Universidade do Minho
Escola de Economia e Gestão

Thi Hien Tran

The Performance of healthcare mutual funds

March of 2016

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Dissertation of Master
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Research conducted under the supervision of
Professor Maria do Céu Cortez

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Declaration

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É AUTORIZADA A REPRODUCÃO PARCIAL DESTA TESE/TRABALHO APENAS PARA EFEITOS DE INVESTIGACÃO, MEDIANTE DECLARACÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.

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The Performance of Healthcare Mutual Funds

Abstract

The objective of this dissertation is to evaluate the performance of actively managed US equity healthcare mutual funds and the persistence of these funds. Fund performance was evaluated based on the Jensen (1968) and Carhart (1997) unconditional measures and also on the full conditional model of Christopherson, Ferson and Glassman (1998). Performance persistence was assessed by means of the cross-sectional regressions and contingency tables over periods of 6 months, 12 months and 24 months. The sample comprises 35 US open-end equity sector healthcare mutual funds during the period from January 2002 to September 2014. Three predetermined public information variables about the state of the economy were taken into account to explain the fund returns.

The results suggest that in general actively managed US equity healthcare mutual funds present neutral performance in relation to the Healthcare Index, and show better performance in relation to a general market index. We also find some evidence of persistence for short periods of 6 months, which tends to disappear for periods of 12 and 24 months. These results are consistent with most of the previous empirical evidence.

The Performance of Healthcare Mutual Funds

Resumo

Esta dissertação pretende investigar o desempenho de fundos de investimento dos EUA que investem no sector da saúde bem como a persistência destes fundos. O desempenho dos fundos é avaliado com base nas medidas não condicionais de Jensen (1968) e Carhart (1997) e também com base no modelo totalmente condicional de Christopherson, Ferson e Glassman (1998). A persistência do desempenho é avaliada por meio de regressões *cross-section* e através de tabelas de contingência para períodos de 6 meses, 12 meses e 24 meses. A amostra é constituída por 35 fundos de investimento dos EUA do sector da saúde para o período de janeiro de 2002 a setembro de 2014. Três variáveis de informação pública sobre o estado da economia são tidas em conta para explicar as rendibilidades do fundo.

Os resultados mostram que, em geral, os fundos de investimento do sector da saúde apresentam um desempenho neutro relativamente ao índice do sector, mas obtêm um desempenho melhor quando avaliados relativamente ao mercado em geral. Os resultados mostram alguma evidência de persistência para curtos períodos de 6 meses, mas que tende a desaparecer para períodos mais longos de 12 e 24 meses. Estes resultados são consistentes com a maior parte da evidência empírica anterior.

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List of Acronyms and Abbreviations

CAPM	*Capital Asset Pricing Model*
CRSP	*Center for Research in Security Prices*
DY	*Dividend yield*
ETF	*Exchange Traded Funds*
HML	*High minus low*
MOM	*Momentum*
SMB	*Small minus big*
TB	*Short term interest rate*
TS	*Term spread*
US	*United States*

1 - INTRODUCTION

Since their creation, mutual funds have been a popular investment vehicle for investors. In 2014, roughly 56.7 million households and 96.2 million individuals in the United States own mutual funds (Investment Company Institute, 2014). Thus, it is more and more important to evaluate the performance of actively managed mutual funds to analyze whether the value of active management compensates the cost of professional management. In addition, knowing whether the performance of these funds is a random outcome or if it persists over time is an important matter both for investors and fund managers. Most of the mutual fund literature investigates the abnormal performance and persistence of performance for well-diversified funds, and only a few studies evaluate sector-specific funds.

As the name implies, a sector fund is a mutual fund that invests in a specific sector of the economy. Healthcare funds are one of the eight sector funds analyzed by Morningstar. These funds can cover any kind of for-profit medical institution, such as pharmaceutical companies. Many of these funds also focus on biotechnology and the companies that make pioneering advances in this industry.

The healthcare sector has gone through a substantial growth over the last twenty-five years: "Healthcare's dominance, moreover, is long-lived. The sector held up remarkably well during the 2007-2009 bear market. The S&P Health Care index was the second top sector during the bloodbath, falling 38.0%, compared with a 55.3% tumble for the S&P 500. Since the bear market's March 9, 2009, nadir, health care returned 287.4%, or 24.3% annualized. That beat the S&P 500 by an average of 1.7 percentage points per year. Health care also performed strongly during the 1990s. Add it all up and, health care is the top-performing sector over the past 25 years, with the S&P Health Care index returning an annualized 12.3%, compared with 9.6% for the S&P 500" (Kiplinger, 2015). Besides, the demand for better healthcare is growing in the developed world and the healthcare products and services are necessary, thus stocks in the healthcare sector are considered to be defensive. The healthcare sector is likely less sensitive to business cycle fluctuations, as a stabilizing sector. According to the commentary about mutual funds of Zacks Investment Research (2015) "The healthcare sector is one of the most desirable avenues for parking investments when markets are headed south. The demand for such services usually remains unchanged even during an economic downturn and investments in the sector provide sufficient protection to the capital invested. Several pharmaceutical companies also provide regular dividends, which can help mitigate losses from falling share price. Healthcare mutual funds provide the perfect avenue for investors looking to invest in this sector". Yet, there are very few studies on healthcare funds. This research focuses on the evaluation of the performance of actively managed healthcare mutual funds and the persistence of these funds in the period from January 2002 to September 2014.

The conditional performance evaluation methodologies we use to assess healthcare fund performance are considered theoretically robust. The bias of traditional models that results from ignoring time-varying estimates of risk and/or performance has led to conditional models being adopted for performance evaluation. Public information variables about the state of the economy that are available to investors are used in these conditional models in such a way that expected returns and risk vary throughout time as public information changes. Ferson and Schadt (1996) and Christopherson, Ferson and Glassman (1998) suggest that the inclusion of conditioning information sharpens inferences on performance. Christopherson, Ferson and Glassman (1998) also suggest that the persistence phenomenon is better assessed when conditional models of performance evaluation are used.

The remainder of this dissertation is organized as follows: In chapter 2, we provide a relevant literature review on the performance of healthcare mutual funds, as well as on the persistence of performance. In chapter 3, we present the methodology used. The data will be described in chapter 4. In chapter 5 we examine the empirical results. In the last chapter, we conclude our findings.

2 – LITERATURE REVIEW

The performance evaluation literature regarding actively managed mutual funds has been broadly debated in the last few decades, and is a critical aspect in investors' decisions. The first studies using risk-adjusted performance measures (Treynor, 1965, Sharpe, 1966 and Jensen, 1968) and most subsequent studies found empirical evidence showing the inability of active equity funds to outperform market indexes. Malkiel (1995) studies US equity mutual funds from 1971 to 1991 and concludes that mutual funds tend to underperform the market not only when returns are gross of all expenses (except load fees) but also after deducting management fees. Kjetsaa (2004) examines mutual funds from Morningstar. He finds that the performance of actively managed mutual funds before expenses is equal to the average market return, and also finds that the performance after expenses is less than the market by roughly the amount of investment expenses. In another study, Karoui and Meier (2009) examine the performance and portfolio characteristics of 828 newly launched US equity mutual funds, and they find that these funds start initially by earning higher excess returns and positive abnormal returns but after some time performance declines. Studies that evaluate the performance of mutual funds by using conditional measures of performance (such as Ferson and Schadt, 1996) also do not find evidence that mutual funds can outperform the market.

Besides analyzing overall performance, academics and practitioners also have investigated whether past performance predicts future performance or not. In fact, some studies have assessed performance persistence of general equity mutual funds in order to analyze portfolio managers' abilities to consistently generate good or bad performance. Grinblatt and Titman (1992) study US equity funds between 1974 and 1984. They find evidence that there is positive persistence in mutual fund performance by using cross-section regressions between estimated alphas of two periods of five years. Goetzmann and Ibbotson (1994) analyze a sample of 728 mutual funds for the period from 1976 to 1988 and also find evidence of persistence in performance at time horizons from one month to three years. They apply both Chi-square tests and cross-sectional regressions to test the persistence of these funds. Khan and Rudd (1995) examine the performance persistence of US equity mutual funds and fixed-income mutual funds using cross-section regression analysis and contingency tables approaches. They show evidence of persistence only for fixed-income fund performance. Brown and Goetzmann (1995) also find evidence of relative risk-adjusted performance persistence of US equity mutual funds for the period from 1976 to 1988 by using the Odds Ratio Z-statistic. Malkiel (1995) examines the performance persistence of equity mutual funds over period from 1971 to 1991 by constructing a Z–test. His results show evidence of persistence performance during 1970s, and no repeat winners during the 1980s. Jan and Hung (2004) examine the performance persistence of 3316 US equity funds for the period January 1961 to 2000. They suggest that investors can benefit from selecting mutual funds on the basis of both short term and long term performances. Silva, Cortez and Armada (2005) focus their study on the European market with a sample of 638 bond funds over the period from 1995 to 2000. By using contingency tables and cross-sectional regressions the authors find evidence of persistence primarily in the Spanish, French and German.

