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1. Introduction

1.1 Context

Mutual funds are managed investment funds that pool money from individuals or professional investors to purchase securities such as bonds, stocks and derivatives. Investing in mutual funds instead of individual market securities offers multiple advantages such as higher level of diversification, higher liquidity, economies of scale and experiences of skilled fund managers. In return, investors pay different fees and expenses incurred by the fund such as marketing and distribution expenses, investment advisory fees or other operating expenses.

A large part of the academic literature on mutual funds examines the relationships between fund characteristics and fund performance to detect whether best performing funds could be predicted based on their age, size, past performance, expense ratio, assets turnover, managers experience, manager gender, number of assets, investment style, whether the fund is sole- or team-managed… Similarly, the thematic of active versus passive management is largely discussed (e.g. Bhootra, Drezner, Schwarz and Stohs, 2015; Prondzinski, 2010), and more particularly whether funds with high expense ratios, often resulting from an active management style, are justified by higher returns for the investors. Previous research findings are mixed and conclude that fund expense ratio has either a nonsignificant effect on predicting fund performance (e.g. Chou & Hardin, 2014; Droms & Walker, 2001), or has a negative influence on investor's returns (e.g. Elton et al., 1993; Ippolito, 1989), indicating that higher fees funds do not guarantee better performance and that investors should even avoid high expenses funds (Golec, 1996). This topic will be one of the questions examined in this thesis.

Ramasamy and Yeung (2003) find that cost of transactions (which is integrated in the fund's expense ratio) is the third factor that matters the most for mutual funds investors. In addition, they find that a fund's past performance and fund size are the two most important factors in the eye of investors, in first and second position, respectively. The opinion of the academic literature on the relationship between fund performance and these two factors is similarly divided. On one hand, Hendrick et al. (1993), Goetzmann & Ibbotson (1994) and Carhart (1997) find that performance persists in the short-term

among U.S. mutual funds, obtaining evidence that past performance is indicative of future short-term performance, Porter & Trifts (1998) add that only underperformance persists while Otten & Bams (2002), Kaushik et al. (2014) and Gopalakrishnan & Ramakrishna (2018) find no performance persistence at all. On the other hand, fund size is found to be negatively related to fund performance in the U.S. due to diseconomies of scale (e.g. Chen et al., 2004; Reuter & Zitzewitz, 2010) and not significant or sometimes positively related to performance for funds outside of the U.S. (e.g. Ferreira et al., 2013; Nguyen, 2004; Otten & Bams, 2002) and funds that are below a possible optimal fund size after which the performance decreases with size (e.g. Indro et al., 1999; Volkman & Wohar, 1995).

The effects of expense ratio, fund size and past performance factors are the three fund characteristics that will be examined in the context of the Belgian mutual funds industry as the academic literature for Belgium is, to our knowledge, almost non-existent.

Finally, fund managers have been examined to see whether they demonstrate high abilities in timing the market and selecting undervalued securities, bringing consistently higher performance to investors than other managers, through variables such as manager's age, tenure, experience, educational background or gender (e.g. Chen et al., 2008; Huang, 2006). For this thesis, we choose to select one manager's attribute, namely the manager's educational background (in addition to the three fund characteristics above) and analyze the studies of its effects on fund performance.

In this thesis, we will be investigating the effects of these four factors on Belgian mutual funds with the hope to bring answers to Belgian investors on these topics.

1.2 Main research questions

The goal of this master thesis is to evaluate the effect of certain fund characteristics, namely fund size, expense ratio, past performance and manager's education on Belgian equity mutual funds from 2016 to 2018.
In the first place, a summary on the existing and recent literature on the effects of these four attributes is presented, in like manner as the review of studies done by Anderson & Schnusenberg (2016). In the second place, an empirical study is carried out on a sample of Belgian equity mutual funds during the timeframe 2016 - 2018.

The main research questions are the following:

- What is the current position of the academic literature on the effects of these characteristics on fund performance?
- Is there a difference in performance among Belgian mutual funds, between large funds and small funds during the period 2016-2018?
- Is there a difference in performance among Belgian mutual funds, between funds with high expense ratio and funds with low expense ratio during the period 2016-2018?
- Is there a "performance persistence effect" among Belgian mutual funds during the period 2016-2018?
- What is the impact of fund size and fund expense ratio on Belgian mutual fund performance between 2016 and 2018?

1.3 Structure and scope

This section describes the structure of this thesis and what is included in the scope of our analysis on the performance of Belgian equity mutual funds and funds characteristics. Part I covers the theoretical aspect of the thesis while Part II covers the empirical aspect.

Part I, Chapter 1 reviews past studies related to the influence of fund attributes on fund performance across the world. Their funds sample, their methodologies and their results are described and summarized. The fund characteristics in our scope are fund's past performance, fund size, fund expense ratio and fund manager education as mentioned in the research questions.

Part II, Chapter 1 describes the data collection, the treatment of missing values and summary statistics of the Belgian mutual funds sample.

Chapter 2 explains the methodologies applied to evaluate the effects of fund attributes on fund performance. Four performance measures are used and described: fund annual returns, excess return (alpha), fund Sharpe ratio and Sortino ratio. Other performance measures and models are out of our scope. First, hypothesis tests for differences in means are used on groups created based on fund size and fund expense ratio. Second, the effect of past performance is examined with the non-parametric Winner-Loser test (e.g. Goetzmann and Ibbotson, 1994). Finally, the impact of fund attributes on fund

performance is assessed through OLS regression models. The goal is to quantify the effects of the fund size and expense ratio by regressing fund performance measures on them and observe whether or not statistically significant relationships exist.

Chapter 3 describes and discusses the results obtained using the methods explained in the previous chapter as well as results of statistical corrections regarding the collinearity, normality and heteroscedasticity in the sample.

Chapter 4 concludes this thesis, points out the possible limitations of the analysis and gives suggestions for further research.

I. Theoretical Part

1. Summary of Literature Review

This section is divided in four parts. With the aim to answer our first research question, each part contains a summary of studies on the relation between fund performance and one of the fund characteristics mentioned of our scope. A conclusion is available at the end of each part and the tables summarizing the studies are available in appendix 6.1. These summaries complement the summary tables of previous authors available in appendix 6.2.

1.1 Effects of fund past performance on performance

Hendricks, Patel & Zeckhauser (1993) evaluate performance persistence of no-load growth equity funds in the U.S. between 1974 to 1988. They find evidence of significant performance persistence and that it is a short-term phenomenon (up to 8 quarters). Furthermore, the authors evaluate the relevant time horizon to analyze past performance to be one year. A "4-quarter holding period and selections updated every 4 quarters (4E4H)" strategy when selecting top performers was significant and provided an excess return greater than 10% annually. They find the effect to be similar for persistent underperforming funds (called icy-hands) and that combining a long position on hot-hands with a short position on icy-hands generated 21% excess returns for the 4E4H strategy (Hendricks et al., 1993).

Goetzmann & Ibbotson (1994) look at possible patterns in the behavior of mutual fund returns. Their sample is composed of 728 mutual funds over the period 1976-1988 and include only the surviving funds in 1988, making the sample subject to survivorship bias. To identify a possible long-term performance, they separated funds into two categories "Winners" and "Losers" based on the prior one-year and two-years performance being above or under the median and analyze whether winners and losers repeat. They find that for four out of five periods, the repeat-winner hypothesis was significant using raw returns and all five periods with alphas. The authors suggest that the winner-winner and loser-loser effects could be attributable to fund style. They regress the two-year alpha of growth funds on the previous two-year alpha and find relative performance persistence from period to period (Goetzmann & Ibbotson, 1994). Globally, they find that the ratio associated with picking a winner based on past performance is 60/40 (60 percent chance

that the winner will stay winner in the next period, 40 percent chance that it becomes a loser). The one-year period is also consistent with the repeat-winner hypothesis.

Carhart (1997) studies the persistence of U.S. equity mutual funds from 1962 to 1993 with a survivorship-free sample of 1892 funds. He employs the CAPM model, his four-factor model and Fama-French three-factor model as performance measures and evaluate them against the New York Stock Exchange (NYSE), American Stock Exchange (Amex) and the NASDAQ stocks. Replicating Hendricks, Patel and Zeckhauser (1993), the author forms ten equally-weighted portfolios based on lagged one-year returns and estimates their performance after holding them during one year before reforming them (Carhart, 1997). The results of this first analysis show a strong variation in mean return over the thirty-year period. As instance, the best portfolio outperforms the worst portfolio by 1 percent per month. The author also applied a contingency table methodology with the previous ranked portfolios and finds that winners are more likely to remain winners while losers are more likely to stay losers or disappear, both effects are significant on the short-term. Carhart (1997) repeated the previous procedure with lagged two- to five-year returns in order to assess long-term persistence and find that using longer past returns interval does not provide more information about future performance.
To conclude, Carhart (1997) finds evidence of persistence for underperforming and outperforming funds for a one-year horizon but not in the years thereafter (Carhart, 1997).

Porter & Trifts (1998) examine the performance of experienced mutual fund managers over the 10-year period 1986-1995. They firstly measure the relative performance of all 791 funds and group them based on whether the fund manager is experienced using manager's tenure. Then, they compare the performance of experienced managers to all others and finally, compare the performance persistence of the experienced managers over two subsequent five-year periods (Porter & Trifts, 1998), contrarily to previous studies using shorter evaluation periods (e.g.; Goetzmann & Ibbotson, 1994; Hendricks et al., 1993). Porter & Trifts (1998) find that experienced managers (with more than 10-year track records at the same fund) do not outperform their peers with less experience and that there is no evidence of superior performance persistence among experienced managers during the subsequent 5-year period. However, they find that inferior performance persists. Although poorly performing managers improved their rankings in

the subsequent period, their performance remained below that of superior managers (Porter & Trifts, 1998).

Otten & Bams (2002) investigate performance persistence among 506 European mutual funds from 1991 through 1998. The data sample is composed of funds from France, Germany, Italy, the Netherlands and the UK. They sorted the funds into portfolios based on previous 12-month returns for each specific country and then held these portfolios during one year. This procedure was repeated for each sample period and the authors obtained time series of monthly returns for each portfolio. They applied the unconditional/conditional 4-factor model and 3-factor model to the portfolio formed and only UK funds demonstrated strong statistically significant effects of 12-month lagged alpha on the subsequent one-year period performance, and for both models. Otten & Bams (2002) conclude that there is weak evidence of persistence performance among European funds, except for UK funds.

Jan & Hung (2003) analyze mutual fund attributes and performance during a time period similar to Carhart (1997) covering 1961 through 2000. In contradiction with Carhart (1997) who focused on equity mutual funds, Jan & Hung (2003) choose a broad sample of 16.435 funds from 24 investment categories. They examine multiple attributes but we will focus on the results concerning fund size, expense and past performance. The authors measured yearly return for each fund and divided the funds into portfolios based on size (large versus small), expense (low versus high) and past one-year performance (winner versus loser after holding the portfolio during one year). They calculated the equally-weighted annual returns for each portfolio and then applied the stochastic dominance (SD) test to identify efficient portfolios (Jan & Hung, 2003). Without going into details, the SD test has the advantage of not requiring an asset-pricing model and benchmark to distinguish efficient portfolios (Jan & Hung, 2003). They make the use of the first degree stochastic dominance (FSP) when investors have no systematic preference with respect to risk, the second degree stochastic dominance (SSD) when investors are risk-averse, and when a risk free asset exists, they use a first degree stochastic dominance with risk-free rate (FSDR).
They find that winners dominate losers among five equity categories, money market categories while losers funds dominate winners in most bonds categories. These results

are consistent with Goetzmann & Ibbotson (1994) who find performance persistence among equity funds in the U.S. (Jan & Hung, 2003).

Jan & Hung (2004) focus on the short-run and long-run persistence of equity mutual funds. Similar to previous research, they group funds on the basis of previous year performance, hold the funds for subsequent periods and compare fund performance during these subsequent years. They hypothesize that if mutual fund performance persists in the short-term, then it should persist in the long run as performance persists in the next period, the next-period performance persists in the subsequent period. Hence, investors could benefit from both short- and long-run prior performance in their selection of mutual funds (Jan & Hung, 2004). They analyze 3.316 U.S. mutual funds between 1961 and 2000 covering three types of funds: aggressive growth, growth and income, long-run growth. The authors grouped the funds according to one-year and three-years lagged alphas and compared groups performance, similarly to Elton, Gruber & Blake's (1993) classification, using Jensen's alpha and Carhart's four-factor models. The authors find that the winners and medium performers in three-year prior periods as well as winners in one-year prior period generated much higher mean returns in subsequent years, suggesting that subsequent performance is predicted by past short-run but also past long-run performance (Jan & Hung, 2004). These results are in line with their own previous findings (Jan & Hung, 2003), suggesting that one-year performance persists in most equity funds including aggressive growth and long-term growth funds.

Lin & Yung (2004) study performance persistence among U.S. real estate mutual funds (REMFs) between 1993 and 2001. After computing monthly Jensen's alpha based on the CAPM, three and four-factor models for multiple periods, Lin & Yung (2004) find that past alpha significantly explained REMFs future performance. In addition, the authors tested whether performance persistence was explained by consistently poor performing funds or by consistently well performing funds and they find that negative alpha funds explained the persistence in the short-run (no exact duration was given) (Lin & Yung, 2004). Past performance is predictive of future performance among REMFs but only in the short-term and persistence is more important for underperforming funds (Lin & Yun, 2004).

Silva, Cortez & Armada (2005) evaluate the persistence of European bond fund performance, likewise Otten & Bams (2002). They use the winner-loser contingency table method, likewise Goetzmann & Ibbotson (1994), and a cross-sectional regression with lagged alpha. The data sample is composed of 58 bond funds from Italy, 157 from Spain, 266 from France, 60 from Germany, 45 from the UK and 22 from Portugal during the sample period 1994-2000, which was divided in two three-years consecutive subperiods. Alphas and excess returns resulting from unconditional/conditional single models and unconditional/conditional multi-index models are used for each of the subperiods. The regression shows evidence of performance persistence among German, French and Spanish bond funds on the long-run (three years) using the unconditional alphas from single and multi-index models. The authors criticize the use of alpha in the regression as the sources of bias in alphas are correlated over time (Silva et al., 2005) and follow Christopherson, Ferson & Glassman (1998) who argue that using future excess return avoid this issue. The results of the regression using excess returns are similar to the first regression. The analysis of the contingency table provides statistical evidence that winners in one period are winners in the subsequent period for Germany, France and Spain bond funds. Finally, the authors identify that persistence was mainly due to poorly performing funds and especially in the case of Spanish bond funds.

