Jussi Tiitola

Market Efficiency and Market Timing: Evidence from US listed CEFs

School of finance
Master's thesis in Finance

Vaasa 2025

UNIVERSITY OF VAASA
School of finance
Author: Jussi Tiitola
Title of the Thesis: Market Efficiency and Market Timing: Evidence from US listed CEFs
Degree: Master of Finance
Programme: Finance Master program
Supervisor: John Kihn
Year: 2025 **PAGES:** 79

ABSTRACT:
This study investigates the phenomenon of CEFs mispricing and the objective is to show that the CEFs mispricing is continuous and can be exploited. The foundational theory of finance implies mispricing within the CEFs is impossible, and any deviation from the CEF NAV is unambiguous proof of inefficiency. Furthermore, academic papers researching the topic of CEFs mispricing often argue that the mispricing of CEFs is mostly due to overall (economic) factors instead of fund specific factors. In short, neither foundational theory or more mainstream empirical work allows for the possibility of mispricing with respect to CEFs.

Yet evidence shows that CEFs relative mispricing is a rule rather than an exception. Moreover, CEF-specific factors do not seem to have a significant impact on mispricing, and the effect of macroeconomic factors seems limited, as well as a large amount of mispricing remains unexplained. In fact, the mispricing of a CEF does not seem to depend on the mispricing of other funds, and that mispricing tends to be mean reverting. At stark odds to normative theory, the results from the trading analysis detailed in this study show that simplified mean reversion-based trading strategies are able to "beat the market" systematically.

All the findings are against the basics concepts of normative finance. Practically all the findings indicate evidence against efficiency and suggest that textbook efficiency is the anomaly, not the other way around. Therefore, it seems that there is a huge gap between the descriptive reality of the markets and normative finance textbook statements to the contrary.

KEYWORDS: Efficient Market Hypothesis, Arbitrage Theory, Normative Finance, Market Timing, Closed-End Funds, Mispricing

Contents

1 Introduction 1

1.1 Purpose of the study 2

1.2 Structure of the study 4

2 Efficient market hypothesis 6

2.1 Degrees of efficient market hypothesis 6

2.1.1 Weak form market efficiency, random walk, and noise 7

2.1.2 Semi-strong form market efficiency 7

2.1.3 Strong form market efficiency 8

2.2 Concept of arbitrage 9

2.3 Joint hypothesis issue 11

2.4 Critic of normative finance 12

2.4.1 Evidence against weak form market efficiency 13

2.4.2 Evidence against semi-strong form market efficiency 14

2.4.3 Evidence against strong form market efficiency 15

3 CEFs´ an unambiguous violation of EMH 16

3.1 Overview of CEFs 16

3.2 CEFs mispricing 17

3.3 CEFs mispricing and EMH 19

4 Market timing 22

4.1 Overview of market timing 22

4.2 Market timing and EMH 23

4.3 Market timing and mean reversion 24

4.4 Market timing and joint hypothesis 25

5 Data 26

5.1 Selected CEFs 26

5.2 Variables 26

5.3 Data validation and outliers 27

6 Methodology 30

6.1 Mispricing analysis and formulas 30
6.2 Mispricing regression model and variables 32
6.3 Trading analysis and trading rules 36
6.4 Trading analysis formulas and variables 39
6.5 Trading analysis financial indicators and regression model 41
6.6 Robustness checks 41
7 Mispricing analysis results 44
7.1 Descriptive statistics 44
7.2 Time analysis of mispricing 48
7.3 CEFs correlation distribution and correlation matrix 50
7.4 Mispricing regression results 53
7.5 Robustness checks results for mispricing analysis 60
8 Trading analysis results 64
8.1 Long and short positions results 64
8.2 Results for market tactic strategies and market strategies 67
8.3 Robustness checks results for trading analysis 72
8.4 Additional consideration about trading analysis 76
9 Conclusions 78
Appendix 80
References 87

Figures

Figure 1 Individual CEFs mispricing correlation distribution 80

Tables

Table 1 Development of CEFs´ (Statista, 2023) 17
Table 2 Trading rules 37
Table 3 Overview of the 3 market tactic strategies and 3 market strategies 38
Table 4 Descriptive statistics for CEFs mispricing 44
Table 5 CEFs mispricing time analysis 49
Table 6 Correlation matrix with variables used in mispricing regression 51
Table 7 OLS regression of CEFs mispricing (2002-2019) 54
Table 8 Long positions returns 65
Table 9 Short positions returns 66
Table 10 Returns of the market tactic strategies and market strategies 67
Table 11 Summary of market tactic strategies statistical significance 70
Table 12 Trading analysis robustness indicators summary 73
Table 13 Weekly data robustness test 74
Table 14 EMH based trading strategy 75
Table 15 Regression model with weekly data 81
Table 16 Mispricing regression with a different time sample 81
Table 17 Newey-West standard error correction 82
Table 18 Autocorrelation corrected regression model 82
Table 19 VIF tests 83
Table 20 Tactics vs market (No TCs) 83
Table 21 Trading analysis OLS regression (Tactic 1) 84
Table 22 Trading analysis OLS regression (Tactic 2) 84
Table 23 Trading analysis OLS regression (Tactic 3) 85
Table 24 Returns with different trading rules 85
Table 25 List of selected CEFs 86

Abbreviations

Closed-end funds (CEFs)

Efficient market hypothesis (EMH)

Law of one price (LOOP)

Purchasing power parity (PPP)

Net asset value (NAV)

Mispricing (Relative mispricing)

Initial public offering (IPO)

Arbitrage pricing theory (ATP)

Seasonal affective disorder (SAD)

Market value (MV)

Portfolio manager (PM)

Holding period return (HPR)

Small minus Big (SMB)

Value-weighted index (VWD)

Durbin-Watson-test (DWT)

Variance inflation factor (VFI)

Breusch-Pagan (BP)

Newey-West (NW)

1 Introduction

The relative mispricing of Closed-End Funds ("CEFs") is closely related to the Efficient Market Hypothesis ("EMH") (i.e., market-based pricing relative to model-based pricing). The current textbook version of the EMH was invented by Samuelsson and Fama in the 1970s and is still considered to be one of the cornerstones of finance, if not its primary cornerstone. According to the EMH active competition should lead to 'efficient' and right prices, and arbitrage should remove the possibility of excess returns. Nevertheless, the evidence from the financial markets speaks directly against this key concept of academic finance.

Furthermore, it should be noted that in reality no one actually knows what the "right" price should be and therefore at least the possibility of "free meals" is then logically available in the financial markets. That is, for example, if nobody knows exactly what the common share price of IBM should be at all times and in all markets that trade common shares of IBM, then how is it possible to achieve no arbitrage conditions for shares of IBM? In other words, how can you eliminate pricing arbitrage for something you are not even confident of its price?

Critics have questioned the unrealistic assumptions of the EMH, such as no taxes or transaction costs. However, a more recent subfield of study within finance has made some effort in explaining away the deviations from efficiency with more behavioral explanations of why prices deviate, namely what is often referred to more recently as "behavioral finance". For example, Kahneman and Tversky (1979, pp. 263–265) presented Prospect Theory ("PT") as an alternative to standard Expected Utility Theory ("EUT") for decision making under uncertainty. For example, when comparing things like PT vs. EUT, as time has passed it would seem that more and more agents in the field of finance are aware of the contradictions between normative and descriptive finance. Given that normative finance explains how agents should behave while descriptive finance explains how agents actually behave (Kahneman & Tversky, 1979, p. 265, 277; Allais 1997, p. 4), we should at least now be more careful before exclaiming that "prices are right".

Furthermore, and given the divide between normative finance theory and the descriptive reality of the financial markets, it is my conclusion that agents should focus more on the practical part of finance as there are numerous ways to demonstrate that markets are inefficient and excess returns are possible. For example, the concept of the Law Of One Price ("LOOP") is claimed to be true, but empirical evidence shows that in practice the LOOP does not hold for anything (see, e.g., Ardeni, 1989, p. 661, 662). For example, the "Big Mac index" shows unambiguous evidence against the concept of the LOOP as Bic Macs have different prices in different countries (i.e., after adjusting for currency differences). Differences in taxes, goods, transaction costs and time make the LOOP practically impossible to realize in practice. The same applies to Purchasing Power Parity ("PPP"), which is essentially the LOOP applied to whole economies. Overall, the magnitude of contradictions and issues linked to the basic concepts of finance is alarming. If we cannot rely on whether prices or interest rates are "right", what then can we rely on to be empirically verifiable? Furthermore, normative finance has even made testing the EMH virtually impossible due to the joint hypothesis issue (Fama, 1970, p. 414).

1.1 Purpose of the study

The primary purpose of this study is to research whether the chosen 108 CEFs listed in US exchanges were efficiently priced relative to their Net Asset Value ("NAV") during the studied period of 2002–2019. The value of a CEF NAV should be equal to the price of a CEF at any given time, and therefore any deviation between them is a clear sign of relative inefficiency (relative mispricing is referred as "mispricing" from this onwards). The CEF NAV is the only indicator we know for certain and on the contrary, no one knows what the "right" price of a CEF should be. Therefore, the research of the CEFs mispricing is based on relative values and the results are only relative indicators of efficiency. The results from the analyses are suggestions based on the relative values and their assumptions, instead of absolute values. Overall, the NAV, price and mispricing are the 3 most important indicators of this study. The NAV per share of a CEF is calculated by dividing the difference between assets and liabilities with the number of shares outstanding. The mispricing describes the difference between the CEF price and NAV.

$$NAV\ per\ share = \frac{Fund\ assets - Fund\ liabilities}{Number\ of\ shares\ outstanding}$$

$$Mispricing = \frac{Price\ per\ share - NAV\ per\ share}{NAV\ per\ share}$$

CEFs are funds initially issued at a fixed amount of shares through an Initial Public Offering ("IPO") to finance their operations (Brealey, et al., 2020, p. 80, 380). CEFs are almost a perfect subject to research relative pricing efficiency since even a single deviation from market efficiency is unambiguous evidence against the EMH and the joint hypothesis issue does not apply to CEFs (Pontiff, 1996, pp. 1135–1136). In reality CEFs commonly trade at a "discount" (i.e., market price is less than NAV) or "premium" (i.e., market price is greater than NAV) for long periods of time in relation to their NAV. In addition, and in fact, CEF IPO underwriters would not even have an incentive to launch CEF IPOs if there would not be any mispricing.

The second purpose of this study is to research whether it is possible to systematically "beat the market" using simple, or not so simple, market timing strategies based on the simple observation that CEFs' mispricing mean reverts. The market timing analysis is a test of whether money is made or loss with the used assumptions of CEFs mispricing mean reversion. Market timing refers to beating the market by predicting its movements (see, e.g., Merton 1981, p. 363; and Baker & Wurgler, 2002, p. 1). The EMH states that market timing is not possible; therefore, the results from a trading analysis can be used as evidence of inefficiency. Although, it should be noted that this type of evidence, and as opposed to the primary relative pricing analysis of market prices vs. NAV, does have the joint hypothesis issue (e.g., we must accept the model of mean reversion is correct).

In the mispricing analysis, the objective is to show that CEFs are systematically mispriced, which, again, if true, directly contradicts the EMH. Furthermore, to research whether there are any specific factors affecting CEFs mispricing would also contradict related theory. In fact, it would seem that actual fundamental factors include CEF specific and

macroeconomic factors (i.e., not just macroeconomic). Furthermore, if the null hypothesis (i.e., essentially there is no mispricing) of this study can be rejected without a joint hypothesis issue and if the evidence confirms that timing strategies result in statistically significant mispricing, then this study will strongly confirm that market inefficiency exists.

Furthermore, and again, in a larger context the purpose of this study is to update and revise the current perception of normative finance and the EMH. Possibly the results of this study would enable financial markets agents to understand the differences between reality in the financial markets vs. what is in modern finance textbooks and taught in classrooms. Potentially, agents should realize the importance of considering descriptive financial market reality rather than believing blindly in the pronouncements of normative finance that lack scientific merit. By exploiting the actual facts of the markets, agents could avoid making common mistakes. Hopefully, this would also assist finance to transform more towards teaching descriptive reality, and away from purely normative theory.

The hypotheses of this study are the following:
H_0 : There is no statistically significant mispricing within the CEF market.
H_1 : There are no CEF market timing strategies that are able to beat the market.

As already stated, the hypotheses are intended to clarify firstly whether the CEF markets are efficient and secondly if there any possibilities to take advantage of relative inefficiency with market timing strategies based on mean reversion. All the researched material and data analysis indicates that the null hypothesis does not hold, and that there are possibilities to take advantage of these inefficiencies. Essentially, the remainder of this thesis after this section is intended to support the rejection of the null hypothesis.

1.2 Structure of the study

The thesis is divided into nine main sections. The first section is the Introduction, and it presents the topic, some background and the hypotheses. Section two presents the core theory section of the study, concentrating on the EMH. Section three introduces CEFs to

the reader. In section four the concept of market timing is presented to the reader. Data and the variables used in the study are presented in section five. Section six introduces the methodology used and related formulas. Section seven and eight present the results for the mispricing and trading strategy analyses. Conclusion are covered in the last section.

2 Efficient market hypothesis

The relative mispricing of Closed-End Funds ("CEFs") is closely related to the Efficient Market Hypothesis ("EMH") (i.e., market-based pricing relative to model-based pricing). The current textbook version of the EMH was invented by Samuelsson (1965, p. 41) and Fama (1970, pp.383-384) in the 1970s and is still considered to be one of the cornerstones of finance, if not its primary cornerstone. According to the EMH active competition should lead to 'efficient' and right prices, and arbitrage should remove the possibility of excess returns (Brealey et al., 2020, pp. 340–342; Bodie et al, 2021, pp.332–333). In the EMH prices are assumed to reflect all the available fundamental information about the financial markets and agents are assumed to be price takers who have no effect to market price. Other assumptions of the EMH are perfect competition, no transaction costs, and rational behavior of agents. Despite the EMH includes many unrealistic assumptions it is still widely taught in textbooks and believed to hold true in practice.

2.1 Degrees of efficient market hypothesis

The degrees of the EMH are weak, semi-strong, and strong. The 3 different degrees of the EMH are classified according to the market efficiency (i.e., how well prices reflect fundamental information. The degrees of the EMH are based on a study published by Fama (1970) in the 1970s,but also many other academics have researched the topic e.g., Malkiel (2014) has presented his owns visions about the degrees in his book called "A random walk down the street". The EMH assumes that only fundamental information has an effect to prices but in reality, also non-fundamental information has an effect to prices. Fundamental information refers to a situation where e.g., a positive change in company earnings increases the stock price of a company. Non-fundamental information refers to a situation where e.g., the company changes its name, and it has a positive effect to the stock price of a company. In reality usually the non-fundamental information has a more significant effect to price than the fundamental information.

2.1.1 Weak form market efficiency, random walk, and noise

In the weak form of market efficiency information is based on historical asset prices (Fama, 1970, pp. 383-384; Malkiel, 2014, p. 26, 140, 183; Brealey et al, 2020, p. 340). The weak form does not believe in the use of technical or fundamental analyses and beating the market is considered impossible. Since there should not be any significant differences in returns random portfolio is preferred over active trading. The weak form is based on the idea that prices seem to follow a random walk (Kendall, 1953). Kendall found out that overall, the prices tend to be independent and uncorrelated from each other (i.e., the price today does not indicate any information about the price in future) instead of certain price patterns. The view of the weak form aligns with the EMH since agents are not allowed to have “free lunches” and arbitrage should balance the price.

The concept of random walk has been actively researched after the Kendall´s study and the academics have concluded that it mostly works, but there are some detectable price patterns (Malkiel, 2014, pp. 141–142; Brealey et al, 2020, pp. 342–343; Bodie et al, 2021, pp. 347–348). Academics have detected these price patterns e.g., in stocks having high momentum and volatility. The findings suggest that momentum seems to effect future prices in both positive and negative ways. Also, stocks including high volatility include clearly detectable price cycles. Furthermore, also noise is often considered to have an effect on price changes. Usually, the random walk is seen as a process, and noise as a describing factor behind the changes. Noise is always included in the agents expectations, and it can be positive or negative depending on the return expectations (Brealey et al, 2020, p. 210). Noise is tricky since it is important, but no one knows what it really is.

2.1.2 Semi-strong form market efficiency

In the semi-strong form of market efficiency, the prices reflect all public and past information available (Fama, 1970, pp. 383-384; Malkiel, 2014, pp. 182–184; Brealey et al, 2020, p. 340, 343; Bodie et al, 2021, p. 336). Usually, the semi-strong form is considered to be the most practical degree of the EMH. The public information refers to sources

such as, news, social media, and financial report and past information to the historical asset prices. In the semi-strong form prices should reflect the public information instantly and as there is no inside information available there should be no use for fundamental or technical analyses. Recently the amount of information and the amount of information sources has substantially increased compared to the time of publishing the theory. Overall, the importance of finding the relevant information has increased. Usually, the semi-strong form is considered to be the most practical form of EMH.

To test whether the semi-strong form holds in practice academics have used fundamental analyses to research stock price reactions to information (Brealey et al, 2020, pp. 343–344; Bodie et al, 2021, p. 349–350). Evaluating whether the reaction is “right” and considering all information is a more challenging analysis due to the joint hypothesis issue which practically removes the ability to test the EMH. In addition to stock price reactions academics have published studies focusing on abnormal returns (i.e., difference between actual and expected return). These studies have tested the reactions of specific stock groups facing the same news. The results from the abnormal tests argue that the price reactions to new information are immediate and in right amount, e.g., in the Enron scandal in 2001 as the fraud became public the stock price of Enron decreased shortly to zero and the company claimed bankruptcy.

2.1.3 Strong form market efficiency

In the strong form of market efficiency prices reflect all available information (i.e., all available past, public and private) on the market (Fama, 1970, pp. 383-384; Malkiel, 2014, pp. 182–184; Brealey et al, 2020, p. 340, 345; Bodie et al, p. 336). The strong form creates a situation where there can be winners and losers but due to fierce competition no one is able to achieve constant excess returns. Therefore, beating the market is possible but to constantly do it is hard or impossible, and even inside information does not inevitably lead to excess returns.

2.2 Concept of arbitrage

The term of arbitrage refers to “riskless profit” (Malkiel, 2014, p. 231; Brealey et al, 2020 p. 59; Bodie et al, p. 311). The concept of arbitrage is based on the Arbitrage Pricing Theory (ATP) which was introduced by Ross in 1976. The ATP shares mostly the same assumptions as the EMH but the ATP assumes that the returns are affected by macroeconomic factors and noise which lead to the right price (Ross, 1976, p. 355; Brealey et al, p. 213). The factors and their sensitivity cannot be predetermined since they vary between the used assets. The ATP assumes two kinds of risks, systematic risk, and unsystematic risk. The textbook arbitrage assumes arbitrage to be only relative instead of absolute, i.e., no one knows what the right price should be. Therefore, models such as Black-Scholes option pricing model are built on the relative arbitrage assumptions.

The term riskless profit can be e.g., achieved by the following chain of events: Suppose in Helsinki you can trade Swedish crowns at ten cent exchange rates, while in Stockholm you can trade euros for Swedish crowns at a twelve-cent exchange rate. In order to make arbitrary riskless wins, one would buy Swedish crowns at Helsinki at ten cent rate and then immediately sell them at Stockholm with twelve cent rate resulting in two cent riskless profit per crown. The profit might seem low, but it might lead to significant amounts as the arbitrageurs are using significant amount of capital. Other well-known arbitrage strategies are e.g., covered interest arbitrage and triangular arbitrage, which are both based on the concept to exploit interest rate differences.

The relationships between the EMH and the ATP can be confusing since the EMH highlights the role of fundamental information behind efficiency, while the ATP highlights the role of price deviation corrections behind efficiency (Brealey et al, 2020, pp. 213, 340–342). Regardless the differences, the so-called textbook arbitrage is more complex than it may sound. In reality arbitrage is never risk-free since there are always limits to arbitrage (Brealey, 2020, pp. 351–353; Schleifer & Vishny, 1997, p.54). Arbitrage is always influenced by at least two types of costs: transaction and holding costs. (Pontiff, 1996, pp. 1138–1139). Transaction costs refer to the cost of opening or closing the trade and

holding costs refer to costs occurring during the investment period. Both of these costs differ between individual and institutional operators. Both of these costs should be positively correlated with efficiency deviations since otherwise there would not be an incentive to reduce them. Therefore, the amount of costs is linked to the inefficiency and if there are no incentives to reduce them inefficiency might remain. Arbitrage is often linked to buying low and selling high it is usually executed with the opposite strategy of buying high and selling low. In shorting the holding costs can be unpredictable if the mispricing takes long to balance. For certain agents shorting is not even possible due to high margin requirements. Also, sometimes agents are not able to find stocks to borrow or they are not able to find stocks to buy them back, resulting in losses.

Information asymmetry is present in the financial markets as some agents possess more information than others (Shleifer & Vishny, 1997, pp, 36–37). Usually, the agents with the additional information are the ones with the most capital and leverage, such as banks, institutions, and governments. The ability to exploit arbitrage opportunities varies between agents. More importantly, detecting inefficiencies are not guarantees of profit (Brealey et al, 2020, p. 343). In 1970 Akerlof (p. 489, 493) described the issues of information asymmetry using a car example. If agents are not confident about the right price the information asymmetry causes adverse selection and moral hazard. The agents without the information have to bear all the costs associated but on contrary the information holder faces moral hazard. Information asymmetry is present and can lead to artificially high prices until and (if) the market corrects the situation.

The argument of agents acting rationally contradict with the empirical findings from financial markets. The findings show that agents cause the asset prices to diverge from their fair values. (Brealey et al, 2020, pp. 349–350). The well-known term “irrational exuberance” by Alan Greenspan is based on this phenomenon and referring to a situation where assets prices are driven too high or low. The expectation of agents always acting rationally is nonsense since most of the agents are amateurs. For example, Kahneman and Tversky (1979, pp. 263–264, 280) stated that agents tend to have strong risk aversion.

Agents are not particularly interested in the current situation of their portfolio, but the overall gains or losses will rather dictate the direction of their investment strategy. If the portfolio overall is positive a riskier strategy is applied and vice versa. Overall, agents tend to have overconfidence of their own skills.