While the performance and persistence of performance of general equity funds has been extensively studied, the performance and performance persistence of sector specific funds has been less explored in the literature. These funds invest fundamentally in equity shares of companies in a particular business sector or industry. While these funds may give higher returns, they are riskier as compared to some well-diversified funds. For instance, Khorana and Nelling (1997) analyze a sample of 147 sector funds and document that these funds do not significantly outperform other general equity funds. Moreover, they do not find repeat performance of their sample of sector funds. Also, they observe that sector funds have higher risk than general equity funds. Nevertheless, in another study Burlacu and Fontaine (2003) examine 102 European sector funds and find that these funds outperform well-diversified funds.

Considering the performance of special sector funds, Kaushik and Pennathur (2012) find empirical evidence of mixed results of over and under – performance in real estate mutual funds. However, the results of Lin and Yung (2004) indicate that on average real estate mutual funds do not provide positive abnormal performance. Additionally, Lin and Yung (2004) also show that fund performance persists in the short term by using the autocorrelation analysis.

There are just a few studies specifically on the performance of healthcare mutual funds. Kaushik, Barnhart and Pennathur (2010) analyze around 1500 sector funds including healthcare funds over the period 1990-2005. They find that healthcare sector funds outperform the market. These results were also observed in recession periods. However, they ignore the longest recession since the end of the Great Depression.

More recently, Kaushik, Saubert and Saubert (2014) analyze 115 US healthcare mutual funds over the period 1/2000-12/2011. They show that, on average, healthcare mutual funds outperform the passive index and that the abnormal over- and under-performances are mean reverting. Therefore, they suggest that retail investors can add value to their overall portfolio by including a portion of their investment in healthcare funds. Further, this study documents that the abnormal over-and under-performance does not persist over subsequent periods.

Given these few studies on healthcare funds, this dissertation aims to contribute to the literature by evaluating the performance of these types of funds, which have a very specific level of risk and returns.

3 - METHODOLOGY

3.1. Performance measures: Unconditional and Conditional models

In order to evaluate the performance of mutual funds, we start by using the Jensen (1968) measure, which is based on an unconditional single factor model. This measure is the intercept of the following regression:

$$r_{p,t} = \alpha_p + \beta_p r_{m,t} + \varepsilon_{p,t} \qquad (1)$$

Where $r_{p,t}$ represents the excess return relative to the risk-free rate; α_p represents the measure of unconditional performance (Jensen's α); $r_{m,t}$ represents the excess return on the market; β_p represents the unconditional measure of systematic risk.

After nearly three decades, Fama and French (1993) introduced the three factor model using market excess returns, size and book-to-market ratio as factors. Academics consider that the three factor model is better than traditional CAPM in capturing the relationship between risk and return. Furthermore, Carhart (1997) added the momentum factor to the Fama and French (1993) three factor model which results in the four factor model:

$$r_{p,t} = \alpha_p + \beta_{1p} r_{m,t} + \beta_{2p}(SMB_t) + \beta_{3p}(HML_t) + \beta_{4p}(MOM_t) + \varepsilon_{p,t} \qquad (2)$$

Where $r_{p,t}$ represents the excess returns relative to the risk-free rate; α_p is the measure of the portfolio's performance; $r_{m,t}$ represents the excess return on the market, SMB_t (Small minus big) is the difference in returns between a portfolio of small and a portfolio of large capitalization stocks; HML_t (High minus low) is the difference in returns between portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks; MOM_t (Momentum) is the difference in the return between a portfolio of stocks of past winners and a portfolio of stocks of past losers.

We will also evaluate the performance of healthcare funds based on the unconditional four factor model of Carhart (1997), estimated by using equation (2). If the alpha is positive, the funds do better than anticipated, whereas a negative alpha indicates underperformance relative to the benchmarks: the market, size, book-to-market, momentum factors.

Unconditional models of performance evaluation tend to produce incorrect performance estimates because they assume that expected returns and risk are invariant over time regardless of market conditions. However, both expected returns and risk are time-varying.

In the conditional performance evaluation framework, fund managers' risk exposures and the related market premiums are allowed to vary over time by using predetermined public information variables. This is consistent with semi-strong form of market efficiency of Fama (1970). Ferson and Schadt (1996) developed a conditional model of performance evaluation in which beta is a linear function of a vector of predetermined information variables (Z_{t-1}):

$$\beta_p (Z_{t-1}) = \beta_{0p} + \beta'_p \, z_{t-1} \qquad (3)$$

Where $z_{t-1} = Z_{t-1} - E(Z)$ is a vector of the deviations of Z_{t-1} from the (unconditional) average values; β'_p is the vector that measures the response of the conditional beta to the public information variables; β_{0p} is an average beta, which represents the (unconditional) mean of the conditional betas.

Replacing the conditional beta in equation (1), it follows that:

$$r_{p,t} = \alpha_p + \beta_{0p} \, r_{m,t} + \beta_p' \, (z_{t-1} \, r_{m,t}) + \varepsilon_{p,t} \qquad (4)$$

Where α_p measures the conditional alpha. If a portfolio manager uses only publicly available information, represented by Z_{t-1}, the conditional alpha should be expected equal to zero.

Christopherson, Ferson and Glassman (1998) extended the partial conditional model by also allowing alphas to be time-varying.

The conditional alpha function is given by:

$$\alpha_p(Z_{t-1}) = \alpha_{0p} + A'_p z_{t-1} \tag{5}$$

Where α_{0p} is an average alpha; A'_p is a vector that measures the response of the conditional alpha to the information variables. Uniting equation (4) and (5) gives a conditional single-factor model:

$$r_{p,t} = \alpha_{0p} + A_p' z_{t-1} + \beta_{0p} r_{m,t} + \beta'_p (z_{t-1} r_{m,t}) + \varepsilon_{p,t} \tag{6}$$

Regression (6) can also be easily extended to a multi-factor framework that results in a conditional multi-factor model with time-varying alphas and betas:

$$r_{p,t} = \alpha_{0p} + A_p' z_{t-1} + \beta_{0p} \lambda_{k,t} + \beta'_p (z_{t-1} \lambda_{k,t}) + \varepsilon_{p,t} \tag{7}$$

Where β_{0p} is an average beta, which represents the (unconditional) mean of the conditional betas; $\lambda_{k,t}$ is the vector of factor returns.

This dissertation will use three predetermined information variables used by Ferson and Schadt (1996) to explain fund returns: the lagged measure of the level of short-term interest rate (TB), the lagged measure of the slope of the term spread (TS) and the lagged dividend yield of a market index (DY). The full conditional version of the single factor model including these predetermined information variables is represented in the following way:

$$r_{p,t} = \alpha_{p0} + \alpha_{p,tb} TB_{t-1} + \alpha_{p,ts} TS_{t-1} + \alpha_{p,dy} DY_{t-1} + \beta_{p0}\, r_{m,,t} + \beta_{p,tb} (TB_{t-1}\, r_{m,t}) + \beta_{p,ts} (TS_{t-1}\, r_{m,t}) + \beta_{p,dy} (DY_{t-1}\, r_{m,t}) + \varepsilon_{p,t} \tag{8}$$

The full conditional version of the four factor model with the three public information variables which was mentioned before is given by following equation:

$$\begin{aligned} r_{p,t} = {} & \alpha_{p0} + \alpha_{p,tb} TB_{t-1} + \alpha_{p,ts} TS_{t-1} + \alpha_{p,dy} DY_{t-1} + \beta_{p0}\, r_{m,,t} + \beta_{p,tb}(TB_{t-1}\, r_{m,t}) + \beta_{p,ts}(TS_{t-1} \\ & r_{m,t}) + \beta_{p,dy}(DY_{t-1}\, r_{m,t}) + \beta_{p,s}(SMB_t) + \beta_{p,s,tb}[TB_{t-1}\,(SMB_t)] + \beta_{p,s,ts}[TS_{t-1}\,(SMB_t)] + \\ & \beta_{p,s,dy}[DY_{t-1}\,(SMB_t)] + \beta_{p,h}(HML_t) + \beta_{p,h,tb}[TB_{t-1}\,(HML_t)] + \beta_{p,h,,ts}[TS_{t-1}\,(HML_t)] + \\ & \beta_{p,h,dy}[DY_{t-1}\,(HML_t)] + \beta_{p,m}(MOM_t) + \beta_{p,m,tb}[TB_{t-1}\,(MOM_t)] + \beta_{p,m,,ts}[TS_{t-1} \end{aligned} \tag{9}$$

$$(MOM_t)] + \beta_{p,m,dy}[DY_{t-1}(MOM_t)] + \varepsilon_{p,t}$$

To test heteroskedasticity and autocorrelation of the residuals of the regressions we use the White (1980) test and the Breusch (1978) - Godfrey (1978) test, respectively. If both of these phenomena exist or only autocorrelation exists, we will adjust the t-statistics of the regressions by following the procedure of Newey and West (1987). However, if only heteroskedasticity exists, the White (1980) procedure will be used.

