

Portfolio Diversification Index as a measure to improve investment portfolio performance

Francois van Dyk Hons. Bcom.

**Dissertation submitted in
partial fulfillment of the requirements for the degree
Magister Commercii (Risk Management) at the
Potchefstroom Campus of the North-West University**

Supervisor: Professor Paul Styger

Co-supervisor: Dr. Gary van Vuuren

Johannesburg

2008

Dedication

Aan

My geliefde ouers

Dries & Lillette van Dyk

Preface

Some of the theoretical work described in this dissertation was carried out whilst in the employment of First National Bank (Head office) in Johannesburg while some of the theoretical and practical work was carried out in collaboration with the School of Economics: North-West University (Potchefstroom campus) under the supervision of Professor Paul Styger.

The work and study represents the original work of the author and has not been submitted to another University in any form. Where use was made of the work of others, this has been duly acknowledged. All the data were obtained from McGregor BFA (provider of stock market, fundamental research data and news to the financial sector and the corporate market) which is linked to Inet and the department of Financial Management at the University of Pretoria, which also publishes the Unit Trust Survey.

F. van Dyk

Monday, 10 November 2008

Acknowledgements

I acknowledge all that have contributed in some way or other to the completion of this dissertation. In particular, I would like to express my gratitude for the assistance provided – in whatever form – to the people mentioned below:

- my parents for their endless love, sacrifice and valuable support during tough times,
- Professor Paul Styger, for his outstanding leadership, huge patience, constructive feedback and willingness. I am blessed for working with such a knowledgeable individual and also immensely grateful for his shared opinions outside and beyond this dissertation.
- Dr. Gary van Vuuren whom is always there, willing and excited to help, truly a walking thesaurus. Thank you for sharing your great knowledge and love for what you do.
- Mr. Leonard Santana of the School of Computers, Statistical and Mathematical Sciences, North-West University (Potchefstroom campus) for his helping hand with the SAS® programming.
- Ms. E. Roodt at the Ferdinand Postma Library of the North-West University for her helping opinions and hard work regarding the references and style of this dissertation.
- Mr. Thys Cronje of the Centre for Business Mathematics and Informatics, North-West University (Potchefstroom campus) for his help with the data extractions.
- Ms. Lesley Wyldbore, for her services as the language editor of this dissertation.
- Mr. Yashin Gopi, Cadiz Securities, for his time and explanation of the PDI.
- Mr. Marius Botha, for the guidance and opinions he provided,
- the North-West University, Potchefstroom campus for the opportunity to complete this dissertation.

Praise to Him that gives us strength and talent.

Abstract

Diversification is one of the three most prominent elements of portfolio management with risk and return being the other two. In addition, diversification is a core objective for combining assets and is a central tenet of portfolio construction. It is also widely known that diversification is concerned with the number of unrelated sources of return and in essence the aim of diversification is to eliminate unsystematic risk from an investment portfolio while systematic risk will remain as it can not be diversified away. This study focuses on the concept of diversification in an investment portfolio setting, while specifically investigating a relatively “new” diversification measure, the Portfolio Diversification Index (PDI).

The objectives of this study are twofold. First, establishing whether or not the PDI is a good diversification measure compared to the conventional/traditional and widely used residual variance method. The traditional method of measuring diversification remains inexact as this method measures portfolio diversification relative to a market index. When the market index itself is, however, poorly or not appropriately diversified it becomes problematic as the diversification measurement of the residual variance method is influenced. The PDI is a diversification measurement concept which is essentially free from the influences of the overall market index. This relatively “new” measure of diversification, the PDI, is based on the number of independent factors observed in a portfolio. These independent factors are quantified using Principal Components Analysis (PCA). In ascertaining the first objective the PDI battles “head-to-head” against the residual variance method of diversification by comparing fund ranking results of five South African unit trusts. This method of testing is used as no suitable statistical method exists. The fund ranking results of the two diversification measures are compared to a number of risk performance measures, including the Sharpe- and Sortino ratios. Extensive use is also made of the Omega ratio in this study as the Omega emerges as the dominant risk performance measure.