Xu (2005) focuses on the performance persistence of corporate bond mutual funds between 1990 and 2003. Each year, the funds are ranked and ten equally-weighted portfolio are created based on lagged 12, 24, 36 or 48-months risk-adjusted performance. These portfolios are held during twelve months and then Xu (2005) estimates the persistence by looking whether high past alpha continue to be high in the subsequent twelve months. The portfolio ranking method shows evidence of short-term performance persistence except with the lagged 48-months risk-adjusted returns (Xu, 2005). Past performance up to last three years for high-quality bond and high-yield bond funds explain the one-year performance persistence (Xu, 2005).

Droms & Walker (2006) evaluate performance persistence of fixed income mutual funds from 1990 to 1999. They ranked the fund's one-year return using the same winner-loser methodology as Goetzmann & Ibbotson (1994), Brown and Goetzmann (1995) and Malkiel (1995) (Droms & Walker, 2006). In addition, they provide tests between periods t until t+4 years as evaluation periods. They find strong and significant performance

persistence among the government and corporate bond funds on all the 18 one-year lag period but one (Droms & Walker, 2006).

Droms (2006) summarizes persistence studies in the United-States that were published during the last 15 years. He postulates that the main implication from performance persistence studies is that historical performance of mutual fund provides useful information about future performance of a one-year holding period at least (Droms, 2006). In other words, winners (losers) of one year tend to stay winners (losers) the year after and this relation is stronger for loser funds. Consequently, investment strategies based on fund winner portfolios outperform fund losers and average funds (Droms, 2006). In addition, the author notices that performance persistence is stronger within fund category than when compared with the market. Moreover, Droms (2006) find that long-term performance (two to four years) is unclear and globally weaker than short-term persistence. Finally, he suggests that persistence is sensitive to the period tested and should not be considered as the only (or the most) important criterion by investors for mutual funds selection. Droms' (2006) summary of the studies analyzed and its results are available in appendix 6.2.

Eser (2007) examines U.S. mutual fund performance. The funds were sorted into quintile and decile portfolios on the last day of each month from 1962 to 1992 based on prior 12 month return and then were held during 12 months similarly to Carhart (1997). Eser finds that persistence might be caused by calendar-related distortions of fund returns instead of manager skills. Indeed, the results show that prior 1-year relative performance is significant in explaining future 1-year relative performance, but only if the investment in mutual funds made in November, December or January (Eser, 2007). Eser adds that this predictive power can be mostly attributed to the persistence of extreme poor performance funds and therefore, only indicates which funds to avoid. However, when funds are not bought/sold at the turn of calendar year, the authors find little evidence of mutual fund performance persistence.

In India, Deb, Banerjee and Chakrabarti (2008) use raw returns, tracking error and information ratio to test the persistence of equity fund managers between 2000 and 2005. The authors use a regression as well as a contingency table approach similar to Kahn & Rudd (1995). They used three-month, six-month, one-year and 36 months past and post

periods to evaluate the subsequent performance persistence in the short- and long-run. The regression results show that when we consider the one-year test period, barely no reversals in performance are observed for all the performance measure used. However, performance reversals are observed when considering the six months and three months test periods (Deb et al., 2008). The winner-loser contingency table validates the regression results. The authors conclude that there is evidence of performance persistence when the time horizon is one year and even more so for growth funds. Performance reversals are observed when considering longer and shorter periods than one year and the number of persistence cases is proportionally lower for these periods (Deb et al., 2008).

Chou & Hardin (2014) analyze the effect of fund flows and fund size on real estate mutual funds (REMFs) during the period 1994-2006. They defined fund flow measure in period t as being the percentage of variation in AUM between period t and t-1 multiplied by fund return in period t. The authors used the CAPM model, four- and eight-factor models to estimate fund performance. In order to test for the relation between fund flow and fund performance, they use a pooled OLS of funds flow on past returns, fees, fund size, fund age and lagged flow. Chou & Hardin (2014) find first that when fund past performance and past flow are high, investors are more likely to invest in these funds, increasing fund flow. Secondly, fund expenses and size have a significant negative effect on fund flow in all the models. Next, the authors regressed fund one-month risk-adjusted return on fund lag flow, past returns, fees and size. They obtain evidence of the positive effect of past performance on subsequent one-month alpha and find that fund size and lag flow are significantly negatively correlated with fund performance. Expenses have no relation with fund performance, contradicting Jan & Hung (2003) who find them negatively correlated. Finally, to better understand the liquidity issue that explains the negative effect of fund size on performance (Chen et al, 2004; Yan, 2008), they repeated the previous regression on the fund sample divided into size categories (small, medium, big) (Chou & Hardin, 2014). While past performance is positively related to future performance across all three size categories, they note that the fees differ across size categories. They are significantly positively related to fund performance for small size funds and the significant positive effect disappears for large sized funds (Chou & Hardin, 2014). Investors of small REMFs have benefits in investing into high expenses fund (Chou

& Hardin, 2014).

To sum up on Chou & Hardin's (2014) findings, the authors obtained evidence that investors chase past winners, resulting in fund flow and fund size increase. However, size increase and such flows have a negative impact on subsequent fund performance. REMFs investors still benefit from return persistence, the latter offsetting the negative influence of size and fund flows (Chou & Hardin, 2014).

Kaushik, Saubert L. and Saubert W. (2014) analyze the performance persistence of 115 actively managed U.S. domestic healthcare mutual funds over the period 2000-2011. They follow the approach of Carhart (1997) and divided funds into quintile each year, based on prior one-year returns (Kaushik & al., 2014). Funds are labeled as winners if they are in the top 20th percentile of returns and are then grouped together. Next, they use Carhart 4-factor equation to estimate funds alpha of each quintile and evaluate the percentage of losers having negative alpha the subsequent year and winners having positive alpha the subsequent year. They find that the performance of both winners and losers is mean reverting and does not persist in the long-term and the short-term (Kaushik et al., 2014).

Kanuri, McLeod & Malhotra (2016) analyze the performance persistence of commodity-based mutual funds in the U.S. from their inception to end of 2012. Kahn and Rudd's (1995) model was used to test performance persistence: the performance of period 2 is regressed against the performance of period 1. Kanuri et al. (2016) used annual returns as measure of performance. The results show negative performance persistence in the case of Equity energy funds, commodity funds, natural resources funs and show that past performance of precious metals funds does not contain information concerning their future performance (Kanuri et al., 2016).

Berkowitz, Schorno & Shapiro (2017) investigate the characteristics of mutual funds with extreme performance between 1999 and 2011. They define extreme performance as having at least one year of top or bottom decile performance. Berkowitz et al. (2017) differs from the previous literature from the fact that the propensity score matching (PSM) technique is used to form the estimation sample. The PSM technique allows a match between a fund *i* and its ten nearest peers that are similar to fund *i* at a certain point in time, in terms of AUM, asset turnover, Sharpe ratio and cash (Berkowitz et al., 2017). This technique is used to determine the start and the end of a hot- or icy-hand streak and which

variables influence the streak.

First, they perform tests on the difference between hot-hand, icy-hand and no-streak funds. The univariate statistics indicate that 87% of funds with extreme performance had one streak, but only 13% had two and more streaks (Berkowitz et al., 2017). There are only 21 funds with two hot-hand streaks against 38 with two, 11 with three, 33 with four and 1 fund with five icy-hand streaks (Berkowitz et al., 2017), indicating that underperformance persistence is more present than consistent outperformance. In addition, hot-hand and icy-hand funds tend to have similar alpha outside of the streak period and icy-hand funds are globally more extreme than hot-hand funds which is in line with Hendricks et al. (1993) (Berkowitz et al., 2017). However, the results indicate also that hot-hand funds are associated with higher alpha and icy-hand funds with lower alpha.

Bosmans (2018) analyzes performance and persistence among 46 Belgian open-ended equity mutual funds from 2010 to 2016. He used both parametric (OLS regression) and non-parametric (Winner-Loser test) methods covering two two-years evaluation periods (comparing 2010-2012 with 2012-2014 and 2012-2014 with 2014-2016). In addition, the author splits up the sample period in seven years to test for short-term persistence. The Winner-Loser contingency tables reported negative persistence when using total returns and positive persistence for Jensen and Carhart model during the first period, however, nonsignificant (Bosmans, 2018). During the second period, all models but Carhart's four-factor reported significantly positive persistence. Concerning the parametric regression test results, Bosmans (2018) find that they differ significantly with the model used and across periods. He concluded in little evidence of long-term persistence for the first period and strongly positive evidence during the second period. Finally, the author did not find evidence of short-term persistence using the seven-period parametric regression, similar to Otten & Bams' (2002) findings (Bosmans, 2018). Bosmans (2018) concludes by saying that the overall results of his study do not indicate past performance to be predictive of relative mutual fund performance.

More recently, Gopalakrishnan & Ramakrishna (2018) inspect the persistence of winners among Indian mutual funds. They study 30 mutual funds schemes and analyze their risk-adjusted returns and returns over subsequent periods between 2007 and 2017. They obtained mixed results of persistence and no persistence and do not confirm that there is performance persistence in Indian mutual funds (Gopalakrishnan & Ramakrishna,

2018) contrarily to Deb et al. (2008). Furthermore, performance persistence disappears when considering the 30-month period (Gopalakrishnan & Ramakrishna, 2018).

1.1.1 Conclusion

To summarize on the results of studies on the effect of fund past performance on future performance, most authors seem to agree on the existence of short-term performance persistence in the U.S. (e.g. Carhart, 1997; Chou & Hardin, 2014; Hendricks et al., 1993; Lin & Yung, 2004). Porter & Trifts (1998) and Eser (2007) add that poorly performing funds have a bigger influence on the persistence of performance than outperforming funds and that past performance can only be used to avoid bad performers.

Outside of the U.S., the opinion is divided. Otten & Bams (2002) find no persistence in France, Germany, Italy and the Netherlands but well in the UK. Bosmans (2018) finds little evidence of performance persistence in Belgium and Gopalakrishnan & Ramakrishna (2018) find no evidence of performance persistence among Indian mutual funds while Deb et al. (2008) do.

Finally, performance persistence might depend on fund's asset class and investment style as proposed by Jan & Hung (2003). Some find strong long-term performance persistence among fixed income funds (Droms & Walker, 2006; Silva et al., 2005; Xu, 2005;) while Kaushik et al. (2014) and Kanuri et al. (2016) did not find persistence among healthcare funds and commodity funds, respectively and even show evidence of negative persistence in performance.

1.2 Effects of fund size on performance

Gorman (1991) studies the relationship between open-end mutual fund returns and fund's assets size in the U.S. from 1974 to 1985. The author suggests explanations for possible performance differences based on fund size, citing the liquidity advantage for small funds, the lower risk and attractive new securities to which large funds have access and the possible impact of scaling on fund returns.

Gorman (1991) uses the capital asset pricing model with a size variable added, to take into account the fund's asset size. Initially, a t-test of means for long-term return indicates that smaller funds have significant higher mean return than larger funds. In addition, the t-test also compare the mean risk measured with fund beta and failed to reject at 5% level of significance a difference between the risk of small funds and big funds (Gorman, 1991). However, at a 10% significance level, the t-test results suggest that larger funds are more risky than small funds, meaning that smaller funds are more efficient (higher return for less risk taken). Moreover, using an OLS and WLS regression model, the author finds that size is statistically significant and negatively related to fund excess returns.
Gorman finds three reasons to explain the difference in returns between small and large funds. Firstly, if small capitalization stocks provide higher returns, larger funds lower return could be explained by the portfolio structure: large funds invest in stocks with large capitalizations because it is less costly. Secondly, the difference might also come from managerial policies, incentives or organizational overhead. For instance, if growth fund managers tend to limit asset size and generate higher returns, then the size variable could reflect the correlation of fund objective and its size (Gorman, 1991). Manager compensation related to assets under management might incite managers to "buy the market" and focus on attracting new investors and will be less likely to focus on searching for new investment ideas (Gorman, 1991). On the contrary, fund managers refusing new investors might spend more time on keeping their current investors (Gorman, 1991).

Grinblatt & Titman (1994) criticize and assess benchmarks, timing and statistical power in fund performance evaluation and analyze the performance of 279 U.S. mutual funds. To assess benchmarks, they use Lehmann and Modest's (1988) ten factor portfolio and an eight-factor portfolio benchmark by Grinblatt & Titman (1988). After proceeding to a cross-sectional regression of the benchmarks on fund characteristics such as fund's net asset value (NAV), expense ratio, load, turnover and management fee, they find that there is no statistical relation between NAV and fund performance.

Volkman & Wohar (1995) investigate the relation between fund size, goal, load, management fees and fund performance persistence between 1980 and 1989 among U.S. mutual funds. The authors employ a modified version of Grinblatt and Titman's (1992) empirical model using a value-weighting method based on the demeaned return of each fund. In addition, they employ overlapping holding periods of 12, 24 and 36 months in

order to increase the robustness of their sample. After using a zero-cost, value-weighted model to regress the persistence of ten portfolio funds segregated by size, they find that small and large funds show negative persistence in performance (Volkman & Wohar, 1995). On the contrary, medium funds show significant positive effects on fund performance persistence. This indicates the risk inherent in small, new funds and that large funds can become too large and inefficient (Volkman & Wohar, 1995) and suggests that there is an optimal fund size.

In a second time, Carhart (1997) investigates the effect of fund characteristics on short-term performance persistence. From the cross-sectional regressions of fund performance measures on fund characteristics, Carhart (1997) finds that fund total net assets are negatively related to fund performance, however, statistically non-significant.

