SOUTH AFRICAN ASSET CLASSES:
RETURN AND VOLATILITY RELATIONSHIP DYNAMICS OVER TIME

by

ADRIAAN ECKHARDT PASK

submitted in fulfilment of the requirements
for the degree of

MASTER OF COMMERCE

in the subject

BUSINESS MANAGEMENT

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: PROF J MARX

NOVEMBER 2008

DECLARATION

Student number: 3619-907-9

I, Adriaan Eckhardt Pask, hereby declare that this research study, **SOUTH AFRICAN ASSET CLASSES: RETURN AND VOLATILTY RELATIONSHP DYNAMICS OVER TIME** is my own original work, that all sources that have been used or quoted have been accurately reported and acknowledged by means of complete references. This dissertation has not previously been submitted to any university in its entirety or in part in order to obtain an academic qualification.

…… ……..

SIGNATURE DATE

(MR A E PASK)

ACKNOWLEDGEMENTS

Although the work contained in this dissertation is the result of countless hours of independent research, without the guidance and support of lecturers, mentors, family and friends the completion of this project would not have been possible.

Firstly, thank you to my study supervisor, Professor Johan Marx, for all his guidance and advice. This dissertation has challenged me in ways I never thought possible and without your guidance I would not have been able to complete it. Your meticulous supervision and ability to push me to go deeper and deeper into my subject have made this dissertation a very proud achievement.

Secondly, thank you to all my professional colleagues who commented on many of the ideas contained in this dissertation. My sincere gratitude goes in particular to my mentor and senior colleague, Wayne Waldeck, for his unbounded generosity in giving of his time and providing support.

Lastly, an enormous thank you to my family and friends, who made many sacrifices of their own to allow me to complete this dissertation. Time with loved ones is never easy to sacrifice. Your understanding and support in this regard were invaluable.

ABSTRACT

This dissertation is based on the hypothesis that a third dimension, namely investment *time horizon,* can add value to the more conventional two-dimensional methodology of assessing the relative *risk* and *return* attributes of various assets and portfolios in order to enhance investment decisions.

This study shows that time horizons should be considered in the investment decision making process and provides concrete evidence that a methodology that is not cognizant of investment time horizon is prone to extensive long-term opportunity cost risk.

In addition to providing evidence of investment time horizon relevance, the study makes suggestions as to how time horizons could be incorporated into the risk return assessments of various asset classes and also presents a framework for the more holistic assessment of asset class properties while incorporating time horizons.

Key terms:
Alternative measures of risk; holistic risk assessment; mean-reversion; mean-variance; return; risk; standard deviation; time diversification; time horizon.

TABLE OF CONTENTS **Page**

DECLARATION ii

ACKNOWLEDGEMENTS iii

ABSTRACT iv

LIST OF GRAPHS ix

LIST OF TABLES xv

CHAPTER 1: INTRODUCTION, METHODOLOGY AND OVERVIEW 1

1.1 Introduction 1
1.2 Background 2
1.2.1 Efficiency frontier of the modern portfolio theory (MPT) 2
1.2.2 Empirical evidence from efficiency frontier application in practice 4
1.2.3 Regulation 28 of the Pension Funds Act – Prudential Investment Guidelines (PIGS) compliance 7
1.3 Objective of the study and problem definition 8
1.4 Methodology 9
1.4.1 Defining the asset classes 9
1.4.2 Guidelines on further interpretation of this study 11
1.5 Overview of the study 16
1.6 Summary 20

CHAPTER 2: LITERATURE REVIEW 22

2.1 Introduction 22
2.2 Major themes 23
2.2.1 Short-term risk-return relationship 23
2.2.2 Long-term risk-return relationship 29
2.2.3 Relative asset class returns 37
2.2.4 Risk reduction properties of time, trends, and mean reversion 43
2.2.5 Alternative and/or additional measures of risk 52
2.2.6 Pros and cons of the mean-variance model 60
2.3 Summary 74

CHAPTER 3: RETURN-VOLATILITY: SHORT-TERM RELATIONSHIP 75

3.1 Introduction 75
3.2 Average South African asset class returns for 1 to 5 years 76
3.3 Average South African asset class standard deviations for 1 to 5 years 80
3.4 Additional measures and assessments of risk 87
3.4.1 Downside risk 87
3.4.2 Potential upside considerations 91
3.4.3 Absolute performance variance: high-low (HL) spreads 94
3.4.4 Relative potential gain measurement: high-low (HL) ratio 99
3.5 Evaluation of the preceding methods and methodology 100
3.6 Conclusion 103
3.6.1 South African equities 103
3.6.2 South African bonds 105
3.6.3 South African cash 106
3.6.4 Summary 107

CHAPTER 4: RETURN-VOLATILITY: LONG-TERM RELATIONSHIP 109

4.1 Introduction 109
4.2 Average South African asset class returns over the long term 110

4.3 Average South African asset class standard deviations over the long term 116
4.4 Additional measures and assessments of risk 125
4.4.1 Downside risk 125
4.4.2 Potential upside considerations 130
4.4.3 Absolute performance variance: high-low (HL) spreads 137
4.4.4 Relative potential gain measurement: high-low (HL) ratio 142
4.5 Conclusion 144
4.5.1 South African equities 144
4.5.2 South African bonds 146
4.5.3 South African cash 147
4.5.4 Summary 148

CHAPTER 5: RETURN-VOLATILITY: DETERIORATING RELATIONSHIP-CAUSES AND CONSEQUENCES 150

5.1 Introduction 150
5.2 Findings from chapters 3 and 4 revisited 151
5.3 Evaluations from variance-based measures: standard deviation and HL spread 154
5.3.1 Standard deviation 154
5.3.2 Absolute performance variance (high-low spread) 159
5.4 Evaluation according to the downside risk measure 162
5.5 Conclusively attaining the thesis objective 165
5.6 Understanding the basis for justifying the above-mentioned analysis - evidence of mean reversion 167
5.6.1 Mean reversion evidence in equity returns 167
5.6.2 Mean reversion evidence in bond returns 172
5.6.3 Mean reversion evidence in cash returns 175
5.7 Recommendations for performing multi-period risk-return assessments 178
5.7.1 Six factors to be considered during holistic risk-return assessment 179
5.7.2 Multi-period risk-return assessment 182

5.8 Summary 188

CHAPTER 6: CONCLUSION 189

6.1 Introduction 189
6.2 Summary of the study 189
6.3 Findings 192
6.4 Implications of the study 193
6.4.1 Implications for modern portfolio theory (MPT) 193
6.4.2 Implications for measures that incorporate standard deviation 195
6.4.3 Implications for Regulation 28 under the Pension Funds Act – Prudential Investment Guidelines (PIGS) compliance 199
6.4.4 Implications for the long-term risk classification of cash 201
6.5 Suggestions for areas for further research 203
6.5.1 Valuations 203
6.5.2 Global investigations that take foreign exchange and inflation into account 205
6.6 Conclusion 206

BIBLIOGRAPHY 207

APPENDIX A 212

LIST OF GRAPHS

Graph		Page
1.1	Efficiency frontier (illustration)……..…….....3	
1.2	Annualised risk-return profile for SA asset classes for 101 years since 1900 …….....5	
3.1	Average rolling 1 to 5 year returns for SA asset classes from 1970 to 2007…….……...77	
3.2	Average rolling 1 to 5 year returns for SA asset classes from 1970 to 2007 (annualised) ……..77	
3.3	Return standard deviations for SA asset classes from 1970 to 2007 for 1 to 5 year investment periods…….....80	
3.4	Return standard deviations for SA asset classes from 1970 to 2007 for 1 to 5 year investment periods (annualised). …….....81	
3.5	Standard deviation (volatility) as a percentage of total return. ……...…...84	
3.6	Lowest total return over any 1 to 5 year period from 1970 to 2007. ……..…….....…...87	
3.7	Lowest total return over any 1 to 5 year period from 1970 to 2007 (annualised). …….……....88	
3.8	Rolling 5-year investment returns (simultaneous calendar performances)……..…….….....89	
3.9	Rolling 5-year investment returns for each asset class (random non-concurrent performances)……..……...…...90	

3.10 Highest total return over any 1 to 5 year period from 1970 to 2007. ……..…….....91

3.11 Performance variance: high-low spreads between the different asset classes…….…….....94

3.12 Performance variance: high-low spreads between the different asset classes (annualised) ……...97

3.13 HL spread relative to the potential downside of the various asset class returns…….....98

3.14 High-low (HL) ratios of different SA asset classes.…….……...…...99

3.15 Equity summary……..…104

3.16 Bonds summary…….106

3.17 Cash summary……...…….....107

4.1 Average rolling 7, 14, 21, 28 and 35 year returns for SA asset classes from 1970 to 2007……...…….…...…112

4.2 Average rolling 7, 14, 21, 28 and 35 year returns for SA asset classes from 1970 to 2007 (annualised) ……...….112

4.3 Return standard deviations for SA asset classes from 1970 to 2007 for 7, 14, 21, 28 and 35 year investment periods.…….117

4.4 Return standard deviations for SA asset classes from 1970 to 2007 for 7, 14, 21, 28 and 35 investment periods (annualised). ……...……..117

4.5 Standard deviation (volatility) as a percentage of total return. …….....……..121

4.6 Lowest total return over all 7, 14, 21, 28 and 35 year rolling investment periods..…….……..….125

4.7 Lowest total return over all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007 (annualised)..……...…….127

4.8 Differences between the "worst-case scenario" annualised returns and the historic average annualised return……..129

4.9 Highest total return over any 7, 14, 21, 28, and 35 year period from 1970 to 2007……...…….…….131

4.10 Highest total return over all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007 (annualised)....…….132

4.11 Differences between the "best-case scenario" annualised returns and the historic average annualised return……..136

4.12 Performance variance: high-low spreads between the different asset classes……...….137

4.13 Performance variance: high-low spreads between the different asset classes (annualised) ……..….140

4.14 HL spread relative to the potential downside of the various asset class returns……..141

4.15 High-low (HL) ratios of different SA asset classes ……...…...143

4.16 Equity summary……..……..….145

4.17 Bonds summary……...…….…….147

4.18 Cash summary…….…….…..148

5.1 Average cumulative returns for SA asset classes over multiple and various rolling periods from 1970 to 2007……..…..…155

5.2 Average cumulative returns for SA asset classes over multiple and various rolling periods from 1970 to 2007 (annualised) ……..155

5.3 Total returns standard deviation for SA asset classes from 1970 to 2007…….….156

5.4 Total returns standard deviation for SA asset classes from 1970 to 2007 (annualised) ……...….157

5.5 1-year investment horizon risk-return analysis (mean-variance model) …….158

5.6 35-year investment horizon risk-return analysis (mean-variance model) (annualised) ……...…….…….158

5.7 HL spread of SA asset classes from 1970 to 2007……..…….…….160

5.8 HL spread of SA asset classes from 1970 to 2007 (annualised) …….…….…….160

5.9 1-year investment horizon risk-return analysis according to HL spread…….…….…..161

5.10 35-year investment horizon risk-return analysis according to HL spread (annualised) ……...…….161

5.11 Downside risk for SA asset classes from 1970 to 2007……....162

5.12 Downside risk for SA asset classes from 1970 to 2007 (annualised) …….…….163

5.13 1-year investment horizon risk-return analysis according to downside risk……...….…….164

5.14 35-year investment horizon risk-return analysis according to downside risk (annualised) ……..……..….164

5.15 High, low, and average returns from SA equities for all rolling 1 to 35 year investment periods (annualised)……...…..….168

5.16 Frequency distribution of SA equity returns over various periods……..…….169

5.17 Chronological annualised equity returns for different rolling periods……...…….171

5.18 High, low, and average returns from SA bonds for all rolling 1 to 35 year investment periods (annualised)……..173

5.19 Frequency distribution of SA bond returns over various periods……174

5.20 High, low, and average returns from SA cash for all rolling 1 to 35 year investment periods (annualised) ……...….176

5.21 Frequency distribution of SA cash returns over various periods……...…….177

5.22 A representation of downside risk……..182

5.23 Upside potential of SA asset classes over varying investment horizons…….….183

5.24 HL ratio of SA asset classes over varying investment horizons. …..183

5.25 Complexity of holistically representing relative risk…….184

5.26 Holistic multi-period risk assessment for SA asset classes over various periods (annualised where applicable) ……..187

6.1 Highest possible bond return vs lowest possible equity return over various periods..……..…….194

6.2 Cash rolling real return and average real return from 1964 to 2008..……...….203

6.3 P/E valuation and subsequent 5-year return……..……204

6.4 Dividend yield valuation and subsequent 5-year return……205

LIST OF TABLES

Table **Page**

1.1 SA risk-return summary for SA asset classes for 101 years since 1900……...…..4

1.2 Illustration of the 25 1-year rolling periods in a three-year term.……..……13

1.3 Number of rolling periods in database per investment term……...……14

2.1 Nominal compound returns for SA asset classes from 1900 to 2001. ……...……32

2.2 Asset classes investigated by Huxley and Burns……..……41

2.3 Best and worst returns over various periods for US large-cap and small-cap stocks [equity]…….……..…64

2.4 The primary differences between Pask and Huxley & Burns……..…65

3.1 Rolling periods in database for each 1 to 5 year investment period…….……76

3.2 Average return spreads (underperformance or outperformance) of SA asset classes over 1 to 5 year terms..……..……79

3.3 Standard deviation spreads of SA asset classes over 1 to 5 year terms.…….…….……83

3.4 Declines in standard deviation (volatility) as a percentage of total return.…..……..……86

3.5 Relative highest total returns over any 1 to 5 year period from 1970 to 2007……93

3.6 Relative performance variance over any 1 to 5 year periods from 1970 to 2007……..……96

3.7 Relative rankings of HL ratios…….……..100

3.8 Summary: risk assessment methodologies.……...102

4.1 Rolling periods in database for all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007..…….111

4.2 Average return spreads (underperformance or outperformance) of SA asset classes over rolling 7, 14, 21, 28 and 35 year investment periods..……115

4.3 Standard deviation spreads of SA asset classes for all 7, 14, 21, 28 and 35 year investment periods……..120

4.4 Declines in standard deviation (volatility) as a percentage of total return over the long term.…..……..……124

4.5 Differences between the "worst-case scenario" annualised returns and the historic average annualised return.… ……..…127

4.6 Relative highest total returns over all 7, 14, 21, 28 and 35 year investment periods from 1970 to 2007……..…..…133

4.7 Differences between the "best-case scenario" annualised returns and the historic average annualised return.……...……134

4.8 Relative performance variance over any 1 to 5 year periods from 1970 to 2007……..……139

4.9 Relative rankings of HL ratios……..…..……144

5.1 Relative risk ranking of SA asset classes……..…….166

5.2 Distribution baskets for frequency calculation……..…….170

5.3 Importance of investigating the frequency distribution of returns……...……..……180

6.1 Formulas of the measures that are functions of standard deviation ……..…..…198

6.2 Bands cognizant of investor time horizon……..……201

6.3 All 10-year periods from 1900 in which real returns were negative……..……202

A1 Adler, T & Kritzman, M. (2007). Mean-variance versus full-scale optimisation..……..……212

A2 Allen, D, Brailsford, T, Bird, R & Faff, R. (2002). A Review of the Research on the Past Performance of Managed Funds……..…212

A3 Alles, L & Athanassakos, G. (2006). The Effect of Investment Horizons on Risk, Return and End-of-period wealth for major asset classes in Canada..……...……..213

A4 Bradfield, D. (2000a). Mean reversion of Equity returns on the JSE: Implications for market timing and risk management..……..……..…213

A5 Bradfield, D. (2000b). Interpreting the Important Concepts of risk..……....……214

A6 Brook, P. (2005). Riding the Roller-coaster Asset Allocation into 2006..……..…….214

A7 Dimson, E, Marsh, P & Staunten, M. (2002). Triumph of the Optimists..……...……..……215

A8 Fabozzi, F, Focardi & S, Kolm P. (2006). A Simple Framework for Time diversification..……..……..215

A9 Firer, C, McLeod H. (1999). Equities, bonds, cash and inflation: historical performance in South Africa 1925 – 1998……..……..216

A10 Harlow, W. (1991). Asset Allocation in a Downside-Risk Framework..……..……..……216

A11 Hübner, G. (2007). How Do Performance Measures Perform.……..……217

A12 Huxley, S, Burns, J. (2005). Asset Dedication..……...……..……217

A13 Israelsen, C. (2005). A refinement to the Sharpe ratio and Information ratio..……..……..……218

A14 Israelsen, C, Cogswell, G. (2007). The error of tracking error……..218

A15 Jahnke, W. (1997). The Asset Allocation Hoax..……...……219

A16 Jeffrey, R. (1984). A new paradigm of portfolio risk..……...…219

A17 Jones, C. (2007). Investments…..……..…220

A18 Kritzman, M & Rich, D. (2002). The Mismeasurement of Risk.…..220

A19 Leland, H. (1999). Beyond Mean-Variance: Performance Measurement in a Nonsymmetrical World..……..…221

A20 Levy, R. (1978). Stocks, Bonds, bills, and inflation over 52 years..……....221

A21 Madhusoodanan, T. (2006). Time diversification: The Indian evidence..……...……..……222

A22 Madhusudan, K. (2006). Stock Market Volatility in the Long run, 1961-2005 ……..……222

A23 Maginn, J, Tuttle, D, Pinto, J & McLeavey, D. (2007). Managing Investment Portfolios..……..……223

A24 McEnally, R. (1986). Latanè's bequest: The best of portfolio strategies..……..……..…223

A25 Michaud, R. (1998). Efficient Asset Management…...……..……224

A26 Nawrocki, D. (1999). A brief History of Downside Risk Measures..……..……224

A27 Pedersen, C & Satchell, S. (2002). On the foundation of performance measures under asymmetric returns……..……225

A28 Scholtz, H. (2007). Refinements to the Sharpe ratio: Comparing alternatives for bear markets..……....…225

A29 Seymour, M. (2008). I need perspective coz I'm facing the wall..……..……226

A30 Sharpe, W. (1994). The Sharpe Ratio..……..……226

A31 Sharpe, W. (2007). Investors and Markets- Portfolio Choices, Asset Prices, and Investment..……....227

A32 Smidt, S. (1978). Investment Horizon and Performance Measurement..……..…….227

A33 Trainer, F, Yawitz, J & Marshall, W. (1979). Holding period is key to risk thresholds..……...……..…228

A34 Wessels, D. (2005). Stock Market Predictability..…….....…228

A 35 Wessels, D. (2006). The Characteristics of Stock Market Volatility..……..…229

CHAPTER 1

INTRODUCTION, METHODOLOGY AND OVERVIEW

1.1 Introduction

Securities and portfolios have historically been selected or constructed after careful consideration and investigation of the risk-return trade-off properties of each security or group of securities. This conventional methodology implies a two-dimensional approach to assessing assets: the consideration of risk and the consideration of return.

It is the primary objective of this study to illustrate that by adding a third dimension, namely *investment horizon,* to this two-dimensional approach, the probability of making superior investment decisions may be enhanced.

Therefore, in the chapters to follow the aspect of investment horizon will be considered when assessing risk and return. The investigation will show that when considering the investment horizon factor, there are some inconsistencies in the results compared to the results produced by traditional measures.

Implicitly, if the three-dimensional methodology can be proved to be superior to that of the conventional two-dimensional model, there will be significant implications for the future investment decisions of all investors.

The primary objective of this chapter is to define the problem. In order to do so logically and clearly, this section will provide the necessary insight into all the aspects that prompted this study.

The purpose of this chapter is therefore to provide a background to the topic of the dissertation and to define the problem accurately.

The problem definition will be followed by comments on the methodology, after which the chapter will be concluded with a study overview and chapter synopsis.

1.2 Background

The background discussion is divided into three distinct sections: The first section will focus on the theoretical background and specifically on the efficiency frontier derived from modern portfolio theory (MPT).

The second section will provide a background to some empirical evidence that was compiled by employing the theoretical methodologies presented in the first section.

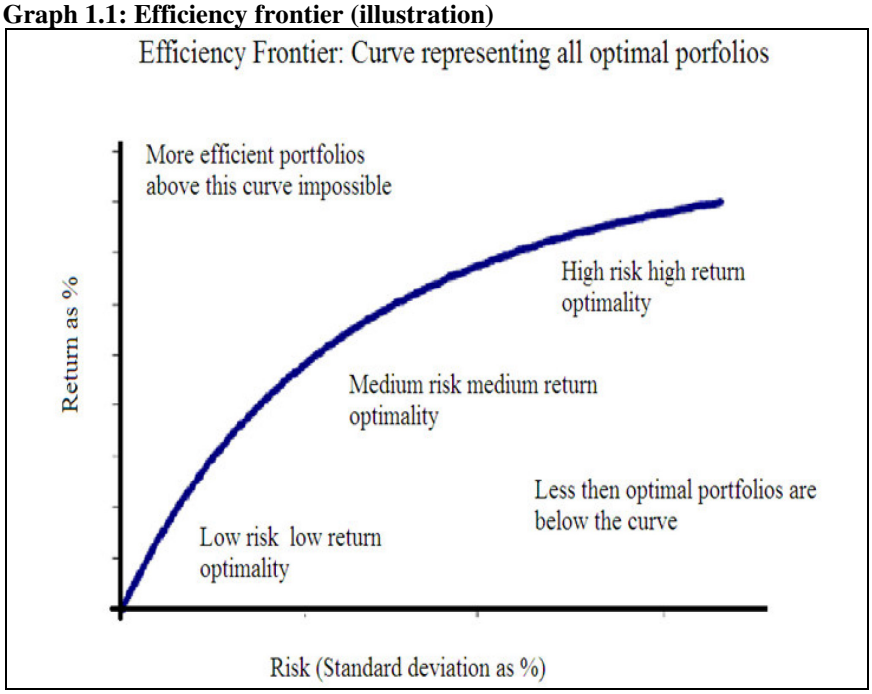
The third section will discuss Regulation 28 under the Pension Funds Act, specifically the compliance requirements contained in the Prudential Investment Guidelines (PIGS).

1.2.1 Efficiency frontier of the modern portfolio theory (MPT)

Modern portfolio theory (hereafter MPT) is theory that suggests how rational investors could use diversification to optimise their portfolios. The fundamental components of MPT are diversification, the efficiency frontier, the capital asset pricing model (CAPM), the alpha and beta coefficients, the capital market line and the securities market line.

The component of MPT which specifically relates to the theme of this dissertation is the *efficiency frontier.* The efficiency frontier is a line that is created from the risk-reward graph and is comprised of optimal portfolios. Optimal portfolios, which have the highest expected return possible for the given amount of risk, are plotted along the curve. Graphically, the efficiency frontier may be presented as follows:

Graph 1.1: Efficiency frontier (illustration)



Compiled from source: Reilly & Brown (2003:228-230)

Portfolios above the frontier are considered impossible as they would have a more efficient risk-return relationship than that described by the efficiency frontier.

Portfolios under the frontier are considered less efficient as the risk-return relationship associated with portfolios under the efficiency frontier would imply that the investor is accepting more risk for a given level of return, or alternatively is achieving an inferior return for a given level of risk.

This implies that any rational investor would not elect to construct a portfolio that is not plotted on the efficiency frontier.

The primary limitations of modern portfolio theory (and implicitly also the efficiency frontier theory) are:

a) the assumption that variance of portfolio returns is the most appropriate measure of risk (Michaud 1998:1)

b) the assumption that investment returns are adequately represented by the normal distribution of returns (Adler & Kritzman 2007:303)

The objective of this study is to illustrate (with the aid of empirical evidence) that these limitations may be responsible for inferior investment decisions, and then to present more appropriate assessments of risk.

In view of the widespread application of standard deviation in basic modern portfolio theory,[1] and its consequent application in extending modern portfolio theory to a broader level,[2] this study assesses standard deviation relative to the alternative measures of risk introduced in the study.

In the following section the study discusses some empirical findings from conventional efficiency frontier application in practice.

1.2.2 Empirical evidence from efficiency frontier application in practice

Dimson, Marsh & Staunten (2002:279) indicate that over the 101 year period since 1900, annualised nominal returns for South African (hereafter referred to as SA) equity, bonds and cash[3] were:

Table 1.1: SA Risk-return summary for SA asset classes for 101 years since 1900

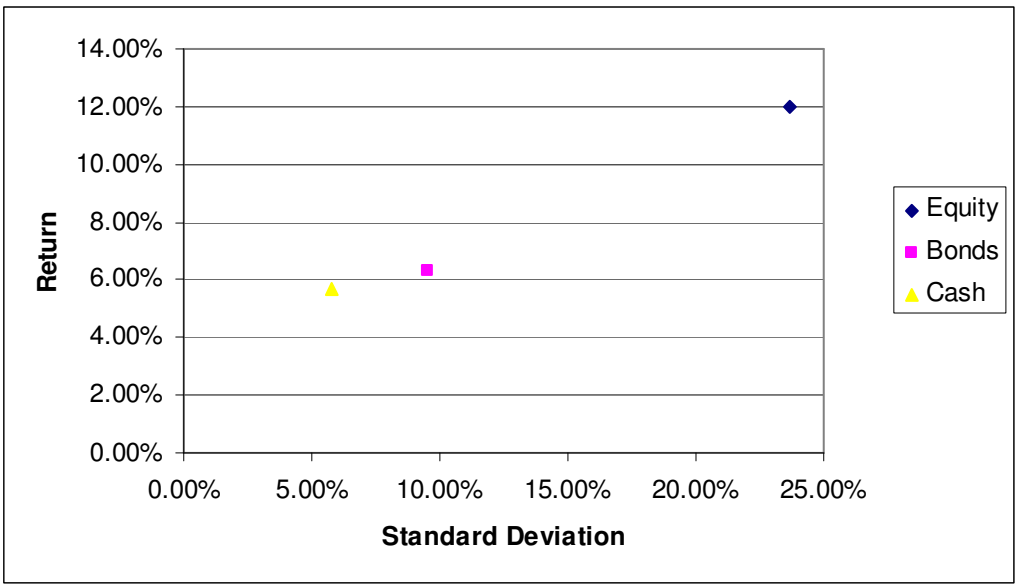
	Returns	Standard deviations
Equity	12.0%	23.7%
Bonds	6.3%	9.5%
Cash	5.7%	5.8%

Source: Dimson, Marsh & Staunten (2002:279)

[1] Chapter 6 illustrates the widespread use of standard deviation in section 6.4.2.
[2] Like CAPM, the alpha and beta coefficients, the capital market line, the securities market line, the Sharpe ratio, the Sortino ratio, the Treynor ratio, the information ratio, tracking error etc all apply standard deviation either directly or indirectly.
[3] Dimson, Marsh and Staunten (2002:279) make use of UK treasury bills as a proxy for short-term interest rates before 1925, between 1925 and 1959 the index is made up of three-month fixed deposits, from 1960 to 1966 bankers' acceptances were used as a proxy, and from 1967 to 2000 negotiable certificates of deposits were used.

When these figures are graphically illustrated (standard deviation on the x-axis and return on the y-axis), the data *resemble* the efficiency frontier from modern portfolio theory (MPT) as follows:

Graph1.2: Annualised risk-return profile for SA asset classes for 101 years since 1900



Equity resembles one optimal portfolio as an investor is unable to increase his return by accepting more risk. Cash resembles a second portfolio as an investor is unable to reduce his risk by accepting a lower return.

Equity and cash are effectively the starting and ending points of the efficiency frontier. Adjusting for different combinations of equity, bonds and cash, the connecting portfolios are plotted to complete the efficiency frontier which depicts all possible optimal relationships between risk and return.

As this study only investigates single asset class returns on a relative basis, the investigation of risk return dynamics by blending asset classes is implicitly beyond its scope. It is important, however, to remain cognisant of the efficiency frontier methodology throughout the discussion of this study.

Applying the MPT efficiency theory guidelines for risk-return analysis to the Dimson, Marsh and Staunten (2002) findings, some of the conclusions one would reach is that over the 101 year period the following apply:

a) Equity was more than four times as risky as cash.
b) Investors with a greater appetite for risk were compensated with a greater return on equity - more than double of that from cash.

In addition to this empirical evidence, further investigation in this study will illustrate the following:[4]

a) Equity is likely to outperform cash reasonably early in any long-term investment horizon.
b) The minimum return from equity, even when taking into consideration "worst-case-scenario" declines in value from time to time, is likely to exceed the maximum return from cash over longer periods.

Is it not therefore inaccurate to state that equity is riskier than other asset classes when the *minimum return* exceeds that of other asset classes? Is the standard deviation measure misleading? Are there more accurate measures that can be universally applied? This study attempts to answer these questions.

This study will illustrate that although there is merit in using standard deviation as a measure of risk over shorter periods,[5] the validity of standard deviation as a measure of risk declines over time. This study will pinpoint over which investment period standard deviation reaches a point which ultimately renders it inconclusive as a measure of risk in isolation.

This dissertation therefore relates to relative asset class dynamics, that is to how the risk-return properties of each asset class change over time and what impact these findings have on current investment practice.[6]

This dissertation will perform a detailed analysis of the return volatility of three of the major South African asset classes (equity, bonds and cash) over different periods from 1970 to 2007.

[4] Both these issues will be discussed in detail in chapters 3, 4 and 5, which investigate the short-term dynamics, long-term dynamics and relative dynamics respectively.
[5] Chapter 3 investigates the merits of using standard deviation based risk measures on shorter periods in detail.
[6] Chapter 6 will discuss the implications of the findings from the preceding chapters 3 to 5.
[7] Chapter 2 (2.2.2 "Long-term risk-return relationship") will elaborate on the reasoning behind investigating this specific period.

1.2.3 Regulation 28 of the Pension Funds Act - Prudential Investment Guidelines (PIGS) compliance

The aim of Regulation 28 under the Pension Funds Act is to impose restrictions on the specific investments that retirement funds may make. The Act intends to protect funds from making imprudent investments.

Regulation 28 prescribes maximum percentages for various types of investment that may be made by a retirement fund. They are intended as a guide to funds which invest in any assets excluding:

- insurance policies that provide any form of guarantee, or
- assets which are linked to the performance of underlying assets and where the underlying assets conform to the requirements of the regulation

The maxima prescribed by the regulation may be broadly summarised as follow:

- No more than 75% may be invested in equity.
- No more than 25% may be invested in property.
- No more than 90% may be invested in a combination of equity and property.
- No more than 5% may be invested in the sponsoring employer.
- No more than 15% may be invested in a large capitalisation listed equity.
- No more than 10% may be invested in any other single equity.
-
- No more than 20% may be invested with any single bank.
- No more than 20% may be invested offshore.
- No more than 2.5% may be invested in "other assets".[7]

[7] Derivative instruments are not defined, leaving them to fall within this category.

The above section provided insight into the restrictions imposed by regulation 28 of the Pension Funds Act. In the final chapter of this study the possible implications of the findings of this dissertation for this part of pension fund legislation will be illustrated.

1.3 Objective of the study and problem definition

The *primary* objective of the study is to illustrate that although asset class returns move along the risk-return curve as conventionally stated, considering the investment term there could be a shift in the risk-return curve/dynamic that could have a significant impact on the investment decision.

A *secondary* objective is to present additional and/or alternative measures of risk that can be accurately applied over varying (multi-period) time frames.

Attaining the above-mentioned objectives necessitates the following:

- asset performance data from January 1970 to December 2007
- returns over different rolling[8] periods of time (calculated from the above)
- return volatility measures over varying time frames (calculated from the above)
- establishing equilibrium points for the risk of the different asset classes, taking into consideration varying time frames (calculated from the above)

In the following section the methodology outlined illustrates the process by which the above-mentioned objectives will be attained.

[8] Refer to table 1.3.

1.4 Methodology

The methodology outlined below will provide insight into the process that was followed in performing this study.

The methodology will define the asset classes referred to throughout the study and provide guidelines for the further interpretation of the empirical findings.

1.4.1 Defining the asset classes

a) Equity

Equities (also often referred to as stock or shares) are securities that allocate proportional ownership of a listed company to the purchaser (investor) of such securities. Equity entitles the investor to a portion of the corporation's assets and earnings.

There are two main types of equity: ordinary shares and preference shares. Ordinary shares usually entitle the owner to vote at shareholders' meetings and to receive dividends. Preference shares generally do not have voting rights, but they may have a higher claim on assets and earnings than ordinary shares.

For example, owners of preference shares receive dividends before ordinary shareholders and have priority if a company should go bankrupt and be liquidated (Reilly & Brown 2006:82-83).

Equity in the context of this dissertation refers to ordinary shares in companies listed on the JSE Securities Exchange (JSE) plus the dividends declared by those companies. The South African All Share Index (ALSI) is a capital-weighted composite index that is generally used to measure the performance of this asset class. In this dissertation the analyses will also make use of the market capitalised ALSI when referring to equity in further discussion.

b) Bonds

Bonds are debt investments in which an investor loans money to an entity, either a corporate institution or the government. Bonds may be used by institutions to finance a variety of projects and activities. The institution (issuer) borrows the funds for a predetermined period of time at a predetermined fixed interest rate (coupon payment).

When the institution issues a bond it states the interest rate (coupon) that will be paid and when the loaned funds (bond principal) are to be returned (maturity date).

Bonds are universally referred to as fixed-income securities and are one of the three main asset classes, along with stocks and cash equivalents (Reilly & Brown 2006:80).

"Bonds" in the context of this study refers to the All Bond Index (ALBI) which consists of the top 20 listed bonds, ranked by market capitalisation and liquidity.

c) Cash

Investopedia defines cash investment (cash) as short-term obligations usually of ninety days or less that provide a return in the form of interest payments like money-market funds and short-term cash deposits (Investopedia 2008).

Cash in the context of this study refers to the Alexander Forbes Money Market Index (AFMM). Therefore the AFMM index will serve as a proxy for cash.

The AFMM Index is calculated on an interest accrual basis and reflects a monthly interest component in the return. Daily rates are averaged to obtain a monthly rate which is used in the calculation of the effective term yield for the n-month(s). The monthly performance is then calculated from that effective term yield. The

performance for that particular month, which is based on the average of the past n-months' performances, is then used to calculate an index value (Davids 2007:2-3).

1.4.2 Guidelines on further interpretation of this study

In each of these three instances[9] the study uses indices for further analysis. An index is a weighted aggregate of a particular set of data, such as the prices and yields of a group of assets. Indices therefore provide users of this financial utility with a holistic view of the performance of an asset class.

Indices are usually updated daily at the end of each day. These index values are the various data points which generate the dataset that the study will use to perform its investigation. Importantly, over time the analyses of indices can indicate broad trends that can be usefully applied in order to improve on future investment decisions.

Indices also provide benchmarks against which asset managers can measure their investment performance. In addition, asset managers often also use historic index data during the valuation of asset classes.

Note that in all instances the study assumes that interest, dividends and capital growth are *reinvested* and contribute to the *total return*. In other words the analysis assumes no fund addition or withdrawal[10] from any of the asset classes at any time.

Note that no reference is made to South African property as an asset class in this study. The reason is that to ensure that the study reaches sound conclusions, it is necessary to use a dataset that

[9] Equity as measured by the ALSI index; bonds are measured by the ALBI index; cash is measured by the AFMM index.
[10] In the form of capital, interest, or yield.

- contains sufficient data to reflect historic performances adequately and comprehensively
- contains data from periods which resemble current market scenarios

In order to accomplish this, the study disregarded data prior to 1970 as the current South African financial market is vastly different from that of the 1960s, 1950s and earlier.[11]

Following the two previously mentioned principles ensures that the analysis strikes a balance between relevance and completeness, but these principles do not allow for the inclusion of listed property returns as these listings only started in the late 1990s.

This study follows a *rolling return analysis* approach. Investopedia (2008) defines rolling returns as:

> *The annualized average return for a period ending with the listed year. Rolling returns are useful for examining the behaviour of returns for holding periods similar to those actually experienced by investors. Also known as "rolling period returns" or "rolling time periods".*
>
> *For example, the five-year rolling return for 1995 covers Jan 1, 1991, through Dec 31, 1995. The five-year rolling return for 1996 is the average annual return for 1992 through 1996….*

To illustrate, there would only be one 5-year rolling period over a five-year term. There would, however, be twenty-five 1-year (monthly compounded) rolling periods over a 3-year term from 1 January 1991 to 31 December 1993:

[11] Chapter 2 (2.2 Long-term risk-return relationship) will elaborate on this aspect.

Table 1.2: Illustration of the 25 1-year rolling periods in a three-year term

Period number	Rolling Return Period	Start Date	End Date
1	12 months	1 January 1991	31 December 1991
2	12 months	1 February 1991	31 January 1992
3	12 months	1 March 1991	29 February 1992
4	12 months	1 April 1991	31 March 1992
5	12 months	1 May 1991	30 April 1992
6	12 months	1 June 1991	31 May 1992
7	12 months	1 July 1991	30 June 1992
8	12 months	1 August 1991	31 July 1992
9	12 months	1 September 1991	31 August 1992
10	12 months	1 October 1991	30 September 1992
11	12 months	1 November 1991	31 October 1992
12	12 months	1 December 1991	30 November 1992
13	12 months	1 January 1992	31 December 1992
14	12 months	1 February 1992	31 January 1993
15	12 months	1 March 1992	28 February 1993
16	12 months	1 April 1992	31 March 1993
17	12 months	1 May 1992	30 April 1993
18	12 months	1 June 1992	31 May 1993
19	12 months	1 July 1992	30 June 1993
20	12 months	1 August 1992	31 July 1993
21	12 months	1 September 1992	31 August 1993
22	12 months	1 October 1992	30 September 1993
23	12 months	1 November 1992	31 October 1993
24	12 months	1 December 1992	30 November 1993
25	12 months	1 January 1993	31 December 1993

Source: Own composition

Through this methodology the study increases the number of data points, thereby establishing a more descriptive result for each investment term investigated.

This method also ensures that the findings resemble actual investment that investors would have experienced as closely as possible by investigating various rolling periods as opposed to the returns for a given calendar year(s).

In this study the January 1970 to December 2007 database is compiled with the aid of return data (obtained from I-Net Bridge) on the South African equity, bond, and cash markets.

This asset class return database was extended (by means of Microsoft Excel) by calculating the relevant means, standard deviations, highs and lows of each asset class over a range of different rolling investment periods.

The January 1970 to December 2007 database that is utilised can be summarised as follows in terms of the number of rolling periods investigated per investment term.

Table 1.3: Number of rolling periods in database per investment term

Investment term *(Years 1-19)*	**Rolling periods in database**	**Investment term** *(Years 20-38)*	**Rolling periods in database**
1	445	20	217
2	433	21	205
3	421	22	193
4	409	23	181
5	397	24	169
6	385	25	157
7	373	26	145
8	361	27	133
9	349	28	121
10	337	29	109
11	325	30	97
12	313	31	85
13	301	32	73
14	289	33	61

15	277	34	49
16	265	35	37
17	253	36	25
18	241	37	13
19	229	38	1

Source: Own composition

Lastly, it should be mentioned that although past returns are never a guarantee of future investment returns, the analysis of past returns provides us with *valuable "leads"*.

This analysis is therefore not a manual for future investment but rather a guideline that should be considered along with other sources of information before formulating an integrated forward-thinking investment strategy.

Sharpe (1994:169) states that most performance measures use historical data but then justify this on the basis of predictable relationships and that practical implementations use ex post results while theoretical discussions focus on ex ante values. In Sharpe's opinion this *implies the assumption that historic results have at least some predictive aptitude.*

Firer and McLeod (1999:1) agree with the view that if it is believed that historical event *types* are likely to be repeated at some point in the future, then there is merit in the belief that investigating the past may lead us along the path of unravelling the future.

These authors would therefore support the basis on which the arguments of this study are presented, which is that although there is no guarantee that history will repeat itself exactly, recognisable patterns do tend to recur.

1.5 Overview of the study

Chapter 2, the literature review, examines and discusses what has been published on the topic. This section will therefore convey ideas that have been established on the topic and evaluate their strengths and weaknesses.

The literature review will show that the topic of return relative to volatility (risk) is one that has been thoroughly researched. The literature review also illustrates that the vast majority of readings differ in at least one or more of the following aspects:

- Objective
- Period investigated
- Region investigated
- Asset classes investigated
- Degree of detail - thoroughness
- Statistical strength in analysis
- Complexity
- Sources
- Applicability and future use
- Targeted reader

The study will show that there are few studies which have attempted to quantify a measure of opportunity cost risk or that recognise the validity[12] of relative volatility of the returns.

The literature review will review earlier research in a thematic framework which resembles the chapter-by-chapter discussion framework of the study.

Chapter 3, "Return-volatility: short-term relationship", the study will perform an analysis of the rolling returns (compounded monthly) over all the 1 to 5 year periods from 1970 to 2007 for each asset class (equities, bonds, cash).

[12] In other words, that have recognised that volatility in return considerations becomes less important (valid) as time passes.

Chapter 3 will analyse the relationship between volatility and return in the short term and will be the first step in demonstrating that the return spread between asset classes is far greater over shorter periods than over longer time frames (dealt with in chapter 5).

Implicitly, it will also illustrate the risk associated with short-term investment. The study will tabulate the returns for each asset class and will discuss patterns/trends.

A volatility-return analysis and discussion on each asset class will follow. This chapter will also discuss the traditional risk-return volatility relationship between the different asset classes. Then the study will identify patterns/trends, discussing the relevance of each finding.

A comparative analysis of the results of the above analyses will conclude the analysis of the return and volatility relationship over the short term.

Chapter 4, "Return-volatility: long-term relationship", will investigate the relationship between volatility and return over the long term and will be the second step in demonstrating that the return spread between asset classes is far greater over shorter periods than over longer time frames (dealt with in chapter 5).

It will emphasise that the implied opportunity cost when investing in various asset classes increases on a relative basis as an investor extends his investment horizon. It will also illustrate the significance of short-term volatility and returns relative to long-term volatility and returns.

The chapter will perform an analysis of the annualised return over 7, 14, 21, 28, and 35 year investment periods for each asset class (equities, bonds and cash) and will again tabulate returns for each asset class and identify patterns/trends. Long-term volatility-return analysis and discussion of each asset class will follow.

A comparative analysis of the results of the above analysis will conclude the analysis of the long-term return volatility relationship.

Chapter 5, “Return-volatility: deteriorating relationship - causes and consequences”, illustrates the differences between the short-term and the long-term analyses and their findings. The study will show that traditional risk/return classification for various assets is biased towards shorter investment periods.

This analysis provides an indication of relative risk. By manipulating time frames the study finds optimal investment periods for each asset class and establishes equilibrium points where asset classes have experienced similar levels of risk (returns differing).

The study will therefore illustrate that there was an optimal holding period for each asset class where a reduced level of risk existed relative to the return: the study will show that risk (volatility) is reduced with time and that the associated risk of some assets is reduced more rapidly than that of others. By holding riskier assets for longer you can reach a similar level of risk to that for low-risk assets over the short term. Compensation for patience (the greater holding period) is a better return at a reduced level of risk.

These are the highly advantageous dynamics in incorporating a time horizon into the conventional risk-return description, and are investigated in this study.

The above analysis holds significant implications for asset managers, portfolio managers, financial advisors and other investment practioners: if the theory holds that assets that are traditionally believed to be riskier have similar risk levels over certain periods to low-risk assets, what this illustrates is that the traditional definition of risk and the diversification theory of multiple asset class portfolios can be manipulated. If this theory is applied/ interpreted incorrectly it can expose portfolios to other risks. Conversely, if it is applied correctly, risk may be significantly reduced and returns enhanced.

The latter part of chapter 5 focuses on causes and consequences of a deteriorating relationship between risk and return. This section will show that some asset classes that have traditionally been considered to carry a higher risk may over certain periods carry less risk (proportionately to return as measured by the Sharpe

ratio[13]) than assets that are traditionally considered low risk through standard deviation measures.

Conversely, the study will also show that some asset classes that have traditionally been considered to carry a lower risk may involve more risk over certain periods (proportionately to return as measured by the Sharpe ratio) than assets that are traditionally considered high risk through the application of standard deviation measures.

The study will then attempt to find corresponding risk levels between asset classes and tie them in with their optimal holding periods for each asset class.

The study will conclude firstly by summarising the findings of the analyses, secondly by discussing the implications of the above analyses and thirdly by suggesting areas for further research. The latter two discourses will focus on the following:

The implications of the study will discuss:

- *Modern portfolio theory:* How can the addition of the third dimension of investment horizon add value to current two-dimensional risk-return assessments?

- *Standard deviation-dependent measures of risk:* How do the findings of this study influence the interpretation of the results of measures that are dependent on standard deviation for input?

- *Regulation 28 of the Pension Funds Act:* How does the evidence presented in this study influence investment decisions, particularly long-term investment decisions?

[13] The Sharpe ratio or Sharpe index or Sharpe measure or reward-to-variability ratio is a measure of the excess return (or risk premium) per unit of risk in an investment asset or a trading strategy (Sharpe 1998:169).

- *The perceived risk properties of time:* How do the findings of this study influence the historically trusted risk properties of cash?

Areas for further research are the following:

- *Valuations:* This section will describe how the integration of asset valuations as a fourth dimension may be incorporated to further enhance the framework presented in this study.
- *Global investigations that consider foreign exchange and inflation:* This discussion will describe how the extent of the data considered is directly correlated with the value of the research.

1.6 Summary

The primary objective of this chapter was to define the problem logically and comprehensibly.

This chapter outlined the objective of the study. The primary objective is to illustrate that although asset class returns move along the risk-return curve as conventionally stated, when the investment term is considered there could be a shift in the risk-return curve/dynamic that could have a significant impact on the investment decision.

The secondary objective is to present a framework for holistic risk assessments that incorporates a third dimension of investment horizon within the conventional risk-return methodology.

The chapter presented a background to the dissertation topic and provided the necessary insights into all the aspects that necessitated this study.

The problem definition was followed by comments regarding the methodology. The chapter will now conclude with an overview of the study.

Chapter 2 will examine and discuss research published on the topic.

Chapter 3, “Return-volatility: short-term relationship”, analyses the monthly returns over all 1 to 5 year periods for each asset class (equities, bonds, cash).

Chapter 4, “Return-volatility: long-term relationship”, investigates the relationship between long-term volatility and return.

Chapter 5, “Return-volatility: deteriorating relationship - causes and consequences”, illustrates the differences between the short-term and the long-term analyses and their findings.

Chapter 6, “Conclusion”, summarises the study by discussing the findings, commenting on the possible implications of these findings, and then suggesting areas for further research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will identify what has been published on the topic. The ideas contained in the literature on the topic will be discussed and the strengths and weaknesses of each reading evaluated. The guiding concept of this chapter will resemble the primary dissertation discussion of return and volatility relationship dynamics over time.

This literature review will demonstrate that the dynamics between return and risk is a thoroughly researched area. The vast majority of readings differ in at least one or more of the following respects:

- Objective
- Period investigated
- Region investigated
- Asset classes investigated
- Degree of detail of investigation
- Statistical strength in analysis
- Complexity
- Sources
- Applicability and future use
- Targeted reader

There are few studies that have attempted to quantify a measure of opportunity cost risk or that recognise deterioration in volatility validity as time progresses – that is dynamic changes over time. In other words, few studies have investigated the *strength* of the standard deviation measure over various investment periods when investigating South African asset classes.

When looking at prior studies another point to consider is how relevant the study is to individual investors. This dissertation is written with the aim of contributing to a forward thinking investment strategy that may be applied in practice by all investment practioners. Where possible the study simplifies analysis/discussion, although care was taken not to do so at the expense of conclusively attaining the objective of the dissertation.

There are six major themes to this study:

Theme 1:	Short-term risk-return relationship
Theme 2:	Long-term risk-return relationship
Theme 3:	Relative asset class returns
Theme 4:	Risk reduction properties of time, trends, and mean reversion
Theme 5:	Alternative and/or additional measures of risk
Theme 6:	Pros and cons of the mean-variance model

In the following sections this literature review will discuss each research reading's differences, strengths and weaknesses within this thematic framework.

2.2 Major themes

2.2.1 Short-term risk-return relationship

In this section the study discusses research that relates to the short-term risk-return relationship. This is a major theme of this study as chapter 3: "Return volatility: short-term relationship", will serve as the first of two steps in demonstrating that the traditional mean-variance model for assessing risk is biased towards short-term investment.

It should be mentioned that although short-term performance is discussed in detail, the short-term results are derived from rolling short-term investment periods compiled from the entire dataset. In other words, where short-term risk

and return are referred to, the study does not refer to the *first* 1-5 year performance, but to *all* 1-5 year performances within the entire 37-year period.[1]

Allen, Brailsford, Bird and Faff (2002), Brook (2005), Jahnke (1997), Kritzman and Rich (2002), and Michaud (1998) performed investigations on the subject of short-term risk-return dynamics. In the following sections the study summarises the findings of their research.

a) Allen, Brailsford, Bird and Faff

Allen, Brailsford, Bird and Faff (2002) investigate the existence (and implicitly also absence) of performance persistence, namely whether the same collective investment scheme managers consistently outperform other managers or underperform.

A potential shortcoming of investigating collective investment schemes as opposed to indexes is that research on collective investment schemes is prone to survivorship bias: In other words, poorly performing schemes tend to go under and disappear from the industry and funds that perform well tend to grow and remain operating for longer periods of time. Long-term investigations, which are required to obtain an impression on long-term performance, tend to overstate returns as poorer returns are excluded from studies.

This study is not prone to survivorship bias as this study investigates index returns which reflects total weighted performance over all periods.

Allen et al (2002) utilise segmented periods of a dataset extending from 1960 to 1999. Some of the research analysis in Allen et al merely makes use of 4 years of data from this 1960 to 1999 dataset.

[1] Recall that the period from January 1970 to December 2007 is being investigated.

Allen et al (2002) find that although there is no conclusive evidence of performance persistence in terms of outperformance, there does seem to be performance persistence in terms of underperformance. It should be mentioned that the findings derived from these shorter periods are likely to be susceptible to inaccurate projections as longer periods are required to present accurate assessments.[2]

Allen et al (2002:8) cited Khan and Rudd (1995), who investigated 300 US equity and fixed interest collective investment schemes. Equity schemes were investigated from 1983 to 1987 and fixed interest schemes from 1986 to1990.

Results from Khan and Rudd indicate that, over this relatively short period, no evidence exists to substantiate performance persistence in equity funds although there is evidence to support the argument for performance persistence in the fixed interest case.

This supports the argument that equity returns need be assessed over longer periods as they are more volatile than fixed interest instruments.

b) Brook

Brook (2005) discusses the viability of asset diversification as a useful means of enhancing returns. Brook (2005:2) supports this argument by referring to the volatility in the various asset markets, in particular the equity market, and points out the significant incline in South African equity returns during 2005.

Brook (2005:3-4) indicates that many investors were unable to enjoy this upswing owing to overcautious investment strategy largely manifested through market volatility over the preceding term. Brook therefore implies that investors often find themselves *speculating on the shorter term* and deviating from long-term

[2] Longer periods were also investigated. These findings are discussed in the section on long- term findings in the section to follow.

investment objectives. In chapters 4 and 5 this study also discusses the importance of being dedicated to a long-term investment strategy.
Brook (2005:8-9) acknowledges that the problem with formulating an efficient strategy lies in short-term volatility.

c) Jahnke

Jahnke questions the findings of Brinson, Hood and Beebower (BHB) in 1986 regarding the relative importance of asset allocation. The BHB study investigates the quarterly returns of 91 large US pension funds within a 10-year period.

Jahnke (1997:109) states that the frequently cited findings of BHB revealed that up to 93.6 percent of the variation in returns could be attributed to asset allocation policy. Jahnke (1997:109) goes on to say that both the conclusions and the interpretations of the BHB study are incorrect. Jahnke (1997:109) states that the fundamental problem in the BHB study is that the analysis is focused on explaining short-term portfolio volatility rather than long-term return.

Jahnke (1997:109) states that investors should be more concerned with the return over a given horizon as opposed to avoiding short-term volatility through a given combination of assets.

Jahnke (1997:110) states that BHB incorrectly shifts the emphasis away from analysing holding period return to focusing on the variance of quarterly returns.

Jahnke (1997:110) refers to a finding in the BHB study which puts the asset allocation contribution to return variance at only 14.6% over a 10-year investigation period. Jahnke (1997:110) explains that the drastic decline is explained by the fact that the periodic returns compound over time, while the volatility in return grows at a slower rate as the investment period is lengthened.

Jahnke (1997:110) states that the above-mentioned shift in emphasis from variation in holding period return to variation in quarterly return has been a source of mass confusion in the industry and in particular to those who often cite the BHB findings.

Jahnke (1997:112) concludes that the idea of static asset allocation weightings is starting to find its way from institutional investors to the retail market, and is of the opinion that although it makes no economic sense, investment advisers have started to implement this strategy.

d) Kritzman and Rich

Kritzman and Rich (2002) introduce two new ways of measuring risk: within horizon probability of loss and continuous value at risk. These measures are intended to assess risk throughout the investment period.

Kritzman and Rich (2002) also investigated shorter datasets in certain areas of their investigation. Some parts of their study only investigated data from 1995 to 1999. The Kritzman and Rich study primarily used hypothetical datasets to illustrate arguments.

Although hypothetical data are useful when illustrating calculations, basing relevant and accurate strategies around these findings can be somewhat risky as the data have little or no practical foundation.

In the work by Kritzman and Rich (2002:94) an investigation of returns on Japanese equities and bonds from 1995 to 1999 indicates that equity shows a greater standard deviation than bonds, and bonds a greater standard deviation than the yen. The short-term investigation therefore illustrates that equities are more volatile than bonds.

e) Michaud

Michaud (1998) describes the problems of mean-variance (hereafter MV) optimisation as a practical tool for institutional asset management. Michaud reviews various proposed alternatives to MV optimisation and describes their limitations.

The goal of Michaud's work (like that of this study) is to define an optimisation process that validly reflects investment insights while maintaining the rigour, informational breadth and convenience of MV optimisation

Michaud (1998) investigates short-term data on a rolling period basis within the January 1978 to December 1995 dataset. Although this dataset is shorter than that of some of the other studies, given that calculations are based on monthly returns (216 months) the study has sufficient statistical strength to analyse shorter investment periods.

As the investment periods decrease the study is able to generate more rolling investment periods, thereby reducing the statistical relevance of each data point. This methodology is also followed in this study.

Michaud (1998) concludes that asset returns are more volatile over short periods than over relatively longer periods.

In the preceding section the study discussed and evaluated research regarding the short-term risk-return relationship between asset classes. All the studies concluded that investment returns are more volatile/unpredictable over the short term than over the long term.

No asset class demonstrated an anomalistic advantage over any other class. In other words, no single asset class illustrated an ability to provide a consistently better risk-adjusted return than any other asset class. The argument for diversification was illustrated.

In the following section the investigation shifts its emphasis from the short term (discussed above) to the long term.

2.2.2 Long-term risk-return relationship

This section of the study discusses research that relates to the long-term risk-return relationship. This is a major theme of this study as chapter 4 of this dissertation will serve as the second of two steps in demonstrating that the traditional mean-variance model for assessing risk is biased towards short-term investment and is inconsistent with the findings from alterative measures when evaluating the long-term case.

As mentioned in chapter 1, in order to ensure that the study reaches sound conclusions, it is necessary to use of a dataset that

- contains sufficient data to reflect historic performances adequately/comprehensively.
- contains data from periods that resemble the current market environment as closely as possible.

In order to strike a balance between relevance and completeness, the study therefore disregarded data prior to 1970 as the current financial market is vastly different from that of the 1960s, 1950s and earlier. These differences are briefly discussed below:

Dimson, Marsh and Staunten (2002) imply that some historic data were influenced by factors that are no longer as prevalent or have a less severe effect on asset class returns in the current investment environment. Some of the most important factors identified are:

- impact of wars
- economic depression

- deflation and hyperinflation
- barriers to international investment
- lack of monetary policy
- illiquidity

Factors that should perhaps be added to the above list are those that have transformed the investment arena in the last few decades. The following are some examples:

- globalisation
- market efficiency
- trading costs
- investor education
- monetary and fiscal policies
- corporate governance
- legislation
- access to information
- trading efficiencies

It could also be argued that investors were better equipped to protect their investments in the latter years of the 20th century through greater access to accurate information, a lowering of barriers to international investment, derivative products and technological advances.

Seymour (2008:2) agrees with this view, stating that the ALSI of today differs from the ALSI of the past in that today the ALSI is far more concentrated in high-market capitalisation equities. In addition, Seymour (2008:3) states that despite temporary breaches of the inflation targets the long-term average should be found between the guideline parameters.

Also, diversification through mean-variance optimisation was only accepted as best practice during the late 1950s, and it has subsequently transformed investment strategies globally.

It is difficult to determine the time frame that would most accurately represent our current investment environment. More importantly, even if the optimal time frame for formulating strategies for the current environment could be conclusively determined, it is unlikely that this time frame would cater for future investment environments into perpetuity as well.

Nevertheless, this study attempts to find a reasonable time frame in order to strike a balance between relevance and completeness and ultimately ensure that the findings are as relevant and as useful as possible. For this purpose, the period from 1970 onwards was deemed the most appropriate.

Brook (2005), Dimson, Marsh & Staunten (2002), Huxley and Burns (2005), Wessels (2005) and Wessels (2006) performed investigations on the subject of long-term risk-return dynamics. The present study summarises the most relevant findings from their research below.

a) Brook

Brook (2005:6) discusses returns from 1960 to 2004 and illustrates the significant outperformance of equity over the long term.