The second objective of this study is to determine whether the PDI can be used as a tool by fund managers to assist in constructing funds (or changing the composition of existing fund) to reduce (or minimise) portfolio risk without a concomitant reduction in portfolio return. The PDI is used to determine the most independent factors of a South African unit trust where after this fund is optimised, using the information of the independent factors, in order to reduce the risk of this fund. The Omega ratio is

used to evaluate the results of the PDI while the marginal portfolio diversification concept is also investigated.

A thorough literature study also presents the most relevant and important concepts and topics of the theory, management and construction of portfolios. Throughout the literature study the concept of diversification along with the topics most relevant to diversification are extensively focused and elaborated on.

The method of testing used not only confirms that the PDI is a good diversification measure compared to the residual variance method, but that the PDI can also be used as a tool when constructing (or changing the composition of an existing portfolio) in order to reduce the portfolio risk without a concomitant reduction in portfolio return.

Uittreksel

Diversifikasie is een van die drie mees prominente portefeulje bestuur elemente, waarvan die ander twee risiko en opbrengs is. Diversifikasie is terselfdertyd 'n kern doelstelling wanneer bates gekombineer word en is dus 'n sentrale tema van portefeulje konstruksie. Dit is ook welbekend dat diversifikasie genoodsaak is met die hoeveelheid onverwante opbrengs bronne en in essensie is die doelstelling van diversifikasie om onsistematiese risiko te elimineer. Systematiese risiko sal egter aanbly in 'n portefeulje aangesien dit nie weg gediversifiseer kan word nie. Hierdie studie fokus op die diversifikasie konsep in 'n belegging portefeulje omgewing terwyl 'n relatiewe "nuwe" diversifikasie maatstaf, die Portefeulje Diversifikasie Indeks (PDI), spesifiek ondersoek word.

Die doelstellings van diè studie is tweeledig. Eerste, om te bepaal of die PDI 'n goeie diversifikasie maatstaf is in vergelyking met die tradisionele en wyd gebruikte residu variansie metode. Die tradisionale metode om diversifikasie te meet is egter nie optimaal doeltreffend, omrede diversifikasie relatief tot 'n mark indeks gemeet word. Indien die mark indeks self nie behoorlik gediversifiseer is nie lei dit tot 'n probleem omrede die diversifikasie meting beïnvloed word. Die PDI is 'n diversifikasie meetinstrument sonder 'n mark invloed. Hierdie relatiewe "nuwe" diversifikasie meetings metode of maatstaf, die PDI, is gebaseer op die hoeveelheid onafhanklike faktore waarneembaar in 'n portefeulje. Hierdie onafhanklike faktore word gekwantifiseer deur gebruik te maak van Hoof Komponent Analise (PCA). In die vergewissing van die eerste doelstelling ding die PDI "kop-teen-kop" mee met die residu variansie metode van diversifikasie deur die fonds rangskikkings resultate van vyf Suid-Afrikaanse effekte trusts te vergelyk. Diè metode van toetsing word gebruik aangesien daar geen geskikte statistiese metode beskikbaar is nie. Die fonds rangskikking resultate van die twee diversifikasie maatstawwe en 'n verskeidenheid risiko-prestasie maatstawwe, insluitend die Sharpe- en Sortino ratios, word vergelyk. Daar is ook intensiewe gebruik gemaak van die Omega ratio in hierdie studie omrede die Omega as die dominante risiko-prestasie maatstaf na vore gekom het.