2.3 Joint hypothesis issue

The normative finance argues that researching market efficiency is problematic or even impossible due to the joint hypothesis issue (Fama, 1970, p. 414; Bodie et al, 2021, p. 349. The joint hypothesis issue refers to a situation where we cannot be sure what we are testing, and therefore what do the results imply. The normative finance claims that the joint hypothesis issue is constructed when typical asset pricing models and assumptions linked to them are used. This leads to a situation where the results can imply: 1. market inefficiency 2. misleading returns (wrong model) or 3. both. Nevertheless, in the case of CEFs the joint hypothesis issue does not apply, since we know the value of NAV and therefore the mispricing tests of the CEFs are solely tests of market efficiency.

In the 1970s Fama stated that market efficiency cannot be tested before knowing how the market reflects information and what is the correct equilibrium asset pricing model to use. Whether the prices reflect all the available information creates a joint hypothesis problem. For example, asset pricing models, like CAPM include fundamental issues, such as expected returns are used instead of real returns, and the expected return is assumed to be only linked to the assets market risk (beta). As a result, the test of the risk adjusted returns are also test of the EMH at the time and all the previously listed 3 outcomes are possible (Bodie et al, 2021, p. 349). This leads to a situation where assumptions linked to the testing process are questionable and the results cannot be interpreted. All things considered the joint hypothesis creates a barrier for testing the market efficiency. In academic context the joint hypothesis issue is often ignored due to its absurdity. The EMH is one of the most important cornerstones of finance and it cannot even be tested due to the nonexistent predictability of CAPM.

The joint hypothesis issue is minimally two folded in the CEFs mispricing analysis of this study: researching the market efficiency and the joint hypothesis linked to CEFs. In the case of the CEFs we know that the joint hypothesis issue does not apply to them since we know the right pricing model for certainty. Therefore, the test of the relative efficiency of the CEFs are solely tests of market efficiency.

2.4 Critic of normative finance

The irrational assumptions and inapplicability of the EMH has faced significant amount of critic since its release. Academics have found direct evidence against all the efficiency forms of the EMH and even further. Overall, assumptions and concepts linked to the EMH have nothing similar with the reality in the financial markets. In other words, the concept of “no free lunch” does not even make any sense since right prices indicate “no free lunch” but “no free lunch” does not indicate prices are right (Kihn, 2015; Brealey et al, 2020, p. 354). Also, the EMH assumption that non-fundamental information has no effect to prices is absurd. According to a former CEFs manager it may be actually one of the key factors behind the CEF mispricing (Kihn, 1996). The findings of Kihn show that the mutual fund price changes are mostly due to non-fundamental factors. Furthermore, the fund performance can be rather defined by its non-fundamental factors (e.g., marketing, imago, changing name) than fundamental factors (e.g., earnings). In reality, there should be no reasons that the mispricing within the CEFs is defined by the fundamental risk, and actually the risk of a CEF is mostly due to the non-fundamental factors, which can therefore be considered as one of the possible reasons behind the mispricing.

According to the EMH arbitrage should be impossible and never risk-free but it is considered to preserve efficiency. According to the theory agents should be price takers which have no abilities to restore efficiency. Who will the correct the price? Actually, in arbitrage no one really knows what the absolute price of a certain asset should be. How is then possible to arbitrage the asset and with what strategy? If it is not possible to know how to arbitrage then textbook arbitrage does not make any sense from theoretical, mathematical, and logical perspectives. Thirdly, the fact that EMH assumes only relative

arbitrage does not make any sense. The theory also assumes that market inefficiencies are opportunities of excess returns. In reality it should be the opposite since market inefficiency means that there is fraud within the market, and agents are going to lose money. Realistically, whether money is made, or loss is not related to the market efficiency. All things considered it seems that arbitrage causes arbitrage and due to joint hypothesis issue it cannot be even tested.

2.4.1 Evidence against weak form market efficiency

The core idea of the weak form market efficiency is that past prices are not indicators of future prices (Fama, 1970, pp. 383-384; Malkiel, 2014, p. 26, 140, 183; Brealey et al, 2020, p. 340; Bodie et al, 2021, pp. 334–335). However, the academic literature has found evidence against this assumption from different time periods (Bodie et al, 2021, pp. 347–348). It seems that certain characteristics such as, momentum of volatility of assets can be used to predict future prices. In momentum the serial correlation of assets can be used to observe asset trends and momentum. On short time periods the correlations are low but as the time is increased the correlation increases and so does the momentum effect (Jegadeesh and Titman, 1993, p. 65). Overall, in short and intermediate periods it is hard to use past stock prices as predictors of future prices, but it is possible.

Fama and French (1988, p. 246) found evidence of negative autocorrelation in the stock returns over time. Indicating that todays high (low) returns forecast lower (higher) returns in the future. Also, Fama and French find out that stocks tend to overreact to certain news, which create short time momentum balancing over time as the expectations reduce. The market cycle indicates that an overreaction will first lead to poor performance followed by a good performance in the long run. Also, DeBondt & Thaler (1985, p. 804) argued that stocks have a reversal effect in which current losers tend to perform better in future and vice versa. Seasonal affective disorder (SAD) is an example where a time factor is used to predict future returns (Kamstra et al, 2003, p. 340). The SAD illustrates the correlation between stock return and the amount of daily light and is a clear violation of the EMH.

2.4.2 Evidence against semi-strong form market efficiency

In the semi-strong form, the question is whether public information can be used to generate abnormal returns (Bodie, 2021, p. 349). The EMH states that risk adjusted abnormal returns are not possible, and the EMH makes testing practically impossible due to the joint hypothesis issue. Regardless of the test results no one knows what the correct model is to test the EMH. The joint hypothesis issue is often ignored and tested with simplified models which do not contradict with the joint hypothesis issue.

For example, simple tests researching the interest rates mispricing using the Fisher´s equation (i.e., nominal interest rate is equal to real interest rate and expected inflation) indicated manipulated interest rates by central banks and governments (Kihn, 2015. If interest rates are manipulated, what would it mean to the asset prices, since they are based on present and future value methods. Also, Basu (1977, p. 668, 680) researched mispricing and found evidence of low price to earnings (PE) portfolios producing higher returns compared to the high price to earnings portfolios. Thirdly, if two firms share the same expected earnings the riskier firm will be cheaper and possess a lower PE ratio which will lead to higher expected return (Bodie et al, 2021, p. 350).

De Jong et all (2009, p. 518) researched the topic of mispricing through dual listed funds and found significant efficiency deviations between them. Apparently factors like, size, volatility etc., can be used to research mispricing and to find the higher return generating assets (Bodie et al, 2021, pp. 351–354). In 1993 Fama and French used the factor models and detected that market return is not the only explaining factor but also factors such as size and value have an effect on stock returns. All things considered, apparently, arbitrage is not efficient enough to balance the price deviations.

2.4.3 Evidence against strong form market efficiency

In the strong form, the question is whether available inside information can be used to generate abnormal returns (Bodie, 2021, p. 354). In practice the financial markets are not strong format efficient since the governments and institutions regulate and limit inside information trading. If inside information and information about the inside trades would be available agents should be able imitate them and generate abnormal returns. Seyhun (1986, p. 210) researched whether it is rational to imitate inside traders and found evidence indicating the opposite. Asset prices tend to rise shortly after the announcement of inside trading but the rise in price is not high enough to counter the transaction costs associated with the trade. As a results, if there are inefficiencies and agents are rational, they do not have the incentive to balance the deviation.

Overall, the findings raise serious questions and concerns towards the core center of normative finance. The findings from the academic literature show direct evidence against all the forms of efficiency, the arbitrage and the EMH itself. The concepts of EMH and ATP are contradicting with each other. Arbitrage causes arbitrage itself and none of the assumptions related to the EMH actually hold in practice. If we cannot be sure about the rightfulness of prices and interest rates, then we cannot be sure about anything related to normative finance itself.

3 CEFs´ an unambiguous violation of EMH

This study has already disclosed that testing the EMH can be hard or even impossible due to the joint hypothesis issue. According to the joint hypothesis issue we do not know what the correct pricing model is to evaluate relative price efficiency or risk associated with asset. However, the CEFs pricing efficiency tests do not contradict with the joint hypothesis. In the case of the CEFs we know the right relative pricing model for certainty, and we do not need to involve standard asset pricing models to research mispricing. Therefore, the joint hypothesis issue does not apply to the CEFs, and the mispricing can be researched through the relation of CEF NAV and price.

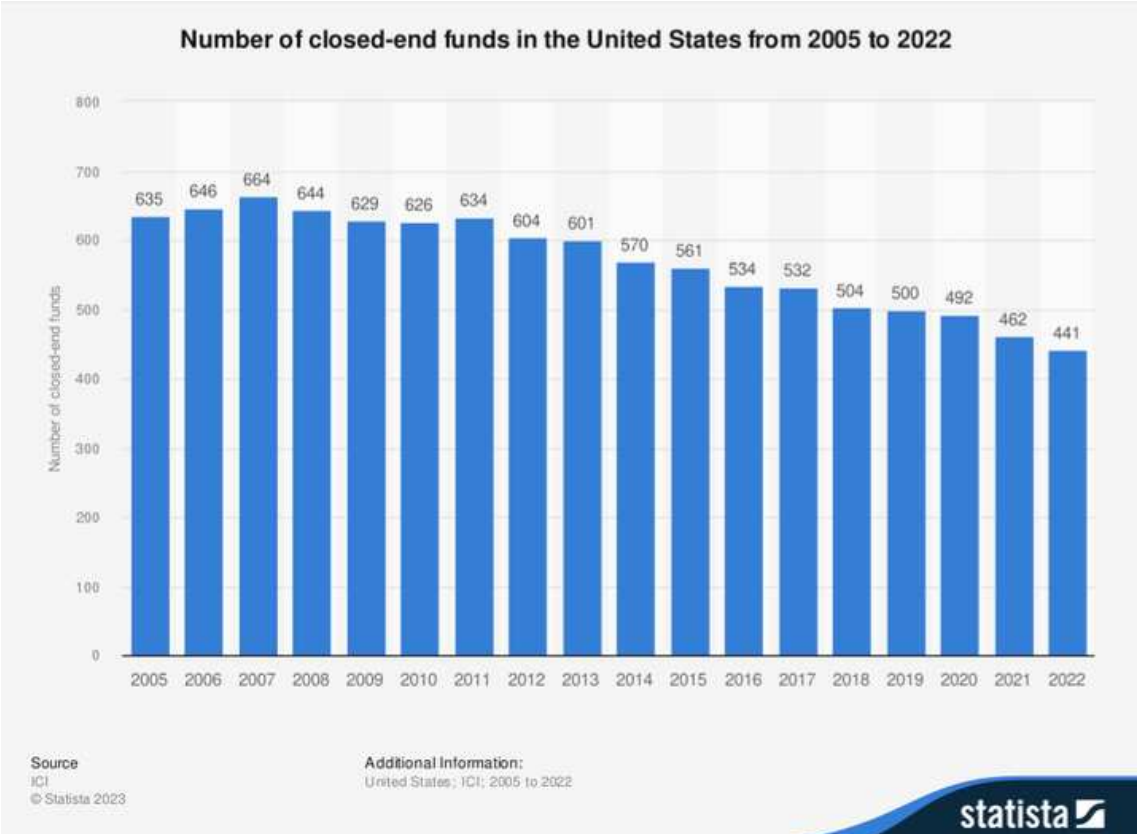
3.1 Overview of CEFs

a CEF is an investing instrument that raises capital by issuing fixed number of shares to market through an IPO (Bodie et al, 2021, p. 96; Brealey et al, 2020, pp. 379–380). CEFs are traded in the financial markets mainly like stocks or ETFs, and the shares are non-redeemable and in fixed numbers. Meaning that they cannot be redeemed against cash and at the time of issuance only a certain number of shares are released. The levered "CEFs" are an exception as they are not technically CEFs since they allow their number of shares to be decreased or increased. Regardless of the difference the behavior of leveraged funds is similar to typical CEFs. Shares of a CEF can only be sold or purchased through the market as no new shares are issued. If agents want to sell off their shares they have to sell their shares to another investor. The raised capital of a CEF is invested into financial assets e.g., stocks or bonds depending on fund strategy. CEFs offer a broad choice of different investment strategies. Most of the CEFs invest into common asset classes, and bonds have usually accounted for the majority of the CEFs´ total assets.

The table one below describes the development of the CEFs in the USA from 2005 to 2022 (Statista, 2023). The trend of the number of CEFs has been negative and it seems that the popularity of the CEFs has declined while agents have found new alternative investment instruments. The amount of the CEFs has decreased over 30 percent during

the studied period. Also, the total assets within the CEFs have decreased marginally, e.g., in 2017 the total assets within the CEFs were 277 billion dollars and in 2022 they were 252 billion dollars (ICI, 2023, p. 64). The trend of the number of the CEFs and the assets suggest that large CEFs have become even greater, and some small CEFs have been closed. It seems that agents are willing to test new investing instruments instead of CEFs. Also, some of the CEFs have lately been liquated, merged or converted into ETFs.

Table 1 Development of CEFs´ (Statista, 2023)



3.2 CEFs mispricing

From the purpose of this study the most important feature of the CEFs is that their market value (MV) usually (always) diverges from their NAV (Lee et al, 1991, pp. 1136–1137; Pontiff, 1996, p. 1150). In practice, the CEFs are always trading at a discount or premium in relation to their NAV. CEFs are said to be trading at a discount (i.e., negative mispricing) when the MV is below the NAV, and when the MV is higher than the NAV they are said

to be trading at a premium (i.e., positive mispricing). The NAV of a CEF is calculated by subtracting the CEF liabilities from the CEF assets, and the NAV per share can be calculated by dividing the total NAV with the amount of shares outstanding (Pontiff, 1996, p. 1150; Lee at all, 1991, pp. 1136–1137). The mispricing of a CEF is calculated by comparing the relation of the CEF NAV and price. The fact that we know the relative efficiency pricing model of the CEFs for certain allows us to research the mispricing without contradicting with the joint hypothesis issue. Nevertheless, it has to be highlighted that the efficiency tests of mispricing are only research of relative values and their assumptions instead of absolute values. In the research only the NAV values are known for certainty, and no one knows what the price of a CEF should be.

The CEF efficiency deviation (i.e., mispricing) is based on the relation of the CEF NAV and price, which according to the EMH should be always equal zero (Bodie et al, 2021, pp. 379–380; Lamont & Thaler, 2003, p. 228). Any deviation from the efficiency is a clear violation of the EMH, and specially law of additivity which claims that the value of a company should be equal to the sum of the values of its different parts at any chosen time. The law of additivity should determine the minimum valuation boundaries for companies but in practice the boundaries are controlled by supply and demand. A former CEF manager mentioned that the CEF manager job is to control the NAV of the CEFs. He claimed that the deviation between CEF NAV and price can be partially controlled but it is virtually impossible the get the NAV and price to match. The agents define the market price of the CEFs and therefore whether the CEF is trading at a premium or discount.

In reality, the NAV of CEF often (always) diverges from the market price. On average the CEFs are trading at a discount but often at time of issuance the CEFs tend to trade at a premium. The finding may sound irrational since why anyone would want to buy a CEF at the time of IPO if the price is likely to fall shortly after. On the contrary, the brokers are not going to launch new CEFs unless they are mispriced (premium). It seems clear that the market cannot add and subtract, and arbitrage is not functioning as the EMH claims it should be.

3.3 CEFs mispricing and EMH

According to the EMH mispricing should not possible since prices are right, agents are rational and arbitrage removes pricing inefficiencies (Samuelson, 1965, p. 41; Fama 1970, pp. 383–384). Nevertheless, in reality the price inefficiencies are rather a rule than exception, even in the security classes like CEFs or ETFs which are considered to be efficiently priced security types. The EMH tries to explain the price deviations e.g., by inaccurate NAV calculations and portfolio manager (PM) irrational behavior related to agency costs (Lee et al, 1990, p. 156). These agency costs include components like, lack of incentives and pressure to perform. According to Malkiel (1977, pp. 854–855) the agency costs related to the CEFs cannot be used as explaining factors of mispricing. CEFs facing similar costs do not trade at the same price and the price behavior is not logical.

Secondly related to agency costs, Boudreaux (1973, pp. 516–517) claims that price deviations within the CEFs might reflect managers trading skills since the NAV of the CEFs should reflect the expected returns associated. Therefore, the skills of managers are considered in the NAV of a CEF (Lee et al, 1990, p. 156). If this is true, there is no logic that the CEFs are systematically trading at a discount. On contrary, Malkiel (1977, pp. 857-858) stated that there is no significant relationship with past performance and mispricing. According to Malkiel the mispricing tends to be linked to overall market conditions, and therefore the discounts tend to decrease in in bear markets and increase in bull markets.

The EMH also argues that restricted stocks might lead to incorrect NAV calculations and can therefore cause mispricing within the CEFs (Lee et al, 1990, p. 157). CEFs are claimed to be misvalued since they include premium trading restricted stocks which cannot be freely sold to the market. Consequently, the CEFs have an incentive to include these stocks in their portfolios since they cannot be liquated. Malkiel (1977, p. 854) and Lee et all (1991, p. 79) found out that these restricted stocks can be used to explain part of the variation in discounts. Despite the findings, some CEFs have no or only a little restricted stocks and still trade at a discount (Lee et al, 1990, p. 157).

The EMH highlights taxes as a possible reason for mispricing (Lee et al, 1990, pp. 157-158). When CEF assets are sold with a profit the agents has to bear the tax liabilities. Furthermore, there is a danger of facing tax payments even if you are a new investor without profits if the CEF decides to realize its assets. Moreover, if the CEF is associated with substantial capital appreciation the CEF is less attractive for agents since its real value is certainly below NAV and trading at a discount. Malkiel (1977, pp. 854-855), and Lee et all (1991, p. 80) researched the tax effects and found out that taxes can only explain a part of mispricing but there was no significant relationship between them.
significant relation between taxes and mispricing was not found.

Lee et all (1991) found out that the mispricing behavior of the CEFs includes four different detectable cycles which can be used as a guideline for CEFs behavior. The first observation was that new CEFs tend to trade at premium at time of IPO and shortly after IPO they tend to shift quickly to a discount (Lee et al, 1990, p. 154). Agents have to face high expectations, cost of becoming public, and transaction costs related to the new CEFs. On the contrary, brokers have the incentive to drive the CEF price up. These systematic price drops are documented in the empirical literature, and it seems irrational to participate in buying the CEFs at time of issuance but shorting them would seem like a viable option. The second observation was that the CEFs tend to trade at a discount in comparison to their NAV (Lee et al, 1990, p. 155). The empirical evidence indicates that it is rather a norm than exception that the CEFs trade at a discount.

The third observation was that pricing mispricing within the CEFs tend to have a high degree of variation over time and between CEFs (Lee et al, 1990, p. 155). Empirical evidence has found a high degree of variation within the CEFs, including both premiums and discounts. Mispricing variation seems to be positively correlated with price and increasing as time period is lengthened. The discounts and premiums tend to move in the same direction. The CEFs variation raises questions of why they variate so much and why they move in the same direction. The fourth observation was that when CEFs are shut down or shifted to open-end funds the prices tend to revert back to the NAV (Lee et al,

1990, p. 155). The observation is not surprising since at the time of the liquation the assets of CEF should be redeemed at the NAV, and therefore there should not be any other possible outcomes. However, some argue that the net assets are reported falsely and force the NAV back to market price.

The examples from academic papers imply that the phenomenon of CEFs mispricing is complex. Furthermore, the EMH tries to explain the deviations from efficiency with different factors. Most of these factors show only minor explaining significance in relation to CEFs mispricing and it seems that mispricing of the CEFs is a phenomenon which is more linked to the macroeconomic factors instead of the CEFs specific factors, while a large amount of mispricing remains unexplained. Anyway, the stand of the normative finance has not changed despite the papers have been able to generate considerable evidence in favor of inefficiencies within the CEFs (Bodie et al, 2021, p. 380). The normative finance is aware of the mispricing but claim mispricing to exist due to combination of unexplainable factors and both premiums and discounts within the CEFs are possible.

4 Market timing

The market timing is in the center of this study since the second objectictive of this study is show that is possible to systematically beat the market index with simplified trading strategies based on the CEFs mispricing mean reversion. This section presents the overview of market timing and its relationship with the EMH and the joint hypothesis issue.

4.1 Overview of market timing

In the context of the CEFs mispricing the market timing can be defined as a way to forecast future market movements and to allocate assets in the portfolio according to the forecasts in order to make profit. Henrikson and Merton (1981) and Henrikson (1984) describe market timing as an option theory related phenomenon, where free call and put options are available due to market inefficiencies. In the context of the CEFs mispricing, agents have the possibility to exploit the systematical difference between CEF price and NAV. The phenomenon can be considered as an opportunity to buy undervalued call or put options and wait for the possible price mean reversion back to the NAV. The behavior of CEFs is asymmetric and on average the CEFs tend to be trading at a discount. Therefore, in practice the CEFs mispricing can be mostly exploited through call options.

Market timing can be further divided into two fields: parametric and non-parametric market timing (Henrikson & Merton, 1981, p. 514); Henrikson, 1984, p. 74). The parametric market timing refers to exploiting efficiency deviations of individual investment targets, such as the CEFs. The non-parametric market timing refers to a broader market exploiting, where agents allocate their assets between risky and non-risky assets depending on the overall trend of the financial markets.

Market timing sounds attractive and effortless to perform but in reality, at least over time it is difficult to perform successfully (Malkiel, 2014, p. 202). For example, behavioral finance has denoted that agents tend to overestimate their own skills. Agents rely too heavily on their own skills to beat the market, end up facing the high risks associated

with the strategy. According to the EMH market timing should not be possible, at least over time. For example, Malkiel (2014, p. 202) states that active trading increases the risk to miss the best return periods since capital is not constantly invested into the market. Malkiel also emphasizes that market timing is a fraud which sounds too good to be true. He argues that beating the stock market average 9 percent return constantly by market timing strategies is impossible, otherwise all others would be also performing it.

4.2 Market timing and EMH

The EMH argues that market timing is not possible since prices are right, agents are rational and arbitrage removes pricing inefficiencies (Samuelson, 1965, p. 41; Fama 1970, pp. 383–384). As already mentioned, none of the assumption hold true in practice and the finance textbooks rarely reflect the reality in the financial markets accurately (Kahneman & Tversky, 1979, p. 265, 277; Allais 1997, p. 4). Market timing belongs to the same group since it is assumed to be impossible but in reality, it is happening constantly. Certainly, there might be some kind of restrictions and of course market timing might not lead to excess returns but at least opportunities to perform market timing are constantly available. It has to also noted that often performing market timing does not need supernatural trading skills since the market and the agents are behaving irrationally.