Brook (2005:6-10) acknowledges the short-term volatility in equity prices but also indicates the superior long-term returns over cash and bonds.

b) Dimson, Marsh and Staunten

It may be recalled that this study briefly examined the South African findings from Dimson, Marsh and Staunten in the introduction to the subject of risk and return dynamics over time. Dimson, Marsh and Staunten (2002:279) indicated that over the 101-year period investigated, nominal compounded returns for South African equity, bonds and cash were as follows:

Table 2.1: Nominal compound returns for SA asset classes from 1900 to 2001

	Returns	Standard deviations
Equity	12.0%	23.7%
Bonds	6.3%	9.5%
Cash	5.7%	5.8%

Source: Dimson, Marsh & Staunten (2002:279)

This study will perform similar analyses, segmenting analyses by investigating the transformation in return-risk dynamics over different periods.

The following key points can be taken from Dimson, Marsh and Staunten's (2002: 45-62) chapter on international capital market history:

- Across the 16 countries that were examined over the 101-year period, real compounded returns for equities ranged from 2.5% to 7.6%, and standard deviations ranged from 17% to 32%.
- Returns on bonds were lower than returns on equities in all 16 countries.
- Cash returns were lower than bond returns in 14 of the 16 countries
- In 5 out of 16 countries real returns on bonds were negative over the entire 101 years.
- The same 5 countries experienced negative returns for cash or cash equivalent instruments.
- Performance of markets varied across the century: The US market offered significantly higher returns on equity, bonds and cash over the final 25 years than over the first 75 years.
- Similarly, the return was higher over the latter 50 years than over the first 50 years.

Dimson, Marsh and Staunten (2002) analyse total return including reinvested income in order to comment on past events and supply advice in the context of

future investment expectations, in particular with regard to the equity risk premium.[3]

Considering the comprehensive database that Dimson, Marsh and Staunten (2002) utilised in order to perform these analyses it is clear that obtaining comprehensive, accurate and reliable results was the paramount consideration. These researchers performed an investigation of long-term returns that spanned over 16 countries, a variety of asset classes, and more than a hundred years of investment return data.

However, although Dimson, Marsh and Staunten (2002) comment in some detail on historic asset class returns they do not consider optimal holding periods for asset classes globally (or for any region). The study does not attempt to formulate a concise investment strategy around the presented evidence.

c) Huxley and Burns

Huxley and Burns (2005:1) state as their objective to shift investors to a new paradigm for personal investment.

Huxley and Burns (2005) dedicate certain asset classes to certain investment periods for each client/investor in order to optimise long-term return within an acceptable level of risk and time frame. The study considers cash-flow requirements often neglected by other investment strategies.

Huxley and Burns' (2005) fundamental approach is to dedicate each unit of funds available for investment purposes to a specific asset to realise a specific purpose over a specific period.

[3] Ibbotson and Sinquefield (cited in Reilly and Brown 2006:439) who initially estimated the equity risk premium define the risk premium as the arithmetic mean of the difference between the annual rate of return from equity minus the annual rate of return from treasury bills.

Huxley and Burns (2005) allocate amount "X" to cash for unforeseeable emergencies, amount "Y" to bonds to provide an income stream over the required period "n", and allocate amount "Z", the balance, to equity.

Huxley and Burns (2005:38) summaries their reasoning by stating that *short-term volatility in stocks [equity] should no longer be a threat as it is in asset allocation because stocks [equity] that will yield the highest expected returns over the investment term are bought.*

Huxley and Burns (2005:38) go on to state that asset dedication implies that the growth portion has been isolated from any withdrawals and that there will be no need to sell any equity until the end of the predetermined investment period.

> *Because asset dedication mathematically minimizes the asset allocation to cash and bonds, it automatically maximizes the amount allocated to stocks [equity] and their higher growth. Hence, it maximizes growth subject to the income stream that must be generated over the horizon to match the investor's individual need.* (Huxley and Burns 2005:38).

Huxley and Burns (2005) propose a forward-thinking investment strategy. They provide sufficient evidence that the strategy may prove superior over asset allocation.

The strength of Huxley and Burns's strategy (2005) lies in its recognition that volatility deteriorates over time. The strategy can therefore focus on protecting short-term cash requirements against volatility while recognising the insignificance of volatility over the long term and realising the long-term growth potential.

There are two shortcomings in Huxley and Burns's strategy (2005). Firstly, it does not recognise the role of collective investment schemes. As collective investment schemes represent the wealth of a group of investors, whereas asset dedication focuses on individual cashflow requirements, it is not possible to apply asset dedication to a collective investment scheme.

The South African collective investment environment accounts for R747 billion out of the South-African investment market[4]. Collective investment schemes are the investments vehicles that are most often used for retirement provision.

As collective investment schemes account for a large portion of the total retirement fund investment arena, asset dedication strategy is therefore limited in its applicability.

The second shortcoming of Huxley and Burns's strategy (2005) is that although asset dedication strategy is focused on the long term, the study ignores the valuation of assets over the entire investment period.

As the largest portion of funds is likely to be allocated to equity, this portion of the portfolio may well be significantly overvalued at times. Ignoring the volatility of returns is only one aspect to address and should still be performed in an equity valuation framework.[5] Equity exposure should be related to equity valuations.[6]

Huxley and Burns (2005) investigated a 76-year period from 1926 to 2002. Although the dataset is comprehensive one may argue that data prior to 1970 may have been susceptible to factors that are no longer as influential[7] in the current investment environment.

d) Wessels, 2005

Wessels (2005) attempts to determine whether the equity market has moved in some sort of predictable pattern in the past. Equity market data for the period 1960 to June 2005 are analysed.

The study attempts to find patterns on which to base a strategy that will take advantage of these trends.

[4] As at September 2008 (Source: Association of Collective Investments)
[5] Valuations are discussed in the final chapter of this investigation.
[6] This aspect is discussed in more detail in the final chapter of this study.
[7] Discussed in the introduction to 2.2.2.

Wessels (2005:5-9) provides evidence that valuations can add value if incorporated into risk-return measures as return is correlated with valuations.[8]

Wessels (2005:3) concludes that over the short term equity returns may be significantly lower or higher than the expected return, but that over the longer term the market will correct on the opposite side. In short, equity returns are risky over the short term but have a better degree of prediction over longer periods.

e) Wessels, 2006

In *The characteristics of stock [equity] market volatility,* Wessels (2006:1) has the primary objective of analysing the typical characteristics of equity market volatility on the JSE (the South African equity bourse) using data for the ALSI[9] from 1960 to March 2006. Wessels (2006) attempts to:

- assess past equity market volatility
- identify volatility patterns
- identify any meaningful link between volatility and returns
- use this information to develop some insight into how to manage future volatility

Wessels (2006) performs a similar analysis to that of this study, investigating the different return-risk dynamics over different periods.

Wessels (2006) does not, however, attempt to find a relative optimal investment period. The study also limits the investigation to the equity market, whereas this study will focus on equity, bonds and cash. This study also ties these three asset classes together by assessing the return volatility dynamics over different periods on a relative basis.

[8] Further discussion on valuations (in particular the findings of Wessels (2005) will follow in the final chapter of this study.
[9] A capital weighted composite index for all South African companies listed on the primary exchange. Refer to the study methodology in chapter 1 of the study for more detail.

Results from the study by Wessels (2006:20) reveal that volatility tends to be reasonably stable until material changes in macroeconomic variables increase uncertainty in the market.

Wessels (2006:20) also concluded that investors should generally be generating reasonable returns when volatility is benign, although as the macroeconomic uncertainty is introduced volatility will increase and negative returns become far more likely.

Wessels (2006:4) finds that the passing of time reduces volatility but does not necessarily have a correlated relationship with annualised returns over the long term. In other words, although standard deviation declines returns remain the same, implicitly arguing the general conception that standard deviation (risk) and return are correlated regardless of the period investigated.

In the preceding segment the study provided a research overview of material that investigated the short-term and long-term risk return evidence. In the section that follows the study will discuss third party research performed on relative asset class returns.

This implies reviewing material that investigated the risk and/or return of various asset classes.

2.2.3 Relative asset class returns

In this section the study discusses research that relates to relative asset class returns between equity, bonds and cash. This is a major theme of this study as this study will illustrate that risk cannot be holistically assessed by merely considering the various volatilities at a specific period. Instead, the relative volatility of time should be considered.[10]

[10] To be discussed in chapters 3, 4, and 5.

Allen et al (2002), Brook (2005), Dimson, Marsh and Staunten (2002), Firer and McLeod (1999), Huxley and Burns (2005) and Michaud (1998) all incorporated relative asset class investigations into their research. The study summarises the findings from this research below.

a) Allen et al

Allen et al (2002) investigated data from the US and the UK, and as the study was initiated to provide insight into the Australian collective investment scheme industry, Australian data were also investigated.

Allen et al (2002) largely examine equity funds. In some areas fixed interest funds are examined.

It is important to mention that in a South African context "managed fund" often refers to a balanced or multiple asset class collective investment scheme, but in this case "managed fund" refers to a fund that is managed by a fund manager(s), as opposed to passive funds like Exchange Traded Funds (ETFs). Allen et al (2002) makes no reference to direct asset classes.

The investigation revealed that equity is the highest long-term return generating asset class and that fixed interest assets exhibited the lowest long-term return.

b) Brook

Brook (2005:6) illustrates the relative outperformance of equity compared to other asset classes over the longer term. Brook (2005:9) demonstrates the risk of equity as a short-term investment relative to other asset classes but also illustrate the long-term superior relative returns.

c) Dimson, Marsh & Staunten

Dimson, Marsh and Staunten (2002) investigated 16 regions which accounted for more than 88% of world market capitalisation at the time of writing. Countries selected for investigation were countries that had at least a century of data. These countries were:

South Africa,[11] Germany, France, the United Kingdom, the United States, Switzerland, Australia, Japan, Canada, Italy, Spain, the Netherlands, Sweden, Belgium, Ireland and Denmark

The Dimson, Marsh and Staunten (2002) study therefore provides the reader with more universal conclusions. In addition, readers only interested in data from certain regions have the option of considering only these findings. Some of the findings may, however, be of little value when considered in isolation.

The Dimson, Marsh and Staunten (2002) study investigated a far greater variety of asset classes as the study attempts to make comments regarding returns of various asset classes relative to each other.

The Dimson, Marsh and Staunten (2002) study considered equity, bonds, and cash. Some analyses segmented equities into large caps, small caps and micro caps. Their study also investigated currencies and inflation.

Although the impact of inflation on investment returns is a critical factor, inflation universally discounts nominal returns to real returns within an isolated region.

Note that this universal discount therefore only applies to assets within a specific region. When considering alternative regions, other inflation rates come into play and respective adjustment is required on a case-by-case basis.

[11] Chapter 28 of Dimson, Marsh and Staunten's *Triumph of the optimists* focuses exclusively on historic South African asset class specifications/characteristics.

This study recognises the importance of inflation but does not engage in the topic further as all assets in this study are affected by South African inflation universally.

It should be mentioned here that had this study investigated different regions (as opposed to SA only), inflation adjustments would certainly have played a role.

d) Firer and McLeod

Firer and McLeod (1999) performed exploratory research of the historic performances of South African asset classes. As in the case of this study, Firer and McLeod also investigate equity, bonds and cash.

The primary difference between this study and the research performed by Firer and McLeod is that the Firer and McLeod study does not identify time horizons as a third dimension for assessing risk and does not present a holistic multiperiod framework for assessing asset classes on a relative basis that is cognisant of time horizons.

That said, Firer and McLeod (1999) do present historical evidence regarding risk and return over different periods which is closely related to the work presented in this study. Firer and McLeod (1999:20) also recognise a reduction in variance over longer investment periods. Firer and McLeod (1999) do not employ any other measure of risk apart from standard deviation.

Firer and McLeod (1999) investigate the period from 1925 to 1998, which is not an entirely relevant period (revisit the discussion on finding an appropriate period for investigating historic returns in section 2.2.2 of this chapter).

Firer and McLeod (1999:17) discuss the historical performances of the various asset classes and state that equity significantly outperformed bonds and cash. According to Firer and McLeod (1999:17), ZAR1 (one South African Rand) invested in equity in 1925 would have been worth ZAR12 951 in 1998. The same

investment in the bond proxy would have been worth ZAR121 and for cash the figure would have been only ZAR86.

Firer and McLeod (1999:20) conclude that equity performance is superior to that of the other classes over all periods, although higher levels of risk (measured by standard deviation) are evident.

This study will illustrate that although the standard deviation measures necessitate a higher standard deviation for a higher return regardless of investment horizon, by employing alternative measures of risk it can be concluded that a higher return is not conditional to accepting a higher risk over the long-term.

e) Huxley and Burns

Table 2.2 below is an extract from Huxley and Burns (2005:10-11) which summarises the list of asset classes investigated in that study. Although comprehensive, the data are confined to the U.S.

Table 2.2: Asset classes investigated by Huxley and Burns

				Average annualised returns (%)	
Asset class	**Source**	**Details**	**Approximate Maturity**	**1926 - 2002**	**1947 - 2002**
Small Cap	The centre for research in Security Prices (CRSP file), U. of Chicago	Approximately the smallest 20 percent of publicly traded companies	-	12.1	12.3
Large Cap	Same as above	S&P 500- Approximately the largest 500 publicly traded companies	-	10.1	11.8

U.S. Treasury bills	Same as above	Includes only "normal" U.S. Treasury bills (excludes callable, nonnegotiable, etc.)	30 days	3.8	4.8
Intermediate-term government bonds	The centre for research in Security Prices (CRSP file), U. of Chicago and Global Financial Data, Inc.	Includes only "normal" U.S. Treasury bonds (excludes callable, nonnegotiable, etc.)	5 years	5.5	6.2
Long-term government bonds	Same as above	Includes only "normal" U.S. Treasury bonds (excludes callable, nonnegotiable, etc.)	20 years	5.2	5.8
Long-term corporate bonds	Global Financial Data, Inc.	Includes only "normal" corporate bonds (excludes callable, nonnegotiable, etc.)	17.5 years	6.8	7.2

Source: Huxley & Burns (2005:10-11)

From the table above it is evident that the 1947 to 2002 period returns exceed those of the 1926 to 2002 period. This analysis implies lower returns from 1926 to 1947 relative to 1947 to 2002.

The evidence also suggests that equity returns far exceeded fixed interest investment returns over all the investigated periods.

Assessing assets on this relative basis reveals that equity provides superior returns over bonds, and that bonds with longer durations outperform bonds with relatively shorter durations.

f) Michaud

Michaud (1998) also made use of data derived from multiple regions. Michaud (1998) investigated data from the US, the UK, Canada, France, Germany and Japan.[12]

Michaud (1998:55) illustrates that equities generally experience higher annualised volatility than bonds and that equities generally outperform bonds.

In the preceding section 2.2.3 the study discussed earlier research on various asset classes on a relative basis. In the section below the study will review research material relating to the risk reduction properties of time.

2.2.4 Risk reduction properties of time, trends, and mean reversion

Bernstein (2007:1) states that the point at which probabilities thin out is the point at which risk is manifested in uncertainty. Bernstein (2007:1) states that it is at this stage when investors effectively cross from the long term into the short term. Risk reduction in investment horizon is implied.

In this section the study discusses research that relates to the risk reduction properties of time. Implicitly studies that evaluate mean reversion are reviewed as this is a prerequisite for time diversification.[13]

Time diversification is a major theme of this study as this study will illustrate that there is strong evidence of mean reversion that (given a sufficient investment horizon) ultimately renders volatility measures obsolete and necessitates the incorporation of alternative and/or additional non-variance based measures of risk. Research on the topic of time diversification and mean reversion in discussed below. This includes research performed by Alles and Athanassakos (2006),

[12] Michaud investigates US equity, US government and corporate bonds, Euros, the Canadian Equity Exchange, the French Equity Exchange, the German Equity Exchange, the Japanese Equity Exchange and the UK Equity Exchange.
[13] This will be illustrated in chapter 5 of this study.

Bradfield (2000a), Brook (2005), Fabozzi, Focardi and Kolm (2006), Jeffrey (1984), Levy (1978), Madhusoodanan (2006), Trainer, Yawitz and Marshall (1979) and Wessels (2005).

a) Alles and Athanassakos

Alles and Athanassakos (2006) investigate the question whether the current practice among financial planners of recommending equity at an early age and progressively moving into cash or bonds as retirement approaches is appropriate.

Alles and Athanassakos (2006:140-141) investigate 1, 5, 10, 15, and 20 year investment horizons from 1957 to 2003. The risk-return properties of equity index total return data, long-term government bonds, and 91-day T-bills[14] over time are investigated.

Alles and Athanassakos (2006:139) state that even among professionals there are differences in opinion as to the implications of the investment horizon on risk. Alles and Athanassakos (2006:139) continue by citing Olsen and Khaki (1998), who suggest that the lack of closure on the debate may be due to the industry's failure to formulate a universal definition of risk and that investors should not restrict risk assessment to standard deviation, but also view risk in terms of potential losses etc.

Alles and Athanassakos (2006:139) state that the long-term horizon risk-return analyses are scarce, possibly owing to limited availability of data outside the US.

Alles and Athanassakos (2006:149) results show that short-term investment outcomes are very different from long term investment outcomes, also between asset classes.

[14] As a proxy for cash as a risk-free investment.

Alles and Athanassakos (2006:149-150) conclude that there is evidence of time diversification and that cash is described as the most efficient asset class according to coefficient of variance measures, although these results were not reflected in the Sharpe ratios. From the above Alles and Athanassakos (2006:150) conclude that conventional risk measures cannot be considered in isolation.

b) Bradfield, 2000a

Bradfield (2000a) attempts to find sufficient evidence of mean reversion in order to build a value-adding strategy around this evidence.

Bradfield (2000a:2) identifies two significant implications for such findings, namely (1) opportunities for market timing and (2) the formulation of equity-biased strategies to enhance returns if return patterns can be proven to be non-random.

Bradfield (2000a:2) states that a significant shift in investment decision making is possible if investors realise that any potential loss in value from a equity is likely to be followed by a significant increase in order to restore average return through mean reversion. Bradfield (2000a:2) states that investors may consequently perceive risk to be lower than is described by conventional volatility measures.

Bradfield (2000a:6) concludes that evidence indicates that there is a compelling argument to be made for evidence of mean reversion, but there is no evidence that suggests that mean reversion should exist on any routine or fixed interval basis. Bradfield (2000a) therefore believes that although there is evidence of mean reversion its unpredictability makes it insufficient to formulate a strategy on this evidence.

This study will illustrate that although the above finding is accurate in the short term, over the long term mean reversion evidence can be successfully applied to the investment decision making process.

Bradfield (2000a:8) also concedes that evidence illustrates that for investors with longer investment horizons (longer than a year in this example), using the measure of variance to describe risk generates an unintuitive (and upward biased) assessment of risk.

c) Brook

It may be recalled that Brook (2005) discusses the effect of short term volatility on portfolio strategy. Brook (2005:10) acknowledges that volatility sharply reduces with holding periods. Brook (2005:11) supports the argument by referring to increases in life expectancy and to the way investors seem to have more time to wait volatility out in order to generate superior returns.

Brook (2005:3-4) also acknowledges that assessing an asset on its short-term price movements will prove costly and indicates that a long-term holding strategy can be effectively built into an investment strategy. Brook (2005) acknowledges the changes in relative risk-return dynamics over time.

d) Fabozzi, Focardi and Kolm

Fabozzi, Focardi and Kolm (2006) attempt to show that the debate on time diversification can be settled in a rigorous yet simple framework.

Fabozzi, Focardi and Kolm (2006:9) state that time diversification implies that price fluctuations are less risky over long-term horizons than over shorter investment periods.

Fabozzi, Focardi and Kolm (2006:9) acknowledge that it is surprising that the debate on time diversification, which is so important and obvious, has not yet been incorporated into a risk return assessment framework.[15]

[15] This statement clearly demonstrates the need of this dissertation.

The framework presented by Fabozzi, Focardi and Kolm (2006:10) only addresses the issue of time diversification. It is therefore not a holistic assessment of risk and can therefore not be considered in isolation.

Fabozzi, Focardi and Kolm (2006:9) state that the existence of time diversification relies on three aspects, the definition of time diversification, whether the chosen model exhibits evidence of mean reversion, and whether the model employed can be trusted.

Evidence from this dissertation will illustrate that standard deviation analysis via the mean-variance model does not exhibit evidence of mean-reversion. To this extent after empirical evidence of mean reversion has been provided, it can be concluded that the mean-variance model is not a conclusively accurate assessor of return distributions, and therefore also traditional measures of risk.

Fabozzi, Focardi and Kolm (2006:16) note that the compounding of returns via geometric and/or exponential models cannot exhibit time diversification. Therefore, when the mean variance model is appropriately exponentially applied (as opposed to averaging or annualising figures that ultimately distort the distribution of returns by normalising or phasing returns), the model does not provide evidence of mean reversion.

Fabozzi, Focardi and Kolm (2006:12) also acknowledge that there may be some ambiguity in the definition of risk and therefore also in the choice of a measure for risk. Different measures imply that there may be less risk (for example the measures presented in this study) or more risk (see the mean variance model) as the time horizon is extended.

Fabozzi, Focardi and Kolm (2006:16) conclude by stating that empirical evidence indicates evidence of mean reversion, but do not offer any meaningful evidence of predictability in this regard. This is in agreement with findings by Bradfield (2000a) and Wessels (2005).

e) Jeffrey

Levy (cited in Jeffrey 1984:143) commented on the current risk paradigm as follows: *"Time horizon is just as important as [return] variability in setting asset mixes."*

Although Levy does not introduce measures of risk that address the need for the incorporation of a time horizon into the traditional risk-return assessment model, the identification of the need is in itself an important observation/step forward.

f) Levy

Levy (1978) attempts to illustrate that time horizon is as important a consideration as volatility in setting asset mixes. Levy (1978:18-19) investigates the S&P 500, corporate bonds, long-term government bonds, T-bills[16] and consumer price inflation assessed on a relative basis from 1926 to 1977.

Levy (1978:18-19) investigates all *calendar* 1, 5, 10, 25 year investment periods for the above-mentioned variables. Unfortunately Levy (1978) does not specify whether dividends are reinvested or not.

Levy (1978:18-19) illustrates that from the perspective of not being able to preserve the purchasing power of funds by beating inflation, equity is effectively the lowest long-term risk asset class. He illustrates that although equity is exposed to a one-year loss of capital of up to 43.3% (where maximum loss over the same period is 8.1% from bonds and 0% from T-bills) equity has a 100% chance (based on historical evidence) of exceeding inflation over a 25-year period. Bonds only have a 39% chance and cash only a 25% chance of exceeding inflation over the same period.

[16] As a proxy for cash as a risk-free investment/instrument.

Levy (1978:19) identifies the need for more intuitive measures of risk, although none is explicitly provided. Levy (1978) avoids debating the shortcomings of traditional measures.

g) Madhusoodanan

Madhusoodanan (2006) investigates whether it is sufficient to discuss diversification only in terms of asset allocation or whether *time horizon* also plays a part, specifically in relation to the risk-return trade-off. He states that above-average returns tend to offset below-average returns over long investment horizons, a phenomenon which is known as time diversification. Madhusoodanan (2006:12) continues by stating that *the risk of holding equities over longer periods will therefore be lower than the risk of holding them over shorter periods.*

Madhusoodanan (2006:12) states that this view may be challenged by arguing that although the chance of losing money in the long run may be less than over shorter periods, the extent of loss is also significantly higher.

This dissertation will illustrate that even considering the greater absolute loss in value, the loss will be less than the loss in terms of opportunity cost for the investor who selected an asset with less volatility.

Madhusoodanan (2006:13) states that for a fixed investment horizon, mean variance has proved useful, although when *adjusting investment horizon to incorporate various risk-return relationships over various periods, mean variance does not provide meaningful results.*

Interestingly, Madhusoodanan (2006:13) states than in the Indian case the mean-variance model allocates almost zero percent to equity for a long-term investment plan. The implications of this recommendation will be catastrophic over the long term[17].

[17] Refer to chapters 4 and 5.

Madhusoodanan (2006:20) also states that results indicate that *time diversification* reduces risk over longer investment horizons and that buy and hold strategies reduce risk considerably.

Madhusoodanan (2006:20) further presents an analysis that illustrates that for the longer term, asset allocation should be tilted more towards equities compared to other asset classes and that even risk-averse investors could look at retaining a long-term equity holding. Although this more arbitrary recommendation is made, no specific model/formula for calculating appropriate exposures for various investment horizons is provided.

Madhusoodanan (2006:22) concludes by stating that results indicate that *time diversification reduces risk and need be considered as an important variable in the investment decision*. He extends this conclusion by stating that it is very important to look beyond asset allocation and that risk should be regarded as a two-dimensional variable that responds to changes in investment horizon.

h) Trainer, Yawitz and Marshall

Trainer, Yawitz and Marshall (1979:48) attempt to demonstrate the relationship between risk and return over shorter and longer periods in a systematic manner in order to improve the risk-return trade-off efficiency in portfolios.

Trainer, Yawitz and Marshall (1979:48) state that although many observers consider long-term investments to be riskier than short-term investments, the assumption is superficial and misleading and the short-term focused investments may be riskier for long-term investors than long-term investments. They state that although the objective of the study focuses on illustrating this risk with bond instruments, it is claimed that the concept applies to any financial or real asset.

Trainer et al (1979:49-52) illustrate this concept by analysing the difference between bond maturity date durations. The evidence shows that the greater the difference between maturity date and actual holding period the greater the risk. Evidence shows that continuously purchasing shorter dated bonds over a longer period will lead to a significant sacrifice in return, which is equivalent to an opportunity cost.

Trainer, Yawitz and Marshall (1979:53) conclude by conceding that although the study succeeded in conceptualising the impact of holding period on investment return, specifically for the bond market, much remains to be investigated, specifically regarding portfolios with additional asset classes.

i) Wessels, 2005

Wessels (2005:9) also provides evidence of mean reversion in the South African all share index. Wessels (2005:9) states that it is important to acknowledge that mean reversion will always exist. He states that although markets are not perfectly efficient, and are bound to experience excessive optimism or pessimism, one can always expect reversion to the mean.

In the preceding section the study evaluated research relating to the risk reduction properties of time. The study provides evidence for the argument that volatility measures may become essentially obsolete as a measure of risk as returns revert to the mean.

In the section below the study discusses research that investigated alternative measures of risk. In this context the study[18] also introduces some additional measures that will be applied in the subsequent chapters.[19]

[18] In chapter 3.
[19] In chapters 3, 4, and 5.

2.2.5 Alternative and/or additional measures of risk[20]

In this section the study discusses research in which alternative[21] measures of risk were investigated.

The investigation of alternative measures of risk is a major theme of this study. Some additional measures of risk are introduced in chapter 3, and are then applied throughout the remainder of the study. This methodology was followed in order to perform more appropriate risk assessments over multiple investment periods in chapter 5.

Contributions to the research of alternative risk measures from Bradfield (2000b), Harlow (1991), Hübner (2007), Israelsen (2005), Israelsen and Cogswell (2007), Kritzman and Rich (2002), Madhusudan (2006), Nawrocki (1999), Pedersen and Satchell (2002), Scholz (2007) and Sharpe (1994) are discussed below.

a) Bradfield, 2000b

Bradfield (2000b:11) focuses on promoting a graphical framework for interpreting and managing various risks. Bradfield (2000b) proposes a single graphic representation of as much as possible of the risk inherent in investing, including absolute risk, relative risk, total risk, tracking error, unique risk, equity selection risk and relative benchmark risk.
A full discussion regarding the technical evidence provided by Bradfield (2000b) is outside the scope of this debate. However, it should be mentioned that Bradfield succeeds in his attempt to include the above-mentioned risks and graphically describe each on a singular interface.

[20] This study will elaborate on the subject in "*Implications for measures that incorporate standard deviation"* in the final chapter of the study.
[21] Alternative measures of risk to those of the conventional mean-variance model, which adopts return variance in the form of standard deviation.

Bradfield (2000b) identifies and addresses a very important need in the industry for a more comprehensive and holistic risk assessment as opposed to isolated measures that usually lack the ability to describe the inherent risks fully.

One shortcoming of the work of Bradfield (2000b), however, is that it does not address the need for a holistic measure that retail investors intuitively find sensible and logical. Much confusion exists in the mind of retail investors as to what constitutes risk. Clear, logical and more descriptive measures would go a long way towards addressing this need.

None the less Bradfield (2000b) succeeds in an attempt to formulate a more descriptive and holistic platform for risk assessment.

b) Harlow

The primary objective of Harlow's work (1991) is to advocate the use of downside-risk measures. Harlow (1991:28) states that downside-risk measures are attractive because they are descriptive, easy to understand, and consistent with risk as investors understand it in relation to the potential loss from an asset.

In addition, Harlow (1991:28) states that in some cases the traditional standard deviation measure of risk is a deficient measure of risk for portfolios that require assessment for a rich set of objectives.

Harlow (1991:35) continues by stating that standard deviation is only sufficient when returns are normally distributed, but if returns are not normally distributed[22] the asset allocation decision that was reached may differ quite significantly from downside-risk models.

Harlow (1991:39) commences his conclusion by reiterating the intuitive nature of downside-risk measures and finalises the argument by stating that downside-risk

[22] Which is often the case with equity return distributions (refer to chapter 3).

measures are more attractive than the traditional standard deviation approach as downside-risk measures will generally lead to a lowering of risk while still maintaining (or even improving) expected return.

c) Hübner

Hübner (2007) investigates the relevance of some of the existing performance measures. Hübner (2007:65) states that there are serious limitations with regard to the assessment of quality performance measures. Hübner (2007) assesses Jensen's alpha, the generalised Treynor ratio (GTR) and the information ratio.

Based on the empirical evidence derived from the investigation of a sample of US collective investment scheme prices from 1993 to 2004, Hübner (2007:67-71) found that (among other findings beyond the scope of this study) the information ratio displays some of the poorest levels of precision, previously unnoticed through the lack of transparency often found in risk measures.

Hübner (2007:72) also found that the Treynor ratio appears to produce better results and that the heavy reliance of the information ratio on variance as a measure of risk is probably responsible for the poor results obtained with this measure.

Hübner (2007:73) concludes that important additional work on the appropriateness of some risk measures needs be performed.

d) Israelsen

Israelsen (2005) attempts to illustrate that by modifying the denominator of the Sharpe and Information ratios, risk assessments are able to provide more accurate assessments of risk. It is important to note that the denominator in both cases is the standard deviation of excess return.

Israelsen (2005:423) illustrates that when the excess return (the nominator in both cases) is negative, both measures no longer provide accurate performance assessments and an anomaly is encountered.

To counter this anomaly Israelsen (2005:425) modifies the conventional Sharpe and information ratios by adding an exponent to the denominator - standard deviation of excess return.

Although Israelsen (2005:425-426) is able to rectify the anomaly through algebraic engineering (illustrated by means of empirical evidence), the root of the problem is never discussed: The asymmetrical distribution of returns, and therefore excess returns and the standard deviation of excess returns, is not identified as the cause of the problem. Israelsen (2005) therefore to a large extent treats the symptoms of the problem as opposed to providing suggestions on how to prevent the discrepancy.

e) Israelsen and Cogswell

Israelsen and Cogswell's (2007) primary objective was to explore the implications of using tracking error when ranking the performance of collective investment schemes.

Tracking error is calculated as the standard deviation of each fund's monthly excess return (in excess of the relevant benchmark).

Israelsen and Cogswell (2007:419) found that although low tracking error is perceived as good in terms of risk management (as in the case of standard deviation), funds with low tracking error exhibited lower alpha (market outperformance), higher beta (correlation to market performance), and lower average performance compared to funds with higher tracking error.
Funds with low tracking error show an ability to track the benchmark more closely than funds with high tracking error. The prospect of outperformance is therefore limited. Similarly to standard deviation measures, a low standard deviation

indicates an ability to generate a return closer to an expected return, but choosing assets purely on this basis would suggest selecting assets with a limited capacity for outperformance.

Israelsen and Cogswell (2007:424) conclude by suggesting that the information ratio is a more useful and accurate risk-adjusted measure of return than tracking error in isolation.

f) Kritzman and Rich

Kritzman and Rich (2002:91) introduce two new ways of measuring risk: within horizon probability of loss, and continuous value at risk. They describe these measures of superior methodology as they assess risk throughout the investment period and not only at a certain point in time.

Kritzman and Rich (2002:91) state that investors measure risk as the probability of losing capital at the *end* of the investment period.

Although Kritzman and Rich (2002) address the need for risk measurement methods that assess risk over different periods, the interpretation of the results is not attainable by retail investors.[23] Although the measures are accurate, they do not address the need for measures that are intuitively logical, descriptive and easy to adopt.

The Kritzman and Rich (2002) study is likely to have a greater degree of future application as the value-at-risk measure is receiving more attention in industry practice.

Continuous value-at-risk is a derivative that is likely to be used in future on the institutional side of the investment industry. The stand-alone value of these measures is low, however, as they do not cater for the retail investor.

[23] Retail investors, in the context of this study, refers to public (individual), non-institutional investors.

g) Madhusudan

Madhusudan (2006) measures the volatility of daily returns on the Indian equity exchange from 1961 to 2005 in order to assess the time varying volatility in returns.

Madhusudan (2006:1796) states that the most common measure of volatility, standard deviation, is the largely preferred measure of risk for financial economists, although it may not always be appropriate for this purpose.

Madhusudan (2006) employs standard deviation on its own as a measure of volatility in order to asses how, and more importantly why, volatility changes over time.

Madhusudan (2006:1801) finds that there is strong evidence that time causes volatility to vary and that periods of high and low volatility tend to cluster. Importantly, these volatility patterns are also found to be predictable to a large extent, which gives rise to the question whether volatility is a risk when it is predictable.

Madhusudan (2006:1801) concludes that although volatility increases when the market experiences losses, the market also experiences high volatility during periods of significant gain. Therefore one cannot conclusively assume that volatility equals risk. Various assessments of risk should rather be performed in order to obtain a clearer and more insightful evaluation of risk.

h) Nawrocki

Nawrocki's study (1999) has the primary objective of explaining downside-risk measures by discussing the history of their development. Nawrocki provides an overview of literature and empirical evidence regarding downside-risk measures formulated from 1952 to 1997.

Nawrocki (1999:20-21) states that there are primarily three factors that should be considered before selecting a risk measure: firstly, that investors perceive risk in terms of potential losses, secondly, that investor risk aversion increases as the probability of potential loss increases, and lastly, that investor expectations and scenarios change.

It is (in part) for the same reasons as those given by Nawrocki that this study advocates the use of multiple measures of risk as opposed to a single measure applied in isolation.

i) Pedersen and Satchell

Pedersen and Satchell (2002) examine two performance measures advocated for asymmetric return distribution, namely the Sortino ratio and the power of utility measure (introduced by Leland 1999).

Pedersen and Satchell (2002:217) state that when returns are asymmetrical (which they generally are) and mean variance rules are no longer efficient, mean-variance based measures could generate flawed assessments of risk.

Pedersen and Satchell (2002:218) also state that although Sortino and Leland's work was undertaken to meet the need for measures that consider asymmetrical (skew) return distributions, these measures have their differences:

Leland assesses excess performance where Sortino extends the Sharpe ratio (excess performance per unit of deviation) (Pedersen and Satchell 2002:218). Pedersen and Satchell (2002:220) state that the adaptation of downside risk measures has been advocated as an innovation and improvement on conventional mean-variance models as early as in Markowitz's original mean-variance text (1952).

Markowitz (cited in Pedersen and Satchell 2002:220) points to the possibility of more attractive measures (that incorporates downside risk) but accepts being

unable to perform further analysis in this regard at the time on account of computational and algebraic limitations.

j) Scholz

Scholz presents measures that have refined the original Sharpe ratio. The objective of the investigation is to compare results from the original measure to those of the refined measures presented.

Scholz (2007:355) shows that the biggest difference in the results from the various derivative Sharpe ratios is between Israelsen's ratio and the suggested normalised Sharpe ratio. He shows that, based on his sample, Israelsen provides even more misleading results than those of the original unadjusted or modified Sharpe ratio, as suggested by Ferruz and Sarto (2004).

Scholz (2007:356) states that only the so-called "normalised Sharpe ratio" produces accurate results in any kind of market environment and that the modified Sharpe ratios created by both Israelsen and Ferruz and Sarto are prone to inaccurate results.

Scholz (2007:356) concludes by stating that the normalised Sharpe ratio should be employed as it is the only measure that consistently generates accurate results. This is opposed to the original Sharpe ratio and the two modified versions presented in the study, all of which deliver inconsistent results.

k) Sharpe

Commenting on the information ratio, Sharpe (1994:172) states that the information ratio lacks a number of the key properties of what he describes as a *"differential return information ratio"* and that in some instances inaccurate answers may result.

This study will elaborate on the subject in 6.4.2, "Implications for measures that incorporate standard deviation" in the final chapter of this study.

In the preceding section the study assessed research into alternative measures of risk. In some cases the introduction of these measures was due to a specific need not previously catered for. In other cases, however, alternatives were developed to address flaws in the mean-variance model. These flaws are discussed in the section that follows.

2.2.6 Pros and cons of the mean-variance model

In this section the study discusses research dealing with the pros and cons of the mean-variance model, which describes volatility (standard deviation) as a primary measure of risk.

This is a major theme of this study, a secondary objective of which is to illustrate that the mean-variance model (which employs standard deviation), *in isolation*, does not facilitate holistic risk assessment.

The investigations of Adler and Kritzman (2007), Huxley and Burns (2005), Jeffrey (1984), Jones (2007), Leland (1999), McEnally (1986), Michaud (1998), Sharpe (1994), Smidt (1978) and Wessels (2006) on the topic of the pros and cons of the mean-variance model are reviewed below.

a) Adler and Kritzman

Adler and Kritzman (2007:302) state that investors have recently decided to investigate alternatives to the mean-variance model on account of certain limitations of mean-variance analysis. Adler and Kritzman (2007:302) propose full-scale optimisation.

Adler and Kritzman (2007:302) state that in contrast to mean-variance analysis, full-scale optimisation identifies the optimal portfolio for any given returns distribution pattern (regardless of the variance in volatility), and for any given investor preference.

Adler and Kritzman (2007:303) state that although many assets display return distributions that are almost normal (fluctuations are similar), no asset produces a perfectly normal return distribution.

Importantly, Adler and Kritzman (2007:303-304) continue by stating that the mean-variance model assumes that investors are as averse to upside performance variance as they are to downside performance variance, which is clearly illogical.

Adler and Kritzman (2007:305) suspect that alternatives to the mean-variance model are now presenting themselves because computational efficiency is now able to facilitate more complex methodologies.

Adler and Kritzman (2007:310) conclude that if you are of the opinion that investors view gains and losses differently then full-scale optimisation is a better alternative than the conventional mean-variance analysis approach.

b) Huxley and Burns

Huxley and Burns (2005:14) also state that there is a flaw in the volatility argument and that volatility in itself is not harmful. Huxley and Burns (2005:14) state that volatility only becomes harmful when it creates risk, which according to Huxley and Burns (2005:14) is the product of the following three factors:

- variations in the value of the portfolio resulting from fluctuations in equity and/or bond prices
- the probability that funds will have to be withdrawn from the portfolio for either an emergency or a regular withdrawal

- the probability that the equity have to be sold at just the wrong time, when the market is down

Huxley and Burns (2005:14-15) state the following: *"If all three of these factors line up against the investor often enough, it could gradually consume the capital in the portfolio. Volatility is only one of the three critical ingredients and by itself is not harmful."*

Huxley and Burns (2005:15-16) sum up by stating that:

- It is better to get a higher return than to be concerned about volatility unless you are withdrawing funds.
- Fluctuations are actually the long-term investor's friend because they generate higher overall returns over the long run.

Huxley and Burns (2005:16-17) state that asset allocation was widely accepted and embraced by the investment community for the following reasons, which promised significant advantages in the adviser-client interaction:

1. *It was easy to understand (on the surface).*
2. *It promoted uniformity in recommendations.*[24]
3. *It appeared to explain 90 percent of the variability in returns.*
4. *It was a great sales pitch.*

There is a close relationship between asset allocation and standard deviation as standard deviation is the input into the Markowitz model where the asset allocation is the output. This study would suggest that the factors identified above, by no coincidence also applies to the popularity of standard deviations as a measure of risk.

[24] Risk profiling of clients by financial advisers in particular.

Huxley and Burns (2005:29) illustrates that an optimal portfolio (based on return figures had an investor invested 100% in the best asset class for the subsequent quarter - perfect quarterly hindsight investment) would have achieved a total annual return of 26.7% from 1990-2000, a 100% equity portfolio would have returned 17.9% and where the average brokers recommended asset allocation for the next quarter would have returned an average of 13.6%.

Note that Huxley and Burns (2005:51) assume reinvestment of income for total return in the case of equity. In the case of bonds, however, Huxley and Burns (2005:45) assume that coupons are withdrawn to provide an income.

Huxley and Burns (2005:30) state that advisers should not concern themselves with the volatility of their portfolios compared to that of the optimal or pure equity portfolios, but rather be cognisant that for investors who lock up their money in a retirement account and cannot touch it anyway, *volatility should not be an issue.*

Huxley and Burns (2005:39) contrast asset dedication with asset allocation by stating that *"…most brokers tend to view bonds as sluggish stocks [equity]. They tell clients to buy bonds to achieve less volatility. In essence, their allegiance to asset allocation leads them to sacrifice return only to reduce volatility."*

Huxley and Burns (2005:52-57) also recognise certain aspects of what this study will examine in chapters 5 and 6 - a diminishing accuracy in the results obtained from employing volatility (standard deviation) as a measure of risk.

Huxley and Burns (2005:52-57) claim that one of the simplest ways to observe this diminishing volatility is to examine the range of returns from the best to worst annual returns for US large cap equity and US small cap equity over 1 to 34 year spans. The table below summarises these findings:

Table 2.3: Best and worst returns over various periods for US large-cap and small-cap stocks [equity]

Range of average annualised Total Returns				
	Large-Cap Stocks [Equity]		*Small-Cap Stocks [Equity]*	
Span	***Best***	***Worst***	***Best***	***Worst***
1 yr	*54.8*	*-45.8*	*187.0*	*-52.8*
2 yr	*41.7*	*-36.8*	*88.8*	*-48.5*
3 yr	*31.5*	*-28.7*	*82.5*	*-49.0*
4 yr	*31.0*	*-23.9*	*83.0*	*-38.2*
5 yr	*29.1*	*-14.1*	*65.2*	*-26.7*
6 yr	*25.2*	*-10.7*	*40.2*	*-21.7*
7 yr	*24.2*	*-4.9*	*35.1*	*-17.8*
8 yr	*21.8*	*-4.7*	*34.1*	*-3.9*
9 yr	*21.1*	*-5.0*	*34.1*	*-2.8*
10 yr	*20.5*	*-2.0*	*29.6*	*-0.4*
11 yr	*19.7*	*-2.1*	*28.3*	*-0.3*
12 yr	*19.4*	*-2.9*	*30.4*	*-1.3*
13 yr	*19.0*	*3.3*	*33.8*	*-2.3*
14 yr	*19.1*	*-1.8*	*31.9*	*0.5*
15 yr	*19.1*	*-0.1*	*28.3*	*2.3*
16 yr	*18.3*	*1.1*	*26.1*	*1.5*
17 yr	*18.5*	*2.9*	*24.6*	*3.9*
18 yr	*18.7*	*2.2*	*25.7*	*5.4*
19 yr	*17.9*	*2.4*	*24.8*	*5.3*
20 yr	*18.0*	*2.5*	*24.0*	*6.1*
21 yr	*18.1*	*3.2*	*23.1*	*8.1*
22 yr	*17.5*	*4.4*	*23.9*	*6.1*
23 yr	*16.7*	*5.2*	*23.8*	*7.6*
24 yr	*17.2*	*5.7*	*23.2*	*7.7*
25 yr	*17.4*	*5.4*	*22.3*	*9.0*
26 yr	*16.2*	*6.5*	*22.7*	*8.5*
27 yr	*15.1*	*7.5*	*22.8*	*8.8*
28 yr	*14.2*	*7.7*	*22.0*	*8.3*

29 yr	*14.2*	*7.1*	*21.7*	*7.5*
30 yr	*13.8*	*8.1*	*21.3*	*9.2*
31 yr	*13.8*	*8.3*	*19.9*	*10.1*
32 yr	*13.6*	*8.1*	*19.9*	*9.3*
33 yr	*13.6*	*8.6*	*20.4*	*10.0*
34 yr	*12.8*	*8.0*	*20.1*	*9.2*

Source: Huxley & Burns (2005:53)

Findings from the table above are closely related to this study as this study also investigates the highest and lowest returns from alternative assets over different periods. Key differences between the two investigations are summarised in the table 2.4 below:

Table 2.4: The primary differences between Pask and Huxley & Burns

	Pask study	**Huxley and Burns**
Region investigated	SA	US
Asset classes investigated	Equity, bonds, and cash	Primarily large caps and small caps
Time period investigated	1970 to 2007	1926 to 2002.
Investment horizons investigated	Up to 35 years	Up to 34 years.

Source: Own composition

Note that although Huxley and Burns (2005) cover a far longer time period (since 1926 as apposed to 1970 in this study), effectively this study has a larger database as it makes use of rolling month periods. For example, Huxley and Burns (2005) would have investigated 42 (one year rolling*)* 34-year periods, whereas this study investigated 49 (one month rolling) 34-year periods.

Another important aspect is to assess how relevant the period under investigation is. As discussed in section 2.2.2, this study regards 1970 and after as the most relevant. So although a shorter period is investigated, the study has more data points over a more relevant period and is therefore more likely to provide a more accurate depiction.

Huxley and Burns (2005:85) state that it is important to understand that standard deviation really only measures volatility and that this is not the same as measuring risk. Huxley and Burns conclude that although there is a relation between risk and volatility the two are not identical.

Huxley and Burns (2005:85) continue by stating that it is really only downward volatility that represents risk and that if there is no cash flow requirement there is no risk involved in a temporary downward movement in value[25].

Huxley and Burns (2005:256) conclude by stating that it is a fact that standard deviation is a good measure for volatility but a questionable one for risk, and that this casts doubt on its usefulness as a fundamental element in MPT (market portfolio theory).

c) Jeffrey

Jeffrey (1984:144) recognises that the acceptance of a new risk paradigm may prove rewarding for many portfolio owners as there is a perception that the current subjective interpretation of what truly constitutes risk in a given situation leads to portfolios with less than optimal equity contents and lower long-term returns than might otherwise be achieved.

Jeffrey (1984:144) also states that the need to develop a model of risk that is intuitively understandable to portfolio owners and is universally applicable

[25] Relates to the Sortino ratio.

becomes more evident as portfolio owners, when confronted with what constitutes an appropriate level of risk, tend to err on the side of accepting too little volatility rather than assessing the long-term implications of their investment decision.

Jeffrey (1984:144) comments as follows on the limitations of using volatility as a proxy for risk: *"The problem with equating portfolio risk solely to the volatility of portfolio returns is simply that the proposition says nothing about what is being risked as a result of the volatility"*.

Jeffrey (1984) then shifts his focus to cash requirements as a part of owner's risk which is ultimately the suggested replacement proxy for volatility. The conclusion is logical although the methodology cannot be integrated into collective investment schemes as the implicit cash flow requirements are unique to each investor.[26]

d) Jones

Jones's (2007) primary objective is to provide a good fundamental understanding of the field of investments.

Jones (2007:11) comments on a graph depicting the risk-return trade-off between various asset classes and states that although common stocks [equity] are risky in relation to bonds, they are not as risky as options or futures contracts.

Jones (2007) makes no reference to investment time horizon as an important consideration during relative risk descriptions. The study will provide evidence that generalised statements like the above can be either more or less correct in their assessment of risk when considering different investment horizons.

[26] A similar finding to that of Huxley and Burns.

e) Leland

Leland (1999) attempts to illustrate that the market portfolio in the capital asset pricing model (CAPM) is mean-variance inefficient and the CAPMs' alpha miss-measures the value added by portfolio mangers.

Leland (1999:27) states that most practitioners employ the CAPM to measure performance. The CAPM model fails, however, to assess performance results accurately because of asymmetrical return distributions which are incorporated into the CAPM model via standard deviation, according to Leland (1999:33).

f) McEnally

McEnally (1986:151) suggests that, referring to long-term investors, *"…portfolio models that stress that expected return and associated risk in a single period – such as the Markowitz model – are neither very appealing nor very relevant"*. He suggests that the proposed geometric mean portfolio strategy seeks to *"…maximize the probability that terminal portfolio will exceed the value that would result from any other portfolio strategy"*.

Essentially McEnally's recommended alternative suggests that selecting the alternative with the highest geometric mean across time will maximise the portfolio growth rate.

This is fairly axiomatic as the compounded result of returns with the best return can only lead to a higher return. However, the strategy relies squarely on the accuracy of the probabilities that are applied and these are unlikely to be consistently accurate.

g) Michaud

Michaud's (1998:xv) objective is two-fold: Firstly, to describe the problems of mean-variance optimisation as a practical tool of institutional asset management (and review various proposed alternatives to mean variance optimisation and the limitations of each).

Secondly, the objective is to define an optimisation process that validly reflects investment insights while maintaining the rigour, informal breadth, and convenience of mean variance optimisation (Michaud 1998:xv).

Michaud (1998) therefore has a very similar objective to that of this study in that this study also presents additions (not only alternatives) to mean variance optimisation. However, Michaud (1998) does not investigate the relative dynamic shifts between asset classes over time.

Michaud (1998:xiv) states that although Markowitz efficiency is a convenient and useful framework for constructing a portfolio optimally, in practise it is an imperfect and error-prone method that often results in irrelevant portfolios.

Michaud (1998:1) further states that in most modern finance textbooks MV efficiency is the measure of choice for determining optimal portfolio structure and for rationalising the relevance of diversification.

Michaud (1998:3) acknowledges that academics and practitioners have raised a number of objections to MV efficiency. Michaud (1998:3) states that criticism tends to fall into one of three categories, namely:

1. Limitations of representing investor utility
2. Multi-period framework
3. Asset-liability financial planning claims of superiority[27]

[27] As in the case of Huxley and Burns (2005)

This study primarily allies itself with the second of the above categories in that MV does not account for the effect of time. Currently the investor is aware of the limitation but has not quantified the error. This study will investigate at which stage(s) standard deviation measures are essentially obsolete.

Michaud (1998:4-5) states that *"practitioners may ignore procedures for enhancing MV optimization for a variety of reasons. The enormous prestige and goodwill Markowitz and his work enjoy in the investment community have led many to ignore the obvious practical limitations of the procedure. Many influential consultants, software providers, and asset managers have vested commercial interests in the status quo. For others, practical considerations have hampered implementation. Until recently, some of the statistical techniques have been inconvenient or inaccessible because they required high-speed computers and advanced mathematical or statistical software. Finally, the statistical character of MV optimization requires a fundamental shift in the notion of portfolio optimality, the need to think statistically, and significant increase in procedural complexity."*[28]

This study would largely agree with the above statements, although more accurate risk assessments need not necessarily be more complex. The problem with standard deviation as a measure of risk originated from its seemingly arbitrary results in the eyes of the retail investor. What is required is a more logical and clear methodology, a methodology that is intuitive, sensible, descriptive, holistic, factual, and presented in context.

Michaud (1998:23) states that many authors have raised serious objections to mean-variance efficiency as the preferred methodology for constructing a portfolio optimally. A number of alternatives have been proposed, most of which fall into one of five categories:

[28] This citation is deliberately directly quoted so as to provide an accurate reflection of Michaud's assertive view. This in an effort to provide additional structural support in favour of the arguments presented in this section of the study.

(1) Non-variance risk measures
(2) Utility function optimisation
(3) Multi-period objectives
(4) Monte Carlo financial planning
(5) Linear programming

Michaud (1998:23) continues by stating that many of these alternatives have serious limitations of their own. Seeing that this study allies itself with (3) above, namely multi-period objectives, the study investigates this part of Michaud's work (1998) in more detail.

Michaud (1998:26) acknowledges that Markowitz MV efficiency is formally a single-period model for investment behaviour. Michaud (1998:26-27) also acknowledges that many institutional investors such as endowment and pension funds have long-term investment horizons of up to 20 years and historically asks how useful MV efficiency is for investors with long-term investment objectives. This is the question that this study will attempt to answer.

In discussing the multi-period investment horizon alternatives as opposed to conventional MV efficiency, Michaud (1998:27) states that one way to address this need for long-term objectives as an input into MV optimisation is to simply perform the analysis on long-term units of time. This approach would not, however, illustrate the dynamic changes that take place between asset classes over time.

Michaud (1998:27) does acknowledge that MV efficiency is probably a more appropriate measure for short-term investment. He states that considering the distribution of these geometric returns may be an alternative. The above form of analysis does coincidently form part of this study[29], among other measures.

[29] Refer to the frequency distribution analysis in chapter 5.

Michaud (1998:142) concludes that much effort is still required to improve the investment value of MV optimisation and that the fact that the limitations of MV optimisation have been ignored for so long casts doubt on the level of sophistication of institutional research.

Michaud's (1998) findings are relevant to future investors but not as a stand-alone measure and not to general retail investors. The study addresses the limitations of mean-variance optimisation but does not provide the reader with alternatives that can be interpreted by retail investors. This leaves the asset class risk perception of investors unchanged.

An important difference of this study is that this study attempts to *adjust the way investors interpret relative asset class risk.*

h) Sharpe

Throughout Sharpe (1994:170), Sharpe extends the conventional mean-variance model: *"assume that the mean and standard deviation of the distribution of one-period return are sufficient statistics for evaluating the prospects of an investment portfolio"*.

This study contends that although the mean variance approach may still be applied successfully, failure to consider the possible outcomes for a portfolio over different periods is not unlike buying a motor vehicle that provides the best fuel efficiency on shorter distances. Obviously the prospective motor car owner should consider fuel efficiency over an adequate number of distances that would ultimately enable the buyer to make the best decision for his/her lifestyle. These are the dynamics that are investigated in this study.

i) Smidt

Smidt (1978:18) investigates the question whether an increase in market value with lower volatility is necessarily a sign of good performance and tries to determine how relevant conventional risk-return measures are. Smidt (1978:19) examines hypothetical investments of up to 10 years. Smidt (1978:21) states that highly simplified examples are deliberately employed to illustrate arguments more effectively.

Smidt (1978:18) states that Treynor (1965), Sharpe (1966) and Jensen (1969) assume that there is a positive correlation between risk and return. Smidt (1978:18) states that these findings are understandable since all three measures share a common theoretical basis - the capital asset pricing model (CAPM) which largely relies on standard deviation as the base case measure for risk and primary variable in newer more developed measures.

Smidt (1978:22) concludes that a portfolio exhibiting more volatility may in reality be less risky than portfolios with stable market values. Therefore the standard deviation measure may in some cases generate inaccurate and misleading results.

j) Wessels (2006)

Wessels (2006:2) states that it is immensely difficult to develop a universally accepted definition of risk since investors apply different time frames to the outcome of their investment efforts and although we know that volatility may lead to the degeneration of investment returns it does not mean that volatility should be avoided altogether (Wessels 2006:7).

Wessels (2006:3) states that it is important to understand the limitations of using volatility (standard deviation) as a measure of risk.

Wessels (2006:4-5) goes on to illustrate these limitations by comparing two investments with identical average and geometrical return patterns but differing standard deviations by extending the investment term of one investment.

Through this demonstration Wessels illustrates firstly that standard deviation is not always an accurate proxy for risk and secondly that standard deviation declines over time without there necessarily being any change in return pattern.

2.3 Summary

This chapter identified what has been published on the topic. The chapter conveyed the ideas contained in these studies and evaluated the strengths and weaknesses of each reading.

It was demonstrated that studies vary according to a variety of aspects. Commentary regarding these aspects is summarised on a reference-by reference basis in Appendix A to this chapter.

Six major themes of this study were presented:

Theme 1: Short-term risk-return relationship
Theme 2: Long-term risk-return relationship
Theme 3: Relative asset class returns
Theme 4: Risk reduction properties of time, trends, and mean reversion
Theme 5: Alternative and/or additional measures of risk
Theme 6: Pros and cons of the mean-variance model

Each research reading's differences, strengths and weaknesses were discussed within this thematic framework.

The objective of this chapter was to illustrate the extent to which the study evaluated research material from alternative sources. The research depth of this study has been illustrated in this literature review.

CHAPTER 3

RETURN-VOLATILITY: SHORT-TERM RELATIONSHIP

3.1 Introduction

In chapter 3, "Return-volatility: short-term relationship", the study will perform an analysis of the 1 to 5 year returns on each asset class (SA equities, SA bonds, SA cash).

Recall that the primary objective of this dissertation is to illustrate that although asset class returns move along the risk-return curve as conventionally stated, considering the investment term there may be a shift in the risk-return curve/dynamic that could have a significant impact on the investment decision.

The secondary objective is to present additional and/or alternative, somewhat more intuitive, measures of risk that could be accurately applied over varying (multi-period) time frames.

This chapter will investigate the relationship between short-term volatility and return and will be the first of two steps[1] in demonstrating that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames (chapter 5).

Implicitly it will also illustrate the risk associated with short-term investment. The study will tabulate the returns for each asset class and will discuss patterns and trends.

Volatility-return analysis and discussion of each asset class will follow. This chapter will also discuss the traditional risk-return volatility relationship between

[1] Chapter 4 will be the second step in this process.

the different asset classes. The chapter will then identify patterns and trends, discussing the relevance of each finding.