Die tweede doelstelling van diè studie is om te bepaal of die PDI aangewend kan word deur fondsbestuurders as 'n instrument om te assisteer met fonds konstruksie (of verandering van 'n bestaande fonds se komposisie) om die portefeulje risiko te

verminder (of minimaliseer) sonder 'n saamegaande vermindering in portefeulje opbrengs. Die PDI word gebruik om die mees onafhanklike faktore van 'n Suid-Afrikaanse effekte trust te bepaal waarna hierdie fonds ge-optimaliseer word met inagneming van die onafhanklike faktore met die doel om die fonds risiko te verminder. Die Omega word aangewend om die PDI resultate te evalueer terwyl die marginal portefeulje diversifikasie konsep ook ondersoek word.

'n Deeglike literatuur studie wat die belangrikste konsepte en onderwerpe van die teorie, bestuur en konstruksie van portefeuljes dek word ook voorgehou. Die konsep van diversifikasie tesame met verdere verwante onderwerpe word deurgaans in die literatuur studie bespreek en uitgebou.

Die gebruikte toetsingsmetode bevestig dat die PDI wel 'n goeie diversifikasie maatstaf is in vergelyking met die residu variansie metode en verder dat die PDI ook as 'n instrument aangewend kan word met portefeulje konstruksie (of verandering van 'n bestaande fonds se komposisie) om die portefeulje risiko te verminder sonder 'n saamegaande vermindering in portefeulje opbrengs.

Table of Contents

Preface	ii
Acknowledgements	iii
Abstract	iv
Uittreksel	vi
Table of contents	viii
List of figures	xvii
List of tables	xix
Chapter 1 Introduction	1
1.1 Introduction and problem statement	1
1.2 Research objectives.....	3
1.3 Benefits of the research.....	3
1.4 Study methodology	4
1.5 Exposition of chapters.....	5
1.6 Limitations of the study	7
1.7 Speech and reference	7
Chapter 2 Modern Portfolio Theory	8
2.1 Introduction.....	8
2.2 Overview.....	9
2.3 Return.....	10
2.4 Risk	11
2.5 The efficient frontier	12
2.6 Capital Market Theory	16

2.6.1 Capital Asset Pricing Model	16
2.6.2 Assumptions of the Capital Market Theory (CMT)	17
2.6.3 The risk-free asset	18
2.7 Portfolio theory and its significance for this study	20
2.8 Summary	20
Chapter 3 Diversification or Risk.....	22
3.1 Introduction.....	22
3.2 Risk	23
3.2.1 What is Risk?	23
3.2.2 Risk types.....	24
3.2.3 Risk measurement.....	24
3.2.3.1 Volatility	25
3.2.3.2 Covariance	27
3.3 Further risk measurement	28
3.3.1 Other volatility measures	28
3.3.1.1 Moving average	28
3.3.1.1.1 Simple Moving Average (SMA).....	29
3.3.1.1.2 Exponentially Moving Average (EMA)	30
3.3.1.2 Generalised Autoregressive Conditional Heteroscedasticity (GARCH) ...	32
3.3.2 Other measures of correlations	34
3.3.3 Beta	35
3.3.4 Alpha.....	37
3.3.5 Risk premium and portfolio theory.....	38
3.4 Return.....	39
3.4.1 Overview.....	39
3.4.2 Required rate of return	40

3.4.3 Measurement of return	42
3.5 The connection between risk and return	43
3.6 Portfolio Construction.....	45
3.6.1 Introduction.....	45
3.6.2 Capital Market Line (CML) construction	46
3.7 Diversification.....	51
3.7.1 Introduction and overview	51
3.7.2 Definition of diversification.....	51
3.7.3 Origin of diversification.....	52
3.7.4 Use of diversification	52
3.7.5 How diversification affects the portfolio	54
3.7.6 Systematic versus unsystematic risk.....	55
3.7.7 Methods of diversifying.....	56
3.7.8 Benefits of diversification.....	58
3.7.9 Concentration.....	62
3.7.10 Measuring diversification	63
3.7.10.1 Traditional diversification measures.....	64
3.7.10.2 Herfindahl-Hirschman Index (HHI)	65
3.7.10.3 Other diversification measures	65
3.7.10.3.1 Concentration Coefficient.....	65
3.7.10.3.2 Intra-Portfolio Correlation (IPC)	66
3.7.10.3.3 IPC3	67
3.7.10.3.4 Portfolio Diversification Index (PDI)	68
3.8 Construction of the optimal risk portfolio	69
3.8.1 Introduction.....	69
3.8.2 Portfolio of two assets.....	69