Indro, Jiang, Hu and Lee (1999) examine the effect of fund size on mutual fund performance. They argue that funds must reach a minimum size to achieve sufficient returns in order to justify their expenses. They add that marginal returns are diminishing to information costs and that marginal returns become negative when fund size exceeds an optimal threshold (Indro et al., 1999). Based on a sample of 683 U.S. actively managed equity mutual funds between 1993 and 1995, they regress the average returns on fund characteristics and use the logarithm of the fund's net asset and logarithm squared as linear and quadratic variable. The results show that both variables are significant at 1 percent level, that the linear variable is positively related to the returns and the quadratic variable negatively related to fund returns (Indro et al., 1999). This confirms the increase of returns at a diminishing rate with respect to fund size hypothesized earlier. Furthermore, they find that 20 percent of the funds were smaller than the breakeven-cost size and 10 percent of the largest funds overinvested in information acquisition and trading (Indro et al., 1999).
In conclusion, fund performance was positively affected by an increase in fund size of net assets while marginal performance decreases with fund size.

Dahlquist, Engström and Söderlind's (2000) study the performance and characteristics of Swedish Mutual funds between 1993 to 1997. Considering one unconditional and one conditional benchmark model to obtain alpha, they regress the latter (using a weighted least square regression) on fund characteristics such as fund size, administrative fees,

load/exit fee, turnover… They find that fund size is negatively related to performance for all types of funds except for money market funds for which it is weakly positively related (Dahlquist et al., 2000).

Otten & Bams (2002) regressed the risk-adjusted performance of the European countries mentioned earlier on fund characteristics and obtain evidence that the natural log of total fund asset is significant and positively related to risk-adjusted performance for the four countries, suggesting economies of scale available in the European fund market (Otten & Bams, 2002).

Jan & Hung (2003) find that risk-averse investors prefer large funds over small funds for almost all categories and find big funds more attractive in the case of bond funds and special funds. In addition, large funds outperformed small ones in most categories, contradicting Grinblatt & Titman (1994) and Carhart (1997) who find size to be nonsignificant in explaining fund performance (Jan & Hung, 2003).

Chen, Hong, Huang and Kubik (2004) investigate whether fund size erodes mutual fund performance among diversified U.S. equity mutual funds from 1962 to 1999. To start, the authors separated the funds into quintile based on fund size (from the small to big funds) and the time-series averages of cross-sectional average of fund returns shows at this point that gross returns, as well as net returns, decrease when fund size increases. This suggests that smaller funds are able to beat their bigger counterparts (Chen et al., 2004). Next, a cross-sectional regression is used to see the variation of fund performance with lagged fund size. The coefficient of the logarithm of lagged fund size is strongly negative for all the performance benchmarks used, meaning that the size of the fund in period *t-1* affects negatively fund performance in period *t*. Multiple regressions are done to test the robustness of the first model and the result concerning fund size was still significant and negatively related to returns for all the regressions. Finally, Chen et al. (2004) design a test of the liquidity hypothesis in order to narrow the list of potential explanations. They expect that fund size has a stronger effect on performance when funds invest in small-capitalization stocks, due to the well-known illiquidity of the latter, than funds that invest in large-capitalization stocks, more liquid. The authors identify and rank funds by style, whether they invest in small or big capitalization stocks, and run a regression model with a dummy variable as interaction term, taking the value of 1 if a fund is a Large Cap fund,

zero otherwise. They find that the sign of the interaction term is significantly positive and, coupled with the negative sign of the size variable, means that for large-cap funds, there is no effect of size on fund performance (Chen et al., 2004). These findings point out the role of liquidity in eroding fund performance.

Nguyen (2004) examines the relationship between fund attributes and fund performance on U.S. actively managed equity mutual funds during the period 1995-2003. Nguyen (2004) tests the hypothesis that mutual fund size in terms of net assets does affect mutual fund performance. The cross-sectional OLS regression results reveal significant effects during 4 years among the 9-years sample period. Moreover, the results suggest that mutual fund size is negatively correlated to performance during 2000 and 2001 while positively correlated during 1998 and 1999 (Nguyen, 2004). The overall conclusion is ambiguous as more than half of the years analyzed do not show enough evidence to generalize on the relationship between fund size and fund performance (Nguyen, 2004).

Philpot & Peterson (2006) analyze the effect of manager characteristics and fund attributes on real estate mutual funds (REMFs) returns, risk and fees between 2001 and 2003. The ordinary least squares regression of alpha on manager and fund characteristics indicates that the fund's total net asset has no significant effect on fund performance. To continue, Philpot & Peterson regress fund risk (using fund beta) and fees on fund attributes and obtain that first, fund size is not significantly related to fund beta and second, that fund size has a practically slight but significant negative effect on management fees (Philpot & Peterson, 2006). A possible explanation is the common practice in the money management industry according to Philpot & Peterson (2006): the competition in the REMF market forces managers to lower the management fees as the AUM increase.

Tng (2007) inspects the effect of expenditure and size on the performance of domestic equity mutual fund in Singapore during two holding periods 1999-2002 and 2003-2004. The research is build following Peterson et al. (2001) study on quantitative characteristics as determinants of performance for U.S. domestic equity funds. Similarly to Indro et al. (1999), Tng (2007) suggests that net assets under management could affect fund performance as funds need to attain a minimum size to be able to generate returns net of research expenses and other costs. On the contrary, funds exceeding the optimal fund size

could incur excessive costs, resulting in diseconomies of scale (Tng, 2007). The author tests the hypothesis that there is no significant difference in performance between small and large funds using a two-sample t-test assuming unequal variance after categorizing the funds into big and small groups. The results show evidence of outperformance by large funds over small ones, although it was not significant for all holding periods tested. This result is consistent with Grinblatt & Titman's (1994) findings from the U.S.

Pollet & Wilson (2008) investigate the effect of size on mutual fund behavior in the U.S. between 1975 and 2000. After sorting funds into quintiles by style (the average market capitalization of stocks held by a fund using portfolio weights), Pollet & Wilson (2008) find that funds tend to increase the ownership shares in companies they already own, suggesting that funds are more interested into scaling up than generating new investment ideas. In addition, they find that funds with more total net assets diversify more rapidly in response to asset growth. Furthermore, Pollet & Wilson (2008) find that diversification is associated with higher monthly risk-adjusted returns. Finally, after regressing risk-adjusted monthly returns on fund characteristics, they find that higher fund TNA are associated with lower returns. In other words, the total net asset value influence negatively fund performance, consistent with Chen et al. (2004) (Pollet & Wilson, 2008).

Yan (2008) uses stock transaction data to empirically analyze the effect of liquidity and investment style on the fund size – performance relationship between 1993 and 2002 for all U.S. mutual funds. Using the bid-ask spread and a market impact variable as liquidity measure, the author firstly finds that larger funds tend to hold portfolio with significantly lower average quoted and effective spread. Contrary to the previous result, when looking at the market impact coefficient, the author finds that larger funds hold less liquid portfolio, which makes sense as larger funds tend to hold larger positions (Yan, 2008). Secondly, the author finds that the smallest size quintile performs significantly better than the largest fund size quintile regardless of the alpha measure used (CAPM, Fama-French 3-factor, Carhart four-factor and conditional four-factor). Yan's (2008) findings show evidence that fund size negatively affect fund performance.

In Australia, Chan & Looi (2009) analyze the effect of the daily transactions of active equity managers on market impact costs and fund performance between 1998 and 2001. They hypothesize that fund size is negatively correlated with fund performance and test

it using a cross-sectional regression framework, including the log of total fund assets under management. They obtained 29 significant and negative coefficients for the 40 months of observations, showing evidence that fund size is negatively correlated with performance and confirming Chen et al (2004) results for U.S. mutual funds. Furthermore, they suggest that the negative relation is due to the transaction costs and after testing the impact of fund size on market, they find that size is positively correlated with aggregate market impact costs (Chan & Looi, 2009). The latter result imply that market impact costs increase as fund size increases and supports the transaction costs theory (Chan & Looi, 2009).

In order to identify the causal impact of fund size on fund future returns, Reuter & Zitzewitz (2010) exploit the fact that small changes in returns can cause discrete differences in size because of the effect of returns on Morningstar ratings. They find that Morningstar ratings influence positively the net flows of mutual funds by approximately 2.5 percent of assets under management (AUM). However, they do not find significant estimates for the effect of incremental net flows on fund returns and globally find little evidence of diseconomies of scale, suggesting that size does not erode returns significantly.

Bodson, Cavenaile & Sougné (2011) test for linear and quadratic relationship between mutual fund size and performance for the sample period 2000-2010, using the Sharpe ratio, Treynor ratio, Jensen's alpha, multi-factor alpha and the BCH ratio (Bodson et al., 2010) as performance measures. The cross-sectional regression results show significant effects of the logarithm of fund assets (linear) on only two out of 5 performance measures used: a negative effect on Treynor ratio and positive effect on BCH ratio. After adding a quadratic term in the regression equation, they obtain significantly negative coefficient of the quadratic variable for all performance measures except for the multi-factor alpha. This latter result suggests that the relation between fund size and performance is more likely to be quadratic rather than linear and that there exists an optimal fund size that maximizes mutual fund performance (given the concave relationship), likewise Volkman & Wohar (1995) (Bodson et al., 2011). The authors find it to be between 36.66 and 325 million USD for U.S. mutual funds.

Ferreira, Keswani and Miguel (2013) find mixed results concerning the fund size-performance relationship. In their study covering actively managed equity mutual funds from 27 countries from 1997 to 2007, Ferreira et al. (2013) regress Carhart's four-factors model alpha on fund characteristics and find that fund size total net asset (TNA) is significantly negatively related to fund performance in the sample of U.S. funds. However, for non-U.S. funds, they obtain a positive significant effect of TNA on performance. The authors explore the reasons behind this difference and test two hypothesis to explain that economies of scale are exhausted after a certain size in fund assets, likewise Indro et al. (1999). Firstly, they hypothesize that as U.S. funds are on average much bigger than non-U.S. funds ($558 million and $170 million respectively), this explain the negative coefficient obtained for U.S. funds (Ferreira et al., 2013).

Secondly, they suggest to take into account the role of liquidity constraints in the lack of scale-ability in the U.S. mentioned by Chen et al. (2004) and Pollet & Wilson (2008). Concerning the first hypothesis, they find that the positive significant effect of non-U.S. funds TNA on performance is explained by funds in the bottom fund size quintile, and that it becomes insignificant when we remove them from the sample (Ferreira et al., 2013). After following the same procedure on U.S. top fund size quintile, they obtained one more time evidence of diseconomies of scale in the U.S. industry, which does not support the hypothesis that the diseconomies of scale are driven by the fact that U.S. funds are bigger than non-U.S. funds (Ferreira et al., 2013).

To test the liquidity hypothesis, they identified large cap and small cap funds and included a large cap fund dummy to the TNA term of the regression to measure the difference between large cap and small cap funds in the relation between TNA and fund performance. The significantly positive effect obtained confirms that in large cap, there is less of an adverse effect of size on performance than in small cap funds (Ferreira et al., 2013). This term is insignificant for non-U.S. funds, meaning that they are not as affected by liquidity constraints when they grow.

They conclude that the evidence supports the liquidity constraints hypothesis, which is consistent with Chen et al. (2004).

Kaushik, Saubert L. & Saubert W. (2014) study the impact of fund specific attributes on the performance and persistence of performance of 115 actively managed domestic healthcare mutual funds in the U.S. over the period 2000-2011. The authors divide the

sample of funds following the "winners-losers" methodology used in previous research to estimate performance persistence (e.g. Goetzmann & Ibbotson, 1994). They observe that performance of losers and winners is reverting and does not persist in the subsequent periods (Kaushik et al., 2014). Next, using the single-factor market model and Carhart's four-factor model, they regress the abnormal performance (alpha) on fund expense ratio, turnover ratio, fund size (log transformation), manager tenure and the percentage of cash held. The cross-sectional analysis points out that both expense ratio and size variable are insignificantly negatively related to fund performance.

Chou & Hardin (2014) examine the relation of fund flows and fund size to REMF performance between 1994 and 2006. They regression results indicate fund size to be statistically significant and negatively correlated to both fund net returns and gross returns.

Stafylas, Anderson & Uddin (2016) analyze the previous literature on performance attribution, performance persistence and fundamental factors in hedge funds. Although our work concerns mutual funds, one might be interested to see how the performance of more aggressive and highly leveraged funds behave to a change in total assets under management. The authors summarized the main papers on the relationship between hedge fund performance and size. Similarly to our own summary in appendix 6.1 and Bodson et al. (2011) summary, most of the papers cited by Stafylas, Anderson & Uddin (2016) show evidence that fund size is significant and negatively correlated to performance. This summary table is available in appendix 6.2.

Berkowitz et al. (2017) find that, on one hand, a decline in AUM is significantly associated with the beginning of an icy-hand period. The decrease in AUM at the start of an icy-hand period could indicate a smart money effect (Berkowitz et al., 2017). On the other hand an increase in AUM is strongly significant and positively associated with the start of hot-hand streaks. The authors were not able to confirm the negative relationship between fund size and performance.

Kaur (2018) hypothesizes that there is a negative effect of size on performance of mutual funds. Using the natural log of fund size as size measure, Kaur (2018) finds that the effect of size is negative for all performance measures used (gross average return, Sharpe ratio and conditional Carhart alpha), showing diseconomies of scale as fund grows

between 2004 and 2013 although only two out of eight regression coefficients were statistically significant at 5% risk level.

In Pakistan, Ahmad, Sun and Khan (2018) examine the impact of fund characteristics on equity mutual fund performance. The average fund size in the sample is 4.35 billion Rs (more or less 25 million euro), which is relatively small compared to European and American mutual funds and indicates the low development of Pakistan mutual fund industry. Using different performance measures (Sharpe ratio, Jensen's alpha, CAPM, FF 3-factors, Carhart 4-factors) the authors find that the fund size, represented as the natural logarithm of fund total net assets, is negatively related to performance but only significant to Carhart 4-factors performance model, Jensen's Alpha and Sharpe ratio. This study contradicts Otten & Bams' (2002) findings suggesting that the smaller size of European funds compared to U.S. counterparts explains that there is still economies of scale possible in Europe. In Ahmad et al. (2018), although the average fund size is significantly lower than U.S. average fund size, the results indicate evidence of diseconomies of scale.