3.2. Performance persistence

There are various methodologies to assess performance persistence: cross-sectional regressions (Grinbatt and Titman, 1992; Khan and Rudd, 1995); portfolios ranked on the previous year performance (Elton, Gruber and Blake, 1996; Huij and Derwall, 2008) and contingency tables (Brown and Goetzmann, 1995; Kahn and Rudd, 1995; Malkiel 1995).

This dissertation will use both the cross-sectional regressions and contingency tables methodologies to assess the persistence performance of healthcare mutual funds. Performance persistence is assessed over period of 6 months, 12 months and 24 months. Monthly alphas are computed in a procedure similar to Ferreira, Keswani, Ramos and Miguel (2013) by using the unconditional four factor model with the Dow Jones US Healthcare Index as benchmark. For each fund, we run a rolling window regression on the previous 24 month periods, and obtain estimated betas coefficients relative to the risk premium, SMB, HML, and MOM for each period. In each month, equilibrium returns are calculated with the coefficients obtained before, as follows:

$$r_{equilibrium,p,t} = r_{f,t} + \hat{\beta}_{1,p,t}\, r_{m,t} + \hat{\beta}_{2,p,t}(SMB_t) + \hat{\beta}_{3,p,t}(HML_t) + \hat{\beta}_{4,p,t}(MOM_t) \qquad (10)$$

Where $r_{equilibrium,p,t}$ is the expected return in month *t*; $\hat{\beta}_{1,p,t}$, $\hat{\beta}_{2,p,t}$, $\hat{\beta}_{3,p,t}$, $\hat{\beta}_{4,p,t}$ are coefficients obtained from estimating the four factor model using the previous 24 month returns.

Then, alpha in each month is computed as the difference between the realized (discrete) return and the expected equilibrium return. By calculating cumulative alpha returns, we get the alphas for 6, 12 and 24 month periods.

3.2.1. Cross–sectional regressions

In the cross-sectional regression approach, future performance is regressed on past performance. The null hypothesis of no persistence of performance will be rejected if the slope coefficient in this regression has a significant positive t-statistic. Khan and Rudd (1995), Silva, Cortez and Armada (2005) and Huij and Derwall (2008) also used this methodology to determine the performance persistence.

For each period, we calculate slope coefficient b_t of the regression using the performance of each fund in period *t* as the dependent variable and the performance of each fund in period *t-1* as the independent variable, as follows:

$$\hat{\alpha}_{p,t} = a_t + b_t\hat{\alpha}_{p,t-1} + \varepsilon_{p,t} \qquad (11)$$

Where $\hat{\alpha}_{p,t}$ and $\hat{\alpha}_{p,t-1}$ represent performance estimates (cumulative alpha for 6, 12 and 24) in period *t* and *t-1,* respectively.

The procedure for computing t-statistic follows the methodology of Fama and MacBeth (1973):

$$T = \frac{\bar{x}}{\sigma_{\bar{x}}/\sqrt{N}} \qquad (12)$$

Where $\bar{x}$ and $\sigma_{\bar{x}}$ respectively are the average and the standard deviation of the time series of a_t or b_t. N is the number of periods in the cross-sectional regression.

3.2.2. Contingency tables

An alternative non-parametric methodology is based on contingency tables, in which funds are categorized as winners (W) and losers (L) over successive periods. Winners have performance above the median performance and losers have performance below the median performance in each sub-period. Therefore, contingency tables show the frequency with which winners and losers repeat. Evidence that winners in one period remain winners in the subsequent period indicates persistence of performance, meaning that the null hypothesis of no performance persistence is rejected. In this dissertation, we apply three statistical tests to investigate performance persistence: Malkiel's (1995) Z –test for percentage of repeated winners, Brown and Goetzmann's (1995) Odds Ratio Z - statistic, and Kahn and Rudd's (1995) Chi – square statistic.

In the first test, Malkiel (1995) shows the percentage of repeated winners (WW) as follows:

$$\text{Percentage of repeated winners} = \frac{WW}{WW+WL} \text{ x } 100\% \tag{13}$$

Then, Malkiel (1995) constructs a Z–test that follows a binominal distribution of p > $\frac{1}{2}$ to check the significance of the proportion of WW to (WW + WL) and LL to (LL + LW). Thus, we have:

$$Z_{\text{winners}} = \frac{WW - (WW + WL) * 0.5}{\sqrt{(WW + WL) * 0.5 * (1 - 0.5)}} \tag{14}$$

$$Z_{\text{losers}} = \frac{LL - (LL + LW) * 0.5}{\sqrt{(LL + LW) * 0.5 * (1 - 0.5)}} \tag{15}$$

Where Z is the statistical variable having a normal distribution (0, 1); WW and LL are respectively the number of repeat winners and repeat losers; WL and LW are respectively the number of funds that are winners in one period then losers in the next period and vice versa.

The null hypothesis will be rejected if we get a percentage of repeated winners or losers greater than 50% and a Z–statistic above zero. This shows the evidence of performance persistence, with a significant level of 5%.

The second test used is to calculate the Odds ratio.

$$\text{Odds ratio} = (WW*LL)/\ (WL*LW). \tag{16}$$

According to the null hypothesis that performance in the first period is unrelated to performance in the second period, the Odds ratio will need to be 1. The value of an Odds ratio higher than 1 indicates that winners in one period will also remain winners in the subsequent period. However, when the Odds ratio is less than one, there is negative persistence or reversals (funds are winners in first period and losers in the next period and vice versa). To assess the statistical significant of the Odds ratio, Brown and Goetzmann (1995) use a Z-statistic, which is the logarithmic Odds ratio divided by its standard error.

$$\text{Z-statistic} = \frac{\ln(Odds\ ratio)}{\sqrt{\frac{1}{WW}+\frac{1}{WL}+\frac{1}{LW}+\frac{1}{LL}}} \tag{17}$$

The log of the estimated Odds ratio is asymptotically normal distributed under the assumption of independence of the observations.

The final statistical test is Chi-square statistic proposed by Kahn and Rudd (1995).

$$\chi^2 = \frac{(\mathrm{WW}-\frac{\mathrm{N}}{4})^2+(\mathrm{WL}-\frac{\mathrm{N}}{4})^2+(\mathrm{LW}-\frac{\mathrm{N}}{4})^2+(\mathrm{LL}-\frac{\mathrm{N}}{4})^2}{\frac{\mathrm{N}}{4}} \tag{18}$$

Where N is the number of funds.

According to Carpenter and Lynch (1999), the Chi-square test is very accurate, powerful and more robust to the presence of survivorship bias when compared to other tests of performance. To adjust the small sample bias, we use Yates's continuity correction (Cortez, Paxson and Armada, 1999):

For a general 2x2 table in the format:

$$\begin{matrix} a & b \\ c & d \end{matrix} \qquad N = a + b + c + d \tag{19}$$

The observed frequencies are equal to:

$$\chi^2 = \frac{N(\mathrm{ad-bc})^2}{(\mathrm{a+b})(\mathrm{c+d})(\mathrm{a+c})(\mathrm{b+d})} \tag{20}$$

The equation for the Yates' continuity correction is as follows:

$$\chi^2 = \frac{N(|ad-bc|-0.5\mathrm{N})^2}{(\mathrm{a+b})(\mathrm{c+d})(\mathrm{a+c})(\mathrm{b+d})} \tag{21}$$

This reduces the chi-squared value obtained and thus increases its P-value.

4 - DATA

This dissertation aims to assess US open-end equity sector healthcare mutual funds during the period of January 2002 to September 2014. The data on US healthcare equity mutual funds was extracted from the Center for Research in Security Prices (CRSP) Survivor-Bias-Free US Mutual Fund Database. The end-of-month discrete returns were collected for each of the funds classified as Health/Biotechnology funds according to the Lipper classification. This resulted in a list of 110 Health/Biotechnology funds.

After having the initial list funds, we excluded all funds with less than 24 monthly observations as well as Exchange Traded Funds (ETF). In case a fund has several share classes, we considered the oldest class and, if necessary, the one having the highest total net assets. In total, only 35 equity sector healthcare funds satisfy these conditions. They are presented in Appendix 1.

