfolios of

the same size within a country. Market neutral portfolios are designed to be either beta or currency neutral, or both. Well-designed portfolios typically control for industry, sector, market capitalization, and other exposures. Leverage is often applied to enhance returns.

Event Driven

This strategy is defined as 'special situations' investing designed to capture price movement generated by a significant pending corporate event such as a merger, corporate restructuring, liquidation, bankruptcy or reorganization. There are three popular sub-categories in event-driven strategies: Risk (Merger) Arbitrage, Distressed and Regulation D.

In Risk Arbitrage Strategy invests simultaneously long and short in the companies involved in a merger or acquisition. Risk arbitrageurs are typically long the stock of the company being acquired and short the stock of the acquirer. In Distressed Strategy fund managers invest in the debt, equity or trade claims of companies in financial distress or already in default. Regulation D. refers to investments in micro and small capitalization public companies that are raising money in private capital markets.

Fixed Income Arbitrage

This strategy aims to profit from price anomalies between related interest rate securities. Most managers trade globally with a goal of generating steady returns with low volatility. This category includes interest rate swap arbitrage, US and non-US government bond arbitrage, forward yield curve arbitrage, and mortgage-backed securities arbitrage. The mortgage-backed market is primarily US-based, over-the-counter and particularly complex.

Global Macro

Global Macro managers carry long and short positions in any of the world's major capital or derivative markets. These positions reflect their views on overall market

direction as influenced by major economic trends and or events. The portfolios of these funds can include stocks, bonds, currencies, and commodities in the form of cash or derivatives instruments. Most funds invest globally in both developed and emerging markets.

Long/Short Equity

This directional strategy involves equity-oriented investing on both the long and short sides of the market. The objective is not to be market neutral. Managers have the ability to shift from value to growth, from small to medium to large capitalization stocks, and from a net long position to a net short position. Managers may use futures and options to hedge. The focus may be regional, such as long/short US or European equity, or sector specific, such as long and short technology or healthcare stocks. Long/Short Equity funds tend to build and hold portfolios that are substantially more concentrated than those of traditional stock funds.

Managed Futures

This strategy invests in listed financial and commodity futures markets and currency markets around the world. The managers are usually referred to as Commodity Trading Advisors, or CTAs. Trading disciplines are generally systematic or discretionary. Systematic traders tend to use price and market specific information (often technical) to make trading decisions, while discretionary managers use a judgmental approach.

Multi-Strategy

Multi-Strategy funds are characterized by their ability to dynamically allocate capital among strategies falling within several traditional hedge fund disciplines. The use of many strategies, and the ability to reallocate capital between them in response to market opportunities, means that such funds are not easily assigned to any traditional category. The Multi-Strategy category also includes funds employing unique strategies that do not fall neatly into other categories.

2.1.3 Potential biases due to the use of hedge fund databases

Contrary to mutual funds, the entire universe of hedge funds is not observable and can only be estimated through the use of different databases. A problem that is already well-documented in hedge fund literature is the presence of measurement biases that hedge fund indexes inherit from the hedge fund databases they were based on. Both scope and quality of data vary among hedge fund database providers (Appendix 1), due to the differences in data collection methods and criteria for including funds, the willingness to participate in any database, and the relatively new existence of commercially available hedge fund databases (Fung and Hsieh, 2002).

There are at least three main sources of difference between performance of hedge funds in the database and performance of hedge funds in the population, namely a survivorship bias, a selection bias and an instant history bias. They will now be discussed in more detail.

Survivorship bias

Survivorship bias arises when a sample of hedge funds includes only funds that are operating at the end of the sampling period and excludes funds that ceased operations during the period. Presumably, funds cease operations because of poor performance. Therefore, the historical return performance of the sample is biased upward and the historical risk is biased downward relative to the universe of all hedge funds (Fung and Hsieh, 2002). Survivorship bias is the most significant bias, as it is a consequence of sampling from an unobservable universe of hedge funds, and therefore generally not rectifiable. Accordingly, Fung and Hsieh call it "natural bias".

Malkiel (1995) studied survivorship bias during the 1971-1991 period using the records[2] of all equity mutual funds that existed at that time. Malkiel compared the mean yearly returns from the funds that survived until 1992 with those funds that

[2] Records provided by Lipper Analytic Services.

did not survive. In each year, the mean return of the surviving funds is substantially and statistically significantly greater than the mean for non-survivors. He therefore concluded that analyses systematically excluding non-surviving funds will significantly overstate the returns received by mutual fund investors.

Contrary to mutual funds, survivorship bias in hedge funds cannot be measured directly because the universe of hedge funds is not observable. It can be only estimated by using hedge funds in a database. For example, Amin and Kat (2003b) studied hedge fund attrition and survivorship bias by counting live and dead[3] funds over the period 1994-2001 using data from the Tremont TASS database. They conclude that the level of hedge fund attrition is high and that the main factors behind attrition are lack of size and lack of performance. They also found that the overall survivorship bias is around 2%.

Selection bias

The combination of the different inclusion processes of database vendors and the voluntary nature of hedge funds information in databases can lead to selection bias. Hedge funds that satisfy the inclusion criteria may enter the database on the basis of their track record and assets under management. Therefore, hedge funds in the database tend to show higher performance than those that were excluded. On the other hand, hedge funds may not participate in a database because they are not trying to attract new investors. These self-excluded funds may exhibit higher performance levels than the average hedge fund. Thus, the net effect of selection bias is ambiguous (Fung and Hsieh, 2002). Furthermore, according to Asness et al. (2001) the self-selection bias is generally slight, since most funds report, and even if some funds are excluded they must exhibit very strong persistence in their performance for any significant downward or upward bias to occur in index performance.

[3] In this case "dead" stands for "no longer reporting into the database".

The magnitude of the selection bias in a database is difficult to determine empirically because one cannot compare the observed hedge funds in the database with the unobservable hedge funds in the population. Differences in the number and the identity of hedge funds among databases, however, are indicative of selection bias (Fung and Hsieh, 2002).

Fung and Hsieh (2000) considered selection bias to be "spurious" because both the causality and magnitude of this bias are inherent in the data-collection process. They continue that selection bias can be eliminated if hedge fund databases eventually converge to the universe of hedge funds.

Instant history bias

Instant history bias occurs if database vendors backfill returns when a new fund is added instead of including its returns only on a going-forward basis. This will overstate index performance, since inclusion in the index is voluntary, and thus funds will generally only be added after very good past performance (Asness et al., 2001).

Ackermann et al. (1999) studied the instant history bias during the 1988-1995 period using Managed Account Reports, Inc. (MAR) and Hedge Fund Research, Inc. (HFR) databases. They adopted an indirect approach to addressing backfilling by eliminating the first two years of reported data, as these years should contain the most backfilled data. The samples include hedge funds with two, four, six and eight years of consecutive data. Then the results for each time period with and without the first two years of returns eliminated were compared. Ackermann et al. found that on average the instant history bias was 0.05% upward, which is not considered to be statistically significant.

Contrary to the results of the aforementioned study, Fung and Hsieh (2000) found evidence of the instant history bias for hedge funds. They analyzed the instant history bias during 1994-1998 using the TASS database. They calculated the

adjusted observable portfolio by dropping the first 12 months return from each hedge fund, and then compared it to the original observable portfolio. They found that the instant history bias for hedge funds is 1.4% per year.

Like selection bias, Fung and Hsieh (2000) argue that instant history bias is "spurious". They suggest that returns of a fund prior to its entry into a database be dropped.

2.2 Performance persistence in literature

Performance persistence in mutual funds has been widely studied, and a number of empirical studies demonstrate that the relative performance of equity mutual funds persists from period to period. Returns are said to persist when good (poor) performance follows good (poor) performance in consecutive periods. In recent years, the performance persistence studies have also been made by using hedge fund data. Section 2.2.1 introduces several previous performance persistence studies, before documenting recent studies of hedge fund performance persistence in section 2.2.2.

2.2.1 Previous performance persistence studies

Carlson (1970) was one of the first to report evidence on performance persistence. He examined the aggregate performance of mutual fund portfolios over the 20-year period 1948 through 1967. He presents evidence that funds with above-median returns over the preceding year typically repeat their superior performance. However, he continues that fund performance vis-à-vis the market is greatly influenced by both time period selected and market index used, and therefore, states that generalizations based on aggregate comparisons of all types of mutual funds with a single market index for one selected time period are of limited value.

Similar evidence about time period dependency is also reported by Brown and Goetzmann (1995) and Malkiel (1995). Both studies show that persistence is strongly dependent upon the time

period of study. More specifically, Malkiel's results indicate strong persistence during the 1970s that failed to exist during the 1990s. However, he did caution that the findings were likely influenced by survivorship bias. Yet it should also be noted that a study two years prior by Hencricks et al. (1993) found significant evidence of short-term persistence, but they concluded that possible survivorship bias was unimportant for studying persistence in mutual fund performance.

The studies of Grinblatt and Titman (1992) and Bers (1998) show that persistence is consistent with the fund managers' ability to perform persistently and earn abnormal returns.