1.2.1 Conclusion

Most of the studies find that, when significant, the fund total net asset value has a negative influence on the performance, suggesting that small funds outperform larger funds and that there are diseconomies of scale (Ahmad et al., 2018; Chan et al., 2008; Chen et al., 2004; Chou & Hardin, 2014; Ferreira et al., 2013; Gorman, 1991; Kaur, 2018; Pollet & Wilson, 2008). The previous result has been found by either regressing fund performance on fund size and various fund characteristics (e.g. Kaur, 2018; Philpot & Peterson, 2006), by regressing fund performance on fund characteristics of portfolios in different size quintile/decile (e.g. Chen et al., 2004; Yan, 2008) or by hypothesis tests of equality of return means between small and large funds (Tng, 2007).

Firstly, this negative relationship is explained, in the literature, by the liquidity issue encountered when investing in small capitalization stocks (Chen et al., 2004). Furthermore, Chan et al. (2009) demonstrated that the aggregate market impact costs increase with fund size.

Secondly, the diseconomies of scale could result from the inability of funds to scale an investment strategy as the fund size increase and diversify less as they grow (Pollet &

Wilson, 2008). On the contrary, Indro et al. (1999), Otten & Bams (2002) and Tng (2007) find that large funds outperformed their small counterparts. However, Indro et al. (1999) add that marginal returns decrease with size. This latter result was found earlier by Volkman & Wohar (1995) and later by Bodson et al. (2011) who show evidence of an optimal fund size as the relation between size and performance is quadratic concave. Before this optimal point, funds encounter economies of scale at a diminishing marginal rate of return, and diseconomies of scale when exceeding the optimal size.

1.3 Effects of fund expense ratio on performance

Grinblatt & Titman (1994) study techniques for performance and fund returns evaluation. After discussing the use of reliable benchmark and comparing different measures of fund performance, they find that performance is not statistically related to expense ratio with both reliable and unreliable benchmark but significantly negatively correlated to management fees, indicating that low fee managers are superior performers (Grinblatt & Titman, 1994). For every 0.10% reduction in management fee, the performance increases by 0.50% per year (Grinblatt & Titman, 1994).

Volkman & Wohar (1995) examine the relationship between fund size, goal, load, management fees and fund performance. They obtained evidence that funds with low management fees show significantly positive persistent performance while high management fees funds demonstrate significantly negative persistent fund performance (Volkman & Wohar, 1995).

Gruber (1996) ranked actively managed funds into deciles based on monthly four index alpha and monthly returns from 1985 to 1994. Gruber (1996) finds that the best performing funds have an expense ratio similar to the expense ratio of average funds and lower than bottom deciles funds when using the monthly returns while the four index alpha regression indicates that investors are better off buying low expense ratio funds (Gruber, 1996). In addition, he finds that good managers have lower expense ratios than bad managers, suggesting a negative relation between expense ratios and fund performance.

Carhart (1997) finds that expense ratios are statistically significant in explaining variation in fund performance. Indeed, he finds that for every 100-basis point increase in expense ratios, the annual abnormal return drops by 154 basis points on average, which shows a strong negative relationship between fund expense ratios and fund performance (Carhart, 1997).

Porter & Trifts (1998) analyze the performance persistence of experienced mutual fund managers over 10 years from 1986 to 1995 and find that managers with 10-year track records at the same fund do not outperform manager with shorter track records. Furthermore, they find that inferior performance persist, more particularly for funds with above average expense ratios, suggesting that expenses are negatively related to fund performance and performance persistence (Porter & Trifts, 1998).

Indro et al. (1999), in their analysis on fund size of actively managed equity mutual funds developed earlier, observe at the start a change in expense ratio when dividing the fund sample in uniformly distributed size groups, decreasing from an average of 2.20% for fund size under $34 million to an average of 0.88% for fund size above $2.146 million (Indro et al., 1999). This change was similar when looking into investment style groups (value funds, blend funds and growth funds) (Indro et al., 1999).Next, they find that there is an minimum fund size to reach in order to achieve sufficient returns to cover costs for acquiring and trading on information. In addition, they obtain evidence that investment style influences expense ratios and that expense ratios are significantly negatively related to fund returns and fund size (Indro et al., 1999).

Dahlquist et al. (2000) findings suggest that administrative fee weakens fund performance, at a one-for-one rate, consistent with Elton & al. (1993) and Carhart (1997) who argue that high fee funds do not perform as well as low fee funds (Dahlquist et al., 2000).

Bers & Madura (2000) examine the variation of performance and net asset value (NAV) persistence among closed-end funds and its relation to fund characteristics. Their intuition is that if a fund performs well and its fees are low, it will continue to perform well since the low fees attract more capital to invest in profitable investments, as shown by Volkman and Wohar (1995) on open-end funds and the inverse effect shown by Porter

& Trifts (1998). The results show significantly negative relation between expense ratio and fund performance persistence, confirming their intuition.

Droms & Walker (2001) analyze the persistence of mutual fund operating characteristics such as returns, turnover rates and expense ratios between 1971 and 1990. Using Jensen's equation (1968) as risk-adjusted total returns measure, they find that the expense ratio has no significant effect on the performance for any of their models and that expense ratios do not persist across mutual funds between the two-decades analyzed.

Elton, Gruber & Blake (2001) compared the expense ratios of funds using incentive fees to see whether they have better alphas due to the fact that they charge lower expenses. They find that funds using incentive fees significantly charge lower expense ratios by 3.6 basis points monthly than funds without incentive fees. Furthermore, they find that incentive-fee funds perform significantly better than actively managed non-incentive-fee funds even after adjusting for differential expenses and that is due to better stock selection ability and lower expenses charged.

Otten & Bams (2002) obtained a significantly negative coefficient for expense ratio in three out of four European countries when regressing conditional 4-factor alpha on expense ratio and other fund characteristics.

Jan & Hung (2003) analyze the relationship between mutual funds attributes and performance for different investment objective categories. They find evidence that "expense ratio is an important factor differentiating the performance characteristics in equity funds, balanced funds, bond funds, […], money market funds, sector funds, special funds and total return funds" (Jan & Hung, 2003, p.167). As instance, some investors prefer low expense to high expense funds among the growth equity and income equity funds while the same investors prefer high expense funds in high yield bond funds and special funds. This means that one cannot analyze the relationship between performance and fund attribute (expense ratio as example) without focusing on a specific fund objective category (Jan & Hung, 2003). However, Jan & Hung (2003) demonstrate than when investors can lend and borrow at risk-free rate, low expense funds dominate high expense funds in terms of performance.

Nguyen (2004) investigates whether mutual fund attributes affect mutual fund performance. Similarly to Tng (2007), the author tests the hypothesis that the level of expense within the mutual fund does not affect mutual fund performance. Nguyen (2004) finds that the expense ratio is significantly negatively correlated with fund returns at 1 percent significance level in all nine years observed but one.

Philpot & Peterson (2006) focus on manager characteristics and real estate mutual funds (REMFs) returns, risk and fees. After regressing funds three-year CAPM alpha on management fees and other manager characteristics, they obtained a significant positive coefficient for the management fee variable indicating that better compensated managers provide better performance (Philpot & Peterson, 2006), confirming Golec's (1996) findings. In addition, the authors regressed management fees on fund and manager characteristics and only alpha shows significantly positive effect, meaning that better performing funds charge higher management fees.

Tng (2007) examines the effect of expenditures and size on domestic equity mutual fund performance of Singapore. The author hypothesizes first that there is no significant difference in performance between funds with high expense ratio and those with low expense ratio, second, that there is no significant difference in expense ratios of big and small funds to inspect the relation between expense ratio and fund size. To test the first hypothesize, Tng (2007) divides the fund sample in two groups after ranking the funds in descending order of expense ratio, with the top half being high expense ratio funds and bottom half being low expense ratio funds. A two-sample t-test assuming unequal variances for returns of high and low expense ratio funds is performed and showed no significant performance differences during none of the two periods used (1999-2002 and 2003-2004). The second hypothesize was tested using similar procedure and resulted in insignificant difference in expense ratio between big and small size funds, even though big funds seems to have lower expense ratio that could suggest possible economies of scale (Tng, 2007), as proposed by Indro et al. (1999). Tng (2007) attributes the insignificance of these effects to the fact that most of return variability is explained by asset allocation policy, demonstrated by Brinson, Hood and Beebower (1989), Brinson, Singer and Beebower (1991), Ibbotson and Kaplan (2000) and Tng (2005) (Tng, 2007).

Haslem, Baker and Smith (2007) test the hypothesis that there is no difference in the average performance of equity mutual funds among expense ratio classes. The authors classified the 6.179 domestic equity funds into 4 categories of expense ratios based on the standard deviation classes, namely: above average, high, very high and extremely high. Very high and extremely high expense ratio funds represent 1.5% of total funds. Although the expense ratio showed a negative association with each of the performance measures used as result, the differences between classes were only significant for two out of four performance measures, namely the five-year annualized total returns and Morningstar star ratings measures (Haslem et al., 2007).

Gil-Bazo & Ruiz-Verdu (2009) focused on the relation between price and performance in the mutual fund industry and investigate whether differences in fees reflects differences in the value created by mutual funds for investors (Gil-Bazo & Ruiz-Verdu, 2009). They obtain evidence of a negative relation between funds' before-fee performance and funds fees.

Nanigian (2012) investigates whether mutual fund expenses matter to investors in the case of mutual funds with minimum initial purchase requirement. Nanigian (2012) separated the sample into 2 categories: the myopes sample for which the minimum initial purchase requirement is less than $100.000 (mainstream investors), and the sophisticates sample for which it is at least $100.000 (sophisticate clientele). The author finds that for the first group of funds, the expense ratio is significantly negatively related to fund performance while it becomes non-significant for the sophisticate sample of funds (Nanigian, 2012).

Ferreira et al. (2013) believe that the determinants of mutual fund performance differ between the U.S. and the rest of the world due to the large size, the old and developed U.S. fund industry. The authors find that in average, equity mutual funds around the 27 countries in their sample underperform by 20 basis points per quarter after fees and controlling for the Fama-French three-factors and momentum. This first result is consistent with the studies that find that managers cannot beat the market after fees like Malkiel (1995), Gruber (1996) (Ferreira et al., 2013).
Secondly, they find a negative correlation between expense ratio and after fees performance. They observe, however, that this relation is statistically insignificant for U.S.

funds and for most of non-U.S. funds and therefore postulate that they do not have enough consistent statistically significant evidence on the relationship between fund fees and performance (Ferreira et al., 2013).

Chou & Hardin (2014) focuses on the performance of real estate mutual funds (REMFs) and the relationship with fund size and fund flows. They find that higher expenses are negatively correlated to fund flows, meaning that high expense ratio reduces the flow of capital (measured the difference in assets under management between the actual and previous month increased by the monthly return of the fund divided by assets under management of the previous month). They also show that REMFs provide excess returns before expenses based on an overall mutual fund portfolio. In addition, on an after expenses basis, REMFs do not perform better than relevant benchmarks (fund expense offset excess returns), which is consistent with Berk and Green's (2004) prediction. Expense ratio is also found to be negatively correlated with fund performance but its effect is not significant.

Berkowitz, Schorno & Shapiro (2017) recently analyze characteristics of mutual funds with periods of extreme performance. Fund characteristics could be responsible for triggering beginning and end of these periods, according to them. With respect to fund expenses, they find that well performing funds charge higher fees, but not necessarily as high as poorly performing funds (Berkowitz et al., 2017). In addition, they find that a decrease in expense ratio has a significant effect on the probability of starting a hot-hand streak while an increase is associated with hot-hand streak ending. Funds with high management fees showed significantly negative persistence (icy-hand). This suggests that a low expense ratio has a positive effect on performance persistence likewise Bers & Madura's (2000) findings and that fund expense ratio is negatively correlated with fund performance.

Ahmad, Sun & Khan (2018) obtained evidence from equity mutual funds in Pakistan that management fee have a significant positive effect on fund performance while expense ratio influence significantly negatively the performance. Nevertheless, it is important to have a look on the magnitude of both effects: management fee effect is relatively weak, increasing the performance with a minimum of 0.3 basis points and a maximum of 0.5 basis points while the expense ratio has a stronger effect, decreasing the performance

from 15 basis points until 26 basis points depending on the performance measure used (CAPM, FF 3-factors and Carhart 4-factors) (Ahmad et al., 2018).

Kaur (2018) investigates Indian equity mutual funds' performance during 2004–2013 and hypothesizes that expense ratios have a negative effect on the different fund performance measures used during that period. The results show a significant positive effect of expense ratio on gross returns and Sharpe ratio (at 5 percent level of significance) and insignificant negative effect on conditional Carhart alpha, contrarily to Otten & Bams (2002). Kaur (2018) insists on the fact that the effect of fund characteristics depends upon the performance measure chosen, that gross returns (unadjusted returns) can be subject to manipulations and that only alpha provides risk-adjusted returns relatively to the market. The results are thus mixed concerning the effect of fund's expense ratio on fund performance.

1.3.1 Conclusion

To conclude on the literature review on fund expense – performance relationship, the global opinion is mixed.

On one hand, when fund performance is regressed on fund characteristics that include expense ratio, the latter has an effect on fund performance that is not statistically significant in explaining the fund performance variation (Chou & Hardin, 2014; Droms & Walker, 2001; Ferreira et al., 2013; Golec, 1996; Grinblatt & Titman, 1994; Ippolito, 1989; Tng, 2007).

On the other hand, when its coefficient is found to be statistically significant at conventional significance levels, it shows evidence of negative correlation with fund performance (Ahmad, Sun & Khan, 2018; Berkowitz et al., 2017; Bers & Madura, 2000; Carhart, 1997; Elton et al., 1993; Gil-Bazo & Ruiz-Verdu, 2009; Gruber, 1996; Indro et al., 1999; Nguyen, 2004; Otten & Bams, 2002; Porter & Trifts, 1998; Sharpe, 1996).