Comparative analysis of the results of the above analyses will conclude the analysis of the short-term return volatility relationship.

3.2 Average South African asset class returns for 1 to 5 years

This section investigates South African asset class returns for 1 to 5 year investment terms for all 1 to 5 year *monthly rolling* investment periods from 1970 to 2007.

Table 3.1 illustrates the number of rolling n-year periods that were used to calculate the average returns for each 1 to 5 year investment period – the investment periods investigated in this chapter.

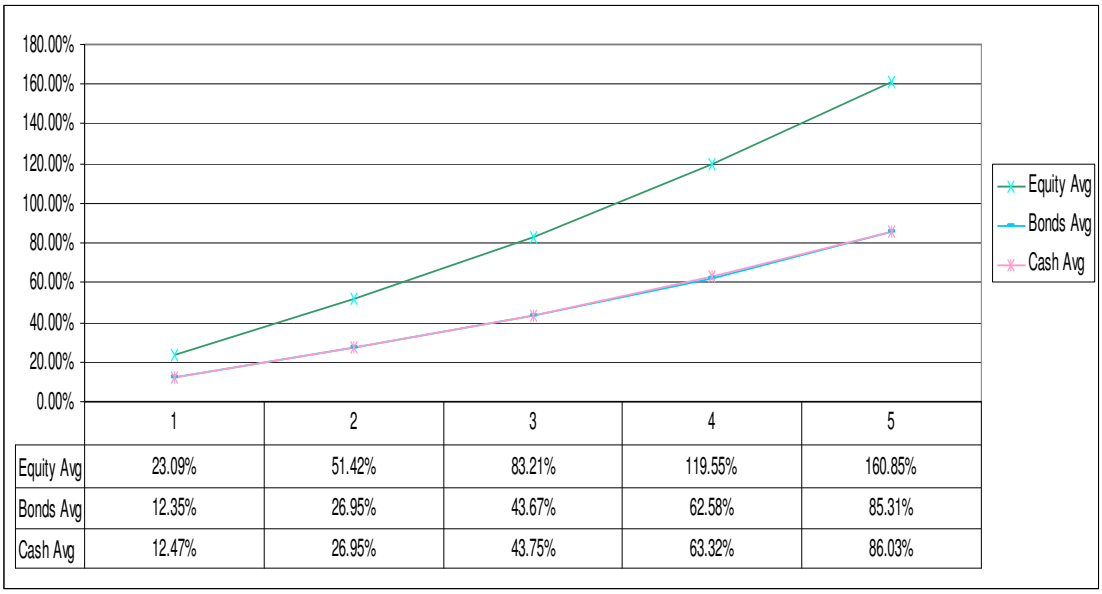
Table 3.1: Rolling periods in database for each 1 to 5 year investment period

Investment term (years)	Rolling periods in database
1	445
2	433
3	421
4	409
5	397

Source: Own composition

Graph 3.1 to follow summarises the *average* total returns from equity, bonds and cash for all rolling 1 to 5 year periods. Graph 3.2 annualises these average total returns to put the figures into perspective.

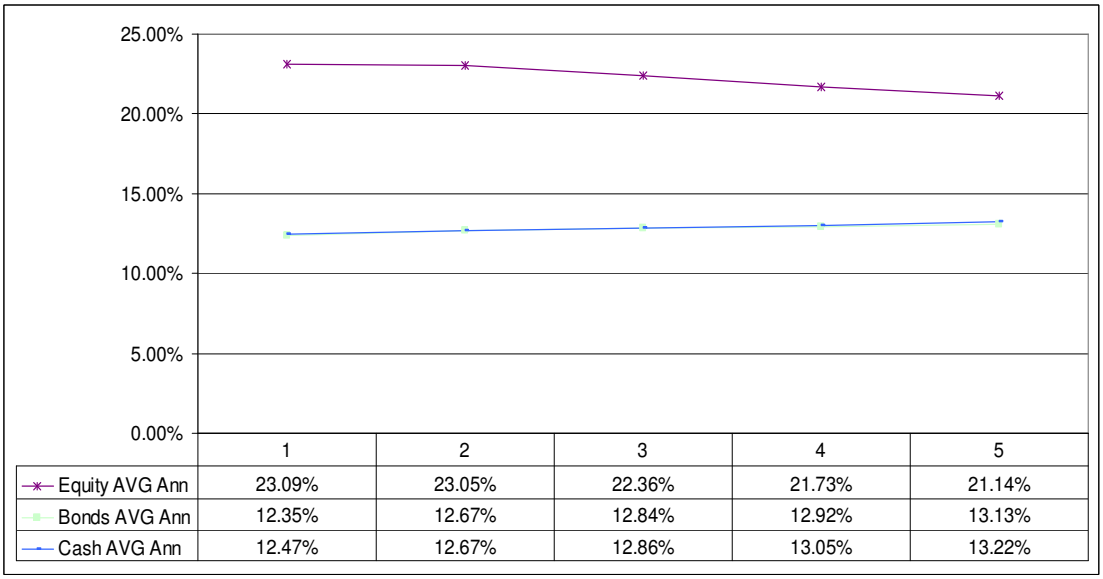
Graph 3.1: Average rolling 1 to 5 year returns for SA asset classes from 1970 to 2007



	1	2	3	4	5
Equity Avg	23.09%	51.42%	83.21%	119.55%	160.85%
Bonds Avg	12.35%	26.95%	43.67%	62.58%	85.31%
Cash Avg	12.47%	26.95%	43.75%	63.32%	86.03%

Source: Own composition

Graph 3.2: Average rolling 1 to 5 year returns for SA asset classes from 1970 to 2007 (annualised)[2]



	1	2	3	4	5
Equity AVG Ann	23.09%	23.05%	22.36%	21.73%	21.14%
Bonds AVG Ann	12.35%	12.67%	12.84%	12.92%	13.13%
Cash AVG Ann	12.47%	12.67%	12.86%	13.05%	13.22%

Source: Own composition

[2] The annualised return or geometric mean is defined by Investopedia as follows: "*The average of a set of products, the calculation of which is commonly used to determine the performance results of an investment or portfolio. Technically defined as "the 'n'th root product of 'n' numbers", the formula for calculating geometric mean is most easily written as:*

$$\{Return\ 1 \times Return\ 2 \times ... Return\ n\}^{\frac{1}{n}}$$

Where 'n' represents the number of returns in the series".

It is important to note that "average" in this context means the average of the sum of the rolling returns over a *fixed* period. Average in this context does not mean that the average return for shorter periods was calculated by averaging the long-term performance by dividing and multiplying by a required number of years.

Where annual figures are indicated, average returns (for a given *fixed* period) were annualised. In other words the geometric mean was calculated. This prevents the study from overstating returns.

It is clear that since 1970 South African equities have managed (on average) to significantly outperform SA bonds and SA cash. Over all 1 to 5 year periods SA bonds and SA cash generated similar returns with equities generating nearly double the returns of bonds and cash. The figures pertaining to these differences are summarized in table 3.2 on the next page.

Note the following from table 3.2:

- Cash and bond returns never differ by more than 74 basis points when matching the investment periods.
- The outperformance from equities over 1 to 5 matched investment periods grows gradually each year from 10.62% to 74.82% relative to cash, and from 10.74% to 75.54% relative to bonds.
- 4 year equity returns outperform the return from bonds and cash over 5 years.

Table 3.2 : Average return spreads (underperformance or outperformance) of SA asset classes over 1 to 5 year terms

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Return	Year		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
12.47%	1	Cash						0.12%	-14.48%	-31.20%	-50.11%	-72.84%	-10.62%	-38.95%	-70.74%	-107.08%	-148.38%
26.95%	2							14.60%	0.00%	-16.72%	-35.63%	-58.36%	3.86%	-24.47%	-56.26%	-92.60%	-133.90%
43.75%	3							31.40%	16.80%	0.08%	-18.83%	-41.56%	20.66%	-7.67%	-39.46%	-75.80%	-117.10%
63.32%	4							50.97%	36.37%	19.65%	0.74%	-21.99%	40.23%	11.90%	-19.89%	-56.23%	-97.53%
86.03%	5							73.68%	59.08%	42.36%	23.45%	0.72%	62.94%	34.61%	2.82%	-33.52%	-74.82%
12.35%	1	Bonds	-0.12%	-14.60%	-31.40%	-50.97%	-73.68%						-10.74%	-39.07%	-70.86%	-107.20%	-148.50%
26.95%	2		14.48%	0.00%	-16.80%	-36.37%	-59.08%						3.86%	-24.47%	-56.26%	-92.60%	-133.90%
43.67%	3		31.20%	16.72%	-0.08%	-19.65%	-42.36%						20.58%	-7.75%	-39.54%	-75.88%	-117.18%
62.58%	4		50.11%	35.63%	18.83%	-0.74%	-23.45%						39.49%	11.16%	-20.63%	-56.97%	-98.27%
85.31%	5		72.84%	58.36%	41.56%	21.99%	-0.72%						62.22%	33.89%	2.10%	-34.24%	-75.54%
23.09%	1	Equity	10.62%	-3.86%	-20.66%	-40.23%	-62.94%	10.74%	-3.86%	-20.58%	-39.49%	-62.22%					
51.42%	2		38.95%	24.47%	7.67%	-11.90%	-34.61%	39.07%	24.47%	7.75%	-11.16%	-33.89%					
83.21%	3		70.74%	56.26%	39.46%	19.89%	-2.82%	70.86%	56.26%	39.54%	20.63%	-2.10%					
119.55%	4		107.08%	92.60%	75.80%	56.23%	33.52%	107.20%	92.60%	75.88%	56.97%	34.24%					
160.85%	5		148.38%	133.90%	117.10%	97.53%	74.82%	148.50%	133.90%	117.18%	98.27%	75.54%					

Source: Own composition

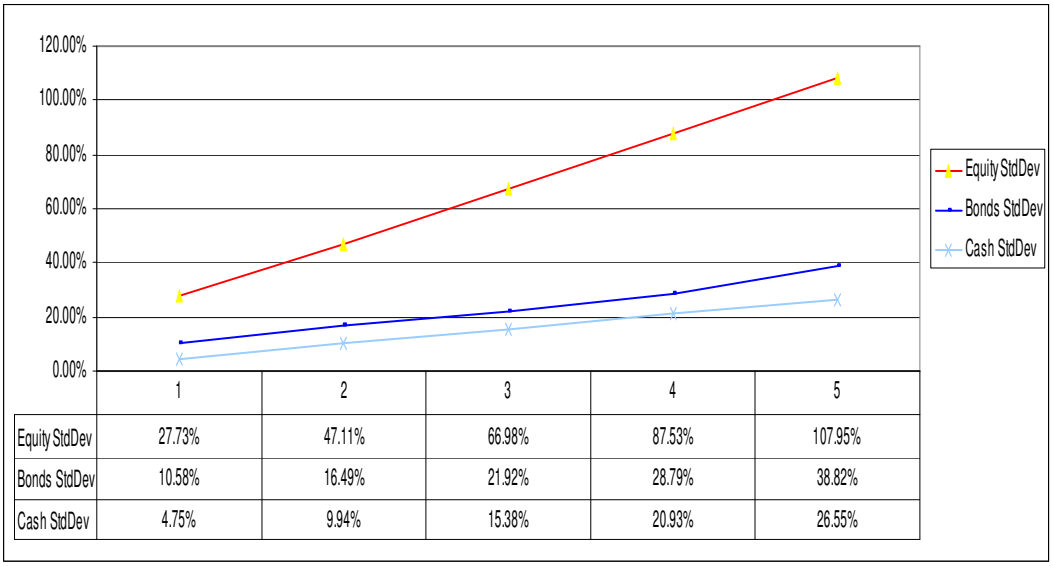
It is important to establish the measure of risk (volatility) that was experienced/accepted to generate these returns. The standard deviations of these returns are discussed in the section below.

3.3 Average South African asset class standard deviations for 1 to 5 years

This section investigates the South African asset class standard deviations for 1 to 5 year investment terms for all 1 to 5 year rolling investment periods from 1970 to 2007.

Graph 3.3 below summarises the standard deviations based on the average returns from SA equity, SA bonds and SA cash for all rolling 1 to 5 year periods.

Graph 3.3: Return standard deviations for SA asset classes from 1970 to 2007 for 1 to 5 year investment periods

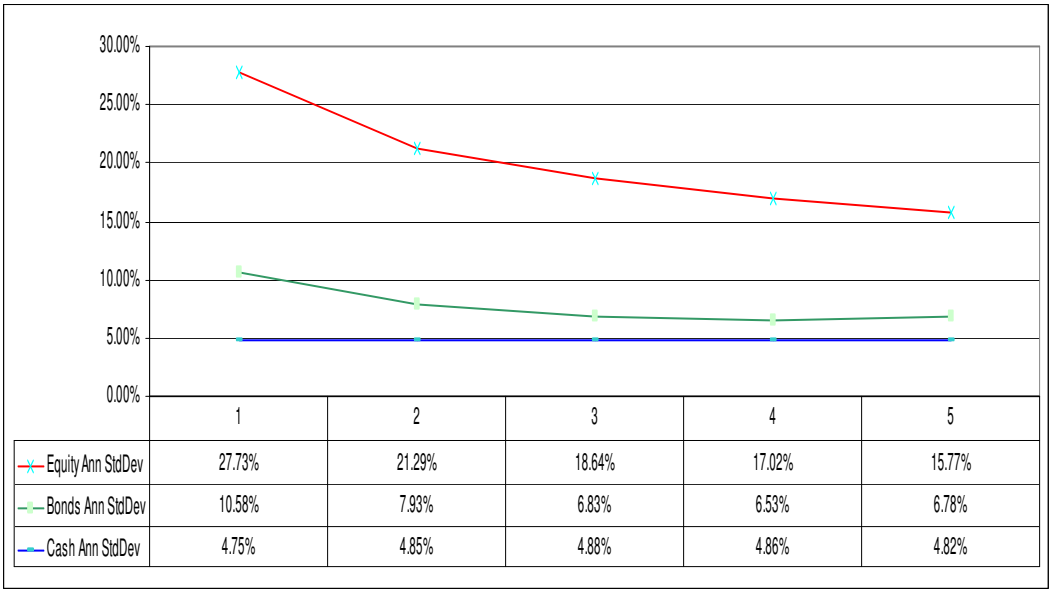


	1	2	3	4	5
Equity StdDev	27.73%	47.11%	66.98%	87.53%	107.95%
Bonds StdDev	10.58%	16.49%	21.92%	28.79%	38.82%
Cash StdDev	4.75%	9.94%	15.38%	20.93%	26.55%

Source: Own composition

Graph 3.4 to follow similarly annualises the standard deviations from above in order to put the relative annual volatility into perspective.

Graph 3.4: Return standard deviations for SA asset classes from 1970 to 2007 for 1 to 5 year investment periods (annualised)



	1	2	3	4	5
Equity Ann StdDev	27.73%	21.29%	18.64%	17.02%	15.77%
Bonds Ann StdDev	10.58%	7.93%	6.83%	6.53%	6.78%
Cash Ann StdDev	4.75%	4.85%	4.88%	4.86%	4.82%

Source: Own composition

It is clear that since 1970 South African equities have experienced significantly higher standard deviations. Over a one-year term SA equities experienced more than five times the standard deviation of SA cash and nearly three times that of SA bonds.

The proportions decline over time, however, with the standard deviation for equities closer to four times of that of cash over five years.

The standard deviation for bonds remains at roughly one-third of that of SA equities for all 1 to 5 year periods, however.

These differences are again summarised on a relative basis over all 1 to 5 year periods in table 3.3.

Table 3.3 illustrates the following:

- Although table 3.2 indicated that bonds and cash generate similar returns for all matched investment periods, the standard deviation of cash is consistently lower than that of bonds.

- Relative to equity, cash and bonds show lower standard deviations for all periods except for those of 4 and 5 year bonds, which exceed the standard deviation for one-year equity investments.
- Considering the previous finding, and using only standard deviation as a measure of risk, one might conclude that 4 and 5 year bonds are effectively riskier than one-year equities.
- Note from tables 3.2 and 3.3 that over no investment periods do equities outperform the other two asset classes at a lower degree of volatility/standard deviation.
- Note from tables 3.2 and 3.3 that cash generated a higher return than bonds for all matched 1 to 5 year investment periods, and managed to generate this return at a reduced standard deviation.

Cash standard deviation		**Bonds standard deviation**	
2 year	9.94%	1 year	10.58%
3 year	15.38%	2 year	16.49%
4 year	20.93%	3 year	21.92%
5 year	26.55%	4 year	28.79%

Source: Own composition

- Note from tables 3.2 and 3.3 that a 5-year cash investment outperformed a 4- year bond investment by 23.45% and that the standard deviation from 5-year cash was *lower* than that of a 4-year bond investment. A higher return was obtained at a lower risk.

- This illustrates how avoiding assets *solely* on the basis of standard deviation considerations can cause inferior investment decision making.

Table 3.3: Standard deviation spreads of SA asset classes over 1 to 5 year terms

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Std dev	Year		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4.75%	1	Cash						-5.83%	-11.74%	-17.17%	-24.04%	-34.07%	-22.98%	-42.36%	-62.23%	-82.78%	-103.20%
9.94%	2							-0.64%	-6.55%	-11.98%	-18.85%	-28.88%	-17.79%	-37.17%	-57.04%	-77.59%	-98.01%
15.38%	3							4.80%	-1.11%	-6.54%	-13.41%	-23.44%	-12.35%	-31.73%	-51.60%	-72.15%	-92.57%
20.93%	4							10.35%	4.44%	-0.99%	-7.86%	-17.89%	-6.80%	-26.18%	-46.05%	-66.60%	-87.02%
26.55%	5							15.97%	10.06%	4.63%	-2.24%	-12.27%	-1.18%	-20.56%	-40.43%	-60.98%	-81.40%
10.58%	1	Bonds	5.83%	0.64%	-4.80%	-10.35%	-15.97%						-17.15%	-36.53%	-56.40%	-76.95%	-97.37%
16.49%	2		11.74%	6.55%	1.11%	-4.44%	-10.06%						-11.24%	-30.62%	-50.49%	-71.04%	-91.46%
21.92%	3		17.17%	11.98%	6.54%	0.99%	-4.63%						-5.81%	-25.19%	-45.06%	-65.61%	-86.03%
28.79%	4		24.04%	18.85%	13.41%	7.86%	2.24%						1.06%	-18.32%	-38.19%	-58.74%	-79.16%
38.82%	5		34.07%	28.88%	23.44%	17.89%	12.27%						11.09%	-8.29%	-28.16%	-48.71%	-69.13%
27.73%	1	Equity	22.98%	17.79%	12.35%	6.80%	1.18%	17.15%	11.24%	5.81%	-1.06%	-11.09%					
47.11%	2		42.36%	37.17%	31.73%	26.18%	20.56%	36.53%	30.62%	25.19%	18.32%	8.29%					
66.98%	3		62.23%	57.04%	51.60%	46.05%	40.43%	56.40%	50.49%	45.06%	38.19%	28.16%					
87.53%	4		82.78%	77.59%	72.15%	66.60%	60.98%	76.95%	71.04%	65.61%	58.74%	48.71%					
107.95%	5		103.20%	98.01%	92.57%	87.02%	81.40%	97.37%	91.46%	86.03%	79.16%	69.13%					

Source: Own composition

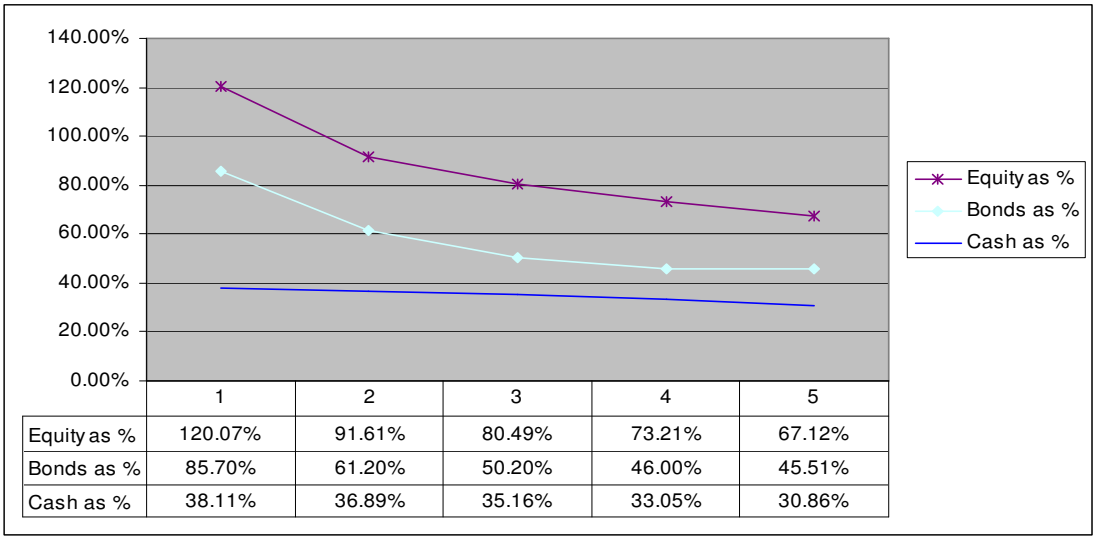
In order to determine the relative risk, graph 3.5 below summarises standard deviation expressed as a percentage of the aforementioned average returns.

Expressed in the form of a formula this would equate to:

$$= \frac{\text{Standard deviation of asset class X over period N}}{\text{Total average return of asset class X over period N}}$$

Note that there is no need to annualise these returns before calculating the volatility as a percentage of the average return as the results would be exactly the same as in the case of un-annualised returns and standard deviations.

Graph 3.5: Standard deviation (volatility) as a percentage of total return



	1	2	3	4	5
Equity as %	120.07%	91.61%	80.49%	73.21%	67.12%
Bonds as %	85.70%	61.20%	50.20%	46.00%	45.51%
Cash as %	38.11%	36.89%	35.16%	33.05%	30.86%

Source: Own composition

Graph 3.5 therefore illustrates the "risk" or volatility relative to the return generated. Therefore, the lower the ratio the higher the return relative to the risk. In other words, less risk was taken per unit of return generated.

Note that this measure is similar to the Sharpe ratio,[3] although the above measure is effectively an imitative inverse version of the Sharpe ratio.

Keeping this in mind, it can be concluded from graph 3.5 that cash showed the most "efficient" return over all 1 to 5 year investment periods, where an investor experienced the least risk/volatility per unit of return that was generated.

Cash volatility in returns was consistently between 30% and 40% of the actual return over the same period. Equities fluctuated between far less "efficient" regions of between 67% and over 120%. Bonds showed a medium level of efficiency, fluctuating between 45% and 86%.

Also note the downward slope (declining trend) in values over time. Table 3.4 below summarises these declines as follow.

Note that graph 3.5 above uses standard deviation as a measure of risk. Therefore, the more volatile the asset class was in generating returns the higher the degree of risk ascribed to that asset.

One shortcoming of this approach is that upside or positive return contributes to return volatility although the investor enjoys the benefit of upside volatility (positive return).[4] Therefore clients avoiding volatile investments may effectively be deterred from making superior investments. This necessitates the *integration of alternative risk* measures.

---

[3] ***The Sharpe ratio***, also known as the ***Sharpe index***, ***Sharpe measure or reward-to-variability ratio,*** is defined by Investopedia as follows: *"A ratio developed by Nobel laureate William F. Sharpe to measure risk-adjusted performance. The Sharpe ratio is calculated by subtracting the risk-free rate - such as that of the 10-year U.S. Treasury bond - from the rate of return for a portfolio and dividing the result by the standard deviation of the portfolio returns."*

$$= \frac{\bar{r}_p - r_f}{\sigma_p}$$

Where:

$\bar{r}_p$ = Expected porfolio return

r_f = Risk free rate

σ_p = Portfolio standard deviation

[4] Refer to the discussion of the evidence from Huxley in Burns (2005) in section 2.2.6 of the literature review.

Table 3.4: Declines in standard deviation (volatility) as a percentage of total return

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Std dev	Year		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
38.11%	1	Cash						-47.59%	-23.09%	-12.09%	-7.89%	-7.40%	-81.96%	-53.50%	-42.38%	-35.10%	-29.01%
36.89%	2							-48.81%	-24.31%	-13.31%	-9.11%	-8.62%	-83.18%	-54.72%	-43.60%	-36.32%	-30.23%
35.16%	3							-50.54%	-26.04%	-15.04%	-10.84%	-10.35%	-84.91%	-56.45%	-45.33%	-38.05%	-31.96%
33.05%	4							-52.65%	-28.15%	-17.15%	-12.95%	-12.46%	-87.02%	-58.56%	-47.44%	-40.16%	-34.07%
30.86%	5							-54.84%	-30.34%	-19.34%	-15.14%	-14.65%	-89.21%	-60.75%	-49.63%	-42.35%	-36.26%
85.70%	1	Bonds	47.59%	48.81%	50.54%	52.65%	54.84%						-34.37%	-5.91%	5.21%	12.49%	18.58%
61.20%	2		23.09%	24.31%	26.04%	28.15%	30.34%						-58.87%	-30.41%	-19.29%	-12.01%	-5.92%
50.20%	3		12.09%	13.31%	15.04%	17.15%	19.34%						-69.87%	-41.41%	-30.29%	-23.01%	-16.92%
46.00%	4		7.89%	9.11%	10.84%	12.95%	15.14%						-74.07%	-45.61%	-34.49%	-27.21%	-21.12%
45.51%	5		7.40%	8.62%	10.35%	12.46%	14.65%						-74.56%	-46.10%	-34.98%	-27.70%	-21.61%
120.07%	1	Equity	81.96%	83.18%	84.91%	87.02%	89.21%	34.37%	58.87%	69.87%	74.07%	74.56%					
91.61%	2		53.50%	54.72%	56.45%	58.56%	60.75%	5.91%	30.41%	41.41%	45.61%	46.10%					
80.49%	3		42.38%	43.60%	45.33%	47.44%	49.63%	-5.21%	19.29%	30.29%	34.49%	34.98%					
73.21%	4		35.10%	36.32%	38.05%	40.16%	42.35%	-12.49%	12.01%	23.01%	27.21%	27.70%					
67.12%	5		29.01%	30.23%	31.96%	34.07%	36.26%	-18.58%	5.92%	16.92%	21.12%	21.61%					

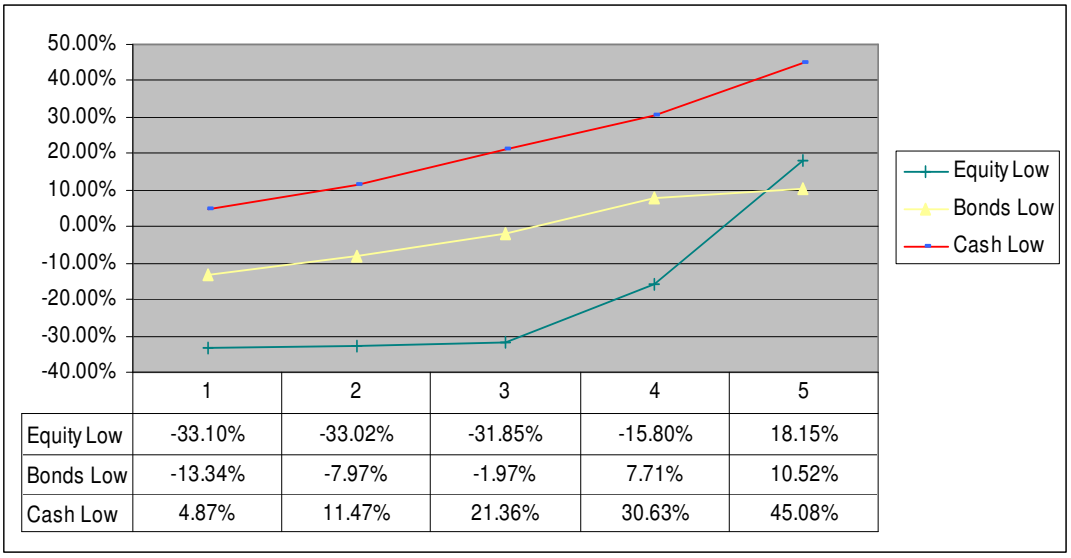
Source: Own composition

3.4 Additional measures and assessments of risk

3.4.1 Downside risk

Graph 6 below illustrates the *lowest* total return over *any* 1 to 5 year rolling (compounded monthly) periods from 1970 to 2007. Effectively, the graph therefore illustrates the "worst-case-scenario" in terms of total returns for each asset class over 1 to 5 year periods. Graph 3.7 annualises the results shown in graph 3.6.

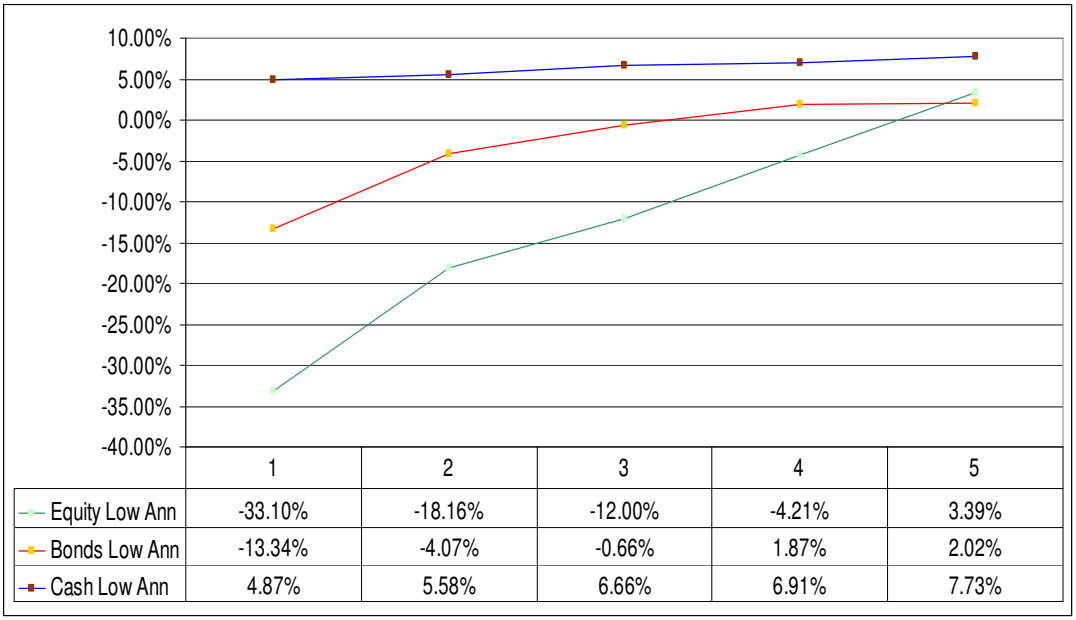
Graph 3.6: Lowest total return over any 1 to 5 year period from 1970 to 2007



	1	2	3	4	5
Equity Low	-33.10%	-33.02%	-31.85%	-15.80%	18.15%
Bonds Low	-13.34%	-7.97%	-1.97%	7.71%	10.52%
Cash Low	4.87%	11.47%	21.36%	30.63%	45.08%

Source: Own composition

Graph 3.7: Lowest total return over any 1 to 5 year period from 1970 to 2007 (annualised)



	1	2	3	4	5
Equity Low Ann	-33.10%	-18.16%	-12.00%	-4.21%	3.39%
Bonds Low Ann	-13.34%	-4.07%	-0.66%	1.87%	2.02%
Cash Low Ann	4.87%	5.58%	6.66%	6.91%	7.73%

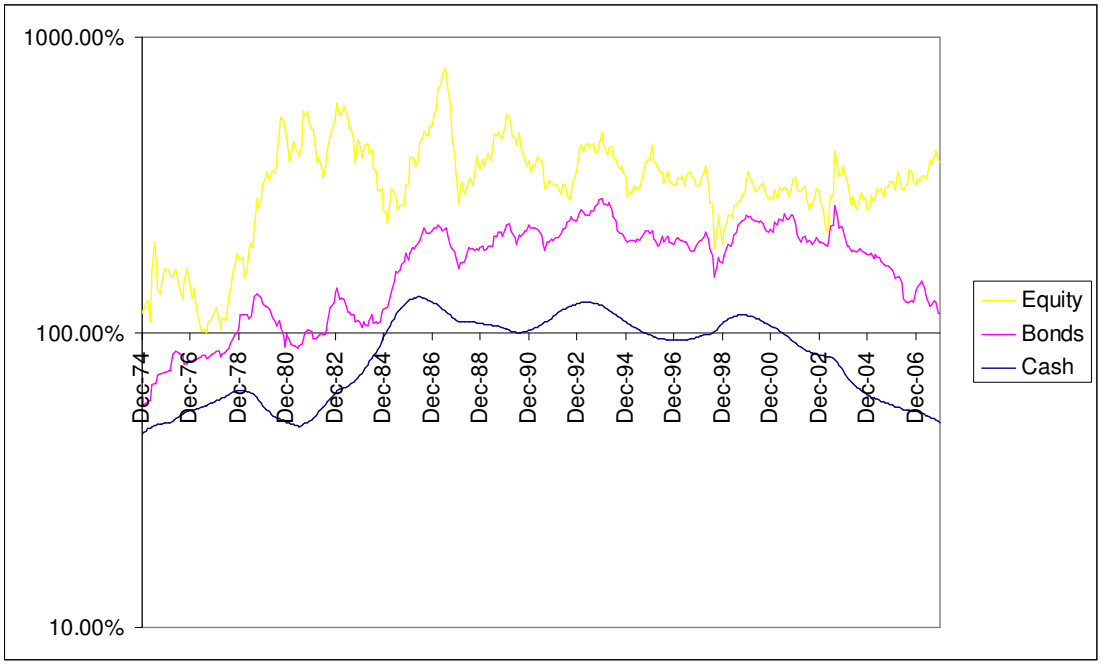
Source: Own composition

Graph 3.6 illustrates the fact that cash fared best in respect of the lowest total return over any 1 to 4 year period. Equities fared worst in respect of the lowest total return, and bonds again fell midway between the two preceding asset classes. It is therefore clear that when comparing potential lowest returns with the traditional standard deviation measure in graph 3.5, equities are indeed the riskiest, bonds were less risky and cash the least risky. Note how these results correspond to those of the standard deviation approach in the preceding section.

One important phase in graph 3.6 should, however, not be overlooked: Note how the lowest total return of equities over any 5-year period exceeds that of bonds. According to the standard deviation measure (graphs 3.3 and 3.4), bonds were less risky than equity. Graph 3.6 above would suggest, however, that this is not necessarily the case as bonds have the potential to perform more poorly than equity over 5-year investment horizons.

In fact, the graph below shows that bonds have never outperformed equity over *the same rolling 5- year period.*

Graph 3.8: Rolling 5-year investment returns (simultaneous calendar performances)



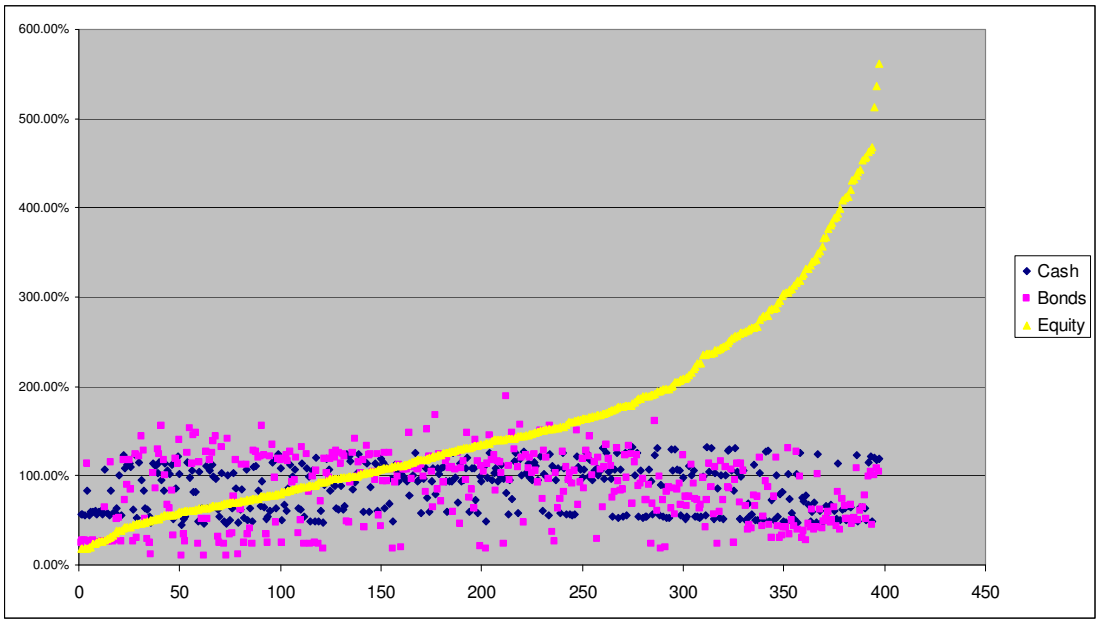
Source: Own composition

This does not indicate, however, that over *any* 5-year term equity has never experienced a lower return than bonds over any other 5-year term.

Graph 3.9 to follow plots all 397 data points for each of the 5-year investment periods for each asset class. The graph illustrate that although it is unlikely that bonds or cash will outperform equity (or that cash will outperform bonds) in the same market environment, 5-year cash and bond investments have outperformed 5-year equity investments.

Graph 3.9 illustrates that it would be inaccurate to state that a 5-year bond or cash investment cannot outperform a 5-year equity investment, although, assuming investments are made at exactly the same time, it is unlikely (graph 3.8 above).

Graph 3.9: Rolling 5-year investment returns for each asset class (random non-concurrent performances)



Source: Own composition

The important message is that asset dynamics change over time. Even over a mere 5-year investment horizon there may be changes.

Bonds can now be regarded (according to the preceding measure) as the asset with the highest *potential downside* over a 5-year period. This is not reflected in the standard deviation measure depicted in graphs 3.3 and 3.4.

Note that the study has assessed the standard deviation and potential downside in the preceding sections. This combined approach is similar to that of the Sortino ratio[5].

[5] Investopedia defines the Sortino ratio as follows: *"A ratio developed by Frank A. Sortino to differentiate between good and bad volatility in the Sharpe ratio. This differentiation of upwards and downwards volatility allows the calculation to provide a risk-adjusted measure of a security or fund's performance without penalizing it for upward price changes. It is calculated as follows:*

$$\text{Sortino Ratio} = \frac{< R > - R_f}{\sigma_d}$$

Where,

$< R >$ = Expected Return

R_f = The Risk Free Rate of Return

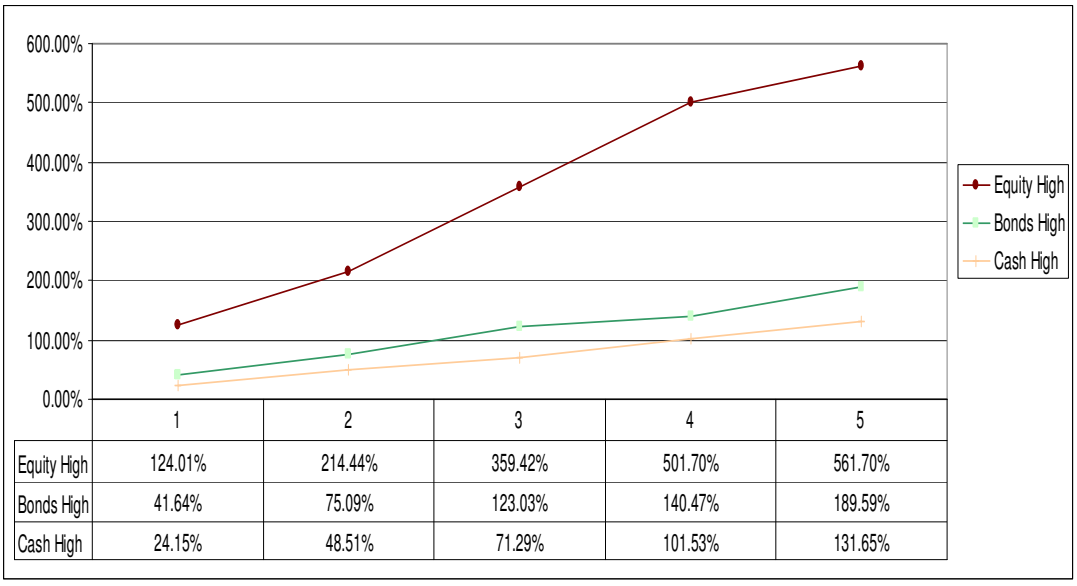
σ_d = Standard Deviation of Negative Asset Returns

Investors should, however, not merely consider possible downturns when making important investment decisions: Although both standard deviation and potential downside have played a role in illustrating risk, an investor must be aware of the potential *upside* in order to make *holistic financial decisions*.

3.4.2 Potential upside considerations

Graphs 3.6 and 3.7 considered the *lowest* total return (compounded monthly) over *any* 1 to 5 year rolling period from 1970 to 2007. Graph 3.10 will illustrate the *highest* total return (compounded monthly) over *any* 1 to 5 year rolling period from 1970 to 2007. Effectively, the graph therefore illustrates the "best-case-scenario" in terms of total returns for each asset class over 1 to 5 year periods.

Graph 3.10: Highest total return over any 1 to 5 year period from 1970 to 2007



	1	2	3	4	5
Equity High	124.01%	214.44%	359.42%	501.70%	561.70%
Bonds High	41.64%	75.09%	123.03%	140.47%	189.59%
Cash High	24.15%	48.51%	71.29%	101.53%	131.65%

Source: Own composition

Graph 3.10 illustrates that although (generally) risk in terms of volatility (graph 3.3) and potential downside (graph 3.6) is the highest with equities, the potential upside far outweighs the return from the other asset classes. Table 3.5 to follow

---

The Sortino ratio is similar to the Sharpe ratio, except it uses downside deviation for the denominator instead of standard deviation, the use of which doesn't discriminate between up and down volatility."

summarises the relative movements in terms of the highest returns over any 1 to 5 year period.

Important observations from preceding graph 3.10 and table 3.5 to follow can be summarised as follow:

- Equities illustrate the highest potential positive return.
- Cash illustrates the lowest potential positive return.
- Bonds fall midway between cash and equities in terms of potential positive return.
- The potential upside from equities accelerates faster than that from the other asset classes over time.
- Although the standard deviation of a 4-year bond investment is higher than that of a 1-year equity investment, the potential upside is 16.46% less on bonds relative to a 1-year equity investment.

Whereas equities showed the lowest low return over most periods and the highest high over all periods, cash showed the highest low over all periods and the lowest high over all periods. This relates to the extent to which an asset class can potentially vary from the average or expected return in terms of actual returns. This variance is also reflected in the standard deviation of the different asset classes.

Table 3.5: Relative highest total returns over any 1 to 5 year period from 1970 to 2007

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Return	Year		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
24.15%	1	Cash						-17.49%	-50.94%	-98.88%	-116.32%	-165.44%	-99.86%	-190.29%	-335.27%	-477.55%	-537.55%
48.51%	2							6.87%	-26.58%	-74.52%	-91.96%	-141.08%	-75.50%	-165.93%	-310.91%	-453.19%	-513.19%
71.29%	3							29.65%	-3.80%	-51.74%	-69.18%	-118.30%	-52.72%	-143.15%	-288.13%	-430.41%	-490.41%
101.53%	4							59.89%	26.44%	-21.50%	-38.94%	-88.06%	-22.48%	-112.91%	-257.89%	-400.17%	-460.17%
131.65%	5							90.01%	56.56%	8.62%	-8.82%	-57.94%	7.64%	-82.79%	-227.77%	-370.05%	-430.05%
41.64%	1	Bonds	17.49%	-6.87%	-29.65%	-59.89%	-90.01%						-82.37%	-172.80%	-317.78%	-460.06%	-520.06%
75.09%	2		50.94%	26.58%	3.80%	-26.44%	-56.56%						-48.92%	-139.35%	-284.33%	-426.61%	-486.61%
123.03%	3		98.88%	74.52%	51.74%	21.50%	-8.62%						-0.98%	-91.41%	-236.39%	-378.67%	-438.67%
140.47%	4		116.32%	91.96%	69.18%	38.94%	8.82%						16.46%	-73.97%	-218.95%	-361.23%	-421.23%
189.59%	5		165.44%	141.08%	118.30%	88.06%	57.94%						65.58%	-24.85%	-169.83%	-312.11%	-372.11%
124.01%	1	Equity	99.86%	75.50%	52.72%	22.48%	-7.64%	82.37%	48.92%	0.98%	-16.46%	-65.58%					
214.44%	2		190.29%	165.93%	143.15%	112.91%	82.79%	172.80%	139.35%	91.41%	73.97%	24.85%					
359.42%	3		335.27%	310.91%	288.13%	257.89%	227.77%	317.78%	284.33%	236.39%	218.95%	169.83%					
501.70%	4		477.55%	453.19%	430.41%	400.17%	370.05%	460.06%	426.61%	378.67%	361.23%	312.11%					
561.70%	5		537.55%	513.19%	490.41%	460.17%	430.05%	520.06%	486.61%	438.67%	421.23%	372.11%					

Source: Own composition

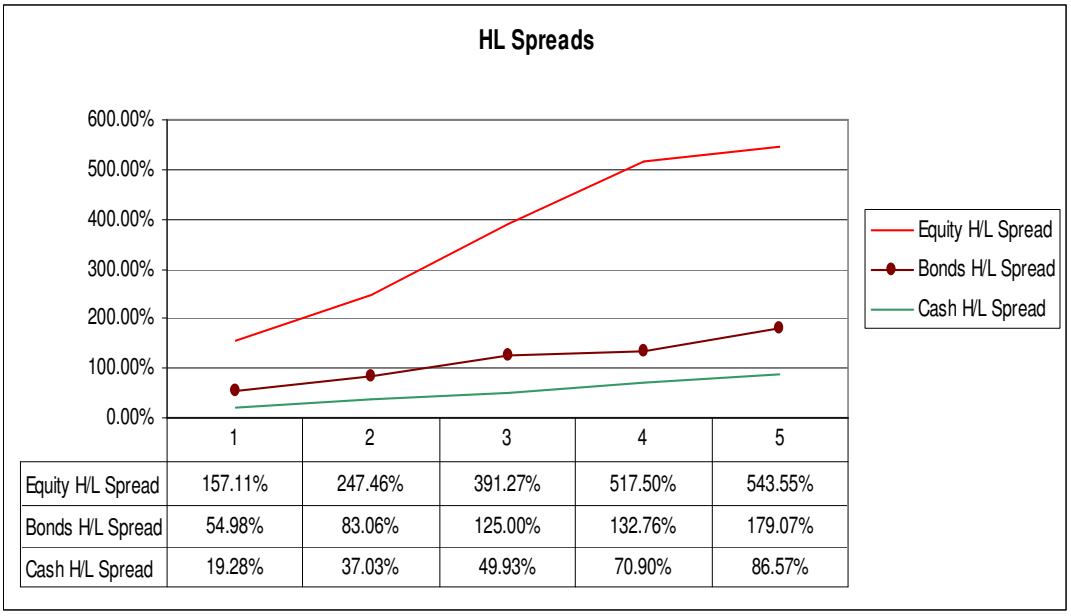
3.4.3 Absolute performance variance: high-low (HL) spreads

Graph 3.11 below illustrates the high-low spread between asset classes. In other words, it calculates the distance between the lowest point and the highest point for each 1 to 5 year period for each of the asset classes. An investor would reasonably expect his/her 1 to 5 year return to fluctuate by no more than the HL spread.

As an illustration, take the example of a very optimistic investor investing in equity for three years who possibly expects the highest returns in history[6] over the same 3-year period, illustrated in graph 3.10 as 359.42%. The investor could possibly only get the historic lowest return, illustrated in graph 3.6 as -31.85%. The HL spread is therefore 391.27% (359.42%. plus 31.85%).

The HL spread can therefore be described as a measure of performance variance, volatility or risk. The potential performance variance between the various asset classes is summarised in graph 3.11 below and table 3.6 to follow.

Graph 3.11: Performance variance: high-low spreads between the different asset classes



	1	2	3	4	5
Equity H/L Spread	157.11%	247.46%	391.27%	517.50%	543.55%
Bonds H/L Spread	54.98%	83.06%	125.00%	132.76%	179.07%
Cash H/L Spread	19.28%	37.03%	49.93%	70.90%	86.57%

Source: Own composition

[6] In this case "history" refers to the January 1970 to December 2007 time period under investigation.

Note from preceding graph 3.11 that:

- The high-low spreads increase over time.
- Relative high-low spreads (possible underperformance or outperformance relative to other asset classes) also increase over time.
- Equities have the steepest slope, indicative of the highest possible performance variance (underperformance or outperformance).
- Cash has the flattest slope, indicative of the lowest possible performance variance (underperformance or outperformance). Cash is the asset with the highest performance consistency.
- Bonds again fall midway between cash and equity in terms of possible performance variance, although the pattern resembles that of cash far more closely.
- The 5-year performance spread of bonds exceeds the 1-year performance spread of equities.

Table 3.6: Relative performance variance over any 1 to 5 year period from 1970 to 2007

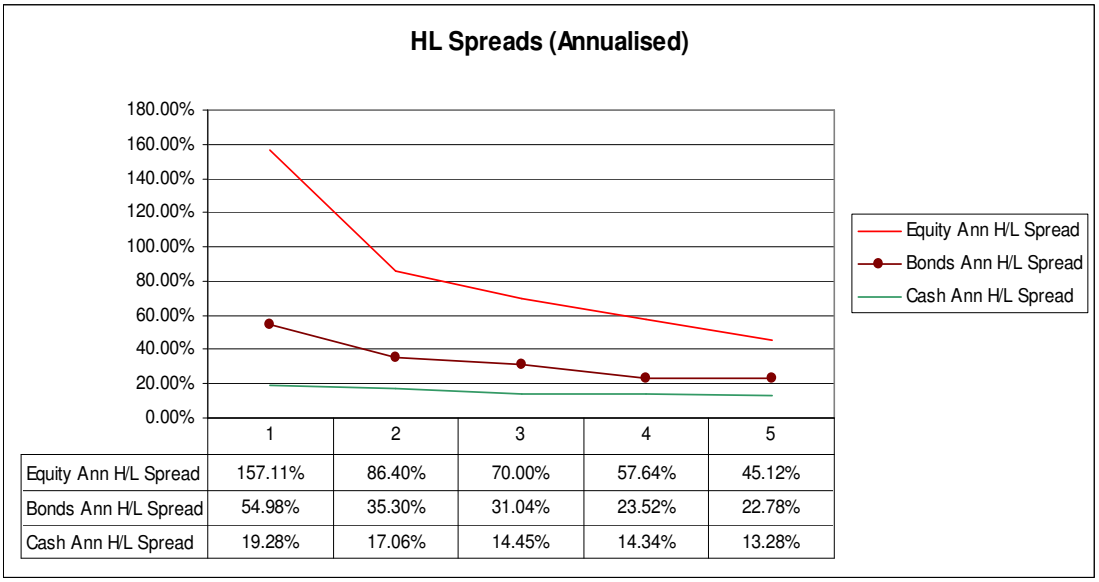
		Asset	Relative to cash					Relative to bonds					Relative to equity				
% HL Spread	Year		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
19.28%	1	Cash						-35.70%	-63.78%	-105.72%	-113.48%	-159.79%	-137.83%	-228.18%	-371.99%	-498.22%	-524.27%
37.03%	2							-17.95%	-46.03%	-87.97%	-95.73%	-142.04%	-120.08%	-210.43%	-354.24%	-480.47%	-506.52%
49.93%	3							-5.05%	-33.13%	-75.07%	-82.83%	-129.14%	-107.18%	-197.53%	-341.34%	-467.57%	-493.62%
70.90%	4							15.92%	-12.16%	-54.10%	-61.86%	-108.17%	-86.21%	-176.56%	-320.37%	-446.60%	-472.65%
86.57%	5							31.59%	3.51%	-38.43%	-46.19%	-92.50%	-70.54%	-160.89%	-304.70%	-430.93%	-456.98%
54.98%	1	Bonds	35.70%	17.95%	5.05%	-15.92%	-31.59%						-102.13%	-192.48%	-336.29%	-462.52%	-488.57%
83.06%	2		63.78%	46.03%	33.13%	12.16%	-3.51%						-74.05%	-164.40%	-308.21%	-434.44%	-460.49%
125.00%	3		105.72%	87.97%	75.07%	54.10%	38.43%						-32.11%	-122.46%	-266.27%	-392.50%	-418.55%
132.76%	4		113.48%	95.73%	82.83%	61.86%	46.19%						-24.35%	-114.70%	-258.51%	-384.74%	-410.79%
179.07%	5		159.79%	142.04%	129.14%	108.17%	92.50%						21.96%	-68.39%	-212.20%	-338.43%	-364.48%
157.11%	1	Equity	137.83%	120.08%	107.18%	86.21%	70.54%	102.13%	74.05%	32.11%	24.35%	-21.96%					
247.46%	2		228.18%	210.43%	197.53%	176.56%	160.89%	192.48%	164.40%	122.46%	114.70%	68.39%					
391.27%	3		371.99%	354.24%	341.34%	320.37%	304.70%	336.29%	308.21%	266.27%	258.51%	212.20%					
517.50%	4		498.22%	480.47%	467.57%	446.60%	430.93%	462.52%	434.44%	392.50%	384.74%	338.43%					
543.55%	5		524.27%	506.52%	493.62%	472.65%	456.98%	488.57%	460.49%	418.55%	410.79%	364.48%					

Source: Own composition

Graph 3.12 below annualises the results from graph 3.11. Note how the HL spread declines over time in a *mean reverting pattern*. This would suggest the following:

a) The possible annualised return can be forecast with a greater measure of accuracy as time passes.
b) There could be a period N in which the HL spread of one asset class is equal to that of other asset classes, although the potential upside is far greater and the potential downside far less.[7]

Graph 3.12: Performance variance: high-low spreads between the different asset classes (annualised)



	1	2	3	4	5
Equity Ann H/L Spread	157.11%	86.40%	70.00%	57.64%	45.12%
Bonds Ann H/L Spread	54.98%	35.30%	31.04%	23.52%	22.78%
Cash Ann H/L Spread	19.28%	17.06%	14.45%	14.34%	13.28%

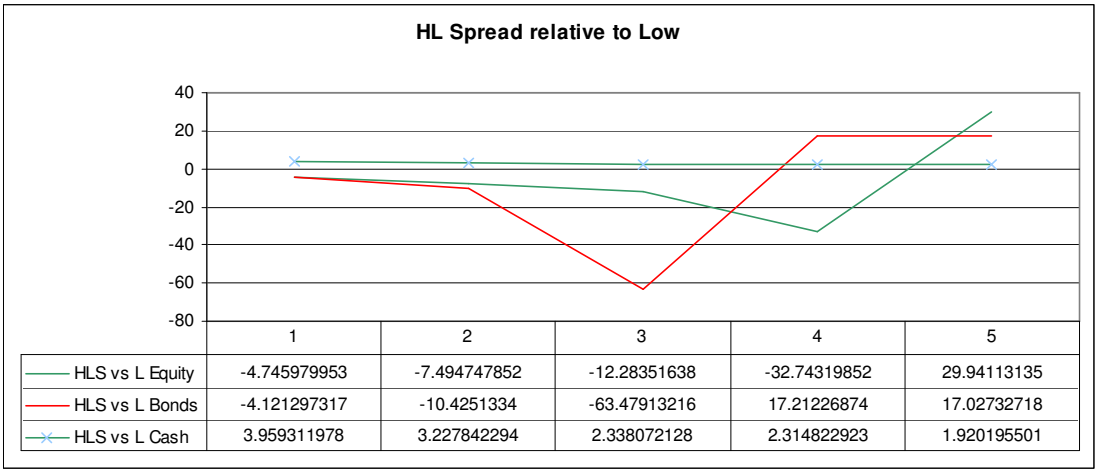
Source: Own composition

As discussed in the preceding section on HL spread, HL spread provides the investor with a valuable alternative/addition to standard deviation in measuring asset class return volatility. In essence, as in the case of standard deviation measurers, this may be used as a measure of *risk*.

[7] This specific discussion is beyond the scope of this chapter although both these aspects will be investigated in detail in chapters 4 and 5.

To conclude the section on HL spread, the study will consider HL spread as a measure of risk, and compare this risk to the potential downside of the various asset class returns.

Graph 3.13: HL spread relative to the potential downside of the various asset class returns



	1	2	3	4	5
HLS vs L Equity	-4.745979953	-7.494747852	-12.28351638	-32.74319852	29.94113135
HLS vs L Bonds	-4.121297317	-10.4251334	-63.47913216	17.21226874	17.02732718
HLS vs L Cash	3.959311978	3.227842294	2.338072128	2.314822923	1.920195501

Source: Own composition

Graph 3.13 illustrates that, relative to the potential low of each asset class for each 1 to 5 year investment period, bonds potentially carry the highest risk as the return spread is not only very high but also *negative*. Equity is the only asset class with a negative ratio for 4 years. None of the asset classes has a negative ratio over 5 years, although return spread for equities remains high at nearly 30. Conversely, the 5 year ratio for cash is the lowest *absolute* figure.

These results concur with those of preceding investigations in the following respects:

- They imply that a 3 year bond investment may be riskier than a 4 year equity investment.
- Over a 1 year period equity is the riskiest asset class.
- A 5 year cash investment is likely to carry the least risk considering the possible variance of actual return compared to expected return.