The London Gold and Silver Fix is an illustrative example of systematical market timing opportunity (Caminschi & Heaney, 2013, p. 1004). In London a certain number of banks or specific parties are setting the price of gold and silver at a fixed level according to supply and demand. An empirical study was conducted where the returns between buy & hold tactic and one specific tactic concentrating on the prices of gold and silver were compared. The specific tactic strategy was to buy the morning fix price and sell at the evening fix on a daily basis. The price of gold (buy & hold) nearly quadrupled during the 30-year period, but the tactic generated almost three times higher cumulate returns during the period. The price of golf seemed to follow a certain price cycle and if this pattern would have been detected a market timing strategy would have led to significant excess returns. As governments and public agencies were behind this price pattern the

credibility of the financial markets could be questioned, and it is foolish to expect this was the only case of governmental price manipulation.

In reality there are numerous examples like the previous one and opportunities for market timing are constantly available. Nevertheless, despite the mispricing within the CEFs may be constantly present taking advantage of might not be so simple. As agents apply traditional market timing strategies of buying low (high) and selling (low), there are no guarantees of the CEFs mispricing reverting back to their long-time average since the premiums or discounts within the CEFs can widen. The uncertainty connected to the mispricing reverting duration increases the fundamental risk substantially. The same phenomenon can be seen in stocks and e.g., Lee et all (1991, p. 76) found out that the discounts within stocks tend be correlated and to move together with the returns of small stocks. Also, Pontiff (1996, p. 1136) found out that the CEFs mispricing is negatively correlated with the idiosyncratic volatility.

4.3 Market timing and mean reversion

The used market timing strategy in this study is constructed using the findings from the mispricing analysis and academic literature. The core idea of the market timing strategy is that the CEFs mispricing tends to follow mean reversion. The idea of mean reversion is that on short and intermediate time periods the variation of the market can be high but in long run the market tends to revert into its long period average (Malkiel, 1977, p. 184, 209; Poterba & Summers, 1988, p. 45). The market can undergo short periods of high (low) returns but they tend to be followed by periods of low (high) returns. The findings from the papers concentrating on the CEFs indicate that the mispricing of CEFs can be explained by CEF-specific and macroeconomic factors, but a large share of mispricing remains unexplained. Furthermore, the effects of CEF-specific factors seem limited and also the macroeconomic factors have only relatively minor effect to mispricing. Overall, it seems that there are no factors which can properly explain mispricing within the CEFs. The mispricing of a CEF does not seem to depend on the mispricing of other funds and is therefore based on mean reversion.

4.4 Market timing and joint hypothesis

In the case of the CEFs mispricing analysis we know the correct pricing model to evaluate the relative pricing efficiency, and there is no risk of contradicting with the joint hypothesis issue (Lee at all, 1991, pp. 1136–1137; Pontiff, 1996, p. 1150; Lamont & Thaler, 2003, p. 228; Bodie et al, 2021, pp. 379–380; Yang & Gould, 2023, p. 1419). On the contrary the market timing analysis of the study includes a joint hypothesis issue since we do not know what the correct model is to test the trading strategy.

The trading analysis of this study ignores the joint hypothesis issue and assumes that the CEFs mispricing is mean reverting and can be possibly exploited to make significant amount of money. Therefore, the trading analysis is rather a tests of whether the CEFs mean reversion based trading strategy leads to a loss or profit based on the relative values. The assumption of mean reversion is based on the mispricing analysis observations, where it seems that the relative difference between the market price and the NAV of a CEF are mean reverting. In order to conclude that it is possible to beat the market systematically the returns for the market tactics have to be considerably higher than for the market.

5 Data

The monthly data of this study concentrates on 108 CEFs listed in the USA exchanges during the studied period of 2002-2019, in total 18 years of data. After data filtering and validation there are in total 22 862 observations. The core data is retrieved from Bloomberg, and it includes information about the CEFs, price, NAV, bid-ask spread, etc. Also, some data and information related to used variables is acquired from yahoo finance, FRED Economic Data (FED), and CEF-specific brochures. Furthermore, also weekly data for the same selected 108 CEFs is retrieved from Bloomberg to enable data comparisons between different data intervals. In the weekly data there are 99 066 observations.

5.1 Selected CEFs

The acquired data from Bloomberg included information about all the listed CEFs in the USA, totaling up to over 500 CEFs. The 108 CEFs were selected in the sample based on 3 conditions: 1. trading data for the selected period of 2002 to 2019, 2. opening year before 2002 since there were also CEFs with trading data before the official opening date, and 3. no consecutive periods with the same price or NAV. The first condition objective was to ensure that there are no lengthy periods with missing observations and the second condition objective was to avoid included shifted or merged funds in the sample. The last condition objective was to ensure that there is no corrupted data. After the conditions were applied the original number of over 500 CEFs decreased to 108 CEFs.

5.2 Variables

This study includes two different analyses: mispricing analysis and trading analysis. The main variables used in the mispricing analysis are mispricing, asset class, premium cycle duration, discount cycle duration, VWD, leverage, location, USA 1-year treasury, and SMB. These variables were selected based on their use in the OLS regression model in the mispricing analysis. Logically, also additional variables were constructed to calculate the main variables, e.g., the calculation of SMB factors required data about the CEFs MV and

NAV, return, and time. The used variables in the trading analysis were partially the same as in the mispricing analysis. The main variables in the trading analysis are Z-score, return, transaction cost, and financial ratios. These main variables are used to research portfolio construction, return calculations, and portfolio return comparisons. In total the number of researched variables was over 70. All the main variables used in the analyses are presented in the upcoming methodology sections.

5.3 Data validation and outliers

Before data validation and outlier checks, the descriptive statistics and overlook of the 108 CEFs data indicate the data to be highly skewed to the right with radical tails values. The skewness of the data was 2,61 and the kurtosis was 17,53. Despite, 82 percent of the observations were within one standard deviation from the mean and overall, the distribution had similarities with normal distribution. High kurtosis values can be natural characteristics of CEFs data but in order to get the data suitable for the OLS regression model the data needed adjustment as OLS is not capable to predict unsymmetric distributions with radical tail values properly. Therefore, different transformations, such as logarithmic (LOG) and square root (SQRT) were tested to make the data more suitable without distorting the results. The results from the LOG and SQRT transformation were limited. Both of the transformations caused distorted the results and were not able to decrease the high kurtosis value. Therefore, both of transformations were declined.

After the LOG and SQRT transformations a one percentage modified winsorizing method was tested to both of the tails of the distribution. The method generated better results, and the high kurtosis value decreased and overall, the distribution became more stable. In modified winsorizing the one percentage tail values were deleted from the sample instead of replacing the deleted values with boundary values. A total of 446 observations (223 observations from both tales) were deleted. The chapters below consider the implications of the deleted observations to ensure that the overall picture of the data did not change due to modified winsorizing method.

The modified winsorizing process of the 446 observations concerns observations from 37 different CEFs. 33 of the 37 CEFs have only a few observations to which modified winsorizing applies. The total share of these 33 CEFs is equal to 46 percentage. As the share of deleted observations is accounted for these 33 different CEFs we can be sure that the results do not distort. The remaining 54 percentage of the deleted observations is accounted by only 4 different CEFs: RCG US Equity (73 observations / 16 %), CLM US Equity (72 observations / 16 %), VFL US Equity (67 observations / 15%), and DNP US Equity (47 observations / 11%). For all the 4 CEFs the number of deleted observations accounts for a significant amount compared to all the observations.

For the RCG 5 years (2006, 2009, 2010, 2011, and 2012) stand out from the deleted data. During all the years there are 10 to 12 deleted observations (i.e., whole year). All of the deleted observations are continuous and in discount, and sometimes they can span out to last 24 months. The average mispricing of the RCG is about 20 percent and the data shows that the RCG is continuously undervalued. Also, for the CLM 3 years (2012, 2013, and 2015) stand out from the deleted data. During all these years there are 10 to 12 deleted observations. Almost all the deleted observations are premiums and for the whole period the CLM average mispricing is about 15 percent.

For the VFL and the DNP the deleted observations experience the same characteristics as the RCG and the CLM. The VFL has 5 years (2002-2006) where all the observations are in substantial premium and deleted. In these deleted observations the price is a on average almost twice as high as the NAV. The DNP has 2 years (2009 and 2010) where the deleted observations concentrate. During these years all the observations are deleted, and the DNP undergoes substantial premium. The research on the 4 CEFs shows that even though a significant amount of observations are deleted the overall picture of these 4 CEFs does not change.

The time perspective of the deleted observations is also crucial since if they concentrate to a specific time period, they might distort the results. By looking at the data it seems

that the deleted observations are divided between all the studied years and vary from 6 to 56 deleted observations on a yearly basis. The amount of observations per year is 1296 so the amount of deleted observations is insignificant and does not distort the results. Furthermore, when the deleted observations are considered on month-year basis 197 unique months stand out. Indicating that the removed observations are well divided between different months and their underlying year, and the deleting is approved.

As a results, the modified winsorizing method is approved as it does not distort the results. On the contrary it seems that modified winsorizing might make the data more reliable by deleting the radical tail values. Due to modified winsorizing descriptive statistics of the data remain relatively unchanged and the kurtosis significantly decreases. After the transformation the data reminds a normal distribution. The effects of modified winsorizing are covered more detailed in the upcoming descriptive statistics section.

6 Methodology

The methodology section of this study includes information about two different analyses: mispricing analysis and trading analysis. First the methodology to research CEFs (relative) mispricing is covered. The methodology includes all the needed information about the formulas, variables, and regression model. In the mispricing analysis the formulas used to evaluate CEFs NAV, and mispricing are the most important indicators to research mispricing. Conclusions about the null hypothesis can be made based on these simplified indicators. The regression analysis of mispricing (additional analysis) objective is to research whether the mispricing of CEFs can be explained with CEF-specific or macroeconomic factors, or is it rather based on specific factors (mean reversion).

The second part concentrates into the trading analysis which will present how trading strategies based on CEFs mispricing mean reversion are created. The second section will also present the used formulas, variables, and regression model. Lastly robustness checks for both analyses are covered. The conclusions about hypothesis 1 are based on the returns between the different market tactics and market strategies.

6.1 Mispricing analysis and formulas

According to Lee et all (1991) and Bodie (2021) mispricing of CEFs can be measured by comparing the difference between the CEF price and the CEF NAV. According to the EMH the CEF price should be always equal to the CEF NAV (prices are efficient). If the price is below (above) the NAV, the CEF is said to trading at a discount (premium). The NAV of a CEF is measured by subtracting the liabilities from the assets. NAV per share is calculated by dividing the total NAV with the number of shares outstanding.

$$NAV\ per\ share = \frac{Fund\ Assets\ -Fund\ Liabilities}{Number\ of\ Shares\ Outstanding} \quad (1)$$

The requirements and regulation for CEFs reporting and NAV updating are linked to law. According to the SEC (2012, p. 3) CEFs´ are not obligated to update their NAV on a daily basis. Nevertheless, most of the CEFs update their NAV on a daily basis. The CEF price per share describes the market price of a CEF at the end of the trading day. The CEF mispricing is calculated by deducting NAV per share from price per share and dividing it by NAV per share. The mispricing is only a relative indicator of efficiency as we only know the NAV of a CEF for certainty, but no one knows what the price of a CEF should be

$$Mispricing = \frac{Price\ per\ share\ -NAV\ per\ share}{NAV\ per\ share} \qquad (2)$$

Further measure of mispricing is NAV-based mispricing, where the CEF size is considered and measured by total NAV. In the typical mispricing formula (2) all CEFs mispricing is assumed to be equivalent. The NAV-based mispricing is calculated by multiplying the mispricing coefficient with the CEF NAV and dividing the result with the NAV of all the selected 108 CEFs. The NAV-based mispricing enables to research how mispricing varies when the CEF size is considered. In the NAV-based mispricing CEFs with higher NAV values will have a greater impact on mispricing compared to CEFs with lower NAV values. The NAV-based mispricing variable is just an interphase of VWD.

$$NAV - based\ mispricing = \frac{Mispricing * Fund\ NAV}{All\ Funds\ NAV} \qquad (3)$$

The NAV-based mispricing can be further refined to a value-weighted index of mispricing (VWD). Lee et all (1991, p. 87) presented this measurement in their study to research mispricing of CEFs´. In the VWD the main idea is similar to NAV-based mispricing, but the difference is that it includes multiple observations as a sum of NAV-based mispricing. The VWD combines all NAV-based mispricing values from a certain time period. In the study there are 216 unique time periods (months) so there are also 216 unique VWD values. In other words, the VWD of 31st of January 2002 includes 108 individual NAV-based mispricing values, which are combined to a single VWD value. The VWD illustrates the mispricing development of the whole CEFs asset class.

$$VWD = \sum_{i=1}^{n_t} NAV - based\ mispricing_t \quad (4)$$

The SMB is a second variable where the CEF size is considered. The SMB variable is a shared variable between all the CEFs at certain time, and in total there are 216 unique SMB values. The variable describes the excess return of small CEFs compared to big CEFs at certain time. All the SMB factors are evaluated and calculated based on the CEFs data.

$$SMB = \frac{1}{3}(SV + SN + SG) - \frac{1}{3}(BV + BN + BG) \quad (5)$$

Where,

SV = Small Value, SN = Small Neutral, SG = Small Growth

BV = Big Value, BN = Big Neutral, BG = Big Value

The durations for the CEF premium and discount cycles are obtained using straightforward formulas. The formula of discount cycle duration is equal to the consecutive months the CEF has been trading at a discount (negative mispricing). The formula for premium cycle duration is equal to the consecutive months the CEF has been trading at a premium (positive mispricing). If the mispricing unit changes from premium to discount or discount to premium the cycle duration starts again from the beginning.

6.2 Mispricing regression model and variables

The objective of the mispricing analysis is to demonstrate that mispricing within the CEFs is a valid and systematic phenomenon. Referring to the null hypothesis of this study: "*There is no statistically significant mispricing within the CEF market".* Whereas the objective of the regression analysis is to research whether the CEFs mispricing can be explained by CEF-specific or macroeconomic factors. The regression analysis is conducted using ordinary least squares (OLS) regression. The OLS regression is selected since it is simple and effective for the purpose of this study.

If the null hypothesis of the study can be rejected the OLS regression model is used to find possible explanations for the CEFs efficiency deviations. Based on the findings in the academic literature, the study expects to find only relatively low coefficients for the explaining factors of mispricing. According to the academic literature CEFs mispricing seems to be caused by a combination of multiple factors, and the mispricing of individual CEFs tends develop in their own specific cycles related to mean reversion. Therefore, the objective of the mispricing analysis is to find evidence of statistically significant mispricing and possibly to be able to explain it with the used variables in the regression model. The formula of the used OLS regression is presented below.

$$Mispricing_{i,t} = \beta_0 + \beta_1 Asset\ Class_i + \beta_2 Premium\ Cycle\ duration_{i,t} + \beta_3 Discount\ Cycle\ Duration_t + \beta_4 VWD_{i,t} + \beta_5 Leverage_{i,t} + \delta_1 Location_i + \theta_1 USA\ Treasury_t + \theta_2 SMB_t + \epsilon_{i,t} \quad (6)$$

Where,

Mispricing $_{i,t}$ = CEF i mispricing at time t

Asset Class $_i$ = CEF i asset class (categorical)

Premium Cycle Duration $_{i,t}$ = CEF i premium mispricing duration at time t

Discount Cycle Duration $_{i,t}$ = CEF i discount mispricing duration at time t

VWD $_t$ = Value-weighted discount index at time t

Leverage $_{i,\,t}$= CEF i leverage status at time t (categorical)

Location $_i$ = CEF i investment location (categorical)

USA Treasury $_t$ = 1-year USA Treasury rate at time t

SMB $_t$ = SMB at time t

$\epsilon_{I,t}$ = CEF i error term at time t

β, δ, θ = Explaining coefficients for variables

β_0 = Intercept term (Asset Class = Fixed Income, Location = USA, Leverage= Unlevered)

The OLS regression model consists of dependent, independent and control variables. Mispricing is used as a dependent variable in the regression model, and it will disclose

how much the CEF price deviates from its NAV. The selected independent variables are asset class, premium cycle duration, discount cycle duration, VWD, and leverage. Each of these variables are tied to their own explaining beta coefficient (β). These variables illustrate the effect of changing the value of independent variable to dependent variable. More detailed, how much will the dependent variable change if the independent variable is increased by one unit, while all the other independent variables remain constant. If the coefficients are positive, they indicate that mispricing increases when variables increase, and vice versa.

The asset class (β_1) variable demonstrates how the asset class of a CEF affects mispricing. It determines what is the primary investing target of a CEF. The alternatives for asset class are equity or fixed income, and as it is a dummy variables the fixed income is selected as reference category and included in the intercept term (β_0). The primary investing asset class of a CEF is obtained from CEF-specific brochures. From the 108 selected CEFs 69 CEFs are primarily investing into fixed income, and 39 CEFs are primarily investing into equity. The asset class is constant for the whole studied period. The upcoming section of categorical variables contains more details about the asset class variable.

The premium cycle duration variable (β_2) measures consecutive months where CEF mispricing remains in premium. When the CEF mispricing is in discount the value of the variable is zero. The variable explains how the duration of premium mispricing will affect mispricing. The discount cycle duration variable (β_3) measures consecutive months where CEF mispricing remains in discount.

The VWD variable (β4) demonstrates how the sum of NAV-based mispricing affects mispricing at certain time. The VWD is a shared coefficient for all the CEFs, and it describes the mispricing development of all the selected 108 CEFs. Therefore, it can be considered as an overall asset class variable of the selected CEFs. The formulas (3) and (4) demonstrate how the VWD values are calculated. VWD is an independent variable, but due to its characteristics it serves more like a control variable.

The leverage (β_5) variable demonstrates how mispricing varies between the CEFs leverage status. It determines whether a CEF uses borrowed capital as a source of funding. The alternatives for leverage status are leveraged or unlevered. The leverage status is defined based on the leverage date of a CEF, and therefore a CEF can be levered and unlevered during the studied period. The selected 108 CEFs are mostly unlevered, and all the leverage dates are after the year 2014. In total there are 51 leveraged and 108 unlevered CEFs. As it is a dummy variable the unlevered category is selected as reference category (0) and included in the intercept term (β_0) of the regression.

The used control variables in the OLS regression are investment location, USA treasury, and SMB. Like independent variables, also control variables have their own coefficients. Overall, control variables are factors which may affect mispricing but are not in the center of the research. The location (δ_1) variable demonstrates how mispricing varies between the CEFs investment location. In other words, how mispricing varies between CEFs investing into USA and foreign countries. The location is a categorical dummy variable with two alternatives USA and foreign. The CEFs investing to USA are selected as reference category (0) and included in the intercept term ($\beta 0$) of the regression. The investment locations of the CEFs are obtained from CEF-specific brochures. The location classification is constant for the whole studied period. Meaning, that a CEF can be only included in one of the categories during the studied period.

USA Treasury (θ_1) variable describes how changes in interest rates impact the CEFs mispricing. The 1-year USA treasury includes monthly observations of USA interest rates obtained from Fred (2025). It is added to analysis to include the effect of macroeconomic factors. The interest rate values are shared between the CEFs and gathered for 216 individual time periods (months).

SMB (θ_2) variable describes how the difference between small and big CEFs returns affects the mispricing of the CEFs. The SMB factors are calculated for all the individual time periods (months) based on the CEFs MV and NAV. Therefore, it is a combined factor for

all the CEFs at each time t. The role of SMB is to consider the CEF size and to make the results of the independent variables more accurate. The size factor is already considered in the independent variables through VWD so therefore SMB is left as a control variable.

The categorical variables asset class, leverage, and location are non-continuous variables which are coded into either one or zero. These variables enable to analysis the effects of non-numerical variables. In each of the categorical variables one category has to be selected as a reference category which is included in the intercept term. The intercept term represents the effect when the values of other variables are assumed to be zero. The reference categories function as comparison values and do not have their individual explaining coefficients. The reference categories are selected based on the rule that what is the most common observation in the data.

The use of the reference categories is critical and based on the phenomenon called dummy trap. The dummy trap refers to a situation where the reference categories are ignored, and the regression model leads to full multicollinearity and incorrect estimates. The regression model is not able to evaluate the effect of categorical variables if all of them are included. In reality there is no need to include all different options for categorical variables, since e.g., a CEF is either investing into USA or to foreign countries. If a fund is investing into USA, it does not invest to foreign countries.

The error term ($\epsilon_{I,t}$) represents the results which the regression model cannot explain by the model factors. Error term signals how the model actually functions.

6.3 Trading analysis and trading rules

The objective of the trading analysis of this study is to show that the core concepts of normative finance are empirically, mathematically, and logically systematically incorrect. In this study it refers that the hypothesis one: *"There are no CEF market timing strategies that are able to beat the market"* has to be tested and rejected. The objective is to reject the hypothesis one and to show that the market index can be systematically beaten using

only short and long positions based on the CEFs mispricing mean reversion. The study is suggesting that the relative difference between the CEFs market price and the NAV is mean reverting. As the trading analysis is contradicting with the joint hypothesis it is rather a test of whether the CEFs mean reversion-based market timing strategies lead to a profit or loss based on the relative mispricing values. It seems that over time the CEFs mispricing variation tends to follow to the long-term mispricing average. The CEFs trade occasionally below the long-term average and occasionally above the long-term average. These can be called as CEFs mispricing cycles, which usually revert back to the long-term average on a relatively short time period.

The test of whether the market index can be systematically beaten with market timing strategies are conducted by comparing the results of 3 market tactic strategies and 3 market strategies performance. The 3 market tactic strategies are constructed based on the concept of CEFs mispricing reversion. All the 3 market tactic strategies have the same trading rules, but the amount of long and short positions varies between them. The 3 market strategies are based on the idea of buy and hold and include only long positions. The trading rules for the 3 market tactic strategies can be seen below in table 2. The trading rules define the positions opening and closing criteria.