Finally, some studies find mixed results concerning the statistical significance of expenses. It might depend upon the performance measure used (Haslem et al., 2007; Kaur, 2018), the minimum initial purchase requirement of the fund (Nanigian, 2012) or fund investment style (Jan & Hung, 2003). Is it important to observe that some studies focused on management fees, which is one of the three main components represented in the expense ratio. Most of them find a significant positive relationship between management fee and fund performance (Ahmad, Sun & Khan, 2018; Philpot & Peterson, 2006; Volkman and Wohar, 1995), although the expense ratio was found to be non-significative or negatively correlated with fund performance. This goes against Grinblatt & Titman (1994) whose findings show evidence of negative correlation between management fees and performance.

1.4 Effects of funds manager education on performance

Golec (1996), one of the main research on this topic, studies the relation between individual manager characteristics and mutual fund performance (alpha, yield), risk and fees (Expense ratio, management fees and turnover) on a data sample period from 1988 to 1990 covering 530 mutual funds listed in the Mutual Fund Sourcebook Volume I by Morningstar Inc. He uses a three-stage least squares (3SLS) regression model in order to solve the endogenous variables issues that prevent the use of the ordinary least squares model. The exogenous variables chosen in his model are: manager age, manager tenure, years of education, whether or not the manager has an MBA degree, the management team size, fund age, load charge and fund objective. The variables of interest are the two educational variables years of education and MBA. Years of education measures the general knowledge of the fund manager and MBA measures the business-specific knowledge (Golec, 1996). He hypothesizes that managers with an MBA degree (MBAs) know the basic principles of investing and can recognize well-managed firms, leading to

a better performance (Golec, 1996). The average fund manager in his sample is 46 years old, holds an MBA degree (64 percent chance), has slightly more than 17 years of education and seven years of tenure.

To begin with, while the regression of the yield showed no significant evidence among the educational variables, the results of the regression of alpha (excess return) on the exogenous variables showed evidence that MBA degree is statistically significant (at 10 percent level) and that having an MBA degree increases the annual excess return by almost one percentage point (Golec, 1996). To continue, the regression of the risk, Golec (1996) predicted the MBA variable to be positively related to beta because MBAs are taught that beta risk gets compensation in the market contrarily to the residual standard deviation. Golec (1996) obtained that the MBA variable was significant only in the beta equation, positively related to beta as predicted, but with a weak impact: a fund manager with an MBA degree will increase the fund beta by 0.05. Finally, Golec (1996) inspected the effects of the two educational variables on the fees, namely the expense ratio, the management fees and the turnover. On one hand, he expects the fees to be negatively correlated to MBA as MBAs are taught to keep costs low in order to boost performance. On the other hand, he expects a positive relationship between years of education and management fee according to human capital theory. The results confirm the negative relationship between MBA and all the three fee variables used but only the management fee coefficient revealed to be significant. The author postulates that "fund managers with MBAs may accept lower compensation, perhaps reflecting strong competition among MBAs for fund manager positions" (Golec, 1996, p.143).

Furthermore, he obtain a significantly positive relationship between years of education and management fees as well as a negative coefficient in the expense ratio regression for the same variable, claiming for the latter that better educated managers can economize by producing their own research and reducing other expenses (Golec, 1996).

To conclude on the contribution of Golec (1996), he established evidences that fund risk-adjusted performance is directly related to manager education level (MBA) and that years of education have no significant impact on risk-adjusted performance. MBAs are able to provide relatively large beta without increasing the residual risk significantly and MBAs charge smaller management fees and expense ratio than non-MBAs (Golec, 1996).

Chevalier and Ellison (1999), examine whether fund performance is related to fund manager characteristics. The authors introduce two educational variables: the average composite SAT[1] score at the manager's undergraduate institution and, similarly to Golec (1996), whether or not the manager has an MBA. They look cross-sectionally at how performance evolves according to manager characteristics instead of looking at the correlation over time of each manager's performance (Chevalier & Ellison, 1999).

Chevalier and Ellison (1999) hypothesize that as mutual fund managers are perceive as skilled professionals, some managers may perform better than others. One might think, as instance, that MBAs or graduates from prestigious colleges might do better in term of performance because they are better educated, smarter, have better networks of contact (Chevalier & Ellison, 1999)… The regression of simple excess return on the set of manager characteristics shows that holding an MBA and the SAT score of manager undergraduate institution have a significantly positive effect on the excess return. Evidence is made that high SAT score institution managers outperform their peers from lower SAT score institutions and that MBAs outperform non-MBAs by 63 basis points annually. Those regression results are similar to Golec (1996) results seen earlier and a study by the Morningstar Inc. on "Ivy League" graduate managers confirms that they achieve annual raw returns 40 basis points higher than non-Ivy League managers (Business Week, July 4 1994, as cited in Chevalier & Ellison, 1999). To explain the results of the prior analysis, Chevalier and Ellison (1999) regressed mutual fund characteristics (beta, log of assets, expense ratio, turnover ratio) and mutual fund's risk-adjusted returns on manager characteristics. The first regression revealed that managers from higher-SAT institutions and MBAs are more likely to manage funds with higher beta while the second regression, risk-adjusted returns on characteristics, indicates that the higher returns obtained earlier for MBAs managers are completely attributable to their greater take on systematic risk (decreasing from 63 basis points to 4.2 basis points per year) and that the SAT effect is still statistically significant and large. One suggested explanation of the authors for the higher returns of the SAT effect is that it exists differences in stock-picking ability, direct effect of better education and social networks provided by the undergraduate institution.

To end on Chevalier & Ellison (1999), they find that managers from more selective

[1] Scholastic Assessment Test, a standardized test commonly used in the United States for college admissions (Heimbach, 2019)

undergraduate institutions have higher performance than managers from less selective undergraduate institutions, undergraduate institutions SAT score being the only educational variable that clearly predicts risk-adjusted market returns.

Philpot & Peterson (2006) follow Golec (1996) and analyze the effects of individual manager characteristics on real estate mutual funds (REMF) risk-adjusted return, management fees and risk, regressing the variables on manager's tenure, manager's real estate experience, whether the manager holds a professional certification (Certified Public Accountant (CPA), Chartered Financial Analyst (CFA), or Certified Financial Planner (CFP)) and whether the manager works alone or in a team. While Golec measures manager education by whether the manager has an MBA degree, Philpot & Peterson (2006) use three financial certifications as more advanced measures of education, the MBA becoming pervasive among managers (Philpot & Peterson, 2006). Due to the endogeneity of some explanatory variables in the model specifications, Philpot & Peterson (2006) confirm their OLS results with a three-stage least squares (3SLS) method similar to Golec (1996) with which they obtain results close to OLS coefficient estimates. During the time period 2001-2003 for the 63 REMFs sample, only 27 percent of fund's managers report holding at least one financial certification (Philpot & Peterson, 2006). Furthermore, they find no significant relationship between the educational variables (professional certification) and REMF excess returns, management fees and systematic risk (beta). The authors nevertheless warns us about the interpretation of the results: the uniqueness of the real estate sector in the broader equity market has to be taken into account. From one part, the single-sector nature of REMF might make the managing easier than a traditional equity mutual fund. From the other part, the specificity of the real estate sector may require managers with specialized real estate expertise (Philpot & Peterson, 2006).

Similarly, Friiss & Smit (2004) investigate whether fund manager characteristics help explain fund performance and propensity to risk taking in 57 South African actively managed funds from 1996 to 2002. The manager's education is represented by three independent variables in their model: the number of years of education and, likewise Golec (1996) and Philpot & Peterson (2006), whether the managers hold an MBA or CA/CFA qualification. They find evidence that managers holding a CA/CFA outperform managers without them, while taking on less risk than MBA holders. Note that the average South African fund manager in their sample is about 40 years old with seven years of

education and does not hold an MBA or CA/CFA qualification.
Their regression results provided statistically significant evidence to infer that CA/CFA holders tend to beat fund managers without these qualifications resulting in higher excess returns. They did not include the MBA as dependent variable in the regression of excess returns but they did include it afterwards in the regression of beta. The regression of fund's beta on the educational variables indicates that managers qualified as CA/CFA take less risk (significant negative coefficient for the CA/CFA variable) than MBA holders (significant positive coefficient). The latter result contrast with the risk-return theory: CA/CFA managers take on less risk while producing better excess returns than MBA holders. Friiss & Smit (2004) find two possible explanations. The main one is related to the efficient frontier portfolio theory. The optimal portfolio on the efficient frontier is the portfolio that maximize the expected return for a given level of risk or, minimize the risk for a given level of possible return. The portfolio managed by fund manager with a CA/CFA qualification could simply be further away on the efficient frontier than the portfolio of MBA fund managers (Friiss & Smit, 2004). The second one is a critic of the CAPM model related to the use of beta as measure to compare riskiness of one share to that of the whole market and Friiss & Smit (2004) refer to market capitalization, price/earnings ratios, leverage and book-to-market ratios to do as well as beta in predicting returns.

In 2006, Gottesman & Morey (2006) followed the path Chevalier & Ellison (1999) and published their research on the relationship between manager education and mutual fund performance. Using the same educational variables as Philpot & Peterson (2006), Chevalier & Ellison (1999) and Huang (2006) namely CFA, SAT score and MBA, they added the Ph.D. and OTHERGRAD variables to see whether managers obtained a Ph.D. degree or a master's degree other than MBA. Gottesman and Morey (2006) go even further by investigating the quality of manager MBA program by using the mean GMAT score of business school and *Business Week* rankings of MBA programs.
The authors find no significant relationship between the education variables and the beta, conversely to Chevalier & Ellison (1999), Friiss & Smit (2004) and Golec (1996) results. According to them, one possible explanation comes from their sample period: they conducted their analysis during a relatively bearish market (2000-2003) while the others conducted their analyses during more bullish markets (1988-1994) and that well-educated managers might take less risky positions during a bear market. Concerning the

performance regressions, they firstly us the OLS method and then use an instrumental variable regression that contains net assets, expense ratio and turnover as independent variables plus the fund manager educational variables. These two methods produced very similar results: there is no significant relationship between the educational variables and fund performance, no matter the performance measures used. The non-significant effect of the MBA variable obtained is consistent with the findings of Chevalier & Ellison (1999). However, Chevalier & Ellison (1999) find significant positive correlation between SAT and fund performance while Gottesman & Morey (2006) do not. Gottesman & Morey (2006) justify their results by their survivorship-free sample contrariwise to Chevalier & Ellison's (1999) data sample that suffers from survivorship bias. The second step is to replace the MBA variable used in the first regression by the mean GMAT score variable and find that only the average GMAT score of the MBA program was positively significantly related to fund performance over the 2000-2003 period, meaning that the quality of the undergraduate institution plays a role in fund performance. In addition, non-MBAs perform significantly better than managers from low ranked MBA programs and that managers from top MBA programs outperform non-MBA managers (Gottesman & Morey, 2006).

Overall, they find no evidence that managers with CFA designation, Ph.D. or other non-MBA masters-level degrees perform better than managers with less educational background. The only significant factor that seems to influence the fund performance is whether the manager graduated from a top or near top MBA program (Gottesman & Morey, 2006).

Huang (2006) focused more particularly on the relation between human capital characteristics and return performance in small and mid-cap mutual funds. Likewise previous studies, the estimates from a robust least square regression (to minimize the influence of outliers) indicates that managers with CFAs outperform non-CFA managers by almost 60 basis points per year on average. The MBA variable effect however, was not statistically significant (Huang, 2006).

Besides, following the methodology of Golec (1996), the author used a 3SLS regression and the results contradict the normal OLS results: MBAs do not outperform non-MBAs anymore (Huang, 2006). MBA and CFA designations are negatively related to fund risk-adjusted returns but this time, only the MBA coefficient is statistically significant.

Confirming Friiss & Smit (2004) results, the MBA coefficient has a positive effect on fund beta and the CFA coefficient is found to be negatively related to the systematic risk.
The overall conclusion is similar to Friiss & Smit (2004) concerning the CFA designation (positive relation with returns), and somewhat unclear for MBAs who do not outperform their peers without MBA after a 3SLS system.

In his second essay, Karagiannidis (2007) analyzes manager characteristics of sole-managed funds. Similarly to Li, Zhang & Zhao (2011), Chevalier & Ellison (1999) and Gottesman & Morey (2006), the results suggest that managers who attended high SAT-score institutions outperform managers from lower SAT-score institution due to the fact that managers from high-SAT score institution attend more prestigious MBA programs and these programs offer better education and better network of connections (Karagiannidis, 2007). The MBA, CFA, SAT score variables have no significant effect on systematic risk, contrarily to Golec (1996), Friiss & Smith (2004), Chevalier & Ellison (1999), Huang (2006), Hwang, Titman and Wang (2018).

Masood & Sergi (2009) survey 110 Turkish fund managers in order to determine the relation between fund manager's performance and fund manager characteristics using educational variables such as whether the manager obtained a master's degree, business degree, Turkish/UK/US degree and the number of training courses attended by managers. Differing from the previous methodologies employed on this topic, fund performance is measured using the number of clients that a fund manager has, the number of investment funds that the manager is responsible for and the size of manager's portfolio. They find that the number training courses attended is positively correlated to the three measures of performance. Furthermore, portfolio size is positively affected by holding a master's degree and negatively affected by holding a business degree which was unexpected (Masood & Sergi, 2009). However, the effects of the latter on the measure of fund performance are numerically negligible (Masood & Sergi, 2009). They agree with Chevalier & Ellison's (1999) findings to say that some managers are better than others.

Li, Zhang & Zhao (2011) provide one of the first studies on manager characteristics impact on the performance of hedge funds. Comparably to studies on mutual fund manager characteristics, they use the SAT score as educational measure.
They find that the composite SAT score for the manager's undergraduate institution has

a negative impact on the systematic risk (higher-SAT institution managers take on less risk) and is positively related to raw and risk-adjusted returns at 1 percent level of significance (Li, Zhang & Zhao, 2001). The relation found between SAT and risk-adjusted returns (alpha) is consistent with Chevalier & Ellison (1999) study on mutual funds. However, the correlation between SAT and the risk contrasts with the latter.