2.2.2 Previous studies of hedge fund performance persistence

Performance persistence has also been studied using hedge fund data. Brown et al. (1999) examined the performance and performance persistence of the offshore hedge funds over the period 1989 through 1995. They incorporated into their study the annual net-of-fee data provided by U.S. Offshore Funds Directory. Moreover, to address the problem of survival, they developed a database that includes both defunct funds and funds currently in operation. However, survivorship may still be a biasing factor. They first used the simplest parametric persistence test, a year-by-year cross-sectional regression of past returns on current returns, in which a significant slope coefficient would be a sign of persistence. They find both negative and positive regression slopes, which suggests that an unidentified factor may be driving the systematic positive and then negative dependence. Secondly, they used a non-parametric method, a contingency table for winners and losers. Persistence in this context relates to the funds that are winners (or losers) in two consecutive periods. As a result, their parametric model shows no evidence of persistence and non-parametric model only very little. Finally, they state that neither fund size nor performance fees are related to future performance.

Agarwal and Naik (2000) furthered the analysis of hedge fund performance persistence by extending the Brown et al. study to multi-period analysis. They investigated the pre- and post-fee performance persistence of hedge funds during 1982-1998 using the HFR database, including

both living and dead funds. In addition to the traditional two-period framework they added a multi-period framework for comparison. Contrary to the results of Brown et al., Agawal and Naik's study shows evidence of performance persistence. However, when persistence is observed, it seems to be driven more by losers than by winners.

They also examined whether persistence is short-term or long-term in nature over quarterly, half-yearly, and yearly intervals, which they find important due to significant lock-up periods. The results show that the extent of persistence is sensitive to the length of return measurement period and in particular, persistence decreases as the interval increases. Moreover, the persistence is highest at the quarterly horizon.

Their analysis also indicates that the level of persistence in the multi-period framework is considerably smaller than that observed under a two-period framework with no persistence at the yearly return horizon even at the 10% significance level. Finally, they show that persistence, whenever present, is unrelated to the type of strategy followed by the fund.

Kat and Menexe (2003b) discuss the possible explanations for the contradictory findings of Brown et al. and Agarwal and Naik studies. They attribute the differences to the way in which performance is measured. More specifically, when the returns generated by a fund are incorrectly adjusted for risk, this may show up as persistence where in fact there is none. In their article, they study whether there is persistence in the fund's overall risk profile, and since persistence does not necessarily imply predictability, they also study whether the parameter values estimated over one period are effective predictors for the values estimated over the following period. They used monthly net-of-fee returns data provided by the Tremont TASS database over the period of 1994-2001. As in previous studies, their analysis uses both parametric and non-parametric approaches to examine persistence. Both the parametric and non-parametric methods show that there is significant persistence in the risk profile of hedge funds, with the standard deviation and the correlation with stocks especially standing out. However, unlike others they show differences in the extent of persistence between different strategy groups. According to their parametric model, the highest persistence is found in Funds of Funds and the lowest in Relative Value funds,

whereas according to the non-parametric model, the highest persistence is found in Long/Short Equity and the lowest in Event Driven strategies[4].

And finally they conclude that despite the observed persistence, the results show that in absolute terms hedge funds' risk profiles are not easily predicted from historical returns alone. They continue that it is not the fund's superior performance that persists but simply the fund's risk profile.

Also using the TASS database, Nokkanen (2003) investigated hedge fund performance persistence over the period 1990 through 2002. His analysis starts by ranking the funds by risk-adjusted returns measured with the Sharpe and Information ratios[5]. He then goes on to test performance persistence with standard two-tailed Spearman rank correlation test. The study period is divided into evaluation period and test period. Evaluation period consists of the previous year's risk-adjusted performance up to five years cumulative risk-adjusted performance, and the test period consists of single year's risk-adjusted returns of one to seven years ahead. He found significant evidence of performance persistence in the following hedge fund strategies: Convertible Arbitrage, Equity Market Neutral, Event Driven, Long/Short Equity, and Fund of Hedge Funds. Weak or no persistence was found in Emerging Markets, Fixed Income, Global Macro and Managed Futures strategies. His results also show that significant persistence seems to react to changing market conditions (Nokkanen, 2003).

Finally, the most recent hedge fund performance persistence study is by Harri and Brorsen (2004). They used data provided by the MAR database over the period 1977-1998 categorized into nine investment styles.[6] They used three alternative methods to test for performance persistence. Firstly, they regressed returns against lagged returns. Secondly, they constructed an eight-factor regression for all the different investment styles using three equity classes, two bond indexes, a Eurodollar deposit, the price of gold for commodities, and the trade-weighted dollar index as regression variables. And thirdly, they used the Spearman rank correlation test using the

[4] In line with CSFB/Tremont Index LLC classification they classified funds in the following subgroups: Long/Short Equity, Event Driven, Global Marco, Emerging Markets, Relative Value, and Funds of Funds.
[5] Information ratio is a simplified variant of Sharpe ratio calculated by portfolio's return to its standard deviation.
[6] Nine styles used were: Global, Sector, Market Neutral, Global Macro, Short Sales, Event Driven, Long Only, Fund of Funds US, and Fund of Funds Non-US.

mean returns, the Sharpe ratio, the mean returns to standard deviation, and Jensen's Alphas to rank the funds.

The results from their autoregressive model show evidence of very short-term performance persistence; for most styles performance persists for three to four months with the biggest effect observed in the first month. This is in accordance with the findings of short-term persistence reported by Agarwal and Naik (2000). Also, the multi-factor regression and Spearman rank correlation test show persistence. The results indicate overall that the styles showing the highest persistence are Market Neutral, and the two Fund of Funds styles. In their analysis they also report a strong negative relation between fund size and returns, and explain it by the exploitation of market inefficiencies by hedge fund managers.

2.3 Predictability of asset returns

Chapter 2.3.1 presents previous research about the predictability of asset returns, and chapter 2.3.2 presents the role of monetary policy in predictability literature and motivates the use of the directional discount rate change (DIR) variable in this study.

2.3.1 Previous predictability studies

Even though Carlson (1970) reports evidence of performance persistence, his results for mutual funds show no consistent predictive value. Kat and Menexe (2003) report similar finding on hedge funds. Despite the observed persistence, their study shows that in absolute terms hedge funds' risk profiles are not easily predicted from historical returns alone. They conclude that hedge funds' track record serves best in providing a fund's risk profile relative to other funds in the same strategy group, instead of predicting a fund's future performance.

Throughout the history of asset return predictability research returns are forecast not only by using past returns but also by using common economic variables. One of the most influential studies was Jensen's early work where he evaluated a portfolio manager's predictive ability,

using 115 mutual fund returns for the ten-year period 1955-1964 (Jensen, 1968). Among others, he used variables such as S&P 500, Dividend Yield and proxies for market return, and focused on interpreting the estimated regression intercepts. His empirical results show very little evidence of predictive ability in individual funds, and no evidence of predictability for the funds on average.

In their study Fama and French (1989) used three common economic variables to forecast variation in expected returns on stocks and bonds. The variables used where the Dividend Yield (D/P), the Default Spread and the Term Spread. As a result, they found a clear link between the three variables and business conditions; the general message being that expected returns are lower when economic conditions are strong and higher when conditions are weak. This link to business conditions has made the use of these variables desirable in academic research – used for example by Booth and Booth (1997).

A resent study of Amenc et al. (2003) is of great importance to this thesis, as it analyzes the predictability in hedge fund returns. They used multifactor models for the return on nine hedge fund indexes, for which they chose factors to measure the many dimensions of financial risk. As a result, they found strong evidence of significant predictability in hedge fund returns.

In their study, they used the monthly data of the nine CSFB/Tremont indexes[7] for the period 1994-2000. They had ten economic variables, six of which were chosen to the final multiregression models after R^2s of single regressions exceeding 5%. In some cases they also included a historical return variable in the model if the persistence was considered to be high enough. Out of these nine strategy groups Amenc et al. could explain some of the return variation of the following strategy groups: Convertible Arbitrage, Emerging Markets, Equity Market Neutral, Event Driven, Fixed Income Arbitrage and Global Macro.

This study will extend the work of Amenc et al. (2003) by taking into consideration the effects of monetary policy motivated by several studies now presented in more detail.

[7] Strategies followed by these nine indexes are presented in chapter 2.1.2.

2.3.2 The role of monetary policy in predictability research

The term "monetary policy" refers to the actions undertaken by a central bank, such as the Federal Reserve, to influence the availability and cost of money and credit to help promote national economic goals.

The Federal Reserve controls the three tools of monetary policy – open market operations, the discount rate, and reserve requirements. Using the three tools, the Federal Reserve influences the demand for, and supply of, balances that depository institutions hold at Federal Reserve Banks and in this way alters the federal funds rate. The federal funds rate is the interest rate at which depository institutions lend balances at the Federal Reserve to other depository institutions overnight.

Changes in the federal funds rate trigger a chain of events that affect other short-term interest rates, foreign exchange rates, long-term interest rates, the amount of money and credit, and, ultimately, a range of economic variables, including employment, output, and prices of goods and services (Federal reserve board, 2004).

There are several empirical studies that suggest that changes to a significant amount of asset return variation is related to monetary policy. For example, the studies of Fama (1981) and Geske and Roll (1983) show evidence linking the monetary sector to the stock market.

Furthermore, several previous studies have used a dummy variable – called the DIR variable – that differentiates increasing and decreasing discount rate change series therefore differentiating restrictive and expansive monetary policy periods. For exemple, Jensen et al. (1996) and Booth and Booth (1997) show that the regression slope coefficient of the DIR variable in the predictability model is negative for both stocks and bonds, corresponding to a decrease in expected returns associated with an increase in economic variables.