An equally weighted portfolio and a value weighted portfolio of healthcare funds are constructed in order to see if there are any differences in the performance of both types of portfolios. Descriptive statistics of these portfolios are showed in table 1. On average, the excess returns of the equally weighted portfolio and the value weighted portfolio are positive. The hypothesis of normally distribution is rejected for both portfolios. The rejection of this hypothesis supports the use of conditional models of performance evaluated, as shown by Adcock, Cortez, Armada and Silva (2012).

The risk-free rate was proxied by the 1-month nominal US government securities Treasury constant maturities and extracted from the Federal Reserve[1].

Other data such as the risk premium, SMB factor, HML factor and MOM factor was extracted from the website of Professor Kenneth R. French[2].

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1 http://www.federalreserve.gov/releases/h15/data.htm

2 http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Table 1 – Summary statistics of the portfolios

This table presents the descriptive statistics of the excess monthly returns of equally weighted portfolio and value weighted portfolio. The period of analysis is from January 2002 to September 2014. P-value (JB) is the probability for a statistical test that the Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis of a normally distribution.

	Equally Weighted Portfolio	Value Weighted Portfolio
Mean	0.0081	0.0085
Median	0.0124	0.0122
Maximum	0.1037	0.1174
Minimum	-0.1451	-0.1581
Std. Dev.	0.0414	0.0445
Skewness	-0.4980	-0.5103
Kurtosis	3.5743	3.6975
Jarque-Bera (JB)	8.4252	9.7426
P-value (JB)	0.0148	0.0077
Sum	1.2324	1.2976
Sum Sq. Dev.	0.2602	0.3014
Observations	153	153

As the market benchmark, two indexes are used: a general market index and style index. The purpose of using these two indexes is to evaluate fund performance relative to the market as a whole and relative to the Health care/Biotechnology sector. The market index from Professor Kenneth French's website is used as a general market index. The Dow Jones US Healthcare Index, which was extracted from Datastream, is used as a style index.

Table 2 presents summary statistics for the benchmarks and three risk factors over the sample period. On average, the market excess returns and risk factors excess return are positive. The hypothesis of normally distribution is rejected for all benchmarks and factors, except for the size factor.

Table 2 – Summary statistics of benchmarks

This table presents the descriptive statistics of the excess monthly returns of two benchmarks: Dow Jones US Healthcare Index, general market index, and three risk factors: SMB factor, HML factor and MOM factor. The period of analysis is from January 2002 to September 2014. P-value (JB) is the probability for a statistical test that the Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis of a normally distribution.

	Dow Jones Index	Market Index	SMB	HML	MOM
Mean	0.0060	0.0056	0.0026	0.0022	0.0008
Median	0.0085	0.0118	0.0011	0.0004	0.0035
Maximum	0.0945	0.1135	0.0590	0.0765	0.1245
Minimum	-0.1258	-0.1723	-0.0522	-0.0967	-0.3458
Std. Dev.	0.0377	0.0438	0.02397	0.0235	0.0494
Skewness	-0.4982	-0.6695	0.1382	-0.4356	-2.5965
Kurtosis	3.8962	4.3640	2.5822	5.2392	18.4540
Jarque-Bera (JB)	11.4486	23.2913	1.5996	36.8022	1694.435
P–value (JB)	0.0033	0.0000	0.4494	0	0
Sum	0.9221	0.8512	0.3979	0.3402	0.1269
Sum Sq. Dev.	0.2158	0.2920	0.0873	0.08366	0.3715
Observations	153	153	153	153	153

The predetermined public information variables that are used in the conditional model are: a lagged measure of the level of short term interest rates, a lagged measure of the slope of the term structure, and a lagged measure of the dividend yield. These variables have been shown by some previous studies such as Fama and French (1989), Pesaran and Timmermann (1995), Gallagher and Jarnecic (2004) and Leite, Cortez and Armada (2009) to be useful in predicting stock returns. The yield on a constant - maturity 3-month US Treasury bill is used as the short-term interest rate. The term spread is measured through the difference between the US constant 10-year Treasury bond yield and the 3-month Treasury bill. These data were extracted from the Federal Reserve website. The dividend yield is based on the Standard and Poors 500 Composite Dividend Yield and was extracted from Datastream.

We apply the stochastic detrending process suggested by Ferson, Sarkissian and Simin (2003) to avoid spurious regressions. Accordingly, each predetermined public information variable was subtracted from their 12 months moving average. These variables are used in their mean zero form. Table 3 presents some descriptive statistics for the public information variables.

Table 3 - Summary statistics of predetermined public information variables

This table presents some descriptive statistics for the lag information variables for the period of January 2002 to September 2014: short term interest rates, the slope of the term structure and the dividend yield. P-value (JB) is the probability for a statistical test that the Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis of a normally distribution.

	Short term interest rates	The slope of the term structure	Dividend yield
Mean	0.0107	-0.0117	-0.0001
Median	0.0903	-0.0297	-0.0146
Maximum	1.1086	1.5437	0.9204
Minimum	-2.3255	-1.0697	-0.7571
Std. Dev.	0.6190	0.5951	0.2520
Skewness	-0.8301	0.2823	0.3826
Kurtosis	4.6351	2.485	7.2838
Jarque-Bera	34.6164	3.7226	120.72
P-value (JB)	0	0.1555	0
Sum	1.6397	-1.7953	-0.0170
Sum Sq. Dev.	58.2431	53.8216	9.6493
Observations	153	153	153

5 – EMPIRICAL RESULTS

In this chapter, we present and analyze the results on the performance and performance persistence of 35 US equity healthcare mutual funds, over the period from January 2002 to September 2014. The performance of these funds is analyzed at the aggregate level by using an equally weighted portfolio and a value weighted portfolio, as well as at the individual fund level. Two market benchmarks are used for each model: a general market index and a style index. Performance is first analyzed by means of unconditional models and afterwards by conditional models. The performance persistence is assessed by using two methodologies: cross-sectional regressions and contingency tables.

5.1. Unconditional and conditional models of performance evaluation

5.1.1. Unconditional models of performance evaluation

First, we use unconditional models to evaluate the performance of the dataset of funds. The results of fund performance using the unconditional single and four factor models are displayed in table 4 and table 5, respectively. In each table, panel A presents the results of regressions using the Dow Jones US Healthcare Index as benchmark and panel B the results of using the general market index as benchmark. We use the Newey and West (1987) procedure to adjust the errors for autocorrelation and heteroskedasticity and the White (1980) to correct only in the case of heteroskedasticity.

In general, funds show neutral performance. In both of the two tables, the equally weighted and value weighted portfolios exhibit neutral performance relative to the Healthcare Index. Most of funds present positive alphas but just few of them are significant at a 5% level. In table 4, panel A displays 3 individual funds out of 27 funds having positive alphas that are statistically significant at a 5% level, and 2 out of 8 funds having negative alphas that are statistically significant at a 5% level; Fund performance is slightly higher when assessed relative to the general market index. Indeed, panel B shows that 5 out of 34 individual funds with positive alphas are statistically significant at a 5% level, and only 1 fund with negative alpha but not statistically significant.

Table 4 – Fund performance using the unconditional single model

This table presents regression estimates for both equally weighted portfolios and value weighted portfolios with the Dow Jones US Healthcare Index as benchmark (panel A) and the general market index as benchmark (panel B) using the unconditional single model during period from 31/01/2002 to 30/09/2014. It shows abnormal performance estimates (alpha), systematic risk (beta) and the adjusted coefficient of determination (Adj. Rsq). Standard errors are corrected, whenever appropriate, for the presence of heteroskedasticity using the correction presented by White (1980), or for the presence of autocorrelation and heteroskedasticity using the procedure suggested by Newey and West (1987). t-statistics are presented in parenthesis. Asterisks (***, **, *) indicate statistically significant values at the 1%, 5% and 10% levels, respectively. The number of individual funds presenting positive (N+) and negative (N-) alphas is reported, the number of those which are statistically significant at the 5% level are reported in brackets.

		α_p	β_p	Adj Rsq
Panel A: Benchmark Dow Jones US Healthcare Index				
Equally weighted portfolio		0.0019	1.0242	86.89%
		(1.535)	*(31.762)****	
Value weighted portfolio		0.0020	1.0735	82.41%
		(1.315)	*(26.707)****	
	N +	27 (3)		
	N -	8 (2)		
Panel B: General Market Index				
Equally weighted portfolio		0.0038	0.7739	65.24%
		*(1.914)**	*(16.921)****	
Value weighted portfolio		0.0041	0.7943	60.88%
		*(1.790)**	*(15.413)****	
	N +	34(5)		
	N -	1(0)		

From panel A of table 5 we observe that there are 25 funds having positive alphas, with 4 of them being statistically significant, and 10 funds having negative alphas with only 2 of them being statistically significant. Panel B of table 5 shows 10 out of 34 funds having positive alphas which are significant at a 5% level, and only 1 fund presenting a negative alpha, although not being statistically significant. These results show that in general US healthcare mutual funds have neutral performance relative to the Healthcare Index and that they tend to perform better when compared against the general market index. Indeed, the performance of the equally and value weighted portfolios is positive and statistically significant at a 5% level when we applied the unconditional four factor model with a general market index as benchmark.