In Taiwan, Hu, Yu and Wang (2012) investigate fund performance evaluation using a four-stage data envelopment analysis (DEA) suggested by Fried et al (1999). The main advantages to use the non-parametric DEA method to assess the performance are that first, this approach may avoid sampling bias and benchmark errors often occurring in parametric method (Hu et al., 2012). Second, DEA can take into account multiples inputs and, for example, consider different risk measures and investment costs. Finally, the DEA allows to discuss optimal resource allocation to generate portfolio return and provide a more accurate performance measure (Hu et al., 2012).
They used MBA and domestic academic degree as categorical variable to represent whether the manager has an MBA and a domestic of foreign academic degree. Both of the variables revealed to have an insignificant effect on fund performance, consistent with the insignificance of MBA effect in Huang (2006) study. Only the manager's tenure and gender among manager characteristics were statistically significant.

Kaur (2017) focuses exclusively on the relation between educational credentials of Indian equity mutual fund managers and fund performance between 2005 and 2013. The educational variable created, edu_cred, takes the value 1 if the manager was in any of premier management education institution, 0 otherwise (Kaur, 2017).
The results show that this variable has no significant effect on performance when running a first model without control variables. After controlling the effect of other fund characteristics such as the log size of fund, the expense ratio or the cash ratio as instance, the educational credential variable showed a significant positive effect on the performance. This indicates that the effect of the educational credential variable may be moderated by control variables (Kaur, 2017). Managers from premier management education institution outperform their peers from non-premier management education institutions (by 2 percent per year), especially during crisis period of economy. Kaur (2017) explains the differentials in performance by education networks, similarly to Chevalier & Ellison (1999). The overall result is alike Gottesman & Morey (2006).

Hwang, Titman and Wang (2018) examine the performance of mutual funds managed by elite graduates in the case of IPOs allocation to funds. They regress mutual fund risk-adjusted returns (alpha) on an elite-school variable and other control variables and find that elite-school dummy affect positively and significantly the risk-adjusted return. Elite-school funds outperform non-elite peers by 0.55% annually (Hwang et al., 2018), the magnitude corresponding to Chevalier & Ellison (1999) results.

More recently, Tan and Sen (2019) studied the effect of educational diversities of US equity fund managers on the performance of team-managed funds mutual funds, contrarily to Karagiannidis (2007), using a sample period from 1994 to 2013. They create two diversity measures based on the specialization subject of managers in their final degree (calculated with Gibbs entropy) and the manager's highest degree and use fund's net return, style-adjusted return and risk-adjusted returns as performance measures (Tan & Sen, 2019). The average manager among the 3.288 team-managed equity mutual funds is 43 years old, has 8 years of experience in asset management industry, has 63 percent chance to be in possession of a bachelor degree as highest degree, 5 percent chance for master level , 1.5 percent chance for a Ph.D. degree, 27 percent for an MBA degree and 66 percent chance to have a background in Business, Administration and Law (Tan & Sen, 2019).

Globally, the authors find that both educational diversity variables (specialization field and highest degree obtained) of a team are statistically positively related to fund performance, especially during a bear market in accordance with Gottesman & Morey (2006). This study differs from the previous authors. Instead of using an academic degree or financial certification as educational measure, they choose to focus on the diversity. One interpretation of the results could be that no matter the type of degree and specialization chosen, it is the diversity of the management team educational background, relating to differences in knowledge and expertise, that affect fund performance (Tan & Sen, 2019).

1.4.1 Conclusion

To sum up on the previous literature, the research on the effects of manager education on fund performance used educational variables such as manager's degree, manager's undergraduate/graduate institution rankings using average SAT scores and whether

manager holds a financial certification (CFA, CA…). Most authors agree to say that some managers do better than others and that is partly due to the manager's educational background.

On one side, Although there is not enough statistically significative evidence in multiple studies to say that managers who hold an MBA degree outperform managers without it (Chevalier & Ellison, 1999; Gottesman & Morey, 2006; Hu et al., 2012; Huang, 2006; Karagiannidis, 2007), some find that the manager's institution average SAT score and manager financial certification (CFA/CA) are predictive and positively correlated to fund's performance (Chevalier & Ellison, 1999; Huang, 2006; Hwang et al., 2018; Karagiannidis, 2007; Kaur, 2017; Li et al., 2011).

Arguments to explain the difference in performance are, first of all, the higher education level provided to these managers, allowing them to be more skilled in managing and obtaining better risk-adjusted returns. Second of all, the network of connections provided by these top-ranked institutions, as proposed by Butler & Gurun (2012) (as cited by Kaur, 2017), by Chevalier & Ellison (1999) and Karagiannidis (2007), from whom to gather information, affects the performance of mutual funds.

II. Empirical Part

In order to answer to our second and third research question, we aim to determine whether the fund size and fund expense ratio influence fund performance between 2016 and 2018. First, two different hypothesis tests of the difference of two means are used, similarly to the methodologies of Gorman (1991), Tng (2007), Millstone (2008).
Furthermore, our fourth research question, the influence of past performance on fund future performance, in other words, the presence of performance persistence in Belgium between 2016 and 2018 is examined, following the nonparametric winner-loser contingency table methodology used by Brown and Goetzmann (1995), Goetzmann & Ibbotson (1994) and Droms & Walker (2006).
Finally, the last research question concerning the impact of the size and expense ratio variables on fund performance is answered using cross-sectional ordinary least squares regressions of the fund performance on these variables, likewise Indro et al. (1999), Otten & Bams (2002), Kaur (2017) and many others.
Due to the lack of available data on Belgian fund managers' educational background, no analysis is performed on manager's education and its influence on the performance of Belgian equity mutual funds. The methods cited above are described in chapter 2.

1. Data

1.1 Screening of mutual funds and data collection

The data sample is retrieved from a Bloomberg terminal available in the ESPO-library of the Université catholique de Louvain.
The following criteria are applied on the Bloomberg database for the screening of the funds:
- Only funds domiciled in *Belgium* are chosen, as defined in the scope of this thesis. This first criteria gives us 1802 Belgian funds.
- The fund type covers *open-ended* mutual funds.
- The fund investment focus is *equity*, as defined in the scope which allows comparison with previous studies.
- The fund geographical focus is *Eurozone*. As mentioned by Bosmans (2018), restricting the geographical focus to Belgium only would leave us with a small number of funds.

Furthermore, the Eurozone selection allows us to compare with previous literature

Once these criteria are applied in Bloomberg's database, we retrieved for each fund the monthly closing price and monthly total fund size between 1st January 2016 until 31st December 2018 included. Furthermore, to our knowledge, no research has been done on recent data on Belgium equity mutual funds after Bosmans (2018) who covered the period 2010-2016. The monthly total fund size on Bloomberg includes fund total assets and fund total cash.

The fund expense ratio is retrieved from Bloomberg database as of 1st July 2019 and missing expense ratios are retrieved on the same date on Morningstar's summary page for each fund via its ISIN number.

Funds with missing data are not taken into consideration in the computations related to the year in which the value is not available. For example, if the inception date of a fund is mid-2016, only the data of the years 2017 and 2018 are used. This leaves us with 18 funds for 2016 and 20 funds for 2017 and 2018.
The possible survivorship bias for a 3-year sample period is between 0.07% and 0.37% annually (Carhart, Carpenter, Lynch & Musto, 2002), which is negligible in our study.

The descriptive statistics of the sample (Table 1) indicate a significant increase in the total fund size between 2016 and 2017 as well as great fund performance for these two years. The year 2018, on the contrary, shows a decrease in the average fund size and the fund performance plunged from + 15 percent in 2017 to -17 percent on average in 2018.

Table 1: Summary of the sample descriptive statistics

		Total fund size (MEUR)	*Annual returns*	*Excess return*	*Sharpe ratio*	*Sortino ratio*
2016	*n=18*					
	Average	340	10,5%	7,5%	3,17	3,37
	Std dev.	242	5,4%	5,7%	2,15	1,39
2017	*n=20*					
	Average	495	15,2%	4,9%	6,38	13,47
	Std dev.	321	6,3%	6,3%	2,60	5,65
2018	*n=20*					
	Average	474	-17,2%	-6,7%	-4,47	-7,30
	Std dev.	304	5,6%	5,6%	1,42	2,38

1.2 Market benchmark

We compare a fund's performance to the performance of the broad market and obtain the fund's excess return (alpha), which is one of the performance measure used. Therefore, a market benchmark is required. "Benchmarks are indexes that includes multiples securities representing some aspects of the total market" (Investopedia, n.d.a).

Like Crombez et al. (2002) and Bosmans (2018) studies on Belgian equity mutual funds, we use the Morgan Stanley Capital International (MSCI) Europe Index as European market benchmark. Indeed, most of Belgian equity funds are compared to this index, either directly on Bloomberg, in their prospectus or on the Morningstar website. The MSCI Europe Index represents the performance of large- and mid-cap across 15 developed European markets such as Belgium, France, the United Kingdom, Germany or Switzerland and covers more than 442 securities (MSCI, 2019). This index is consequently well suited to compare the performance of Belgian equity mutual funds investing in the Eurozone to the performance of the European equity market.
The annual returns of the index are calculated using the net returns index so that it includes the reinvestment of dividends (after withholding taxes).

1.3 Risk-free rate

The risk-free rate for European investments is often considered to be the lowest government bond rate available in Europe as it approximates the true risk-free rate. In this study, the three-month German bond yield is used as risk-free interest rate for 2016, 2017 and 2018. The data are retrieved as yearly rates from the OECD Main Indicators report issue no.6 (June 2019).

2. Methodology

2.1 Performance evaluation measures

Our analysis makes use of four fund performance measures. First, an absolute performance measure is used, namely fund's annual returns similarly to previous research such as Porter & Trifts (1998), Indro et al. (1999), Nguyen (2004) and Tng (2007).

Second, we use a performance measure that is relative to a market benchmark, namely the excess return or alpha, similarly to Elton et al. (1996) and Kaur (2017).
Third, we use two performance measures relative to the risk that is bore by the investors, the Sharpe ratio and Sortino ratio, similarly to Haslem et al. (2007), Ahmad et al. (2018) and Kaur (2018). Indeed, previous studies indicate that the results obtained depends on the performance measure used (absolute performance, relative to risk or to different benchmarks).

The **annual return** is the return of a fund over a period of one year. In our case, the annual return for each fund are calculated from monthly returns compounded using the following formula: $\prod_{rr\,r}^{r\,r}(1 + r_r) - 1$ under the assumption of monthly reinvestment of income, similar to Goetzmann & Ibbotson (1994).
The holding period starts in January and ends in December for each year.

The **alpha** or excess return is the performance of the fund minus the performance of the market and indicates whether the fund has outperformed or underperformed the latter. The MSCI Europe Index is used as proxy for market performance, as lots of funds in the sample are compared with this index in their prospectus. The excess return for fund *i* in period *t* is the difference between the return of fund *i* in period *t* and market return of the corresponding period.

Formally, $r_{r,r} = r_{r,r} - r\,r_{\ r}$

with $r_{r,r}$ = Return of fund *i* in period *t*.

$r\,r_{\ r}$= Market Return in period *t*.

The **Sharpe ratio** is used as first measure of fund risk-adjusted returns (e.g. Haslem et al., 2007; Bodson et al., 2011, Ahmad et al. 2018; Kaur, 2018). It is calculated for each year as the difference between the fund's return and the market risk-free rate divided by the standard deviation of the fund. In other words, it represents the marginal excess return obtained by unit of risk indicated by returns volatility.

Formally, $rhrrrr\ rrrr = \frac{r_r r\, r_r}{r_r}$

with : r_r = Fund's return

r_r = Risk-free rate

r_r = standard deviation of fund's returns

A negative Sharpe ratio value indicates that the investment/portfolio has a performance that is worse than the risk-free rate. A Sharpe ratio value between 0 and 1 indicates that the excess return is obtained by taking great risk and a value over 1 indicates that the outperformance does not cost excessive risk. The rule of thumb is to select the portfolio/investment which has the highest Sharpe ratio. One has to take into consideration that the Sharpe ratio considers the returns to be normally distributed, which is also debated in the academic literature and tested later in the study.

The **Sortino ratio** is the second relative performance measure used. It is a variation of the Sharpe ratio and takes only the downside variation into consideration while the Sharpe ratio takes both upside and downside volatility. Therefore, it focuses on returns that are below an acceptable threshold that is the risk-free rate. The downside variation, at the denominator, is measured by the semi-deviation of investment returns.

Formally, $rrrrrr\ rrrr = \frac{r_r r\, r_r}{r_r}$

where: r_r = fund's return

r_r = Risk-free rate

r_r = fund's downside volatility measured as $(\frac{r}{r} \sum_{rr\, r\, (r)}^{r} (r\,(r) - r)^r)^{r/r}$

For similar Sharpe ratios, the higher Sortino ratio value the better as it means that the investments returns are higher per unit of bad risk (Investopedia, n.d.b).

2.2 Hypothesis tests of the difference of two means

Two different hypothesis tests are used in our analysis. We proceed to two-sided Student's t-tests and Wilcoxon tests. The Student's t-test helps to determine whether the mean of two data sets are significantly different from each other, assuming the normality of the data distribution and variances homogeneity. The null hypothesis is that the

difference between the means of the two sets is null while the alternative hypothesis assumes that the two means are different.

The first t-test verifies if there is no difference in performance between large and small Belgian equity mutual funds. The funds are categorized as *Small* or *Large* funds for each year studied. A fund is categorized as *Small* if its average monthly total fund size is below the median of fund total assets of the fund sample during that period and categorized as *Large* when its average monthly total fund size exceeds the median.

The second t-test hypothesizes that there is no difference in performance between funds with high and low expense ratios for each of the year studied. The fund sample is divided into *High* and *Low* expense ratio funds, based on whether the fund expense ratio is below or over the expense ratio median. Once these groups are obtained, we proceed to the comparison of the performance measures of *Small* funds versus *Large* funds as well as *High* expense ratio funds versus *Low* expense ratio funds for 2016, 2017 and 2018.