Previous research on the relationship between variation in return predictability and monetary environment is not limited to stocks and bonds only. Rusi (2002) investigated the predictable

variation in expected returns of commodity futures and his findings show significant evidence of future returns varying dependent on the prevailing monetary environment. However, contrary to stock and bond returns, there is an increase in expected returns of commodity futures associated with an increase in different monetary policy variables.

Table 1 summarizes the findings of these aforementioned studies on the forecast power of the directional discount rate change (DIR) variable.

TABLE 1
Previous Findings on the Forecast Power of DIR variable

This table reports the results from previous research that has evidenced predictable variation in returns on stocks, bonds and commodity futures captured by the DIR dummy variable used in this study. The table reports the sign of the regression slope coefficient obtained in the examination of forecast power. A positive (negative) coefficient corresponds to an increase (decrease) in expected returns associated with an increase in the variable. DIR is the directional discount rate change dummy variable. It takes value of one (zero) if the previous rate change was an increase (decrease).

	Sign of the coefficient	Study
Stocks	Negative	Booth and Booth (1997), Jensen et al. (1996)
Bonds	Negative	Booth and Booth (1997), Jensen et al. (1996)
Commodity Futures	Positive	Rusi (2002)

As a result of these previous findings, the DIR variable will be used also in this study in two ways; in the multiregression model to forecast the hedge fund returns, and to determine the stance of monetary policy in order to investigate whether the performance varies with the monetary policy.

The DIR variable is desirable in academic research also due to its ex ante nature, so that investors could then replicate the findings in their investment decisions.

3 HYPOTHESES AND METHODOLOGY

3.1 Hypotheses

The hypotheses are constructed directly from the research objectives in accordance with the existing literature presented in Chapter 2. The first hypothesis of this study arises from the objective about performance persistence.

Hypothesis 1: Hedge fund returns persist.

If Hypothesis 1 is accepted, a question arises about the generalization of this persistence over different investment strategies. Supplementary hypothesis is constructed corresponding to the secondary objective concerning persistence performance.[8] It is formulated and presented as hypothesis 1.1.

Hypothesis 1.1: Performance persistence varies according to different strategies.

The second primary research objective concerns predictability of hedge fund returns. In accordance with the study of Amenc et al. (2003) and several previous predictability studies on mutual funds, I assume that part of the hedge fund returns are predictable using common economic variables. As a result, hypothesis 2 is constructed.

Hypothesis 2: The economic variables have predictive power on hedge fund returns.

In this study, F-value of the model significant at 5% level is considered significant enough to accept hypothesis 2. If this indeed is the case, two questions arise. First, does predictability vary according to different strategies? And second, do economic forecast variables' slope coefficients

[8] Presented in Figure 1.

have a common sign across different hedge fund strategy groups? Therefore, two supplementary hypotheses are constructed.

Hypothesis 2.1: Return predictability varies according to different strategy groups.

Hypothesis 2.2: Forecast variables' slope coefficients do not have a common sign across all the strategy groups.

Motivated by Booth and Booth (1997), Jensen et al. (1996) and Rusi (2002), I assume that the findings of their predictability studies on stocks, bonds and commodity futures apply also to hedge fund returns.

Hypothesis 3: Hedge fund performance varies with the stance of monetary policy.

If this is the case, a practical question arises. How could investors use this ex ante information in their investment decisions? This question is not formulated as a hypothesis, but will be discussed later in the analysis if hypothesis 3 is accepted.

3.2 Methodology for testing performance persistence

Persistence of the hedge fund indexes is now analyzed using two methods; autoregressions and Hurst exponents. First, like in the recent study of Harri and Brorsen (2004), returns are regressed against lagged returns as follows,

$$r_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k r_{i(t-k)} + \varepsilon_{it} \qquad (1)$$

$$i = 1,\ldots,n; t = 1,\ldots,T$$

where, r_{it} is the monthly return of index i in month t. Significantly positive β indicates short-term performance persistence. This measure is relative to time rather than to other funds (Harri

and Brorsen, 2004). Furthermore, in their study Harri and Brorsen regressed returns against historical returns from 24 months. Motivated by their results of very short-term persistence, here returns are regressed against returns lagged by six months[9].

Secondly, motivated by studies of Amenc et al. (2003) and Peters (1989), performance persistence is analyzed using the Hurst Exponent. The Hurst exponent is a convenient summary of statistics of persistence in time-series data that has been applied in broad areas of economics, finance, and natural sciences[10]. It is calculated as follows. First the accumulated normalized rate of return is calculated using the following formula:

$$X_{t,N} = \sum_{t=1}^{N} (x_t - \mu) \tag{2}$$

where, x_t is the return in month t and μ is the mean return. Next, the range of the accumulated deviations R is calculated, as the difference between the maximum and minimum cumulative deviations over N periods.

$$R = Max(X_{t,N}) - Min(X_{t,N}), (1 \le t \le N) \tag{3}$$

And finally, the Hurst exponent, H, can be calculated, using the following formula:

$$H = \frac{\log(R/S)}{\log(N)} \tag{4}$$

where, S is the standard deviation, and N is the number of observations.

H can range between zero and one. 0.5 implies a random walk. An H less than 0.5 implies antipersistent behavior. This means that if a trend has been positive (negative) in the last period,

[9] In their study the slope coefficient was negative for all the indexes already at fifth month by the latest (Harri and Brorsen, 2004).

[10] In the literature for the first time Hurst Exponent was used to measure natural phenomena by Hurst H. E. himself in 1951.

it is more likely that it will be negative (positive) than positive in the next period. Conversely, an H greater than 0.5 implies persistent behavior. This means that if the trend has been positive in the last observed period, the chances are that it will continue to be positive in the next period. However, Hurst Exponent very close to 0.5 is difficult to interpret, and therefore it is used here together with autoregressions.

3.3 Methodology for testing predictability

The first step in measuring predictability is single variable regression. All nine indexes are regressed against all eight lagged economic variables. For each hedge index a subset of variables is then chosen according to the explanatory power of single variables. The explanatory power is measured simply in terms of the in-sample R^2s of regressions, and a variable is included in the model if R2 exceeds 1%.

After single regressions, multi-regressions are run through by regressing each hedge fund index against the particular subset of lagged variables found in the first step. The formula for multi-regressions is as follows:

$$\begin{aligned} Ri,t = {} & a_i + b_{i1}\delta_{i1}\mathrm{Return}_{i,t-1} + b_{i2}\delta_{i2}S\,\&\,P500_{t-1} + b_{i3}\delta_{i3}Default_{t-1} \\ & + b_{i4}\delta_{i4}D/P_{t-1} + b_{i5}\delta_{i5}3MT - bill_{t-1} + b_{i6}\delta_{i6}Term_{t-1} \\ & + b_{i7}\delta_{i7}VIX_{t-1} + b_{i8}\delta_{i8}Vol_{t-1} + b_{i9}\delta_{i9}Dollar_{t-1} + \varepsilon_{i,t} \end{aligned} \qquad (5)$$

where the coefficients δ_{ik} takes the value of zero when the variable k is not used in the model for index i, and takes the value of one when the variable is included in the model. $\varepsilon_{i,t}$ is residual term.

After these regressions, the effect of monetary policy is added into the model. Same regressions are run through with the inclusion of the DIR dummy variable. DIR takes the value of one if the previous rate change was an increase and a value of zero if the previous discount rate change was a decrease.

And finally, the study period is divided into two monetary environments using the DIR variable. A DIR value of one indicates that a month falls into a restrictive monetary environment and a value of zero indicates that the monetary policy is expansive. The difference in performance between the two environments will then be compared, and tested. The difference in the mean returns is tested using a simple t-test, and the difference in the standard deviations is tested using F-test.

4 DATA

4.1 Data description

As data for the whole hedge fund universe is not available, this study uses a publicly available hedge fund database to represent the hedge fund universe. More specifically, this study uses CSFB/Tremont indexes that are built from the TASS and CSFB/Tremont databases, which track more than 3000 funds. TASS database has been widely used in previous hedge fund studies (Liang, 2001; Brooks and Kat, 2002; Fung and Hsieh, 2002; Amenc et al. 2003). Moreover, Liang (2000) studied the differences in hedge fund databases and recommended the use of TASS database for academic research because of its relative completeness and accuracy.

TASS Management define the index universe as funds with a minimum of US $10 million assets under management, a minimum one-year track record, and current audited financial statements. Funds are separated into ten primary subcategories based on their investment style[11]. The indexes are calculated and rebalanced monthly. Funds are reselected on a quarterly basis as necessary. The database was created in 1999 and the indexes were tracked back to 1994.

This study uses nine CSFB/Tremont hedge fund indexes over the period January 1, 1994 though December 31, 2003. The indexes used are Convertible Arbitrage, Dedicated Short Bias, Emerging Markets, Equity Market Neutral, Event Driven, Fixed Income Arbitrage, Global Macro, Long/Short Equity, and Managed Futures. The tenth CSFB/Tremont category, Multi-Strategy, is excluded from the study as it also includes funds employing unique strategies that do not fall under any of the other descriptions. Therefore, this category shows hardly any common characteristics.

[11] These categories are presented in detail in Chapter 2.1.2 Hedge Fund Investment Strategies.