3.9 Constructing complete portfolios.....	73
3.9.1 Introduction.....	73
3.9.2 Determining the weights.....	74
3.10 Summary.....	76
Chapter 4 Markets, Funds and Performance Measures	79
4.1 Introduction.....	79
4.2 Security Markets	79
4.2.1 Introduction.....	79
4.2.2 Market definition	80
4.2.3 Characteristics of a good market.....	81
4.2.4 Classification of markets.....	82
4.2.5 Efficient Markets	83
4.2.6 Efficient Market Hypothesis (EMH)	83
4.2.6.1 Weak form EMH.....	84
4.2.6.2 Semi-strong form EMH	84
4.2.6.3 Strong form EMH	85
4.2.6.4 Implications of the EMH	85
4.2.7 Existing markets.....	86
4.2.7.1 Bond and equity markets (Traditional markets)	86
4.2.7.2 Real estate markets (Semi-traditional markets)	87
4.2.8 Summary.....	88
4.3 Funds.....	89
4.3.1 Introduction to funds.....	89
4.3.2 Definition of hedge funds and mutual funds.....	90
4.3.2.1 Hedge fund.....	90
4.3.2.2 Mutual fund.....	92

4.3.3 Differences between funds.....	92
4.3.3.1 Unit trusts versus investment trusts	92
4.3.3.2 Unit trust versus hedge fund	93
4.3.4 The historical development of funds.....	95
4.3.4.1 Hedge funds	95
4.3.4.2 Unit trusts.....	95
4.3.5 Advantages and disadvantages of hedge funds and unit trusts.....	98
4.3.5.1 Advantages of hedge funds.....	98
4.3.5.2 Disadvantages of hedge funds	99
4.3.5.3 Advantages of unit trusts	99
4.3.5.4 Disadvantages of unit trusts.....	100
4.3.6 Types and styles of hedge funds and unit trusts	101
4.3.6.1 Types, styles or strategies of hedge funds	101
4.3.6.2 Types of unit trusts.....	104
4.3.7 Fund industry in SA.....	105
4.3.7.1 Hedge fund industry in SA	105
4.3.7.2 Unit trust industry in SA	110
4.4 Fund Performance.....	114
4.4.1 Introduction.....	114
4.4.2 Performance measures	114
4.4.2.1 Introduction to performance measures.....	114
4.4.2.2 Standard deviation	115
4.4.2.3 Sharpe ratio	115
4.4.2.4 Treynor measure	116
4.4.2.5 Sortino ratio	117
4.4.2.6 Jensen measure.....	118

4.4.2.7 Information ratio	119
4.4.2.8 Omega ratio.....	120
4.4.2.9 Summary.....	122
4.5 Asset Allocation.....	122
4.5.1 Introduction.....	122
4.5.2 Asset allocation defined.....	123
4.5.3 Brief explanation of asset allocation.....	123
4.5.4 Academic studies regarding asset allocation	125
4.6 Indices and benchmarks	126
4.6.1 Introduction.....	126
4.6.2 Definition of an index	126
4.6.3 Uses of indices	126
4.6.4 Benchmark determination.....	127
4.6.5 Summary.....	128
4.7 Conclusion	128
Chapter 5 Portfolio Diversification Index	130
5.1 Introduction.....	130
5.2 Past diversification studies.....	130
5.3 Background to the PDI.....	131
5.4 Principal Component Analysis (PCA)	132
5.5 Portfolio Diversification Index construction	134
5.5.1 Further explanation of the PDI	135
5.5.2 Explanation and Interpretation of the PDI.....	136
5.6 Process to construct the PDI	139
5.7 Two different PDI approaches	139