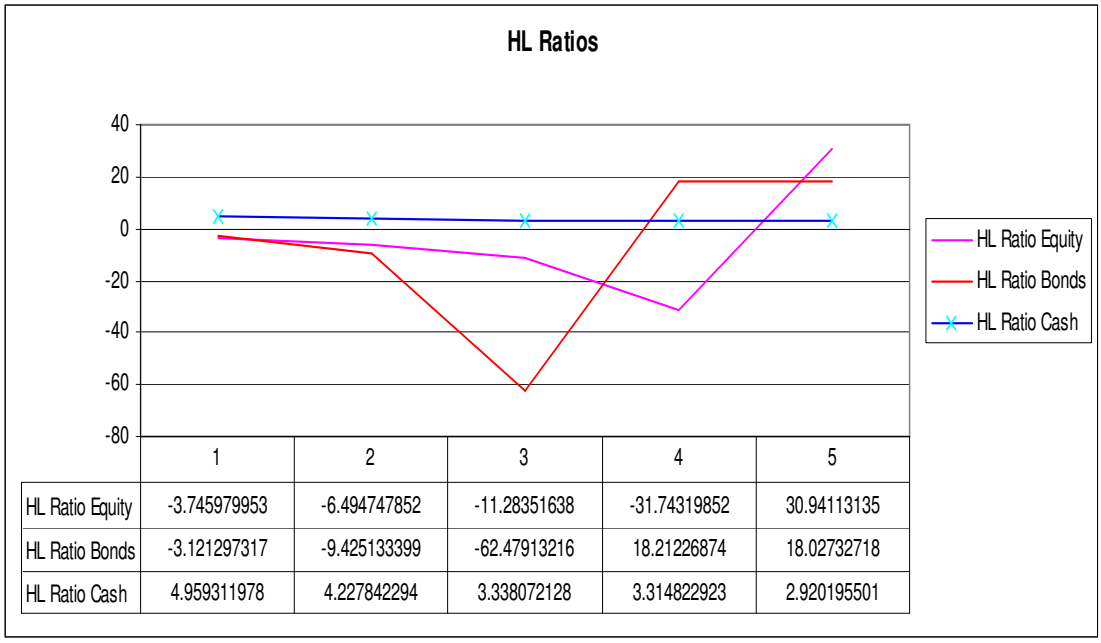
After considering the asset class standard deviation, potential downside, potential upside and high-low spread, an investor would have to consider the potential

upside *relative* to the potential downside in order to decide whether the potential gain is justified. For this purpose, the study examines the respective high-low (HL) ratios in the section below.

3.4.4 Relative potential gain measurement: high-low (HL) ratio

As the name suggests, relative potential gain measurement is the measurement of the potential upside of an investment relative to the potential downside. This measure is therefore an additional assessment of risk that may be integrated into the traditional standard deviation through mean variance methodology. Graph 3.14 below investigates the HL ratios for the different asset classes over all 1 to 5 year periods.

Graph 3.14: High-low (HL) ratios of different SA asset classes



	1	2	3	4	5
HL Ratio Equity	-3.745979953	-6.494747852	-11.28351638	-31.74319852	30.94113135
HL Ratio Bonds	-3.121297317	-9.425133399	-62.47913216	18.21226874	18.02732718
HL Ratio Cash	4.959311978	4.227842294	3.338072128	3.314822923	2.920195501

Source: Own composition

The following conclusions may be drawn from graph 3.14:

- Over 1 to 3 years cash generates superior potential returns (relative to the potential downside) and is *consistently* higher.
- Equities are the highest over 5 years.
- Bonds have very low ratios until year 3.

- Bonds exceed cash over years 4 and 5.
- Cash (although consistent) loses ground from best performer over 1 to 3 years to 2nd over 4 years and last over 5 years.
- Cash's HL ratio is very consistent. (Graphs 3.6, 3.10 and 3.11 explain low upside and low downside over all 1 to 5 year investment periods.)
- Equities are consistent up to year 4 and outweigh other asset classes drastically after that.
- Bonds' HL ratio is very volatile.

The relative rankings of the various high-low ratios can be summarised as follows:

Table 3.7: Relative rankings of HL ratios

Year	Asset ranked 1st	Asset ranked 2nd	Asset ranked 3rd
1	Cash	Bonds	Equity
2	Cash	Equity	Bonds
3	Cash	Equity	Bonds
4	Bonds	Cash	Equity
5	Equity	Bonds	Cash

Source: Own composition

In preceding sections the study discussed potential return and historic risk in more detail. The study evaluated the traditional standard deviation (mean-variance) measure and some additional assessors of risk were discussed.

3.5 Evaluation of the preceding methods and methodology

This section will assess the pros and cons of each of the methods in the preceding section. The study briefly summarises each form of methodology according to each of the following factors (source: own composition):

Arbitrary:	Refers to the measures' input and output variables.
Client friendly:	Refers to which form of investor will be able to make use of the methodology, directly (as investment researcher/practitioner) or indirectly (as reader/client).
Compatibility:	Does this measure add value to a more holistic approach to investment decision making? Can it be sensibly integrated with existing measures?
Easy to understand:	Refers to the level of investment competency required for accurate interpretation and translation of research results.
Accuracy:	Does this measure provide an accurate indication of what is investigated?
Misleading:	Is this measure susceptible to manipulation, whether deliberate or not?
Limited applicability:	Does the measure have limited applicability or scope for further integration?
Future use:	Is there a future use for this form of methodology?
Similar measures:	What other measures are similar to the measure? In which way are they similar and/or different?
Stand-alone value:	How accurate and applicable is this measure when applied in isolation?

Table 3.8 comments on each of the above-mentioned factors.

Table 3.8: Summary: risk assessment methodologies

	Standard deviation	Downside risk	Upside considerations	Absolute performance variance	Relative potential gain measurement
Arbitrary	Input: No Output: To client	Input: No Output: No	Input: No Output: No	Input: No Output: No	Input: No Output: To client
Client friendly	Directly: Yes Indirectly: No	Directly: Yes Indirectly: Yes	Directly: Yes Indirectly: Yes	Directly: Yes Indirectly: Yes	Directly: Yes Indirectly: No
Compatibility	Yes	Yes	Yes	Yes	Yes
Easy to understand	Intermediate	Beginner	Beginner	Beginner	Intermediate
Accuracy	Likely	Yes	Yes	Yes	Likely
Misleading	Deliberate and not deliberate	Deliberate manipulation only	Deliberate manipulation only	Deliberate manipulation only	Deliberate manipulation only
Limited applicability	Yes	Yes	Yes	Yes	Yes
Future use	Yes	Yes	Yes	Yes	Yes
Similar measures	Variance	Maximum drawdown	Sortino	Mean-variance / standard deviation	Sharpe
Stand-alone value	Historically the stand-alone value has been high.	Low	Low	Higher than that of downside and upside consideration methods but still low as a stand-alone measure	Higher than that of downside and upside consideration methods but still low as a stand-alone measure

Source: Own composition

The most notable factors illustrated by table 3.8 are the following:

- All the measures have limited applicability when considered in isolation: Every measure has a limit to what it can achieve. Depending on the requirements of the investigation, a measure will become obsolete if it can no longer accurately provide the researcher with the required results.
- The standard deviation measure is not easy to interpret, is not client friendly and may be misleading.
- The historic stand-alone value standard deviation has been high. There is a demand for additional risk assessment measures.
- Most additional assessment measures are easier to understand, cannot be manipulated and are not misleading.

3.6 Conclusion

To conclude this chapter the discussion on each asset class is briefly revisited and a chapter summary is then provided.

3.6.1 South African equities

a) The average annual return on equity is relatively stable. The average annualised return of the 445 rolling 1-year investment periods is 23.09% and the average annualised return of the 397 rolling 5-year investment periods is 21.14%.

b) The average annualised return *declines* year-on-year from 1-year rolling investment periods to 5-year rolling investment periods. This is indicative of the development of a mean reverting pattern. Chapter 4 will extend the investigation to determine whether a mean reverting pattern exists.

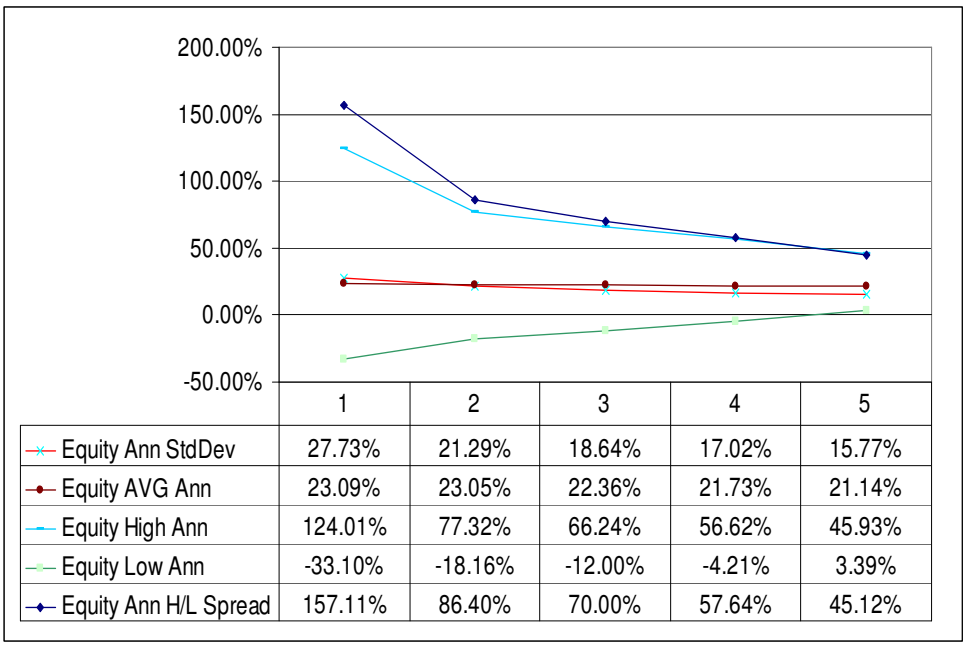
c) Equity experienced the lowest negative annualised return for 1 to 4 year rolling investment periods. Bonds experienced the lowest annualised rolling 5-year investment return.

d) Equity shows by far the greatest performance variance (HL spread). The spread declines rapidly over time, which is indicative of the development of a mean reverting pattern.

e) Equity standard deviation declines more rapidly than equity average return (relative risk reduces over time).

f) Equity HL spread and potential upside (high) are positively correlated. Equity HL spread and potential downside (low) are negatively correlated, which is indicative of the development of a mean reverting pattern.

Graph 3.15: Equity summary



	1	2	3	4	5
Equity Ann StdDev	27.73%	21.29%	18.64%	17.02%	15.77%
Equity AVG Ann	23.09%	23.05%	22.36%	21.73%	21.14%
Equity High Ann	124.01%	77.32%	66.24%	56.62%	45.93%
Equity Low Ann	-33.10%	-18.16%	-12.00%	-4.21%	3.39%
Equity Ann H/L Spread	157.11%	86.40%	70.00%	57.64%	45.12%

Source: Own composition

3.6.2 South African bonds

a) The average annual return on bonds is relatively stable. The average annualised return of the 445 rolling 1-year investment periods is 12.35% and the average annualised return of the 397 rolling 5-year investment periods is 13.13% – a 78 basis point difference.

b) In contrast to the finding in the case of equity, average annualised return *increases* year-on-year from 1-year rolling investment periods to 5-year rolling investment periods as investors are rewarded for taking on longer dated bonds (upward sloping yield curve).

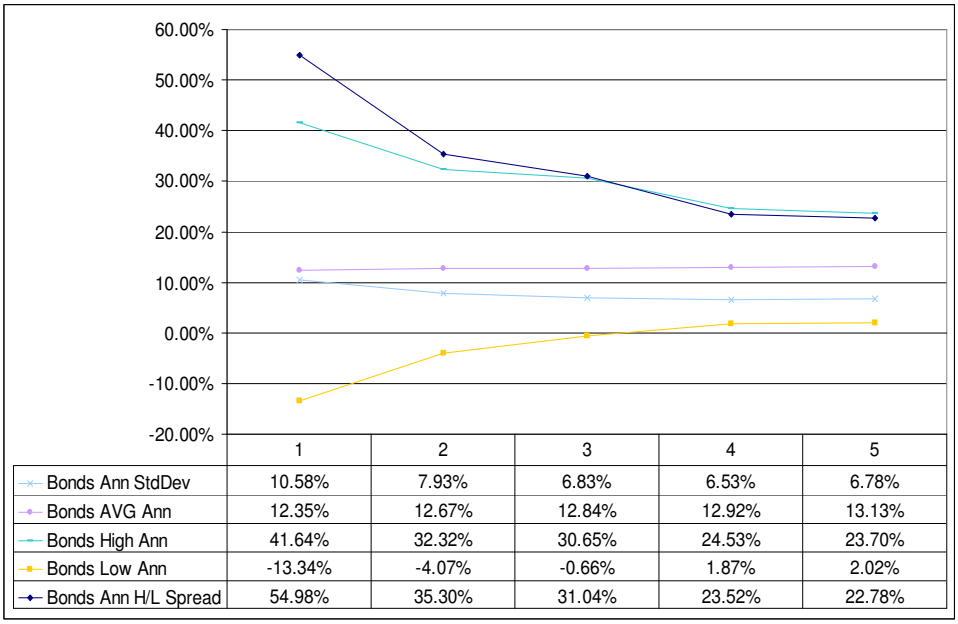
c) Bonds experienced a more stable standard deviation and variance than equity although it was *significantly* higher than that of cash.

d) Again, a rapidly declining HL spread is indicative of the development of a mean reverting pattern.

e) Bonds experienced a negative lowest return for 1, 2 and 3 year rolling investment periods, indicating that they are not a risk-free asset.

f) As in the case of equities, a declining highest return, declining lowest return, positively correlated high and HL spread and negatively correlated low and HL spread, are all indicative of the development of a mean reverting pattern.

Graph 3.16: Bonds summary



	1	2	3	4	5
Bonds Ann StdDev	10.58%	7.93%	6.83%	6.53%	6.78%
Bonds AVG Ann	12.35%	12.67%	12.84%	12.92%	13.13%
Bonds High Ann	41.64%	32.32%	30.65%	24.53%	23.70%
Bonds Low Ann	-13.34%	-4.07%	-0.66%	1.87%	2.02%
Bonds Ann H/L Spread	54.98%	35.30%	31.04%	23.52%	22.78%

Source: Own composition

3.6.3 South African cash

a) The average annual return on cash is very stable. The average annualised return of the 445 rolling 1-year investment periods is 12.47% and the average annualised return of the 397 rolling 5-year investment periods is 13.22% – a 75 basis point difference.

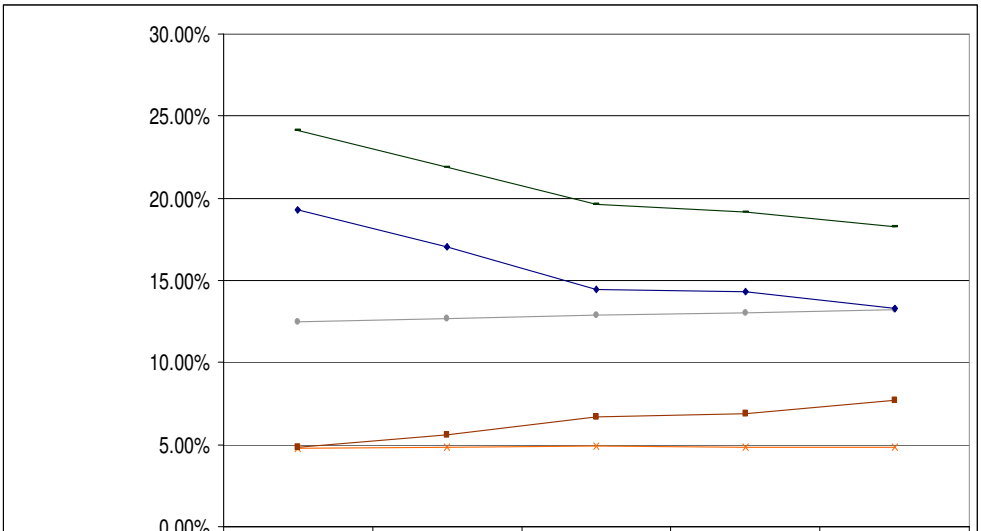
b) In contrast to the finding in the case of equity (but in correspondence with the finding in the case of bonds), the average annualised return *increases* year-on-year from 1-year rolling investment periods to 5-year rolling investment periods as investors are rewarded for taking on longer-dated yields like term/fixed deposits.

c) As in the case of equities and bonds, a declining highest return, declining lowest return, positively correlated high and HL spread and negatively correlated low and HL spread, are all indicative of the development of a mean reverting pattern.

d) Cash return and cash standard deviation are highly correlated. This should not be considered a given since, as the 4-year bond case illustrates, standard deviation may be due to inferior (or even negative) returns.

e) Cash experienced no negative returns over any rolling investment period.

Graph 3.17: Cash summary



	1	2	3	4	5
Cash Ann StdDev	4.75%	4.85%	4.88%	4.86%	4.82%
Cash AVG Ann	12.47%	12.67%	12.86%	13.05%	13.22%
Cash High Ann	24.15%	21.86%	19.65%	19.15%	18.29%
Cash Low Ann	4.87%	5.58%	6.66%	6.91%	7.73%
Cash Ann H/L Spread	19.28%	17.06%	14.45%	14.34%	13.28%

Source: Own composition

3.6.4 Summary

The primary objective of this chapter was to investigate the relationship between short-term[8] volatility and return and to serve as the first of two steps[9] in

[8] In this chapter the study performed an analysis on the 1 to 5 year investment returns and risk of each asset class, namely equities, bonds and cash.
[9] Chapter 4 will be the second building block in this process as it will investigate long-term volatility and return.

demonstrating that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames.[10]

Implicitly, the chapter also illustrated the risk associated with short-term investment, investigated and discussed the relationship between risk and return on a relative basis, and tabulated the returns for each asset class before discussing the patterns and trends.

The secondary objective of the chapter of presenting additional and/or alternative, somewhat more intuitive measures of risk was satisfied. The chapter presented the potential downside, potential upside, high-low spread, and relative potential gain measurement via the high-low (HL) ratio measures. The pros and cons of each measure were also assessed.

The chapter illustrated, via all the above-mentioned measures, that the risk associated with short-term investment was significant on account of higher performance variance.

The chapter identified the development of mean reverting patterns in asset class returns and emphasised the importance of holistic risk assessment and management.

The short-term risk return relationship was therefore intensively studied. New risk measures were presented and these will now be applied/ utilised in the long-term investment investigation in chapter 4.

[10] Chapter 5 will apply the findings from chapters 3 and 4, to illustrate that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames.

CHAPTER 4

RETURN-VOLATILITY: LONG-TERM RELATIONSHIP

4.1 Introduction

In chapter 3, "Return-volatility: short-term relationship", the study performed an analysis of the 1 to 5 year returns of each asset class (SA equities, SA bonds and SA cash).

To a large extent chapter 4 replicates the investigation reported on in chapter 3. A volatility-return analysis is again performed and each asset class discussed; returns and risk are investigated not only in terms of standard deviation but also in terms of the additional newly presented risk measures, downside risk, potential upside considerations, absolute performance variance, and relative potential gain measurement. In the part of the investigation reported on in chapter 4, only one variable has changed from chapter 3 – the period investigated.

Chapter 4, "Return-volatility: long-term relationship", will investigate the relationship between *long-term* volatility and return and will be the second of two steps[1] in demonstrating that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames (chapter 5).

As in chapter 3, chapter 4 will also investigate five periods from the database spanning most of the acquired data.[2] Chapter 4 will investigate five terms at seven year intervals within the 37-year database. This provides an evenly distributed view of long-term risk return dynamics.

[1] Chapter 3 was the first step in this process.

[2] In an attempt to prevent any form of statistical inaccuracy this investigation has not allocated more than a 3% weighting to any single data point. As each of the rolling periods in the 36, 37 and 38 year investment horizons exceed the 3% weighting they have not been considered here for further discussion. Although these individual investment horizons have been ignored, data from the entire 37 year database were applied for periods of 35 years or less.

This chapter will therefore perform an analysis of the returns[3] generated over 7, 14, 21, 28 and 35 year periods[4] by each asset class (equities, bonds, and cash) and again tabulate returns and return volatility for each asset class before identifying patterns/trends. Volatility-return analysis and discussion of each asset class will follow.

It may be recalled that the objective of this dissertation is to illustrate that although asset class returns move along the risk-return curve as conventionally stated, when the investment term is considered there could be a shift in the risk-return curve/dynamic that could have a significant impact on the investment decision.

The main objective of this chapter is therefore to prepare the ground for chapter 5 to identify any consistencies or inconsistencies in the results obtained from our various risk measures in the short-term investigation in chapter 3 versus the results obtained in this long-term investigation.

As risk measures play an important role in the investment decision making process of all investors, any inconsistencies found in the results obtained over different periods from the risk measures presented should be investigated further[5] and the implications of any such inconsistencies should be determined.[6]

4.2 Average South African asset class returns over the long term

This section investigates South African asset class returns for all monthly rolling 7, 14, 21, 28 and 35 year investment periods from 1970 to 2007.

Table 4.1 illustrates the number of rolling N-year periods that were used to calculate the average returns for each of the 7, 14, 21, 28 and 35 year investment periods – the investment periods investigated in this chapter.

[3] Either as total returns or annualised depending on the argument and/or requirement.
[4] This investigation should therefore cater for most definitions of "long-term investment".
[5] Chapter 5 will discuss the results given in chapters 3 and 4 on a relative basis.
[6] Chapter 6 will conclude this dissertation by discussing the implications of the findings of this study.

Table 4.1 also includes the particulars of the statistical contribution of each data point. The statistical contribution/weighting of each data point is a critical consideration, particularly when investigating longer time frames. As investigation periods increase, the statistical contribution of each data point will increase.[7]

In order to prevent inaccuracies of any kind, the study limited its investigation to 35-year investment horizons. This implies a 2.703% weighting (100% divided by the number of data points represented by the number of rolling periods in the database) for each data point. These individual data points should not cause any distortion or misrepresentations in the results of the analyses as the contribution of an individual data point is too small to manipulate the result from the analysis of the entire dataset.

Table 4.1: Rolling periods in database for all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007

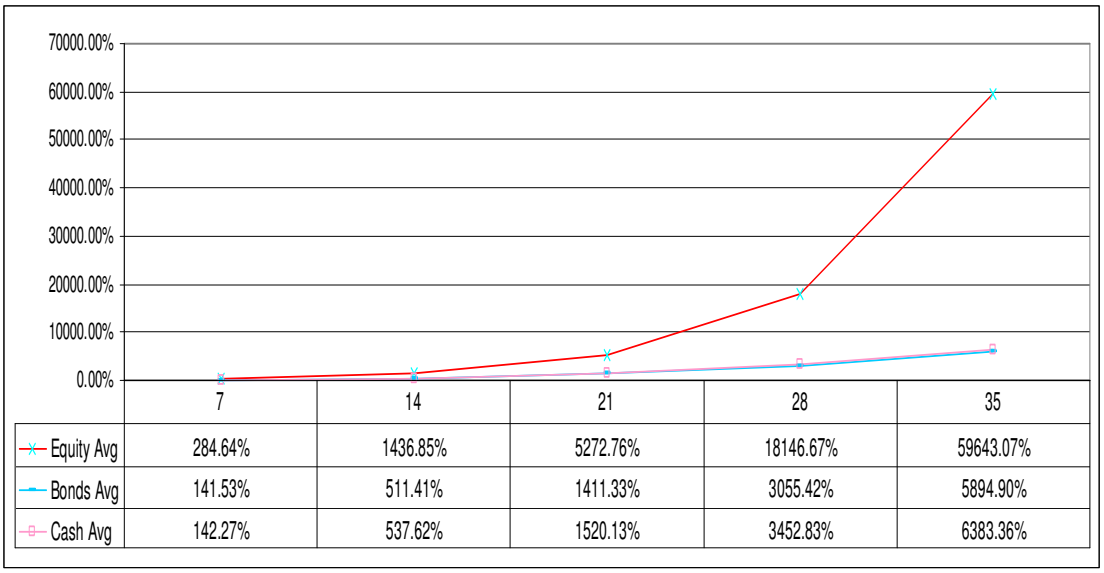
Investment term (years)	Rolling periods in database	Statistical contribution of each data point
7	373	0.268%
14	289	0.346%
21	205	0.488%
28	121	0.826%
35	37	2.703%

Source: Own composition.

Graph 4.1 summarises the average total returns from equity, bonds and cash for 7, 14, 21, 28 and 35 year rolling investment periods. Graph 4.2 annualises these average total returns to put the figures into perspective.

[7] Because the greater investigation periods take up a greater portion of the sample data.

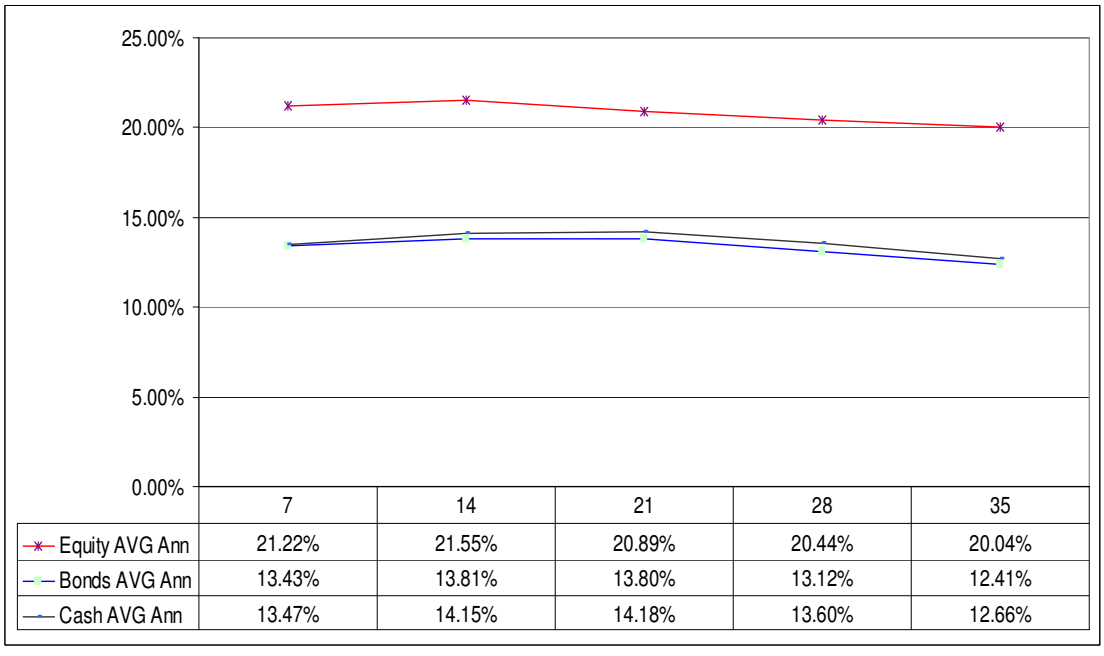
Graph 4.1: Average[8] rolling 7, 14, 21, 28 and 35 year returns for SA asset classes from 1970 to 2007



	7	14	21	28	35
Equity Avg	284.64%	1436.85%	5272.76%	18146.67%	59643.07%
Bonds Avg	141.53%	511.41%	1411.33%	3055.42%	5894.90%
Cash Avg	142.27%	537.62%	1520.13%	3452.83%	6383.36%

Source: Own composition

Graph 4.2: Average rolling 7, 14, 21, 28 and 35 year returns for SA asset classes from 1970 to 2007 (annualised)



	7	14	21	28	35
Equity AVG Ann	21.22%	21.55%	20.89%	20.44%	20.04%
Bonds AVG Ann	13.43%	13.81%	13.80%	13.12%	12.41%
Cash AVG Ann	13.47%	14.15%	14.18%	13.60%	12.66%

Source: Own composition

[8] As mentioned in chapter 3 "average" in this context means the average of the sum of the rolling returns over a *fixed* period. Average in this context does not mean that the average return for shorter periods was calculated by averaging the long-term performance by dividing and multiplying by a required number of years. Where annual figures are indicated, average returns (for a given fixed period) were annualised. In other words the geometric mean was calculated. This prevents the study from overstating returns.

Note from graph 4.2 that equity returns fluctuate between 20.04% and 21.55%, considering the 7 to 35 year investment horizons. This is evidence of notable stability. Possibly a degree of mean reversion exists.[9]

As may be expected, at least to a degree, the average returns from bonds and cash were similarly stable: bond returns fluctuated between 12.41% and 13.81% and cash between 12.66% and 14.18%.

Note that all the asset classes increase in average return when the 7 and 14 year investment intervals are compared. Considering the 14 to 28 year intervals, returns slope slightly downwards, however. In this case it is important to mention that the general trend presented in graph 4.2 is downward sloping returns for all asset classes. However, considering the diminutive form of this degeneration and the irrationality of the interim movements, it can be argued that mean reversion has been reached and the differences mentioned above are mere marginal anomalies. The topic of mean reversion will be investigated in detail in chapter 5.

To sum up the discussion on graph 4.2, it is clear that since 1970 South African equities have managed to (on average) significantly outperform SA bonds and SA cash. Over all 7, 14, 21, 28 and 35 year periods SA bonds and SA cash generated similar returns, with equities generating roughly a 7.5% equity premium.[10] The details pertaining to these differences are summarised in table 4.2, which reflects the results from graph 4.1 on a relative basis.

Note from table 4.2 and graph 4.1 that:

- There are significant similarities in the returns on cash and bonds over all investment periods.

[9] The topic of mean reversion extends beyond the objectives of this chapter. Mean reversion will, however, be investigated in chapter 5.

[10] An equity risk premium is an excess return paid to the investor for accepting an excess risk over a risk-free rate. Conventionally the equity risk premium is accepted as the difference in return from the equity or equity portfolio and a Treasury bill (T-bill). In this case the equity premium refers to the excess return from equity compared to cash.

- However, when matching the 35 year investment periods (graph 4.1), annualised cash exceeds bond returns only by 25 basis points. In terms of total return the 25 basis point difference compounds to 488% of capital invested and an outperformance of 8.3%.
- On average, over a 7-year investment term, equities returned around double the return on bonds and cash.
- A 14-year equity investment would have outperformed a 21-year bond investment by more than 25% of the capital invested.
- On average, over a 35-year investment term, equities returned roughly *ten times* as much as bonds or cash.
- The average 14-year equity investment return exceeds the average 21-year bond investment return. In other words, the long-term bond investor can reduce his investment horizon by more than 33% to 14 years by accepting a greater measure of volatility.[11]
- Similarly, the average 21-year equity investment return exceeds the average 35-year bond investment return. In other words, the long-term bond investor can reduce his investment horizon by 14 years (40%) by accepting a greater measure of volatility.

[11] Volatility will be discussed in the following section.

Table 4.2 : Average return spreads (underperformance or outperformance) of SA asset classes over rolling 7, 14, 21, 28 and 35 year investment periods

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Return	Year		7	14	21	28	35	7	14	21	28	35	7	14	21	28	35
142.27%	7	Cash						0.74%	-369.14%	-1269.07%	-2913.15%	-5752.63%	-142.37%	-1294.58%	-5130.49%	-18004.40%	-59500.81%
537.62%	14							396.09%	26.21%	-873.71%	-2517.80%	-5357.28%	252.98%	-899.23%	-4735.14%	-17609.05%	-59105.45%
1520.13%	21							1378.60%	1008.73%	108.80%	-1535.29%	-4374.77%	1235.50%	83.28%	-3752.62%	-16626.54%	-58122.94%
3452.83%	28							3311.30%	2941.42%	2041.49%	397.41%	-2442.07%	3168.19%	2015.98%	-1819.93%	-14693.84%	-56190.25%
6383.36%	35							6241.83%	5871.95%	4972.02%	3327.94%	488.46%	6098.72%	4946.51%	1110.60%	-11763.31%	-53259.72%
141.53%	7	Bonds	-0.74%	-396.09%	-1378.60%	-3311.30%	-6241.83%						-143.11%	-1295.32%	-5131.23%	-18005.14%	-59501.55%
511.41%	14		369.14%	-26.21%	-1008.73%	-2941.42%	-5871.95%						226.77%	-925.45%	-4761.35%	-17635.27%	-59131.67%
1411.33%	21		1269.07%	873.71%	-108.80%	-2041.49%	-4972.02%						1126.70%	-25.52%	-3861.42%	-16735.34%	-58231.74%
3055.42%	28		2913.15%	2517.80%	1535.29%	-397.41%	-3327.94%						2770.78%	1618.57%	-2217.33%	-15091.25%	-56587.65%
5894.90%	35		5752.63%	5357.28%	4374.77%	2442.07%	-488.46%						5610.27%	4458.05%	622.15%	-12251.77%	-53748.17%
284.64%	7	Equity	142.37%	-252.98%	-1235.50%	-3168.19%	-6098.72%	143.11%	-226.77%	-1126.70%	-2770.78%	-5610.27%					
1436.85%	14		1294.58%	899.23%	-83.28%	-2015.98%	-4946.51%	1295.32%	925.45%	25.52%	-1618.57%	-4458.05%					
5272.76%	21		5130.49%	4735.14%	3752.62%	1819.93%	-1110.60%	5131.23%	4761.35%	3861.42%	2217.33%	-622.15%					
18146.67%	28		18004.40%	17609.05%	16626.54%	14693.84%	11763.31%	18005.14%	17635.27%	16735.34%	15091.25%	12251.77%					
59643.07%	35		59500.81%	59105.45%	58122.94%	56190.25%	53259.72%	59501.55%	59131.67%	58231.74%	56587.65%	53748.17%					

Source: Own composition

In the preceding section the study investigated long-term average total and annualised returns.

It is important to establish the measure of volatility that was experienced/accepted to generate these returns. The standard deviations of these returns are discussed in the section below.

The discussion on standard deviation will be followed by the assessments of risk from the newly presented risk measures.[12]

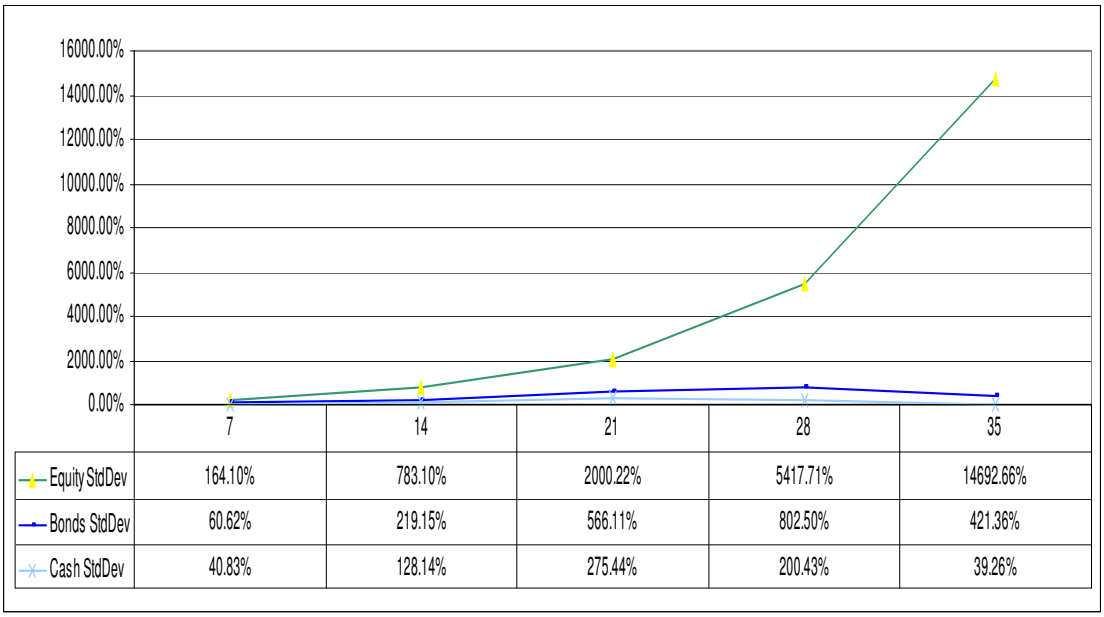
4.3 Average South African asset class standard deviations over the long term

This section investigates the South African asset class standard deviations for all monthly rolling 7, 14, 21, 28 and 35 year investment terms from 1970 to 2007.

Graph 4.3 below summarises the standard deviations based on the average returns from SA equity, SA bonds and SA cash for all rolling 7, 14, 21, 28 and 35 year investment periods.

[12] In chapter 3 the following additional measures of risk were presented: 1) downside risk 2) potential upside consideration 3) absolute performance variance (high-low spread), and 4) relative potential gain measurement via the high-low (HL) ratio.

Graph 4.3: Return standard deviations for SA asset classes from 1970 to 2007 for 7, 14, 21, 28 and 35 year investment periods

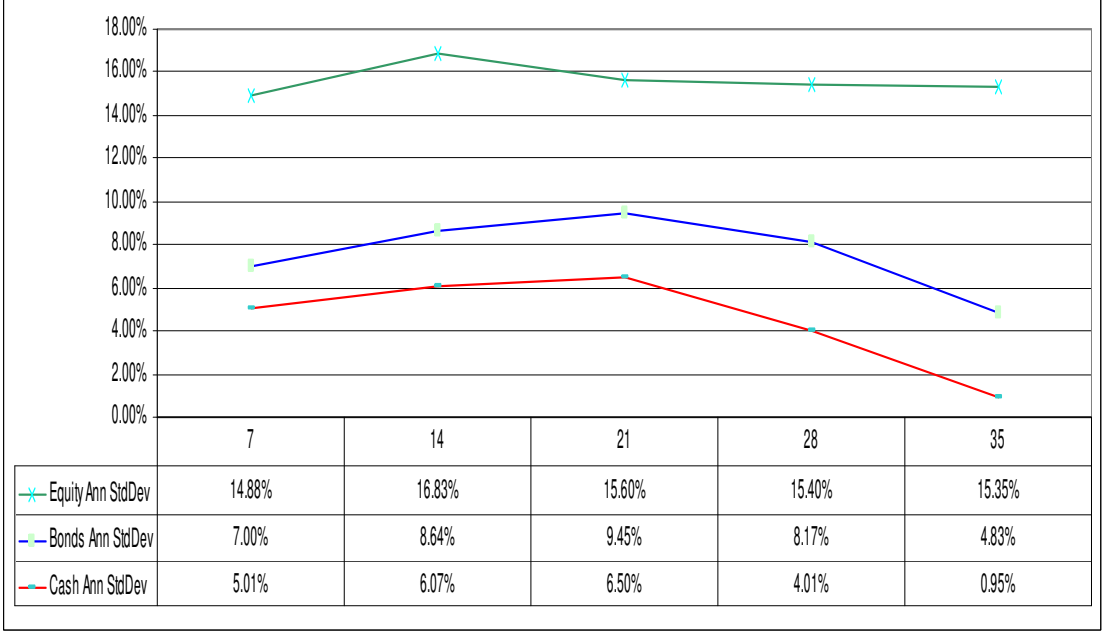


	7	14	21	28	35
Equity StdDev	164.10%	783.10%	2000.22%	5417.71%	14692.66%
Bonds StdDev	60.62%	219.15%	566.11%	802.50%	421.36%
Cash StdDev	40.83%	128.14%	275.44%	200.43%	39.26%

Source: Own composition

Again, graph 4.4 below annualises the standard deviations from above in order to put the relative annual volatility into perspective.

Graph 4.4: Return standard deviations for SA asset classes from 1970 to 2007 for 7, 14, 21, 28 and 35 investment periods (annualised)



	7	14	21	28	35
Equity Ann StdDev	14.88%	16.83%	15.60%	15.40%	15.35%
Bonds Ann StdDev	7.00%	8.64%	9.45%	8.17%	4.83%
Cash Ann StdDev	5.01%	6.07%	6.50%	4.01%	0.95%

Source: Own composition

It is clear that since 1970 South African equities have experienced significantly higher standard deviations than South African bonds or cash.

Graph 4.4 above illustrates that equity carries a significantly higher risk[13] than bonds and cash. The graph also illustrates that cash and bond standard deviations decline rapidly at some point after 21 years.

Equity risk declines far more slowly and generally remains relatively constant at 15% regardless of investment term.

The following may also be noted from graph 4.4:

- Standard deviation increases from the 7-year horizon to the 14-year horizon, but then slopes downwards thereafter.
- This finding is similar to that of the return investigation in graph 4.2 – the return variance is therefore reflected in the standard deviation measure.
- The 35-year standard deviation of cash and bonds is less than the 7- year standard deviation of cash and bonds.
- In the equity case, however, the 35-year annualised standard deviation of equity exceeds the 7-year annualised standard deviation of equity, suggesting that a 35-year equity investment is riskier than a 7-year equity investment.[14]
- Another inconsistency is evident: 21-year equity investments returned the highest standard deviation of the five intervals investigated. 21-year equity investments are therefore somehow perceived as riskier than equity invested in both shorter and longer periods.

Graphs 4.3 and 4.4 indicate that although bonds and cash generate similar returns for all matched investment periods (graph 4.2), the standard deviation of cash is consistently lower than that of bonds.

[13] Defined here as standard deviation.
[14] This finding will be disproved in chapter 5.

These differences are again summarised on a relative basis over all rolling 7, 14, 21, 28 and 35 year investment periods in table 4.3 on the following page.

Note from table 4.3 that:

- Over no investment period does equity outperform the other two asset classes at a lower degree of volatility (standard deviation).[15]

- However, equities returned roughly ten times the return from either bonds or cash over a 35 year investment term (table 4.2).

- This illustrates how avoiding assets solely on the basis of standard deviation considerations can cause inferior long-term investment decision making.

[15] Section 4.4.1 of this chapter will illustrate, however, that equities have outperformed cash and bonds and in most cases generate superior "worst-case-scenario" returns. Refer to section 4.1 for a more detailed discussion of this topic.

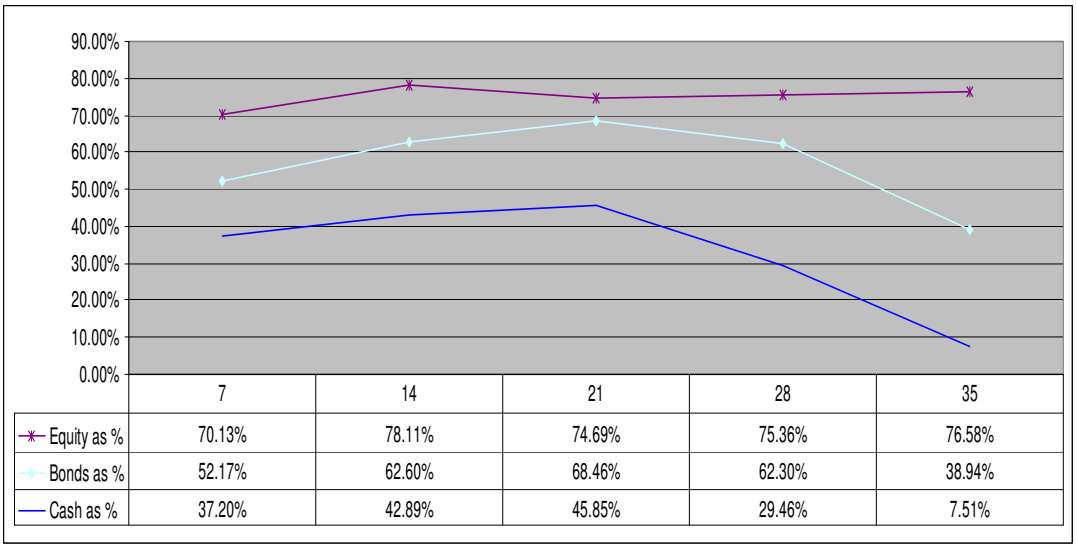
Table 4.3: Standard deviation spreads of SA asset classes for all 7, 14, 21, 28 and 35 year investment periods

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Std.dev	Year		7	14	21	28	35	7	14	21	28	35	7	14	21	28	35
40.83%	7	Cash						-19.79%	-178.32%	-525.28%	-761.67%	-380.53%	-123.27%	-742.27%	-1959.39%	-5376.88%	-14651.83%
128.14%	14							67.52%	-91.00%	-437.97%	-674.36%	-293.22%	-35.96%	-654.95%	-1872.07%	-5289.57%	-14564.52%
275.44%	21							214.82%	56.29%	-290.67%	-527.06%	-145.93%	111.34%	-507.66%	-1724.78%	-5142.27%	-14417.22%
200.43%	28							139.81%	-18.72%	-365.68%	-602.07%	-220.93%	36.33%	-582.67%	-1799.79%	-5217.28%	-14492.23%
39.26%	35							-21.37%	-179.89%	-526.86%	-763.25%	-382.11%	-124.84%	-743.84%	-1960.96%	-5378.45%	-14653.41%
60.62%	7	Bonds	19.79%	-67.52%	-214.82%	-139.81%	21.37%						-103.48%	-722.47%	-1939.59%	-5357.09%	-14632.04%
219.15%	14		178.32%	91.00%	-56.29%	18.72%	179.89%						55.05%	-563.95%	-1781.07%	-5198.56%	-14473.52%
566.11%	21		525.28%	437.97%	290.67%	365.68%	526.86%						402.01%	-216.98%	-1434.10%	-4851.60%	-14126.55%
802.50%	28		761.67%	674.36%	527.06%	602.07%	763.25%						638.40%	19.41%	-1197.71%	-4615.20%	-13890.16%
421.36%	35		380.53%	293.22%	145.93%	220.93%	382.11%						257.27%	-361.73%	-1578.85%	-4996.34%	-14271.30%
164.10%	7	Equity	123.27%	35.96%	-111.34%	-36.33%	124.84%	103.48%	-55.05%	-402.01%	-638.40%	-257.27%					
783.10%	14		742.27%	654.95%	507.66%	582.67%	743.84%	722.47%	563.95%	216.98%	-19.41%	361.73%					
2000.22%	21		1959.39%	1872.07%	1724.78%	1799.79%	1960.96%	1939.59%	1781.07%	1434.10%	1197.71%	1578.85%					
5417.71%	28		5376.88%	5289.57%	5142.27%	5217.28%	5378.45%	5357.09%	5198.56%	4851.60%	4615.20%	4996.34%					
14692.66%	35		14651.83%	14564.52%	14417.22%	14492.23%	14653.41%	14632.04%	14473.52%	14126.55%	13890.16%	14271.30%					

Source: Own composition

In order to determine the relative risk, graph 4.5 below summarises standard deviation expressed as a percentage of the aforementioned average returns.[16] [17]

Graph 4.5: Standard deviation (volatility) as a percentage of total return



	7	14	21	28	35
Equity as %	70.13%	78.11%	74.69%	75.36%	76.58%
Bonds as %	52.17%	62.60%	68.46%	62.30%	38.94%
Cash as %	37.20%	42.89%	45.85%	29.46%	7.51%

Source: Own composition

Graph 4.5 therefore illustrates the "risk" or volatility relative to the return generated. Therefore, the lower the ratio the higher the return relative to the risk (less risk/volatility was accepted per unit of return generated).

Keeping this in mind, it can be concluded from graph 4.5 that cash showed the most "efficient" return over all the investigated investment periods as it adopted less risk to generate the same *unitised* return over all periods. To reiterate, the measure suggests that an investor experienced the least risk (volatility) per unit of return invested in cash.

[16] Note that there is no need to annualise these returns before calculating the volatility as a percentage of the average return as the results would be exactly the same as in the case of cumulative returns and standard deviations.

[17] It may be recalled that chapter 3 expressed this in the form of a formula as:

$$= \frac{\text{Standard deviation of asset class X period N}}{\text{Total average return of asset class X period N}}$$

Cash volatility in returns was between 7.5% and 45.9% of the actual return over the same period. Equities fluctuated between far less "efficient" regions of between 70.1% and more than 78.1%. Bonds fluctuated between 38.9% and 45.6%, a level of efficiency midway between cash and equities. .

Note that although the "efficiency level" of equity is drastically lower than that of cash and bonds, the efficiency level remains relatively constant. This may be an indication either that equity is riskier than the other asset classes or that the level of growth from equity *necessitates* this degree of volatility.

Also note the downward slope (declining trend) in the standard deviation of the total return ratios of cash and bonds over time. Table 4.4 summarises these declines.

Note from table 4.4 that a 35-year equity investment would be only slightly less risky than a 7-year cash investment (relative to the average return from the respective asset classes).

Considering the previous finding, and using only standard deviation as a measure of risk, one might conclude that a 7-year cash investment has a higher probability of loss than 35-year equity investments.[18]

It is important to mention that as this measure makes use of only two factors, return and volatility, the resulting ratio can only vary due to changes in either one or both of these factors. An irrationally high or low value as nominator or denominator can significantly impact the ratio without the reader necessarily understanding which of the factors may have caused this effect.

Cash experienced so little volatility for example that any respectable return is magnified after volatility considerations.

[18] Using the newly presented risk measures from chapter 3, this will be disproved in section 4, "Additional measures and assessments of risk" of this chapter.

Conversely, equity (which experienced the highest return by far), experienced dwarfed volatility-adjusted returns.

This would intuitively suggest that volatility considerations should not be consulted in isolation when making holistic investment decisions. The need for additional/supplemental measures and assessments of risk has been emphasised.

Table 4.4: Declines in standard deviation (volatility) as a percentage of total return over the long term

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Std.dev	Year		7	14	21	28	35	7	14	21	28	35	7	14	21	28	35
28.70%	7	Cash						-14.13%	-14.15%	-11.41%	2.43%	21.55%	-28.95%	-25.80%	-9.24%	-1.16%	4.06%
23.84%	14							-19.00%	-19.02%	-16.28%	-2.43%	16.69%	-33.82%	-30.67%	-14.10%	-6.02%	-0.80%
18.12%	21							-24.71%	-24.73%	-21.99%	-8.15%	10.97%	-39.53%	-36.38%	-19.82%	-11.74%	-6.51%
5.80%	28							-37.03%	-37.05%	-34.31%	-20.46%	-1.34%	-51.85%	-48.70%	-32.13%	-24.05%	-18.83%
0.61%	35							-42.22%	-42.24%	-39.50%	-25.65%	-6.53%	-57.04%	-53.89%	-37.32%	-29.24%	-24.02%
42.83%	7	Bonds	14.13%	19.00%	24.71%	37.03%	42.22%						-14.82%	-11.67%	4.90%	12.98%	18.20%
42.85%	14		14.15%	19.02%	24.73%	37.05%	42.24%						-14.80%	-11.65%	4.92%	13.00%	18.22%
40.11%	21		11.41%	16.28%	21.99%	34.31%	39.50%						-17.54%	-14.39%	2.18%	10.26%	15.48%
26.26%	28		-2.43%	2.43%	8.15%	20.46%	25.65%						-31.39%	-28.24%	-11.67%	-3.59%	1.63%
7.15%	35		-21.55%	-16.69%	-10.97%	1.34%	6.53%						-50.50%	-47.35%	-30.79%	-22.71%	-17.49%
57.65%	7	Equity	28.95%	33.82%	39.53%	51.85%	57.04%	14.82%	14.80%	17.54%	31.39%	50.50%					
54.50%	14		25.80%	30.67%	36.38%	48.70%	53.89%	11.67%	11.65%	14.39%	28.24%	47.35%					
37.93%	21		9.24%	14.10%	19.82%	32.13%	37.32%	-4.90%	-4.92%	-2.18%	11.67%	30.79%					
29.86%	28		1.16%	6.02%	11.74%	24.05%	29.24%	-12.98%	-13.00%	-10.26%	3.59%	22.71%					
24.63%	35		-4.06%	0.80%	6.51%	18.83%	24.02%	-18.20%	-18.22%	-15.48%	-1.63%	17.49%					

Source: Own composition

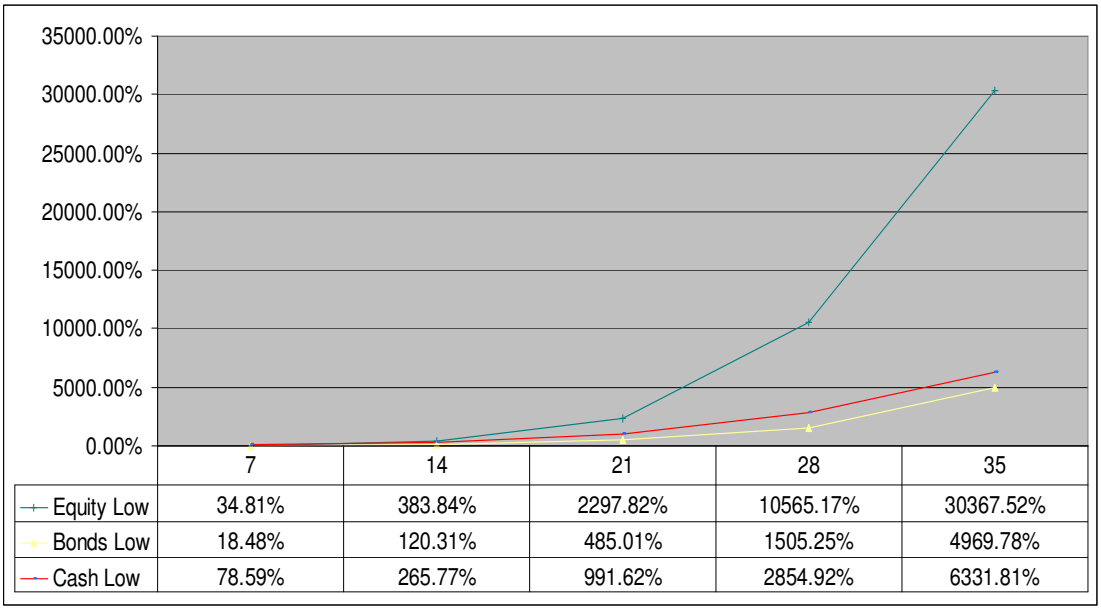
4.4 Additional measures and assessments of risk

4.4.1 Downside risk

Graph 4.6 below illustrates the lowest total return over all 7, 14, 21, 28 and 35 year monthly rolling investment periods from 1970 to 2007.

Effectively, the graph therefore illustrates the "worst-case-scenario" in terms of total returns for each asset class over 7, 14, 21, 28 and 35 year periods.

Graph 4.6: Lowest total return over all 7, 14, 21, 28 and 35 year rolling investment periods



	7	14	21	28	35
Equity Low	34.81%	383.84%	2297.82%	10565.17%	30367.52%
Bonds Low	18.48%	120.31%	485.01%	1505.25%	4969.78%
Cash Low	78.59%	265.77%	991.62%	2854.92%	6331.81%

Source: Own composition

Note from graph 4.6 that:

- No asset experienced a negative return over any of the investigated periods.
- Time horizon and return show a strong positive correlation (applicable to all asset classes).

- Equity minimum return has already exceeded bond minimum return at the 7-year investment horizon.[19]
- Equity minimum return exceeds cash somewhere between the 7-year investment horizon and the 14-year investment horizon.[20]
- The 21-year minimum equity return is more than double that of cash and more than 4 times that of bonds.
- The 28-year minimum return from equity is double that of the minimum 35-year bond investment and 1.5 times that of cash.
- The minimum 35-year equity return is 6 times that of bonds and almost 5 times that of cash.

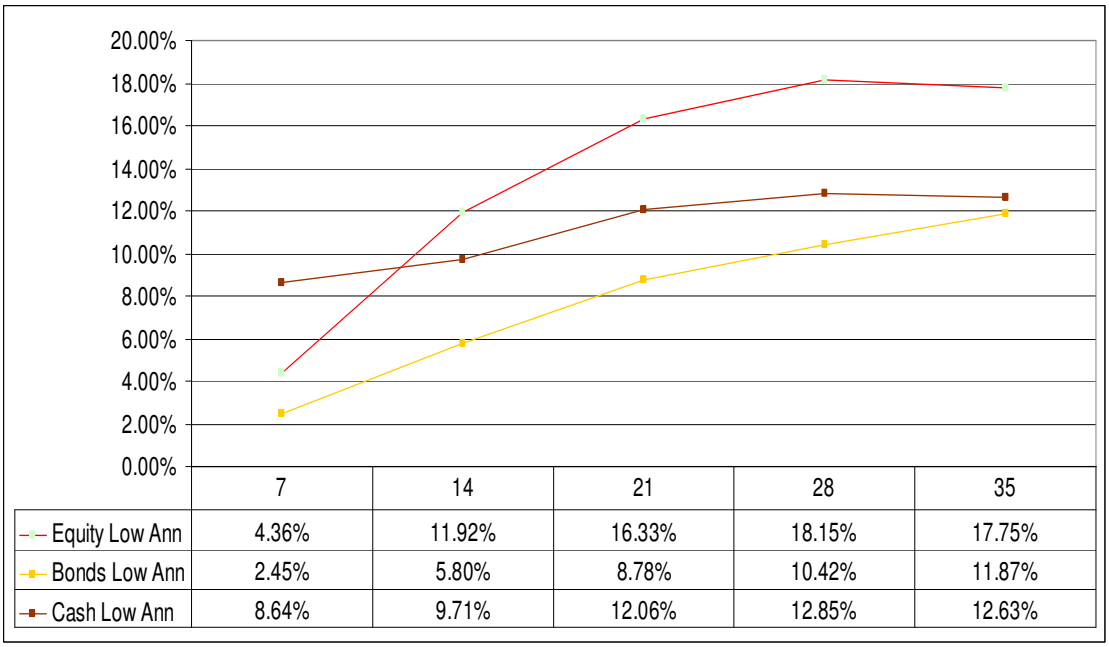
Graph 4.7 annualises the results from graph 4.6. An important implication of this section is that findings from the downside risk measure and findings from the standard deviation measure are contradictory, as indicated below.