Table 2 shows some descriptive statistics for the CSFB/Tremont hedge fund indexes over the ten-year study period January 1994 through December 2003. It shows that the hedge fund universe really is heterogeneous, as the mean monthly returns vary from -0.14 for Dedicated Short Bias to 1.19 for Global Macro strategy, and the standard deviations vary from 0.89 for Equity Market Neutral to 5.20 for Dedicated Short Bias. The homogeneity can also be seen in the cross-correlation matrix showing the strongest negative correlation between Long/Short Equity and Dedicated Short Bias, and the strongest positive correlation between Event Driven and Emerging Markets.

TABLE 2

Descriptive Statistics for CSFB/Tremont Hedge Fund Indexes, 1994-2003

This table reports the mean monthly returns (%), standard deviations (%) and correlations of the returns between nine different CSFB/Tremont Hedge Fund Indexes over the period January 1994 through December 2003.

Statistic	Convertible Arbitrage	Dedicated Short Bias	Emerging Markets	Equity Market Neutral	Event Driven	Fixed-Income Arbitrage	Global Macro	Long/Short Equity	Managed Futures
Mean Monthly Return	0.85	-0.14	0.71	0.85	0.92	0.56	1.19	1.01	0.63
Standard Deviation	1.38	5.20	5.13	0.89	1.74	1.14	3.50	3.18	3.50
Index	**Correlation Matrix**								
Convertible Arbitrage	1.00								
Dedicated Short Bias	-0.22	1.00							
Emerging Markets	0.31	-0.57	1.00						
Equity Market Neutral	0.31	-0.35	0.22	1.00					
Event Driven	0.58	-0.63	0.68	0.38	1.00				
Fixed Income Arbitrage	0.55	-0.08	0.30	0.09	0.39	1.00			
Global Macro	0.29	-0.13	0.41	0.21	0.37	0.45	1.00		
Long/Short Equity	0.25	-0.72	0.58	0.35	0.65	0.21	0.42	1.00	
Managed Futures	-0.21	0.25	-0.14	0.13	-0.24	-0.08	0.25	-0.07	1.00

The empirical part of this study also employs various variables that would measure the many dimensions of financial risk. The following proxies are used in the study:

Yield on US three-month T-bill rate (3M T-bill)

Three-month T-bill rate serves as a proxy for expectations of future economic activity. In this study Merrill Lynch 3 Month T-bill Index represents the US Government T-bills over the time period 1994-2003. The use of this variable is motivated by the study of Amenc et al. (2003).

Dividend Yield (D/P)

The dividend yield serves as a proxy for time variation in the unobservable risk premium because a high dividend yield indicates that dividends have been discounted at a higher rate (Amenc et al., 2003). The dividend yield expresses the dividend per share as a percentage of the share price. In this study the S&P 500 composite value-weighted index dividend yield is used as proxy. The use of this variable is motivated for example by the studies of Fama and French (1989), Booth and Booth (1997) and Jensen et al. (1996). Moreover, Jensen used the Dividend Yield variable already in his earlier predictability study in 1968.

Default Spread (Default)

The default spread is a business conditions variable that is higher during recession and lower during expansions (Fama and French, 1989). It is proxied by changes in the monthly observations of the difference between the yield on long-term Baa credit rated bonds and the yield on long-term AAA credit rated bonds. Here the default spread is the calculated using Lehman US corporate Baa long bond and US corporate AAA long bond indexes. The use of this variable is motivated for example by the studies of Fama and French (1989), Booth and Booth (1997) and Jensen et al. (1996).

Term Spread (Term)

The term spread is related to shorter-term measured business cycles. Fama and French (1989) showed that it is low near business-cycle peaks and high near troughs. It is proxied by monthly observations of the difference between the yields on 10-20 year US Treasury bonds and three-month US Government T-bills. In this study Lehman US Treasury 10-20 Year Index represents the performance of US Treasury bonds, and Merrill Lynch 3 Month T-bill Index represents the US Government T-bills over the time period 1994-2003. The use of this variable is motivated for example by the studies of Fama and French (1989), Booth and Booth (1997) and Jensen et al. (1996).

Implicit Volatility (VIX)

VIX is a benchmark for stock market volatility and reflects investors' consensus view of future expected stock market volatility; during periods of financial stress, option prices and therefore VIX tend to rise. VIX, introduced by the Chicago Board Options Exchange in 1993, measures market expectation of near-term volatility conveyed by stock index option prices. The index is based on real-time S&P 500 index option prices and uses a weighted average of options with a constant maturity of 30 days to expiration. In this study the implicit volatility is proxied by changes in the average of intramonth values of the CBOE Volatility Index (VIX)[12]. The use of this variable is motivated by the study of Amenc et al. (2003).

US Equity (S&P 500)

In this study the US market portfolio of equities is proxied by the monthly return on the S&P 500 Composite Index. The use of this variable is motivated for example by the studies of Amenc et al. (2003) and Jensen (1968).

[12] http://www.cboe.com/mktdata/datahouse/vixarchive.xls, February 14, 2004.

Market Volume (Vol)

In this study market volume was proxied by changes in the monthly market volume on the NYSE. The use of this variable is motivated by the study of Amenc et al. (2003).

Currency (Dollar)

The currency factor was proxied by changes in the level of a trade-weighted exchange index of the U.S. Dollar. Data is provided by the St. Louis Federal Reserve Bank.[13] The use of this variable is motivated by the study of Amenc et al. (2003).

All the aforementioned variables except for VIX and Dollar were obtained from the Datastream service and they cover the same ten-year time period January 1, 1994 through December 31, 2003. Furthermore, the study uses monthly index returns, and the total amount of monthly observations is 120.

Table 3 shows some descriptive statistics for the predictive factors over the ten-year study period January 1994 through December 2003.

[13] http://www.economagic.com/em-cgi/data.exe/fedstl/twexbmth+2, February 14, 2004.

TABLE 3
Descriptive Statistics for the Regression Variables, 1994-2003

This table reports the mean monthly returns (%), standard deviations (%) and correlations of the returns between seven different regression variables over the period January 1994 through December 2003. S&P 500 is the US equity factor, proxied by the S&P 500 Composite Index. Default is the difference between the yield on long-term Baa credit rated bonds and the yield on long-term AAA credit rated bonds, proxied by Lehman US corporate Baa long bond and US corporate AAA long bond indexes. D/P is the dividend yield, proxied by S&P 500 composite value-weighted index dividend yield. 3M T-bill is the yield on US three-month T-bill rate, proxied by Merrill Lynch 3 Month T-bill Index. Term is the difference between the yields on 10-20 year US Treasury bonds and three-month US Government T-bills, proxied by Lehman US Treasury 10-20 Year Index and Merrill Lynch 3 Month T-bill Index. VIX is the implicit volatility, proxied by changes in the average of intramonth values of the CBOE Volatility Index. Vol is the market volume, proxied by changes in the monthly market volume on the NYSE. Dollar is the currency factor, proxied by changes in the level of a trade-weighted exchange index of the U.S. Dollar.

	S&P 500	Default	D/P	3M T-bill	Term	VIX	Vol	Dollar
Mean Return	0.931	0.959	1.807	0.346	0.150	1.035	2.557	0.250
Standard Deviation	4.407	0.296	0.559	0.131	0.096	13.772	15.390	1.155
				Correlation Matrix				
S&P 500	1.000							
Default	-0.339	1.000						
D/P	0.057	-0.280	1.000					
3M T-bill	0.100	-0.472	0.068	1.000				
Term	-0.089	0.288	0.308	-0.837	1.000			
VIX	-0.274	-0.026	-0.039	0.084	-0.098	1.000		
Vol	0.079	-0.001	-0.013	0.000	-0.035	0.035	1.000	
Dollar	-0.063	-0.180	0.025	0.269	-0.239	0.049	-0.103	1.000

In addition to the eight above-mentioned variables, also one monetary policy variable is used in this study.

Discount Rate Changes (DIR)

DIR is the directional discount rate change dummy variable. DIR takes value of one if the previous rate change was an increase and a value of zero if the previous discount rate change was a decrease. A DIR value of one indicates that a month falls into a restrictive monetary environment and a value of zero indicates that the monetary policy is expansive. Discount rate is defined as "the rate at which member

banks may borrow short term funds directly from a Federal Reserve Bank".[14] The use of this variable is motivated for example by the studies of Booth and Booth (1997), Jensen et al. (1996), and Rusi (2002).

Table 4 presents the discount rate change changes through the period 1994-2003.

TABLE 4
Discount Rate Changes, 1994-2003

This table shows the Federal Reserve Discount Rate change series December 1990 through December 2003. A series is defined as a sequence of consecutive discount rate changes in the same direction. The total number of monthly observations is 120, of which 83 observations following rate decreases and 37 rate increases.

First rate change in series	Number of rate changes	Monthly observations
Dec 18, 1990*	0 decreases	4
May 17, 1994	4 increases	20
Jan 31, 1996	3 decreases	43
Aug 24, 1999	5 increases	17
Jan 3, 2001	13 decreases	36

* The study period starts in January 1994, and therefore the first series has only 4 monthly observations and zero rate changes. However, the period January 1994 through May 1994 falls into a restrictive monetary environment.

4.2 Limitations of the data

Contrary to other indexes, the CSFB/Tremont indexes are asset-weighted instead of equally weighted. There can be significant differences in the size between the funds included in these indexes. Large funds therefore have a larger influence on the indexes than smaller funds. This may lead to an asymmetric weighting, which may raise the variability of return. Brooks and Kat show in 2002, that this is indeed the case.