As expected, by using the Dow Jones US Healthcare Index as benchmark we get higher adjusted coefficients of determination than using the general market index as benchmark. Also, the equally weighted portfolio has an adjusted R^2 greater than that obtained with the value weighted portfolio. Additionally, the explanatory power of the unconditional four factor model is higher than the unconditional single model.

The coefficients for the market are always positive and statistically significant at a 1% level, thus indicating a strong positive correlation between funds and market returns. The coefficients for SMB factor of the portfolios are positive and statistically significant at a 1% level in the regression using the Dow Jones Index as the benchmark, suggesting that portfolios have exposure to small stocks. The coefficients of the HML factor are negative and statistically significant at a 1% level, thus indicating that the portfolios are mainly exposed to growth stocks. The coefficients of MOM factor are not statistically significant. Based on the Wald test, the null hypothesis that the coefficients of the market, size (SMB), book-to-market (HML), and momentum (MOM) factors are jointly equal to zero is rejected for all portfolios.

Table 5 – Fund performance using the unconditional four factor model

This table presents regression estimates for both equally weighted portfolios and value weighted portfolios with the Dow Jones US Healthcare Index as benchmark (panel A) and the general market index as benchmark (panel B) using the unconditional Carhart (1997) four factor model during period from 31/01/2002 to 30/09/2014. It shows abnormal performance estimates (alpha), systematic risk (beta), the regressions coefficients of Size ($\beta_{p,s}$), Value ($\beta_{p,h}$), and Momentum ($\beta_{p,m}$) factors and the adjusted coefficient of determination (Adj. Rsq). Wald indicates the result of the Wald test for the null hypothesis that the coefficients of the market, size, book-to-market and momentum factors are jointly equal to zero. Standard errors are corrected, whenever appropriate, for the presence of heteroskedasticity using the correction presented by White (1980), or for the presence of autocorrelation and heteroskedasticity using the procedure suggested by Newey and West (1987). t-statistics are presented in parenthesis. Asterisks (***, **, *) indicate statistically significant values at the 1%, 5% and 10% levels, respectively. The number of individual funds presenting positive (N+) and negative (N-) alphas is reported, the number of those which are statistically significant at the 5% level are reported in brackets.

		α_p	$\beta_{p,0}$	$\beta_{p,s}$	$\beta_{p,h}$	$\beta_{p,m}$	Adj Rsq	Wald
Panel A: Benchmark Dow Jones US Healthcare Index								
Equally weighted portfolio		0.0014	0.9891	0.4094	-0.1704	-0.0086	92.51%	470.617***
		(1.512)	*(38.168)****	*(10.448)****	*(-4.246)****	*(-0.433)*		
Value weighted portfolio		0.0017	1.0376	0.4399	-0.2752	-0.0123	88.75%	300.651***
		(1.381)	(30.348)***	(8.509)***	(-5.198)***	(-0.472)		
	N +	25 (4)						
	N -	10 (2)						
Panel B: General Market Index								
Equally weighted portfolio		0.0040	0.7856	0.1265	-0.3165	0.0287	68.19%	71.357***
		*(2.051)***	*(12.351)****	*(1.227)*	*(-3.152)****	*(0.431)*		
Value weighted portfolio		0.0045	0.8234	0.1436	-0.4282	0.0265	65.55%	73.294***
		*(2.077)***	*(14.184)****	*(1.490)*	*(-4.604)****	*(0.554)*		
	N +	34 (10)						
	N -	1(0)						

5.1.2. Conditional models of performance evaluation

To avoid the bias of unconditional models that results from ignoring time-varying estimates of risk, the performance of the portfolios is evaluated by using the full conditional model of Christopherson, Ferson and Glassman (1998), which considers not only the time-varying betas but also time-varying alphas. The conditional approach is applied to the single index model and to the Carhart (1997) four factor model.

The performance results using the conditional single index and the conditional four factor models are displayed in tables 6 and table 7, respectively.

Once again, we find that the performance of the portfolios using the general market index as benchmark is better than that obtained when using the Dow Jones US Healthcare Index.

Similar to the unconditional models, most individual funds show neutral performance. In table 6, we observe that 34 out of 35 funds have positive alphas, with 13 being statistically significant when using the general market index as benchmark. Only 1 fund has negative alpha but it is not statistically significant. When using the Dow Jones US Healthcare Index as benchmark, there are 28 funds having positive alphas, with 4 of them being statistically significant. Besides, seven funds have negative alphas, with 2 of them being statistically significant.

In table 7 we observe that when using the general market index benchmark, all 35 funds have positive alphas, and 14 of those alphas are statistically significant at a 5% level. When using the Dow Jones US Healthcare Index as benchmark, there are 27 funds having positive alphas, with 6 of them are statistically significant at a 5% level. Additionally, 8 funds show negative alphas, with 4 of them being statistically significant at a 5% level. The highest adjusted R^2 is obtained when using the Dow Jones US Healthcare Index as benchmark and has a value of 99.99%.

Table 6 – Fund performance using the conditional single model

This table presents regression estimates for both equally weighted portfolios and value weighted portfolios with the Dow Jones US Healthcare Index as benchmark (panel A) and the general market index as benchmark (panel B) using the full conditional one factor model during period from 31/01/2002 to 30/09/2014. It shows abnormal performance estimates (conditional alphas), conditional systematic risk (betas) and the adjusted coefficient of determination (Adj. Rsq). Three predetermined public information variables are used: the short term interest rate level (tb), the slope of term spread (ts) and the dividend yield (dy). Wald 1, Wald 2 and Wald 3 correspond to the null hypothesis that the coefficients of conditional alphas, conditional betas, and conditional alphas and conditional betas, respectively, are jointly equal to zero. Standard errors are corrected, whenever appropriate, for the presence of heteroskedasticity using the correction presented by White (1980), or for the presence of autocorrelation and heteroskedasticity using the procedure suggested by Newey and West (1987). t-statistics are presented in parenthesis. Asterisks (***, **, *) indicate statistically significant values at the 1%, 5% and 10% levels, respectively. The number of individual funds presenting positive (N+) and negative (N-) alphas is reported, the number of those which are statistically significant at the 5% level are reported in brackets.

	α_p	$\alpha_{p,tb}$	$\alpha_{p,ts}$	$\alpha_{p,dy}$	$\beta_{p,0}$	$\beta_{p,tb}$	$\beta_{p,ts}$	$\beta_{p,dy}$	Adj Rsq	Wald 1	Wald 2	Wald 3
Panel A: Benchmark Dow Jones US Healthcare Index												
Equally weighted portfolio	0.0021	-0.0013	-0.0029	-0.0048	1.0103	0.0104	0.0739	-0.0723	86.67%	0.429	219.71***	142.167***
	(1.632)	*(-0.334)*	*(-0.763)*	*(-0.776)*	*(27.54)****	*(0.093)*	*(0.838)*	*(-0.540)*				
Value weighted portfolio	0.0023	-0.0013	-0.0039	-0.0046	1.0595	0.0527	0.1211	-0.0583	82.13%	0.485	155.581***	100.821***
	(1.387)	*(-0.278)*	*(-0.837)*	*(-0.595)*	*(23.183)****	*(0.377)*	*(1.103)*	*(-349)*				
N +	28(4)											
N -	7(2)											
Panel B: General Market Index												
Equally weighted portfolio	0.0036	-0.0039	-0.0068	-0.0025	0.8096	0.1608	0.2152	-0.1487	65.85%	0.471	63.39***	46.063***
	*(1.747)**	*(-0.645)*	*(-1.105)*	*(-0.216)*	*(13.771)****	*(0.920)*	*(1.567)*	*(-0.620)*				
Value weighted portfolio	0.0039	-0.0039	-0.0078	-0.0023	0.8432	0.1605	0.2173	-0.1822	61.39%	0.6	52.511***	35.520***
	(1.6242)	*(-0.561)*	*(-1.141)*	*(-0.199)*	*(13.285)****	*(0.856)*	*(1.513)*	*(-0.831)*				
N +	34(13)											
N -	1(0)											

The conditional four factor model indicates that only the additional risk factor that has statistically significant betas at a 1% level is the HML factor, meaning that the funds are mainly exposed to growth companies.

Additionally, the results of the Wald test for conditional alphas show that there is no evidence of time-varying alphas. This finding suggests that that the performance of the portfolios does not vary over time according to predetermined public information variables. However, we can reject the null hypothesis of the conditional betas being jointly equal to zero, which indicates that risk varies over time according to public information variables. Likewise, the null hypothesis of the conditional alphas and conditional betas being jointly equal to zero for all portfolios can also be rejected. The importance of incorporating the public information variables in the performance assessment models is reinforced through these results.