The standard deviation measure (graph 4.4) illustrated that equities are three times riskier than cash and twice as risky as bonds over a 7-year investment horizon. Over 35 years the standard deviation of equity return was more than 15 times that of cash and more than 3 times that of bonds.

The downside risk measure would suggest that these findings are incorrect as the minimum return on equity far exceeds that on cash (after 9/10 years) and bonds (after 4/5 years).

[19] Chapter 3 illustrated that the minimum worst case scenario return from equity exceeded the minimum worst case scenario return from bonds at around the 4 and 5 year investment horizon period.
[20] The investigation of the entire investment term in chapter 5 will reveal that this occurs just after the 9-year investment horizon.

Graph 4.7: Lowest total return over all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007 (annualised)



	7	14	21	28	35
Equity Low Ann	4.36%	11.92%	16.33%	18.15%	17.75%
Bonds Low Ann	2.45%	5.80%	8.78%	10.42%	11.87%
Cash Low Ann	8.64%	9.71%	12.06%	12.85%	12.63%

Source: Own composition

In table 4.5 below the differences between the "worst-case scenario" annualised returns (graph 4.7) are compared with the historic average annualised return (graph 4.2) in order to quantify the level of divergence.

Table 4.5: Differences between the "worst-case scenario" annualised returns and the historic average annualised return[21]

		Average return %	Minimum return %	Difference as %	Difference as % of average return
7-year investment horizon	Equity	21.22	4.36	16.86	79
	Bonds	13.43	2.45	10.98	82
	Cash	13.47	8.64	4.83	36
14-year investment horizon	Equity	21.55	11.92	9.63	45
	Bonds	13.81	5.80	8.01	58
	Cash	14.15	9.71	4.44	31

[21] This analysis will be performed on all investment periods ranging from 1 year to 35 years in the investigation of mean reversion in chapter 5.

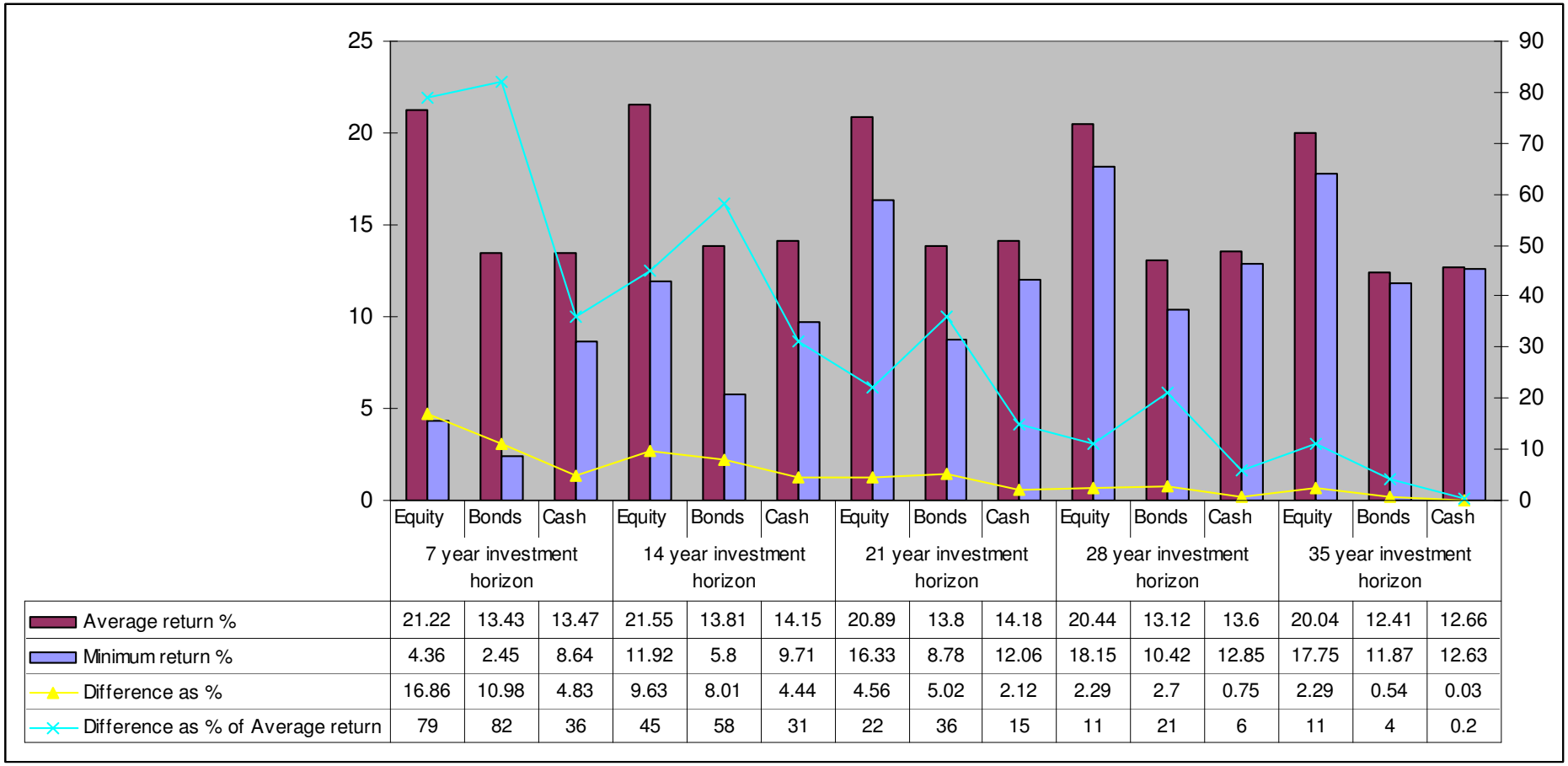
21-year investment horizon	Equity	20.89	16.33	4.56	22
	Bonds	13.80	8.78	5.02	36
	Cash	14.18	12.06	2.12	15
28-year investment horizon	Equity	20.44	18.15	2.29	11
	Bonds	13.12	10.42	2.70	21
	Cash	13.60	12.85	0.75	6
35-year investment horizon	Equity	20.04	17.75	2.29	11
	Bonds	12.41	11.87	0.54	4
	Cash	12.66	12.63	0.03	0.2

Source: Own composition

The data from table 4.5 are graphically represented in graph 4.8 below. Note the strong negative correlation between the investment horizon and the difference between the average return and the worst case scenario return expressed as a percentage of the average return.

As the investment term is increased, the difference becomes smaller. This is clearly evidence of a broader trend of mean reversion in asset class returns.

Graph 4.8: Differences between the "worst-case scenario" annualised returns and the historic average annualised return



	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
	7 year investment horizon			14 year investment horizon			21 year investment horizon			28 year investment horizon			35 year investment horizon		
Average return %	21.22	13.43	13.47	21.55	13.81	14.15	20.89	13.8	14.18	20.44	13.12	13.6	20.04	12.41	12.66
Minimum return %	4.36	2.45	8.64	11.92	5.8	9.71	16.33	8.78	12.06	18.15	10.42	12.85	17.75	11.87	12.63
Difference as %	16.86	10.98	4.83	9.63	8.01	4.44	4.56	5.02	2.12	2.29	2.7	0.75	2.29	0.54	0.03
Difference as % of Average return	79	82	36	45	58	31	22	36	15	11	21	6	11	4	0.2

Own composition

The important message is that asset dynamics change over time, especially over the longer term.

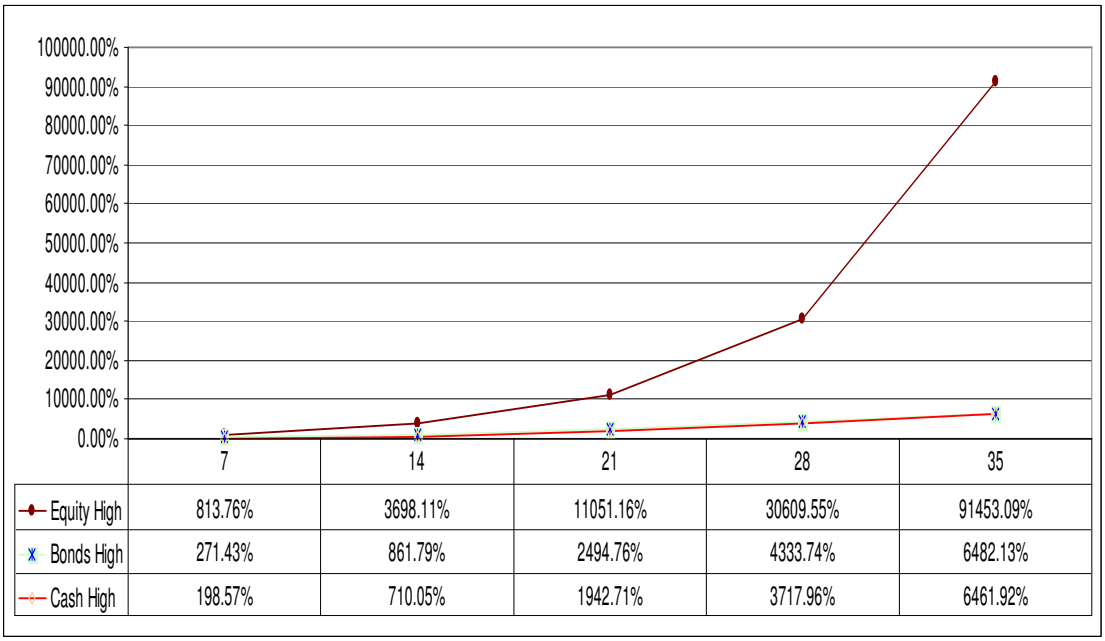
Bonds can now be regarded (according to the preceding measure) as the asset with the highest potential downside over all long-term investment periods investigated. This is not reflected in the standard deviation measure depicted in graphs 4.3 and 4.4.

Note that the study assessed the standard deviation and potential downside in the preceding sections. Investors should, however, not consider possible downturns only when making investment decisions. An investor must be aware of the potential upside in order to make holistic financial decisions.

4.4.2 Potential upside considerations

Graphs 4.6 and 4.7 considered the lowest total return over any 7, 14, 21, 28, and 35 year rolling periods (compounded monthly) from 1970 to 2007. Graph 4.9 will illustrate the highest total return over any 7, 14, 21, 28, and 35 year rolling periods (compounded monthly) from 1970 to 2007. Effectively, the graph therefore illustrates the "best-case-scenario" in terms of total returns for each asset class over 7, 14, 21, 28, and 35 year periods.

Graph 4.9: Highest total return over any 7, 14, 21, 28, and 35 year period from 1970 to 2007



	7	14	21	28	35
Equity High	813.76%	3698.11%	11051.16%	30609.55%	91453.09%
Bonds High	271.43%	861.79%	2494.76%	4333.74%	6482.13%
Cash High	198.57%	710.05%	1942.71%	3717.96%	6461.92%

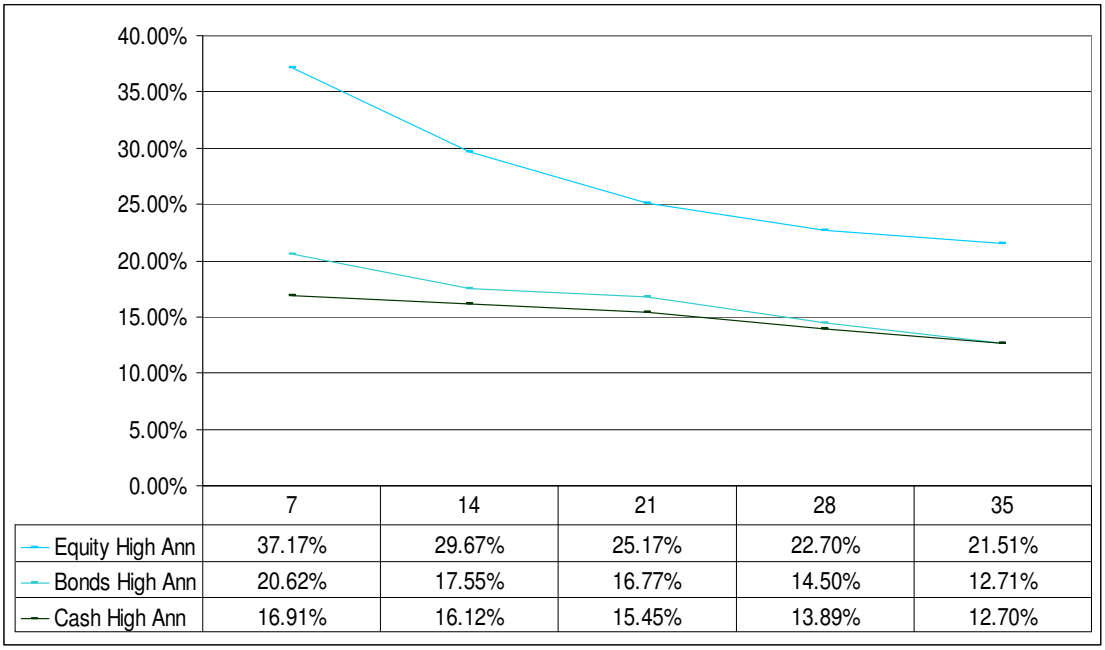
Source: Own composition

Graph 4.9 illustrates that although (generally) risk in terms of volatility (graph 4.3) and potential downside (graph 4.6) is the highest with equities, the potential upside far outweighs the return from the other asset classes. Further note that:

- The 35 year equity highest return is more than 14 times that of cash and bonds.
- Equity highs are consistently higher than those of bonds and cash.
- Bond highs are consistently higher than those of cash, although the margin degenerates over time – negatively correlated with the time horizon.

Graph 4.10 annualises the findings from graph 4.8.

Graph 4.10: Highest total return over all 7, 14, 21, 28 and 35 year rolling investment periods from 1970 to 2007 (annualised)



	7	14	21	28	35
Equity High Ann	37.17%	29.67%	25.17%	22.70%	21.51%
Bonds High Ann	20.62%	17.55%	16.77%	14.50%	12.71%
Cash High Ann	16.91%	16.12%	15.45%	13.89%	12.70%

Source: Own composition

Table 4.6 to follow summarises the relative movements in terms of the highest returns over any monthly rolling 7, 14, 21, 28 and 35 year investment horizon.

Table 4.6: Relative highest total returns over all 7, 14, 21, 28 and 35 year investment periods from 1970 to 2007

		Asset	Relative to cash					Relative to bonds					Relative to equity				
% Return	Year		7	14	21	28	35	7	14	21	28	35	7	14	21	28	35
142.27%	7	Cash						-129.16%	-719.52%	-2352.50%	-4191.47%	-6339.86%	-671.49%	-3555.84%	-10908.90%	-30467.28%	-91310.82%
537.62%	14							266.19%	-324.17%	-1957.14%	-3796.12%	-5944.51%	-276.14%	-3160.49%	-10513.54%	-30071.93%	-90915.47%
1520.13%	21							1248.71%	658.35%	-974.63%	-2813.61%	-4962.00%	706.37%	-2177.98%	-9531.03%	-29089.42%	-89932.96%
3452.83%	28							3181.40%	2591.04%	958.06%	-880.91%	-3029.30%	2639.07%	-245.28%	-7598.34%	-27156.72%	-88000.26%
6383.36%	35							6111.93%	5521.57%	3888.59%	2049.62%	-98.77%	5569.60%	2685.25%	-4667.81%	-24226.19%	-85069.73%
271.43%	7	Bonds	129.16%	-266.19%	-1248.71%	-3181.40%	-6111.93%						-542.34%	-3426.68%	-10779.74%	-30338.12%	-91181.67%
861.79%	14		719.52%	324.17%	-658.35%	-2591.04%	-5521.57%						48.02%	-2836.32%	-10189.38%	-29747.76%	-90591.31%
2494.76%	21		2352.50%	1957.14%	974.63%	-958.06%	-3888.59%						1681.00%	-1203.35%	-8556.40%	-28114.78%	-88958.33%
4333.74%	28		4191.47%	3796.12%	2813.61%	880.91%	-2049.62%						3519.98%	635.63%	-6717.42%	-26275.81%	-87119.35%
6482.13%	35		6339.86%	5944.51%	4962.00%	3029.30%	98.77%						5668.37%	2784.02%	-4569.04%	-24127.42%	-84970.96%
813.76%	7	Equity	671.49%	276.14%	-706.37%	-2639.07%	-5569.60%	542.34%	-48.02%	-1681.00%	-3519.98%	-5668.37%					
3698.11%	14		3555.84%	3160.49%	2177.98%	245.28%	-2685.25%	3426.68%	2836.32%	1203.35%	-635.63%	-2784.02%					
11051.16%	21		10908.90%	10513.54%	9531.03%	7598.34%	4667.81%	10779.74%	10189.38%	8556.40%	6717.42%	4569.04%					
30609.55%	28		30467.28%	30071.93%	29089.42%	27156.72%	24226.19%	30338.12%	29747.76%	28114.78%	26275.81%	24127.42%					
91453.09%	35		91310.82%	90915.47%	89932.96%	88000.26%	85069.73%	91181.67%	90591.31%	88958.33%	87119.35%	84970.96%					

Source: Own composition

Important observations from graph 4.10 and table 4.6 can be summarised as follows:

- Equities illustrate the highest potential positive return.
- Cash illustrates the lowest potential positive return.
- Bonds are in the middle in terms of potential positive return relative to cash and equities.
- The potential upside from equities accelerates faster than that of the other asset classes over time.

In table 4.7 below the differences between the "best-case scenario" annualised returns (graph 4.10) are compared with the historic average annualised return (graph 4.2) in order to quantify the deviation.

Table 4.7: Differences between the "best-case scenario" annualised returns and the historic average annualised return

		Average return %	**Maximum return %**	**Difference as %**	**Difference as % of average return**
7-year investment horizon	Equity	21.22	37.17	15.95	75
	Bonds	13.43	20.62	7.19	54
	Cash	13.47	16.91	3.44	26
14-year investment horizon	Equity	21.55	29.67	8.12	38
	Bonds	13.81	17.55	3.74	27
	Cash	14.15	16.12	1.97	14
21-year investment horizon	Equity	20.89	25.17	4.28	20
	Bonds	13.80	16.77	2.97	22
	Cash	14.18	15.45	1.27	9
28-year investment horizon	Equity	20.44	22.70	2.26	11
	Bonds	13.12	14.50	1.38	11
	Cash	13.60	13.89	0.29	2
35-year investment horizon	Equity	20.04	21.51	1.47	7
	Bonds	12.41	12.71	0.3	2
	Cash	12.66	12.70	0.04	0.3

Source: Own composition

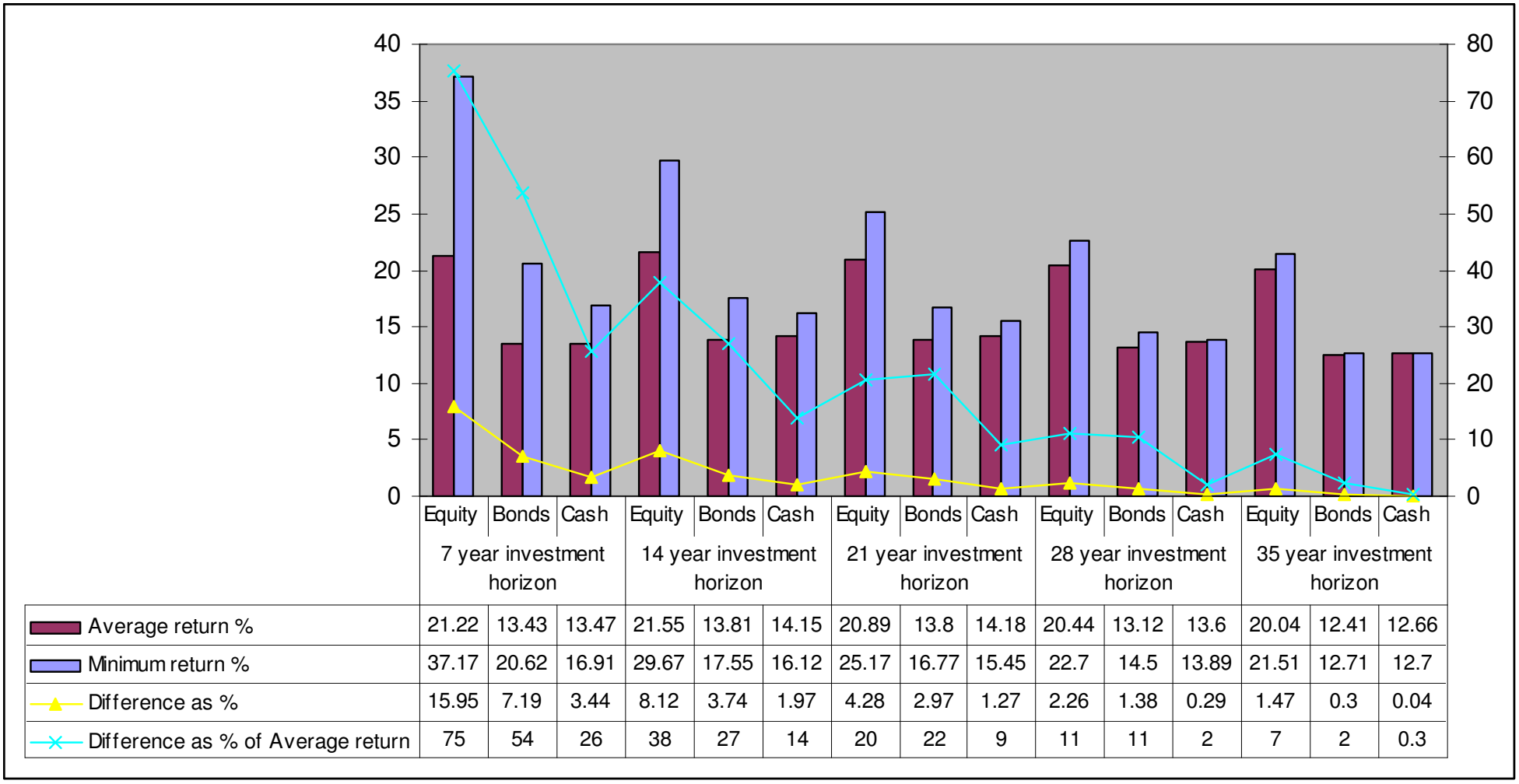
The data from table 4.7 are graphically represented in graph 4.11 to follow. Again, there is a clear negative correlation between the investment horizon and the difference between the average return and the best case scenario return expressed as a percentage of the average return.

This serves as additional evidence that as the investment term is increased, the deviation from the average becomes less marked. This is clearly evidence of a broader trend of mean reversion in asset class returns.

In the preceding section it was established that equities illustrated the lowest low return over most periods and the highest high over all periods; cash illustrated the lowest high over all periods. This relates to the extent to which an asset class can potentially vary from the average or expected return in terms of actual returns.

Although this variance is reflected in the standard deviation of the different asset classes (graph 4.3 and graph 4.4), this chapter will investigate the absolute variance in the section to follow.

Graph 4.11: Differences between the "best-case scenario" annualised returns and the historic average annualised return



	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
	7 year investment horizon			14 year investment horizon			21 year investment horizon			28 year investment horizon			35 year investment horizon		
Average return %	21.22	13.43	13.47	21.55	13.81	14.15	20.89	13.8	14.18	20.44	13.12	13.6	20.04	12.41	12.66
Minimum return %	37.17	20.62	16.91	29.67	17.55	16.12	25.17	16.77	15.45	22.7	14.5	13.89	21.51	12.71	12.7
Difference as %	15.95	7.19	3.44	8.12	3.74	1.97	4.28	2.97	1.27	2.26	1.38	0.29	1.47	0.3	0.04
Difference as % of Average return	75	54	26	38	27	14	20	22	9	11	11	2	7	2	0.3

Source: Own composition

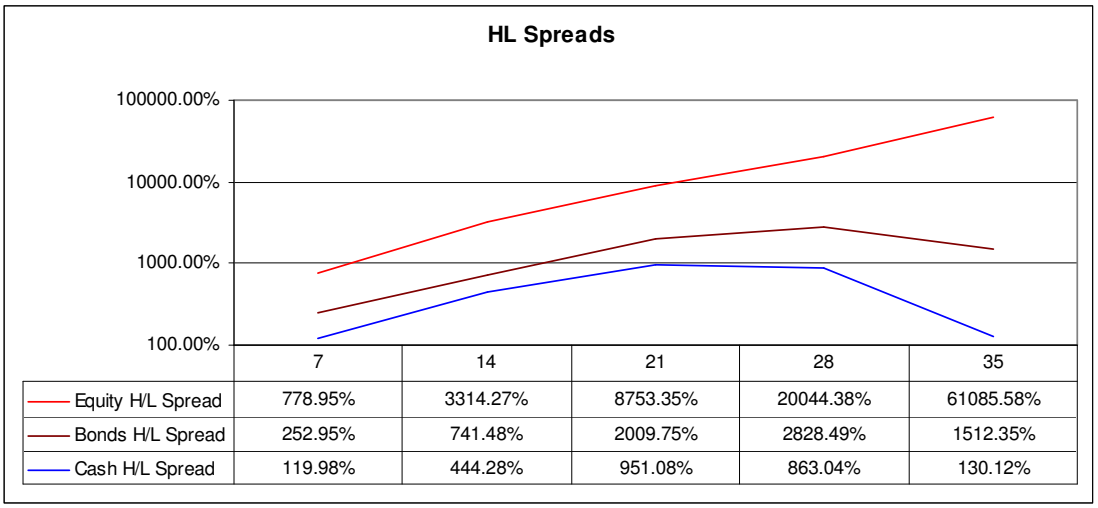
4.4.3 Absolute performance variance: high-low (HL) spreads

Graph 4.12 below illustrates the high-low spread between asset classes. In other words it calculates the distance between the lowest point and the highest point for each 7, 14, 21, 28 and 35 year investment for each of the asset classes. An investor would reasonably expect his/her 7, 14, 21, 28 and 35 year return to fluctuate by no more than the HL spread.

To illustrate this, take the example of a very optimistic investor investing in equity for 7 years who might expect the highest ever historic return over the same 7-year period, illustrated in graph 4.9 as 813.76%. The investor may only obtain the historic lowest return, illustrated in graph 4.6 as 34.81%, therefore the HL spread is 778.95% (813.76% minus 34.81%).

The HL spread can therefore be described as a measure of performance variance, volatility, or risk. The potential performance variances between the various asset classes are summarised in graph 4.12 and table 4.8 below.

Graph 4.12: Performance variance: high-low spreads between the different asset classes[22]



	7	14	21	28	35
Equity H/L Spread	778.95%	3314.27%	8753.35%	20044.38%	61085.58%
Bonds H/L Spread	252.95%	741.48%	2009.75%	2828.49%	1512.35%
Cash H/L Spread	119.98%	444.28%	951.08%	863.04%	130.12%

Source: Own composition

[22] A logarithmic scale is applied to the graph and this distorts the true relationship of the variables to make the smaller percentages graphically visible.

Note from graph 4.12 that:

- The high-low spread of equity increases over time.
- The high-low spread of cash and bonds increases to year 28 and then degenerates rapidly.
- Equities have the steepest slope, which is indicative of the highest possible performance variance (underperformance or outperformance).
- Cash reflects the lowest possible performance variance (underperformance or outperformance). Cash is the asset with the highest performance consistency (a more reflective representation of this evidence is provided in graph 4.13).
- Bonds lie midway between cash and equity in terms of possible performance variance, although the pattern resembles that of cash far more closely.

Table 4.8: Relative performance variance over any 1 to 5 year periods from 1970 to 2007

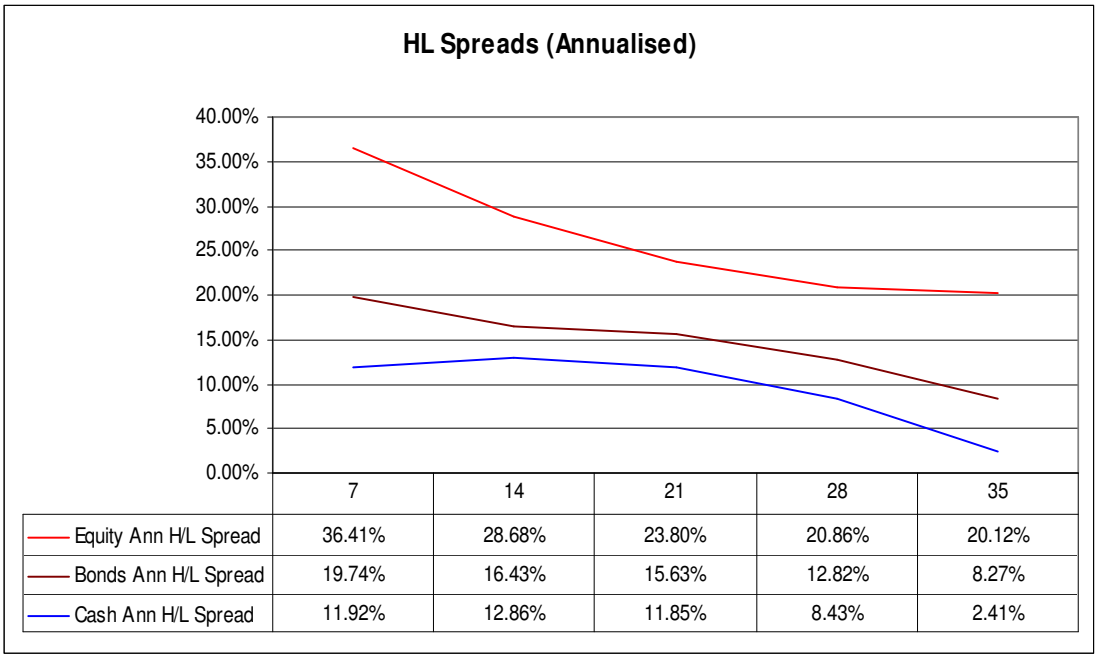
		Asset	Relative to cash					Relative to bonds					Relative to equity				
% HL Ratio	Year		7	14	21	28	35	7	14	21	28	35	7	14	21	28	35
252.67%	7	Cash						-1216.45%	-463.65%	-261.71%	-35.24%	122.23%	-2084.95%	-710.79%	-228.28%	-37.06%	-48.49%
267.16%	14							-1201.95%	-449.16%	-247.21%	-20.74%	136.73%	-2070.45%	-696.29%	-213.78%	-22.56%	-33.99%
195.91%	21							-1273.20%	-520.41%	-318.46%	-92.00%	65.48%	-2141.71%	-767.54%	-285.03%	-93.81%	-105.24%
130.23%	28							-1338.88%	-586.09%	-384.14%	-157.68%	-0.20%	-2207.39%	-833.22%	-350.71%	-159.49%	-170.92%
102.05%	35							-1367.06%	-614.27%	-412.32%	-185.85%	-28.38%	-2235.56%	-861.40%	-378.89%	-187.67%	-199.10%
1469.11%	7	Bonds	1216.45%	1201.95%	1273.20%	1338.88%	1367.06%						-868.50%	505.66%	988.17%	1179.39%	1167.96%
716.32%	14		463.65%	449.16%	520.41%	586.09%	614.27%						-1621.30%	-247.13%	235.38%	426.60%	415.17%
514.37%	21		261.71%	247.21%	318.46%	384.14%	412.32%						-1823.24%	-449.08%	33.43%	224.65%	213.22%
287.91%	28		35.24%	20.74%	92.00%	157.68%	185.85%						-2049.71%	-675.54%	-193.03%	-1.81%	-13.25%
130.43%	35		-122.23%	-136.73%	-65.48%	0.20%	28.38%						-2207.19%	-833.02%	-350.51%	-159.29%	-170.72%
2337.62%	7	Equity	2084.95%	2070.45%	2141.71%	2207.39%	2235.56%	868.50%	1621.30%	1823.24%	2049.71%	2207.19%					
963.45%	14		710.79%	696.29%	767.54%	833.22%	861.40%	-505.66%	247.13%	449.08%	675.54%	833.02%					
480.94%	21		228.28%	213.78%	285.03%	350.71%	378.89%	-988.17%	-235.38%	-33.43%	193.03%	350.51%					
289.72%	28		37.06%	22.56%	93.81%	159.49%	187.67%	-1179.39%	-426.60%	-224.65%	1.81%	159.29%					
301.15%	35		48.49%	33.99%	105.24%	170.92%	199.10%	-1167.96%	-415.17%	-213.22%	13.25%	170.72%					

Source: Own composition

Graph 4.13 below annualises the results from graph 4.12. Note how the HL spread declines over time in a *mean reverting pattern*. This would suggest the following:

a) Forecasting the possible annualised return can be done with a greater measure of accuracy as time passes.
b) There could be a period N where the HL spread of one asset class is equal to that of the other asset classes although the potential upside is far greater and the potential downside far less.[23]

Graph 4.13: Performance variance: high-low spreads between the different asset classes (annualised)[24]



	7	14	21	28	35
Equity Ann H/L Spread	36.41%	28.68%	23.80%	20.86%	20.12%
Bonds Ann H/L Spread	19.74%	16.43%	15.63%	12.82%	8.27%
Cash Ann H/L Spread	11.92%	12.86%	11.85%	8.43%	2.41%

Source: Own composition

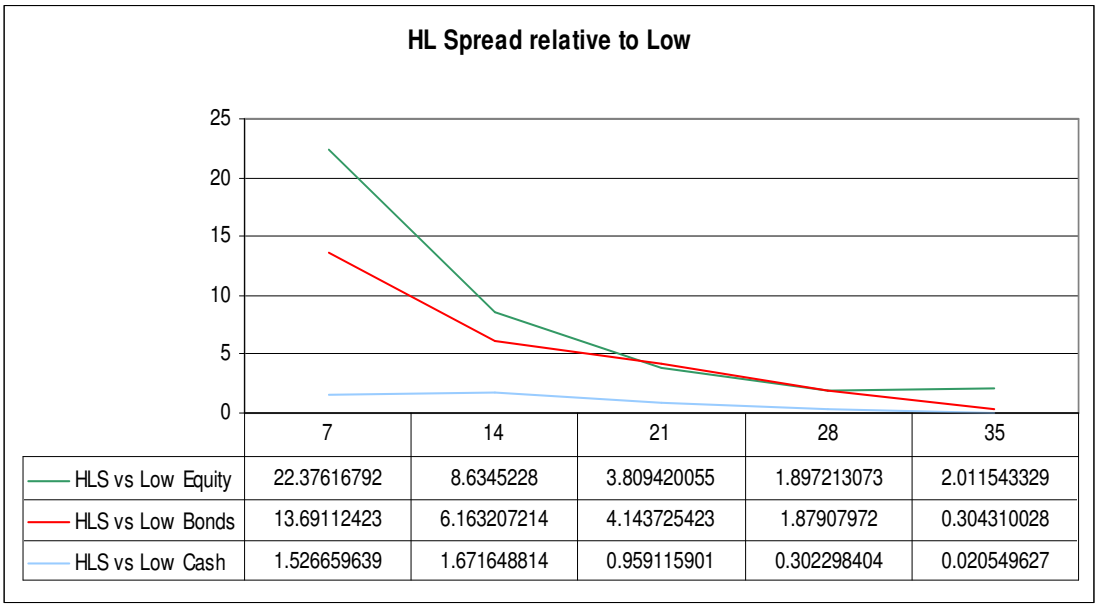
As discussed in the preceding section on HL spread, HL spread provides the investor with a valuable alternative/addition to standard deviation in measuring asset class return volatility/variance. In essence, as in the case of standard deviation measures, this may be used as a measure of risk.

[23] This specific discussion is beyond the scope of this chapter although both these aspects will be investigated in detail in chapter 4 and chapter 5.
[24] Note that the annualised HL spread would not simply be the difference between the annualised high and the annualised low as the annualised HL spread reflects the geometric average performance deviation over the full term. Merely subtracting the annualised low from the annualised high (for all periods except year 1) would result in a misrepresentation of the risk absorbed over the investment term.

It should be mentioned although both measures[25] are good indicators of possible performance variance, neither of the variance measures presented here provides an indication of possible loss or return as in the case of the downside risk and upside potential measures. This again emphasises the need for the consultation of multiple risk measures in order to make sound assessments of risk.

To conclude the section on HL spread, the study will consider HL spread as a measure of risk, and compare this risk to the potential downside of the various asset class returns.

Graph 4.14: HL spread relative to the potential downside of the various asset class returns



	7	14	21	28	35
HLS vs Low Equity	22.37616792	8.6345228	3.809420055	1.897213073	2.011543329
HLS vs Low Bonds	13.69112423	6.163207214	4.143725423	1.87907972	0.304310028
HLS vs Low Cash	1.526659639	1.671648814	0.959115901	0.302298404	0.020549627

Source: Own composition

Graph 4.14 illustrates HL spread relative to the potential low of each asset class for each monthly rolling 7, 14, 21, 28, and 35 year investment period.

Note the following from graph 4.14:

- Equity generally has the highest high-low spread (hereafter referred to as HLS) to low ratio as the HLS far exceeds that of the other asset classes.

[25] Standard deviation and the high-low spread

- The higher lowest returns inherent in equity (graph 4.10), although reflected in this measure, are not explicitly noticeable.
- Notably, the respective downside risk and upside potential are not retractable from the HL spread (or standard deviation).
- This again illustrates that measures such as standard deviation and HLS, *and measures that integrate these as factors in their models, ratios or equations,*[26] may be deceptive when considered in isolation.

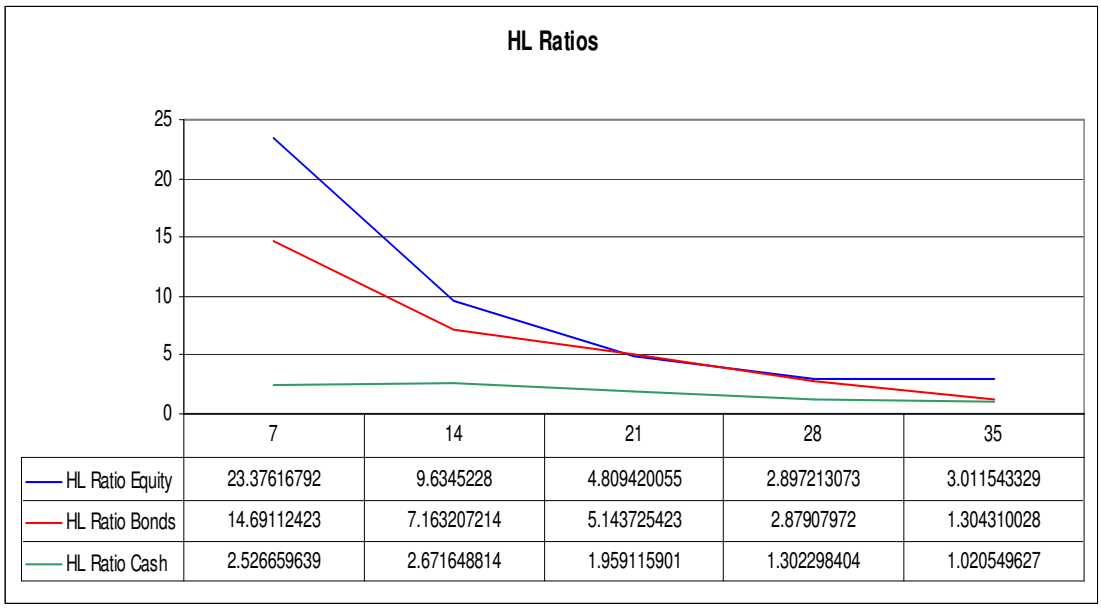
After considering the asset class standard deviation,[27] potential downside, potential upside and high-low spread,[28] an investor will need to consider whether the potential upside *relative* to the potential downside is justified in order to evaluate the potential gain. To this end the study examines the respective high-low (HL) ratios in the following section.

4.4.4 Relative potential gain measurement: high-low (HL) ratio

As the name suggests, relative potential gain measurement is the measurement of the potential upside of an investment relative to the potential downside. This measure is therefore an *additional* assessment of risk that may be integrated into a holistic risk assessment methodology. Graph 4.15 below investigates the HL ratios for the different asset classes over all rolling 7, 14, 21, 28, and 35 year investment periods.

[26] This aspect will be discussed in chapter 6, which addresses the implications of the findings of this dissertation.
[27] Illustrates the standard (average) deviation from the mean (average return).
[28] Illustrates the most extreme deviation from the geometric average return. HL spread is therefore a less forgiving assessor of variance than standard deviation.

Graph 4.15: High-low (HL) ratios of different SA asset classes



	7	14	21	28	35
HL Ratio Equity	23.37616792	9.6345228	4.809420055	2.897213073	3.011543329
HL Ratio Bonds	14.69112423	7.163207214	5.143725423	2.87907972	1.304310028
HL Ratio Cash	2.526659639	2.671648814	1.959115901	1.302298404	1.020549627

Source: Own composition

The following conclusions may be drawn from graph 4.15:

- Over all long-term investment periods cash generated the poorest potential returns (relative to the potential downside) and was *consistently* lower.
- Equities generally reflect the highest HL ratio, excluding the 21 year bond investment.
- The margins between the HL ratios of the various asset classes are far greater over the 7 and 14 year periods than over the 21, 28, and 35 year periods.
- The degeneration of the margins mentioned above is the most rapid for equity, then for bonds, then for cash.
- The HL ratio for cash is reasonably consistent. (Graphs 4.6, 4.10 and 4.12 explain low upside and low downside over all long- term investment periods.)
- This degeneration of the HL ratios may suggest evidence of mean reversion.[29]

[29] To be investigated in chapter 5.

The relative rankings of the various high-low ratios can be summarised as follows (table 4.9):

Table 4.9: Relative rankings of HL ratios

Year	Asset ranked 1st	Asset ranked 2nd	Asset ranked 3rd
7	Equity	Bonds	Cash
14	Equity	Bonds	Cash
21	Bonds	Equity	Cash
28	Equity	Bonds	Cash
35	Equity	Bonds	Cash

Source: Own composition

In preceding arguments the study discussed potential return and potential risk in more detail. The study evaluated the traditional standard deviation (mean-variance) measure and some additional assessors of risk were discussed.

4.5 Conclusion

To conclude this chapter the discussion on each asset class is briefly revisited and a chapter summary is then provided.

4.5.1 South African equities

a) The average annual return on equity is relatively stable. The average annualised return of the 373 rolling 7-year investment periods is 21.22% and the average annualised return of the 37 rolling 35-year investment periods is 20.04%.

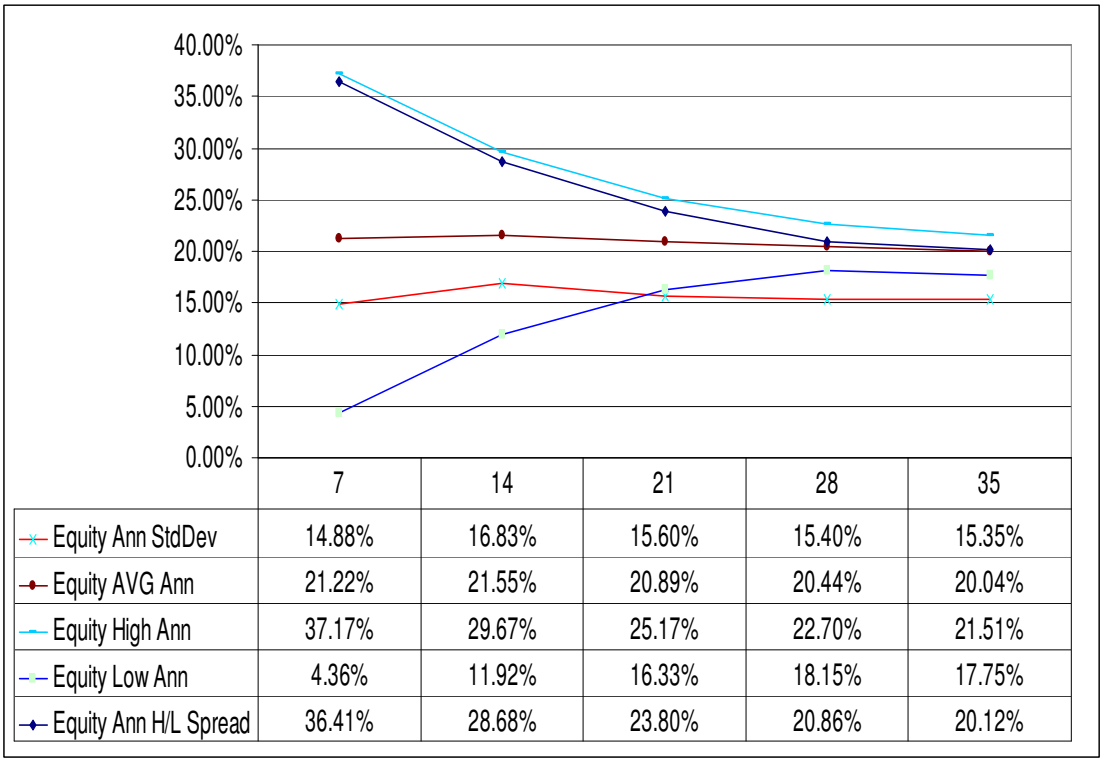
b) Average annualised return generally *declines* throughout the 7-year intervals investigated. This is indicative of the development of a mean reverting pattern. Chapter 5 will supplement the research from chapter 3 and chapter 4 in order to establish whether a mean reverting pattern exists.

c) The equity annualised low improves over time. Implicitly the risk of loss diminishes and further evidence of mean reversion becomes evident.

d) The equity annualised high decreases over time. There is again evidence of mean reversion.

e) Equity annualised HL spread (an indicator of volatility) decreases over time but standard deviation remains relatively constant. This illustrates that the HLS is effectively a more aggressive assessor of risk (describing assets as more risky) than standard deviation. This is due to the fact that standard deviation calculates the standard (average) deviation from the mean, whereas HLS calculates the most extreme deviations from the geometric average.

Graph 4.16: Equity summary



	7	14	21	28	35
Equity Ann StdDev	14.88%	16.83%	15.60%	15.40%	15.35%
Equity AVG Ann	21.22%	21.55%	20.89%	20.44%	20.04%
Equity High Ann	37.17%	29.67%	25.17%	22.70%	21.51%
Equity Low Ann	4.36%	11.92%	16.33%	18.15%	17.75%
Equity Ann H/L Spread	36.41%	28.68%	23.80%	20.86%	20.12%

Source: Own composition

4.5.2 South African bonds

a) The average annual return on bonds is relatively stable. The average annualised return of the 373 rolling 7-year investment periods is 13.43% and the average annualised return of the 37 rolling 35-year investment periods is 12.41% – a 102 basis point difference.

b) Bond returns are reasonably stable over the longer-term periods investigated. This may be a reflection of the flattening yields on the longer end of the bond yield curve.

c) Bonds experienced a more stable standard deviation/variance than equity although it was *significantly* higher than that of cash.

d) Annualised bond standard deviation decreased more rapidly than annualised equity standard deviation.

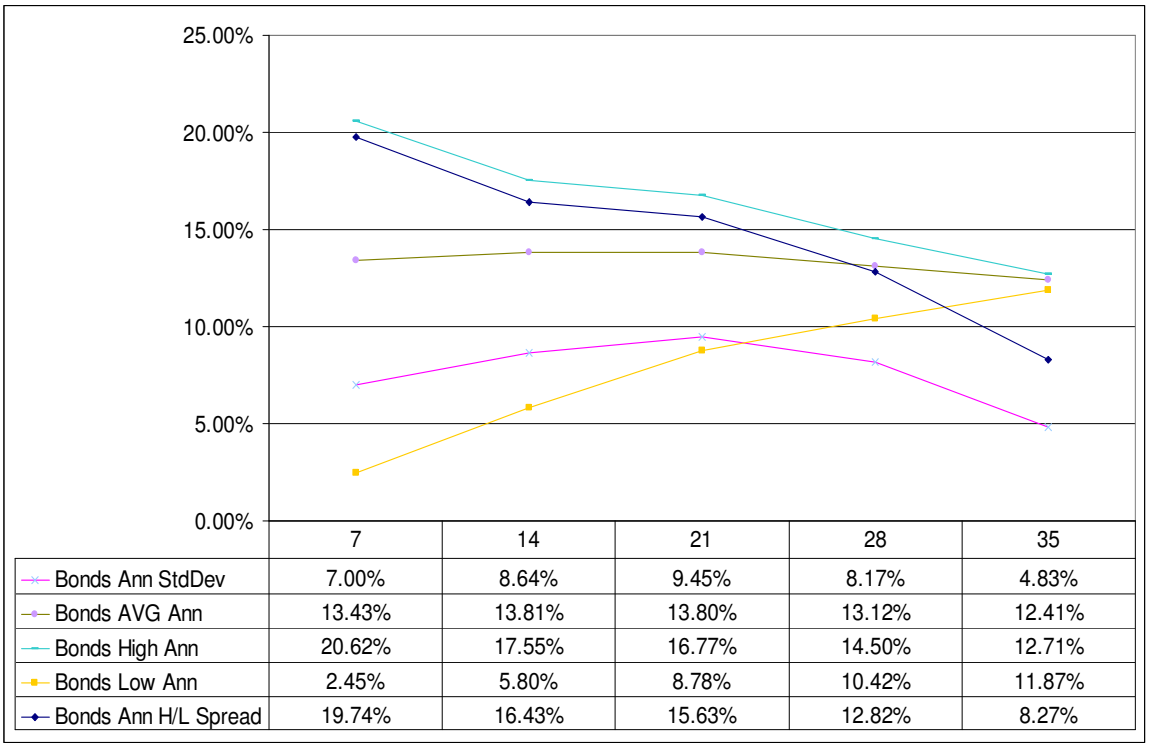
e) Annualised bond standard deviation decreased slower than annualised cash standard deviation.

f) Notes d) and e) above illustrate the standard deviation's tendency to generate inconsistent results when applied in a geometric framework.

g) The bond annualised low improves over time. Implicitly the risk of loss diminishes and further evidence of mean reversion becomes evident.

h) As in the case of equities a declining highest return, declining lowest return, positively correlated high and HL spread and negatively correlated low and HL spread, are all indicative of the development of a mean reverting pattern.

Graph 4.17: Bonds summary



	7	14	21	28	35
Bonds Ann StdDev	7.00%	8.64%	9.45%	8.17%	4.83%
Bonds AVG Ann	13.43%	13.81%	13.80%	13.12%	12.41%
Bonds High Ann	20.62%	17.55%	16.77%	14.50%	12.71%
Bonds Low Ann	2.45%	5.80%	8.78%	10.42%	11.87%
Bonds Ann H/L Spread	19.74%	16.43%	15.63%	12.82%	8.27%

Source: Own composition

4.5.3 South African cash

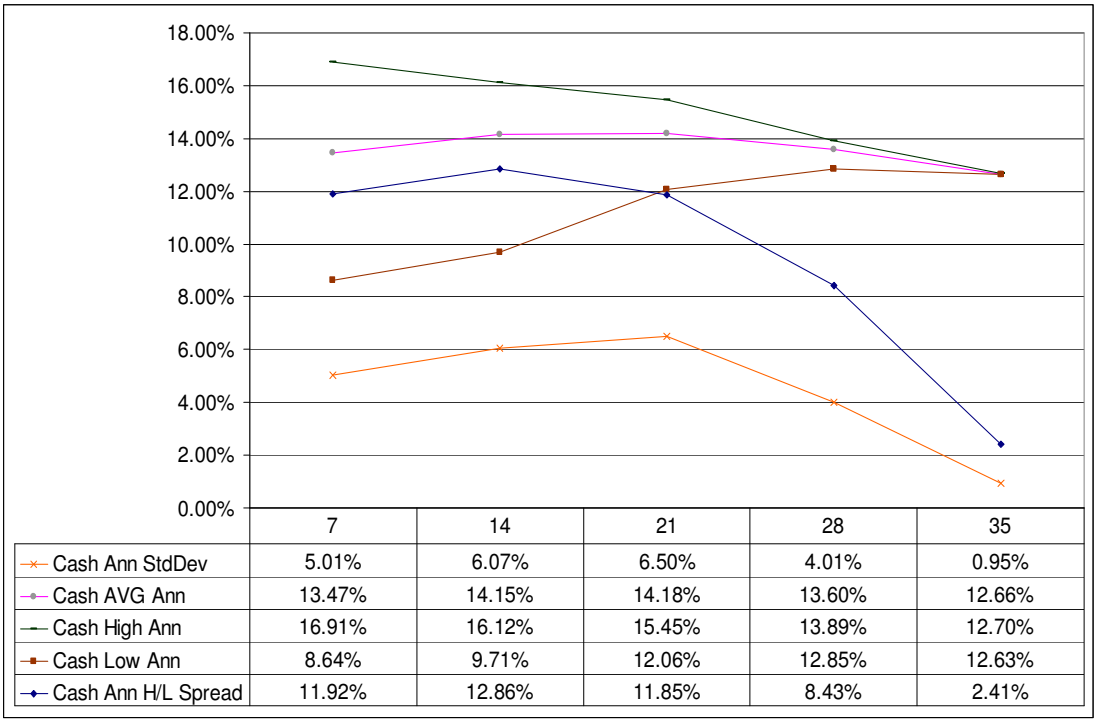
a) The average annual return on cash is very stable. The average annualised return of the 373 rolling 7-year investment periods is 13.47% and the average annualised return of the 37 rolling 35-year investment periods is 12.66% – an 81 basis point difference.

b) Cash returns are reasonably stable over the longer-term periods investigated. This may be an indication that yields have already reverted to the mean over the periods investigated. One could possibly argue that this long-term return investigation should reflect both upward and downward interest rate cycles, thereby showing a reasonable "average" return.

c) As in the case of equities and bonds, a declining highest return, declining lowest return, positively correlated high and HL spread and negatively

correlated low and HL spread are all indicative of the development of a mean reverting pattern.

Graph 4.18: Cash summary



	7	14	21	28	35
Cash Ann StdDev	5.01%	6.07%	6.50%	4.01%	0.95%
Cash AVG Ann	13.47%	14.15%	14.18%	13.60%	12.66%
Cash High Ann	16.91%	16.12%	15.45%	13.89%	12.70%
Cash Low Ann	8.64%	9.71%	12.06%	12.85%	12.63%
Cash Ann H/L Spread	11.92%	12.86%	11.85%	8.43%	2.41%

Source: Own composition

4.5.4 Summary

The primary objective of this chapter was to investigate the relationship between *long-term*[30] volatility and return and to serve as the *second* of two steps[31] in demonstrating that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames.[32]

Implicitly, the objective of this chapter is to prepare the ground for chapter 5 to identify any consistencies or inconsistencies in the results obtained from the

[30]This chapter of the study contained an analysis on the rolling 7, 14, 21, 28 and 35 year investment returns and the risk of each asset class, namely equities, bonds and cash.
[31] Chapter 3 was the first step in this process, as it investigated short-term volatility and return.
[32] Chapter 5 will apply the findings from chapters 3 and 4, to demonstrate that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames.

various risk measures in the short-term investigation in chapter 3 versus the results of this long-term investigation.

The chapter therefore illustrated the risk associated with long-term investment, investigated and discussed the relationship between risk and return on a relative basis, and tabulated the *returns and volatility of returns* for each asset class before discussing the patterns and trends.

The investigation applied the newly presented measures of risk from chapter 3 to the long-term case. The chapter presented the potential downside, potential upside, high-low spread, and relative potential gain measurement via the high-low (HL) ratio.

The chapter illustrated, via the above-mentioned measures, that, owing to higher performance variance, the risk associated with long-term investment was not an accurate reflection of the risk of losing capital.

The chapter also identified the development of mean reverting patterns in asset class returns and emphasised the importance of holistic risk assessment and management.

As risk measures play an important role in the investment decision making process of all investors, any inconsistencies found in the results obtained over different periods from the presented risk measures should be evaluated further and their implications investigated.

Chapter 5 will discuss the results of chapters 3 and 4 on a relative basis.

Chapter 6 will conclude the dissertation by discussing the implications of the findings of this study and suggesting areas for further research.

CHAPTER 5

RETURN-VOLATILITY: DETERIORATING RELATIONSHIP – CAUSES AND CONSEQUENCES

5.1 Introduction

In chapter 5, "Return-volatility: deteriorating relationship – causes and consequences", the differences between the short-term[1] and the long-term[2] analyses and their findings will be illustrated. The study will show that the traditional mean-variance models' risk-return depiction for various assets is biased towards shorter investment periods.

This analysis will provide a good indication of *relative* risk. By investigating time frames the study will attempt to find optimal investment periods for each asset class and establish breaking points where asset classes have experienced similar levels of risk but differing returns (or alternatively similar levels of returns with differing levels of risk).

The study will show that risk is reduced with time and that some assets' associated risk is reduced more rapidly than that of others. By holding riskier assets for longer you can reach a similar level of risk as for low-risk assets over the short term. Mean reversion implies a compensation for patience (a greater holding period): a better return at a reduced level of risk.

The latter part of chapter 5 will focus on the *causes and consequences*[3] of deteriorating volatility validity. This section will show that some asset classes that have traditionally been considered to carry a higher risk may carry less risk over certain periods when assessed more holistically.