The potential biases presented in chapter 2.1.3, even though existing, were not alarming for the TASS database. According to Amin and Kat (2003b) overall survivorship bias in the TASS

[14] http://www.investorwords.com/1911/Federal_Reserve_Discount_Rate.html, March 29, 2004.

database is 2% which can be emphasized between 1994-1996 when TASS did not yet include liquidated hedge fund data. Furthermore, Fung and Hsieh (2000) found an instant history bias of 1.4%. However, the TASS database is recommended for academic purposes due to its completeness and accuracy (Liang, 2000).

This study uses variables at index level, which can further create uncertainty in the results of some investment strategies. Especially in the mid nineties when the number of funds was still quite limited in some categories.

5 ANALYSIS AND RESULTS

Chapter 5 reports the findings of the empirical part of this study. In chapter 5.1 the results of performance persistence measurement is analyzed. Chapter 5.2 analyzes the results of predictability study, and chapter 5.3 analyzes the differences in performance of hedge fund indexes between restrictive and expansive monetary policies.

5.1 Analysis of performance persistence results

Table 5 shows the results of performance persistence analysis using both autoregressions and Hurst Exponents. The results show evidence of very short-term persistence with the biggest effect observed in the first month. Furthermore, on average the regression coefficient turns to negative already when returns are regressed against returns with a three-month lag. This evidence of short-term persistence is in accordance with the findings of Harri and Brorsen (2004) and Agarwal and Naik (2000). Also, the extent of persistence varies between different strategy groups, which concurs with the findings of Kat and Menexe (2003). Table 5 is now analyzed in detail each strategy group separately.

For the Convertible Arbitrage the regression coefficients of lagged returns are positive and statistically significant on traditional levels for the first two monthly lags implying significant performance persistence. Returns regressed against 1-month lagged returns get a positive slope coefficient that is significant at 1% level, and the second monthly lag coefficient is still positive and significant at 5% level. The regression model has the highest explanatory power compared to other categories, its R^2 being 0.361. However, interestingly the slope coefficient of the 3-month lag turns out to be negative and yet statistically significant suggesting that after two months of persistence, returns are likely to reverse, i.e. good (poor) performance persists two months followed by poor (good) performance. Also the Hurst Exponent of 0.598 supports the findings of the regression analysis[15]. Moreover, it is coherent with Amenc et al. (2003) who report Hurst

[15] Hurst exponent > 0.5 is evidence of persistence and Hurst < 0.5 is evidence of antipersistence.

Exponent of 0.609. All of these findings are in accordance with the results of Nokkanen (2002) who found strong evidence of statistically significant performance persistence for Convertible Arbitrage. As a conclusion of the aforementioned results, for Convertible Arbitrage hypothesis 1 is accepted; performance persists.

For the Dedicated Short Bias the regression coefficients of lagged returns are negative for all the other monthly lags except for the first month. However, the first month's slope coefficient is only slightly positive with a p-value of 0.550 showing its insignificance. Also, the Hurst Exponent which is very close to 0.5 (0.481) is difficult to interpret; either returns in Dedicated Short Bias do not persist or they show slight antipersistent behavior. Therefore, for this category hypothesis 1 is rejected; returns do not persist.

For the Emerging Markets the regression coefficient of a 1-month lag is positive and significant at 5% level. Furthermore, historical returns lagged by more than one month, show randomly positive and negative signs with the t-test having high p-values, implying short-term persistence on returns for Emerging Market strategy. Also, the Hurst Exponent of 0.539 supports the findings being coherent with the study of Amenc et al. (2003). Also, Nokkanen (2002) reports a little evidence of performance persistence measured by Sharpe ratio and more significant persistence measured by information ratio. As a conclusion of the aforementioned results, for Emerging Markets hypothesis 1 is accepted; performance persists. It is important to note that the nature of this persistence is very short-term.

For the Equity Market Neutral the regression coefficients of lagged returns are positive and statistically significant for the first two months, the first of which has a t-test p-value of 0.080 and therefore is relatively significant. Moreover, the Hurst Exponent of 0.598 suggests persistence. Therefore, hypothesis 1 is accepted; performance of Equity Market Neutral funds persists. These findings are coherent with the studies of Amenc et al. (2003), Harri and Brorsen (2004) and Nokkanen (2002) who report significant persistence for funds following Equity Market Neutral strategy.

For the Event Driven the regression coefficients of lagged returns are positive and statistically significant for the first month which is significant at 1% level. The Hurst Exponent of 0.578 supports the regression results. Hypothesis 1 is accepted; performance of Event Driven funds persists. These findings are coherent with the studies of Amenc et al. (2003) who report a Hurst Exponent of 0.591, Harri and Brorsen (2004) who show significant short-term persistence of one month, and Nokkanen (2002) who reports significant persistence for Event Driven strategy.

Also, for Fixed Income Arbitrage the results show significant persistence, but only on short-term. The first month's slope coefficient is the second highest right after Convertible Arbitrage and significant at 1% level. However, already the following months show negative signs. Hypothesis 1 is accepted as performance persists, and thus this variable is taken into the multi-regression model. Also Nokkanen (2002) reports moderate performance persistence in this strategy group.

For Global Macro funds some evidence of persistence was found, as also the findings of Harri and Brorsen (2004) suggest. The regression coefficients of three first months were positive. But as the coefficients are only slightly positive and not significant, hypothesis 1 is rejected. There is little, but not enough, evidence of performance persistence.

Similarly to Global Macro only little evidence of persistence was found for Long/Short Equity, and therefore hypothesis 1 is rejected.

For the Managed Futures strategy the regression coefficients are mostly negative, sometimes randomly positive. Also, Hurst Exponent of 0.485 suggests a slight antipersistent behavior. Therefore, for this category hypothesis 1 is rejected; returns of Managed Futures do not persist. Also, the study of Nokkanen (2002) shows no evidence of persistence measured by both Sharpe and information ratios.

TABLE 5

Autoregressions and Hurst Exponents for CSFB/Tremont Hedge Fund Indexes, 1994-2003

This table reports the results of two alternative methods to test performance persistence of nine different CSFB/Tremont Hedge Fund Indexes over the period January 1994 through December 2003. Firstly, it contains the results of autoregressions were hedge fund index returns are regressed against monthly lagged returns. The p-values of the regression coefficients' t-tests are shown in parentheses. Secondly it reports the Hurst exponents.

Hedge Fund	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5	Lag 6	R2	Hurst
Convertible Arbitrage	0.462	0.290	-0.357	0.111	0.178	-0.244	0.361	0.598
	(0.000)	(0.014)	(0.003)	(0.368)	(0.151)	(0.051)		
Dedicated Short Bias	0.064	-0.051	-0.003	-0.094	-0.097	-0.033	0.110	0.481
	(0.550)	(0.629)	(0.976)	(0.370)	(0.352)	(0.756)		
Emerging Markets	0.208	-0.066	0.070	-0.028	0.053	-0.097	0.159	0.539
	(0.048)	(0.532)	(0.505)	(0.787)	(0.616)	(0.354)		
Equity Market Neutral	0.180	0.099	-0.007	-0.106	0.042	-0.070	0.186	0.598
	(0.080)	(0.337)	(0.949)	(0.299)	(0.681)	(0.481)		
Event Driven	0.334	0.025	-0.014	-0.004	-0.029	-0.008	0.162	0.578
	(0.002)	(0.818)	(0.901)	(0.971)	(0.790)	(0.938)		
Fixed Income Arbitrage	0.437	-0.084	-0.013	0.116	-0.056	-0.047	0.244	0.589
	(0.000)	(0.466)	(0.911)	(0.303)	(0.622)	(0.680)		
Global Macro	0.122	0.066	0.024	-0.140	0.290	-0.088	0.199	0.582
	(0.243)	(0.529)	(0.816)	(0.174)	(0.006)	(0.405)		
Long/Short Equity	0.151	0.013	-0.060	-0.026	-0.199	0.261	0.169	0.633
	(0.149)	(0.900)	(0.566)	(0.802)	(0.058)	(0.015)		
Managed Futures	-0.001	-0.153	0.031	-0.018	0.002	-0.133	0.126	0.485
	(0.995)	(0.134)	(0.765)	(0.857)	(0.984)	(0.187)		

Note: Hurst exponent > 0.5 is evidence of persistence and Hurst < 0.5 is evidence of antipersistence.

5.2 Analysis of predictability results

Table 6 reports the findings of multiregressions of the nine hedge indexes regressed against sub-groups of variables formed of eight different economic variables and a historical return variable. There is evidence of forecast power in certain strategy groups, as suggested by Amenc et al. (2003). Now table 6 will be analyzed in detail for all the strategy groups separately.

After the persistence analysis the next step was to run through single regressions for the forecast variable selection. Of the eight potential variables, Dividend Yield (D/P_{t-1}), Term Spread ($Term_{t-1}$) and Implicit Volatility (VIX_{t-1}) were chosen to the final multi-regression model for Convertible Arbitrage as they had the regression R^2 exceeding 1%. In addition, 1-month lagged returns were included as a forecast variable ($Return_{t-1}$) due to its significance, and monthly returns of Convertible Arbitrage Index were then regressed against these four variables. Also Amenc et al. (2003) could explain a part of the return variation of Convertible Arbitrage, but of all the variables in their model only $Return_{t-1}$ was used in this study. Like persistence analysis suggests, the $Return_{t-1}$ variable has a positive and statistically significant regression coefficient. Other variables on the other hand have negative coefficients which are less significant. Yet the R^2 of the whole model is 0.313 and F-value is significant at 1% level, hypothesis 2 is thus accepted; variables have predictability power on Convertible Arbitrage returns.