The explanatory power of the conditional four factor models is improved when compared to the unconditional Carhart (1997) four factor models and the conditional single index models, which is consistent with the empirical evidence of Christopherson, Ferson and Glassman (1998) and Ferson and Schadt (1996).

Table 7 – Fund performance using the conditional four factor model

This table presents regression estimates for both equally weighted portfolios and value weighted portfolios with the Dow Jones US Healthcare Index as benchmark (panel A) and the general market index as benchmark (panel B) using the full conditional four factor model during period from 31/01/2002 to 30/09/2014. It shows abnormal performance estimates (conditional alphas), conditional systematic risk (betas), the regressions coefficients of Size ($\beta_{p,s}$), Value ($\beta_{p,h}$), and Momentum ($\beta_{p,m}$) factors and the adjusted coefficient of determination (Adj. Rsq). Wald indicates the result of the Wald test for the null hypothesis that the coefficients of the market, size, book-to-market and momentum factors are jointly equal to zero. Three predetermined public information variables are the short term interest rate level (tb), the slope of term spread (ts) and the dividend yield (dy). Wald 1, Wald 2 and Wald 3 correspond to the null hypothesis that the coefficients of conditional alphas, conditional betas, conditional alphas and conditional betas, respectively, being jointly equal to zero. Standard errors are corrected, whenever appropriate, for the presence of heteroskedasticity using the correction presented by White (1980), or for the presence of autocorrelation and heteroskedasticity using the procedure suggested by Newey and West (1987). t-statistics are presented in parenthesis. Asterisks (***, **, *) indicate statistically significant values at the 1%, 5% and 10% levels, respectively. The number of individual funds presenting positive (N+) and negative (N-) alphas is reported, the number of those which are statistically significant at the 5% level are reported in brackets.

	αp0	αp,tb	αp,ts	αp,dy	βp0	βp,tb	βp,ts	βp,dy	βp,s	βp,s,tb	βp,s,ts	βp,s,dy	βp,h	βp,h,tb	βp,h,ts	βp,h,dy	βp,m	βp,m,tb	βp,m,ts	βp,m,dy	Adi. Rsq	Wald 1	Wald 2	Wald 3
Panel A: Benchmark Dow Jones US Healthcare Index																								
Equally weighted	0.0023	0.0006	-0.001	-0.004	0.9643	0.0193	0.101	-0.066	0.4175	-0.064	-0.118	*-0.141*	-0.184	-0.217	-0.2513	-0.2364	-0.023	0.0445	0.0018	0.0305	92.9%	0.674	454 ***	*491* ***
portfolio	*(2.29)* **	*(0.18)*	*(-0.43)*	*(-0.855)*	*(38)****	*(0.24)*	*(1.54)*	*(-0.66)*	*(8.4)****	*(-0.43)*	*(-0.94)*	*(-0.65)*	*(-3.84)* ***	*(-1.64)*	*(-1.17)***	*(-1.17)*	*(-0.60)*	*(0.41)*	*(0.01)*	*(0.33)*				
Value weighted	0.0025	0.001	-0.002	-0.0074	1.0031	0.082	0.190	0.033	0.4396	-0.095	-0.21	-0.26	-0.282	-0.264	-0.3176	-0.382	-0.02	0.045	0.025	-0.01	89%	1.171	72.03 ***	68.01 ***
portfolio	*(1.92)**	*(0.35)*	*(-0.4)*	*(-1.1)*	*(26)****	*(0.72)*	*(1.9)**	*(0.23)*	*(7.9)****	*(-0.5)*	*(-1.3)*	*(-1.2)*	*(-4.5)* ***	*(-1.4)*	*(-2.3)***	*(-1.36)*	*(-0.5)*	*(0.37)*	*(0.23)*	*(-0.1)*				
N+	27 (6)																							
N -	8 (4)																							
Panel B: General Market Index																								
Equally weighted	0.0058	-0.001	-0.002	-0.0022	0.8329	0.265	0.252	0.049	0.1367	-0.35	-0.02	0.029	-0.415	-0.46	-0.4596	-0.261	-0.03	0.09	-0.08	0.284	71%	0.062	20.74 ***	20.25 ***
Portfolio	*(2.8)* ***	*(-0.3)*	*(-0.4)*	*(-0.21)*	*(13.3)* ***	*(1.46)*	*(1.7)**	*(0.17)*	*(1.48)*	*(-1.2)*	*(-0.1)*	*(0.08)*	*(-4.3)* ***	*(-1.6)*	*(-1.89)**	*(-0.54)*	*(-0.5)*	*(0.49)*	*(-0.5)*	*(1.8)**				
Value weighted	0.0064	-0.0002	-0.002	-0.005	0.8527	0.267	0.283	0.136	0.1595	-0.37	-0.08	-0.04	-0.5239	-0.53	-0.5382	-0.49	-0.03	0.08	-0.08	0.247	67%	0.137	17.71 ***	17.3 ***
portfolio	*(2.8)* ***	*(-0.1)*	*(-0.3)*	*(-0.42)*	*(11.9)* ***	*(1.29)*	*(1.7)**	*(0.43)*	*(1.52)*	*(-1.1)*	*(-0.3)*	*(0.11)*	*(-4.8)* ***	*(-1.6)*	*(-1.95)**	*(-0.88)*	*(-0.4)*	*(0.38)*	*(-0.4)*	*(1.36)*				
N+	35 (14)																							
N -	0(0)																							

5.2. Performance persistence

In this section, we analyze the performance persistence of healthcare mutual funds to analyze whether past performance can help predict future performance or not.

To evaluate the performance persistence, we use two different approaches: cross-sectional regressions and contingency tables. We use three different periods of analysis: 6 months, 12 months and 24 months, to test performance persistence over shorter and longer periods.

The assessment of persistence is based on risk-adjusted alphas obtained through the unconditional four factor model of Carhart (1997).

5.2.1. Cross-sectional regressions

This approach to measure persistence is based on cross-sectional regressions that are used to analyze the relationship of future performance with past performance. With a significant positive t-statistic for the slope coefficient, we can reject the null hypothesis of no persistence of performance, thereby concluding that there is evidence of persistence or future performance is related to past performance.

The results of the cross-sectional regressions (as in Fama and MacBeth, 1973) between the future alphas and the past alphas for the periods of 6 months, 12 months and 24 months are reported in table 8.

Table 8 shows strong evidence of performance persistence for the period of 6 months. For this time period, the regression coefficients are positive and statistically significant at a 5% level. Looking at the statistics for the periods of 12 and 24 months, we observe that the slope coefficient for the period of 12 months is negative, while the slope coefficient for the period of 24 months is positive, but none of them are statistically significant. We can therefore conclude that there is no evidence of persistence for 12 and 24 month periods.

Table 8 – Performance persistence: Cross-sectional regressions

This table reports the statistics for the cross-sectional regressions (as in Fama and MacBeth, 1973) between the future alphas and past alphas for periods 6 months, 12 months and 24 months from January 2004 to June 2014. Monthly alphas are obtained through the unconditional four factor model. t-statistics are presented in parenthesis. Asterisks (***, **, *) indicate statistically significant values at the 1%, 5% and 10% levels, respectively.

Periods	Unconditional four factor model			
	a	t-stat	b	t-stat
6 months	0.833	9.885***	0.220	2.691**
12 months	1.039	4.632***	-0.022	-0.097
24 months	0.812	2.510*	0.213	0.626

5.2.2. Contingency tables

The contingency tables are a non-parametric methodology widely used to assess the existence of performance persistence. As mentioned before, the null hypothesis of no persistence will be rejected if we find statistical evidence that winners in one period remain winner in the next period.

Table 9 presents the contingency table results for periods of 6 months for the second semester of 2004 to the first semester of 2004. Similar to the results obtained with the cross-sectional regressions, we find strong evidence of persistence. The percentage of repeat winners is more than 50% and Malkiel's (1995) Z-statistic is statistically significant at a 5% level. Likewise, Brown and Goetzmann's (1995) Odds ratio is greater than 1, and its Z-statistic is statistically significant at a 5% level. Moreover, Kahn and Rudd's (1995) Chi-square statistic shows statistically significant persistence at a 5% level as well.

Look at the individual periods in the table 9, we find that there is persistence of positive performance in 2 out of the 20 periods with Malkiel's (1995) Z-test. By Brown and Goetzmann's (1995) Odds ratio Z-statistic test and Kahn and Rudd's

(1995) Chi-square test, we conclude that 3 of the 20 periods show statistically significant persistence at a 5% level.