[1] Investigation in chapter 3
[2] Investigation in chapter 4
[3] Note that the consequences discussed here are discussed in the context of this chapter, which deals with a shift in the risk-return curve/dynamic. The conclusion of this dissertation provides a more detailed discussion of the possible implications of the findings of the dissertation.

With regard to *causes,* mean reversion is analysed as a prerequisite for the illustrated diversification properties of time.

Consequences refer to how these findings can be applied in order to perform multi-period risk-return assessments.

It may be recalled that the objective of this dissertation is to illustrate that although asset class returns move along the risk-return curve as conventionally stated, considering the investment term there may be a shift in the risk-return curve/dynamic that could have a significant impact on investment decisions.

The analysis in this chapter has significant implications for asset managers, portfolio managers, financial advisers and other investment practioners: if the theory holds that assets traditionally believed to be riskier have similar levels of risk over certain periods as low-risk assets do, the implication is that the traditional definition of risk and diversification theory of multiple asset class portfolios may be manipulated. If this is applied/ interpreted incorrectly it may involve *other risks* for portfolios. Conversely, if applied correctly, risk may be significantly reduced and returns enhanced.

5.2 Findings from chapters 3 and 4 revisited

Chapter 3 investigated the relationship between short-term[4] volatility and return and served as the first of two steps in demonstrating, in this chapter, that the return spread (variance) between asset classes is far greater over shorter periods than over longer time frames.

[4] In this chapter the rolling 1 to 5 year investment returns and risk of each asset class, namely equities, bonds and cash, are analysed.

The primary objective of chapter 4 was to investigate the relationship between *long-term*[5] volatility and return. This chapter served as the second step in demonstrating that the return spread between asset classes is far greater over shorter periods than over longer time frames.

Implicitly the objective of the preceding two chapters was to prepare the ground for this chapter to identify any consistencies or inconsistencies in the results obtained from the various risk measures[6] between the short-term investigations in chapter 3 and the long-term investigations in chapter 4.

It may be recalled that in chapter 3 the following conclusions were reached:

- As revealed by *all* the applied measures,[7] the risk associated with short-term investment due to higher performance variance was significant.
- All the applied risk measures provided similar interpretations of risk for periods under 5 years.
- Equity was found to be riskier than bonds, and bonds riskier than cash.
- Equity proved to offer a greater potential upside than bonds, and bonds a greater potential upside than cash.
- The traditional mean-variance model, arrived at via the standard deviation measure, provided an accurate interpretation of risk: the findings of the short-term investigation corresponded to the traditional shape of the efficiency frontier.

[5] In this chapter the study performed an analysis on the rolling 7, 14, 21, 28 and 35 year investment returns and risk of each asset class, namely equities, bonds and cash.
[6] Refers to standard deviation as the measure of risk in the mean-variance model, as well as the newly presented measures of risk presented in chapters 3 and 4.
[7] The standard deviation, potential downside, potential upside, high-low spread, and relative potential gain measurement via the high-low (HL) ratio.

In chapter 4 the following conclusions were reached:

- Via the above-mentioned newly presented measures of risk, it was concluded that the risk associated with long-term investment due to higher performance variance was *not an accurate reflection of the risk of losing capital*.
- Although standard deviation is higher for equity than for bonds, and higher for bonds than for cash, the minimum return from equity will at some point exceed the maximum return from bonds and cash.
- Some of the applied risk measures provided accurate interpretations of this risk, although the variance-based measures[8] did not.
- The variance-based measures illustrated that equity was found to be riskier than bonds, and bonds riskier than cash.
- The downside risk measure provided a contradictory finding: Equity risk is lower than risk from bonds and cash, given a set investment horizon.
- The traditional mean-variance model, via the standard deviation measure, provided an *inaccurate* interpretation of risk as *the findings from the long-term investigation did not correspond to the traditional shape of the efficient frontier.*

In the following sections chapter 5 will:

- Plot and evaluate the risk return frontier over the short and long term for the mean-variance model.
- Evaluate the risk return findings from the high-low spread (HLS) model.
- Evaluate the risk return findings from the downside risk model.
- Investigate mean reversion as a prerequisite for time diversification
- Provide recommendations for performing multiperiod risk-return assessments.

[8] Standard deviation and high-low spread.

5.3 Evaluations from variance-based measures: standard deviation and HL spread[9]

The standard deviation measure and the HL spread measure are both indicators of variance in the historic returns from assets. The standard deviation measure depicts the average "error" (deviation from the mean return). The smaller deviations are therefore considered with more extreme deviations, after which the average deviation is calculated.

The HL spread focuses on the spread between the worst case scenario (the poorest return deviation) and the best case scenario (the best return deviation). As mentioned earlier, this makes the HL spread a more aggressive assessor of risk and/or variance than standard deviation. In the following section the study investigates how the findings from the two variance measures differ.

5.3.1 Standard deviation

Upon re-examination of the historic return for the various asset classes in graphs 5.1 and 5.2[10] (which annualises the results from 5.1) below, it is evident that equities (on average) yield superior returns over returns from bonds and cash, regardless of time horizon.

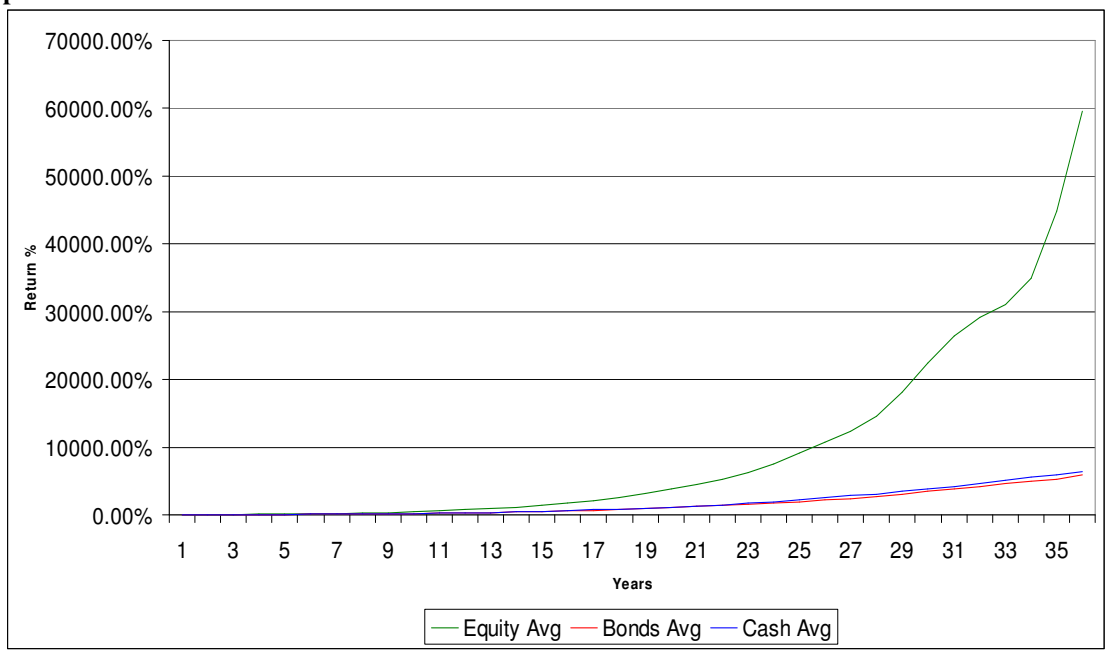
The depictions also indicate that bonds generate a similar return to cash, regardless of time horizon. These findings are consistent with those from the traditionally accepted measure and model for risk return analysis, the mean-variance model and subsequent efficient frontier.

The study reiterates that, as in chapters 3 and 4, all investments periods reflect the results from all "n" year monthly rolling investment periods between 1970 and 2007.

[9] The measure for the calculation of absolute performance variance

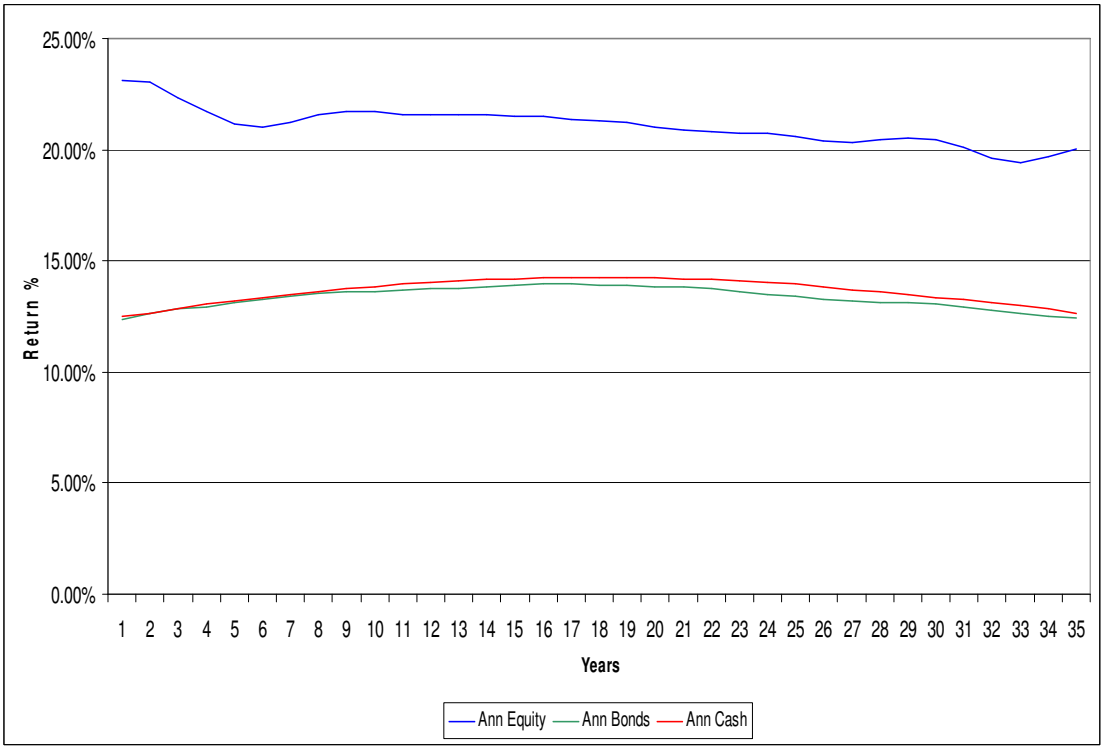
[10] Note that these illustrations portray the results from the *entire 35 year period*. This is in contrast to segmenting the illustrations, as in the case of chapters 3 and 4.

Graph 5.1: Average cumulative returns for SA asset classes over multiple and various rolling periods from 1970 to 2007



Source: Own composition

Graph 5.2: Average cumulative returns for SA asset classes over multiple and various rolling periods from 1970 to 2007 (annualised)

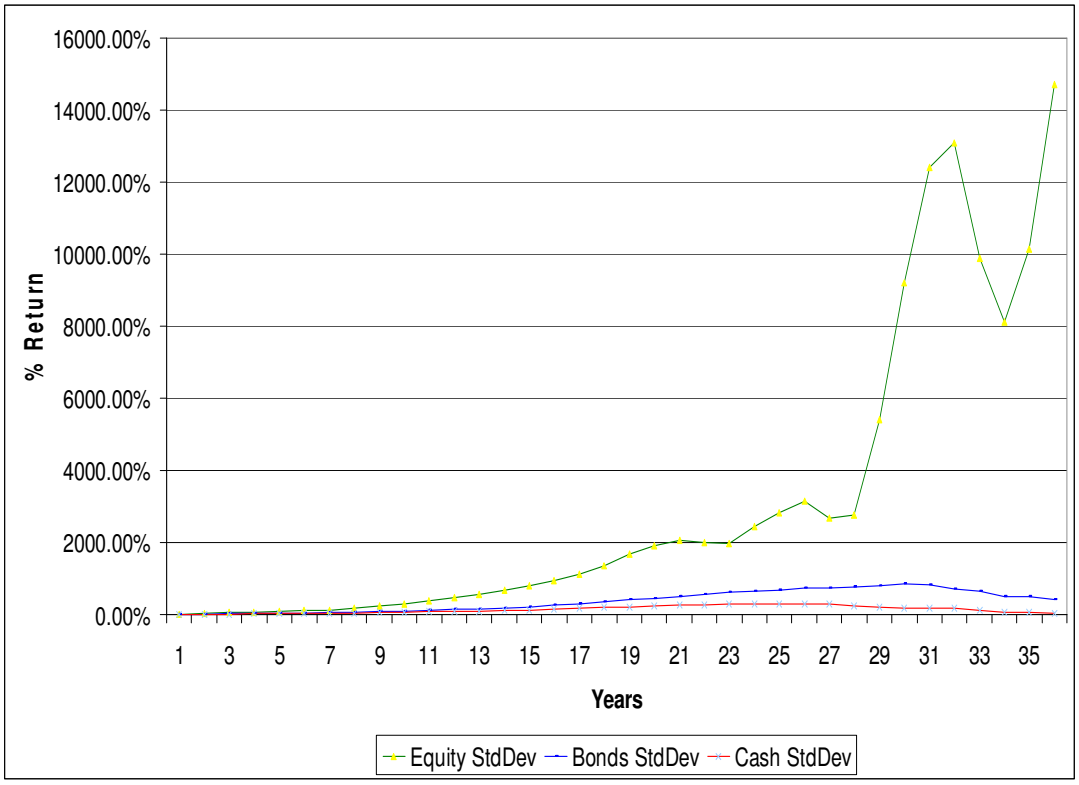


Source: Own composition

Graphs 5.3 and 5.4 illustrate the historic standard deviation for the various asset classes (annualised in graph 5.4) below. It is evident that the volatility from equities (on average) exceeds that from bonds and cash, regardless of time horizon.

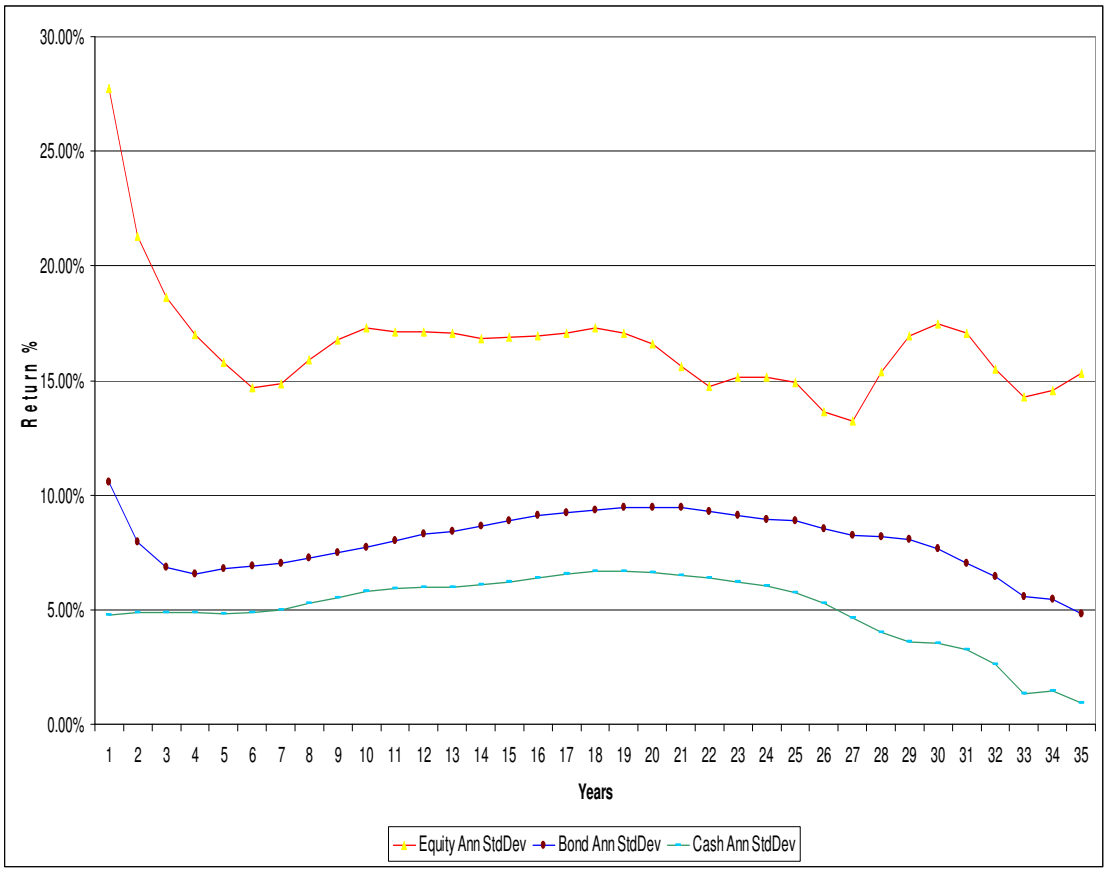
The graphs further confirm the findings from the mean-variance model in that bonds experience a greater standard deviation than cash over any investment period.

Graph 5.3: Total returns standard deviation for SA asset classes from 1970 to 2007



Source: Own composition

Graph 5.4 Total returns standard deviation for SA asset classes from 1970 to 2007 (annualised)



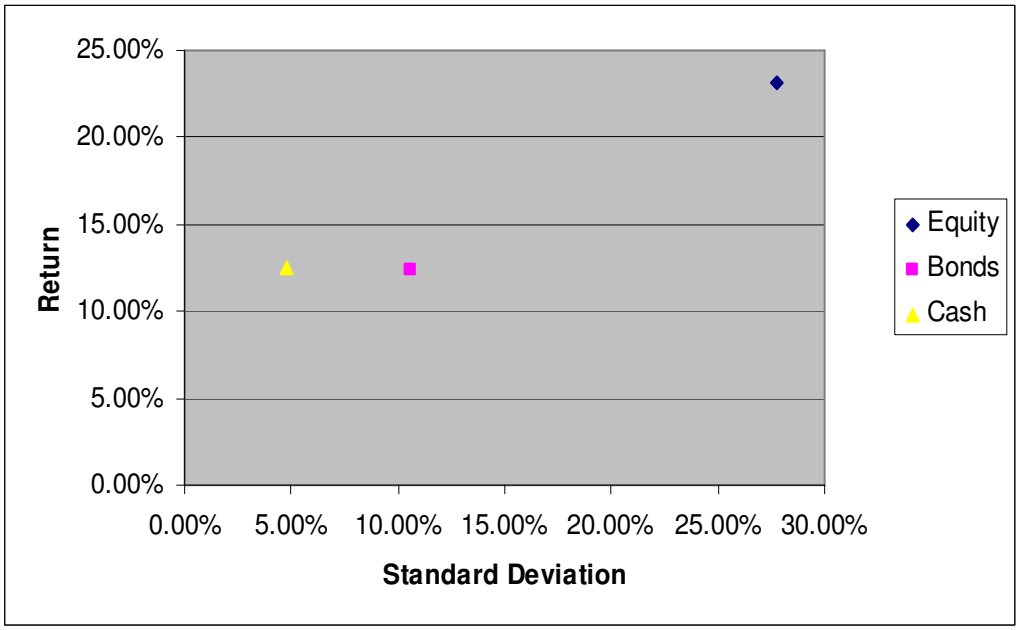
Source: Own composition

The risk-return analysis for the 1-year and 35-year results are illustrated below in graphs 5.5 and 5.6. Note that there is just about no change in the *shape* of the placement of the risk-return summary of the two periods.

Both risk and return findings are consistent with those from the traditionally accepted model for risk return analysis.[11]

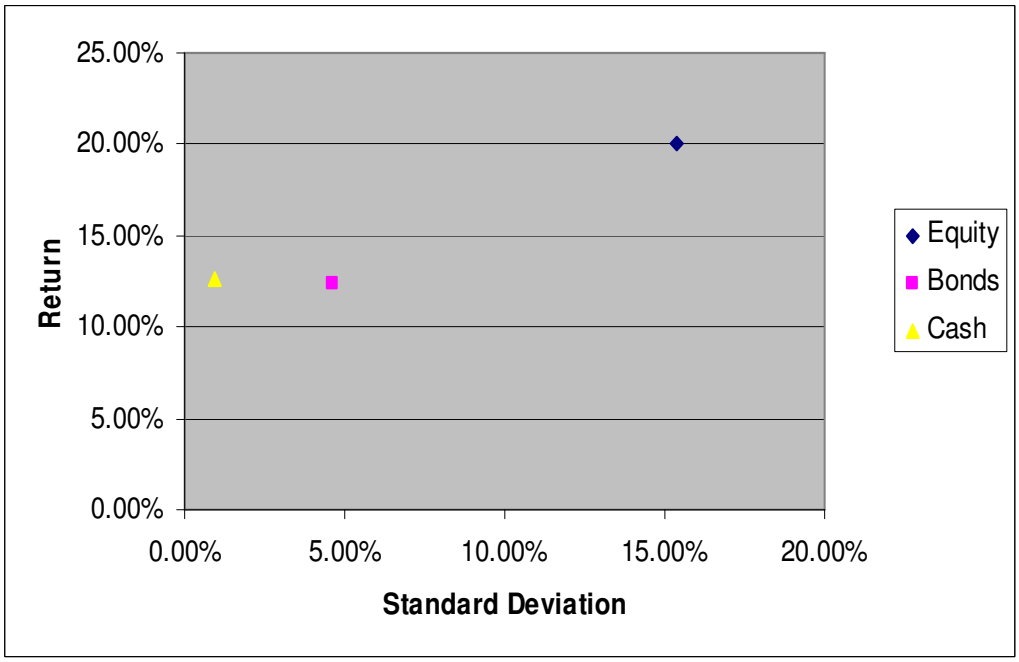
[11] Refer to graph 1.1 in the introduction to this dissertation.

Graph 5.5: 1-year investment horizon risk-return analysis (mean-variance model)



Source: Own composition

Graph 5.6: 35-year investment horizon risk-return analysis (mean-variance model) (annualised)



Source: Own composition

Before the debate on the mean-variance model is wound up, the findings of the study are summarised as follows: Additional risk over that of cash is required to obtain a higher return than cash. There was no need to perform multi-period analyses on standard deviation as the results remain the same[12] regardless of time period.

The following section will illustrate that there is a time diversification factor that is reflected in the standard deviation model,[13] but is by no means quantified or incorporated in the risk return description.

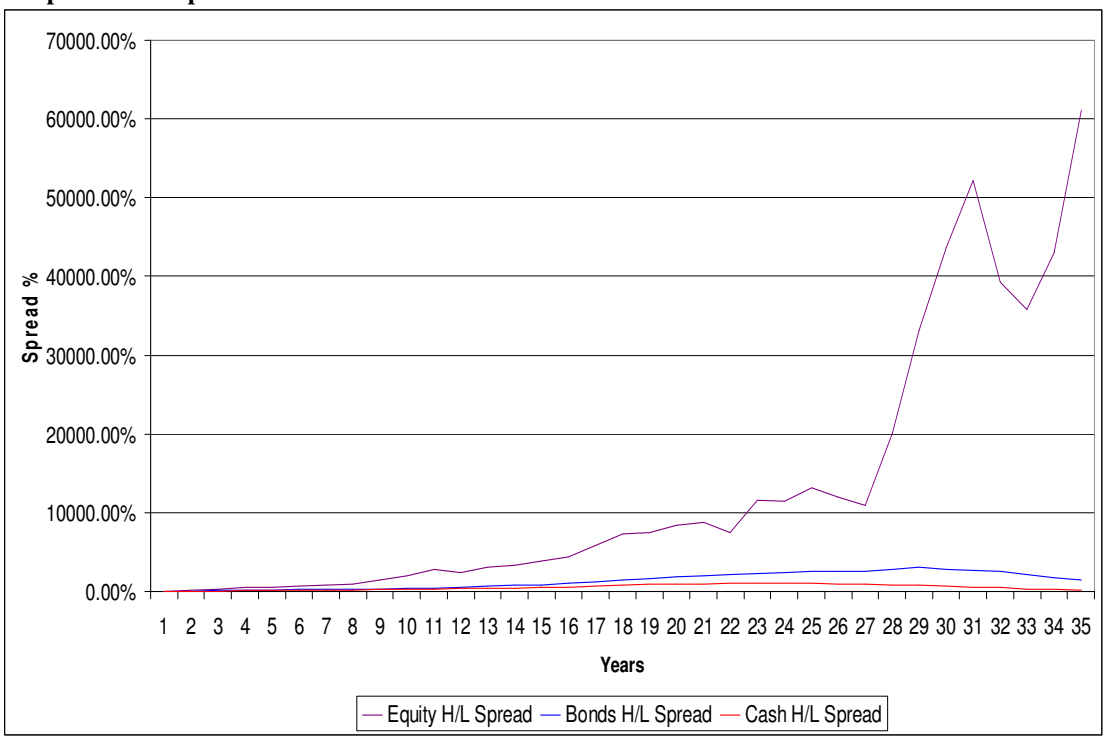
5.3.2 Absolute performance variance (high-low spread)

It may be recalled that absolute performance variance is the high-low spread between asset classes. In other words it calculates the distance between the lowest point and the highest point for a given period for each of the asset classes. An investor would reasonably expect his/her return of investment period equal to "n" to fluctuate by no more than the HL spread for period "n"[14].

Graph 5.7 to follow illustrates the historic HL spread between asset classes over the period investigated. Again, graph 5.8 annualises the findings.

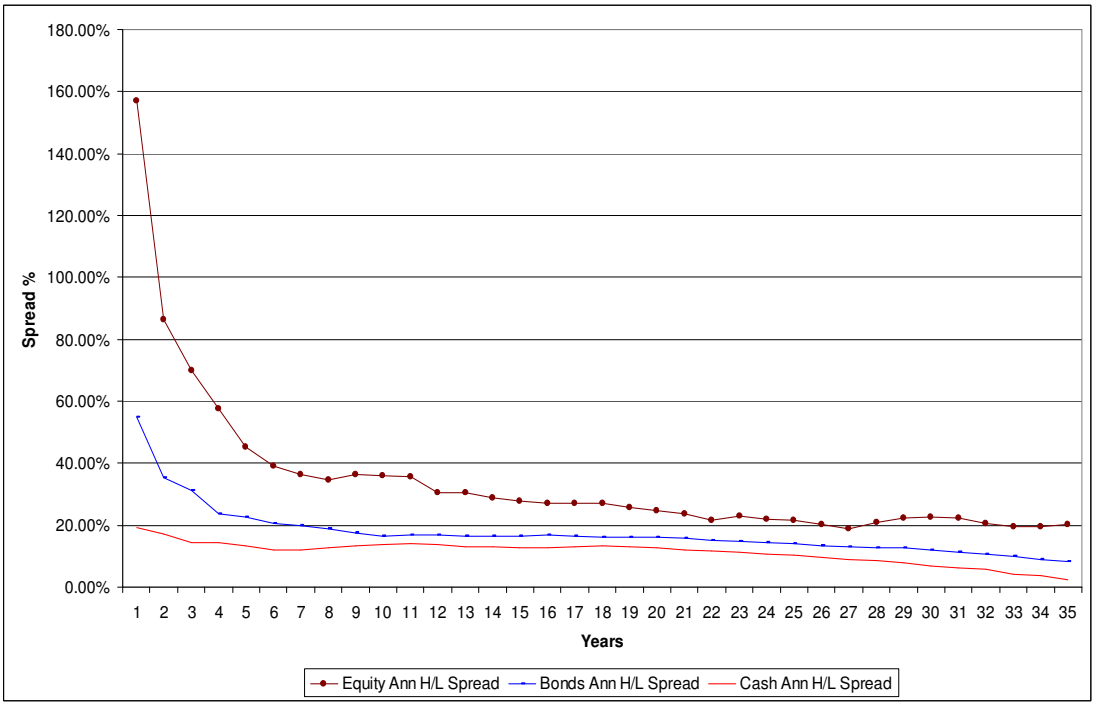
[12] On a relative and total return annualised basis.
[13] As standard deviation tends to decline over time.
[14] If expectations are based on historic evidence.

Graph 5.7: HL spread of SA asset classes from 1970 to 2007



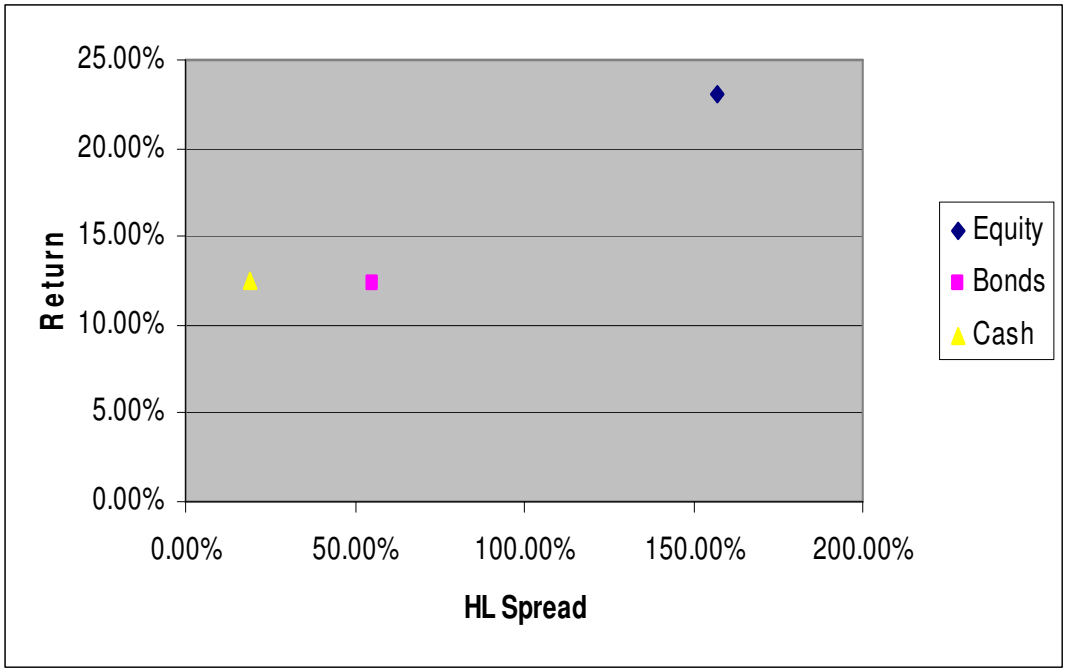
Source: Own composition

Graph 5.8: HL spread of SA asset classes from 1970 to 2007 (annualised)



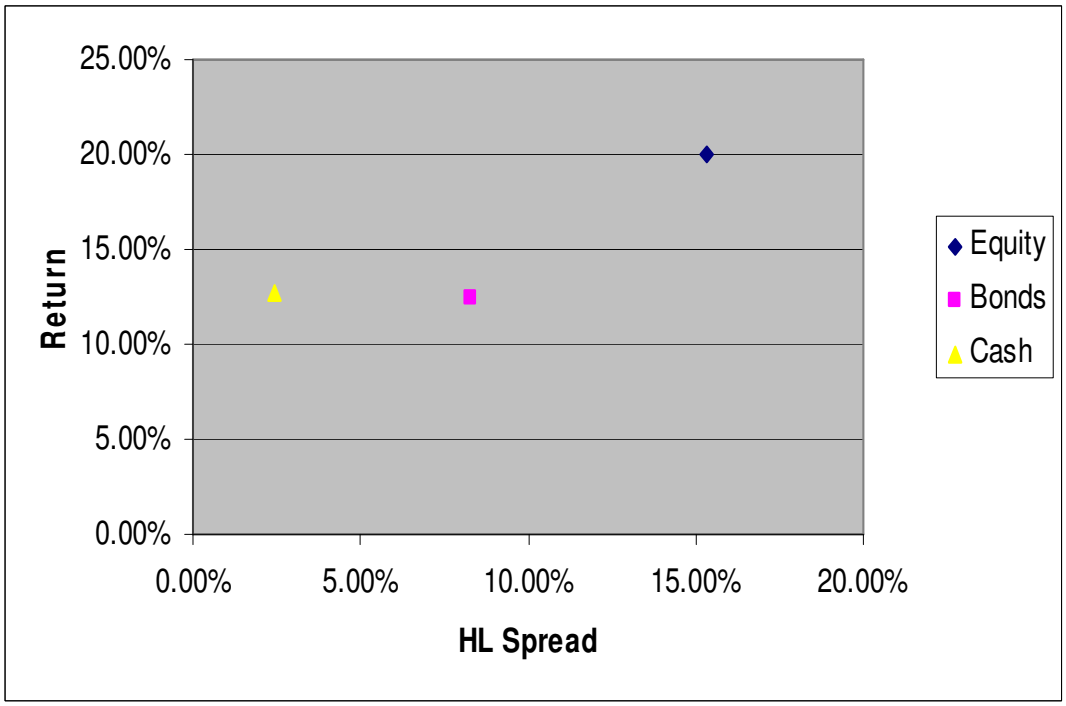
Source: Own composition

Graph 5.9: 1-year investment horizon risk-return analysis according to HL spread



Source: Own composition

Graph 5.10: 35-year investment horizon risk-return analysis according to HL spread (annualised)



Source: Own composition

Graphs 5.9 and 5.10 correspond to the findings from the mean-variance model in that equity experiences a greater degree of potential performance variance than bonds and cash, regardless of time horizon. Bonds experience a greater variance than cash over any investment period.

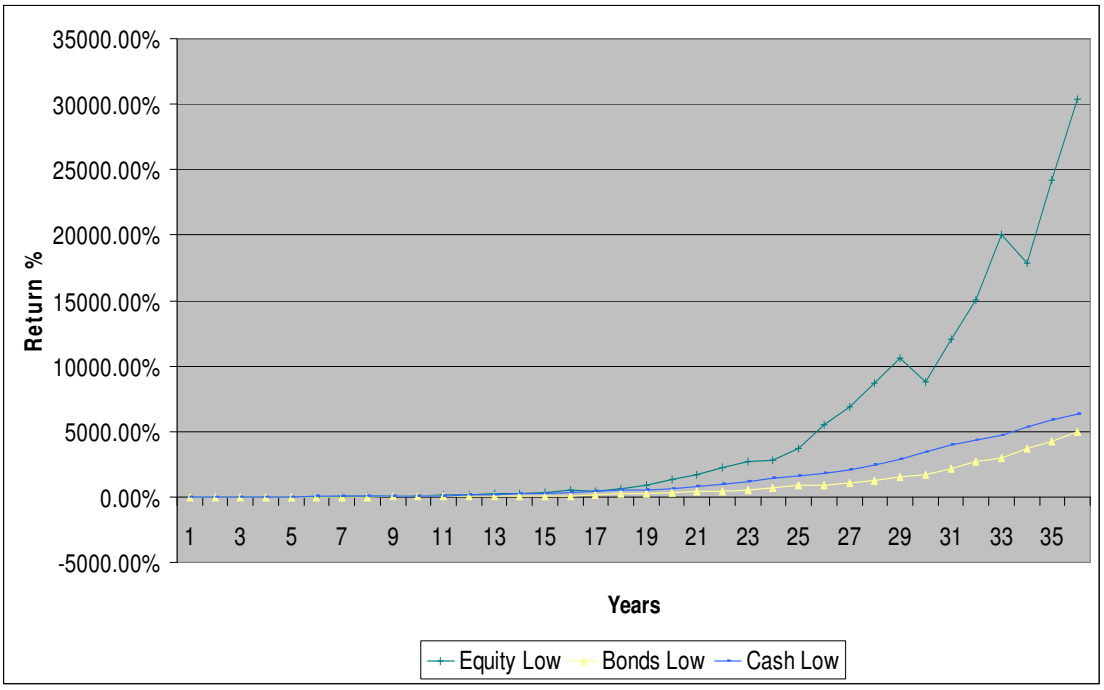
The findings are therefore consistent with those from the preceding analysis based on the mean-variance model. Both variance models reached similar conclusions.

In the discussion to follow the study will investigate the results derived from non-variance bases assessments.

5.4 Evaluation according to the downside risk measure

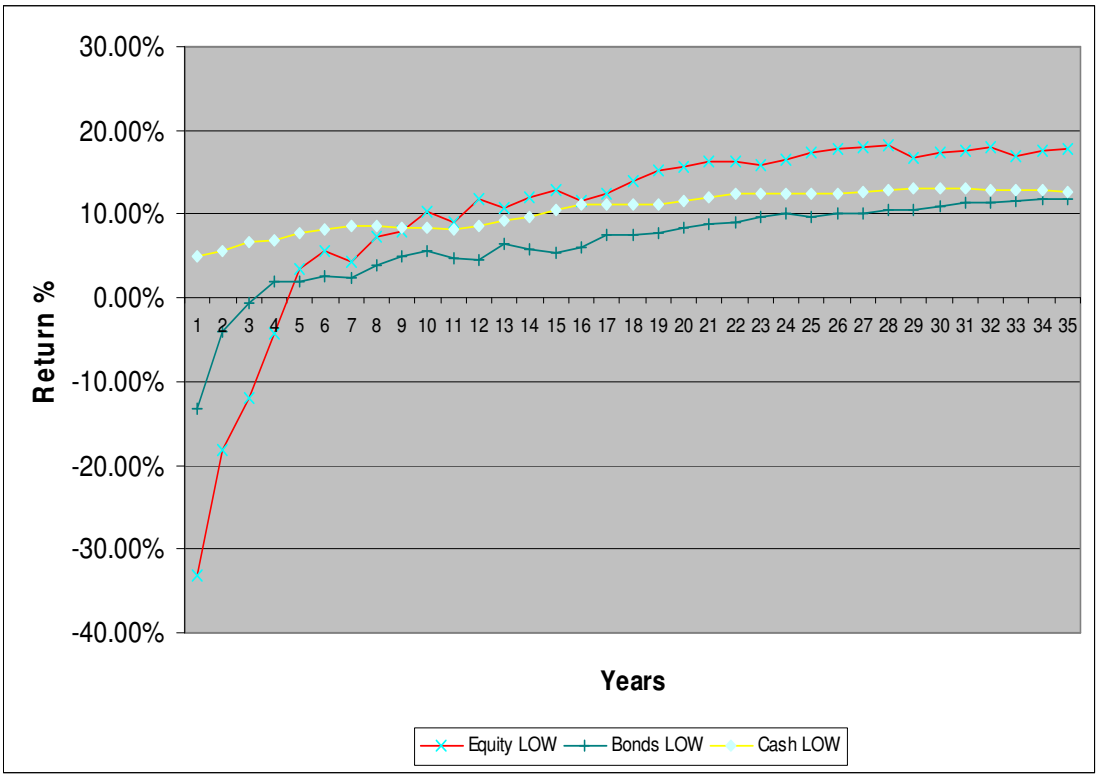
It may be recalled that the downside risk illustrates the "worst case scenario" in terms of total returns. Graphs 5.11 and 5.12 below illustrate the downside risk evident over 1 to 35 year investment horizons for each of the asset classes.

Graph 5.11: Downside risk for SA asset classes from 1970 to 2007



Source: Own composition

Graph 5.12 Downside risk for SA asset classes from 1970 to 2007 (annualised)

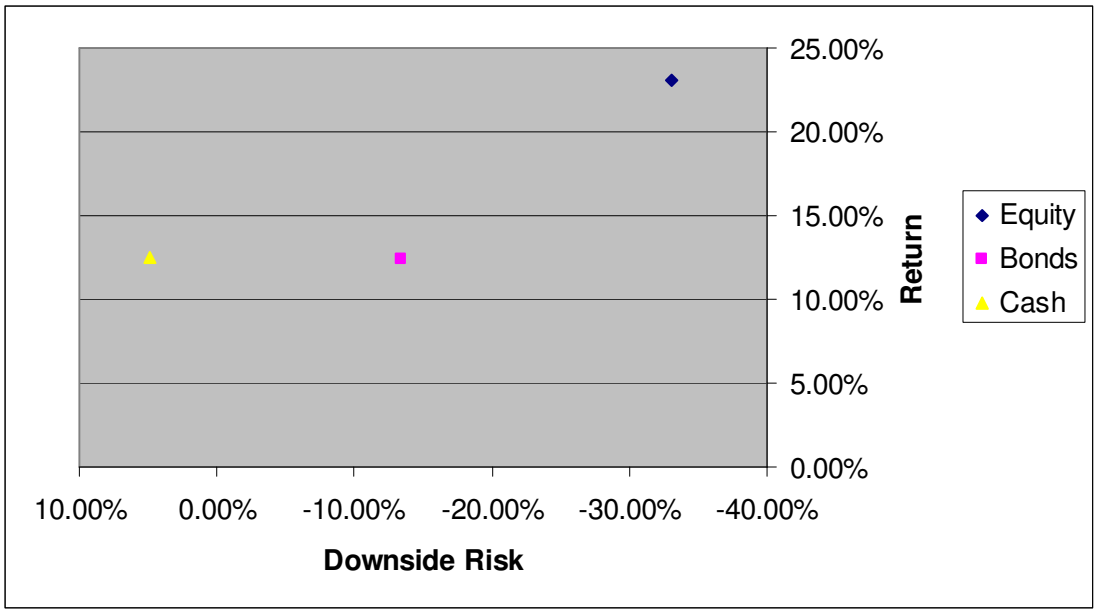


Source: Own composition

The graphs do not correspond to the findings obtained from the mean-variance model in that equity shows a greater minimum return than bonds, for periods longer than 4 years and a greater minimum return than cash for periods longer than 9 years.

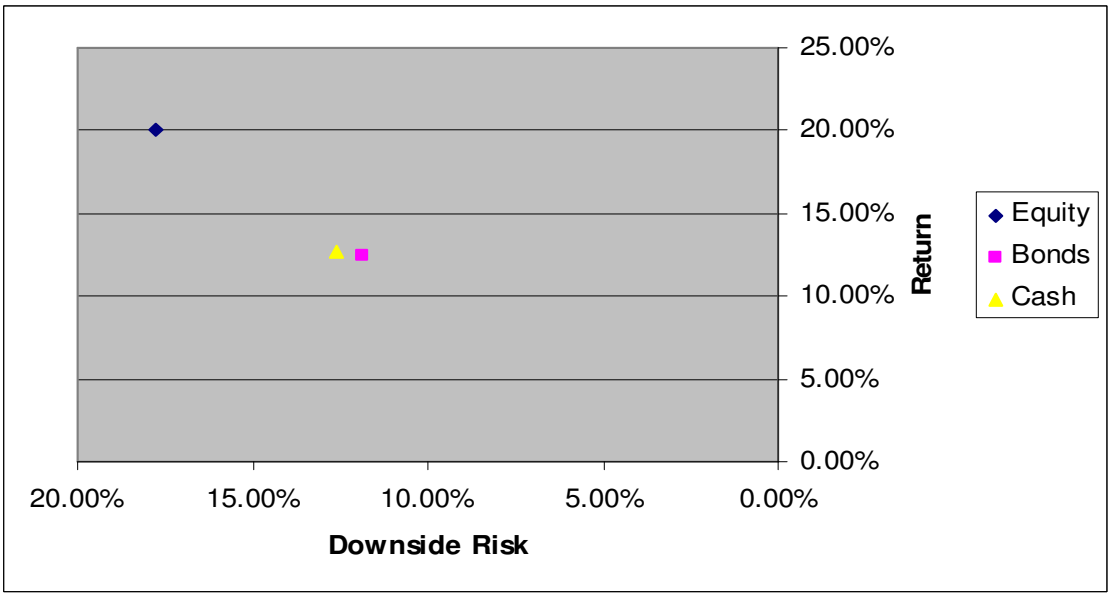
A 1-year and 35-year risk return comparative assessment was again carried out within the efficiency frontier framework in graphs 5.13 and 5.14 to follow.

Graph 5.13: 1-year investment horizon risk-return analysis according to downside risk



Source: Own composition

Graph 5.14: 35-year investment horizon risk-return analysis according to downside risk (annualised)



Source: Own composition

Although the plot of the 1-year downside risk (graph 5.13) and return is similar to that of the preceding variance models, the illustration from the 35-year case (graph 5.14) indicates a drastic change in the shape of the risk-return dynamic.

Graph 5.14 defines equity as the asset with the highest return and the lowest risk. Cash and bonds show similar returns, with cash carrying less risk.

These long-term findings are inconsistent with findings from the variance- based models. The downside risk assessment implies that holistic multi-period risk assessments are (or should be) an important consideration during the investment decision making process.

5.5 Conclusively attaining the dissertation objective

The objective of this dissertation is to illustrate the change in the *shape* of risk-return dynamics in relation to different investment horizons. In the preceding section the study illustrated the marked change in the shape of the dynamics as time progresses. A more accurate (although not holistic)[15] interpretation of risk was provided.

Table 5.1 below summarises the results from the preceding section in terms of the relative rankings of risk inherent in the various asset classes according to the measures described above.

[15] The holistic assessment will follow in section 7 of this chapter.

Table 5.1: Relative risk ranking of SA asset classes

	Mean-variance model (standard deviation)			Absolute performance variance (HLS)			Downside risk measure		
Year	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**	**1st**	**2nd**	**3rd**
1	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
2	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
3	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
4	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
5	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Equity	Cash
6	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Equity	Cash
7	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Equity	Cash
8	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Equity	Cash
9	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Equity	Cash
10	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
11	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
12	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
13	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
14	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
15	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
16	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
17	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
18	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
19	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
20	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
21	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
22	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
23	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
24	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
25	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
26	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
27	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
28	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
29	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
30	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
31	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
32	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
33	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
34	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity
35	Equity	Bonds	Cash	Equity	Bonds	Cash	Bonds	Cash	Equity

Source: Own composition

In the following section the *causes* of this reduction and shift of risk over time are investigated.

5.6 Understanding the basis for justifying the above-mentioned analysis - evidence of mean reversion

Throughout chapters 3, 4, and 5 evidence of reversion to the mean return was consistently reported. In other words returns tended to revert back to some form of average return.

The study will show that risk reduces with time and that the associated variance of some assets reduces more rapidly than that of others. By holding riskier assets for longer you can reach a similar level of risk to that of low-risk assets over the short term.

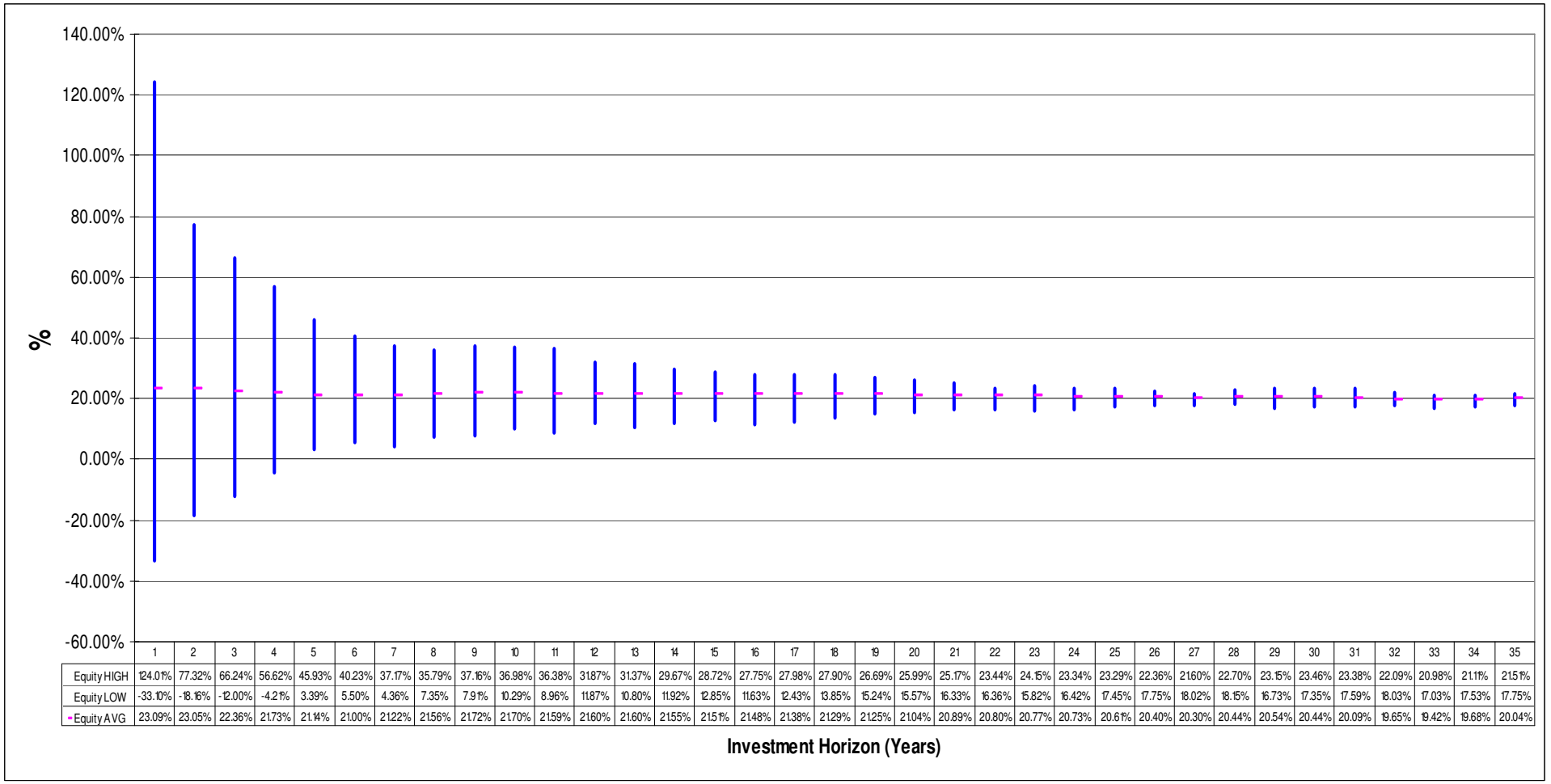
Earlier evidence revealed that annualised total return standard deviation and HL spread measures declined as the investigation periods were prolonged. Intuitively declining standard deviations and declining HL spreads, as measures of variance, imply a form of mean reversion. The empirical evidence is provided in the following section.

5.6.1 Mean reversion evidence in equity returns

In the candlestick graph (5.15) the average annualised returns from equity (the magenta-coloured markers) are plotted on the potential annualised equity low and potential annualised equity high returns for each period.

Note how the size of the potential annualised equity low and potential annualised equity high returns is negatively correlated with the time horizon. As the investment period is prolonged the possible variance in performance is reduced.

Graph 5.15: High, low, and average returns from SA equities for all rolling 1 to 35 year investment periods (annualised)



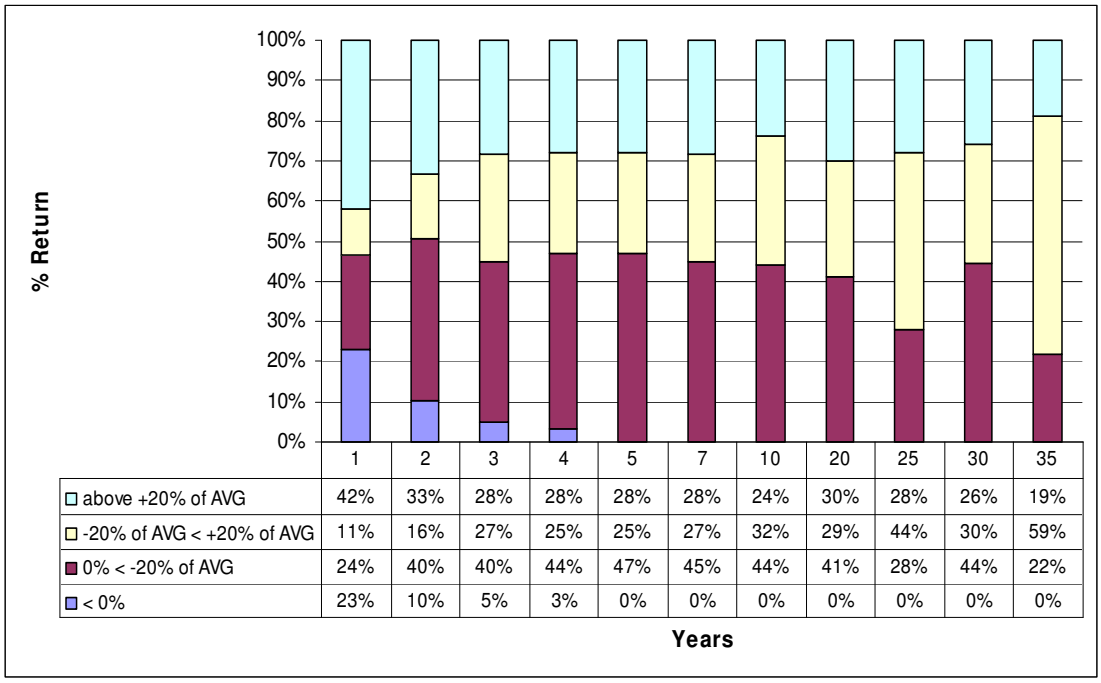
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Equity HIGH	124.01%	77.32%	66.24%	56.62%	45.93%	40.23%	37.17%	35.79%	37.16%	36.98%	36.38%	31.87%	31.37%	29.67%	28.72%	27.75%	27.98%	27.90%	26.69%	25.99%	25.17%	23.44%	24.15%	23.34%	23.29%	22.36%	21.60%	22.70%	23.15%	23.46%	23.38%	22.09%	20.98%	21.11%	21.51%
Equity LOW	-33.10%	-18.16%	-12.00%	-4.21%	3.39%	5.50%	4.36%	7.35%	7.91%	10.29%	8.96%	11.87%	10.80%	11.92%	12.85%	11.63%	12.43%	13.85%	15.24%	15.57%	16.33%	16.36%	15.82%	16.42%	17.45%	17.75%	18.02%	18.15%	16.73%	17.35%	17.59%	18.03%	17.03%	17.53%	17.75%
Equity AVG	23.09%	23.05%	22.36%	21.73%	21.14%	21.00%	21.22%	21.56%	21.72%	21.70%	21.59%	21.60%	21.60%	21.55%	21.51%	21.48%	21.38%	21.29%	21.25%	21.04%	20.89%	20.80%	20.77%	20.73%	20.61%	20.40%	20.30%	20.44%	20.54%	20.44%	20.09%	19.65%	19.42%	19.68%	20.04%

Source: Own composition

It is important to investigate how returns have historically been distributed between this potential low and potential high as these extreme returns may have been caused by highly unusual (or unlikely to be repeated) circumstances.

It is therefore important to investigate the distribution of the returns in order to arrive at an accurate assessment of the probabilities of the potential degree of variance from the mean. For this reason the study examines the frequency distribution of equity returns in the following section.

Graph 5.16: Frequency distribution of SA equity returns over various periods



	1	2	3	4	5	7	10	20	25	30	35
above +20% of AVG	42%	33%	28%	28%	28%	28%	24%	30%	28%	26%	19%
-20% of AVG < +20% of AVG	11%	16%	27%	25%	25%	27%	32%	29%	44%	30%	59%
0% < -20% of AVG	24%	40%	40%	44%	47%	45%	44%	41%	28%	44%	22%
< 0%	23%	10%	5%	3%	0%	0%	0%	0%	0%	0%	0%

Source: Own composition

Graph 5.16 depicts the distribution of equity returns over various short- and long-term periods. Returns were placed in distribution baskets as follows:

Table 5.2: Distribution baskets for frequency calculation

	Basket name	Description	Example
Basket 1	Above +20% of AVG	Returns over 20% of the average return for the period "n"	If the average return for the period is 20%, this segment would represent the returns over 24%
Basket 2	-20% of AVG < +20% of AVG	Returns between under 20% and over 20% of the average return for the period "n"	If the average return for the period is 20%, this segment would represent the returns between 16% and 24%
Basket 3	0% < -20% of AVG	Return between 0% and under 20% of the average return for the period "n"	If the average return for the period is 20%, this segment would represent the returns between 0% and 16%
Basket 4	< 0%	Negative returns for period "n"	This segment would represent the returns under 0%

Source: Own composition

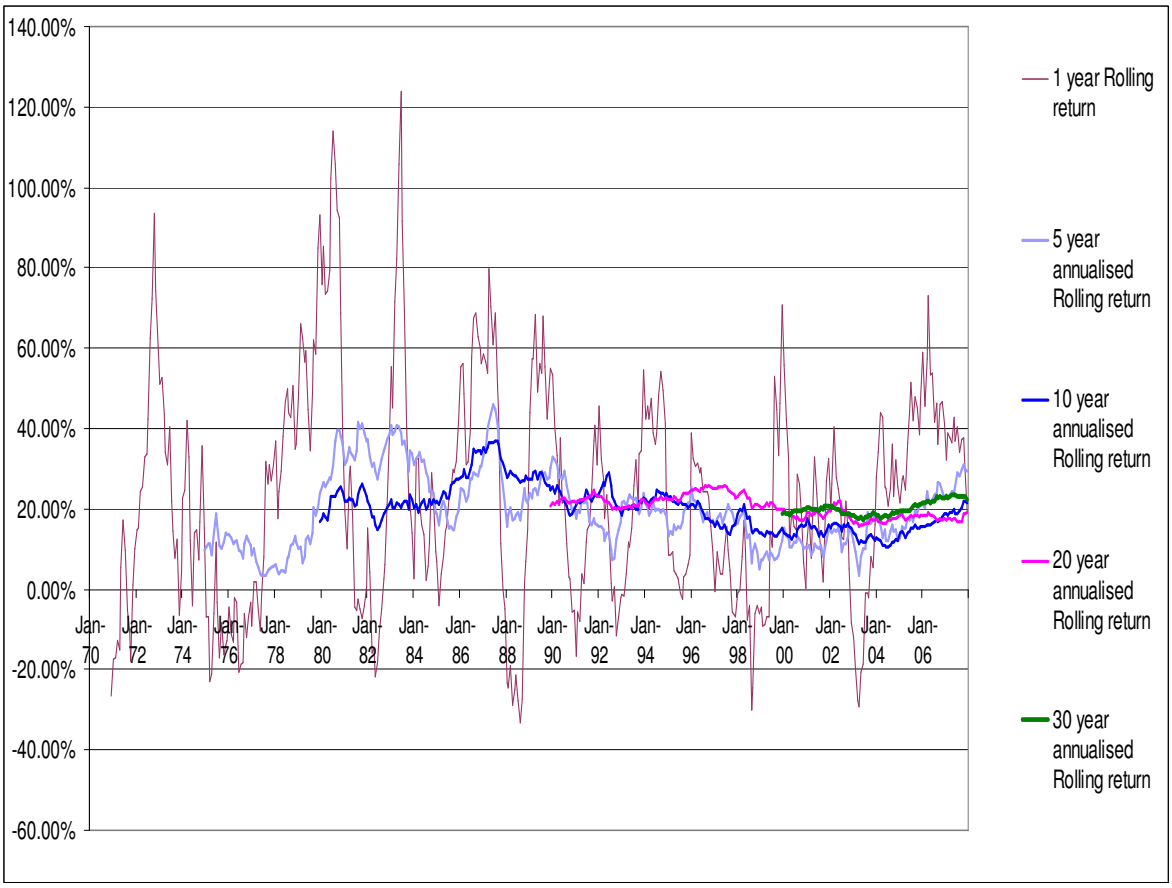
Note the following from graph 5.16:

- Although the downside risk only subsides after year 4, the likelihood of incurring a negative return is already fairly small in years 3 and 4 at 5% and 3% respectively.
- The probability of incurring a return within 20% of the historic average for the period increases over time: from 11% in year 1 to 59% in year 35.