Table 2 Trading rules

The trading rules for the long and short positions in the market tactics

Trading rules	Long	Short
Position opening (Z-value)	**Lower than -1**	**Higher than >1**
Transaction costs threshold	5 %	5 %
Ranking based selection	YES	YES
Maximum simultaneous positions	3	2
Duplicate positions simutalneously	NO	NO
Position close (Z-value)	**Higher than -0,5**	**Lower than 0,5**
Available positions	1404	647

The most important trading rule indicator for the CEFs mispricing mean reversion based 3 market tactic strategies is the Z-value. The Z-value describes how many standard

deviations the CEF mispricing is from its long-term average mispricing. The Z-values are used as indicators to close and open the trading positions. The long positions are opened when the Z-value of a CEF is lower than -1 and the transaction costs are below 5 percent. The short positions are opened if the Z-value of a CEF is above 1 and the transaction costs are below 5 percent. The long and short position opening is also based on Z-value ranking, i.e., lowest (long) and highest (short) Z-value CEFs prioritized in the position opening. The maximum amount of long positions is 3 and 2 for short positions, and there cannot be duplicate positions simultaneously. As the positions are opened, they are held in the portfolio until the position closing criteria is fulfilled. The long positions are closed (replaced by a new CEF) when the Z-value is higher than -0,5 and the short positions are closed when the Z-value is lower than 0,5.

Table 3 Overview of the 3 market tactic strategies and 3 market strategies

Overview of the tactics and strategies

* In all of the portfolios 218 observations and 18 years of data (monthly observations)

Portfolio	Includes	Trading strategy
Tactic (1)	3 long positions & 2 short positions	Active trading based on the trading rules
Tactic (2)	2 long positions & 1 short position	Active trading based on the trading rules
Tactic (3)	1 long position & 1 short position	Active trading based on the trading rules
Buy & Forget (1)	All the CEFs (108)	Bought at the beginning and sold at the end
Buy & Forget (2)	Best performing CEFs (5)	Bought at the beginning and sold at the end
Buy & Forget (3)	All the CEFs used in tactics (63)	Bought at the beginning and sold at the end

The 3 market tactic strategies are constructed based on the trading rules presented in table 2, but the amount of long and short positions varies between the 3 strategies. The detailed contents of all the strategies can be seen in table 3 above. The tactic 1 includes 5 constantly active positions (3 long & 2 short). The tactic 2 includes 3 constantly active positions (2 long & 1 short). The tactic 3 includes 2 constantly active positions (1 long & 1 short). The 3 market strategies (buy & forget) are included in the analysis to research the returns of the CEFs market. The buy and forget 1 is constructed from all the 108 selected CEFs and it is used as a market index in this study. The buy and forget 2 is constructed from the five best performing (cumulative return) CEFs. The buy and forget 3 is

constructed from all the CEFs which are used in the 3 market tactic strategies. In all of the 3 market tactic strategies and the 3 market strategies the positions are equally weighted, i.e., the weight of an asset is calculated by 1 divided by the number of assets.

6.4 Trading analysis formulas and variables

The trading analysis of the market tactic strategies is based on 4 variables: Z-score, transaction costs, returns, and financial indicators. Only the first 3 variables are needed to construct the 3 market tactic strategies based on the CEFs mispricing mean reversion and the financial indicators are needed to compare the results between the market tactic and the market strategies. The Z-value is the most crucial variable of the trading analysis, since it is used to define the position opening and closing criteria. In this study the Z-value variable defines how many standard deviations the CEF mispricing observation is from the CEF mispricing long-term average. Therefore, each of the 108 CEFs has a unique long-term average mispricing and unique Z-values for all the observations.

$$Z - value = \frac{X-\mu}{\sigma} \quad (7)$$

Where,

X = Mispricing coefficient

μ = Mean (CEF specific)

σ = Standard deviation (CEF specific)

The transaction costs are estimated using the bid-ask spread obtained from the Bloomberg data. The bid price represents the demand and ask price represents the supply for an asset. The difference between the demand and the supply can be used to estimate the transaction cost at time t.

$$Transaction\ costs = \frac{Ask\ price - Bid\ price}{Ask\ price} \quad (8)$$

The CEFs returns are calculated using the current and original price of the CEF. The returns for short positions are calculated by one divided by the long return. Net returns are calculated by deducting transaction costs from returns.

$$Return = \frac{CEF\ current\ price - CEF\ original\ price}{CEF\ original\ price} \quad (9)$$

The financial indicators to compare the results of the 3 market tactic strategies and the 3 market strategies are cumulative return, average annual return, standard deviation, reward to risk ratio, sharpe ratio and alpha. The cumulative returns are calculated by multiplying the holding period returns (HPR) of the period. The average annual returns are calculated from the yearly cumulative returns. The standard deviation is calculated using the HPRs. The reward to risk ratio is evaluated by comparing the average annual return and the standard deviation. The key financial indicators to evaluate the strategies performance are the sharpe ratio and the alpha. The sharpe ratio is similar to reward risk ratio but it takes also the risk-free rate into account. The sharpe ratio describes the risk-adjusted return of the strategy. The alpha measures the excess return of the strategy in comparison to the market index. In all of the alpha calculations the beta coefficients are re-evaluated according to the circumstances of the strategy.

$$Sharpe\ Ratio = \frac{Average\ annual\ return - risk\ free\ rate}{Standard\ deviation} \quad (10)$$

$$Alpha = R_p - (r_f + \beta(R_m - R_f)) \quad (11)$$

Where,

R_p = Portfolio return

r_f = Risk-free rate

r_m = Market return

β = Portfolio beta

6.5 Trading analysis financial indicators and regression model

The results of the trading analysis are reviewed using financial indicators and a regression model. First the financial indicators between the 3 market tactic strategies and the 3 market strategies are compared to see how the results differ between the CEFs mispricing mean reversion and the buy and hold based strategies. Secondly to research if the CEFs mispricing mean reversion-based market tactic strategies are able to generate statistically significant and positive alpha in order to reject the hypothesis one.

$$Tactic\ R_i = \alpha + \beta * Market\ R_i + \epsilon_i \quad (12)$$

Where,

Tactic R = Return from the tactic strategy (dependent variable)

α = Intercept (alpha)

β = Regression coefficient (measuring market effect to tactic returns)

Market R = Return from the market index (independent variable)

The statistical significance is evaluated using a simple OLS regression model. Regressions are conducted where the HPRs of market tactic strategies are compared to the HPRs of market index (buy & forget 1). The objective of the regression model is to find statistically significant and positive alpha (intercept) coefficient implying that the returns within the market tactic are systematically higher compared to the market index.

6.6 Robustness checks

The robustness checks of this study include 3 tests: 1. tests with different data intervals (weekly data), 2. tests with specific time sample, and 3. tests with robustness indicators. All the 3 tests are carried out in both of the analyses. The objective of these tests is to ensure the data quality and applicability, and to show that results from the analyses are reliable. In the first and the second tests the objective is to generate similar results with different data intervals and specific time periods. The robustness indicators role is to

show that the results from the analyses are reliable. The used robustness indicators are Durbin-Watson Test (DWT) to test autocorrelation, Variance Inflation Factor (VIF) to test multicollinearity, Newey-West Method (NW) to re-evaluate statistical significance, and Breusch-Pagan (BP) to evaluate the heteroskedasticity. In the mispricing analysis the used robustness indicators are DWT, VIF, and NW. In the trading analysis the used robustness indicators are DWT, NW and BP. The robustness tests of the trading analysis include also an additional test of what returns would an EMH based trading strategy generate.

The error term test of autocorrelation are carried to ensure that the error terms are not dependent on time i.e., past time error terms can affect the current time error terms. The autocorrelation test is performed by using the Durbin-Watson-test (DWT). The result of the test varies between zero and four, and if the result from the test is 2= no autocorrelation, <2 = positive autocorrelation, >2 negative autocorrelation. If the results is significantly divergent from the value of 2 there can be sign of autocorrelation.

$$DWT = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} \quad (13)$$

Where,

e_t = Error (residual) at time t

e_{t-1} = Error (residual) at previous time

n = Amount of observations

Multicollinearity tests of variance inflation factor (VFI) are performed to ensure that there are no multicollinearity between the independent variables. The VIF test evaluates how significantly how significantly the variance of one variable is linked to other variables in the model. More detailed, a regression is conducted where 1 independent variable is used as a dependent variable and all the others are used as explaining variables. If the VIF is equal to 1= variable is not correlated with other variables, if the VIF >1= variables is correlated with other variables, and if VIF > 10 = variable is strongly correlated with other variables.

$$VIF_j = \frac{1}{1-R_j^2} \quad (14)$$

In case the robustness tests generate signs of statistically unreliable data, the Newey-West (NW) corrections are applied to re-evaluate the statistical significance. The NW correction formula can be seen below. The NW correction calculates a new standard error for the data which can be used to re-evaluate the statistical significance.

$$NW = \left(X^{'}X\right)^{-1}\left(\sum_{t=1}^{n} u_t^2 X_t X_t^{'} + 2\sum_{j=1}^{L} w_j \sum_{t=j+1}^{n} u_t u_{t-j} X_t X_{t-j}^{'}\right)\left(X^{'}X\right)^{-1} \quad (15)$$

The heteroskedasticity is evaluated using Breusch-Pagan (BP) tests. The BP tests are applied to detect the error term variance variation since heteroskedasticity can lead to unreliable statistical significance.

$$BP = n\ x\ R^2 \quad (16)$$

Where,

n = amount of observations

R^2 = regression r-square

The EMH based trading strategy is built on the assumptions of the EMH, and it includes the same characteristics as the other market tactics. The positions are opened based on the highest mispricing value and positions are closed as the mispricing reverts to zero as the EMH claims. The EMH based strategy will face significant issues as there are basically none 0 mispricing values, since the concept of the EMH does not work in practice. Therefore, to simplify if the mispricing coefficient of a CEF reverts from negative to premium or vice versa the position is closed. The strategy includes only long positions as the EMH expects the mispricing always to recover back to zero.

7 Mispricing analysis results

This section reviews the results for the CEFs mispricing analysis. The objective of the analysis is to show that the CEFs are systematically mispriced, and to reject the null hypothesis: "*There is no statistically significant mispricing within the CEF market"*. Secondly if the null hypothesis can be rejected to research if there are any CEF-specific or macroeconomic factors which can explain the mispricing of the CEFs. In the end the statistical significance of the findings is tested by robustness tests.

7.1 Descriptive statistics

The descriptive statistics of the CEFs mispricing are presented below in table 4. The descriptive statistics are based on the monthly data of the 108 US listed CEFs during the studied period of 2002-2019. The data is based on the values after the one percent modified winsorizing. In the table 4 the CEFs are arranged to categories based on the used CEF-specific variables of the study. The used variables are all CEFs, asset class, leverage status, and location.

Table 4 Descriptive statistics for CEFs mispricing

Descriptive Statistics for Monthly Data (2002-2019)

**-1% and +1% modified winsorizing applied to both tails of the mispricing distribution*

**CEFs can be both levered and unlevered during the studied period*

	All CEFs	Equity	Fixed income	Leveraged*	Unlevered*	USA	Foreign
Number of funds	**108**	39	69	51	108	70	38
Observations	**22862**	8059	14803	2101	20761	14881	7981
Mean	**-5,11 %**	-7,27 %	-3,94 %	-6,18 %	-5,00 %	-4,50 %	-6,26 %
Median	**-6,28 %**	-9,50 %	-4,90 %	-7,66 %	-6,1 %	-5,37 %	-8,30 %
Standard deviation	**0,08**	0,09	0,07	0,07	0,08	0,07	0,09
Minimum	**-23,94 %**	-23,94 %	-23,85 %	-18,23 %	-23,94 %	-23,94 %	-23,94 %
Maximum	**31,14 %**	31,14 %	30,90 %	31,14 %	31,09 %	31,14 %	31,02 %
Skewness	**0,91**	1,27	0,92	1,97	0,84	0,86	1,09
Kurtsosis	**1,65**	2,01	1,72	5,96	1,41	1,84	1,55
Two-tailed t-tests		Equity - Fixed Income		Leveraged - Unlevered		USA - Foreign	
P-value		0,00% ***		0,00% ***		0,00% ***	

*** Significant at the 0,1 % level in two-tailed tests

The mean refers to the average mispricing of the CEFs. The mean is negative for all the categories indicating significant discounts among the CEFs. For all the CEFs the mean is -5,11 percent. From the categories the equity CEFs have the lowest mean of -7,27 percent and the fixed income CEFs have the highest mean of -3,94 percent. Overall, the statistics for mean did not change substantially due to the modified winsorizing process. Before the modified winsorizing process, the mean ranged from -3,53 percent to -7,00 percent, being -4,78 percentage for all the CEFs.

Based on the means in table 4 it seems that there are differences between different categories mispricing. A simple two-tailed t-test applied to research if there are statistically significant differences between the three variables mispricing. The t-test generated statistically significant p-values for all the three groups at 0,1 percent significance level. Indicating that in there are significant differences between the variables mispricing, which is a good sign for the upcoming explaining factors regression model analysis. The difference in the means seems logical since e.g., the equity CEFs can be viewed more riskier compared to fixed income CEFs. Also, the CEFs investing to foreign countries can be more discounted than the CEFs investing to USA since foreign financial markets can be viewed more riskier and less transparent compared to the liquid US financial markets.

Also, the median is negative for all the categories, being -6,28 percent for all the CEFs. The range of median is from -4,90 percent to -9,50 percent. The relation between the mean and the median is interesting since all the medians are 1-2 percents lower than the means. Implying that most of the observations locate close to median and are lower than the mean but there are also higher values which increase the mean compared to the median. The sample median did not change radically after the modified winsorizing.

The standard deviation ranges from 0,07 to 0,09 between the categories. For all the CEFs the standard deviation is 0,08. Referring that the observations differ on average 8 percents from the mean. The relatively high standard deviation compared to the mean indicates that mispricing varies considerably between the CEFs. The variation of standard

deviations between the categories is low, implying that the variation is not linked to CEF-specific factors but rather to market factors or CEFs mean reversion. The modified winsorizing decreased the standard deviation for all the categories. In the original data the standard deviation for all the CEFs was 0,10. In normal distribution 68 percent of the observations are within one standard deviation from the mean, the equivalent number for the CEFs mispricing data 72 percent. Overall, the observations in the CEFs data resemble normal distribution. 70 percent of the observations have values between -13 percent and 3 percent. Prior to the modified winsorizing the distribution was more centralized, and 80 percent of the values were within one standard deviation from the mean. After the transformation the distribution is better and suitable for the regression model.

The minimum values for the categories vary from -23,94 percent to -18,35 percent and the maximum values for the categories vary from 30,90 percent to 31,14 percent. Minimum and maximum values illustrate that the mispricing varies significantly in all the categories, but the radical values are similar between the categories. Prior to modified winsorizing the minimum and maximum values were substantially higher. As the one percentage tail values were deleted from the data these figures naturally decreased.

The skewness indicates whether the distribution is asymmetric and to which direction. The skewness ranged from 0,84 to 1,97, being 0,91 for all the CEFs. The positive values for skewness indicate asymmetric distribution where the right tale is a bit longer and includes more diverging values compared to the left side. The skewness is relatively close to normal distribution. As all the means for different categories were negative the finding that the distribution is skewed to the right is logical. Since the skewness is positive also the mean should be higher than the median. Prior to modified winsorizing the skewness variables ranged from 1,85 to 3,97, being 2,61 for all the CEFs. With the transformation the values of skewness decreased, but the original direction of skewness was maintained.

The kurtosis indicates how sharply pointed or flat the distribution is compared to the normal distribution. The range for kurtosis is from 1,41 to 5,96, being 1,65 for all the

CEFs. The excess kurtosis for all the CEFs is slightly negative, but relatively close to the equivalent value of normal distribution. The low positive kurtosis denotes that the distribution has wider tails and lower peak compared to normal distribution. As the observations are viewed visually the distribution reminds a copy of normal distribution. In the original data kurtosis was substantially higher and one of the main reasons to execute the transformation. In the original data the range of kurtosis between the categories was from 7,18 to 33,42, being 17,53 for all the CEFSs. The fact that leveraged CEFs still have a relatively high kurtosis has to be accepted and it is due to the low observation amount.

Overall, the most important finding from the descriptive statistics and examples from the data is that the CEFs are on average mispriced, which should not be possible according to the normative finance. Essentially the differences between the means do not matter since all of them are unambiguous signs of inefficiency. From the 22 862 CEFs mispricing observations only 61 observations are equal to zero (no mispricing), while 22 801 observations include mispricing. The percentage of mispricing observations is equal to 99,7, while the equivalent number of no mispricing observation is 0,3 percent. Moreover, 93,1 percent of the observations are over 1 percent or under -1 percent mispriced, i.e., only 6,9 percent of the mispricing observations are between 1 and -1 percent.

71 of the 108 CEFs do not have a single mispricing value during the studied period of 18 years. Only 37 funds have 1 or more mispricing value equal to zero during the period. The highest amount of individual CEF mispricing values equal to zero is 5. During the studied period of 18 years (each year about 1250 observations) there are years where none of the CEFs mispricing observations are equal to zero. The highest amount of mispricing observations equal to zero is from year 2007 where the amount is 9. During that year 9 observations account for 0,7 percent of all the observations.

Based on the statistics and examples from the data it seems that mispricing within the CEFs is more like a rule than exception. The descriptive statistics and the examples show no signs implying that the CEFs are not mispriced. As a result, a simple t-test to research

if the CEFs' mispricing observations deviate statistically substantially from zero is applied. The t-test generated a p-value of 0,00 indicating strong statistical significance at a 0,1 percent significance level. From the 108 selected CEFs none cannot be accepted to comply with the concepts of the EMH. The CEFs mispricing values even at an individual CEF level show statistically significant mispricing differentiating from zero. The markets are clearly not efficient. Based on the findings the null hypothesis of no statistically significant mispricing within the CEF market can be confidently declined. Next, the mispricing analysis continues to evaluate how the CEFs mispricing varies over time and categories before advancing to the regression model which evaluates how the CEF-specific and macroeconomic factors are able to explain the CEFs mispricing.

7.2 Time analysis of mispricing

The findings from the descriptive statistics in table 4 show that even though mispricing is negative across all the categories there are differences in the CEFs mispricing between the CEF-specific variables. Nevertheless, according to findings most of the CEFs mispricing values locate close to the mean and radical values are uncommon. In order to find out has there been any significant differences in the CEFs mispricing development during the studied period a time analysis of CEFs mispricing is applied. In the time analysis the CEFs mispricing values are analyzed with 4 time periods and a yearly level (18 years). The objective is to find whether time has an effect to the CEFs mispricing and do the CEFs mispricing values show similar characteristics with the descriptive statistics.

The time analysis in table 5 below shows how the CEFs average mispricing has developed during 4 time periods and individual years. All the CEFs mispricing values in the time analysis are negative and therefore similar to the descriptive statistics. In all the categories the 4 periods CEFs mispricing values are relatively close to each other, but when the categories are compared with different categories there are significant differences. As the individual years are considered the variation inside and between the categories increases. The highest yearly average mispricing is -2,42 percent in 2011 for the USA category, while the lowest observation is -8,78 percent in 2003 for the equity category. The

equivalent values for the 4 periods are -3,2 percent and -7,59 percent, which are close to the highest and lowest mispricing values in the descriptive statistics.

Table 5 CEFs mispricing time analysis

CEFs mispricing for different time periods (2002-2019)

**No data for the levered funds as the earliest leverage year is 2015*

Time	All CEFs	Equity	Fixed income	Leveraged	Unlevered	USA	Foreign
2002 - 2019	**-5,11 %**	**-7,27 %**	**-3,94 %**	**-6,18 %**	**-5,00 %**	**-4,50 %**	**-6,26 %**
2002 - 2006	**-4,68 %**	-7,30 %	-3,25 %	No data	-4,68 %	-3,93 %	-6,07 %
2007 - 2009	**-5,23 %**	-7,59 %	-3,95 %	No data	-5,23 %	-4,44 %	-6,68 %
2010 - 2014	**-4,46 %**	-6,81 %	-3,20 %	No data	-4,46 %	-3,56 %	-6,16 %
2015 - 2019	**-6,11 %**	-7,49 %	-5,35 %	-6,18 %	-6,08 %	-6,01 %	-6,30 %
2002	**-5,05 %**	-8,51 %	-3,16 %	No data	-5,05 %	-3,60 %	-7,84 %
2003	**-5,33 %**	-8,78 %	-3,54 %	No data	-5,33 %	-4,02 %	-7,96 %
2004	**-4,86 %**	-6,96 %	-3,69 %	No data	-4,86 %	-4,26 %	-5,95 %
2005	**-4,06 %**	-5,33 %	-3,38 %	No data	-4,06 %	-3,94 %	-4,29 %
2006	**-4,09 %**	-7,00 %	-2,49 %	No data	-4,09 %	-3,85 %	-4,52 %
2007	**-4,70 %**	-7,03 %	-3,40 %	No data	-4,70 %	-3,80 %	-6,35 %
2008	**-5,69 %**	-8,16 %	-4,37 %	No data	-5,69 %	-4,78 %	-7,39 %
2009	**-5,30 %**	-7,58 %	-4,09 %	No data	-5,30 %	-4,73 %	-6,32 %
2010	**-4,79 %**	-7,56 %	-3,34 %	No data	-4,79 %	-3,68 %	-6,83 %
2011	**-3,62 %**	-5,78 %	-2,49 %	No data	-3,62 %	-2,42 %	-5,89 %
2012	**-4,64 %**	-7,52 %	-3,11 %	No data	-4,64 %	-3,46 %	-6,89 %
2013	**-4,36 %**	-6,57 %	-3,13 %	No data	-4,36 %	-3,68 %	-5,63 %
2014	**-4,89 %**	-6,63 %	-3,92 %	No data	-4,89 %	-4,53 %	-5,56 %
2015	**-6,01 %**	-8,46 %	-4,67 %	-6,30 %	-6,00 %	-5,89 %	-6,22 %
2016	**-5,29 %**	-8,69 %	-3,42 %	-5,39 %	-5,26 %	-5,40 %	-5,07 %
2017	**-5,63 %**	-7,40 %	-4,64 %	-5,15 %	-6,03 %	-5,39 %	-6,09 %
2018	**-6,83 %**	-6,75 %	-6,88 %	-7,09 %	-6,60 %	-6,53 %	-7,39 %
2019	**-6,80 %**	-6,20 %	-7,12 %	-6,63 %	-6,94 %	-6,85 %	-6,70 %

Despite the CEFs mispricing seems similar in each of the categories there are some visible differences in them. In the 4 periods the lowest CEFs mispricing range is in the foreign CEFs where the variation is 0,62 percent units, while the USA CEFs have the highest range of 2,46 percent units. In most of the categories the CEFs average mispricing coefficients for the 4 time periods are close their whole period mean, but e.g., for all the CEFs, the fixed income CEFs , and the USA CEFs the range is higher than the whole period mean. In the consideration of individual years, the findings are relatively similar. The fixed income CEFs and the USA CEFs have the highest range and the leveraged CEFs and the unlevered CEFs have the lowest range. Overall, the yearly CEFs mispricing shares the same features as the 4 periods and the CEFs mispricing varies close -5 percent.