Table 9 – Performance persistence: Contingency table for periods of 6 months

This table presents the results of the contingency table for 6 months based on unconditional multi-index alphas for the second semester of 2004 to the first semester of 2014. WW indicates funds that were winners in two subsequent periods; WL indicates funds that were winners in one period and losers in the next period; LW indicates funds that were losers in one period and winners in the next period; WW indicates funds that were losers in two subsequent periods. The % RW refers to the percentage of repeated winners as in Malkiel (1995). The Odd ratio is calculated as in Brown and Goetzmann (1995). The Z statistic and corresponding P-value are also reported. Chi refers to the chi-square test as in Kahn and Rudd (1995) and Yate's P-value is the corresponding p-value considering the Yate correction for continuity. Values in the bold refer to statistical significance at the 5% level.

Periods		**WW**	**LW**	**WL**	**LL**	**Malkiel**			**Brown and Goetzmann**			**Kahn and Rudd**	
						% RW	**Z**	**P-value**	**Odds ratio**	**Z**	**P-value**	**Chi**	**Yate's P-value**
1	**2**	5	4	4	5	0.56	0.33	0.739	1.56	0.47	0.638	0.22	1.000
2	**3**	4	6	6	3	0.40	-0.63	0.527	0.33	-1.15	0.251	1.42	0.483
3	**4**	7	3	3	6	0.70	1.26	0.206	4.67	1.56	0.119	2.68	0.255
4	**5**	9	1	1	8	**0.90**	**2.53**	**0.011**	**72.0**	**2.86**	**0.004**	**11.95**	**0.003**
5	**6**	6	4	4	5	0.60	0.63	0.527	1.88	0.68	0.500	0.58	0.827
6	**7**	7	4	4	6	0.64	0.90	0.366	2.63	1.07	0.283	1.29	0.518
7	**8**	7	4	4	6	0.64	0.90	0.366	2.63	1.07	0.283	1.29	0.518
8	**9**	5	6	6	4	0.45	-0.30	0.763	0.56	-0.66	0.507	0.52	0.819
9	**10**	7	4	4	6	0.64	0.90	0.366	2.63	1.07	0.283	1.29	0.518
10	**11**	5	6	6	4	0.45	-0.30	0.763	0.56	-0.66	0.507	0.52	0.819
11	**12**	5	6	6	4	0.45	-0.30	0.763	0.56	-0.66	0.507	0.52	0.819
12	**13**	7	4	4	7	0.64	0.90	0.366	3.06	1.26	0.207	1.64	0.394
13	**14**	8	4	4	7	0.67	1.15	0.248	3.50	1.43	0.153	2.22	0.300
14	**15**	10	3	2	8	**0.83**	**2.31**	**0.021**	**13.3**	**2.52**	**0.012**	**7.78**	**0.022**
15	**16**	7	10	10	7	0.41	-0.73	0.467	0.49	-1.02	0.306	1.06	0.493
16	**17**	12	5	5	12	0.71	1.70	0.090	**5.76**	**2.33**	**0.020**	**5.76**	**0.040**
17	**18**	10	7	7	10	0.59	0.73	0.467	2.04	1.02	0.306	1.06	0.493
18	**19**	8	9	9	8	0.47	-0.24	0.808	0.79	-0.34	0.732	0.12	1.000
19	**20**	9	8	8	9	0.53	0.24	0.808	1.27	0.34	0.732	0.12	1.000
20	**21**	8	9	9	8	0.47	-0.24	0.808	0.79	-0.34	0.732	0.12	1.000
Total		**146**	**107**	**106**	**133**	**0.58**	**2.52**	**0.01**	**1.71**	**2.95**	**0.003**	**9.54**	**0.004**

In table 10, we display the contingency table results for periods of 12 months.

Table 10 – Performance persistence: Contingency table for periods of 12 months

This table presents the results of the contingency table for 12 months based on unconditional multi-index alphas for the period of January 2005 to December 2013. WW indicates funds that were winners in two subsequent periods; WL indicates funds that were winners in one period and losers in the next period; LW indicates funds that were losers in one period and winners in the next period; WW indicates funds that were losers in two subsequent periods. The % RW refers to the percentage of repeated winners as in Malkiel (1995). The Odd ratio is calculated as in Brown and Goetzmann (1995). The Z statistic and corresponding P-value are also reported. Chi refers to the chi-square test as in Kahn and Rudd (1995) and Yate's P-value is the corresponding p-value considering the Yate correction for continuity. Values in the bold refer to statistical significance at the 5% level.

Periods		WW	LW	WL	LL	Malkiel			Brown and Goetzmann			Kahn and Rudd	
						% RW	Z	P-value	Odds ratio	Z	P-value	Chi	Yate's P-value
1	**2**	6	3	3	6	0.67	1.00	0.317	4.00	1.39	0.166	2.00	0.346
2	**3**	7	3	3	6	0.70	1.26	0.206	4.67	1.56	0.119	2.68	0.255
3	**4**	7	3	3	6	0.70	1.26	0.206	4.67	1.56	0.119	2.68	0.255
4	**5**	2	9	9	1	0.18	-2.11	0.035	0.02	-2.82	**0.005**	**10.81**	**0.004**
5	**6**	4	7	7	3	0.36	-0.90	0.366	0.24	-1.51	0.131	2.43	0.270
6	**7**	7	3	4	7	0.64	0.90	0.366	4.08	1.51	0.131	2.43	0.270
7	**8**	7	5	5	6	0.58	0.58	0.564	1.68	0.62	0.538	0.48	0.842
8	**9**	11	6	6	11	0.65	1.21	0.225	3.36	1.69	0.091	2.94	0.170
9	**10**	14	3	3	14	**0.82**	**2.67**	**0.008**	**21.78**	**3.42**	**0.001**	**14.24**	**0.001**
Total		**65**	**42**	**43**	**60**	**0.60**	**2.12**	**0.034**	**2.16**	**2.74**	**0.006**	**7.87**	**0.009**

In contrast with the results obtained with the cross-sectional regressions, at the aggregate level the three tests used show evidence of persistence for periods of 12 months.

At the individual period level, there is statistically significant evidence at 1% level of persistence in 1 out of 9 periods with Malkiel's (1995) Z-test and Brown and Goetzmann's (1995) Odds ratio Z-statistic test. Using the Chi-square test of Kahn and Rudd's (1995), we conclude that 2 out of the 9 periods show statistically significant persistence at a 1% level.

For periods of 24 months, the results of contingency table for January 2005 to December 2013 are reported in table 11. Similar to the results obtained with cross-sectional regressions, for the aggregate level we cannot reject the null hypothesis of no persistence for periods of 24 months. However, at the individual level, we find evidence of persistence in 1 out of 4 periods on the basis of Brown and Goetzmann's (1995) Odds ratio Z-statistic test.

Table 11 – Performance persistence: Contingency table for periods of 24 months

This table presents the results of the contingency table for 24 months based on unconditional multi-index alphas for January 2006 to December 2013. WW indicates funds that were winners in two subsequent periods; WL indicates funds that were winners in one period and losers in the next period; LW indicates funds that were losers in one period and winners in the next period; WW indicates funds that were losers in two subsequent periods. The % RW refers to the percentage of repeated winners as in Malkiel (1995). The Odd ratio is calculated as in Brown and Goetzmann (1995). The Z statistic and corresponding P-value are also reported. Chi refers to the chi-square test as in Kahn and Rudd (1995) and Yate's P-value is the corresponding p-value considering the Yate correction for continuity. Values in the bold refer to statistical significance at the 5% level.

Periods		WW	LW	WL	LL	Malkiel			Brown and Goetzmann			Kahn and Rudd	
						% RW	Z	P-value	Odds ratio	Z	P-value	Chi	Yate's P-value
1	**2**	4	5	5	4	0.44	-0.33	0.739	0.64	-0.47	0.638	0.22	1.000
2	**3**	4	6	6	3	0.40	-0.63	0.527	0.33	-1.15	0.251	1.42	0.483
3	**4**	5	5	6	5	0.45	-0.30	0.763	0.83	-0.21	0.835	0.14	0.819
4	**5**	8	2	4	9	0.67	1.15	0.248	**9.00**	**2.21**	**0.027**	5.70	0.055
Total		**21**	**18**	**21**	**21**	0.50	0.00	1.00	1.17	0.35	0.729	0.33	0.902

To summarize this analysis of contingency table approach, we found evidence of performance persistence for two periods of 6 and 12 months. However, for longer periods of 24 months, there is no evidence of persistence.

6 - CONCLUSIONS

The performance evaluation of actively managed mutual funds has been one of the most attractive debate topics in finance. Moreover, the assessment of performance persistence is also an important topic for fund managers and investors. However, most of studies on mutual fund performance investigate the abnormal performance and the persistence of performance for well-diversified funds, and only a few studies evaluate sector-specific funds. Currently, there are very few studies which focus on healthcare funds. This dissertation aims to contribute to the literature by evaluating the performance and the persistence of performance of this type of funds, which have a very specific risk and return characteristics.