In the equity case the study investigates the 1, 5, 10, 20, and 30 rolling year *chronological* annualised equity returns. Graph 5.17 graphically depicts these findings.

A chronological time line was applied in order to verify that mean reversion (from the actual results that investors experience by investing in equity) is evident.

Graph 5.17: Chronological annualised equity returns for different rolling periods



Source: Own Composition

Note how the curve is flattened as the investment period is prolonged. This would suggest that investors who remained invested in the equity market the longest could predict the outcome of their investment returns with the greatest accuracy.

Similarly, investors with short investment horizons have far less predictive ability. This uncertainty relates to the inherent risk associated with short-term equity investments.

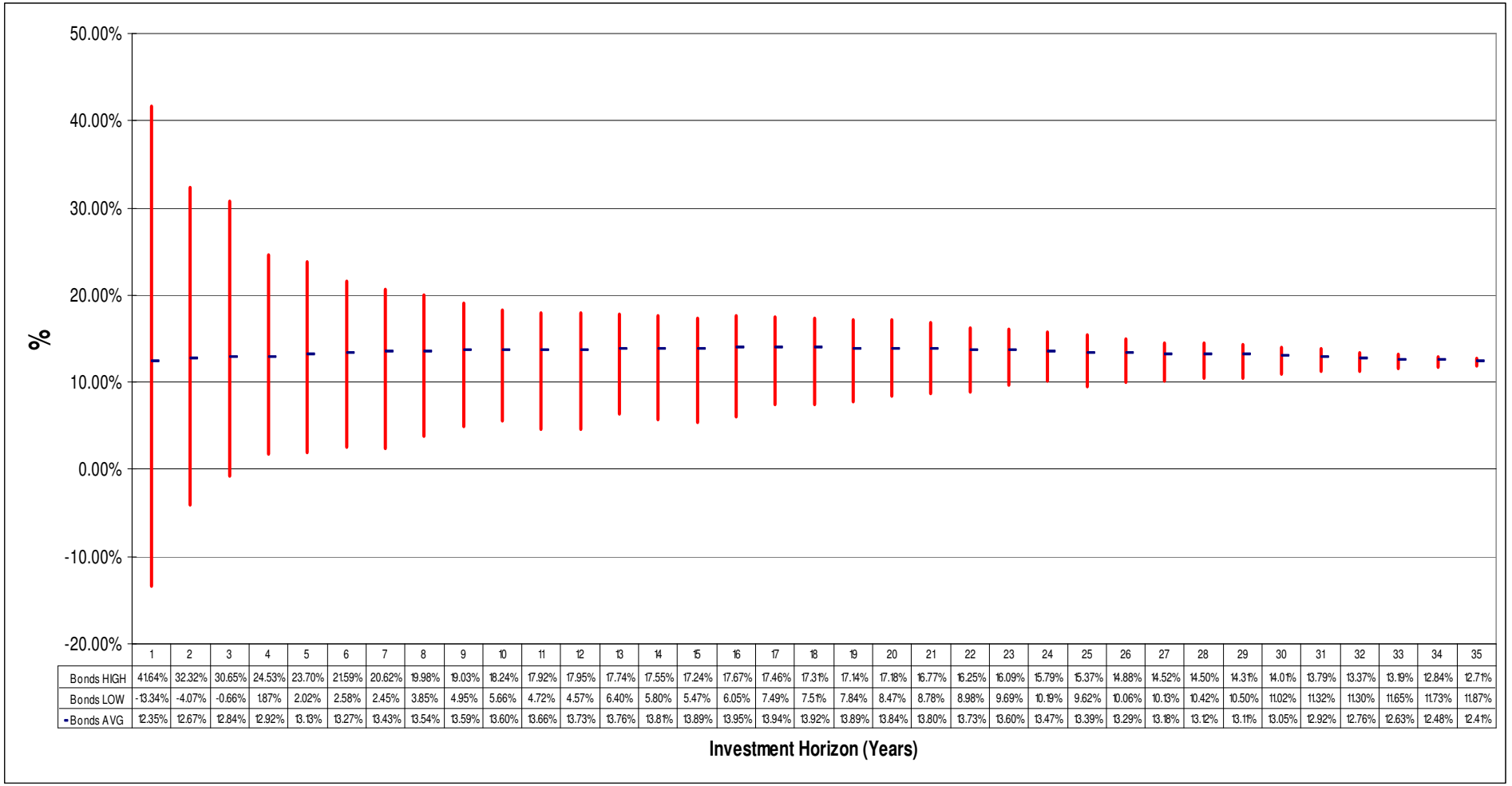
The study provided clear evidence of mean reversion in equity returns. The case for bonds and cash was similarly investigated.

5.6.2 Mean reversion evidence in bond returns

In the candlestick graph below (5.18) the average annualised returns from bonds (the blue markers) are plotted on the potential annualised bond low and potential annualised bond high returns (the red bars) for each period.

Note how the size of the potential annualised bond low and potential annualised bond high returns are negatively correlated with the time horizon. As the investment period is extended any possible variance in performance becomes less likely.

Graph 5.18: High, low, and average returns from SA bonds for all rolling 1 to 35 year investment periods (annualised)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Bonds HIGH	41.64%	32.32%	30.65%	24.53%	23.70%	21.59%	20.62%	19.98%	19.03%	18.24%	17.92%	17.95%	17.74%	17.55%	17.24%	17.67%	17.46%	17.31%	17.14%	17.18%	16.77%	16.25%	16.09%	15.79%	15.37%	14.88%	14.52%	14.50%	14.31%	14.01%	13.79%	13.37%	13.19%	12.84%	12.71%
Bonds LOW	-13.34%	-4.07%	-0.66%	1.87%	2.02%	2.58%	2.45%	3.85%	4.95%	5.66%	4.72%	4.57%	6.40%	5.80%	5.47%	6.05%	7.49%	7.51%	7.84%	8.47%	8.78%	8.98%	9.69%	10.19%	9.62%	10.06%	10.13%	10.42%	10.50%	11.02%	11.32%	11.30%	11.65%	11.73%	11.87%
Bonds AVG	12.35%	12.67%	12.84%	12.92%	13.13%	13.27%	13.43%	13.54%	13.59%	13.60%	13.66%	13.73%	13.76%	13.81%	13.89%	13.95%	13.94%	13.92%	13.89%	13.84%	13.80%	13.73%	13.60%	13.47%	13.39%	13.29%	13.18%	13.12%	13.11%	13.05%	12.92%	12.76%	12.63%	12.48%	12.41%

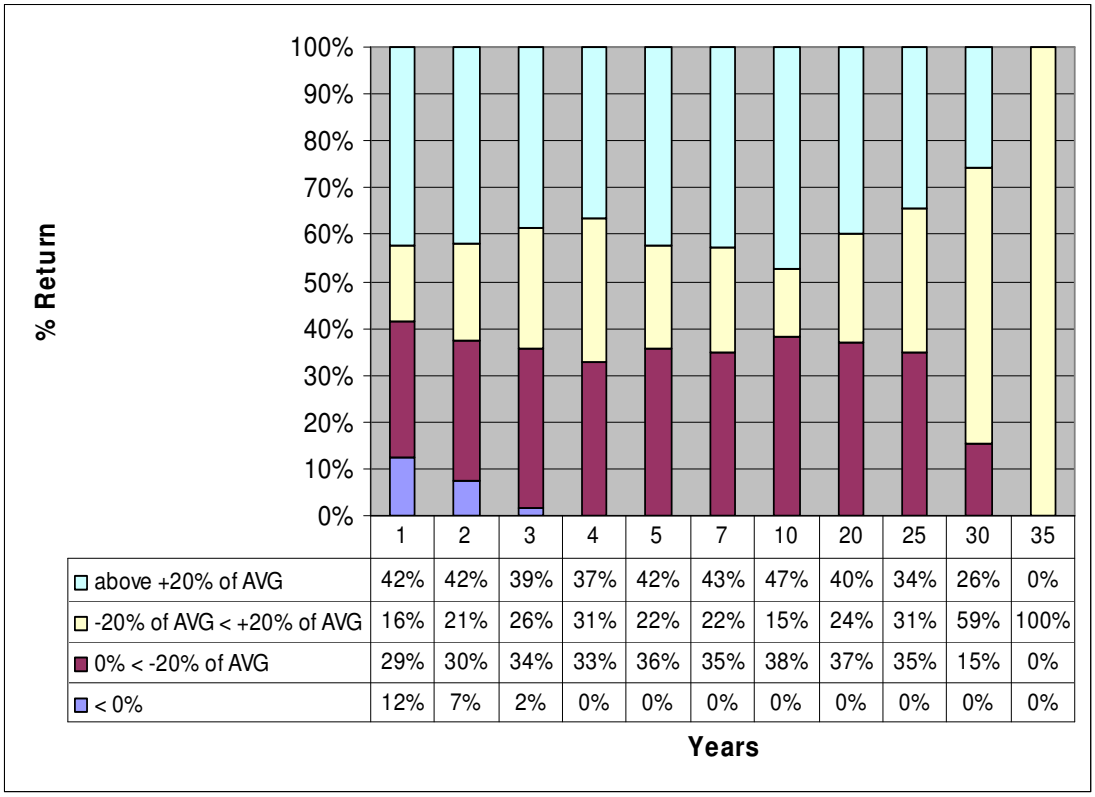
Source: Own composition

Note the following from graph 5.19, which summarises the return distribution for SA bonds:

- Although the downside risk only subsides after year 3, the likelihood of incurring a negative return is already fairly small in years 2 and 3 at 7% and 2% respectively.
- The probability of incurring a return within 20% of the historic average for the period increases over time: from 16% in year 1 to 100% in year 35.

The study presented clear evidence of mean reversion in the bond returns investigation. The case for cash is also described before the section on mean reversion is concluded.

Graph 5.19: Frequency distribution of SA bond returns over various periods



	1	2	3	4	5	7	10	20	25	30	35
above +20% of AVG	42%	42%	39%	37%	42%	43%	47%	40%	34%	26%	0%
-20% of AVG < +20% of AVG	16%	21%	26%	31%	22%	22%	15%	24%	31%	59%	100%
0% < -20% of AVG	29%	30%	34%	33%	36%	35%	38%	37%	35%	15%	0%
< 0%	12%	7%	2%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Own composition

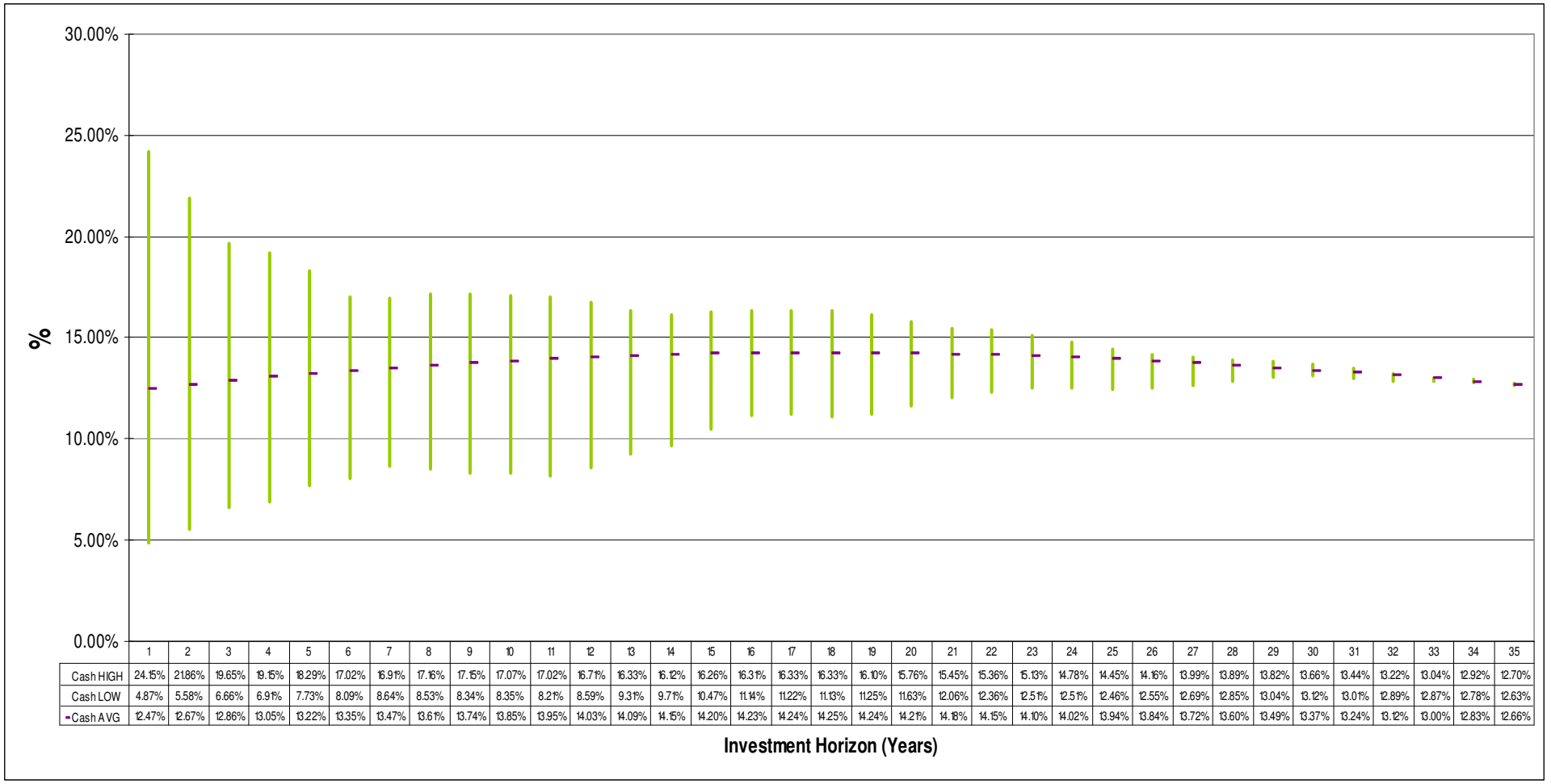
5.6.3 Mean reversion evidence in cash returns

In the candlestick graph below (5.20) the average annualised returns from cash (the purple markers) are plotted on the potential annualised cash lowest returns and potential annualised cash highest returns for each period.

Again, note how the sizes of the potential annualised cash lowest and potential annualised equity highest returns are negatively correlated with the time horizon.

As in the case of equity and bonds, as the investment period is prolonged the possible variance in performance is reduced.

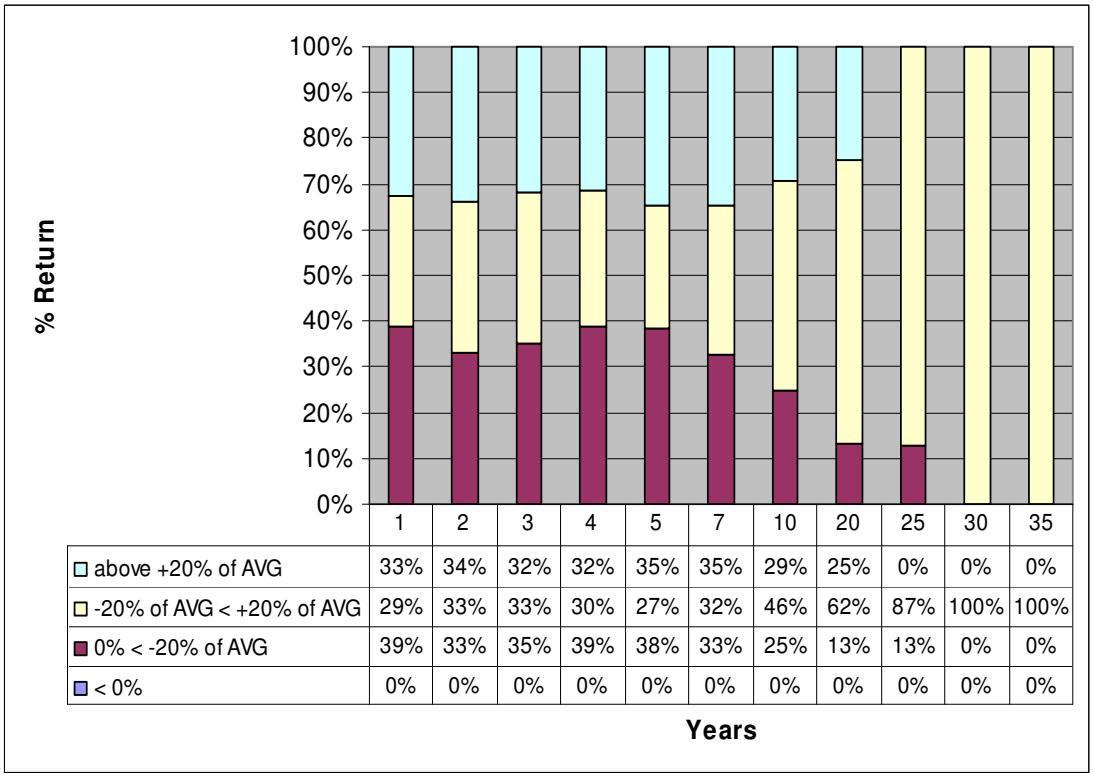
Graph 5.20: High, low, and average returns from SA cash for all rolling 1 to 35 year investment periods (annualised)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Cash HIGH	24.15%	21.86%	19.65%	19.15%	18.29%	17.02%	16.91%	17.16%	17.15%	17.07%	17.02%	16.71%	16.33%	16.12%	16.26%	16.31%	16.33%	16.33%	16.10%	15.76%	15.45%	15.36%	15.13%	14.78%	14.45%	14.16%	13.99%	13.89%	13.82%	13.66%	13.44%	13.22%	13.04%	12.92%	12.70%
Cash LOW	4.87%	5.58%	6.66%	6.91%	7.73%	8.09%	8.64%	8.53%	8.34%	8.35%	8.21%	8.59%	9.31%	9.71%	10.47%	11.14%	11.22%	11.13%	11.25%	11.63%	12.06%	12.36%	12.51%	12.51%	12.46%	12.55%	12.69%	12.85%	13.04%	13.12%	13.01%	12.89%	12.87%	12.78%	12.63%
Cash AVG	12.47%	12.67%	12.86%	13.05%	13.22%	13.35%	13.47%	13.61%	13.74%	13.85%	13.95%	14.03%	14.09%	14.15%	14.20%	14.23%	14.24%	14.25%	14.24%	14.21%	14.18%	14.15%	14.10%	14.02%	13.94%	13.84%	13.72%	13.60%	13.49%	13.37%	13.24%	13.12%	13.00%	12.83%	12.66%

Source: Own composition

Graph 5.21: Frequency distribution of SA cash returns over various periods



	1	2	3	4	5	7	10	20	25	30	35
above +20% of AVG	33%	34%	32%	32%	35%	35%	29%	25%	0%	0%	0%
-20% of AVG < +20% of AVG	29%	33%	33%	30%	27%	32%	46%	62%	87%	100%	100%
0% < -20% of AVG	39%	33%	35%	39%	38%	33%	25%	13%	13%	0%	0%
< 0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source: Own composition

Note the following from graph 5.21, which summarises the distribution of returns from cash:

- The likelihood of incurring a negative return is zero, regardless of the investment term.
- The probability of experiencing a return within a 20% range of the historic average for the period increases over time: from 29% in year 1 to 100% in years 34 and 35.

In the preceding section the study provided conclusive empirical evidence of mean reversion in the returns of South African equities, bonds, and cash. This evidence provides the basis for formulating strategies around time diversification theory.

Also note that the above evidence explains (in part) the differences in the results obtained from the risk-return analysis of pure variance measures and those of the downside measure.

As time passes the volatility of asset class returns becomes less important as a measure of risk because returns tend to revert to the mean. Other considerations like downside risk and potential upside considerations become exceedingly important as time passes.

The study has attained its primary objective[16] and verified the basis for its findings.[17] The study showed that the dynamics of time should play an important role in the investment decision making process.

The next step in achieving the secondary objective of the dissertation, is to make some recommendations for performing holistic *multi-period* risk return assessments that are implicitly cognisant of the investment horizon.

5.7 Recommendations for performing multi-period risk-return assessments

The objective of these concluding remarks is to provide recommendations for performing multi-period risk-return assessments that *accurately* illustrate the relationship between risk and return of the various asset classes over various periods.

It is the opinion of the researcher that this necessitates (***at least***) a six-factor process of evaluation over different periods. In the following sections the study will discuss the six factors that this study considers critical in portraying an accurate risk evaluation. This will be followed by the presentation of a holistic multi-period risk-return assessment.

[16] Paragraph 5.5.
[17] Paragraph 5.6.

5.7.1 Six factors to be considered during holistic risk-return assessment

In the following section the study will discuss six factors to be considered during holistic risk-return assessment: Downside risk, potential upside considerations, asset efficiency (the HL ratio), frequency, opportunity cost risk, and valuations.

a) Downside risk

It should be remembered that the downside risk illustrates the "worst-case-scenario" in terms of total returns.

b) Potential upside considerations

As discussed in chapter 3, potential upside considerations illustrate the "best-case-scenario" in terms of return.

c) Asset efficiency (high-low ratio)

It may be recalled that the HL ratio illustrates the potential gain relative to the potential loss. The measure is indicative of how efficient an asset class is in generating returns. Effectively, the measure could calculate the potential upside for a predetermined amount of potential downside.

d) Frequency

Frequency analysis in terms of performance analysis refers to the distribution of returns from an asset. Frequency is an important consideration because it provides additional insight into the results from the other measures in this holistic risk assessment model. For example, investigating the downside risk of equity revealed that the downside risk of exhibiting a loss is 0% when the investment

term exceeds 4 years. Downside risk was evident for all periods of 4 years and less. The downside risk of equity over years 1 to 3 was relatively stable at just over -30%. However, frequency analysis revealed that the probability of downside risk is generally reduced by half every year:

Table 5.3: Importance of investigating the frequency distribution of returns

Investment horizon	Downside risk (Minimum return)	Frequency of downside under 0%
1 Year	-33.16%	23%
2 Year	-33.02%	10%
3 Year	-31.85%	5%
4 Year	-15.8%	3%
5 Year	+18.15%	0%

Source: Own composition

Table 5.3 above illustrates that frequency is an important consideration for the interpretation of downside risk. Similarly, frequency analysis should be applied when assessing the variance, potential upside, and average return.

e) Opportunity cost risk

The opportunity cost risk is implicitly taken into account by evaluating the high, low and average returns. For example, this study indicated that the best case scenario returns from bonds over 23 years cannot exceed the worst case scenario returns from equity over the same period. It can therefore be concluded that an investment in bonds for longer than 23 years is very likely to result in an opportunity cost to the investor.

The opportunity cost parameters may also vary according to a predetermined level. The assessor could, for example, compare the likely spread in the average returns from one asset with the likely average returns from another asset class.

Ultimately, the calculation is flexible and parameters may be adjusted to appropriate levels, according to requirements and/or the demands of the assessment.

f) Valuations

The valuation of assets is a complex and very much an independent investigation. Unfortunately the study of valuations is beyond the scope of this study. This study would, however, like to emphasise the importance of the incorporation of valuations into holistic risk assessments:

Valuations and returns (and implicitly risk) would appear to share a strong negative correlation: The lower the figure at which the asset is valued, the greater the subsequent return. Vice versa, the higher the valuation, the smaller the subsequent return and the greater the probability of inferior returns or potential losses.

This should have a significant impact on the assessment of risk, for example: assume the equity market is at a record low valuation, should a conservative investor not consider entering the market, even just marginally? Conversely, if the market is overvalued, should the aggressive investor not reduce his equity exposure?

Five of the six factors identified in the above section have been assessed in this study. As it is an independent investigation, valuations were not investigated.[18] This study will, however, assess the five investigated factors identified above in order to present a holistic multi-period risk-return assessment.

[18] In terms of the study objectives valuations were not considered here. Independent work on valuations would, however, add value if incorporated into this investigation.

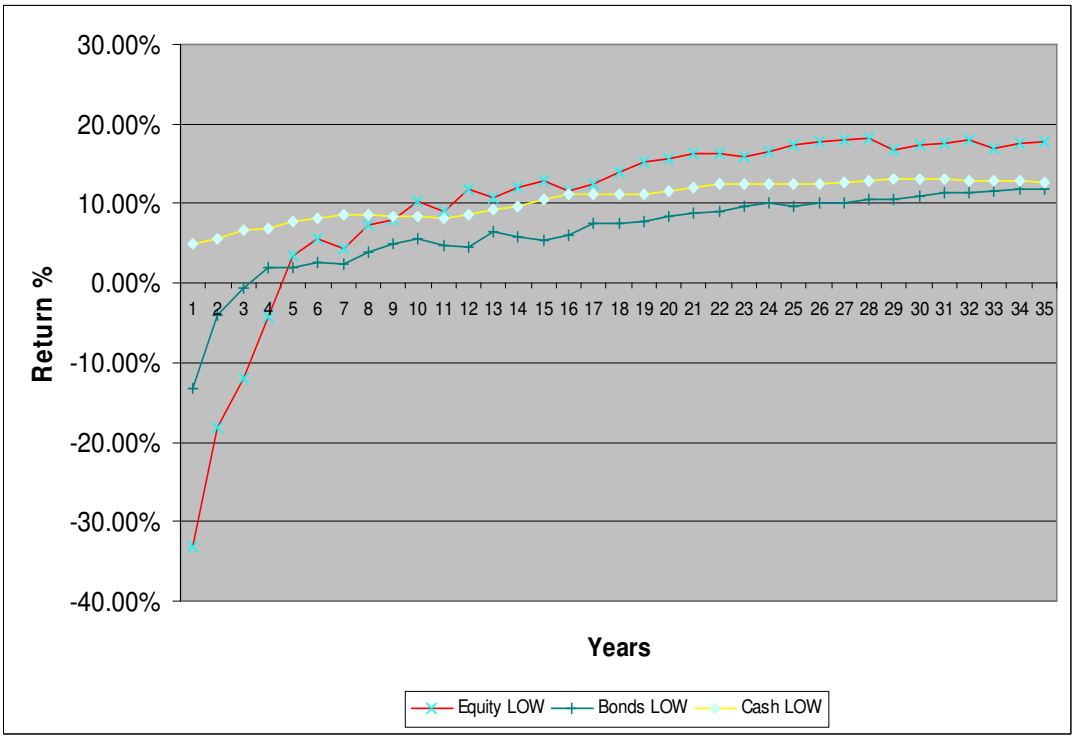
5.7.2 Multi-period risk-return assessment

It should be remembered that the objective is to accurately illustrate the relationship between risk and return of the various asset classes *over time*.

The study has established that a good assessment of risk should provide an indication of at least the following six factors:

- Downside risk
- Potential upside considerations
- Asset efficiency (high-low ratio)
- Frequency
- Opportunity cost risk
- Valuations

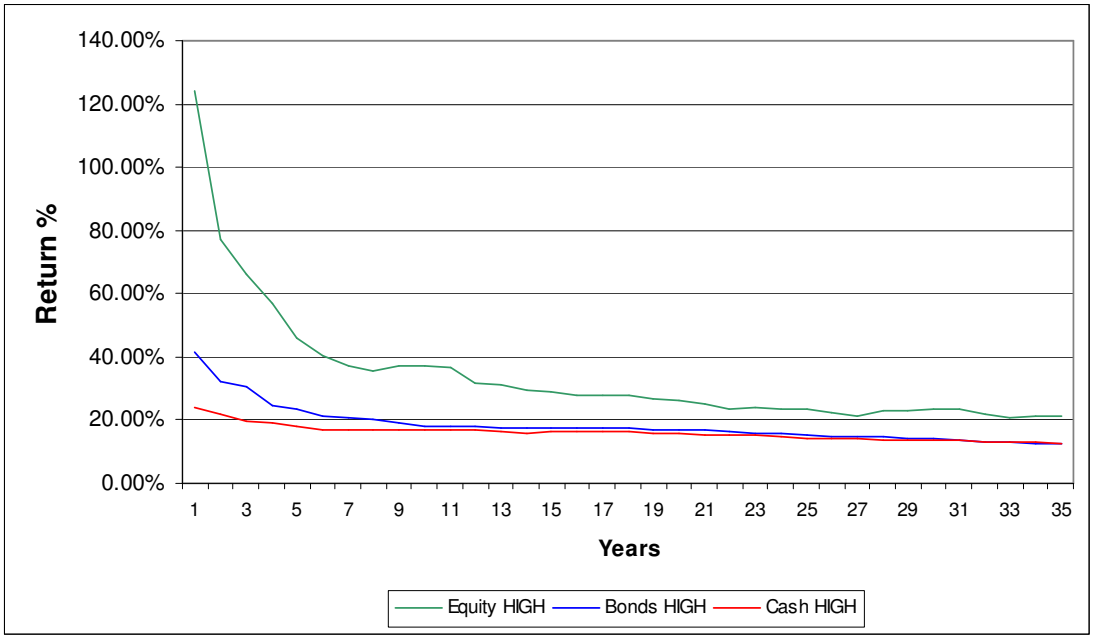
Graph 5.22: A representation of downside risk



Source: Own composition

The second step would be to consider the upside potential illustrated in graph 5.22 above.

Graph 5.23: Upside potential of SA asset classes over varying investment horizons

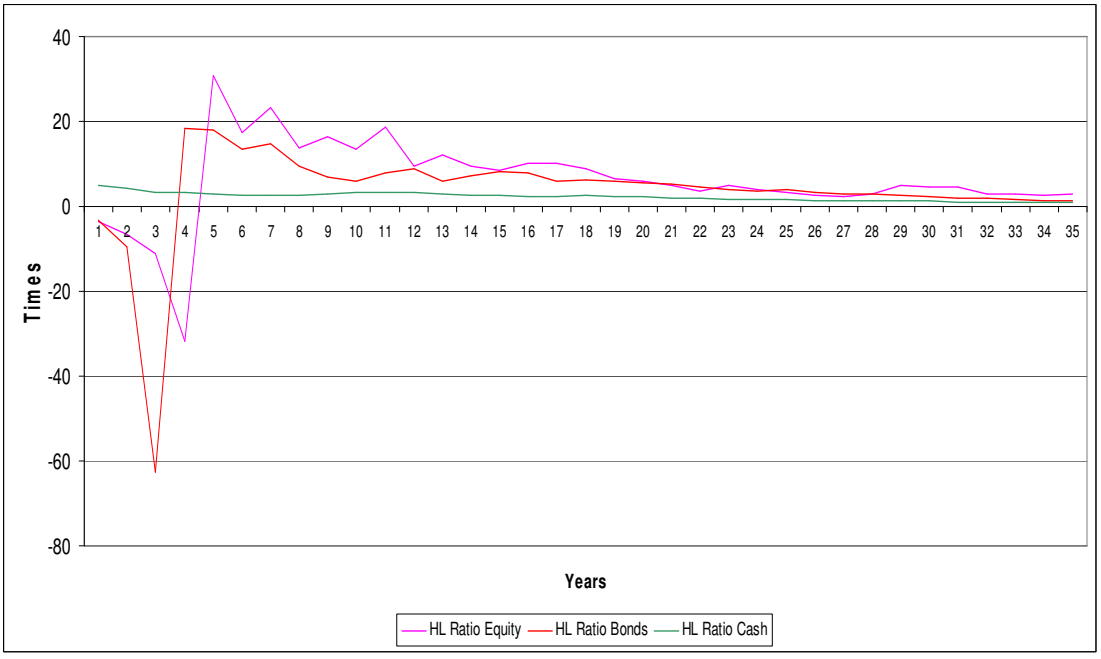


Source: Own composition

It is evident from graph 5.22 that equity provides the highest potential upside, followed by bonds, and then cash.

Asset efficiency, the third factor, is illustrated above (graph 5.23) by means of the HL ratio:

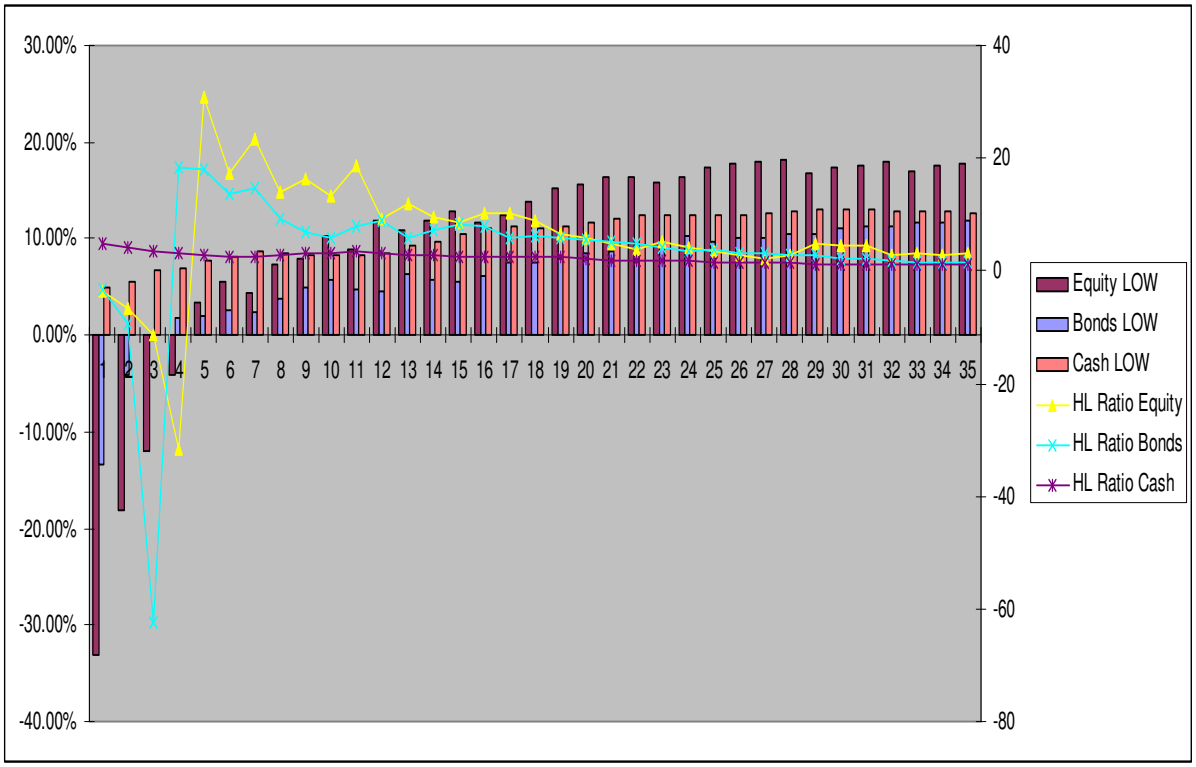
Graph 5.24: HL ratio of SA asset classes over varying investment horizons



Source: Own composition

An integrated representation of downside risk and asset efficiency would result in graph 5.24 provided at the bottom of the previous page. In order to simplify the illustration, potential upside is not plotted for the moment, although one should keep in mind that it was established in the preceding section that equity provides the highest potential upside, followed by bonds, and then cash.

Graph 5.25: Complexity of holistically presenting relative risk



Source: Own composition

Note that graph 5.25, even after simplification and without factors 4 and 5, is not easy to interpret. Frequency, the fourth factor, can be implemented to good effect here in order to simplify the results. It should be remembered that frequency distribution analysis refers to the distribution of returns from an asset.

Frequency can therefore be implemented to indicate returns within given parameters or a given set of parameters. The frequency distribution in graph 5.25 above has been set to include the risk of incurring a negative return in order to simplify the illustration.

Note that graph 5.25 illustrates the downside risk, upside potential and HL ratio, and incorporates the frequency distribution of returns according to the same guidelines as were previously applied in the discussion on mean reversion.[19]

Interpretation of graph 5.25:

- A negative HL ratio implies a probability of negative returns.
- The size of the HL bar (regardless of preceding denomination, positive or negative) indicates asset efficiency.
- The closer the HL ratio is to 1 the less volatile the return; perfect forecasting ability equates to an HL ratio of 1.
- HL can never be smaller than 1 and larger than 0 as the best case scenario return cannot be a fraction of the downside risk.
- The red, yellow and orange bars indicate the frequency distribution of the returns.
- The red bar indicates downside risk.
- The yellow bar depicts the potential for above-average performance.
- The blue bar illustrates the average for reference purposes.
- The red horizontally striped bar indicates the worst case scenario return.
- The green diagonally striped bar indicates the best case scenario return.

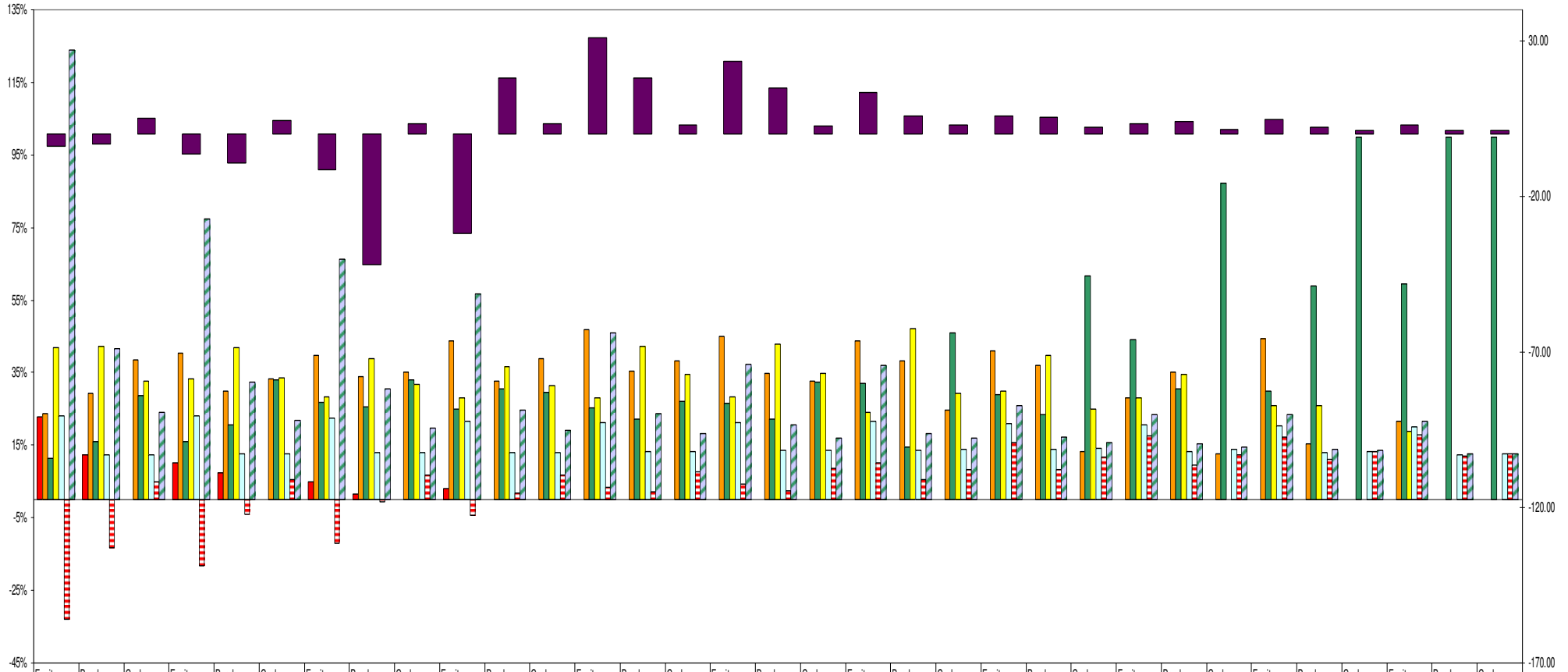
[19] Refer to table 5.2.

Note the following from graph 5.25:

- The green bars, which reflect the likelihood of attaining a return close the average increase over time - time diversification benefit.
- The HL ratio (asset efficiency) of equity is consistently higher than that of the other asset classes.
- The lowest return from equity in year 25 is 2.08% higher than the highest return form bonds for the same period. This indicates the annualised opportunity cost.

The illustration incorporated downside risk, potential upside considerations, asset efficiency (high-low ratio) and frequency and accurately depicts the relationship between risk and return of the various asset classes over time.

Graph 5.26: Holistic multi-period risk assessment for SA asset classes over various periods (annualised where applicable)



	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash	Equity	Bonds	Cash
	1 YR			2 YR			3 YR			4 YR			5 YR			7 YR			10 YR			20 YR			25 YR			30 YR			35 YR		
< 0%	23%	12%	0%	10%	7%	0%	5%	2%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0% < -20% of AVG	24%	29%	39%	40%	30%	33%	40%	34%	35%	44%	33%	39%	47%	36%	38%	45%	35%	33%	44%	38%	25%	41%	37%	13%	28%	35%	13%	44%	15%	0%	22%	0%	0%
-20% of AVG < +20% of AVG	11%	16%	29%	16%	21%	33%	27%	26%	33%	25%	31%	30%	25%	22%	27%	27%	22%	32%	32%	15%	46%	29%	24%	62%	44%	31%	87%	30%	59%	100%	59%	100%	100%
above +20% of AVG	42%	42%	33%	33%	42%	34%	28%	39%	32%	28%	37%	32%	28%	42%	35%	28%	43%	35%	24%	47%	29%	30%	40%	25%	28%	34%	0%	26%	26%	0%	19%	0%	0%
Average return	23.09%	12.35%	12.47%	23.05%	12.67%	12.67%	22.36%	12.84%	12.86%	21.73%	12.92%	13.05%	21.14%	13.13%	13.22%	21.22%	13.43%	13.47%	21.70%	13.60%	13.85%	21.04%	13.84%	14.21%	20.61%	13.39%	13.94%	20.44%	13.05%	13.37%	20.04%	12.41%	12.66%
Minimum	-33.10%	-13.34%	4.87%	-18.16%	-4.07%	5.58%	-12.00%	-0.66%	6.66%	-4.21%	1.87%	6.91%	3.39%	2.02%	7.73%	4.36%	2.45%	8.64%	10.29%	5.66%	8.35%	15.57%	8.47%	11.63%	17.45%	9.62%	12.46%	17.35%	11.02%	13.12%	17.75%	11.87%	12.63%
Maximum	124.01%	41.64%	24.15%	77.32%	32.32%	21.86%	66.24%	30.65%	19.65%	56.62%	24.53%	19.15%	45.93%	23.70%	18.29%	37.17%	20.62%	16.91%	36.98%	18.24%	17.07%	25.99%	17.18%	15.76%	23.29%	15.37%	14.45%	23.46%	14.01%	13.66%	21.51%	12.71%	12.70%
HL Ratio	-3.75	-3.12	4.96	-6.49	-9.43	4.23	-11.28	-41.90	3.34	-31.74	18.21	3.31	30.94	18.03	2.92	23.38	14.69	2.53	13.39	5.92	3.12	5.90	5.59	2.20	3.40	3.88	1.58	4.62	2.27	1.16	3.01	1.30	1.02

Source: Own composition

5.8 Summary

This chapter illustrated the differences between the short-term and the long-term analyses and their findings. The study showed that traditional risk/return classification for various assets is biased towards shorter investment periods.

This analysis indicated that by manipulating time frames an investor can find relative optimal investment periods for each asset class by establishing breaking points where asset classes have experienced similar levels of risk (with differing returns).

The last part of chapter 5 focused on *causes and consequences* of a deteriorating positive correlation between risk and return. The investigation showed that some asset classes that have traditionally been considered to be riskier may over certain periods be less risky than assets that are traditionally considered low risk through volatility measures.

The above analysis has significant implications for asset managers, portfolio managers, financial advisers and other investment practioners: the theory advanced is that assets that are traditionally believed to be riskier have similar risk levels over certain periods to assets that are traditionally believed to carry a low risk (or the risk levels may even be lower).

This demonstrates that the traditional definition of risk and diversification theory of multiple asset class portfolios may be manipulated, and if applied/interpreted incorrectly can impose other risks on portfolios.[20] Conversely, if applied correctly, risk may be significantly reduced and returns enhanced.

This dissertation will be concluded in the following chapter by briefly revisiting the findings of the preceding chapters, discussing some of the major implications of these findings, and suggesting areas for further investigation.

[20] In particular opportunity cost risk.

CHAPTER 6

CONCLUSION

6.1 Introduction

The primary objective of the study is to illustrate that although asset class returns move along the risk-return curve/dynamic as conventionally believed, if a third dimension of *investment horizon* is incorporated into risk-return assessments there may be a shift in the risk-return curve/dynamic that can significantly influence the investment decision.

The secondary objective is to present a framework for more holistic assessments of risk that are cognizant of investment horizon.

This chapter summarises the study by discussing the findings from the preceding chapters, commenting on the possible implications of these findings, and then suggesting areas for further research.

6.2 Summary of the study

Chapter 1, "Introduction, methodology and overview", defined the problem, described the study methodology and provided a study overview. The chapter presented a background discussion of the topic and provided the required insight into the theoretical and practical aspects of the study. Comments regarding the study methodology followed, after which the chapter was concluded by means of a study overview.

In chapter 2, the "Literature review", the research that has been published on the topic was presented. This research was examined and discussed. The chapter evaluated accepted concepts regarding the topic and commented on their strengths and weaknesses.

In this chapter the study found that the topic of return relative to volatility (risk) is a thoroughly researched area. However, the vast majority of readings differ in one or more of the following respects:

- Objective
- Period investigated
- Region investigated
- Asset classes investigated
- Degree of detail of investigation – thoroughness
- Statistical strength in analysis
- Complexity
- Sources
- Applicability and future use
- Targeted reader

The above aspects of each reading were investigated and discussed with reference to a thematic structure. The literature review discussed research within the framework of the following themes:

- Short-term risk-return relationship
- Long-term risk-return relationship
- Relative asset class returns
- Risk reduction properties of time, trends and mean reversion
- Alternative and/or additional measures of risk
- Pros and cons of the mean-variance model

In chapter 3, "Return-volatility: short- term relationship", the study performed an analysis of the total annualised returns over all 1 to 5 year periods for each asset class.

The chapter served as the first of two steps in demonstrating that the return spread between asset classes is far greater over shorter periods than over longer time frames (chapter 5).

The chapter presented additional measures of risk and performed risk assessments according to these measures. The chapter presented the potential downside, potential upside, high-low spread, and relative potential gain measurement via the high-low (HL) ratio measure and assessed the pros and cons of each measure.

Chapter 3 illustrated, consistently via all the above-mentioned measures, that the risk associated with short-term equity investment due to higher performance variance was significant. The empirical evidence of this chapter illustrated that equity returns become increasingly erratic as investment horizons are shortened.

The chapter also identified the development of mean reverting patterns in asset class returns and emphasised the importance of holistic risk assessment and management.

Chapter 4, "Return-volatility: long-term relationship", investigated the relationship between long-term volatility and return and served as the second step in demonstrating that the return spread between asset classes is far greater over shorter periods than over longer time frames (chapter 5).

The chapter performed an analysis of the total annualised return over all rolling 7, 14, 21, 28 and 35 year periods for each asset class (equities, bonds and cash) and again tabulated these returns for each asset class. Volatility-return analysis and discussion of each asset class followed.

The chapter re-applied the newly presented measures of risk from chapter 3 to the long-term case. The chapter illustrated, via these measures, that variance was not an accurate indicator of the risk of losing capital over the long term.

The chapter also identified the development of mean reverting patterns in asset class returns.

The chapter concluded by reiterating that risk measures play an important role in the investment decision making process of all investors and that any inconsistencies found in the results obtained over different periods from the presented risk measures should be evaluated further and their implications investigated.

Chapter 5, "Return-volatility: deteriorating relationship: causes and consequences", illustrated the differences between the short term and the long term analyses and their findings. The study showed that traditional risk-return classification for various assets is biased towards shorter investment periods as the long-term findings from the newly presented risk measures were *inconsistent* with the findings from the long-term results obtained from the mean variance model.

This analysis indicated that by manipulating the investment horizon an investor can find relative optimal investment periods for each asset class by establishing breaking points where asset classes have experienced similar levels of risk (with differing returns).

The latter part of chapter 5 focused on *causes and consequences* of a deteriorating positive correlation between risk (particularly based on variance) and return. The investigation showed that some asset classes that have traditionally been considered to be riskier may over certain periods carry less risk than assets that have traditionally been considered low risk through volatility measures.

6.3 Findings

The primary objective was attained by illustrating that the three-dimensional methodology (which incorporates *investment horizon*) produced different results from those produced by the conventional two-dimensional risk-return methodology. These results illustrated the increased likelihood of making inferior investment decisions when relying squarely on the two-dimensional model as a decision making utility.

The secondary objective was attained by presenting a framework for performing three-dimensional, multiple-period, risk assessments for various asset classes on a relative basis.

This chapter, the "Conclusion" summarised the findings from the preceding chapters (above). The chapter will discuss the implications of the above analyses, and suggest areas for further research in the segments to follow.

6.4 Implications of the study

This section of the study will explain why the work presented in this dissertation is valuable. This section expands the findings of this study from a narrow focus on the study itself to a broader focus on how the evidence fits into the bigger picture of investment research.

In the section below the study will therefore discuss the implications for modern portfolio theory, the implications for standard deviation dependent measures of risk, the implications for Regulation 28 of the Pension Funds Act, and the implications for the perceived risk-related properties of time.

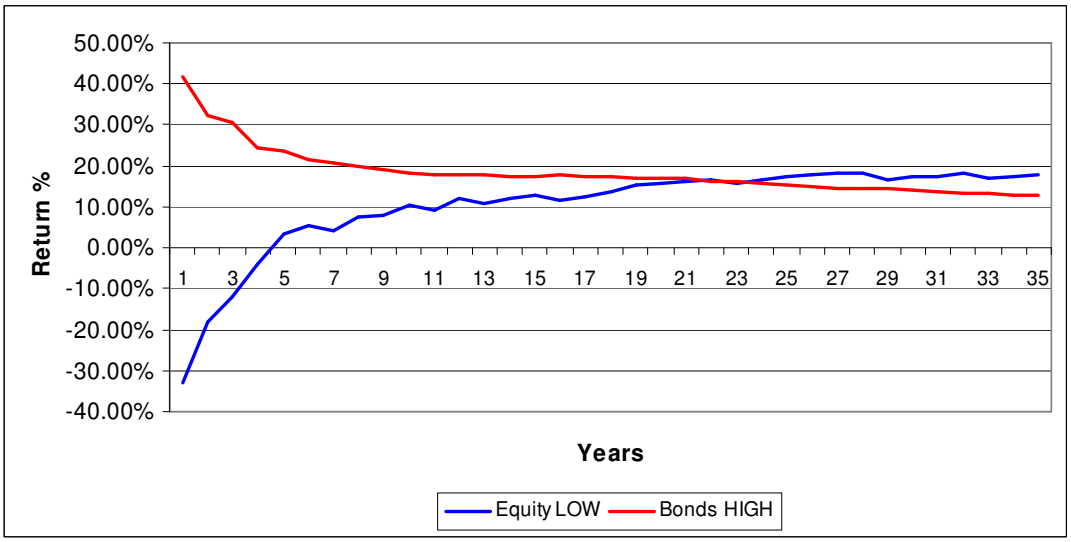
6.4.1 Implications for modern portfolio theory (MPT)

Modern portfolio theory is commonly accepted and regarded as the group of theories that provide the foundation for investment strategies. One of these theories is the efficiency frontier via the mean-variance model, which states that in order to achieve a higher return a greater degree of risk is necessitated.

Based on the evidence in this study the above statement only held good for short-term investments as it was illustrated that it may be possible to generate a higher return by accepting less long-term risk in some cases. The study also illustrated that variance is not always a conclusive indicator of risk for periods of more than 5 years.

Graph 6.1 below illustrates that, based on the relative risk-return analysis of this study that a 21+ year bond investment may be obsolete as the highest 21+ year return from bonds over the period investigated in this study is less than the lowest 21+ year return from equity.

Graph 6.1: Highest possible bond return vs lowest possible equity return over various periods



Source: Own composition

The empirical evidence above (graph 6.1) suggests that retaining bond exposure in a portfolio within a 21+ year investment horizon would therefore constitute irrational investment behaviour. Although volatility in the portfolio should be reduced, the portfolio will be exposed to far greater (and more relevant) opportunity cost risk.

By minimising variance, as part of any long-term investment strategy of 5 years or more, investors are likely to experience an inferior return without reducing monetary risk, and exposing them to additional opportunity cost risk. Chapter 5 illustrated that the longer the investment horizon the greater the likelihood of an inferior investment recommendation from the two-dimensional model.

The following scenario provides a further illustration:

- a very conservative investor with no tolerance for risk whatsoever
- with a 25 year investment horizon

- invested in a non-discretionary retirement investment vehicle (no cash flow requirements over the period)

According to the mean-variance model the client would be fully allocated to cash as it has the least amount of volatility - the optimal investment portfolio for most conservative investors.

In terms of the newly presented multi-period risk assessment (see chapter 5), the investor would be advised to invest in equity until the investment horizon has reduced to 9 years. Thereafter the full portion would be allocated to cash.

Although the second method might lead to a higher degree of volatility the client has[1] a 100% probability of generating a positive return, a 100% probability of exceeding the return from the first strategy, has limited the opportunity cost risk within his/her risk mandate, and has enhanced his/her asset efficiency without accepting more risk.

The findings from the preceding chapters illustrated that although the traditional mean-variance model indicates a shift in the efficiency frontier it does not reflect a change in the shape of the frontier over time (which more accurately depicts the long-term risk return relationship).

Volatility measures become obsolete as returns tend to mean revert. Alternative measures have been introduced in order to assist in making more accurate, holistic, multi-period risk assessments.

6.4.2 Implications for measures that incorporate standard deviation

Chapter 5 illustrated that standard deviation provides inconsistent assessments of risk as the investment horizon (the dynamic of time) is incorporated.

[1] Based on the risk-return analyses over the period from 1970 to 2007 presented in this study. Refer to chapter 1, section 4.2 for discussion on why it is the view of this study that past performance is a relevant and useful consideration for formulating a basis for assessing the future behaviour of investment return distributions.