Because the findings of the persistence analysis show no evidence of significant persistence for Dedicated short bias, lagged returns were not used to forecast the returns of Dedicated Short Bias. Only US three-month T-bill rate ($3M\ T\text{-}bill_{t-1}$) and Market Volume (Vol_{t-1}) were chosen after single regressions. Even these variables did not give significant coefficients, and the R^2 of the model stayed at 0.036. F-value was not significant at traditional levels, thus hypothesis 2 is rejected; variables have no predictability power on Dedicated Short Bias returns. Also in previous studies the findings concerning Dedicated Short Bias have been less important. Amenc et al. (2003) could not forecast the returns and for example Nokkanen (2002) entirely excluded this category from the data.

The ($Return_{t-1}$) variable is included in the multi-regression model for Emerging Markets to show effect of short-term persistence. Like assumed, it receives a positive and statistically significant regression coefficient. Other variables included in the model were Yield on US three-month T-bill rate (3M $T\text{-}bill_{t-1}$), Term Spread ($Term_{t-1}$) and Currency factor ($Dollar_{t-1}$), after R^2 of single regressions. Monthly returns of Emerging Markets Index were then regressed against these four variables, and the F-value was significant at 5% level. Thus, hypothesis 2 is accepted; variables have predictability power on Emerging Markets returns. However, the results may be little difficult to interpret or generalize, as Emerging Markets show a lot of geographical differences between individual funds even though employing same strategy.

As a consequence of the hypothesis 1 for Equity Market Neutral strategy being accepted, lagged returns were used in the multi-regression model together with Dividend Yield (D/P_{t-1}), Term Spread ($Term_{t-1}$) and US three-month T-bill rate (3M $T\text{-}bill_{t-1}$). Again only the lagged returns variable ($Return_{t-1}$) was chosen by Amenc et al. (2003), and therefore results of the two studies concerning predictability of Equity Market Neutral funds are not fully comparable. However, the variable ($Return_{t-1}$) was positive and significant for both studies as expected. Coefficients of D/P_{t-1} and $Term_{t-1}$ have negative signs as in the model for Convertible Arbitrage, but are not statistically significant. The similar behavior of these variables for both Convertible Arbitrage and Equity Market Neutral strategy could be explained partially by similar characteristics, such as simultaneous long and short positions with the difference of Convertible Arbitrage having long positions in bonds instead of stocks. Hypothesis 2 is accepted; variables have predictability power on Equity Market Neutral returns. Indeed, the forecast model has an R^2 of 0.147, and an F-value that is significant at 1% level.

Due to the significant persistence found for Event Driven strategy, lagged returns were again used in the multi-regression model, as were Default Spread ($Default_{t-1}$) and Implicit Volatility (VIX_{t-1}) due to good explanatory power in the single regressions. The inclusion of Default Spread could be explained by the fact that Event Driven funds exploit special situations like mergers, restructurings, liquidations, bankruptcies and reorganizations in which default risk is often significant. However, a negative sign of the $Default_{t-1}$ variable suggest that when a business

cycle turns into recession, also the returns of Event Driven funds decrease[16]. As a conclusion of the multi-regression analysis, hypothesis 2 is accepted; variables have predictability power on Event Driven returns. Indeed, the F-value is again significant at 1% level.

For Fixed Income Arbitrage also in the predictability regression, ($Return_{t-1}$) variable has a statistically significant positive coefficient. Other variables included were US Equity ($S\&P\ 500_{t-1}$), Implicit Volatility (VIX_{t-1}), the same variables that Amenc et al. (2003) used in their study, and also Currency factor ($Dollar_{t-1}$). The results were in accordance with their findings. Both studies show a positive regression coefficient for $S\&P\ 500_{t-1}$ and a negative one for VIX_{t-1}. Currency factor's ($Dollar_{t-1}$) negative sign received a t-test p-value of 0.077. This relatively significant factor could partially be explained by the investment strategy which Fixed Income Arbitrage funds employ. Even though trading globally most managers use US-based securities such as US government bonds and mortgage-backed securities, therefore being dependent on the rate of the USD. The negative sign implies that the higher the changes in the level of USD exchange rate, the lower the returns for Fixed Income Arbitrage funds. Nevertheless, hypothesis 2 is again accepted for this category; variables have predictive power on Fixed Income Arbitrage.

For the Global Macro strategy the $Return_{t-1}$ variable was however included in the model without significant results. In addition, the US Equity factor ($S\&P\ 500_{t-1}$) was selected and it gained a positive coefficient at 5% level, like in the study of Amenc et al. (2003). In spite of the significance of the equity factor, the model as a whole could not explain enough of the return variation; the regression R^2 stayed at 0.045, and the F-value was not significant at traditional levels. Therefore, hypothesis 2 is rejected; variables do not have predictive power on the Global Macro strategy. On the other hand, Amenc et al. (2003) report an R^2 of 0.22 of their forecast model for the Global Marco funds. This might be due to a highly significant regression coefficient of the oil price factor included in their model, excluded here.

For the Long/Short Equity the $Return_{t-1}$ variable was included in the model with the US Equity factor ($S\&P\ 500_{t-1}$) and the Default Spread variable ($Default_{t-1}$) without significant results. Also

[16] The default spread is higher during recession and lower during expansions (Fama and French, 1989).

hypothesis 2 is rejected; these variables have no predictability power on returns of Long/Short Equity.

Because the findings of persistence analysis show no evidence of significant persistence for Managed Futures, lagged returns were not used to forecast the returns of Manage Futures. Instead Default Spread ($Default_{t-1}$), Implicit Volatility (VIX_{t-1}), Market Volume (Vol_{t-1}) were selected after single regressions. Even these variables did not give significant coefficients, and the R^2 of the model stayed at 0.044. Also F-values were not significant at traditional significance levels. Thus, hypothesis 2 is rejected; variables have no predictability power on Managed Futures returns.

TABLE 6
Regressions for CSFB/Tremont Hedge Fund Indexes, 1994-2003

This table reports the results of multiregressions of nine different CSFB/Tremont Hedge Fund Indexes over the period January 1994 through December 2003. The p-values of the regression coefficients' t-tests are shown in parentheses.

Index	$Return_{t-1}$	$S\&P\ 500_{t-1}$	$Default_{t-1}$	D/P_{t-1}	$3M\ T\text{-}bill_{t-1}$	$Term_{t-1}$	VIX_{t-1}	Vol_{t-1}	$Dollar_{t-1}$	R^2	F-value
Convertible Arbitrage	0.498			-0.075		-1.368	-0.008			0.313	13.012
	(0.000)			(0.715)		(0.257)	(0.307)				(0.000)
Dedicated Short Bias					4.130			0.042		0.036	1.421
					(0.262)			(0.174)			(0.240)
Emerging Markets	0.279				-0.521	2.055			-0.418	0.107	3.402
	(0.002)				(0.934)	(0.812)			(0.305)		(0.011)
Equity Market Neutral	0.208			-0.183	0.945	-0.837				0.147	4.911
	(0.024)			(0.329)	(0.491)	(0.671)					(0.001)
Event Driven	0.337		-0.336				0.000			0.125	5.498
	(0.002)		(0.521)				(0.990)				(0.001)
Fixed Income Arbitrage	0.381	0.025					-0.008		-0.147	0.214	7.750
	(0.000)	(0.283)					(0.245)		(0.077)		(0.000)
Global Macro	0.052	0.164								0.045	2.765
	(0.570)	(0.025)									(0.067)
Long/Short Equity	0.134	0.054	-1.090							0.047	1.875
	(0.152)	(0.445)	(0.303)								(0.138)
Managed Futures			1.487				0.028	0.028		0.044	1.308
			(0.179)				(0.255)	(0.180)			(0.271)

Table 7 shows the same regressions with the inclusion of the DIR dummy variable.

When the DIR dummy variable is included in the model, none of the coefficients change significantly, and the coefficient of DIR variable does not differ significantly from zero. This finding is surprising, as in previous studies carried out using stock, bond and futures data, all the aforementioned asset groups received a DIR regression coefficient that differs significantly from zero.

F-value slightly decreases with the inclusion of the dummy variable, therefore the increase of R^2 can be interpreted by the decrease in the degree of freedom due to one additional variable.

In this model as well, same strategy groups receive significant F-values. Indeed, again same groups get hypothesis 2 accepted. All in all, the dummy variable has no significant effect on the model.

TABLE 7
DIR Extended Regressions for CSFB/Tremont Hedge Fund Indexes, 1994-2003

This table reports the results of multiregressions of nine different CSFB/Tremont Hedge Fund Indexes over the period January 1994 through December 2003. The p-values of the regression coefficients' t-tests are shown in parentheses.