Formally, the first hypothesis test is the following:

$r\ 0: r_{rrrrr} - r_{rr\ rr} = 0$

$r\ 1: r_{rrrrr} \neq r_{rr\ rr}$

with R = fund performance (alpha, Sharpe ratio and Sortino ratio)

Formally, the second hypothesis tested is the following:

$r\ 0: r_{r\ rr\ rr} - r_{rrr\ \ rr} = 0$

$r\ 1: r_{r\ rr\ rr} \neq r_{rrr\ \ rr}$

with R = fund performance (alpha, Sharpe ratio and Sortino ratio)

The Wilcoxon test is a nonparametric test alternative to Student's t-test. It is used when the data do not follow a normal distribution and the variances between groups are heterogeneous. Its null hypothesis assumes that the difference of medians between two groups is null, instead of the means used in t-tests. The general idea of the Wilcoxon test is to sort the values of two data sets in ascending or descending order and verify whether we observe alternately the values of the two sets. The null hypothesis is questioned when

the values of one set are observed more frequently than the other set for certain values. The significance level chosen for the Wilcoxon tests is fixed at 5%.

After checking the assumptions of normality of the data distributions and homogeneity of variances between groups, the hypothesis tests of difference in average performance between small and large funds are applied three times for each performance measure and for each year of the sample period 2016-2018.
Concerning the test of difference in average performance of high versus low expense ratio funds, we were not able to obtain expense ratios for each year and could only retrieved them as of July 2019. Despite this, expense ratios are relatively stable over time and therefore it is not unrealistic to assume constant expense ratios during the three years sample period.

As the results of the previous studies are mixed concerning the effect of fund size on performance, we would expect to find either a non-statistically significant difference in performance between *Small* and *Large* funds or a statistically significant difference indicating that one group outperforms the other.
Concerning the hypothesis tests on performance of *High* and *Low* Expense ratio funds, we would expect to find either non-statistically significant differences in performance between the two groups of funds or a difference indicating that one group outperform the other.

2.3 Winner-Loser methodology

The Winner-Loser contingency table is a nonparametric methodology used in assessing fund performance persistence. A fund is categorized as winner (loser) in period *t* when its return is greater (lower) than the median performance of all funds in year *t*. Once this procedure is applied for all the years studied, it allows us to see whether winner (loser) funds in period t are still winners (losers) in t+1, in other words if performance persists or not. From the contingency tables, we obtain the number of winners staying winners (WW), winners becoming losers (WL), losers becoming winners (LW) and losers staying losers (LL) as represented in Table 2.

Table 2: Example of Winner-Loser contingency table

Previous period \ Consecutive period	Winner	Loser
Winner	WW	WL
Loser	LW	LL

As cited in Bosmans (2018), contingency tables are preferred when the sample is limited (Vidal-Garcia, 2013), which is the case here.

We split up the sample in three one-year periods, January 2016 - December 2016, January 2017 - December 2017 and January 2018 - December 2018, following Goetzmann & Ibbotson's (1994) procedure and Hendricks et al. (1993) who find the relevant time horizon to analyze past performance to be one year. We obtain two contingency tables for each performance measure, the first one evaluating the persistence of fund performance of 2016 in 2017, the second one evaluating the performance persistence of 2017 in 2018.

In this study, the Winner-Loser method relies on fund alpha and Sharpe ratio. Indeed, Goetzmann & Ibbotson (1994) obtained a reversal of performance using funds absolute performance such as total returns while the results indicated performance persistence when relative performance measure such as Jensen's alpha as risk-adjusted performance measure. This justifies our use of both raw benchmark adjusted and risk-adjusted performance measures.

Like Bosmans (2018) and European studies (e.g. Silva et al., 2005) findings on equity mutual funds' performance persistence, we expect to find significant performance reversals or non-significant performance persistence.

2.4 Ordinary least squares regression

The ordinary least squares (OLS) regression is a linear regression model that minimizes the sum of square differences between the observed and the predicted values. Similarly to most studies on mutual fund attributes (e.g. Berkowitz et al., 2017; Gorman, 1991;

Nguyen, 2004;), the OLS regression is used to predict the performance of funds through the *size* and *expense ratio* variables and quantify the impact of the latter on fund's alpha, Sharpe ratio and Sortino ratio. For each year, the three performance measures are regressed separately on the size and expense ratio of the fund for a total of 9 regressions. The regression models used are:

$$r_r = r_r + r_r * rrr_r + r_r * rrrrrr\ rrrr + r \quad \text{(model 1)}$$

$$rhrrrr\ rrrr_r = r_r + r_r * rrr_r + r_r * rrrrrr\ rrrr + r \quad \text{(model 2)}$$

$$rrrrrr\ rrrr_r = r_r + r_r * rrr_r + r_r * rrrrrr\ rrrr + r \quad \text{(model 3)}$$

with:

r_r= fund's alpha in year t

$rhrrrr\ rrrr_r$ = fund Sharpe ratio in year t

$rrrrrr\ rrrr_r$ = fund Sortino ratio in year y

rrr_r= Average total fund size in year t

$rrrrrr\ rrrr$ = fund's expense ratio

Each independent variable is examined for model fit, statistical significance, coefficient size and sign for 2016, 2017 and 2018.

Similar to the conclusion made on previous studies on fund size and performance, we first expect to find no significant effects of the size variable on performance or significant negative coefficients indicating that small funds outperform larger funds due to diseconomies of scale. However, as mentioned by Bodson et al. (2011) and Ferreira et al. (2013), the diseconomies occurs when funds exceed an optimal size which is mainly observed among U.S. funds, the latter being substantially bigger than the average Belgian fund. This explains why it would not be surprising to obtain a positive relationship between size and performance, like Otten and Bams (2002) study on European mutual funds.

What concerns the relation between fund performance and expense ratio, we expect to find either an insignificant effect or a negative relationship in a like manner as previous studies.

2.5 Robustness

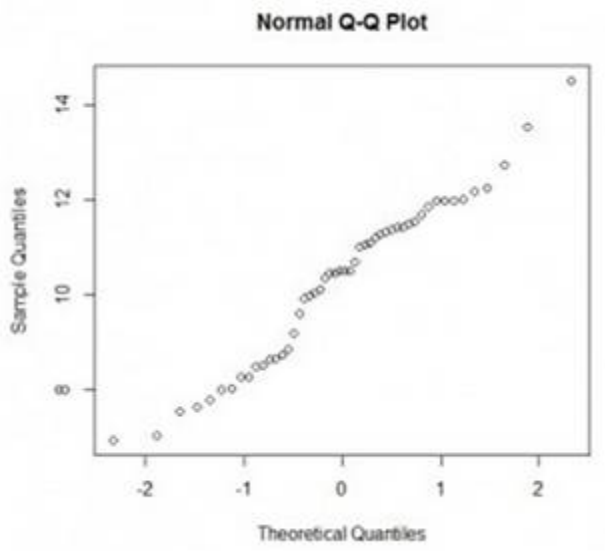
2.5.1 Normality of the data distribution

The hypothesis tests of two means require that the data distribution of each group (small funds, large funds, high expense ratio funds and low expense ratio funds) follows a normal distribution. In the case of normal distributions, the Student's t-test can be used. If we cannot assume that the data are normally distributed, a nonparametric test, namely the Wilcoxon test, will be used for the hypothesis tests.

For that purpose, we tested the normality of each performance measure within each group and for each year of the period study using a graphical method, the quantile-quantile plots, as well as a probabilistic method, the Shapiro-Wilk test.

The Q-Q plot is a scatterplot that is created by plotting the sample quantiles against theoretical quantiles. The normality of the data distribution is assumed when the points form a line that is roughly straight. Figure 1 is an example of Q-Q plot of a normally distributed data set.

Figure 1: Example of Q-Q Plot



Source: Clay Ford, 2015

The Shapiro-Wilk normality test checks the null hypothesis that the data sample are normally distributed, in other words, the sample comes from a normally distributed

population. A p-value inferior to a 5% significance level indicates that the assumption of distribution normality has to be rejected and we should use the Wilcoxon test while a p-value greater than a 5% significance level indicates that we fail to reject the null hypothesis of normality. Normality of the data can therefore be assumed and we can proceed to t-tests.

2.5.2 Homogeneity of variances

The homogeneity of variances is an assumption underlying parametric tests such as the independent samples t-test. The variances of the groups that are compared to each other in the hypothesis tests (*large* against *sma*ll, *high* against *low)* should be similar in order to proceed to Student's t-test, otherwise a nonparametric test is used. We tested the homogeneity of variance of the groups for each year using one-tailed Fisher tests at a 5% significance level. The F-test tests the null hypothesis that the variances of two samples are equal.

2.5.3 Performance persistence with Winner-Loser methodology

Similar to Vidal-Garcia (2013), we use the binomial test r_r: p≤0.5 and r_r: p>0.5 proposed by Malkiel (1995) to verify the significance of the proportion of WW to (WW+WL):

$$r = (r - rr)/r\,\overline{rr(1-r)}$$

where Z follows a normal distribution (0,1), y is the number of repeat winners (WW), n is the number of repeat winners and winner/losers (WW+WL) and p equals 50%. A percentage winner funds to the number of repeat winners and winner/losers above 50% and a Z-statistic above zero show performance persistence (Vidal-Garcia, 2013).

2.5.4 Collinearity

Before applying the linear regression model, we check for collinearity between the independent variables. Multicollinearity occurs when independent variables are too highly correlated with each other, making harder to identify the effect of the individual variables. The Pearson correlation matrix is used to compute the correlation between the expense ratio and size variables. A correlation coefficient close to 0 indicates that the

correlation between the two variables is weak while a coefficient close to 1 indicates a strong correlation. We adopt the conservative approach and state that collinearity exists when the correlation coefficient is greater than 0.50 and that the no-collinearity hypothesis is respected when the correlation coefficient is lower than 0.50.

2.5.5 Homoscedasticity and normality of residuals

The homoscedasticity and normality of the residuals are verified graphically each year and for all models with residuals versus fitted plots and Q-Q plots. The hypothesis of homoscedasticity in linear regression means that the variance of residuals should not increase or decrease with the fitted value of the response variable. The normality of residuals assume that the residuals are normally distributed and therefore we should observe straight lines on the Q-Q plots.

3. Results

The following sections describe the results obtained using the various methodologies explained earlier. Due to the redundancy in the results between fund's annual returns and fund's alpha, only the results concerning the performance measures fund's alpha, Sharpe ratio and Sortino ratio are described.

3.1 Performance of High expense ratio vs Low expense ratio funds

This section describes the results of the hypothesis tests on the difference of mean performance between the groups of funds with *High* expense ratios and *Low* expense ratios using Wilcoxon and Student's t-tests.
The normality of the data distribution as well as the homogeneity of variances have been tested to decide whether the parametric (t-test) or nonparametric (Wilcoxon test) is appropriate. Wilcoxon's tests are used when the hypothesis of normality and homogeneity are rejected at 5% significance level and Student's t-tests in all other cases. The results of the normality and the homogeneity tests are available in appendix 6.3 and appendix 6.4 respectively.

Despite the fact that *High* expense ratio funds outperformed *Low* expense ratio funds with all the performance measures used (positive differences observed for most of the years), neither Wilcoxon tests nor Student's t-test results show statistically significant

difference in performance between high expense ratio funds and low expense ratio funds, and this for the whole sample period. The high p-values obtained indicate that we fail to reject the null hypothesis of equal means/medians and, hence, our sample does not provide strong enough statistical evidence to say that one group performs better than the other. Table 3 and Table 4 report the differences in median and mean respectively, between the groups *High* and *Low* as well as the p-value obtained.

Although non-significant, the greater performance of high expense ratio funds observed contradicts the inverse relationship found in previous research. However, similarly to our results, Ippolito (1989) find evidence that high expenses are offset by superior results, which characterizes the presence of costly information in efficient markets. Moreover, these results are in line with Tng (2007) who find that high expense ratio funds outperformed low expense ratio funds between one period, but not the other. In addition, Tng (2007) failed to find significant differences in performance between high and low expense ratio funds in the USA for the periods 1999-2002 and 2003-2004 using hypothesis testing of two means.

Table 3: Results of Wilcoxon's tests on High versus Low expense ratio funds between 2016 and 2018

	Wilcoxon's tests					
	2016		2017		2018	
High - low	Difference	p-value	Difference	p-value	Difference	p-value
α	-0,02	0,81	-	-	0,02	0,66
Sharpe Ratio	0,06	0,96	-	-	0,09	0,78
Sortino Ratio	0,49	0,61	0,14	1	-	-

Table 4: Results of t-tests on High versus Low expense ratio funds between 2016 and 2018

	Two-sample Student's t-tests					
	2016		2017		2018	
High - low	Difference	p-value	Difference	p-value	Difference	p-value
α	-	-	0,03	0,28	-	-
Sharpe Ratio	-	-	1,18	0,35	-	-
Sortino Ratio	-	-	-	-	-1,18	0,30

3.2 Performance of Large vs Small funds

This section describes the results of the hypothesis tests on the difference of average performance between *Large* funds and *Small* funds using Wilcoxon and Student's t-tests. In a like manner as the previous section, the normality and homogeneity hypothesis have been tested and summarized in appendix 6.3 and appendix 6.4 respectively. Wilcoxon's tests are used when the hypothesis of normality and homogeneity are rejected at 5% significance level and Student's t-tests in all other cases.

We observe that large funds had excess returns, on average, 1 percent higher in 2016 and 2018 than small funds. Concerning the risk-adjusted performance measures, the Sortino ratios of large funds is, on average, higher while small funds outperformed large funds in terms of Sharpe Ratio during 2017 and 2018 (negative differences). This indicates that small funds have better risk-adjusted returns and greater downside risk than their large counterpart. Overall results show evidence that large funds outperformed small funds in most periods, for two out of three performance measures used (alpha and Sortino ratio). However, the Wilcoxon and Student's t-test fail to reject the null hypothesis at 5% significance level for all the performance measures used and for all the periods of the study. This indicates that our sample does not provide strong enough statistical evidence to say that one group performs better than the other. Table 5 and Table 6 report the differences in median and mean respectively, between the groups *Large* and *Small* as well as the p-value obtained.