This study has indicated that standard deviation is flawed because this measure of volatility:

- indicates average deviation and does not define maximum and minimum return
- reflects frequency but does not *describe* it
- does not reflect the mean reversion in total returns
- reflects mean reversion in annualised return but then understates the volatility in actual total return
- is too often applied as a measure of risk where volatility is not always able to accurately describe risk
- is not able to define the distribution of returns, and therefore cannot define the distribution of risk either

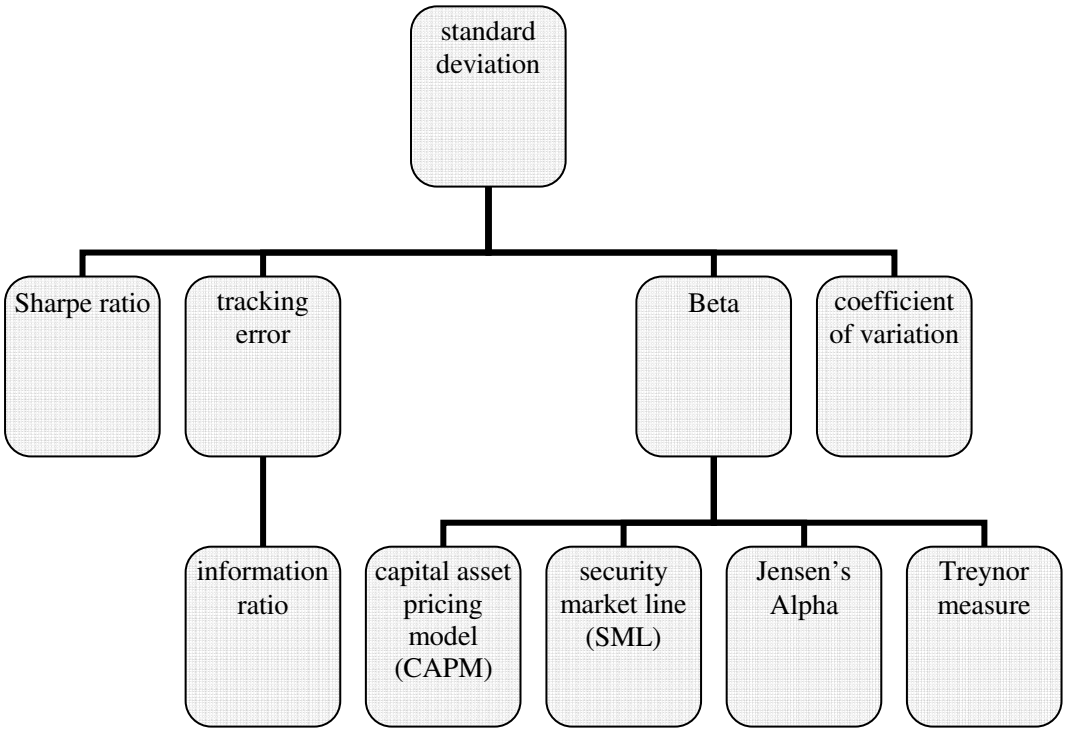
In this study standard deviation has been shown to be error-prone over investment horizons of 5 years and longer. Measures that incorporate standard deviation may therefore unintentionally be inheriting these misrepresentations.

As standard deviation is a function of additional measures of alternative investment variables, incorporation of standard deviation into such measures may, in certain cases, generate inaccurate and/or misleading results. Some of these measures include:

- the Sharpe ratio
- tracking error
- Beta
- coefficient of variation
- information ratio
- capital asset pricing model (CAPM)
- security market line (SML)
- Alpha
- the Treynor measure

Diagramme 6.1 below illustrates the incorporation of standard deviation into alternative measures.

Diagramme 6.1: Incorporation of standard deviation



Source: Own composition

Importantly, measures that rely on standard deviation as a measure of risk are susceptible to inaccurate results. Bear in mind that Hübner (2007:72) found that the heavy reliance of the information ratio on variance as a measure of risk is probably responsible for the poor results obtained from the information ratio.

In turn Nawrocki (1999:10) found that the heavy reliance of the downside risk measures on standard deviation is also responsible for inaccurate results.

Leland (1999:33) found that the CAPM model fails to assess performance results accurately owing to asymmetrical return distributions which are incorporated into the CAPM model via standard deviation.

It is the contention of this study that measures that rely on standard deviation as a measure of *variance* only will not necessarily be susceptible to the same manifestation of inaccuracy and that problems occur as architects of measures of risk rely too heavily on return variance as opposed to alternative indicators (that have been illustrated in the investigation) that may help to portray a more accurate picture of risk.

Table 6.1 below summarises the formulas of each of the above-mentioned measures for further reference.

Table 6.1: Formulas of the measures that are functions of standard deviation

Measure	Formula	Notes
The Sharpe ratio	$= \frac{\bar{r}_p - r_f}{\sigma_p}$	$\bar{r}_p$ = Expected portfolio return r_f = Risk free rate σ_p = Portfolio Standard deviation
Tracking error	$= \sqrt{Var(d-b)}$	d = Portfolio return b = Benchmark return
Beta	$= \frac{Cov(r_a, r_p)}{Var(r_p)}$	r_a = Rate of return asset r_p = Rate of return of the portfolio of which the asset is a part $Cov(r_a, r_p)$ = Covariance between the rates of return
Coefficient of variation	$= \frac{\sigma}{\bar{r}}$	σ = Standard deviation $\bar{r}$ = Expected return
Information ratio	$= \frac{(r_p - r_i)}{\sigma_{p-i}}$	r_p = Return of the portfolio r_i = Return of the index/benchmark σ_{p-i} = Tracking error (*standard deviation* of the difference between returns of the portfolio and the returns of the index)
CAPM	$\bar{r}_a = r_f + \beta_a(\bar{r}_m - r_f)$	r_f = Risk free rate β_a = Beta of asset

		$\bar{r}_m$ = Expected market return
SML	$= \alpha_a + \beta_a r_{m,t} + \varepsilon_{a,t}$	α_a = Alpha coefficient β_a = Beta coefficient $r_{m,t}$ = the rate of return for the market portfolio M during period t $\varepsilon_{a,t}$ = the random error term
Jensen's Alpha	$\alpha_p = \bar{r}_p - [r_f + \beta_p (\bar{r}_m - r_f)]$	$\bar{r}_p$ = Expected return for portfolio r_f = Risk free rate β_p = Beta of Portfolio $\bar{r}_m$ = Expected Market return
Treynor measure	$= \frac{r_p - r_f}{\beta}$	r_p = Portfolio return r_f = Risk free rate β = Portfolio Beta

Source: Bodie, Kane & Marcus (2007)

Investigating the implications of standard deviation when used in the measures of risk mentioned above (table 6.1) is beyond the scope of this study. The purpose of this section is solely to create awareness that results may be inaccurate if based solely on standard deviation as a measure of risk.

6.4.3 Implications for Regulation 28 under the Pension Funds Act – Prudential Investment Guidelines (PIGS) compliance

It may be recalled that a background to the Prudential Investment Guidelines set out in Regulation 28 of the Pension Funds Act was provided in chapter 1.[2]

This background illustrated that the regulation allows up to 100% to be invested in fixed interest instruments. This study has illustrated that the lack of equity

[2] Refer to paragraph 1.2.3 in chapter 1.

exposure, for investors with long-term investment horizons (5 years and longer), increases the likelihood of exposure to an opportunity cost over this period.

This background illustrated that the regulation allows for up to 75% of total assets to be invested in equity, which (as demonstrated in this study) will impact adversely on the long-term growth prospects of the portfolio.

Although there is provision for the Registrar to exempt funds from some or all of these maxima on prior written application, exclusion for a single member on the basis of specific investment objectives is unlikely.

The evidence advanced in this study shows that Regulation 28:

1. is prudent but does not appear to be optimal
2. does not fluctuate maxima according to investment horizon or market valuations
3. needs to incorporate a new multiperiod holistic framework for regulation of prudent investment

Some recommendations in this regard follow below.

a) Bands cognisant of investor time horizon

Bands cognisant of investor time horizon should be incorporated into the current guidelines. A 24 year old investor should be able to allocate a greater portion of his/her retirement funds to equity than a 60 year old investor. Assuming retirement at 65 years for example:

Table 6.2: Bands cognizant of investor time horizon

Investor age	Investment horizon for retirement at 65 years of age	Current maximum equity exposure	Time horizon maximum equity exposure (illustrative only)
64 year old investor	1 year investment horizon	75%	0%
25 year old investor	40 year investment horizon	75%	100%

Source: Own composition

Table 6.2 shows that as the investment horizon decreases so should the exposure to equity, and vice versa if investment horizons are longer (40 years in the above example) any allocation of less than 100% to equity would be illogical (as demonstrated in this study).

6.4.4 Implications for the long-term risk classification of cash

According to the standard deviation based mean-variance model, cash is the lowest risk asset class regardless of investment period (refer to graphs 5.5 and 5.6).

In contradiction to this, the measures introduced in this dissertation demonstrated the following:

- There is a significant opportunity cost payable (a sacrifice in return) without reducing the long-term risk relative to other asset classes when investing solely in cash (refer to graphs 5.13 and 5.14).
- Cash may be the lowest short-term risk asset class but is effectively an increasingly risky long-term asset in terms of opportunity cost risk (refer to graph 5.14).

Table 6.3 on the following page illustrates each asset's historic ability to outperform inflation. Calculating (as a percentage) all 10-year periods from 1900 onwards in which real returns were negative for each of the asset classes, the table

illustrates that cash was unable to outperform inflation over a 10 year period 26% of the time.

Table 6.3: All 10-year periods from 1900 in which real returns were negative

Asset class	Frequency
Equity	0%
Bonds	20%
Cash	26%

Source: Credit Suisse Standard Securities (2008)

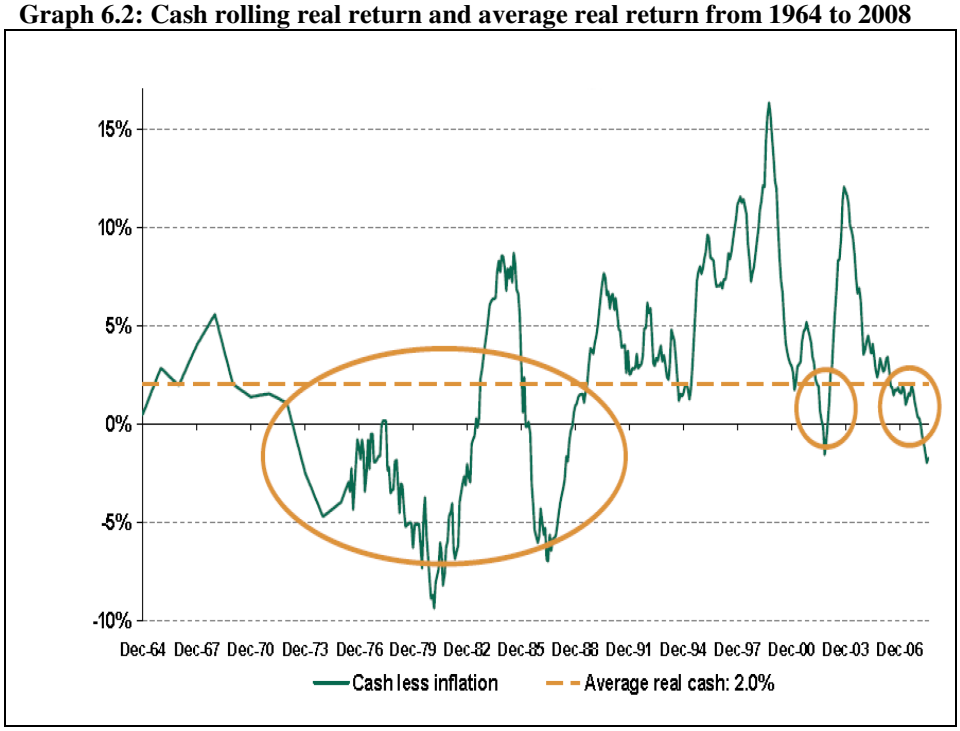
This illustrates that although the investor enjoyed a stable return over the period, his/her return was effectively negative in real inflation-adjusted terms. This implies that the investor was unable to preserve the purchasing power of his funds over the period.

Bond returns were unable to exceed inflation 20% of the time. Equity has never failed to outperform inflation over any 10-year period since 1900.

Graph 6.2 illustrates the real return obtained on cash since 1964 (green line). It is evident that cash experienced long periods of inflation underperformance, or negative real returns.

Graph 6.2 also shows the average real return on cash (dashed orange line) to be 2%. If cognizance is taken of all relevant costs and taxes, it becomes increasingly unlikely that cash will be able to exceed inflation (generate a positive real return) over prolonged periods.

Graph 6.2: Cash rolling real return and average real return from 1964 to 2008



Source: Prescient (2008)

This section has provided some evidence that suggest that cash should perhaps not be defined as a low-risk asset when investing for prolonged periods. The study has presented evidence that suggest that cash may be a high-risk asset class for long-term investors.

6.5 Suggestions for areas for further research

6.5.1 Valuations

Wessels (2005:3) states the following:

> *Notwithstanding that it is useful and reassuring to know that if for example you invest during a bear market phase that reversal will happen some time in the future, but obviously you do not know exactly when. (Limited in isolation) serious investors are not too concerned about short-term price movements or*

trading activities. However, they should be concerned when they invest in the market, preferably nearer to the bottom than the top.

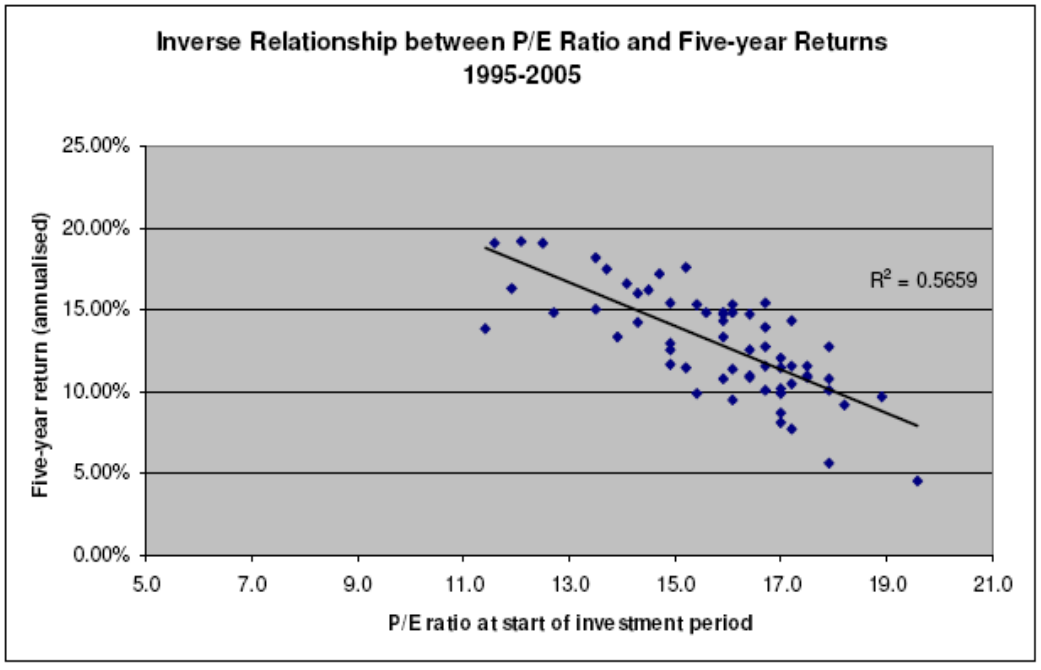
In the section to follow the study will illustrate the importance of considering market valuations in equity.

The measures most commonly used to judge whether equity markets are expensive or discounted are the price-earnings (P/E) and dividend yield ratios.

Graphs 6.3 and 6.4 depict these relationships relative to the subsequent 5-year return from the ALSI from 1995 to 2005. Note the negative correlation between the P/E ratio at the time of the investment and the subsequent five-year period return.

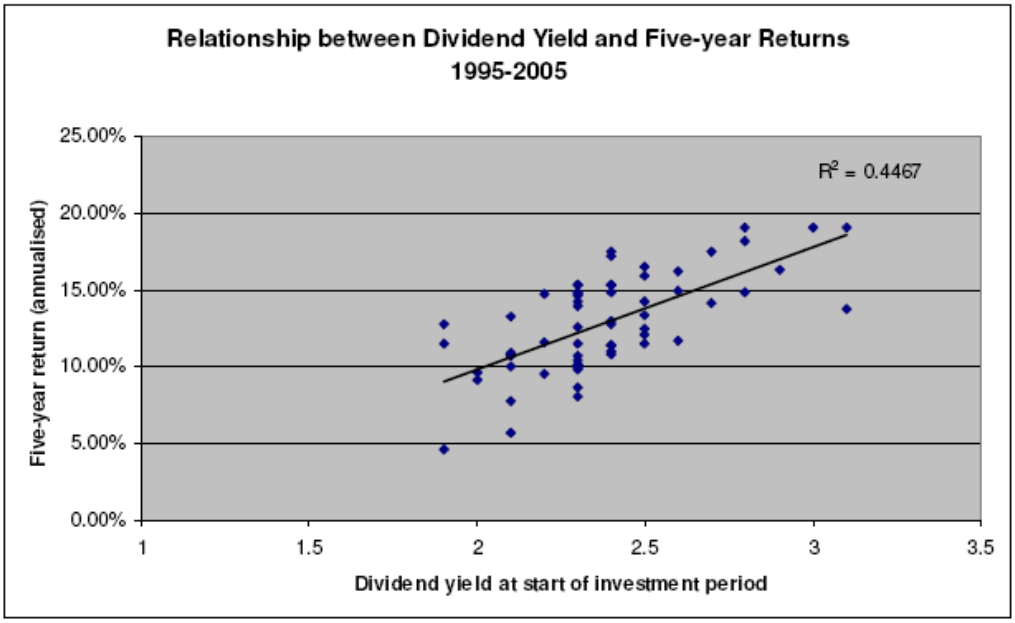
Graph 6.4 shows that the dividend yield and subsequent five-year returns exhibit a positive relationship.

Graph 6.3: P/E valuation and subsequent 5-year return



Source: Wessels (2005:6)

Graph 6.4: Dividend yield valuation and subsequent 5-year return



Source: Wessels (2005:7)

In the preceding section the study provided some empirical evidence that suggest that market valuations may play an important role in the return-risk dynamic. There is a need for further research that incorporates valuations into a holistic risk assessment framework similar to that which has been provided in this study.

6.5.2 Global investigations that take foreign exchange and inflation into account

Dimson, Marsh & Staunten (2002) examine pre-inflation (nominal) and post-inflation (real) returns. This study also acknowledges the importance of the impact of inflation on the real value of the investment. However, seeing that inflation restricts investment growth in a single country in a similar fashion (as it is universally unavoidable), this study has opted not to adjust historical returns for inflation.

Nevertheless, when considering multiple regions with differing inflation rates, returns should be adjusted for inflation to reflect real returns accordingly.

There is a need for research that performs multi-region risk-return analyses for multiple asset classes (similar to the Dimson, Marsh and Staunten study) in a holistic multi-period framework (similar to that of this study).

6.6 Conclusion

This chapter provided a summary of the preceding chapters, each of which contributed to attaining the primary and secondary objectives of this dissertation.

The chapter discussed the following implications for the industry arising from the findings of this study:

- Implications for MPT
- Implications for measures that incorporate standard deviation
- Regulation 28 of the Pension Funds Act and PIGS compliance
- Cash as the riskiest asset class

The chapter concluded by identifying some areas for further research. These include:

- Holistic multi-period risk-return assessments that incorporate valuations
- Global investigation conducted on the same basis that takes foreign exchange fluctuations and inflation differentials into account

BIBLIOGRAPHY

Adler, T & Kritzman, M. 2007. Mean-variance versus full-scale optimisation: in and out of sample. *Journal of Asset Management* 7(5):302-311.

Allen, D, Brailsford, T, Bird, R & Faff, R. 2002. *A review of the research on the past performance of managed funds*. Sydney: Fund Management Research Centre (FMRC) Press.

Alles, L & Athanassakos, G. 2006. The effect of investment horizons on risk, return and end-of-period wealth for major asset classes in Canada. *Canadian Journal of Administrative Sciences* 23(2):138-152.

Association of Collective Investments. 2008. Quick Quarterly Summary. http://www.aci.co.za/pebble.asp?relid=21. (Last accessed on 7 January 2009.)

Bernstein, P. 2007. The time dimension of risk. *The Journal of Portfolio Management* 33(4):1-1.

Brinson, G, Hood, R & Beebower, G. 1986. Determinants of portfolio performance. *Financial Analysts Journal* 42(4):39-48.

Bodie, Z, Kane, A & Marcus, A. 2007. *Essentials of investments*. 6th edition. New York: McGraw-Hill.

Bradfield, D. 2000a. *Mean reversion of equity returns on the JSE: implications for market timing and risk management.* http://www.cadiz.co.za/securities/quantitative-research.asp. (Last accessed on 15 June 2008.)

Bradfield, D. (2000b). *Interpreting the important concepts of risk.* http://www.cadiz.co.za/securities/quantitative-research.asp. (Last accessed on 15 June 2008.)

Brook, P. 2005. *Riding the roller-coaster asset allocation into 2006.* www.iclub.co.za/downloads/PeterBrookeNov05 .pps. (Last accessed on 3 November 2006.)

Credit Suisse Standard Securities (CSSS). 2008. *Prudential Portfolio Managers Due Diligence August 2008*. Prudential Conference handouts. Slide number 38.

Davids, M. 2007. *Short term fixed interest* (STEFI). www.alexanderforbes.com/AfricaFinancial/AssetCons/Surveys/STeFI/Updated%20STeFI-Benchmark.doc. (Last accessed on 7 January 2009.)

Dimson, E, Marsh, P & Staunten, M. 2002. *Triumph of the optimists, 101 years of global investment returns*. New Jersey: Princeton University Press.

Fabozzi, F, Focardi, S & Kolm P. 2006. A simple framework for time diversification. *The Journal of Investing* 15(3):8-17.

Firer, C & McLeod, H. 1999. Equities, bonds, cash and inflation: historical performance in South Africa 1925 - 1998. *The Investment Analysts Journal* 50(1):7-28.

Harlow, W. 1991. Asset allocation in a downside-risk framework. *Financial Analysts Journal* 47(5):28-40.

Hübner, G. 2007. How do performance measures perform. *Journal of Portfolio Management* 33(4):64-74.

Huxley, S & Burns, J. 2005. *Asset dedication: how to grow wealthy with the next generation of asset allocation*. New York: McGraw-Hill.

Ibbotson, R & Sinquefield, R. 1982. *Stocks, bonds, bills, and inflation: the past and the future*. Charlottesville: Financial Analysts Research Foundation.

Investopedia. 2008. *Cash.* http://www.investopedia.com/terms/c/cash.asp. (Last accessed on 14 July 2008.)

Investopedia. 2009. *Rolling returns.* http://www.investopedia.com/terms/r/rollingreturns.asp. (Last accessed on 7 January 2009.)

Investopedia. 2009. *Sharpe ratio.* http://www.investopedia.com/terms/s/sharperatio.asp. (Last accessed on 10 January 2009.)

Investopedia. 2009. *Sortino ratio.* http://www.investopedia.com/terms/s/sortinoratio.asp. (Last accessed on 10 January 2009.)

Israelsen, C. 2005. Refinement to the Sharpe ratio and information ratio. *Journal of Asset Management* 5(6):423-427.

Israelsen, C & Cogswell, G. 2007. The error of tracking error. *Journal of Asset Management* 7(6):419-424.

Jahnke, W. 1997. The asset allocation hoax. *Journal of Financial Planning* 10 (1): 109-113.

Jeffrey, R. 1984. A new paradigm of portfolio risk, in *Streetwise: the best of the Journal of Portfolio management,* edited by P Bernstein & F Fabozzi. . New Jersey: Princeton University Press:143-150.

Jones, C. 2007. *Investments.* 10th edition. New Jersey: Wiley.

Khan, R & A Rudd. 1995. Does historical performance predict future performance? *Financial Analysts Journal* 51(6):43-52.

Kritzman, M & Rich, D. 2002. The mismeasurement of risk. *Financial Analysts Journal* 58(3):91-99.

Leland, H. 1999. Beyond mean-variance: performance measurement in a nonsymmetrical world. *Financial Analysts Journal* 55(1):27-36.

Levy, R. 1978. Stocks, bonds, bills, and inflation over 52 years. *The Journal of Portfolio Management* 4(4):18-19.

Madhusoodanan, T. 2006. Time diversification: the Indian evidence. *Journal of Financial Management and Analysis* 10(2):11-22.

Madhusudan, K. 2006. Stock market volatility in the long run, 1961-2005. *Economic and Political Weekly* 41(18):1796-1802.

McEnally, R. 1986. Latanè's bequest: the best of portfolio strategies, in *Streetwise: the best of the Journal of Portfolio Management,* edited by P Bernstein & F Fabozzi. . New Jersey: Princeton University Press:151-160.

Michaud, R (1998). *Efficient Asset Management*. Boston: Harvard Business Scholl Press.

Nawrocki, D. 1999. A brief history of downside risk measures. *Journal of Investing* 8(3):9-25.

Olsen, R & Khaki, M. 1998. Risk, rationality and time diversification. *Financial Analysts Journal* 54(5):59-62.

Pedersen, C & Satchell, S. 2002. On the foundation of performance measures under asymmetric returns. *Quantitative Finance* 2(3):217–223.

Prescient. 2008. *Opportunities and strategies in tough times*. Nedgroup Investments Conference handouts. Slide number 64.

Reilly, F & Brown, K. 2003. *Investment analysis and portfolio management*. 7th edition. California: South-Western College Publishing.

Scholtz, H. 2007. Refinements to the Sharpe ratio: comparing alternatives for bear markets. *Journal of Asset Management* 7(5):347-357.

Seymour, M. 2008. *I need perspective coz I'm facing the wall.* http://www.alphenam.co.za/docs/docredir.asp?version=85055. (Last accessed on 23 October 2008.)

Smidt, S. 1978. Investment horizon and performance measurement. *The Journal of Portfolio Management* 4(2):18-22.

Sharpe, W. 1994. The Sharpe ratio, in *Streetwise: the best of the Journal of portfolio management,* edited by P Bernstein & F Fabozzi.. New Jersey: Princeton University Press:169-178.

Trainer, F, Yawitz, J & Marshall, W. 1979. Holding period is key to risk thresholds. *The Journal of Portfolio Management* 5(2):48-53.

Wessels, D. 2005. *Stock market predictability.* http://www.indexinvestor.co.za/index_files/MyFiles/StockMarketPredictability.pdf. (Last accessed on 7 October 2008.)

Wessels, D. 2006. *The characteristics of stock market volatility.* http://www.indexinvestor.co.za/index_files/MyFiles/StockMarketVolatility.pdf. (Last accessed on 7 October 2008.)

APPENDIX A

Table A1: Adler, T & Kritzman, M. (2007). Mean-variance versus full-scale optimisation

	Strength	Weakness
Objective	To present an alternative to the mean-variance model for portfolio construction called full-scale optimization.	
Time period investigated	1994 to 2003	
Region investigated		US Only
Asset classes investigated		US hedge funds only
Detail of investigation-thoroughness	Adequate research of earlier work	Term of investigation and the isolation of US results restricted the credibility of this important proposition
Statistical strength in analysis	Advanced. Statistical complexity required to provide empirical evidence and ultimately attain the objective.	
Complexity	Advanced	
Sources	Variety of journals	
Applicability and future use		Complexity somewhat restricts mass adoption of the suggested strategy.
Targeted reader	Institutional investors, academics	

Table A2: Allen, D, Brailsford, T, Bird, R & Faff, R. (2002). A Review of the Research on the Past Performance of Managed Funds

	Strength	Weakness
Objective	Investigates the existence of performance persistence i.e. whether the same manager out-or under-performs persistently.	
Time period investigated	Varies between as early as 1960 to 1999. Some range over full span others for only 4 years.	
Region investigated	US, UK and Australia	
Asset classes investigated	Managed collective investment schemes	No reference to direct asset classes
Detail of investigation-thoroughness	Academic research is strong with 40 studies consulted.	
Statistical strength in analysis	Simple but relevant. Makes good use of more integral ratios and statistics like standard deviation, Sharpe, Jensen's Alpha & Treynor.	
Complexity	Simple. Easy to read. Logical and sensible. No unnecessary over complications.	
Sources	US and UK based studies that focuses on equity, fixed interest and managed portfolios. Focus on Australian work as well. Focuses on "more recent studies with a more robust methodology"	
Applicability and future use		Indifferent: found evidence for and against performance persistence.
Targeted reader	Strong focus on typical situation of public investor. Risk adjusted studies aimed at experts.	

Table A3: Alles, L & Athanassakos, G. (2006). The Effect of Investment Horizons on Risk, Return and End-of-period wealth for major asset classes in Canada

	Strength	Weakness
Objective	Investigates whether the current practice amongst financial planners of recommending stocks at an early age and progressively moving into cash or bonds as retirement approaches is appropriate.	
Time period investigated	1, 5, 10, 15, and 20 year investment horizons from 1957 to 2003.	
Region investigated		Canada only
Asset classes investigated	Stock index total return data; long term government bonds; 91 day T-bills	
Detail of investigation-thoroughness	Good. Concise but simple illustration of arguments provided and researched.	
Statistical strength in analysis	Good. One of very few studies to investigate frequency distributions.	
Complexity	Simple. Effective.	
Sources	Various international journals	
Applicability and future use	Closely resembles the SA based work from this study. Aspects addressed are client demand driven and should enjoy further application in practise.	
Targeted reader	Financial advisors, retail investors, institutional investors, money managers, portfolio managers, pension funds.	

Table A4: Bradfield, D. (2000a). Mean reversion of Equity returns on the JSE: Implications for market timing and risk management

	Strength	Weakness
Objective	To find sufficient evidence of mean reversion to formulate a strategy that exploits those findings.	
Time period investigated	1980 tot 1999	
Region investigated		SA only
Asset classes investigated		SA Equity only
Detail of investigation-thoroughness		Inconclusive as findings are not developed into useful material or strategies.
Statistical strength in analysis	Reasonable	
Complexity	Simple.	
Sources	International Journals	
Applicability and future use		Does not indicate how findings may be applied usefully.
Targeted reader	Retail investors, Financial advisors, researchers	

Table A5: Bradfield, D. (2000b). Interpreting the Important Concepts of risk

	Strength	Weakness
Objective	To promote a useful graphical framework to assist with interpretations and monitoring of risk.	
Time period investigated	Aug 1998 to July 2000. Very short, but for illustrative purposes only.	
Region investigated	SA only	
Asset classes investigated	General equity collective investment schemes and the largest 10 pension funds in SA	
Detail of investigation-thoroughness	Thorough	
Statistical strength in analysis	Strong	
Complexity		Not for retail use
Sources		Independent investigation
Applicability and future use	Strong in the institutional and more sophisticated sectors of industry.	Not for retail use
Targeted reader	Institutional investors, Multi-Managers, Money Managers, Portfolio Managers, Pension fund investment committees	

Table A6: Brook, P. (2005). Riding the Roller-coaster Asset Allocation into 2006

	Strength	Weakness
Objective	To illustrate the risk and return properties of various SA asset classes over different periods.	
Time period investigated	Various since 1900: 1 year; 8 years; 11 years; 45 years; 101 years (citing work from Dimson, Marsh, Staunten 2002)	
Region investigated		Largely SA only. Very briefly refers to evidence from Dimson, Marsh, Staunten 2002, who also investigated 15 other countries.
Asset classes investigated	Depending on investigation period, Equity; Listed property; bonds; cash; offshore equity	
Detail of investigation-thoroughness	Sufficient to illustrate the SA case.	Insufficient to illustrate the world wide case.
Statistical strength in analysis	Basic- little required in order to endorse findings further.	
Complexity	Simple. Understanding of basic investment fundamentals required.	
Sources		Largely independent investigation. None consulted in the SA case. Evidence from Dimson, Marsh, Staunten 2002 provided in the offshore case.
Applicability and future use		Insightful but does not provide a clear suggestion/recommendation that can be usefully incorporated into an investment strategy.
Targeted reader	Financial advisors, retail investors, institutional investors.	

Table A7: Dimson, E, Marsh, P & Staunten, M. (2002). Triumph of the Optimists

	Strength	Weakness
Objective	Analyses total return including reinvested income. Focuses on historical equity premium and implication for future risk premium (define by footnote)	
Time period investigated	1900 to 2000 (101 years)	Too long a period: Questionable relevance of findings
Region investigated	16 countries including SA. 88% of world market cap. Countries selected are those who have a century of financial data. The countries investigated are, South Africa, Germany, France, United Kingdom, United States, Switzerland, Australia, Japan, Canada, Italy, Spain, Netherlands, Sweden, Belgium, Ireland and Denmark.	
Asset classes investigated	Equities, bonds (range/various), bills, currencies and inflation. Large caps, small and micro caps.	
Detail of investigation-thoroughness	Very comprehensive, logical and concise	
Statistical strength in analysis	Straight forward and accessible methodology ensures that analyses present real outcomes for investors	Very few formal statistical tests are reported
Complexity		Complex with foreign exchange and inflation considerations for each country. What is gained in thoroughness is lost in complexity.
Sources		Text references is largely US based research. Chapters 17 to 24 explains/describes the global database that was used.
Applicability and future use	Very high as general guidelines	
Targeted reader	Investment professionals, financial economists, investors IFAs	

Table A8: Fabozzi, F, Focardi & S, Kolm P. (2006). A Simple Framework for Time diversification

	Strength	Weakness
Objective	To show that the debate on time diversification can be settled in a rigorous yet simple framework.	
Time period investigated		Hypothetical. None specified. Does not define its interpretation of long term or short term investments.
Region investigated	Hypothetical	
Asset classes investigated	Hypothetical “asset”	
Detail of investigation-thoroughness	Thorough investigation based on hypothetical figures.	Credibility is lost without the use of empirical evidence.
Statistical strength in analysis	Strong	Over complicated analysis.
Complexity		Over complicated
Sources	Largely various international journals	
Applicability and future use	In agreement with a newer school of though that believes that time horizon should be incorporated into the risk return investigation which should enjoy future application in a holistic assessment of risk.	Measure is not a holistic assessment of risk in isolation.
Targeted reader	Academics, researchers, investment statisticians	Not reachable to retail investor

Table A9: Firer, C & McLeod H. (1999). Equities, bonds, cash and inflation: historical performance in South Africa 1925–1998

	Strength	Weakness
Objective	Exploratory research of historic performances of South African asset classes.	
Time period investigated		1925 to 1998. A period which is perhaps too long to accurately represent more sophisticated capital markets of today.
Region investigated	South Africa (therefore directly relates to this study)	
Asset classes investigated	Equity, bonds, cash.	
Detail of investigation-thoroughness	Good	Time period investigated perhaps too long. This also necessitates over complication of proxies for various asset class indices.
Statistical strength in analysis	Reasonable	
Complexity	Sufficient to attain objectives. Investigation is not unnecessarily overcomplicated.	
Sources	Various South African studies and literature.	
Applicability and future use		Does not present a strategy based on evidence.
Targeted reader	Primarily researchers and investment practioners.	

Table A10: Harlow, W. (1991). Asset Allocation in a Downside-Risk Framework

	Strength	Weakness
Objective	To advocate more extensive use of various downside risk measures.	
Time period investigated		1980 to 1990
Region investigated	11 countries worldwide: 1. Germany 2. France 3. United Kingdom 4. United States 5. Switzerland 6. Australia 7. Japan 8. Canada 9. Netherlands 10. Sweden 11. Hong-Kong	
Asset classes investigated		Equity and bonds only
Detail of investigation-thoroughness		Based on too short a period.
Statistical strength in analysis	Reasonable	
Complexity	Reasonable	
Sources	Various international journals	
Applicability and future use	High, as an integrated indicator of risk in a holistic risk assessment framework.	Downside risk measures are not fully descriptive in isolation.
Targeted reader	Largely academics and researchers.	

Table A11: Hübner, G. (2007). How Do Performance Measures Perform

	Strength	Weakness
Objective	To investigate the relevance of some of the existing performance measures.	
Time period investigated	1993 to 2004	
Region investigated		US only
Asset classes investigated		US directional collective investment schemes only
Detail of investigation-thoroughness	Thorough	
Statistical strength in analysis	Strong	
Complexity		Overcomplicated debate.
Sources	International journals	
Applicability and future use	Insightful arguments against certain performance measures may spark further research on the topic.	
Targeted reader	Investment practioners	Not targeted at retail investors

Table A12: Huxley, S & Burns, J. (2005). Asset Dedication

	Strength	Weakness
Objective	Shift investor to new paradigm for personal investment. Asset allocation has had a good run but is beginning to show its age. Every dollar in a portfolio should be there for a specific reason/purpose.	Primary flow of asset allocation is that it looks a defensible way to determine the optimal formula for allocating funds to different asset classes. Idea of asset dedication is not revolutionary. Better described as evolutionary.
Time period investigated	1926 to 2002	
Region investigated	US	
Asset classes investigated	Refer to table on p. 10 of Huxley and Burns	Isolated to US
Detail of investigation-thoroughness	Dynamic with practical financial advice underpins. Thorough and extensive.	
Statistical strength in analysis	Reasonably simple yet relevant. Not too many complex techniques implemented. Not required as the study make its point without complex statistical methodology. Universally readable.	
Complexity	Based on simple principles. Logic is strong and well explained/illustrated.	Disregarded that tax issues differ from country to country and changes often.
Sources		Mostly US based and academic in nature.
Applicability and future use	Strong and sensible methodology. A forward thinking investment strategy.	Leaves little room for incorporation of alternative reasoning.
Targeted reader	Investors and those who advise them. For retail and institutional use.	Can not be applied by collective investment schemes as the strategy focuses on individual cash flow requirements.

Table A13: Israelsen, C. (2005). A refinement to the Sharpe ratio and Information ratio

	Strength	Weakness
Objective	To illustrate that by modifying the denominator of the Sharpe and Information ratios, risk assessments are able to provide better more accurate assessments of risk.	
Time period investigated		1993to 2003 only
Region investigated		US only. Largely hypothetical for illustrative purposes.
Asset classes investigated		Two hypothetical collective investment schemes and the US S&P 500.
Detail of investigation-thoroughness		Lacks empirical evidence.
Statistical strength in analysis	Sufficient. Driven as required by the measures investigated. No over complication of analysis.	
Complexity	Intermediate knowledge of performance measures required. Basic mathematical competency required.	
Sources		Sharpe (1966) Treynor (1973)
Applicability and future use	Identification of limitations in the current assessments of the Sharpe ratio and Information ratio has already stimulated further investigation	The lack in transparency of the proposed modifications may limit its limitation in industry practice.
Targeted reader	Portfolio managers, money managers, institutional investors, researchers.	

Table A14: Israelsen, C & Cogswell, G. (2007). The error of tracking error

	Strength	Weakness
Objective	To explore the implications of ranking collective investment schemes according to tracking error	
Time period investigated	1996 to 2005	
Region investigated		US only
Asset classes investigated		Large Cap (Market capitalization) US Equity collective investment schemes only
Detail of investigation-thoroughness	Reasonable. Sufficient to provide evidence to support argument.	
Statistical strength in analysis	Knowledge of fundamental performance measures required.	
Complexity	Simple. Logical.	
Sources	Various journals	
Applicability and future use	Recommends the use of Information ratio over tracking error is isolation in order to put deviation in context- a useful recommendation.	
Targeted reader	Financial advisors, sophisticated retail investors, institutional investors, money managers.	

Table A15: Jahnke, W. (1997). The Asset Allocation Hoax

	Strength	Weakness
Objective	Questions the findings from Brinson, Hood, and Beebower (BHB) regarding the relative importance of asset allocation.	
Time period investigated	Quarterly returns from 1974 to 1983	
Region investigated		US only
Asset classes investigated	91 pension plans I the SEI Large Pension Plans Universe	
Detail of investigation-thoroughness	Sufficient to illustrate argument	
Statistical strength in analysis	None employed	
Complexity	Simple. Logical.	
Sources		Independent investigation
Applicability and future use	Reflects on some important aspects regarding the asset allocation debate which should certainly be considered prior to implementing the investment plan.	
Targeted reader	Retail investors, Financial advisors, institutional investors, money managers, portfolio managers	

Table A16: Jeffrey, R. (1984). A new paradigm of portfolio risk

	Strength	Weakness
Objective	To prove that the portfolio management process should work more easily and rewardingly if a paradigm shift were to occur in the belief that risk is strictly a function of volatility of returns.	
Time period investigated	Largely hypothetical apart from some analysis that compares inflation versus S&P 500 dividends.	Very little empirical evidence
Region investigated		US only
Asset classes investigated	Equity via the S&P 500	
Detail of investigation-thoroughness	Short, however sufficient	
Statistical strength in analysis	Not applicable as no statistical analysis is performed.	
Complexity	Logic	
Sources	Mostly journals	
Applicability and future use	Large if considered as part of holistic risk management	Can be applied as stand-alone measure although there are limitations as suggestions cannot be adopted by collective investment schemes
Targeted reader	Financial advisors, retail investors, money managers, scholars, academics, portfolio owners, portfolio trustees	

Table A17: Jones, C. (2007). Investments

	Strength	Weakness
Objective	To provide a good fundamental understanding of the field of investments while stimulating interest in the subject.	
Time period investigated		No specific period or region. Study is completed/written from an American perspective. Generally the discussed topics are fundamental in nature with commentary regarding process driven portfolio management that may be universally applied regardless of region.
Region investigated		
Asset classes investigated	Cash, Money market (including deposits), Bonds, T-Bills, Currency, Stocks, derivatives, Mutual Funds and ETFs.	
Detail of investigation-thoroughness	Broad (but not deep)	Introductory
Statistical strength in analysis	Mathematical and statistic techniques requires basic competency.	
Complexity	Variable according to topic/discussion. Generally fairly basic. Introductory.	
Sources	Vast. Majority is Us based. Specialist from the field- required as topics vary.	
Applicability and future use	Wide spread	Nature is so that it is inevitable that some theories will "expire" and become dated.
Targeted reader	Academics/students. Reachable to retail investors.	Not of much use to experienced investment practitioners.

Table A18: Kritzman, M & Rich, D. (2002). The Mismeasurement of Risk

	Strength	Weakness
Objective	Introduce 2 new ways of measuring risk: within horizon probability of loss and continuous value at risk. Measures that assesses risk throughout the investment period.	States that investors measure risk as probability of losing capital at end of investment period (disagree)
Time period investigated		Investigates Japan over very short period of 1995 to 1999 in certain sections. Except for the before mentioned, the study is largely based on hypothetical data.
Region investigated	Largely hypothetical illustrations. Investigates Japan in certain sections.	
Asset classes investigated		Stock and bonds only
Detail of investigation-thoroughness		Research is very brief and hypothetical.
Statistical strength in analysis	Statistical strength is strong and mathematical techniques are advanced.	
Complexity	Reasonable, with more complicated mathematical techniques in certain areas	
Sources	Largely financial journal were used as references	
Applicability and future use	Value-at-risk is getting more attention although continuous value-at-risk is a newer derivative that is likely to enjoy future use on institutional side. Stand alone value is low as it doesn't cater for the retail investor.	
Targeted reader	Investment professionals and financial economists	Not reachable for private/retail investors

Table A19: Leland, H. (1999). Beyond Mean-Variance: Performance Measurement in a Nonsymmetrical World

	Strength	Weakness
Objective	To illustrate that the market portfolio in the CAPM model is mean-variance inefficient and the Capital Asset Pricing Models' (CAPM) alpha miss-measures the value added by portfolio mangers.	
Time period investigated		Hypothetical
Region investigated		Hypothetical
Asset classes investigated		Hypothetical. Focus is on options, although the methodology is claimed to be applicable to most other assets as well.
Detail of investigation-thoroughness	Strong	
Statistical strength in analysis	As required by revision and modification of the CAPM model.	
Complexity	Intermediate investment performance measure knowledge required.	Not reachable by retail investors
Sources	Various international journals	
Applicability and future use		Although the study succeeds in attaining the study objectives, the model does not cater for interpretation by retail investors.
Targeted reader	Money managers, portfolio managers, researchers, academics, scholars.	

Table A20: Levy, R. (1978). Stocks, Bonds, bills, and inflation over 52 years

	Strength	Weakness
Objective	To illustrate that time horizon is as an important consideration as volatility in setting asset mixes.	
Time period investigated	1926 to 1977	Sufficient in length but not necessarily a relevant period *today*.
Region investigated		US only
Asset classes investigated	US S&P 500; corporate bonds; Long-term government bonds, T-bills; and CPI assessed on a relative basis	
Detail of investigation-thoroughness	Illustrates arguments conclusively.	Does not present measures that incorporate the findings
Statistical strength in analysis	Strong	
Complexity	Simple. Adequate	
Sources		Independent analysis- none
Applicability and future use	Forward thinking and relevant, should therefore be considered within a holistic risk assessment process.	
Targeted reader	Should be reachable to all level of competency investors	

Table A21: Madhusoodanan, T. (2006). Time diversification: The Indian evidence

	Strength	Weakness
Objective	Investigates whether it is sufficient to discuss diversification only in terms of asset allocation or whether time horizon also plays a part.	
Time period investigated	1979 to 1997	
Region investigated		India only
Asset classes investigated		Bombay Stock Exchange (BSE) Index only
Detail of investigation-thoroughness	Reasonable. Sufficient to illustrate argument.	Some research performed over only 250 days, which may be too short to consider in isolation, even for short term investigations.
Statistical strength in analysis	Reasonable.	
Complexity	Discussion is logical despite the complexity of the investigation.	
Sources	Various journals	
Applicability and future use	Methodology for assessing risk is likely to enjoy greater use once the deadlock of the mean-variance model on the industry is unlocked.	Limited due to isolated Indian evidence.
Targeted reader	Retail investors, financial advisors, institutional investors, money managers, fund trustees.	

Table A22: Madhusudan, K. (2006). Stock Market Volatility in the Long run, 1961-2005

	Strength	Weakness
Objective	To measure the volatility of daily returns on the Indian stock exchange from 1961 to 2005 in order to assess the time varying volatility in returns.	
Time period investigated	1961 to 2005.	
Region investigated		India only
Asset classes investigated		Stocks only
Detail of investigation-thoroughness	Reasonable.	Specific to Indian evidence.
Statistical strength in analysis	Strong. Not over complex, Efficient use of statistical indicators/utilities.	
Complexity		Not reachable by retail investors
Sources	Various International journals	
Applicability and future use	Analysis forms part of a greater area of investigation of cyclical strategies that plays an important part in active risk management.	
Targeted reader	Researchers, academics, scholars, financial advisors, cyclical investors.	

Table A23: Maginn, J, Tuttle, D, Pinto, J & McLeavey, D. (2007). Managing Investment Portfolios

	Strength	Weakness
Objective	To survey the best of current portfolio management practice, recognizing that management is an integrated set of activities. Topic coverage is organised according to a well-articulated portfolio management decision making process.	Not specific to my own topic
Time period investigated		No specific period or region. Study is completed/written from an American perspective. Generally the discussed topics are fundamental in nature with commentary regarding process driven portfolio management that may be universally applied regardless of region.
Region investigated		
Asset classes investigated	Stocks, Bonds, derivatives (futures, options), T-bills, debentures, currency, REITs.	
Detail of investigation-thoroughness	Extremely. Background is covered; strategies in all asset classes on general portfolio management covered.	Too long, useful as reference.
Statistical strength in analysis	More mathematical than statistical in nature, although an intermediate competence in both field required.	
Complexity	Variable according to topic/discussion.	
Sources	Vast. Majority is Us based. Specialist from the field- required as topics vary.	
Applicability and future use	Wide spread	Nature is so that it is inevitable that some theories will "expire" and become dated.
Targeted reader	Academics/students	Not for retail investor.

Table A24: McEnally, R. (1986). Latanè's bequest: The best of portfolio strategies

	Strength	Weakness
Objective	To illustrate that the geometric mean portfolio strategy is superior to single-period models such as the Markowitz model	
Time period investigated	Hypothetical investigation over "different states of nature"	No empirical evidence is provided
Region investigated		Hypothetical
Asset classes investigated		Hypothetical
Detail of investigation-thoroughness	Sufficient to argue its case	No empirical analysis
Statistical strength in analysis	Intermediate. Investigates probabilities and geometric mean which is central to the investigation	
Complexity	Some mathematical and statistical competency is required. Arguments are logical and well explained.	
Sources		Majority US based
Applicability and future use	If considered as part of a holistic risk management approach.	
Targeted reader	Financial advisors, retail investors, money managers, scholars, academics, portfolio owners, portfolio trustees	

Table A25: Michaud, R. (1998). Efficient Asset Management

	Strength	Weakness
Objective	1) Describes the problems of MV optimization as a practical tool of institutional asset management. It reviews various proposed alternatives to MV optimization and describes their limitations. 2) The goal of this book (as is that of this study) is to define an optimization process that validly reflects investment insights while maintaining the rigor, informational breadth, and convenience of MV optimization	Does not go into dynamics changes between asset classes over time
Time period investigated	216 months from January 1978 to December 1995	
Region investigated	US, UK, Canada, France, Germany, Japan	
Asset classes investigated	• US Stocks • US Government and Corporate bonds • Euros • Canadian Stock Exchange • French Stock Exchange • German Stock Exchange • Japanese Stock Exchange • UK Stock Exchange	
Detail of investigation-thoroughness	Basic. Return, mean, standard deviation, correlation investigated, some other statistical methodology.	
Statistical strength in analysis	Knowledge of statistical methods and modern finance at the level of a relatively nontechnical paper in the Financial analysis journal is desirable.	
Complexity	The discussions are mostly self-contained and generally require little additional reading. The technical level required of the reader in the body of the text is relatively minimal. The footnotes and appendices discuss technical issues and topics of special interest.	
Sources		Only as references. Topic based on own models/research.
Applicability and future use	Relevant, but not as stand alone measure and not to general retail investor. Addresses limitation of MV optimization but doesn't provide the reader with alternatives that can be interpreted by retail investors- risk perception doesn't change.	
Targeted reader	In particular Institutional Investors. Secondary audience investors, investment managers, consultants.	

Table A26: Nawrocki, D. (1999). A brief History of Downside Risk Measures

	Strength	Weakness
Objective	To explain downside risk measures by discussing the history of its development.	
Time period investigated	Literature and secondary empirical findings from 1952 to 1997.	
Region investigated	Worldwide	
Asset classes investigated		Primarily equities
Detail of investigation-thoroughness	Very thorough literature review.	
Statistical strength in analysis	Reasonable	Based on prior academic research.
Complexity	Reasonable. Knowledge of fundamental risk measures required.	
Sources	Worldwide literature and research in the form of books, articles and journals.	
Applicability and future use	High, as an integrated indicator of risk in a holistic risk assessment framework.	Not applicable on isolation.
Targeted reader	Investment academics and researchers.	

Table A27: Pedersen, C & Satchell, S. (2002). On the foundation of performance measures under asymmetric returns

	Strength	Weakness
Objective	Examine two performance measures advocated for asymmetric return distribution- Sortino and power of utility measures.	
Time period investigated		Hypothetical- none specified
Region investigated		Hypothetical- none specified
Asset classes investigated		Hypothetical portfolios
Detail of investigation-thoroughness	Comprehensive research of earlier work	No empirical evidence
Statistical strength in analysis	Advanced	Overcomplicated
Complexity	Advanced	Somewhat overcomplicated simple measures of risk
Sources	Various international books and journals. Comprehensive research.	
Applicability and future use		Over complication of simpler versions restricts future use to an extent.
Targeted reader	Researchers, academics, money managers, institutional investors	

Table A28: Scholtz, H. (2007). Refinements to the Sharpe ratio: Comparing alternatives for bear markets

	Strength	Weakness
Objective	To present refinements to the Sharpe ratio and to compare the findings from these alternatives to that of the original Sharpe measure	
Time period investigated	1999 to 2003	
Region investigated		US Only
Asset classes investigated		US Equity collective investment schemes only
Detail of investigation-thoroughness	Excellent in terms of researching earlier work	Insufficient testing for equity collective investment schemes (4 years)
Statistical strength in analysis	Advanced.. Makes use of Spearman rank correlation coefficients.	
Complexity	Advanced. Mathematical competency is required.	
Sources	Variety of journals	
Applicability and future use		Given the deep roots of the original Sharpe ratio it may take some time for investors to adopt any form of adaptation.
Targeted reader	Institutional investors and money managers	

Table A29: Seymour, M. (2008). I need perspective coz I'm facing the wall

	Strength	Weakness
Objective	Provide perspective on significant market draw downs on the ALSI, returns preceding and valuations following these draw downs.	
Time period investigated	1960 to 2008	
Region investigated		SA Only
Asset classes investigated		Equity only
Detail of investigation-thoroughness	Sufficient to adequately illustrate argument.	
Statistical strength in analysis	Basic statistical competencies required.	
Complexity	Simple and informal. Understanding of basic valuation methods required.	
Sources		Independent investigation.
Applicability and future use	Insightful in periods following market draw downs.	No continuous use.
Targeted reader	Financial advisors, sophisticated retail investors, institutional investors.	

Table A30: Sharpe, W. (1994). The Sharpe Ratio

	Strength	Weakness
Objective	To go well beyond the discussion of the original Sharpe measure studies, providing more generality and covering a broader range of applications.	
Time period investigated	Hypothetical	No empirical evidence is provided
Region investigated		No specific region- hypothetical
Asset classes investigated		Non specific assets- hypothetical
Detail of investigation-thoroughness		No empirical evidence is provided
Statistical strength in analysis	Intermediate to strong. Familiarity on risk measures required to grasp the reading.	
Complexity	Should be reachable to all investment practioners	Not reachable by retail investors
Sources	US Based	
Applicability and future use	Already broadly applied. Sharpe should not be considered.	Not sufficient as stand-alone measure as standard deviation (a variable of the Sharpe ratio) can be deceptive.
Targeted reader	Financial advisors, money managers, scholars, academics, portfolio trustees	

Table A31: Sharpe, W. (2007). Investors and Markets- Portfolio Choices, Asset Prices, and Investment

	Strength	Weakness
Objective	Explain the effects of investors interacting in capital markets and the implications for those who advise investors concerning their saving and investment decisions.	
Time period investigated	Hypothetical. Based on simulation.	The study relies extensively on the use of simulation. See "simulation" on p.3 (1.2.2) of Sharpe (2007)
Region investigated	Hypothetical. Based on simulation.	
Asset classes investigated	Equities	References to derivative instruments and portfolios (baskets with different risk return components)
Detail of investigation-thoroughness	Very thorough. Deals with everything from basic definitions to complex statistical methodology and advice to investment practitioners.	
Statistical strength in analysis	Not based on mean variance as in the case of prior Sharpe work, and work from Linter (1965), Mossin (1966), Treynor (1999). Instead bases on "state/preference approach" developed by Arrow (1953)	
Complexity	Although an attempt is made to simplify the topic it remains complex (see peeling the onion p5)	
Sources	Research is done independently although references are quoted in terms of some form of methodology (see references p5)	
Applicability and future use	Simulation models' relevance will probably only increase over time. New research can easily be integrated/uploaded as simulation models tend to be very flexible.	
Targeted reader	Broad range of investment professionals including investments advisors, money managers and financial analysts.	

Table A32: Smidt, S. (1978). Investment Horizon and Performance Measurement

	Strength	Weakness
Objective	To investigate whether an increase in market value with lower volatility is necessarily a sign of good performance and to investigate how relevant conventional risk-return measures are.	
Time period investigated		Hypothetical investments of up to 10 years
Region investigated		Hypothetical data applied
Asset classes investigated	Focus is on bonds but also briefly investigates growth stocks	Does not perform comparative asset class risk-return analysis.
Detail of investigation-thoroughness	Sufficient illustration to effectively argue its case.	Hypothetical data. Identifies problems with conventional measures but does not attempt to provide a better alternative.
Statistical strength in analysis	Simple. Effective.	
Complexity	Simple. Logical.	
Sources	Jack Treynor (1965) William Sharpe (1966) Michael Jensen (1969)	
Applicability and future use	Forward thinking at the time. Issue still applicable.	Does not present alternative measure (s) despite identifying problems with existing measures.
Targeted reader	Financial advisors, retail investors, institutional investors, money managers, portfolio managers, pension funds.	

Table A33: Trainer, F, Yawitz, J & Marshall, W. (1979). Holding period is key to risk thresholds

	Strength	Weakness
Objective	To demonstrate the relationship between risk and return over shorter and longer periods in a systematic manner in order to improve the risk-return trade-off in portfolios.	
Time period investigated		1-30 year bonds yields between 1953 and 1972.
Region investigated		US only
Asset classes investigated		Bonds exclusively
Detail of investigation-thoroughness		Limitation to bonds only restricts the credibility of the investigation to an extent.
Statistical strength in analysis		Limited
Complexity	**Simple.**	Sufficient to argue the bond case only.
Sources	Various international journals	
Applicability and future use		Limited applicability due to its isolated investigation on bonds.
Targeted reader	Financial advisors and retail investors	

Table A34: Wessels, D. (2005). Stock Market Predictability

	Strength	Weakness
Objective	Investigates whether stock market has moved in some sort of predictable pattern in past.	No other objective is mentioned
Time period investigated	1960 to 2005 (Autocorrelation of ALSI returns) 1995 to 2005 (P/E & D/Y correlation to 5 year subsequent returns)	
Region investigated		South Africa only
Asset classes investigated		Equity only
Detail of investigation-thoroughness	Reasonable. Short but adequate to the vrify the arguments	
Statistical strength in analysis	Reasonable	Autocorrelation has limited use in isolation
Complexity	Simple	
Sources		Largely US journals
Applicability and future use	Not as stand alone assessment. Important consideration outside scope of my own study (this study) PE DY 5 year return autocorrelation provides a clear message	No clear methodology
Targeted reader	Private, Retail, IFA	

Table A 35: Wessels, D. (2006). The Characteristics of Stock Market Volatility

	Strength	Weakness
Objective	To analyse the characteristics of stock market volatility on the JSE	
Time period investigated	1960 to March 2006 (46 years)	
Region investigated		South Africa only
Asset classes investigated		Equity only
Detail of investigation-thoroughness	Provides a general background on meaning and implication of volatility. Analyses the stock market volatility in terms of its distribution movement patterns and duration. Investigates relationship between volatility and return (with focus on correlation).	
Statistical strength in analysis	Reasonable	
Complexity	Reasonable	Knowledge of basic statistic terminology and methodology required. Not reachable to retail investor.
Sources		Informal research undertone. Only two sources consulted
Applicability and future use	Nothing new. But gives some insight into some the inherent risk to using standard deviation as stand alone risk measure.	
Targeted reader	Private/retail investors with basic knowledge of investment environment. Financial advisors.	