Index	$Return_{t-1}$	$S\&P\ 500_{t-1}$	$Default_{t-1}$	D/P_{t-1}	$3M\ T\text{-}bill_{t-1}$	$Term_{t-1}$	VIX_{t-1}	Vol_{t-1}	$Dollar_{t-1}$	DIR	R^2	F-value
Convertible Arbitrage	0.505			-0.128		-0.796	-0.008			0.001	0.319	10.305
	(0.000)			(0.582)		(0.537)	(0.330)			(0.708)		(0.000)
Dedicated Short Bias					3.466			0.043		0.004	0.037	1.068
					(0.405)			(0.183)		(0.712)		(0.376)
Emerging Markets	0.271				0.899	4.971			-0.406	-0.002	0.111	2.734
	(0.003)				(0.907)	(0.609)			(0.325)	(0.857)		(0.023)
Equity Market Neutral	0.173			-0.202	2.469	0.825				-0.004	0.164	4.324
	(0.065)			(0.291)	(0.107)	(0.689)				(0.073)		(0.001)
Event Driven	0.323		-0.442				-0.001			-0.002	0.129	4.111
	(0.004)		(0.412)				(0.958)			(0.556)		(0.004)
Fixed Income Arbitrage	0.375	0.031					-0.008		-0.142	0.000	0.221	6.225
	(0.000)	(0.187)					(0.252)		(0.092)	(0.926)		(0.000)
Global Macro	0.015	0.178								0.001	0.052	2.049
	(0.867)	(0.015)								(0.878)		(0.111)
Long/Short Equity	0.137	0.055	-1.036							0.000	0.046	1.337
	(0.152)	(0.450)	(0.345)							(0.969)		(0.261)
Managed Futures			1.512				0.030	0.028		-0.005	0.051	1.175
			(0.186)				(0.234)	(0.190)		(0.495)		(0.326)

5.3 Analysis of monetary policy effect in performance

Table 8 reports the mean returns and standard deviations during the periods of restrictive and expansive monetary policy for the nine Hedge Fund Indexes. Moreover, the difference between the two monetary environments is calculated and tested. The difference was calculated by subtracting the result for expansive periods from the equivalent result for the periods of restrictive monetary policy, where the monetary stringency was identified by the directional discount rate change dummy variable (DIR), implying that a month was expansive (restrictive) if the latest change in the Federal Reserve's Discount Rate was a decrease (an increase). These results show evidence that volatility varies significantly according to the monetary environment in some strategy groups. Now table 8 is analyzed in detail for each strategy group separately.

When all the data of Convertible Arbitrage funds is divided into expansive and restrictive monetary environments, there is no evidence of the performance varying with the stance of monetary policy. Thus, for Convertible Arbitrage hypothesis 3 is rejected; performance does not vary with the stance of monetary policy.

Also, for Dedicated Short Bias there is no statistically significant difference in the performance under different stances of monetary policy. Therefore, hypothesis 3 is rejected for Dedicated Short Bias; performance does not vary with the stance of monetary policy.

However, when all the data of Emerging Market funds is divided into subgroups according to expansive and restrictive monetary environments for a more detailed analysis of performance, the difference in volatility between the two subgroups is significant at 5% level. For the ten-year period the volatility of Emerging Markets was 6.069% and 4.611% on average under the periods of restrictive and expansive monetary policy, respectively. However, the difference in returns is not significantly different from zero. Hypothesis 3 is accepted concerning the volatility; performance of funds using Emerging Markets strategy varies with the stance of monetary policy. As hypothesis 3 is accepted, the implications should be taken into consideration. In practice this means the reallocation of capital especially when Federal Reserve announces the

first increase in the discount rate after several decreases, i.e. a change in the monetary environment from expansive to restrictive, meaning a significant increase in the volatility of Emerging Markets funds without a respective increase in expected returns.

Again for Equity Market Neutral strategy, there is no evidence of the performance varying with the stance of monetary policy. Thus, for Equity Market Neutral strategy hypothesis 3 is rejected; performance does not vary with the stance of monetary policy.

However, for the Event Driven strategy the difference in volatility between the periods of restrictive and expansive monetary policy is significant at 1% level. Hypothesis 3 is accepted concerning the volatility; the performance of Event Driven funds varies with the stance of monetary policy. However, contrary to the findings of Emerging Markets, the volatility of Event Driven is higher under an expansive monetary policy (1.971%) compared to the volatility in a restrictive monetary environment (1.192%). Therefore, the investors should reallocate their capital invested in Event Driven funds especially when Federal Reserve announces the first decrease in the discount rate after several increases, i.e. a change in the monetary environment from restrictive to expansive, meaning a significant increase in the volatility of Event Driven funds without a respective increase in expected returns.

Also for Fixed Income Arbitrage hypothesis 3 is accepted concerning the volatility, as the F-value is significant at 1% level showing that the difference in volatility across expansive and restrictive monetary environments varies significantly. Like for the funds following Event Driven strategy, Fixed Income Arbitrage funds have higher volatility under an expansive monetary policy (1.298%) compared to the volatility in a restrictive monetary environment (0.787%). Therefore, the implications to investors are similar than discussed concerning the Event Driven strategy.

For the Global Macro, hypothesis 3 is rejected as neither returns nor volatility vary with the stance of monetary policy.

Interestingly after the rejection of hypotheses 1 and 2 for Long/Short Equity, hypothesis 3 is accepted concerning the volatility, as the F-value is significant at 1% level showing that the difference in volatility across expansive and restrictive monetary environments varies significantly. Contrary to the funds following Event Driven and Fixed Income Arbitrage strategies Long/Short Equity behaves like Emerging Markets funds with the changes in the monetary policy. Long/Short Equity funds have higher volatility under a restrictive monetary policy (4.030%) compared to the volatility in an expansive monetary environment (2.719%). Therefore, the implications to investors are similar than discussed concerning Emerging Markets strategy.

Managed Futures show no statistically significant difference in performance due to different stance of monetary policy.

TABLE 8

Differences in performance of CSFB/Tremont Hedge Fund Indexes between Periods of Restrictive and Expansive Monetary Policy

This table reports the mean returns (%) and standard deviations (%) during the periods of restrictive and expansive monetary policy for the nine Hedge Fund Indexes. The difference between the two monetary environments is calculated and tested. The difference was calculated by subtracting the result for expansive periods from the equivalent result for the periods of restrictive monetary policy, where the monetary stringency was identified by the directional discount rate change dummy variable (DIR), implying that a month was expansive (restrictive) if the latest change in the Federal Reserve's Discount Rate was a decrease (an increase). The study period was January 1994 through December 2003. The total number of monthly observations is 116, of which 81 during expansive monetary environment and 35 during restrictive monetary environment. T-tests were used in testing whether the difference in returns deviates statistically significantly from zero and F-tests for the differences in standard deviations.

	Restrictive Monetary Policy		Expansive Monetary Policy		Difference		Difference	
	Mean return	Standard deviation	Mean return	Standard deviation	in mean returns	t-statistic	in standard deviations	F-statistic
Convertible Arbitrage	0.864	1.417	0.811	1.364	0.053	0.193	0.053	1.079
Dedicated Short Bias	0.399	5.088	-0.468	5.343	0.867	0.833	-0.255	1.103
Emerging Markets	0.518	6.069	0.708	4.611	-0.190	-0.189	1.458	1.732*
Equity Market Neutral	0.655	0.918	0.917	0.855	-0.262	-1.516	0.063	1.153
Event Driven	0.786	1.192	0.945	1.971	-0.160	-0.456	-0.779	2.734**
Fixed Income Arbitrage	0.544	0.787	0.553	1.298	-0.009	-0.038	-0.511	2.718**
Global Macro	1.171	3.485	1.111	3.392	0.060	0.089	0.093	1.056
Long/Short Equity	1.068	4.030	1.005	2.719	0.063	0.100	1.311	2.196**
Managed Futures	0.228	3.473	0.835	3.580	-0.608	-0.866	-0.107	1.063

*significant at 5% level
** significant at 1% level

6 SUMMARY AND CONCLUSIONS

This study examined the performance persistence and predictability of hedge fund returns, by taking monetary policy into account. The research hypotheses were as follows; hypothesis 1: Hedge fund returns persist; hypothesis 2: The economic variables have predictive power on hedge fund returns; and hypothesis 3: Hedge fund performance varies with the stance of monetary policy.

Findings of hedge fund performance persistence studies have been little controversial, as Brown et al. (1999) did not found evidence of persistence, and on the other hand Agawal and Naik (2000), Kat and Menexe (2003), and Nokkanen (2002) report evidence of hedge fund performance persistence. Also this study found evidence of persistence, and moreover results show that the extent of persistence varies between different strategy groups. Persistence was found and hypothesis 1 was accepted in the following strategy groups; Convertible Arbitrage, Emerging Markets, Equity Market Neutral, Event Driven, and Fixed Income Arbitrage.

These same strategy groups showed also predictability when regressed using common economic variables. Therefore, also hypothesis 2 was accepted for Convertible Arbitrage, Emerging Markets, Equity Market Neutral, Event Driven, and Fixed Income Arbitrage. Also Amenc et al. (2003) could explain some return variation of the same strategy groups, with the exception of Global Macro which here received an R^2 of 0.045 compared to their 0.22. The reason of them getting high R^2 for Global Macro can be due to the choice of variables, as they included an oil variable that was not used in this study.

For hypothesis 3, the difference in performance under the two stances of monetary policy was examined and tested. Results show evidence that hedge fund volatility varies according to the monetary policy, and the difference in volatility between periods of restrictive and expansive monetary policy is statistically significant, and the hypothesis 3 is accepted for Emerging Markets, Event Driven, Fixed Income Arbitrage and Long/Short Equity.