5.8 Marginal portfolio diversification.....	140
5.9 Summary	141
Chapter 6 Empirical study of the PDI as diversification measure	143
6.1 Introduction.....	143
6.2 Background and information for the empirical study	144
6.2.1 Introduction to the empirical study.....	144
6.2.2 The data.....	145
6.2.2.1 The funds	145
6.2.2.2 PDI data	146
6.2.2.3 Fund closing prices	148
6.3 PDI versus traditional diversification measures	148
6.3.1 The calculation of the Portfolio Diversification Index (PDI)	149
6.3.2 The PDI results	149
6.3.3 Traditional diversification measure	150
6.3.4 Results of the traditional diversification measure.....	151
6.3.5 Comparison of PDI and traditional diversification measure results	153
6.3.6 Concentration.....	153
6.3.7 Concentration results	155
6.3.8 The effect of concentration on diversification.....	156
6.4 Fund Performance.....	159
6.4.1 Return performance	160
6.4.1.1 Annual return performance.....	160
6.4.1.2 Compounded (aggregate) fund and benchmark performance.....	161
6.4.2 Performance measures or ratios	162
6.4.2.1 Standard deviation	163
6.4.2.2 Sharpe ratio	166

6.4.2.3 Sortino ratio	169
6.4.2.4 Treynor measure	173
6.4.2.5 Omega ratio.....	175
6.4.2.5.1 PDI versus Omega (Threshold = -2%).....	180
6.4.2.6 Beta	183
6.4.2.7 Information ratio	187
6.4.2.8 Conclusion	188
Chapter 7 Empirical study of the PDI as a fund management tool	191
7.1 Introduction.....	191
7.2 PDI as a fund management tool	191
7.2.1 Introduction.....	191
7.2.2 Scenario.....	191
7.2.2.1 Determining the maximum and minimum constraints.....	195
7.2.2.2 Optimisation of Fund C	196
7.2.3 Scenario results	197
7.2.3.1 PDI results.....	197
7.2.3.2 Omega results.....	198
7.2.3.3 Relationship between PDI and Omega results.....	199
7.2.3.4 Summary of the PDI as a fund management tool	200
7.3 Additional PDI concepts or uses.....	201
7.3.1 Possible other uses of the PDI	201
7.3.2 Marginal portfolio diversification.....	202
7.3.2.1 Introduction.....	202
7.3.2.2 Scenario.....	202
7.3.2.3 Marginal PDI results	204
7.3.3 Return & diversification matrix.....	205

7.3.4 Conclusion	207
Chapter 8 Summary, conclusions and suggestions for future research.....	209
8.1 Summary.....	209
8.2 Conclusions of the literature study	210
8.3 Conclusions of the empirical study.....	212
8.4 Suggestions for future research.....	215
9. Appendix.....	216
A.1 Regression results for PDI against HHI.....	216
A.2 Regression results for Residual variance against HHI.....	217
References	218

List of figures

Figure 2.1: Probability distribution of two assets with different risk levels.....	11
Figure 2.2: The efficient frontier	13
Figure 2.3: Risk/Return combinations of two assets	14
Figure 2.4: Efficient Frontier and Utility Curves.....	14
Figure 2.5: Combining a Risky Portfolio and a Risk-Free Asset	19
Figure 3.1: Probability Distribution.....	26
Figure 3.2: Example of weight decrease as used in the EMA approach.....	30
Figure 3.3: The Relationship between Risk and Return	48
Figure 3.4: Systematic and Unsystematic risk.....	54
Figure 3.5: Risk/ Return profile of portfolios	61
Figure 3.6: Number of shares in a well diversified portfolio.....	63
Figure 3.7: Expected return of the portfolio assuming different equity weights	72
Figure 3.8: Standard deviation of the portfolio assuming different equity weights	72
Figure 3.9: Efficient frontiers given different correlations.....	73
Figure 4.1: Breakdown of strategies per assets under management	103
Figure 4.2: Change in assets under management per strategy	103
Figure 4.3: Access to SA hedge funds	109
Figure 4.4: Local and Foreign funds distributions as at 31 March 2008	111
Figure 4.5: Example of an Omega function.....	121
Figure 5.1: Schematic of Principal Components Analysis	132
Figure 5.2: Graphical representation of a well diversified portfolio	135
Figure 5.3: Graphical representation of a less diversified portfolio	136
Figure 5.4: The maximum PDI in a hypothetical perfectly diversified portfolio	137
Figure 5.5: PDI in a hypothetical portfolio influenced by concentrated factors.....	138