The findings from the time analysis repeat the finding that the CEFs are mispricing constantly and there are average CEFs mispricing values even close to comply with the assumptions of the EMH. It seems that the CEFs average mispricing varies significantly in some categories and in some it does not. There is no evidence of group effects and overall, the CEFs average mispricing seems to be relatively constant. Based on the time analysis no clear conclusions about the CEF-specific factors effects to the CEFs mispricing cannot be made. This finding matches with the findings from the academic literature which imply that the CEFs mispricing is more due to macroeconomic (overall) factors or other factors (mean reversion). Considering the fact that economic conditions have varied during the studied period a lot but the CEFs mispricing has not, it can be said that the CEFs mispricing seems not be significantly dependent on the development of the economy. This finding is logical since the CEFs mispricing is not directly related to the price development of the CEFs and as we do not know what the right price a CEF we should be cannot make any absolute conclusions. Despite we can for certain state that based on the relative analysis the CEFs are definitely mispriced, and the mispricing behavior seems to be more fund specific, possibly related to mean reversion.

7.3 CEFs correlation distribution and correlation matrix

A correlation matrix where all the 108 CEFs were represented was constructed to research the mispricing behavior. A total of 5832 CEF-specific were obtained but due to visualization restrictions, there is no reasonable way to present the results. The individual fund correlation distribution can be found in the appendix in figure 1. The CEF-specific correlations in figure 1 ranged from 1 to -0,79, while the average correlation between the CEFs was 0,023. Most of the CEF-specific correlations locate between -0,2 and 0,2. There are not many high or low correlations, and CEFs with +-0,5 correlations sum up to around 10 percent. The low correlations are not an issue as they supports the assumption CEFs mispricing mean reversion. It seems that the CEFs tend to be mispriced as individuals and the mispricing is developing regardless of other factors. If the average correlation would have been higher, even like 0,25 it would have been alarming since it

would have indicated that the mispricing of the CEFs tends to move at the same direction. This fictional situation would have created an easy opportunity to exploit the mispricing. Overall, based on the low average CEF-specific correlation it seems that the mispricing of a CEF is not linked to the mispricing of other CEFs. This finding fits together with the assumption that the CEFs mispricing is mean reverting.

Next the correlations of the used variables in the mispricing analysis regression model are reviewed in a correlation matrix, the results can be seen below in table 6. The used variables in the mispricing regression model are mispricing, asset class, premium cycle duration, discount cycle duration, VWD, leverage, location, USA 1-year treasury, and SMB. The correlation matrix is constructed in order to research how to variables affect each other and whether there are any connections between the used variables. Also, strong high or low correlations can be used as indicators for problematic multicollinearity in the analysis.

Table 6 Correlation matrix with variables used in mispricing regression

Correlation Matrix with statistical significance

**Similar variables used as in the OLS regression model*

	Mispricing	*Asset Class*	*Premium Cycle D.*	*Discount Cycle D.*	*WVD*	*Leverage*	*Location*	*1-year Treasury*	*SMB*
Mispiricing	*1*								
Asset Class	-0,20*	1							
Premium Cycle D.	0,55*	- 0,02*	1						
Discount Cycle D.	-0,45*	0,19*	-0,24*	1					
WVD	0,01***	0,00	0,01	0,12*	1				
Leverage	-0,04*	-0,12*	-0,03*	0,08*	0,04	1			
Location	-0,10*	0,29*	0,02***	0,21*	0,00	-0,09*	1		
1-year Treasury	0,01	0,00	0,01	-0,06*	-0,57*	0,03	0,01	1	
SMB	0,01	0,00	0,01	0,03*	0,05*	-0,01	0,00	-0,02**	1

** Significant at the 5 % level*

*** Significant at the 1 % level*

**** Significant at the 0,1 % level*

Overall, the correlations between the variables are weak and similar to the individual CEFs correlations. The correlation range between the variables are from -0,45 to 0,55 and in total 22 of the 45 correlations are statistically significant. The weak statistically significant correlations between the variables indicate low connections between the variables. The strongest statistical significance is between mispricing and VWD, and investment location and premium cycle duration. Since the VWD is calculated using the

mispricing coefficients it is logical that there is a strong statistical significance between the two variables. The low correlation between the variables is also logical as the VWD is an advanced measure of NAV-based mispricing and the two variables should not correlate with each other. On contrary, the strong statistical significance between premium cycle duration and investment location is not expected since the two variables are not linked to each other.

The independent and the control variables (i.e. mispricing removed from the analysis) generate low correlations relatively close to zero. The asset class and the location variables generate the highest correlation of 0,29, and the 1-year treasury and the VWD generate the lowest correlation -0,57. The higher correlation between the asset class and the location is logical since as they are both dummy variables. If the asset class of CEF is equity, is it more probably that also the CEF investment location is foreign. Furthermore, there is a detectible economic connection explaining the correlation between the 1-year rate and the VWD. As interest rates are increased the value of the VWD slightly decreases. The impact of increasing interest rates focuses on MV but can indirectly influence also the NAV. Overall, the increase of interest rates can be considered negative for stock markets as capital is reallocated to fixed income assets. The weak correlations between the explaining variables imply that there are no strong systematical connections between the variables and no danger of multicollinearity.

As the correlations of all the variables are compared to the dependent variable (mispricing) the variation of the correlations is higher. Again, most of the correlations are close to zero indicating only minor connections between the explaining and the dependent variables. Six out of the eight explaining variables correlations are statistically significant. Variables such as, asset class, premium cycle duration, and discount cycle duration have relatively stronger correlations compared to the other variables, e.g., the equity CEFs are more likely to be more mispriced than the fixed income CEFs. This example matches with the findings from the descriptive statistics. There are also logical explanations for the inversely related correlations of premium and discount cycle durations. When the

discount cycle duration starts (i.e., a CEF goes from premium to discount) the discount of a CEF starts to increase, and the duration increases until the CEF shifts to premium. The same phenomenon applies to the premium cycle.

Overall, the findings from the correlation matrix show in table 6 imply that the used variables are only partially able to explain the CEFs mispricing. The findings support the assumption that the CEFs mispricing is caused by a combination of CEF-specific and macroeconomic factors. Still a significant amount of mispricing seems to be unexplained, and it is possibly due to the mispricing mean reversion of CEFs. The correlations of individual CEFs show that the level of mispricing of a certain CEF is not on average strongly linked to the mispricing of the other CEFs. It seems that mispricing within the CEFs is varying and possibly mean reverting.

7.4 Mispricing regression results

The table 7 below presents the results of the OLS regression model researching the CEFs mispricing. The OLS regression researches the data of 108 CEFs during the studied period of 2002-2019. In total there are 22 82 monthly observations. The objective of the regression model is to find out whether the CEF-specific and macroeconomic factors are able to explain the mispricing within the CEFs. Therefore, the regression model focuses on 8 variables which are used to explain the mispricing of the CEFs. The independent variables (bolded in the table) of the model are asset class, premium cycle duration, discount cycle duration, VWD, and leverage. Whereas location, USA 1-year treasury, and SMB serve as control variables in the regression model.

The regression model generated a R-square (R^2) of 0,43 for the analyzed data. The R^2 indicates that 43 percents of the CEFs mispricing observations can be explained by the used variables. The adjusted R^2 of 0,43 is identical to the R^2 which increases the quality of the model. The model appears to be well balanced and there are no signs of variable overfitting. The R^2 indicates that the CEFs mispricing can be partially explained by the explaining variables. Even though the R^2 is not between 0,6 and 0,8 the obtained R^2 of

0,43 can be considered valid for analysis since in the academic literature there has been issues to find statistically significant variables able to explain mispricing within the CEFs. From theoretical standpoint there should be zero explaining factors for mispricing and the R^2 should be zero since mispricing should be always equal to zero. The standard error of the model is 0,06. The standard error implies that the predictions of the model differ from the dependent variable by six percent. As the variation range of the CEFs mispricing observations is 55 percent these predictions can be considered relatively accurate.

Table 7 OLS regression of CEFs mispricing (2002-2019)

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0,6549
R Square	0,4289
Adjusted R Square	0,4287
Standard Error	0,0608
Observations	22862

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	63,3704	7,9213	2145,3824	0
Residual	22853	84,3791	0,0037		
Total	22861	147,7496			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0,0306***	0,0009	-35,8648	0,0000	-0,0323	-0,0290	-0,0323	-0,0290
Asset Class (Dummy)	-0,0208***	0,0009	-23,1888	0,0000	-0,0225	-0,0190	-0,0225	-0,0190
Premium Cycle duration	0,0052***	0,0001	90,8479	0,0000	0,0051	0,0053	0,0051	0,0053
Discount Cycle Duration	-0,0006***	0,0000	-58,5144	0,0000	-0,0006	-0,0006	-0,0006	-0,0006
VWD	0,1368***	0,0138	9,9109	0,0000	0,1097	0,1638	0,1097	0,1638
Leverage (Dummy	-0,0049***	0,0014	-3,4499	0,0006	-0,0077	-0,0021	-0,0077	-0,0021
Location (Dummy)	-0,0021*	0,0009	-2,3552	0,0185	-0,0039	-0,0004	-0,0039	-0,0004
USA 1-year Treasury	0,1237***	0,0327	3,7789	0,0002	0,0595	0,1878	0,0595	0,1878
SMB	0,0658**	0,0225	2,9193	0,0035	0,0216	0,1099	0,0216	0,1099

** Significant at the 5% level*
*** Significant at the 1% level*
**** Significant at the 0,1% level*

The statistical significance of the regression model can be evaluated using the F-score of the regression model and the p-values of the variables. The F-score of the regression model evaluates whether the regression model as whole is statistically significant. The F-score of the regression model is 0,00 indicating statistical significance at 0,1 percent level. The F-score confirms that at least one explaining variable is significantly effecting the dependent variable. The p-values for the eight different variables are all statistically significant. Six of the explaining variables and the intercept coefficient are statistically significant at 0,1 percent level. The explaining variables coefficients are relatively low

and most of the coefficients are positive but also negative coefficients appear. The highest coefficient is 0,137 and the lowest coefficients is – 0,021.

The asset class (dummy) variable has a negative coefficient of -0,021 with a p-value of 0,00. The coefficient of -0,021 indicates low mispricing variation between the asset class alternatives with a 0,1 percent statistical significance level. As the asset class is a dummy variable, it implies how the equity CEFs are mispriced compared to the fixed income CEFs. The fixed income CEFs function as a reference category and are included in the intercept term. The -0,021 coefficient implies that on average mispricing within the equity CEFs is two percent lower compared to the fixed income CEFs. In practical terms, this implies that on average the mispricing of equity CEFs is two percent less positive or two percents more negative compared to the fixed income CEFs.

The findings are similar compared to the descriptive statistics and correlation matrix findings. The descriptive statistics in table 4 show that the average mispricing within the equity CEFs (-7,27%) is lower compared to the mispricing of fixed income CEFs (-3,94%). In table 6 the correlation between mispricing and asset class is -0,2 at five percent significance level. Both the correlation and the regression coefficient indicate that the asset class (fixed income) has a negative effect to mispricing. The decrease from -0,2 correlation to -0,021 coefficient gives the impression that the significance of the variable decreases when other factors in the model are considered. Even though, a test of rearranging (add/remove) the variables in the regression model is applied the coefficient remains similar with statistical significance. Therefore, the impact of the asset class variable to the dependent variable is stable and does not depend on the effects of other variables.

The variables premium and discount cycle durations are to some extent opposites of each other. The premium cycle duration has a positive coefficient of 0,005 with a p-value of 0,00. The low coefficient for premium cycle duration indicate that mispricing increases by 0,5 percent as the duration increases by one unit (month). The premium cycle duration effect is low but as the duration of mispricing increases so does the mispricing. The

discount cycle duration has a negative coefficient of -0,0006 with a p-value of 0,00. Indicating that increase in discount cycle duration by unit will decrease mispricing by 0,06 percent. Both of the variables are statistically significant at 0,1 percent level.

The low coefficients for the cycle durations are related to the logic of the variables. The variables research how many consecutive months the CEF remains in premium or discount. The duration can increase until the CEF shifts from premium to discount or vice versa. The duration does not require consecutive increasing or decreasing mispricing values to increase. Therefore, e.g., the three-month premium cycle duration can include values such as, 8%, 6% and 6% and lead to a strong relation with the dependent variable. The duration variables were created to research whether the duration of discount or premium mispricing has an effect to the CEFs mispricing. Due to the low duration coefficients, it seems that there is no clear relation between the premium or discount duration to mispricing even though discount duration is substantially more common. The CEFs mispricing cycle durations seems to vary between the CEFs, and a longer duration is not linked related to higher or lower mispricing. This findings supports the assumption of CEF-specific mispricing variation, i.e., mean reversion.

The duration variables correlations to dependent variable create the highest 0,55 and the lowest -0,45 correlations of all variables. The strong correlations imply that there is a link between dependent variable and both of the duration variables. The strong correlations are logical as the discount duration includes only negative mispricing values and vice versa. The low coefficients for the duration variables are not a surprise as the regression model researches the changes in mispricing when the duration is increased. The correlations and the coefficients are not comparable since they research mispricing from two different perspectives. Nevertheless, to ensure that the duration variables effect is stable and do not depend on other variables the regression model was tested. The modified regressions (add/remove variables) provided similar coefficients and significance for the duration variables, indicating that the variables function correctly.

The variable VWD has a positive coefficient of 0,137 with a p-value of 0,00. The VWD functions as a general measure of mispricing, reflecting the mispricing of all the CEFs at certain time. The VWD is an independent variable, but due to its macroeconomic characteristics serves like a control variable. The results indicate that the aggregate measurement of mispricing has a statistically significant and a positive effect to mispricing at a 0,1 percent level. More specifically, the mispricing increases by 14 percent as the VWD is increased by one unit. The correlation between the mispricing and the VWD is 0,01 in the table 6. The correlation and the regression coefficient of VWD are not comparable but the difference is re-evaluated. As variables are added or deleted from the regression model the impact of the VWD varies from 0,06 to 0,135. It seems that additional factors can be used to explain part of the VWD. The findings of the VWD match with the findings from academic literature as academics suggest that the mispricing of CEFs is affected by overall (macroeconomic) factors.

The independent variable leverage has a negative coefficient of -0,005 with a p-value of 0,00. The leverage coefficient indicates low negative effects to mispricing depending on the leverage status. The results are statistically significant at 1 percent level. The leverage is a dummy variable researching how mispricing in the leveraged CEFs varies in comparison to the unlevered CEFs (reference category). The results indicate that on average the mispricing within leveraged CEFs is 0,5 percents lower compared to unlevered funds. Specifically, mispricing in the leveraged CEFs is 0,5 percents more negative compared to the unlevered CEFs. The findings match the results in the descriptive statistics in table 4 and in the correlation matrix in table 6. In table 4 the leveraged CEFs are on average about one percent more discounted than the unlevered CEFs. The correlation between mispricing and leverage is -0,04 indicating that levered CEFs are probably more discounted than unlevered CEFs. The results imply that the leverage variable impact to the dependent variable is stable and does not depend on the effects of other variables.

The control variables location, 1-year treasury, and SMB are included in the model to decrease the effect of distracting factors to the independent variables. The control

variables did not significantly increase the R^2 of the model, but their statistical significance indicates that they can be used explain the dependent variable. The objective of the control variables is to control the background factors not to explain the phenomenon of mispricing. The location was supposed to be an independent variable but due to low statistical significance it was shifted to a control variable to increase the reliability of other variables. The 1-year treasury and the SMB variables are used to decrease the distractions of macroeconomic and size related issues linked to mispricing.

The control variable location has a negative coefficient of -0,002 with a p-value of 0,02. Indicating statistically significant but minor impacts to mispricing. The location is a dummy variable defining whether the CEF investment location is USA or foreign. USA is used as reference category and included in the intercept term. The low coefficient of location indicates that foreign CEFs tend to be slightly more mispriced compared to USA CEFs, this relation can also be seen in descriptive statistics in table 4. Even though the coefficient is low the location stabilizes the coefficients of the independent variables.

The control variable USA 1-year treasury has a positive coefficient of 0,124 with a p-value of 0,00. Indicating relatively strong and significant impact to mispricing. The coefficient indicates that as interest rates are increased by one unit the mispricing will increase by 12 percent. Similarly to the VWD the interest rates seem to have a stronger effect on mispricing. Therefore, it seems that the macroeconomic variables have the strongest coefficients of all the variables.

The control variable SMB has a positive coefficient of 0,066 with a p-value of 0,00. The SMB variable researches the CEF size (MV) effects to returns. Therefore, it offers a secondary view to the CEF size using the MV, while the VWD investigates the NAV as size indicator. The SMB shares same characteristics as the VWD since the coefficients are approximated for all the CEFS at certain time. The coefficient indicates that as SMB is increased by one unit the mispricing will increase by 7 percent. Specifically implying that small-cap CEFs (measured by MV) tend to be more mispriced than large-cap CEFs.

The intercept term indicates that mispricing is close to -3 percent at a 0,1 percent significance level when all the other variables are assumed to be zero. The intercept term differs from the -5 percent mean in the descriptive statistics in table 4 possibly due to the fact that the intercept term includes multiple dummy variable reference categories. Based on this finding the intercept term of the regression implies that mispricing is close to -3 percent if the CEFs asset class is fixed income, the CEF is unlevered and the CEF is investing to USA, while all the other variables are zero. As a result, the interpretation of the intercept term is not reasonable. If the variables including reference categories are excluded from the regression model the intercept term is statistically significant and close to the -5 percent mean in descriptive statistics.

Again, the findings from the mispricing analysis show that mispricing within the CEFs is rather a rule than an exception, and we can be contended to reject the null hypothesis in an early stage. Furthermore, the findings from the regression model results in table 7 show that the CEFs mispricing is a complex phenomenon which can be only partially explained by the CEF-specific and the macroeconomic factors. It seems that the statistically significant CEF-specific factors have only a minor effect to the CEFs mispricing, and the statistically significant macroeconomic factors have a stronger effect to the CEFs mispricing. Nevertheless, a significant amount of the CEFs mispricing remains unexplained, and the results from the correlation section and time analysis suggest that the mispricing of a CEF is not linked to the mispricing of the other CEFs. Therefore, the CEFs mispricing tends to develop in CEF-specific cycles following mean reversion. The findings are on some level similar to academic literature which claims that the CEFs mispricing is not related to CEF specific factors but rather to macroeconomic (overall) factors. On the contrary, the findings differ from the views of normative finance which states that the CEFs mispricing is not possible.

The findings from the mispricing analysis are partially similar to the four detectable cycles of the CEFs discovered by Lee et all (1991). In this study there was no data from the mispricing behavior of opened CEFs and therefore no conclusions about the opening

time mispricing behavior cannot be made. Similar to Lee et all, the studied CEFs tend to trade at a discount in comparison to their NAV. The findings also proved that the CEFs mispricing tends to variate significantly during the studied period in CEF-specific cycles. This study did not include any CEFs which were shut down or shifter to ETFs during the studied period so no conclusions about the price reverting back to NAV cannot be made.

7.5 Robustness checks results for mispricing analysis

The objective of the robustness checks in the mispricing analysis is to conclude that the results are statistically significant and reliable. The robustness checks of the CEFs mispricing analysis concentrate on 4 tests: 1. different variables test, 2. data interval test, 3. time sample test, and 4. robustness indicators. Also, some robustness consideration has already been presented in the regression analysis results section. I.e., how the results react to variable modifications and how the results compare to the findings in descriptive statistics and correlation matrix. All the tests and comparisons conducted did not indicate worrying signs towards the data or model applicability.

In the regression model construction stage over 70 different variables were created to investigate the CEFs mispricing. Number of tests were applied where the independent variables of the model were mostly kept fixed but different kind of control variables were changed to increase the quality of the results. These tests generated over 4000 regression combinations where the R^2 of the different combinations varied between 0,4 and 0,47. Most of the tested control variables were based on time or macroeconomic factors. The models generated similar low statistically significant coefficients for independent variables and statistically significant mediocre coefficients for macroeconomic control variables. Regardless, the tests with different variables showed that the results of the regression model were similar even though some of the variables were changed and therefore the results from the variable tests can be considered robust.

The regression model was also tested with different time interval data. Therefore, the used variables in the regression were calculated for weekly data, expect the SMB variable

was used in monthly values. The results from the regression with weekly mispricing values and the same variables generated similar results in comparison to the monthly values based original regression. The results of the weekly regression can be seen in table 15 in appendix. The R^2 of 0,41 (0,43) and the adjusted R^2 of 0,41 (0,43) of the weekly regressions are almost similar to the original regression. In addition, all the coefficient signs are similar, and the coefficient values and statistical significance are almost copies of each other. Therefore, it seems that the data from different time interval illustrate the mispricing phenomenon similarly and the model is robust.

The time analysis of the CEFs mispricing in table 5 indicated that the mispricing variation is relatively low between time periods. Therefore, a test of different time sample (2010-2019) regression is executed to see whether the results vary between different time periods. The results of the time sample test can be seen in appendix in table 16. The results for the time sample are almost identical to the results from the original regression model. The R^2 of 0,48 (0,43) and the adjusted R^2 of 0,48 (0,43) are relatively similar to the original model. In the results all the variable coefficients share the same signs except location and the USA 1-year treasury. The coefficients for the same signs sharing variables are again almost identical to the coefficients in the original regression model. The difference between the location coefficients is minimal but the difference in USA 1-year treasury is significant. The opposite relation of interest rates and mispricing in the different time sample is probably due to the long stable period of close to zero interest rates. In the original period there is much more variation in interest rates and the effect towards mispricing is different. The findings from the time sample test are robust.

The robustness indicators the DWT and the VIF are calculated for the CEFs mispricing data. The DWT tests evaluating the autocorrelation generates a result of 0,3 indicating significance autocorrelation within the data. The result is expected thus worrying since the CEFs mispricing tends be developing in CEF-specific cycles (mean reversion) and a value now can be used to predict the value in future. Evidence about this argument is presented later in the trading strategy section. Also, the explaining variables of the

model indirectly impact to the autocorrelation of the model. In explaining variables many of the variables current values can be used to predict their values in the future, e.g., the monthly duration variables are exposed to autocorrelation since in those variables the next value forecasting is effortless. Also, the autocorrelation is linked to the OLS regression model since it is not built to model timely dependency. All things considered it seems that the autocorrelation is a normal characteristic of the studied data. Nevertheless, it has to be studied since it might lead to unrealistic statistical significance.