In this dissertation we examine the performance of 35 US equity sector healthcare mutual funds over the period of January 2002 to September 2014. Fund performance is evaluated based on the Jensen (1968) and Carhart (1997) unconditional measures as well as the full conditional model of Christopherson, Ferson and Glassman (1998). Three predetermined public information variables are used to proxy for market conditions: the lagged measure of the level of short-term interest rate, the lagged measure of the slope of the term spread and the lagged dividend yield of a market index. We used the Dow Jones US Healthcare Index and a general market index as benchmarks in each model.

In terms of overall performance, the results suggest that healthcare funds show neutral performance relative to the Healthcare Index. In each model, the equally weighted and value weighted portfolios exhibit neutral performance as well. The neutral performance of mutual funds is thus consistent with most previous empirical evidence. Most of funds present positive alphas but just few funds are significant at a 5% level. Furthermore, as in Cortez, Silva and Areal (2009), Bauer, Derwall and Otten (2007), and Areal, Cortez and Silva (2013), our results also indicate that conditional models lead to better regression estimates than unconditional models. The performance of the equally and value weighted portfolios is positive when we apply the unconditional four factor model with the general market index benchmark. In fact, the performance of the portfolios is always better when using the general market index as benchmark than when using the Dow Jones US Healthcare Index as benchmark, which indicates that healthcare mutual funds outperform the market. We observe higher adjusted coefficient of determination when using the Dow Jones US Healthcare Index than when using general market index. Additionally, the equally weighted portfolios have adjusted R^2 greater than the value weighted portfolios. The explanatory power of the conditional four factor models is higher when compared to the unconditional Carhart (1997) four factor models and the conditional single models, which is consistent with the empirical evidence of Christopher, Ferson and Glassman (1998) and Ferson and Schadt (1996).

Furthermore, our results suggest that US healthcare mutual funds are exposed to small stocks and growth stocks. This result confirms that the size and book-to-market effects need to be controlled for, besides market risk. We also find that there is no evidence of time-varying conditional alphas while there is some evidence of time-varying betas, which means the performance of the portfolios does not vary over time according to predetermined public information variables, but the risk varies over time according to public information variables. These results reinforce the importance of incorporating the public information variables in the performance evaluation models, as motivated by Fama and French (1989).

The persistence phenomenon was assessed over periods of 6 months, 12 months, and 24 months by using both cross-sectional regressions and the contingency tables methodologies. The results of the cross-sectional regression between the future alphas and past alphas show that there is evidence of persistence for periods of 6 months, but there is no evidence of persistence for the periods of 12 and 24 months. Using the contingency table approach, we test the null hypothesis of no performance persistence by means of the Z-test for repeat winners, Odds ratio Z-statistic and Chi-square test for independence, as well as Yates's continuity correction to adjust for the small sample bias. We find some evidence of persistence for 6 month and 12 month periods, but no persistence for 24 month periods.

The main limitation of this study is that the dataset is not survivorship bias free and the number of healthcare funds is small. Another limitation is that the management fees in healthcare mutual funds have not been considered and so we did not evaluate the effect of this factor on fund performance. We suggest that further research might consider more sector fund categories and the effects of management fees on assessing fund performance.

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APPENDIX

Appendix 1 – List of US equity sector healthcare mutual funds

This appendix shows the list of 35 US equity sector healthcare mutual funds obtaining from CRSP for period from January 2002 to September 2014. Lipper_class H: *Health/ Biotechnology funds*; Lipper_asset EQ: *Equity*; TNA: *Total net assets* at 9/30/2014

Fund's number	Name of fund	Lipper_class	Lipper_asset	Start date	Last date	TNA
3929	Alger Funds: Alger Health Sciences Fund; Class A Shares	H	EQ	4/30/2002	9/30/2014	16,619
4606	Allianz Funds: AllianzGI Wellness Fund; Class D Shares	H	EQ	12/31/1996	9/30/2014	21,165
6299	BlackRock Funds: BlackRock Health Sciences Opportunities Portfolio; Investor A Shares	H	EQ	11/30/1999	9/30/2014	91,602
8447	Deutsche Securities Trust: Deutsche Health and Wellness Fund; Class S Shares	H	EQ	3/31/1998	9/30/2014	26,065
11655	Fidelity Advisor Series VII: Fidelity Advisor Biotechnology Fund; Class T Shares	H	EQ	3/31/1998	9/30/2014	3,549
11685	Fidelity Advisor Series VII: Fidelity Advisor Health Care Fund; Class T Shares	H	EQ	9/30/1996	9/30/2014	37,480
12026	Fidelity Select Portfolios: Health Care Portfolio	H	EQ	7/31/1981	9/30/2014	423,844
12042	Fidelity Select Portfolios: Medical Equipment and Systems Portfolio	H	EQ	4/30/1998	9/30/2014	160,415
12059	Fidelity Select Portfolios: Medical Delivery Portfolio	H	EQ	6/30/1986	9/30/2014	89,331
12066	Fidelity Select Portfolios: Biotechnology Portfolio	H	EQ	12/31/1985	9/30/2014	442,368
13058	Franklin Strategic Series: Franklin Biotechnology Discovery Fund; Class A Shares	H	EQ	9/30/1997	9/30/2014	108,332

Fund's number	Name of fund	Lipper_class	Lipper_asset	Start date	Last date	TNA
15402	ICON Funds: ICON Healthcare Fund; Class S Shares	H	EQ	2/28/1997	9/30/2014	36,715
15659	Voya Investors Trust: VY BlackRock Health Sciences Opportunities Portfolio; Service Class Shares	H	EQ	5/28/2004	6/30/2014	24,143
16962	Prudential Sector Funds, Inc: Prudential Jennison Health Sciences Fund; Class A Shares	H	EQ	5/28/1999	9/30/2014	61,661
22635	Oak Associates Funds: Live Oak Health Sciences Fund	H	EQ	5/31/2001	9/30/2014	4,233
24800	T Rowe Price Health Sciences Fund, Inc	H	EQ	12/29/1995	9/30/2014	446,843
27324	Rydex Series Funds: Health Care Fund; Investor Class Shares	H	EQ	4/30/1998	9/30/2014	8,282
27337	Rydex Series Funds: Biotechnology Fund; Investor Class Shares	H	EQ	4/30/1998	9/30/2014	29,823
27949	Saratoga Advantage Trust: Health & Biotechnology Portfolio; Class A Shares	H	EQ	6/30/1999	9/30/2014	4,014
28136	Schwab Capital Trust: Schwab Health Care Fund	H	EQ	6/30/2000	9/30/2014	58,368
30885	VALIC Company I: Health Sciences Fund	H	EQ	5/31/2007	9/30/2014	23,734
36331	Delaware Group Equity Funds IV: Delaware Healthcare Fund; Class A Shares	H	EQ	8/31/2007	9/30/2014	4,181
38766	AIM Variable Insurance Funds (Invesco Variable Insurance Funds): Invesco VI Global Health Care Fd; Srs I Shs	H	EQ	9/30/2008	9/30/2014	10,016

Fund's number	Name of fund	Lipper_class	Lipper_asset	Start date	Last date	TNA
38965	Putnam Variable Trust: Putnam VT Global Health Care Fund; Class IB Shares	H	EQ	9/30/2008	9/30/2014	5,239
39130	Rydex Variable Trust: Biotechnology Fund	H	EQ	9/30/2008	9/30/2014	1,334
39136	Rydex Variable Trust: Health Care Fund	H	EQ	9/30/2008	9/30/2014	1,498
39583	ProFunds: ProFund VP Biotechnology	H	EQ	9/30/2008	9/30/2014	(941)
39586	ProFunds: ProFund VP Health Care	H	EQ	9/30/2008	9/30/2014	(230)
39617	John Hancock Variable Insurance Trust: Health Sciences Trust; Series I Shares	H	EQ	9/30/2008	9/30/2014	5,037
39660	Pacific Select Fund: Health Sciences Portfolio; Class I Shares	H	EQ	7/31/2008	9/30/2014	10,905
40023	T Rowe Price Equity Series, Inc: T Rowe Price Health Sciences Portfolio-II	H	EQ	9/30/2008	9/30/2014	7,571
40027	ProFunds: ProFund VP Pharmaceuticals	H	EQ	9/30/2008	9/30/2014	(1,243)
41102	Variable Insurance Products Fund IV: Health Care Portfolio; Investor Class Shares	H	EQ	9/30/2008	9/30/2014	9,844
48020	JNL Variable Fund LLC: JNL/Mellon Capital Healthcare Sector Fund; Class B Shares	H	EQ	3/31/2004	9/30/2014	(268)
53239	John Hancock Funds II: Health Sciences Fund; Class NAV Shares	H	EQ	9/30/2011	9/30/2014	17,814