Figure 6.1: South African market capitalization by industry (1 March 2008).....	156
Figure 6.2: Relationship between PDI and HHI	158
Figure 6.3: Relationship between residual variance and HHI	159
Figure 6.4: Annual fund and benchmark returns	161
Figure 6.5: Compounded yearly returns	162
Figure 6.6: Four year compound returns versus four year volatilities.....	163
Figure 6.7: Sharpe ratio trends.....	167
Figure 6.8: Four year active (excess) return versus Sharpe ratio.....	168
Figure 6.9: Sortino ratio results	170
Figure 6.10: ALSI performance 1990 to December 2008	171
Figure 6.11: Treynor measure results	174
Figure 6.12: Omega results #1	176
Figure 6.13: Omega results #2	178
Figure 6.14: Omega results #3	179
Figure 6.15: Downside Omega results.....	179
Figure 6.16: Section of upside Omega results	180
Figure 6.17: Omega at threshold = -2%.....	181
Figure 7.1: Fund C's optimised Omega results	198
Figure 7.2: Fund C's optimised Omega results at -2%.....	199
Figure 7.3: Omega and diversification benchmark.....	201
Figure 7.4: Marginal PDI.....	205
Figure 7.5: Four year return versus PDI contribution.....	207

List of tables

Table 3.1: Differences between alpha and beta	38
Table 3.2: Test Data #1	49
Table 3.3: Test Data #2	50
Table 3.4: Monthly returns on three prominent United States shares.....	60
Table 3.5: IPC values	67
Table 3.6: Standard deviation for given correlations and weights.....	70
Table 4.1: Differences between unit trusts and investment trusts	93
Table 4.2: Differences between unit trusts and hedge funds	94
Table 4.3: Local statistics (31 March 2008)	110
Table 4.4: Foreign statistics (31 March 2008).....	110
Table 4.5: Summary of South African collective investment industry.....	112
Table 5.1: Two approaches to measuring the PDI.....	140
Table 6.1: Number of shares in each fund	145
Table 6.2: Invested sectors of each fund.....	146
Table 6.3: The PDI results	149
Table 6.4: PDI results of each fund in sorted order	150
Table 6.5: Residual variance of each fund.....	152
Table 6.6: Residual variance of each fund in sorted order	152
Table 6.7: PDI and traditional diversification measure results.....	153
Table 6.8: Concentration results	155
Table 6.9: Fund concentration & PDI results	157
Table 6.10: Annual fund and benchmark returns.....	160
Table 6.11: Compounded yearly returns.....	162
Table 6.12: Standard deviation results.....	164