The observations are in line with Tng's (2007) findings for U.S. mutual funds and findings of Ferreira et al. (2013) for non-U.S. funds who obtained outperformance of small funds by larger funds. In addition, our results confirm the non-significant effect of fund size on fund performance obtained by Grinblatt & Titman (1994), Reuter & Zitzewitz (2010) and Kaushik et al. (2014) for U.S. mutual funds.

In Europe, although statistically non-significant, our results are coherent with Otten & Bams (2002) who find evidence of positive relationship between fund assets and risk-adjusted performance. They suggest that economies of scale are still possible in Europe. Indeed, the average U.S. fund size is two times greater than the average Belgian fund size in our sample. This indicates that Belgian funds still have to grow to reach an efficient asset size (Otten & Bams, 2002). However, funds exceeding this optimal size will

encounter diseconomies of scale and we could observe a negative relationship between fund size and fund performance (Indro et al., 1999; Tng, 2007; Volkman & Wohar, 1995;). Finally, our results contradict the findings of Dahlquist et al. (2000) when it comes to Swedish equity and bond mutual funds.

Table 5: Results of Wilcoxon's tests on Small funds versus Large funds between 2016 and 2018

	Wilcoxon's tests					
	2016		2017		2018	
Large - Small	Difference	p-value	Difference	p-value	Difference	p-value
α	-	-	-	-	-	-
Sharpe Ratio	0,78	0,73	-	-	-	-
Sortino Ratio	-0,30	0,67	-	-	-	-

Table 6: Results of Student's t-tests on Small funds versus Large funds between 2016 and 2018

	Two-sample Student's t-tests					
	2016		2017		2018	
Large - Small	Difference	p-value	Difference	p-value	Difference	p-value
α	0,01	0,56	-0,04	0,15	0,01	0,85
Sharpe Ratio	-	-	-1,44	0,23	-0,14	0,84
Sortino Ratio	-	-	0,52	0,84	0,56	0,61

3.3 Performance persistence

This section describes the results of the Winner-Loser methodology of Goetzmann & Ibbotson (1994) as well as their significance, tested using binomial tests as described in Chapter 2.

The four contingency tables represented in table 7, table 8, table 9 and table 10 show negative performance persistence of 2016 through 2017 and of 2017 through 2018 using the fund's alpha and Sharpe ratio as performance measures. Indeed, the ratio associated with picking a winner fund based upon past winning performance is 43/57 using alpha and 33/67 using the Sharpe ratio for the period 2016-2017 while persistence is found when the probability of picking a winner-winner is above 50%. This ratio is about 40/60 for both performance measures for 2017-2018. All the binomial tests fail to reject the null hypothesis of $p \leq 0.5$ at 5% significance level. In addition to the binomial tests, we applied the Log-Odds ratio test that is commonly used to detect both positive and negative

performance and even though the LOR indicates negative performance, the ratios were not found significant[2].

These results are partially in line with Bosmans (2018) who failed to find significant performance persistence among Belgian equity mutual funds during 2010-2016, using Jensen and Carhart's model alpha while total returns reported significant negative persistence. Moreover, Otten & Bams (2002) similarly found weak evidence of performance persistence among European equity mutual funds. Finally, our results contrast with Vidal-Garcia (2013) who obtained strong evidence of short-term and long-term (two and three years) performance persistence among European equity mutual funds from 1988 to 2010.

Table 7: Winner-Loser contingency table of 2016-2017 using fund's alpha

	2016-2017		Binomial test		
	Winner	Loser	% WW	Z	p-value
Winner	3	4	43%	-0,38	0,35
Loser	5	3			

Table 8: Winner-Loser contingency table of 2016-2017 using fund Sharpe ratio

	2016-2017		Binomial test		
	Winner	Loser	% WW	Z	p-value
Winner	3	6	33%	-1,00	0,16
Loser	6	3			

Table 9: Winner-Loser contingency table of 2017-2018 using fund's alpha

	2017-2018		Binomial test		
	Winner	Loser	% WW	Z	p-value
Winner	4	5	44%	-0,33	0,37
Loser	7	4			

Table 10: Winner-Loser contingency table of 2017-2018 using fund Sharpe ratio

[2] More details on the t-statistics for the significance of the Log-Odds ratio are available in Brown & Goetzmann (1995).

	2017-2018		Binomial test		
	Winner	Loser	% WW	Z	p-value
Winner	4	6	40%	-0,63	0,26
Loser	6	4			

3.4 Results of the Ordinary Least Squares regression

This section describes the results from the OLS regressions of fund's alpha (Table 11), fund Sharpe ratio (Table 12) and Sortino ratio (Table 13) on fund size and expense ratio for the years 2016, 2017 and 2018 as described in Chapter 2.

The first model uses fund's alpha as a the fund performance measure. The regression results show a positive relationship between fund size and alpha for 2016 and a negative relationship for the years 2017 and 2018. Even though only the 2017 estimates of the size variable are significant at the 10% risk level, the coefficient is extremely small, indicating a weak effect of size on the alpha during that year. The coefficient of the expense ratio estimate is positive and significant at the 10% risk level in 2016 and negative and non-statistically significant in the two last years. This indicates that funds with higher expense ratios obtained, on average, higher alpha than low expense ratio funds. An increase in fund's expense ratio of 1% increases fund's alpha by 5.7% on average in 2016.

The second model uses the fund Sharpe ratio as the fund performance measure. The regression results show a positive relationship between the Sharpe ratio and the explicative variables in 2016. The estimate coefficients become negative in the next years, indicating that fund size and fund expense ratio is negatively related to the Sharpe ratio. Only in 2016 the expense ratio estimate is significant at conventional risk levels. An increase of 1% in expense ratio increases the fund Sharpe ratio by 3,261 on average.

The third model uses the fund Sortino ratio as the fund performance measure. The regression results show a weak negative relationship between the Sortino ratios and fund size in 2016 and 2017 and becomes weakly positive in 2018. The fund expense ratio influences positively the fund Sortino ratio in 2016 and this effect reverses itself in 2017 and 2018. None of the coefficient are statistically significant at 5% level.

The multiple R-squared is interpreted as the percentage of variation in fund's performance that is explained by the variation in the explanatory variables. The second model does the best job in explaining the variation in fund's performance for 2016. Almost 44% of the variation in fund's performance is explained by variations in fund size and expense ratio, against 22% and 11% for model 1 and 3. For the year 2017, 25% of the variation in fund performance is explained by the variables against 17% and 12% for model 2 and 3. Finally, the extremely low R^2 for all three models in 2018 indicate that the models failed to explain the variation in fund performance at a reasonable level, and therefore the results for 2018 should not be taken into account. Despite that, low R-squared are not surprising as they are commonly found when regressing fund performance on fund attributes (e.g. Chou & Hardin, 2014; Nguyen, 2004; Vidal-Garcia, 2018).

The F-statistic measures the significance of the overall model. While the first and third models are insignificant for 2016, 2017 and 2018, the second model is significant at the 5% level in 2016 only.

Although the impact of size on performance is not significant, the dominant negative relationships of size-performance obtained in the results are in line with previous studies (e.g. Chan et al., 2009; Chou & Hardin, 2014; Kaur, 2018; Yan, 2008). This result goes against Otten & Bams (2002) who find that size was positively related to risk-adjusted performance in the European market, indicating possible economies of scale for European mutual funds.

What concerns the impact of fund's expense ratio on fund performance, the insignificance of the coefficient estimates of the regressions are in line with the literature. However, when significant, our results contrast with previous studies. As mentioned in section 2.3.1, previous research found the expense ratio to be negatively related to the fund performance while we find a positive relationship with the fund's alpha and the Sharpe ratio in 2016. Funds with higher fund's expense ratio resulted on higher alpha and Sharpe ratio. Overall, we cannot conclude on the relationship between fund's expense ratio and fund performance as only two out of nine regressions showed statistically significant results with moderate R-squared.

Table 11: Regression results of model 1

	Regressions results using α		
	2016	*2017*	*2018*
(Intercept)	0,034	0,134 **	-0,045
	(1,028)	(3,329)	(-1,213)
SIZE	8,30E-06	-9,58E-05 *	-2,55E-05
	(0,154)	(-2,022)	(-0,530)
EXPENSE RATIO	0,057 *	-0,042	-0,015
	(1,937)	(-1,230)	(-0,469)
Multiple R-squared	0,21	0,25	0,03
F-statistic	1,92	2,33	0,21
P-value	0,18	0,13	0,81

Notes: t-Statistics are between parentheses; '***','**' and '*' denote significance at the 1%, 5%, and 10% levels, respectively

Table 12: Regression results of model 2

	Regression results using Sharpe ratio		
	2016	*2017*	*2018*
(Intercept)	0,674	8,974 ***	-3,440 **
	(0,593)	(5,250)	(-3,769)
SIZE	4E-04	-0,003	-0,001
	(0,228)	(-1,654)	(-1,007)
EXPENSE RATIO	3,261 ***	-0,852	-0,731
	(3,251)	(-0,590)	(-0,908)
Multiple R-squared	0,44	0,17	0,09
F-statistic	5,41	1,38	0,77
P-value	0,02	0,28	0,48

Notes: t-Statistics are between parentheses; '***','**' and '*' denote significance at the 1%, 5%, and 10% levels, respectively

Table 13: Regression results of model 3

	Regression results using Sortino ratio		
	2016	*2017*	*2018*
(Intercept)	2,809 **	17,798	-6,903 ***
	(3,044)	(4,768)	(-4,357)
SIZE	-4,52E-04	-1,32E-03	2,03E-04
	(-0,305)	(-0,299)	(0,1)
EXPENSE RATIO	0,962	-4,315	-0,742
	(1,182)	(-1,369)	(-0,530)
Multiple R-squared	0,11	0,12	0,02
F-statistic	0,87	0,94	0,16
P-value	0,44	0,41	0,85

Notes: t-Statistics are between parentheses; '***','**' and '*' denote significance at the 1%, 5%, and 10% levels, respectively

3.4.1 Statistical tests

As explained in the methodology section, the linear regression assumes no collinearity between variables and normality as well as variance homoscedasticity of the residuals. We checked for collinearity and obtain correlation coefficients around -0.20 for all sample periods (Table 26, Table 27 and Table 28 in appendix 6.5) indicating weak and negative correlation between fund size and fund expense ratio. We therefore exclude the existence of collinearity in our sample.

The homoscedasticity and normality hypothesis of the residuals of the models has been verified graphically, using Q-Q and residuals versus fitted plots. While the normality of residuals is respected in all the regressions, we observe heteroscedasticity in model 3 for the years 2017 and 2018, causing the coefficient estimates to be less precise and producing p-values that are smaller than they should normally be. However, the p-values of model 3 are already non-significant at 10% level and therefore the conclusions on the results of model 3 do not change. The residuals versus fitted plots and Q-Q plots are available in appendix 6.6.

4. Conclusion

In this thesis, we examine the relationship between fund performance and the fund attributes size, expense ratio and past performance among 20 Belgian equity mutual funds between 2016 and 2018. After summarizing studies investigating these factors as well as the manager's education-fund performance relationship, we tested the first hypothesis that there is no difference in performance between funds with high expense ratio and funds with low expense ratio. The second hypothesis tested is that there is no difference in performance between large funds and small funds. Student's t-tests and Wilcoxon tests are used to answer these hypothesis. Furthermore, we examined the influence of past performance on future performance, performance persistence, using a nonparametric method (the Winner-Loser test). Finally, we performed OLS regressions of the fund performance measures on expense ratios and fund sizes to quantify the impact of these variables on the performance. Fund performance is measured each year of the sample period using fund's alpha (excess return), Sharpe ratio and Sortino ratio.

Our results for the hypothesis tests are partially in line with previous studies. We failed to reject the null hypothesis of equality of means between high expense ratio funds and low expense ratio funds as well as between large funds and small funds, suggesting that our fund sample provides weak evidence to say that one group performs better than the other, which is in line with Grinblatt & Titman (1994), Otten & Bams (2002), Tng (2007) and Kaushik et al. (2014).

In a like manner as Bosmans (2018), the nonparametric Winner-Loser tests show weak evidence of performance persistence among Belgian mutual funds from the performance of 2016 through 2017 and of 2017 through 2018. The reversal of performance (negative persistence) is observed each year and with all the performance measures used. These results are partially in line with previous studies on the persistence of European mutual funds (Otten and Bams [2002] and Vidal-Garcia [2013]). Finally, the OLS regression models show positive relationships between fund's expense ratio and fund performance in 2016 and overall, insignificant effects of fund size and expense ratio on performance, which is in line with some studies on U.S. and European mutual funds that did not find significant effects for these factors (e.g. Droms & Walker, 2001; Philpot & Peterson, 2006; Tng, 2007; Chou & Hardin, 2014). However, when the variables are found statistically

significant at conventional risk levels, previous studies found that fund expense ratio and fund size have a negative impact on fund performance, which is coherent with the negative coefficient obtained for our regression estimates.

The limitations of this thesis have to do with sample size and sample period. The size of our sample is relatively small compared to the sample size of previous research. This is explained by our screening criteria and the relative low development of the Belgian open-ended equity mutual fund market. This could have had an impact on the results obtained on performance persistence (Otten & Bams, 2002 as cited in Bosmans, 2018) and/or on their statistical significance. Longer study periods would also benefit the investigation of performance persistence in both short- and long-term. All the studies on performance persistence summarized in Appendix 8.1 Table 16 present a sample period larger than 5 years.

Recommendations for future research on the influence of fund characteristics on fund performance would include broadening the sample period and sample size by including multiple asset classes for instance. In addition, creating portfolios of funds based on asset focus class or investment style, similarly to Jan & Hung (2003) or Yan (2008) would provide more understanding of the relationships. Indeed, we studied the relation of fund attributes and performance for all open-ended equity mutual funds, whatever the fund style, while Yan (2008) found variations between investment styles.

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