The statistical significance of the variables needs to be re-evaluated. The p-values are re-evaluated using the Newey-West standard error (NW) which is used to remove the uncertainty linked to statistical significance of the variables. The NW test is conducted by re-evaluating the standard error with the help of the residual values, the results of the NW test can be seen in the appendix in table 17. The results imply that possibly two of the eight variables pos contain misleading p-values, and all the other variables p-values are evaluated correctly. The NW test indicates that due to autocorrelation the p-values for the discount cycle duration and the location are overestimated. According to NW test they should not be statistically significant. As autocorrelation can be considered a normal feature of data the results consideration is twofold. As a precautionary measure, a new regression model excluding the two variables is constructed to determine if the overall results have changed substantially. If the results remain relatively similar, the two variables will not be removed from the model but will be treated with increasing caution.

The results of the autocorrelation corrected regression model can be seen in the appendix in table 18. The R^2 and the adjusted R^2 of the regression decreases by about 10 percent to 34 percent compared to the original regression model. The coefficients of all the independent variables, expect the VWD are relatively similar. In the new regression model the VWD decreases about 10 percent to 4 percent while the statistical significance remains similar. The control variable USA 1-year treasury coefficient decreases 2 percent, and the statistical significance remains similar. The control variable SMB coefficient decreases 3 percent, and the statistical significance turns into insignificant. All the variables'

coefficient signs are identical to the original regression model. Also, as the DWT test is executed again for the modified regression model the result remain similar close to 0,4 indicating significant autocorrelation. At the latest this confirms that autocorrelation is a normal feature of the data and has to be accepted. If the residuals of the newly constructed autocorrelation regression model are evaluated with the NW method, the results imply that the statistical significance of all the variables is evaluated correctly.

The results from the autocorrelation analysis imply that despite autocorrelation is present the results of the regression model remain similar. Most of the variable coefficients remained similar, or there were only minor changes. More detailed, the CEF-specific variable coefficients remained relatively unchanged, and the macroeconomic variables coefficients slightly decreased. As proved the autocorrelation persisted in the model even the two variables were deleted, implying that autocorrelation is normal characteristic of the data and must be accepted. All things considered, the analysis continues with the original variables, but the two variables with unreliable statistical significance will be treated with caution. The remaining robustness tests of the mispricing analysis will include values from both the original and the autocorrelation-corrected regression.

The VIF coefficients of the variables can be found in the appendix in table 19. All the calculated VIF coefficients are clearly below five, which is the threshold of multicollinearity. The VIF coefficients of all the variables are relatively close to one indicating low or no correlation between variables. The finding matches with the findings of the correlation matrix in table 6. The removal of the two variables does not seem to effect to the multicollinearity of the model. There are no signs of multicollinearity which is a good sign of the model robustness.

8 Trading analysis results

The trading analysis of this study will concentrate to find out whether the CEFs mispricing mean reversion-based market timing strategies are able to beat the market index systematically. The objective is carried out by comparing the returns and financial indicators of 3 market tactic strategies based on the CEFs mispricing mean reversion and 3 market strategies based on buy and hold concept. If the results show that the market index can be systematically beaten with CEFs mispricing mean reversion-based strategies the hypothesis one of the study can be rejected. The market tactic strategies trading rules are simplified, and the strategies include only long and short positions. The section will first introduce the returns connected to the 3 long and 2 short positions, which are later used to construct the 3 market tactic strategies. After that the study continues to the main section of the trading analysis. In this section the returns of the 3 market tactic strategies and 3 market strategies are compared to make conclusions about the hypothesis 1.

8.1 Long and short positions results

The long and short positions are selected for the 3 market tactic strategies according to the trading rules presented in table 2. The returns and financial indicators of the 3 long and 2 short positions can be seen below in tables 8 and 9. The table presents the results for the long positions and the table presents the results for the short positions. The results for the positions are covered briefly but the main analysis concentrates into the 3 market tactic strategies results, which are presented in the upcoming sections. The objective of the long and short position result analysis is to explain how the long and short positions are used to build the 3 market tactic strategies. For example, the market tactic 1 strategy is constructed from the returns of 3 long and 2 short constantly active positions with equal weights. Therefore, the returns of the market tactic strategy 1 in year 2002 (in table) are calculated from the first rows of tables below with the formula of average return. This logic applies to the other market tactic strategies, but the amount of long and short positions varies between the tactic strategies and e.g., the market tactic 2 strategy includes only 2 long and 1 short positions constantly active.

Table 8 Long positions returns

Yearly returns of the three long positions (transactions considered/transactions not considered)

**CEF position opening based on the <-1 z-value and position closing based on the >-0,5 rules*

	Transaction costs considered			**No transaction costs**		
Year	R. long pos (1)	R. long pos (2)	R. long pos (3)	R. long pos (1)	R. long pos (2)	R. long pos (3)
2002	34,35 %	15,92 %	-5,45 %	39,09 %	20,75 %	2,78 %
2003	-1,29 %	-12,17 %	43,41 %	2,09 %	-4,58 %	43,41 %
2004	-2,28 %	13,68 %	-34,24 %	24,22 %	20,71 %	-29,80 %
2005	-4,55 %	8,98 %	-11,25 %	2,58 %	18,68 %	-11,25 %
2006	19,03 %	106,45 %	5,20 %	24,73 %	106,45 %	16,54 %
2007	38,16 %	-10,61 %	1,47 %	46,81 %	-3,58 %	7,57 %
2008	18,24 %	-12,72 %	-0,07 %	20,48 %	-10,01 %	-0,07 %
2009	40,99 %	16,40 %	2,13 %	40,99 %	17,89 %	3,16 %
2010	33,12 %	22,67 %	20,35 %	33,94 %	23,23 %	27,18 %
2011	17,81 %	13,19 %	5,25 %	19,87 %	15,67 %	7,78 %
2012	37,80 %	15,38 %	18,37 %	41,34 %	19,31 %	21,34 %
2013	16,98 %	12,87 %	47,90 %	23,15 %	17,41 %	50,42 %
2014	17,17 %	10,77 %	-2,34 %	17,81 %	14,89 %	-0,83 %
2015	-0,29 %	47,11 %	5,32 %	1,48 %	49,58 %	5,67 %
2016	8,12 %	12,35 %	19,18 %	8,23 %	12,35 %	24,72 %
2017	-2,34 %	6,67 %	0,14 %	-2,24 %	7,15 %	1,69 %
2018	13,98 %	14,76 %	50,59 %	15,36 %	15,20 %	54,01 %
2019	11,22 %	16,85 %	9,61 %	13,38 %	17,99 %	9,80 %
Cumulative return	**1241 %**	**1020 %**	**287 %**	**2502 %**	**1857 %**	**567 %**
Average annual	15,51 %	14,36 %	7,81 %	19,85 %	17,97 %	11,12 %
STDEV	0,19	0,21	0,23	0,19	0,21	0,22
Reward/Risk Ratio	0,80	0,69	0,35	1,05	0,86	0,50
Sharpe ratio	**0,72**	**0,62**	**0,28**	**0,96**	**0,79**	**0,43**
Alpha	**13,97 %**	**12,75 %**	**6,41 %**	**18,26 %**	**16,40 %**	**9,51 %**

The table 8 above presents the returns of the 3 long positions based on the CEFs mispricing mean reversion. The returns are with and without transaction costs and the analysis will concentrate on the transaction considered returns. All the 3 long positions are able to generate positive cumulative returns and there are only few years where the returns are negative. The positive returns for long positions are substantially high especially in the first and second long positions. Compared to 9-10 percent the average annual return of the stock market these long positions are able to generate superior returns.

Nevertheless, it can be seen that the cumulative returns decrease from long position 1 to 3, implying that the intrinsic Z-values and long positions returns are positively correlated. For example, the long position 1 includes more CEFs with an opening Z-values close to -2 leading to higher returns, while the opening Z-values in position 3 are closer to -1 leading to lower returns compared to the other long positions. Also, the effect of active trading can also be seen since the returns decrease substantially when the transaction

costs are considered. The financial ratios for the long positions are all positive but the relatively high standard deviation decreases them. All the sharpe ratios are below 1 and they cannot be considered as superior. Nevertheless, the alphas show that all the long positions are able to generate significant excess returns compared to the market index.

Table 9 Short positions returns

Yearly returns of the two short positions (transactions considered/transactions not considered)

**CEF position opening based on the >1 z-value and position closing based on the < 0,5 rules*

	Transaction costs considered		**No transaction costs**	
Year	R. short pos (1)	R. short pos (2)	R. short pos (1)	R. short pos (2)
2002	-34,75 %	7,37 %	-29,05 %	14,19 %
2003	29,02 %	9,49 %	45,03 %	13,83 %
2004	12,00 %	10,53 %	23,29 %	13,66 %
2005	11,06 %	0,00 %	11,62 %	0,00 %
2006	-2,70 %	40,20 %	3,68 %	50,60 %
2007	29,73 %	1,24 %	38,31 %	9,91 %
2008	63,67 %	2,45 %	86,49 %	10,18 %
2009	9,01 %	-0,72 %	9,01 %	-0,72 %
2010	-3,62 %	10,68 %	6,88 %	17,40 %
2011	4,71 %	2,03 %	4,93 %	2,03 %
2012	6,43 %	24,59 %	6,43 %	31,24 %
2013	-11,33 %	101,19 %	-11,33 %	113,96 %
2014	17,17 %	20,17 %	18,35 %	24,89 %
2015	6,59 %	1,01 %	10,55 %	1,01 %
2016	-2,43 %	23,98 %	-1,47 %	26,86 %
2017	-1,24 %	6,53 %	-1,24 %	7,24 %
2018	33,15 %	-1,78 %	34,19 %	-0,68 %
2019	71,77 %	22,24 %	72,16 %	22,52 %
Cumulative return	**518 %**	**922 %**	**1185 %**	**1779 %**
Average annual	10,65 %	13,78 %	15,24 %	17,70 %
STDEV	0,25	0,23	0,25	0,23
Reward / Risk Ratio	0,43	0,61	0,60	0,79
Sharpe ratio	**0,37**	**0,54**	**0,54**	**0,72**
Alpha	**8,84 %**	**12,09 %**	**13,77 %**	**16,14 %**

The table 9 above presents the returns of the 2 short positions based on the CEFs mis-pricing mean reversion. Similarly, to table 8 it includes returns with and without the effect of transaction costs. Also, all the short positions are able to generate positive returns, but they are a bit lower compared to the returns of the long positions. Similarly to the long positions the relatively high standard deviation decreases the financial ratios. The alphas of the short positions are still relatively high indicating excess returns compared to the market index. In the short positions the relation of the opening Z-values and the

returns seems to be opposite compared to the long positions. In the short positions the lower ranked opening Z-values lead to higher returns. Overall, the findings for the short positions are positive and imply that they can be used in the market tactic strategies.

8.2 Results for market tactic strategies and market strategies

Overall, the findings from the 3 long and 2 short positions returns are positive and indicate that there are no reasons to believe that the CEFs mispricing mean reversion-based market tactic strategies would not work. All the individual long and short positions indicate significant excess returns compared to the market index before even constructing the market tactic strategies. Next the analysis will continue to analyze how the 3 market tactic strategies based on the CEFs mispricing mean reversion (constructed from the long and short positions) perform compared the 3 market strategies.

Table 10 Returns of the market tactic strategies and market strategies

Yearly portfolio returns using different market tactics and buy & forget (market) tactics

**All of the porftolio assets are equally weighted, depending on the number of assets (1/N)*
**In tactics the portfolio positions (which short/long position) are selected based on the highest returns*
** Transaction costs are considered*

Portfolio Includes:	*3 long positions 2 short positions*	*2 long positions 1 short position*	*1 long position 1 short position*	*All 108 CEFs*	*5 best performing CEFs (cumulative r)*	*All the CEFs used in the market tactics*
Year	Tactic (1)	Tactic (2)	Tactic (3)	Buy & forget (1)	Buy & forget (2)	Buy & forget (3)
2002	3,44 %	19,79 %	21,33 %	3,16 %	26,48 %	-2,63 %
2003	13,14 %	-1,15 %	4,27 %	3,83 %	7,46 %	2,17 %
2004	-0,09 %	8,08 %	4,51 %	2,88 %	7,71 %	1,54 %
2005	1,66 %	1,72 %	-2,01 %	1,46 %	20,86 %	1,54 %
2006	31,83 %	53,93 %	31,45 %	-1,74 %	6,42 %	-3,70 %
2007	14,49 %	9,71 %	20,16 %	-4,14 %	5,08 %	-2,55 %
2008	15,10 %	4,23 %	12,60 %	-1,10 %	11,61 %	-2,42 %
2009	14,70 %	19,25 %	19,79 %	5,31 %	11,46 %	7,38 %
2010	17,19 %	23,35 %	22,34 %	3,54 %	11,57 %	3,40 %
2011	10,47 %	12,85 %	10,39 %	2,30 %	-15,95 %	2,83 %
2012	22,66 %	29,01 %	33,15 %	4,62 %	32,12 %	3,93 %
2013	30,50 %	40,67 %	55,72 %	2,58 %	1,79 %	1,48 %
2014	13,97 %	17,63 %	19,00 %	-5,37 %	-17,00 %	-5,10 %
2015	12,40 %	15,29 %	0,68 %	5,07 %	14,15 %	7,95 %
2016	12,99 %	15,93 %	16,31 %	3,96 %	11,33 %	3,32 %
2017	2,48 %	4,33 %	2,72 %	-2,92 %	11,20 %	-2,05 %
2018	22,87 %	9,38 %	6,40 %	0,23 %	11,77 %	1,08 %
2019	26,83 %	17,16 %	17,15 %	2,82 %	9,73 %	2,00 %
Cumulative return	**1035 %**	**1351 %**	**1279 %**	**29 %**	**347 %**	**21 %**
Average annual	14,45 %	16,02 %	15,69 %	1,42 %	8,67 %	1,06 %
STDEV	0,10	0,13	0,16	0,02	0,12	0,02
Reward/Risk Ratio	1,40	1,22	1,00	0,75	0,73	0,44
Sharpe Ratio	**1,25**	**1,10**	**0,90**	**-0,07**	**0,60**	**-0,20**
Alpha	**12,91 %**	**14,53 %**	**14,21 %**	**0,00 %**	**7,32 %**	**-0,37 %**

The table 10 above presents the results of the 3 market tactic strategies based on the CEFs mispricing mean reversion and the 3 market strategies based on buy and hold. The table 10 includes yearly returns and financial indicators for the 6 strategies during the studied period of 2002-2019. Transaction costs have been considered in the returns. The contents of each strategy is defined on the first row “portfolio includes”. The tactic 1 can be considered as the main market tactic strategy and the buy and forget 1 as the main market strategy (market index). The other market tactic strategies are constructed so evaluate how the amount of active positions effects to returns. The other market strategies are constructed to add comparable market return indicators.

The results in table 10 show that the 3 market tactic strategies based on the CEFs mean reversion are superior compared to the 3 market strategies based on buy and hold. The amount of negative yearly returns in the 3 tactic strategies is limited to 1 or 2 and all the other yearly returns are positive. The annual returns of all the 3 market tactic strategies are quite close to each other at 15-16 percent. In the 3 market strategies the amount of negative yearly returns is significantly higher. Also, the annual returns of all the 3 market strategies are significantly lower compared to the 3 market tactic strategies. During the 18-year period all the 3 market tactic strategies have generate over a 1000 percent cumulative return, while the cumulative return for the 3 market strategies is between 21 and 347 percent. The buy and hold 2 strategy is by far the best performing market strategy but as it is constructed by picking the 5 best performing CEFs it cannot be considered as a reasonable option for the market index. Despite, if an agent would have selected the 5 best performing CEFs by chance it would have generated close to a 350 percent cumulative return, and 8,7 percent return annually.

The 3 market tactic strategies include significantly higher amount of risk measured by standard deviation. The finding is logical since the market tactic strategies include active trading while the market strategies include only buy and hold. The effect of active trading can be evaluated through the market strategy 3 since it includes all the CEFs used in the market tactic strategies. The standard deviation increases from 0,02 (market strategy 3)

to about 0,1 (market tactic strategies) due to active trading. From standard deviation perspective the market strategy 2 stands outs since the variation is close to the market tactic strategies even though the market strategy 2 does not involve active trading. The high standard deviation is probably due to the low diversification effect as the strategy includes only 5 CEFs. Nevertheless, the finding is important since it indicates that the market tactic strategies can also be less risky than market strategies. Overall, the standard deviations of the market tactic strategies can be considered relatively low as the standard deviation of stock indexes, such as SP500 can be close to 0,2. Furthermore, by looking at the standard deviations in the tables 8, 9 and 10 it can be seen that the standard deviation significantly decreases when the long and short positions are combined to market tactic strategies.

The reward to risk ratios in table 10 highlight the role of risk and decrease the superiority of the market tactic strategies, still the reward to risk ratios are substantially higher in all of the 3 market tactic strategies compared to the 3 market strategies. As the reward to risk ratio does not consider the effect of risk-free rate it can be misleading and therefore a sharpe ratio is a better fitting risk adjusted indicator. Again, the sharpe ratios are substantially higher in all of the 3 market tactic strategies and e.g., the sharpe ratios of market strategies 1 and 3 are negative due the effect of risk-free rate. The sharpe ratios for the 3 market tactic strategies are 1,25, 1,10 and 0,90. From a risk adjusted perspective all the market tactic strategies are better options as any of the 3 market strategies.

The 3 market tactic strategies alphas imply also superior performance compared to the 3 market strategies. The alphas indicate that all the 3 market tactic strategies are able to generate substantial excess returns compared to the market index (market strategy 1). The alphas of the 3 market tactic strategies are 13, 15 and 14 percents. Based on the alphas of the 3 market tactic strategies it can be stated the CEFs mispricing mean reversion-based market timing strategies are able to systematically beat the market. Despite the study will analyze the statistical significance of the alphas before making conclusion about the hypothesis 1.

The equivalent returns and financial indicators of the 3 market tactic strategies and the 3 market strategies without the effect of transaction costs can be seen in the appendix in table 20. The similar analysis without the effect of transaction costs generates similar with table 10. The only visible difference is that the returns in the 3 market tactic strategies are significantly higher due to the effect of missing transaction costs. Logically, also the financial indicators for the 3 market tactic strategies are higher.

The results from the table 10 show that there are no reasons to believe that the CEFs mispricing mean reversion-based market tactic strategies are not able to systematically beat the market index. All the 3 market tactic strategies are able to generate better results in all of the used indicators than the 3 market strategies. Before making conclusions about the hypothesis 1 of: *"There are no CEF market timing strategies that are able to beat the market"* this study will research the statistical significance of the 3 market tactic strategies alphas and if the alphas are positive and statistically significant the hypothesis 1 of the study can be rejected. The alphas are researched by conducting 3 simple OLS regression between market tactic strategies and the market strategy 1 (market index) returns. The complete results of the 3 market tactic strategies regression models can be found in the appendix from tables 21, 22 and 23 , but a summary table of the alphas statistical significance is included in this section. Transaction costs are considered in all of the regression models.

Table 11 Summary of market tactic strategies statistical significance

Statistical sigficance summary: Tactics OLS regressions

Strategy	Intercept (Alpha)	Alpha (p-value)	Beta (Market)	Beta (p-value)
Tactic 1	0,0123	0,0000***	-0,4550	0,2214
Tactic 2	0,0137	0,0000***	-0,4885	0,3040
Tactic 3	0,0138	0,0000***	-0,5134	0,3649

**** If p-value <0,001 significant at the 0,1% level*

The summary table 11 above shows that all the 3 market tactic strategies alphas are positive and statistically significant at a 0,1 percent significance level. Indicating that the results are highly unlikely to be due to randomness. The positive alphas imply that on

average the 3 market tactic strategies monthly returns are about 1,3 percent if the market index returns are zero. The 3 alpha coefficients are relatively similar, which matches to the findings in table 10. It has to be highlighted that the alphas in table 11 appear low compared to the findings in table 10 but there is a logical explanation for the difference. The OLS regression model uses arithmetic returns and cannot consider the compounding effect. Therefore, the data in the regression model includes only single monthly returns. If the returns in the two tables have to be compared the regression model alphas have to converted to 1+ alpha powered with the amount of observations. As the regression model are converted to include the compounding effect, they start to appear similar with table 10, e.g., the 1,3 percent alpha for the market tactic strategy 1 shifts to about 16 percents annually.

The other statistics in the regression models are not at the center of interest in the trading analysis. The only objective of the regression models is to show that the 3 market tactic strategies alphas are positive and statistically significant. The regression models R^2, the market coefficients and the statistical significance of the market are secondary objects of interest. The R^2´s are naturally low since the objective of the tactics is to beat the market regardless of the market movements. The R^2s´ are below 1 percent in all of the models. The low R^2s support the perception that the 3 market tactic strategies function as their own regardless of the market movements. The market coefficients are negative and relatively strong in all of the regressions. The p-values of the market coefficients are all statistically insignificant and therefore no reliable conclusions about them cannot be made. Nonetheless, as all the market coefficients are relatively similar it can be stated with caution that the tactic and the market returns are negatively related. This finding seems logical as the market returns for the studied period are nearly negative and all the 3 market tactic strategies have over 1000 percent cumulative returns during the period.

The results from the 3 market tactic strategies regression models confirm that the market index can be systematically beaten with simplified market timing strategies. In fact, all the 3 market tactic strategies are able to beat all the 108 CEFs during the studied

period. It looks that basically all the CEFs are following mean reversion. The findings did not show any signs against the overperformance of the 3 market tactic strategies in relation to the market index. All the alphas of the 3 market tactic strategies were positive and statistically significant at 0,1 percent level. Furthermore, the regression models R^2 and the market coefficients implied that the 3 market tactic strategies function regardless of the market as they should since they are based on mean reversion. Therefore, this study can confidently reject the hypothesis 1 of the study. It seems that at least the mispricing of the 108 US listed CEFs selected for this study are following mean reversion. Next the study continues to confirm the statistical significance of the findings with robustness tests.

8.3 Robustness checks results for trading analysis

The robustness checks of the trading analysis include 4 tests: robustness indicators, specific time sample test, different data interval tests, and tests with the EMH based trading strategy. The objective of the robustness checks is to verify the statistical significance of the findings and applicability to different circumstances. The used robustness indicators are DWT to evaluate autocorrelation, BP to evaluate heteroskedasticity, and NW-method to re-evaluate statistical significance. The specific time sample tests objective is to show that the CEFs mean reversion-based trading strategies are able to generate similar results regardless of the studied time period. The tests with different data interval aim to show that the trading strategies function regardless of the used data interval. Lastly the EMH based trading strategy is constructed to show that the assumptions related to the EMH does not function in practice.