Dedicated Short Bias, Global Macro and Managed Futures were the only categories for which all the three hypotheses were rejected. Also in previous studies the findings concerning Dedicated Short Bias and Managed Futures strategy groups have been less important. Amenc et al. (2003) could not forecast the returns of funds employing Dedicated Short Bias or Managed Futures strategies. Furthermore, the study of Nokkanen (2002) shows no evidence of persistence for Managed Futures and entirely excludes Dedicated Short Bias. Table 9 summarizes the hypotheses accepted for each strategy group.

TABLE 9
Summary of the Hypotheses Accepted

This table summarizes the acceptance of hypotheses separately for each hedge fund strategy. Hypotheses accepted are marked with an X. Hypotheses were as follows. Hypothesis 1: Hedge fund returns persist; hypothesis 2: The economic variables have predictive power on hedge fund returns; and hypothesis 3: Hedge fund performance varies with the stance of monetary policy.

	Hypothesis 1	Hypothesis 2	Hypothesis 3
Convertible Arbitrage	X	X	
Dedicated Short Bias			
Emerging Markets	X	X	X
Equity Market Neutral	X	X	
Event Driven	X	X	X
Fixed Income Arbitrage	X	X	X
Global Macro			
Long/Short Equity			X
Managed Futures			

After these results, conclusions can be made in terms of supplementary hypotheses. The acceptance and rejection of hypothesis 1 shows that performance persistence indeed varies according to different strategies, and therefore also hypothesis 1.1 is accepted. Same conclusions can be made about hypothesis 2 leading to the acceptance of both supplementary hypotheses 2.1 and 2.2; return predictability varies according to different strategy groups, and forecast variables' slope coefficients do not have a common sign across all the strategy groups. Hypothesis 3 had no supplementary hypothesis but results can be considered surprising, as monetary policy had a statistically significant effect on volatility, but not to hedge fund returns themselves, which is the case in other asset classes.

However, these findings are of great importance to investors who can replicate the results in their investment decisions. Especially cases where hypothesis 3 was accepted, investor should reallocate hedge fund investments in order to benefit from more desirable risk/return relationship.

Despite the importance of these findings, this area still stays under constant research. For further studies, these models and their robustness could be investigated for example by dividing time horizon into study and evaluation periods and comparing the outcomes of model's forecast ability.

REFERENCES

Ackermann, C., McEnally, R., Ravenscraft, D., 1999, "The Performance of Hedge Funds: Risk, Return, and Incentives", Journal of Finance, Vol. 54 Issue 3, p833-874.

Agarwal, V., Naik, N. Y., 2000, "Multi-Period Performance Persistence Analysis of Hedge Funds", Journal of Financial & Quantitative Analysis, Vol. 35 Issue 3, p327-342.

Amenc, N., El Bied, S., Martellini, L., 2003, "Predictability in Hedge Fund Returns", Financial Analysts Journal, Vol. 59 Issue 5, p32-46.

Amin, G. S., Kat, H. M., 2003a, "Hedge Fund Performance 1990-2000: Do the 'Money Machines' Really Add Value?", Journal of Financial & Quantitative Analysis, Vol. 38 Issue 2, 251-274.

Amin, G. S., Kat, H. M., 2003b, "Welcome to the Dark Side: Hedge Fund Attrition and Survivorship Bias over the Period 1994-2001", Journal of Alternative Investments, 2003, Vol. 6 Issue 1, 57-74.

Asness, C., Krail, R., Liew, J., 2001, "Do Hedge Funds Hedge?", Journal of Portfolio Management, Vol. 28 Issue 1, 6-19.

Bers, M. K., 1998, "Causal relations among stock returns, inflation: Persistence of international mutual fund performance", Global Finance Journal, Vol. 9 Issue 2, p225-240.

Booth, J. R., Booth, L. C., 1997, "Economic Factors, Monetary Policy, and Expected Returns on Stocks and Bonds", Economic Review (Federal Reserve Bank of San Francisco), Issue 2, 32-42.

Brooks, C., Kat, H. M., 2002, "The Statistical Properties of Hedge Fund Index Returns and Their Implications for Investors", Journal of Alternative Investments, Vol. 5 Issue 2, 26-44.

Brown, S. J., Goetzmann, W. N., 1995, "Performance persistence", Journal of Finance, Vol. 50 Issue 2, 679-698.

Brown, S. J., Goetzmann, W. N., Ibbotson, R.G., 1999, "Offshore Hedge Funds: Survival and Performance, 1989-95", Journal of Business, Vol. 72 Issue 1, 91-117.

Carlson, R. S., 1970, "Aggregate Performance of Mutual Funds, 1948-1967", Journal of Financial & Quantitative Analysis, Vol. 5 Issue 1, 1-32.

Fama, E. F., 1981, "Stock Returns, Real Activity, Inflation, and Money", American Economic Review, Vol. 71 Issue 4, 545-565.

Fama, E. F., French, K. R., 1989, "Business Conditions and Expected Returns on Stocks and Bonds", Journal of Financial Economics, Vol. 25, 23-49.

Federal Reserve Board, http://www.federalreserve.gov/fomc/, August 11, 2004, Last Update August 10, 2004.

Fung, W., Hsieh, D.A., 1997, "Empirical characteristics of dynamic trading strategies: the case of hedge funds", Review of Financial Studies, Vol. 10 Issue 2, 275-302.

Fung, W., Hsieh, D. A., 2000, "Performance Characteristics of Hedge Funds and Commodity Funds: Natural vs. Spurious Biases", Journal of Financial & Quantitative Analysis, Vol. 35 Issue 3, 291-307.

Fung, W., Hsieh, D. A., 2002, "Hedge-Fund Benchmarks: Information Content and Biases", Financial Analysts Journal, Vol. 58 Issue 1, 22-34.

Geske, R., Roll, R., 1983, "The Fiscal and Monetary Linkage Between Stock Returns and Inflation", Journal of Finance, Vol. 38 Issue 1, 1-33.

Grinblatt, M., Titman, S., 1992, "The Persistence of Mutual Fund Performance", Journal of Finance, Vol. 47 Issue 5, p1977, 8p

Harri, A., Brorsen, B.W., 2004, "Performance persistence and the source of returns for hedge funds", Applied Financial Economics, Vol. 14 Issue 2, p131-141.

Hendricks, D., Patel, J., Zeckhauser, R., 1993, "Hot Hands in Mutual Funds: Short-Run Persistence of Relative Performance, 1974-1988", Journal of Finance, Vol. 48 Issue 1, 93-130.

Jensen, M. C., 1968, "The Performance of Mutual Funds in the Period 1945-1964", Journal of Finance, Vol. 23 Issue 2, 389-416.

Jensen, G. R., Johnson, R. R., Mercer, J. M., 1996, "Business Conditions, Monetary Policy, and Expected Security Returns", Journal of Financial Economics, Vol. 40 Issue 2, 213-237.

Kat, H., M., Menexe, F., 2003, "Persistence in Hedge Fund Performance: The True Value of a Track Record", Journal of Alternative Investments, Vol. 5 Issue 4, 66-72.

Liang, B., 1999, "On the Performance of Hedge Funds", Financial Analysts Journal, Vol. 55 Issue 4, 72-85.

Liang, B., 2000, "Hedge Funds: The living and the dead", Journal of Financial and Quantitative Analysis, Vol. 35 Issue 3, 309-326.

Liang, B., 2001, "Hedge Fund Performance: 1990-1999", Financial Analysts Journal, Vol. 57 Issue 1, 11-18.

Malkiel, B. G., 1995, "Returns from Investing in Equity Mutual Funds 1971 to 1991", Journal of Finance, Vol. 50 Issue 2, 549-572.

Nokkanen, J., 2003, "Hedge fund performance persistence", Master's Thesis, Helsinki School of Economics, Department of Accounting and Finance.

Peters, E.E., 1989, "Fractal Structure in the Capital Markets", Financial Analysts Journal, Vol. 45 Issue 4, 32-37.

Rusi, M., 2002, "Predictable Variation in Expected Returns: Commodity Futures in Diversified Portfolios", Master's Thesis, Helsinki School of Economics, Department of Accounting and Finance.

APPENDIX 1: HEDGE FUND DATABASE PROVIDERS

HFR

Hedge Fund Research (HFR) is a hedge fund research and consulting firm that has collected data on around 4,000 different hedge funds. HFR uses a subset of around 1,500 funds to calculate 33 indexes. These indexes reflect the monthly net of fee returns on equally weighted basket of funds (www.hfr.com).

MAR

The Zurich Capital Market database and the indexes calculated from it were originally developed and compiled by Managed Accounts Reports (MAR) but were sold to Zurich Capital Markets in March 2001. The database contains information on around 1,500 hedge funds, which are used to calculate 19 indexes. The latter reflect the median monthly net of fee returns on the funds in the indexes (www.marhedge.com).

CSFB/Tremont

The CSFB/Tremont indexes are based on the TASS and CSFB/Tremont databases which tracks more than 3,000 funds. CSFB/Tremont calculates 10 indexes. Contrary to other indexes, the CSFB/Tremont indexes reflect the monthly net of fee return on asset-weighted basket of funds. There are strict rules for fund selection. The universe consists only of funds with a minimum of USD 10 million under management and current audited financial statement. Funds are re-selected quarterly as necessary (www.hedgeindex.com).