The robustness indicators in the table 12 below are calculated based on the regression models data of the 3 market tactic strategies. The results from the DWT tests show that there are no signs of autocorrelation within the 3 market tactic strategies. On the contrary, the BP tests generate signs of heteroskedasticity for the market tactic strategies 2 and 3. Nevertheless, this study assumes that these signs of heteroskedasticity are logical since both the market tactic strategies and the market index include similar CEFs. Also,

the returns and the risks variate differently between the two variables due to their characteristics. Therefore, heteroscedasticity is not considered as a natural characteristic of the data but the statistical significance of the 3 alphas is re-evaluated using the NW-method. As the NW-method is applied (see lower part of table 12) and the statistical significance of the 3 alphas is re-evaluated the statistical significance of the 3 market tactic strategies alphas remains unchanged. Actually, the re-evaluated p-values are lower compared to the original regressions implying only increasing statistical significance. As a result, it can be concluded that the alphas and their statistical significance is robust.

Table 12 Trading analysis robustness indicators summary

Robustness tests for the trading analysis

Strategy	DWT test	Breusch-Pagan test	Actions
Tactic 1	1,97	No signs of heteroscedasticity	No actions needed
Tactic 2	1,87	Signs of heteroscedasticity	Newey-West apllied
Tactic 3	2,04	Signs of heteroscedasticity	Newey-West apllied

Statistical significance: Newey-West tests to double check statistical significance due to signs of heteroscedasticity

Strategy	New Standard error	New T-stat	New P-value	Implications
Tactic 1				
Tactic 2	0,0018 (0,0026)	5,77 (5,20)	0,0000 (0,0000)	Statistical significance remains
Tactic 3	0,0027 (0,0031)	5,20 (4,38)	0,0000 (0,0000)	Statistical significance remains

**** If p-value <0,001 significant at the 0,1% level*

The second part of the robustness checks is to research how the 3 market tactic strategies function on specific time periods. There should not be any restrictions linked to the applicability of the market tactic strategies on specific time periods. By looking at the findings in table 10 we can observe the performance of the 3 market tactic strategies on specific time periods. The yearly returns in table 10 show that the 3 market tactic strategies are able to generate surprisingly high returns regardless of the studied period. In table 10 there are only few negative returns in each of the 3 market tactic strategies. If an agent would have invested according to any of the market tactic strategies for any 2 consecutive years, the tactic would have generated positive excess returns. As, a results the market tactic strategies are robust and function on specific time periods.

The third part of the robustness checks is to evaluate how the 3 market tactic strategies function with weekly data. There should not be any reasons why the 3 market tactic strategies would not generate similar results with the weekly data. Nevertheless, as the 3 market tactic strategies were constructed for monthly data the idea to transfer the exact same positions to weekly data is not reasonable. Weekly data is much more accurate and the CEFs mispricing mean reversion-based strategies depend heavily on the positions opening and closing Z-value optimization. Therefore, the 3 market tactic strategies are constructed from scratch with the same trading rules for the weekly data.

Table 13 Weekly data robustness test

Weekly data robustness test with the same trading rules: summary of the returns

** Same trading rules applied for the weekly data, position opening if Z-value >1 or <-1 and closing if Z-value <0,5 or >-0,5*

**** No transactions costs considered***

Portfolio	Long 1	Long 2	Long 3	Short 1	Short 2	Tactic 1	Tactic 2	Tactic 3
Cumulative return	**2921 %**	**960 %**	**10494 %**	**1880 %**	**4821 %**	**4844 %**	**7707 %**	**3183 %**
Annual return	20,85 %	14,02 %	29,57 %	18,04 %	24,17 %	24,20 %	27,39 %	21,41 %
STDEV	0,27	0,24	0,25	0,27	0,23	0,12	0,14	0,17
Reward/Risk ratio	0,78	0,57	1,17	0,67	1,07	2,05	1,91	1,27
Sharpe Ratio	**0,72**	**0,51**	**1,11**	**0,62**	**1,00**	**1,92**	**1,80**	**1,17**
Alpha	**19,26 %**	**12,45 %**	**27,96 %**	**16,57 %**	**22,61 %**	**22,64 %**	**25,82 %**	**19,83 %**

** Same trading rules applied for the weekly data, position opening if Z-value >1 or <-1 and closing if Z-value <0,5 or >-0,5*

**** Transactions costs considered***

Portfolio	Long 1	Long 2	Long 3	Short 1	Short 2	Tactic 1	Tactic 2	Tactic 3
Cumulative return	**1342 %**	**414 %**	**3243 %**	**631 %**	**1861 %**	**1912 %**	**1532 %**	**3183 %**
Annual return	15,98 %	9,53 %	21,53 %	11,69 %	17,98 %	18,15 %	16,78 %	21,41 %
STDEV	0,27	0,25	0,26	0,27	0,22	0,12	0,14	0,17
Reward/Risk ratio	0,59	0,39	0,84	0,44	0,82	1,54	1,18	1,27
Sharpe Ratio	**0,53**	**0,32**	**0,78**	**0,38**	**0,75**	**1,40**	**1,07**	**1,17**
Alpha	**14,44 %**	**7,92 %**	**20,13 %**	**9,88 %**	**16,28 %**	**16,61 %**	**15,29 %**	**19,92 %**

The results of the trading analysis based on weekly data can be seen above in table 13, while the comparable results from the trading analysis with monthly data can be found from tables 8, 9 and 10. The results of the weekly data based CEFs mispricing mean reversion strategies are similar to the returns in tables 8, 9 and 10. All the positions and the 3 market tactic strategies returns are positive and resemble the findings in the monthly analysis. Overall, it seems that the returns are actually higher with the weekly data but so is the negative effect of transaction costs. Possibly the portfolio closing can be better optimized due to more frequent Z-value updating with the weekly data. The

most important indicators for portfolio selection, the cumulative return, the sharpe ratio and the alpha are higher with the weekly. All things considered the analysis shows that the trading strategy is robust and functions with different data intervals. Actually, it seems that the trading strategy functions better with the weekly data.

Table 14 EMH based trading strategy

Market tactic returns with the EMH based trading strategy

* Transaction cost are not considered
* Position opening based on the most radical mispricing value
* Position closing when the mispricing sign changes

Statistics	R. long pos (1)	R. long pos (2)	R. long pos (3)	Example tactic
Cumulative return	169 %	23 %	22 %	148 %
Average annual	5,64 %	1,14 %	1,11 %	5,17 %
STDEV	0,33	0,33	0,31	0,19
Reward / Risk ratio	0,17	0,03	0,04	0,27

The last robustness check of the trading analysis is to evaluate what kind of results would a trading strategy based on the assumptions of the EMH generate, i.e., to show that all trading strategies based on the CEFs mispricing do not work, and more importantly the EMH does not hold true in practice. All the analyzes and academic literature indicate that the EMH does not work logically, mathematically and empirically. The table 14 above presents the returns from the EMH based CEFs mispricing trading strategy. The returns from the EMH based trading strategy are low as expected since arbitrage does not correct the CEFs mispricing (as the EMH strategy expects). The returns are not negative, but if the annual returns are considered they are relatively low compared to the 3market tactic strategies returns. The example tactic (3 constantly active long positions) does not include any short positions due to the characteristics of the EMH. The core issue of the strategy is that as the EMH expects the CEFs mispricing values to revert back to zero in practice they do not never revert back to zero. Therefore, the positions are closed if the mispricing is zero or the sign of mispricing changes. The results show: 1. not all trading strategies related to CEFs mispricing work and generate superior returns and 2. the EMH does not work in practice at least in the CEF market.

8.4 Additional consideration about trading analysis

The idea of the additional consideration is to show that despite the details related to the market tactic strategies were not optimized they were able to systematically beat the market with all the used indicators. Moreover, it would be interesting to see what kind of results the market tactic strategies could generate if all the trading rules are settings would be optimized. In this study the used trading rules and settings were selected by researching the results between 3 combination of trading rules and settings. The variable which seemed to affect the returns the most was the position closing Z-value, and therefore it was the center piece of the trading rules. The 3 different trading rules researched can be seen in the appendix in table 24.

In table 24 the “selected portfolio” represents the used trading rules, while the “alternative portfolio” 1 and 2 represent the other two trading rules. In the alternative portfolio 1 the positions are closed when the Z-values reach 0,25 or -0,25, while the equivalent numbers in the alternative portfolio 2 are 0,75 and -0,75. The trading rules in the alternative portfolio 1 can be viewed riskier since the positions are kept open longer. The returns from the alternative portfolio 1 are positive and above the market strategies, yet significantly lower compared to the 3 market tactic strategies used in the trading analysis. It is interesting that in this riskier strategy the standard deviation is the lowest among all strategies. This finding is possibly due to the fact that it does not include as active trading compared to the other strategies since the positions are kept open longer.

The trading rules in alternative strategy 2 can be viewed as a more cautious since the positions are kept open for a shorter time. The returns are similar to the alternative strategy 1 yet significantly lower compared to the 3 market tactic strategies used in the trading analysis. Comparing the returns with the 2 alternative trading rules the selected trading rules appear to be the right choice. Nevertheless, there are for sure ways to optimize the trading rules and position weights more efficiently with more advance methods.

9 Conclusions

The objective of this study is to evaluate and reshape the concepts of normative finance by researching the mispricing of the 108 US-listed CEFs during the studied period of 2002-2019. More specifically: 1. to demonstrate that the CEFs are systematically mispriced in relation to their NAV 2. to research can the CEF-specific and macroeconomic factors be used to explain the mispricing within the CEFs 3. to demonstrate that the CEFs mispricing mean reversion-based market timing strategies are able to systematically beat the market index. The null hypothesis of the study is: "There is no statistically significant mispricing within the CEF market, while the hypothesis 1 of the study is: "There are no CEF market timing strategies that are able to beat the market. In academic research the papers researching the topic claim that the CEFs mispricing is mostly due to macroeconomic (overall) factors instead of CEF-specific factors, while a large share of mispricing remains unexplained. Whereas from the perspective of normative finance any deviation between the CEF NAV and price is an unambiguous proof of inefficiency.

The results from the mispricing analysis show that mispricing within the CEFs is rather a rule than an exception. On average, the CEFs tend to trade at a -5 percent discount and in 99,7 percent of the observations the CEFs are mispriced during the studied period. The findings show direct evidence that the markets are not efficient. In practice none of the 108 researched CEFs follow the concepts of the EMH. In all stages of the mispricing analysis the mispricing is a norm rather than an anomaly and the null hypothesis of the study can be rejected.

The results from the mispricing regression analysis suggest that the CEFs mispricing is caused by a combination of CEF-specific and macroeconomic factors, while a large share of mispricing remains unexplained. The CEF-specific factors asset class, leverage, and location generate statistically significant but relatively weak coefficients indicating only minor differences in mispricing. The macroeconomic factors VWD, USA 1-year treasury, and SMB generate statistically significant and stronger coefficients compared to the CEF-specific factors. The results suggest that the mispricing of a CEF is CEF-specific (i.e.,

mispricing of a CEF does not depend on the mispricing of the other CEFs “mean reversion”), and also the macroeconomic factors have a minor effect to mispricing.

The results from the trading analysis show that it is possible to systematically beat the market index using simplified trading strategies based on the CEFs mispricing mean reversion. In the trading analysis all the 3 market tactic strategies are able to beat the market index in all the used indicators. The 3 market tactic strategies are superior compared to the 3 market strategies and the alphas of all 3 market tactic strategies are close to 14 percent. Also, the sharpe ratios are over ten times higher in all of the market tactic strategies compared to the market strategies. The trading regression analysis generates positive and statistically significant alphas for all the 3 market tactic strategies, and it seems that the CEFs mispricing is indeed mean reverting. Therefore, the hypothesis 1 of the study can be rejected. One part of the trading analysis robustness checks was to test what kind of results would weekly data generate. The weekly data based trading strategy generated even higher returns compared to the monthly data based trading strategy. As the market tactic strategies undoubtedly function it seems that market timing is not impossible, and arbitrage is not able to remove the inefficiencies within the CEFs.

There should be no direct restrictions with the data and assumptions of this study. The data is acquired from Bloomberg, and the sample size and studied period can be considered valid. The study does not include radical assumptions, and the results in both of the analyses have been tested with robustness tests. Although it has to be highlighted that all the tests of efficiency are only tests of relative values as no one knows what the right price should be. Therefore, e.g., the trading analysis is only a test of whether the CEFs mispricing mean reversion based trading strategy leads to a profit or loss based on relative values. The suggestions for further research concentrate to the mispricing analysis modifications and to the trading strategy optimization. Overall, the results show that there is a huge gap between the descriptive reality of the financial markets and normative finance textbook statements to the contrary. Throughout the study basically none of the observations indicated that the CEF market is efficient in terms of the EMH.

Appendix

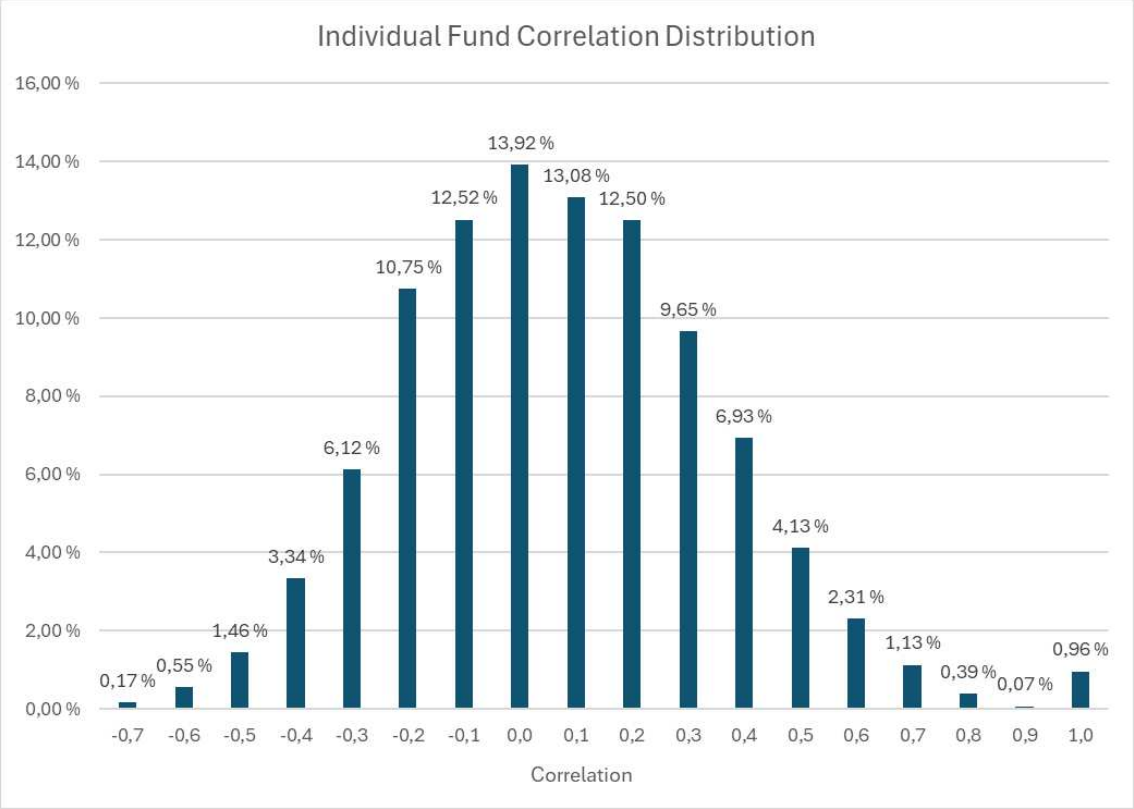


Figure 1 Individual CEFs mispricing correlation distribution

Table 15 Regression model with weekly data

SUMMARY OUTPUT

Regression Statistics with weekly data	
Multiple R	0,6423
R Square	0,4126
Adjusted R Square	0,4126
Standard Error	0,0622
Observations	99069

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	269,4854	33,6857	8697,7456	0
Residual	99060	383,6514	0,0039		
Total	99068	653,1368			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0,028	0,0004	-67,9376	0,0000	-0,0288	-0,0272	-0,0288	-0,0272
Asset class	-0,019	0,0004	-43,3066	0,0000	-0,0201	-0,0183	-0,0201	-0,0183
Premium Cycle duration	0,001	0,0000	180,7075	0,0000	0,0014	0,0014	0,0014	0,0014
Discount Cycle duration	0,000	0,0000	-127,5746	0,0000	-0,0002	-0,0002	-0,0002	-0,0002
WWD	0,144	0,0063	22,7375	0,0000	0,1317	0,1565	0,1317	0,1565
Leverage	-0,007	0,0007	-10,0800	0,0000	-0,0085	-0,0057	-0,0085	-0,0057
Foreign	-0,003	0,0004	-6,3301	0,0000	-0,0036	-0,0019	-0,0036	-0,0019
1-year Treasury	0,099	0,0162	6,1104	0,0000	0,0673	0,1309	0,0673	0,1309
SMB	0,050	0,0111	4,4773	0,0000	0,0281	0,0718	0,0281	0,0718

If p-value <0,001 Significant at 0,1% level
If p-value <0,01 Significant at 1% level
If p-value <0,05 Significant at 5% level

Table 16 Mispricing regression with a different time sample

SUMMARY OUTPUT
Modified sample of 2010 to 2019

Regression Statistics	
Multiple R	0,6896
R Square	0,4755
Adjusted R Square	0,4752
Standard Error	0,0546
Observations	12758

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	8	34,48184388	4,310230485	1444,807858	0
Residual	12749	38,03351991	0,002983255		
Total	12757	72,51536379			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0,0328	0,001	-34,407	0,0000	-0,0346	-0,0309	-0,0346	-0,0309
Asset Class (Dummy)	-0,0133	0,001	-12,130	0,0000	-0,0155	-0,0112	-0,0155	-0,0112
Premium Cycle duration	0,0045	0,000	71,309	0,0000	0,0044	0,0046	0,0044	0,0046
Discount Cycle Duration	-0,0006	0,000	-51,332	0,0000	-0,0006	-0,0005	-0,0006	-0,0005
VWD	0,1050	0,020	5,318	0,0000	0,0663	0,1437	0,0663	0,1437
Leverage (Dummy	-0,0033	0,002	-2,117	0,0342	-0,0064	-0,0002	-0,0064	-0,0002
Location (Dummy)	0,0041	0,001	3,802	0,0001	0,0020	0,0063	0,0020	0,0063
USA 1-year Treasury	-0,1180	0,075	-1,581	0,1139	-0,2644	0,0283	-0,2644	0,0283
SMB	0,0316	0,032	0,992	0,3210	-0,0308	0,0940	-0,0308	0,0940

If p-value <0,001 Significant at the 0,1%
If p-value <0,01 Significant at the 1%
If p-value <0,05 Significant at the 5%

Table 17 Newey-West standard error correction

Newey-West Standard error correction

*Conducted on basis on Durbin-Watson test results

Variable	T-stat	P-value	New T-stat	New P-value	Stat. Significance
Intercept	-35,86	0,00	-20,46	0,00	Yes
Asset Class (Dummy)	-23,19	0,00	-13,86	0,00	Yes
Premium Cycle duration	90,85	0,00	3,48	0,00	Yes
Discount Cycle Duration	-58,51	0,00	-0,40	0,69	Not anymore
VWD	9,91	0,00	91,32	0,00	Yes
Leverage (Dummy	-3,45	0,00	-3,27	0,00	Yes
Location (Dummy)	-2,36	0,02	-1,41	0,16	Not anymore
USA 1-year Treasury	3,78	0,00	82,58	0,00	Yes
SMB	2,92	0,00	43,91	0,00	Yes

Table 18 Autocorrelation corrected regression model

SUMMARY OUTPUT

*Variables "Discount cycle duration" and "Location" are excluded due to autocorrelation

Regression Statistics	
Multiple R	0,5824
R Square	0,3392
Adjusted R Square	0,3390
Standard Error	0,0654
Observations	22862

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	6	50,1149	8,3525	1955,2094	0
Residual	22855	97,6346	0,0043		
Total	22861	147,7496			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	-0,0519	0,0008	-63,2304	0,0000	-0,0535	-0,0503	-0,0535	-0,0503
Asset class (Dummy)	-0,0320	0,0009	-35,1080	0,0000	-0,0338	-0,0302	-0,0338	-0,0302
Premium cycle duration	0,0060	0,0001	100,9194	0,0000	0,0059	0,0061	0,0059	0,0061
VWD	0,0441	0,0147	2,9904	0,0028	0,0152	0,0730	0,0152	0,0730
Leverage (Dummy)	-0,0131	0,0015	-8,6369	0,0000	-0,0160	-0,0101	-0,0160	-0,0101
USA 1-year Treasury	0,0995	0,0352	2,8267	0,0047	0,0305	0,1685	0,0305	0,1685
SMB	0,0338	0,0242	1,3943	0,1632	-0,0137	0,0813	-0,0137	0,0813

If p-value <0,001 Significant at the 0,1%

If p-value <0,01 Significant at the 1%

If p-value <0,05 Significant at the 5%

Table 19 VIF tests

Variance Inflation Factors (VIF) for the CEFs mispricing regression model

*Both regression models considered due to autocorrelation issue

Variable	Original regression	Autocorrelation corrected regression
Asset class	1,13	1,02
Premium cycle duration	1,07	1,00
Discount cycle duration	1,17	-
VWD	1,52	1,50
Leverage	1,04	1,02
Location	1,13	-
USA 1-year treasury	1,50	1,50
SMB	1,00	1,00

Table 20 Tactics vs market (No TCs)

Yearly portfolio returns using different market tactics and buy & forget (market) tactics

**All of the porftolio assets are equally weighted, depending on the number of assets (1/N)*
**In tactics the portfolio positions (which short/long position) are selected based on the highest returns*
** Transaction costs are not considered*

Portfolio Includes:	*3 long positions 2 short positions*	*2 long positions 1 short position*	*1 long position 1 short position*	*All 108 CEFs*	*5 best performing CEFs (cumulative r)*	*All the CEFs used in the market tactics*
Year	Tactic (1)	Tactic (2)	Tactic (3)	Buy & forget (1)	Buy & forget (2)	Buy & forget (3)
2002	9,85 %	25,48 %	27,41 %	5,79 %	26,40 %	-0,15 %
2003	19,43 %	4,05 %	8,20 %	3,83 %	5,44 %	2,17 %
2004	10,19 %	20,32 %	19,40 %	2,88 %	8,07 %	1,54 %
2005	5,08 %	7,22 %	1,54 %	1,46 %	19,97 %	1,54 %
2006	39,18 %	60,01 %	39,42 %	-1,74 %	9,03 %	-3,70 %
2007	22,46 %	17,75 %	28,80 %	-4,14 %	3,75 %	-2,55 %
2008	21,17 %	8,40 %	17,55 %	-1,10 %	12,57 %	-2,42 %
2009	15,20 %	19,75 %	19,79 %	5,31 %	8,37 %	7,38 %
2010	22,69 %	26,19 %	26,39 %	3,54 %	14,07 %	3,40 %
2011	11,75 %	14,21 %	11,37 %	2,30 %	-17,53 %	2,83 %
2012	26,05 %	33,96 %	38,24 %	4,62 %	33,18 %	3,93 %
2013	34,79 %	47,69 %	64,35 %	2,58 %	1,91 %	1,48 %
2014	16,36 %	20,75 %	21,65 %	-5,37 %	-16,43 %	-5,10 %
2015	14,07 %	16,61 %	1,60 %	5,07 %	11,66 %	7,95 %
2016	14,86 %	16,84 %	17,70 %	3,96 %	13,49 %	3,32 %
2017	3,03 %	4,75 %	3,12 %	-2,92 %	10,24 %	-2,05 %
2018	24,25 %	10,35 %	7,63 %	0,23 %	13,33 %	1,08 %
2019	27,72 %	18,38 %	18,42 %	3,18 %	55,60 %	2,38 %
Cumulative return	**1998 %**	**2544 %**	**2484 %**	**33 %**	**527 %**	**24 %**
Average annual	18,42 %	19,96 %	19,80 %	1,58 %	10,74 %	1,22 %
STDEV	0,11	0,13	0,16	0,02	0,15	0,02
Reward/Risk Ratio	1,75	1,50	1,27	0,83	0,74	0,53
Sharpe ratio	**1,61**	**1,38**	**1,17**	**0,02**	**0,63**	**-0,14**
Alpha	**16,86 %**	**18,38 %**	**18,23 %**	**0,00 %**	**9,13 %**	**-0,36 %**

Table 21 Trading analysis OLS regression (Tactic 1)

OLS regression between the Tactic 1 and the Market

Regression Statistics	
Multiple R	0,0835
R Square	0,0070
Adjusted R Square	0,0023
Standard Error	0,0297
Observations	216

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,0013	0,0013	1,5038	0,2214
Residual	214	0,1884	0,0009		
Total	215	0,1898			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	**0,0123**	0,0021	5,9409	**0,0000**	0,0082	0,0164	0,0082	0,0164
Market	-0,4550	0,3711	-1,2263	0,2214	-1,1864	0,2764	-1,1864	0,2764

**** If p-value <0,001 significant at the 0,1% level*

*** If p-value <0,01 significant at the 1% level*

**** If p-value <0,05 significant at the 5% level*

Table 22 Trading analysis OLS regression (Tactic 2)

OLS regression between the Tactic 2 and the Market

Regression Statistics	
Multiple R	0,0703
R Square	0,0049
Adjusted R Square	0,0003
Standard Error	0,0379
Observations	216

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,002	0,002	1,062	0,304
Residual	214	0,308	0,001		
Total	215	0,309			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	**0,0137**	0,0026	5,1988	**0,0000**	0,0085	0,0189	0,0085	0,0189
Market	-0,4885	0,4740	-1,0304	0,3040	-1,4228	0,4459	-1,4228	0,4459

**** If p-value <0,001 significant at the 0,1% level*

*** If p-value <0,01 significant at the 1% level*

**** If p-value <0,05 significant at the 5% level*

Table 23 Trading analysis OLS regression (Tactic 3)

OLS regression between the Tactic 3 and the Market

Regression Statistics	
Multiple R	0,0619
R Square	0,0038
Adjusted R Square	-0,0008
Standard Error	0,0452
Observations	216

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,002	0,002	0,824	0,365
Residual	214	0,438	0,002		
Total	215	0,439			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	**0,0138**	0,0031	4,3824	**0,0000**	0,0076	0,0200	0,0076	0,0200
X Variable 1	-0,5134	0,5654	-0,9079	0,3649	-1,6279	0,6011	-1,6279	0,6011

**** If p-value <0,001 significant at the 0,1% level*

*** If p-value <0,01 significant at the 1% level*

**** If p-value <0,05 significant at the 5% level*

Table 24 Returns with different trading rules

Summary of portfolio returns where two strategies based on different trading rules are apllied

*Transaction costs are not considered and the objective is to show the capability of the strategy also with different trading rules settings

*Selected portfolio: opening z-value > 1 (short) or <-1 (long), and the position closing when z-value < 0,5 (short) or >-0,5 (long)						
Statistics	R. long pos (1)	R. long pos (2)	R. long pos (3)	R. short pos (1)	R. short pos (2)	Tactic (1)
Cumulative return	**2502 %**	**1857 %**	**567 %**	**1185 %**	**1779 %**	**1998 %**
Average Annual	19,85 %	17,97 %	11,12 %	15,24 %	17,70 %	18,42 %
STDEV	0,19	0,21	0,22	0,25	0,23	0,11
Reward / Risk ratio	**1,05**	**0,86**	**0,50**	**0,60**	**0,79**	**1,75**

**Alternative portfolio 1: opening z-value >1 (short) or <-1 (long), and the position closing when z-value <0,25 (short) or >-0,25 (long)*						
Statistics	R. long pos (1)	R. long pos (2)	R. long pos (3)	R. short pos (1)	R. short pos (2)	Tactic (1)
Cumulative return	**1633 %**	**651 %**	**460 %**	**316 %**	**374 %**	**780 %**
Average Annual	17,17 %	11,85 %	10,05 %	8,24 %	9,03 %	12,84 %
STDEV	0,20	0,19	0,15	0,21	0,19	0,08
Reward / Risk ratio	**0,85**	**0,62**	**0,68**	**0,39**	**0,47**	**1,61**

**Alternative portfolio 2: opening z-value >1 (short) or <-1 (long), and the position closing when z-value <0,75 (short) or >-0,75 (long)*						
Statistics	R. long pos (1)	R. long pos (2)	R. long pos (3)	R. short pos (1)	R. short pos (2)	Tactic (1)
Cumulative return	**1153 %**	**144 %**	**924 %**	**1377 %**	**1369 %**	**1160 %**
Average Annual	15,08 %	5,07 %	13,80 %	16,14 %	16,10 %	15,11 %
STDEV	0,25	0,22	0,20	0,23	0,19	0,11
Reward / Risk ratio	**0,61**	**0,23**	**0,70**	**0,72**	**0,84**	**1,43**

Table 25 List of selected CEFs

Number	Fund ticker	Fund name	Number	Fund ticker	Fund name
1.	PCM US Equity	PCM FUND INC	55.	MQT US Equity	BLACKROCK MUNIYIELD QUAL II
2.	GF US Equity	NEW GERMANY FUND	56.	JOF US Equity	JAPAN SMALLER CAPITALIZATION
3.	RCS US Equity	PIMCO STRATEGIC INCOME FUND	57.	PPT US Equity	PUTNAM PREMIER INCOME TRUST
4.	FCO US Equity	ABRDN GLOBAL INCOME FUND INC	58.	MYN US Equity	BLACKROCK MUNIYIELD NY QUALI
5.	TWN US Equity	TAIWAN FUND INC	59.	MQY US Equity	BLACKROCK MUNIYIELD QUALITY
6.	CLM US Equity	CORNERSTONE STRATEGIC VALUE	60.	MPA US Equity	BLACKROCK MUNIYIELD PENNSYLV
7.	KF US Equity	KOREA FUND INC	61.	INSI US Equity	INSIGHT SELECT INCOME FUND
8.	TDF US Equity	TEMPLETON DRAGON FUND INC	62.	CMU US Equity	MFS HIGH YIELD MUNICIPAL TRU
9.	EEA US Equity	EUROPEAN EQUITY FUND INC/THE	63.	DSM US Equity	BNYM STRAT MUNI BND
10.	PFD US Equity	FLAHERTY & CRUMRINE PREFERRE	64.	NXC US Equity	NUVEEN CA SEL TX-FR INC PORT
11.	CUBA US Equity	HERZFELD CARIBBEAN BASIN	65.	MHF US Equity	WESTERN ASSET MUNICIPAL HIGH
12.	IAF US Equity	ABRDN AUSTRALIA EQUITY FUND	66.	VPV US Equity	INVESCO PA VAL MUNI INC
13.	CHN US Equity	CHINA FUND INC	67.	GCV US Equity	GABELLI CONV AND INCOME SEC
14.	USA US Equity	LIBERTY ALL STAR EQUITY FUND	68.	IIM US Equity	INVESCO VALUE MUNICIPAL INCO
15.	CEE US Equity	CENTRAL AND EASTERN EUROPE F	69.	MYD US Equity	BLACKROCK MUNIYIELD FUND
16.	BKN US Equity	BLACKROCK INVEST QLTY MUNI	70.	TEI US Equity	TEMPLETON EMERG MKTS INC FD
17.	ECF US Equity	ELLSWORTH GROWTH AND INCOME	71.	NMT US Equity	NUVEEN MA QUAL MUNI INC FD
18.	IRL US Equity	NEW IRELAND FUND INC	72.	NXP US Equity	NUVEEN SEL TX-FR INC PORT
19.	PFO US Equity	FLAHERTY & CRUMRINE PREFERRE	73.	BKT US Equity	BLACKROCK INCOME TRUST
20.	MXF US Equity	MEXICO FUND INC	74.	DMF US Equity	BNYM MUNICIPAL INCOME
21.	MCR US Equity	MFS CHARTER INCOME TRUST	75.	ZTR US Equity	VIRTUS TOTAL RETURN FUND INC
22.	OIA US Equity	INVESCO MUNICIPAL INCOME OPP	76.	MIN US Equity	MFS INTERMEDIATE INC TRUST
23.	ASG US Equity	LIBERTY ALL-STAR GROWTH FD	77.	KTF US Equity	DWS MUNICIPAL INCOME TRUST
24.	FAX US Equity	ABRDN ASIA-PACIFIC INCOME FU	78.	NXN US Equity	NUVEEN NY SEL TX-FR INC PORT
25.	RVT US Equity	ROYCE VALUE TRUST	79.	PIM US Equity	PUTNAM MASTER INTER INC TST
26.	VLT US Equity	INVESCO HIGH INCOME TRUST II	80.	SWZ US Equity	SWISS HELVETIA FUND
27.	AWF US Equity	ALLIANCEBERNSTEIN GL HI INC	81.	VTN US Equity	INVESCO TR FOR INVEST GRD NY
28.	BRW US Equity	SABA CAPITAL INCOME & OPPORT	82.	SBI US Equity	WESTERN ASSET INTERMEDIATE
29.	RMT US Equity	ROYCE MICRO-CAP TRUST INC	83.	MSD US Equity	MORGAN STANLEY EMRG MKT DEBT
30.	NPV US Equity	NUVEEN VA QUAL MUNI INC FD	84.	MMU US Equity	WESTERN ASSET MANAGED MUNICI
31.	PCF US Equity	HIGH INCOME SECURITIES FUND	85.	SPE US Equity	SPECIAL OPPORTUNITIES FUND
32.	PMO US Equity	PUTNAM MUNI OPPORTUNITIES TR	86.	NQP US Equity	NUVEEN PA QUAL MUNI INC
33.	IFN US Equity	INDIA FUND INC	87.	VKI US Equity	INVESCO ADV MUNI INC TR II
34.	TSI US Equity	TCW STRATEGIC INCOME FUND	88.	MUA US Equity	BLACKROCK MUNIASSETS FUND
35.	CIF US Equity	MFS INTERMEDIATE HIGH INC FN	89.	NIM US Equity	NUVEEN SEL MAT MUNI FD
36.	AEF US Equity	ABRDN EMERGING MARKETS EQUIT	90.	GGT US Equity	GABELLI MULTIMEDIA TRUST INC
37.	JHI US Equity	JOHN HANCOCK INVEST TRUST	91.	JMM US Equity	NUVEEN MULTI-MARKET INCOME
38.	FUND US Equity	SPROTT FOCUS TRUST INC	92.	NUO US Equity	NUVEEN OHIO QLTY MUNI INC
39.	ADX US Equity	ADAMS DIVERSIFIED EQUITY	93.	HIO US Equity	WESTERN ASSET HI INC OPPORT
40.	RFI US Equity	COHEN & STEERS TOT RET RLTY	94.	DTF US Equity	DTF TAX-FREE INCOME 2028 TER
41.	KSM US Equity	DWS STRATEGIC MUNICIPAL INCO	95.	HQH US Equity	TEKLA HEALTHCARE INVESTORS
42.	IQI US Equity	INVESCO QUALITY MUNI INC TR	96.	MYI US Equity	BLACKROCK MUNIYIELD QLTY III
43.	JHS US Equity	JOHN HANCOCK INCOME SECS TR	97.	VKQ US Equity	INVESCO MUNICIPAL TRUST
44.	BTO US Equity	JOHN HANCOCK FINANCIAL OPPOR	98.	STEW US Equity	SRH TOTAL RETURN FUND INC
45.	CXE US Equity	MFS HIGH INCOME MUNICIPAL TR	99.	HQL US Equity	TEKLA LIFE SCIENCES INVESTOR
46.	MNP US Equity	WESTERN ASSET MUNICIPAL PART	100.	VBF US Equity	INVESCO BOND FUND
47.	GAM US Equity	GENERAL AMERICAN INVESTORS	101.	PDT US Equity	JOHN HAN PREMIUM DIVIDEND FD
48.	TY US Equity	TRI-CONTINENTAL CORP	102.	VMO US Equity	INVESCO MUNICIPAL OPPORT
49.	VFL US Equity	DELAWARE INV NATL MUNI INC F	103.	DNP US Equity	DNP SELECT INCOME FUND INC
50.	PAI US Equity	WESTERN ASSET INVESTMENT GRA	104.	SOR US Equity	SOURCE CAPITAL INC
51.	NCA US Equity	NUVEEN CALIFORNIA MUNICIPAL	105.	DDF US Equity	DELAWARE INV DIVIDEND & INC
52.	VCV US Equity	INVESCO CA V M I	106.	PEO US Equity	ADAMS NATURAL RESOURCES FUND
53.	FT US Equity	FRANKLIN UNIVERSAL TRUST	107.	IIF US Equity	MORGAN STANLEY INDIA INVEST
54.	MVT US Equity	BLACKROCK MUNIVEST FUND II	108.	RCG US Equity	RENN FUND INC

References

Akerlof, G. (1970). The Market for “Lemons”: Quality Uncertainty and the Market Mechanism. *The Quarterly Journal of* Economics 84(3), 488–500. https://doi.org/10.2307/1879431.

Allais, M. (1997). An outline of My Contributions to Economic Science. *The American Economic Review* 87(6), 1–12. https://doi.org/10.1007/BF00134634.

Ardeni, P. (1989). Does the Law of One Price Really Hold for Commodity Prices? *American Journal of Agricultural Economics* 71(3), 661–669. https://doi.org/10.2307/1242021.

Baker, M., & Wurgler, J. (2002). Market Timing and Capital Structure. *The Journal of Finance* 57(1), 1–32. https://doi.org/10.1111/1540-6261.00414.

Basu, S. (1977). Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of The Efficient Market Hypothesis. *The Journal of Finance* 32(3), 663–682. https://doi.org/10.1111/j.1540-6261.1977.tb01979.x.

Black, F. (1986). Noise. The Journal of Finance 41(3), 528–543. https://doi.org/10.1111/j.1540-6261.1986.tb04513.x.

Bodie, Z., Kane, A., & Marcus, A. (2021). *Investments* (Twelfth edition). McGraw Hill-Education.

Boudreaux, K. (1973). Discounts and Premiums on Closed-End Mutual Funds: A study in Valution. *The Journal of Finance* 28(2), 515–522. https://doi.org/10.2307/2978326.

Brealey, R., Myers, S., & Allen, F. (2020). *Principles of Corporate finance* (Thirteenth edition). McGraw Hill-Education.

Caminschi, A, & Heaney, R. (2013). Fixing a Leaky Fixing: Short-Term Market Reactions to the London PM Gold Price Fixing. *Journal of Futures Markets* 34(11), 1003–1039. https://doi.org/10.1002/fut.21636.

De Bondt, W., & Thaler, R. (1985). Does the Stock Market Overreact? *The Journal of Finance* 40(3), 793–805. https://doi.org/10.2307/2327804.

De Jong, A., Rosenthal, L., & Van Dijk, M. (2009). The Risk and Return of Arbitrage in Dual-Listed Companies. *Review of Finance* 13(3), 495–520. https://doi.org/10.1093/rof/rfn031.

Fama, E. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance* 25(2), 383-417. https://doi.org/10.2307/2325486.

Fama, E., & French, K. (1988). Permanent and Temporary Components of Stock Prices. *Journal of Political Economy* 96(2), 246–273. https://doi.org/10.1086/261535.

Fama, E., & French, K. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance* 47(2), 427–465. https://doi.org/10.2307/2329112.

Fama, E., & French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics* 33(1), 3–56. https://doi.org/10.1016/0304-405X(93)90023-5.

Federal Reserve Bank of St. Louis and US. Office of Management and Budget, Federal debt: Yearly change in US real interest rate, retrieved from Fred; https://fred.stlouisfed.org/series/DFF.

Henriksson, R. D. (1984). Market Timing and Mutual Fund Performance: An Empirical Investigation. Journal of Business, 57(1), 73-96. http://dx.doi.org/10.1086/296224.

Henriksson, R., & Merton, R. (1981). On Market Timing and Investment Performance. II. Statistical Procedures for Evaluating Forecasting Skills. *The Journal of Business* 54 (4), 513–533. http://dx.doi.org/10.1086/296144.

ICI, (2023). Investment Company Fact Book: A Review of Trends and Activities in the Investment Company Industry (Sixty-third edition). Investment Company Institute. https://www.icifactbook.org/pdf/2023-factbook.pdf.

Jegadeesh, N., & Titman, S. (1993). Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *The Journal of Finance* 48(1), 65–91. https://doi.org/10.2307/2328882.

Kahneman, D., & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica* 47(2), 263–291. https://doi.org/10.2307/1914185.

Kamstra, M., Kramer, L., & Levi, M. (2003). Winter Blues: A SAD Stock Market Cycle. *The American Economic Review* 93(1), 324–343. https://www.jstor.org/stable/3132178.

Kendall, M. (1953). The Analysis of Economic Time-Series-Part I: Prices. Journal of the Royal Statistical Society 116(1), 11–34. https://doi.org/10.2307/2980947.

Kihn, J. (1996). To Load or Not to Load? A Study of the Marketing and Distribution Charges of Mutual Funds. Financial Analysts Journal, 52(3), 28–36. https://doi.org/10.2469/faj.v52.n3.1993.

Kihn, J. (2015). *Behavioral Finance 201: Normative Finance Deprogramming*. CreateSpace Independent Publishing Platform.

Lamont, O., & Thaler, R. (2003). Can the Market Add and Subtract? Mispricing in Tech Stock Carve-outs. *Journal of Political Economy* 111(2), 227–268. https://doi.org/10.1086/367683.

Lee, C., Schleifer A., & Thaler, R. (1990). Anomalies: Closed-End Mutual Funds. *Journal of Economic Perspectives* 4(4), 153–164. https://doi.org/10.1257/jep.4.4.153.

Lee, C., Shleifer, A., & Thaler, R. (1991). Investor Sentiment and the Closed-End Puzzle. Journal of Finance 46(1), 75–109. https://doi.org/10.2307/2328690.

Malkiel, B. (1977). The Valuation of Closed-End Investment-Company Shares. *The Journal of Finance* 32(3), 847–859. https://doi.org/10.2307/2326318.

Malkiel, B. (2014). *A Random walk down wall street* (Eleventh edition). WW. Norton & Company.

Merton, R. (1981). On Market Timing and Investment Performance I. An Equilibrium Theory of Value for Markets Forecast. *The Journal of Business* 54(3), 363–406. http://dx.doi.org/10.1086/296137.

Pontiff, J. (1996). Costly Arbitrage: Evidence from Closed-End Funds. *The Quarterly Journal of Economics* 111(4), 1135–1151. https://doi.org/10.2307/2946710.

Poterba, J., & Summers, L. (1988). Mean reversion in stock prices: Evidence and Implications. Journal of Financial Economics 22(1), 27–59, 27–59. https://doi.org/10.1016/0304-405X(88)90021-9.

Ross, S. (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory* 13(3), 341–360. https://doi.org/10.1016/0022-0531(76)90046-6.

Samuelson, P. (1965). Proof that Properly Anticipated Prices Fluctuate Randomly. *Industrial Management Review*, 6 (2), 41–49. https://doi.org/10.1142/9789814566926_0002.

SEC. (2012). Investor Bulletin: Exchanged-Traded Funds (ETFs). SEC office of investor, education, and advocacy, 1–5. Retrieved 2023-11-20 from https://www.sec.gov/investor/alerts/etfs.pdf.

Seyhun, H. (1986). Insider´s profits, cost of trading, and market efficiency. Journal of Financial Economics 16(2), 189–212. https://doi.org/10.1016/0304-405X(86)90060-7.

Shiller, R. (1981). Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends? *The American Economic Review* 71(3), 421–436. https://www.jstor.org/stable/1802789.

Shiller, R. (2000). Irrational Exuberance. Princeton University Press.

Shleifer, A., & Vishny, R. (1997). The Limits of Arbitrage. *The Journal of Finance* 52(1), 35–55. https://doi.org/10.2307/2329555.

Statista. (2023, 12th June). Number of closed-end funds in the U.S. 2005-2022. Statista Research Department. Retrieved 2023-11-10 from https://www.statista.com/statistics/331674/number-closed-end-funds-usa/.

Statista. (2023, 21st July). Number of exchanged traded funds (ETFs) in the United States from 2003 to 2022. Statista Research Department. Retrieved 2023-11-10 from https://www.statista.com/statistics/350525/number-etfs-usa/.

Yahoo finance. https://finance.yahoo.com.

Yang, J., May, L., & Gould, J. (2023). Exchange-traded fund ownership and underlying stock mispricing. Accounting & Finance 63(1), 1417–1445. https://doi.org/10.1111/acfi.13071.