Table 6.13: Comparative ranking results (Standard deviation)	165
Table 6.14: Sharpe ratio results	166
Table 6.15: Comparative ranking results (Sharpe ratio).....	168
Table 6.16: Sortino ratio results.....	170
Table 6.17: Comparative ranking results (Sortino results)	171
Table 6.18: Combined Sortino and Sharpe results (four year)	172
Table 6.19: Treynor measure results.....	174
Table 6.20: Comparative ranking results (Treynor measure)	175
Table 6.21: Omega results in sorted order	181
Table 6.22: Comparative PDI & Omega (threshold = -2%) results.....	182
Table 6.23: Comparative ranking results (Omega).....	182
Table 6.24: Comparative ranking results (adjusted) (Omega).....	183
Table 6.25: Beta results.....	184
Table 6.26: Beta and R^2	185
Table 6.27: Beta ranking results	186
Table 6.28: Beta results in sorted order	186
Table 6.29: Comparative ranking results (Beta)	186
Table 6.30: Information ratio results	188
Table 6.31: Information ratio results in sorted order	188
Table 6.32: Summary results	189
Table 7.1: Performance of Fund C.....	192
Table 7.2: Independent factors in Fund C.....	193
Table 7.3: Negative independent (non-dependent) factors in Fund C.....	194
Table 7.4: Optimal weights for most independent shares.....	195
Table 7.5: Optimal weights for non-independent shares	196
Table 7.6: Optimal weights for Fund C	197

Table 7.7: Four year return versus PDI contribution206

Chapter 1

Introduction

1.1 Introduction and problem statement

“As new generations of increasingly scientific investment managers come to the task, they will rely more on analysis, process and structure than on intuition, advice and whim” (Grinold & Kahn, 2000:1).

As modern financial markets become larger, more highly developed, more transparent and even more efficient by the day and with market participants having access to endless amounts of information, the tools and analysis used will (and will have to) develop alongside. With the markets becoming even more efficient, the process of attaining above average risk-adjusted returns will become ever more difficult. In essence diversification is concerned with the number of unrelated sources of return (Gopi, Dugmore & Bradfield, 2006:4). The focus of investors and market participants should be prompted to shift towards effective portfolio diversification in order to help ease the task of attaining above average risk-adjusted returns. The importance of diversification is emphasised by the following quotes:

- *“Diversification in a portfolio of securities is a primary tenet of modern portfolio theory,”* (Rudin & Morgan, 2006:81).
- *“Modern portfolio theory suggests that diversification is rational,”* (Dobbins, Witt & Fielding, 1996:12).
- *“Diversification means that many assets are held in the portfolio so that exposure to any particular asset is limited”* (Bodie, Kane & Marcus, 2002:10).
- *“This portfolio that includes all risky assets is referred to as the market portfolio...because the market portfolio contains all risky assets, it is a completely diversified portfolio”* (Reilly & Brown, 2006:236).
- *“...given that investors should only take on that part of risk for which they expect to be rewarded”* (Dobbins et al., 1996:12).

- “The major benefit of portfolio diversification is the potential to increase returns in the long term through minimising risk and reducing the negative effects of market volatility on your portfolio” (Anon, 2000:1).

Although the development of financial markets has been speedy and rampant, the basic building blocks for sound investment portfolio construction remain the same (Hattingh, 2004:1). The tools used to analyse and assess these portfolios, however, will advance and develop, becoming more complex and sophisticated as financial markets evolve.

Although diversification is fundamental to portfolio construction, the most common and traditional manner in which to measure the degree of portfolio diversification remains inexact. The “traditional” diversification method (which is the residual variance method) correlates the returns of the portfolio with the returns of, for example, an index. Although this method is easily understood and not time consuming, it does have some shortcomings (Gopi *et al.*, 2006:4). One aspect of this approach is its use of the market index as a benchmark for complete diversification. An extensive problem occurs when the market index itself is not appropriately diversified across industries (Gopi *et al.*, 2006:1) and is therefore not representative.

One of the more sophisticated tools developed to cope with the expansion and evolution of financial markets is the Portfolio Diversification Index, which is a measure of portfolio diversification. This new diversification measure also improves on the traditional approach of measuring diversification, as it is free of market index influence (Smith, 2006:4). The Portfolio Diversification Index (PDI) appeared in the academic literature in 2006 and was proposed by Rudin and Morgan (Smith, 2006:4).

The central questions being addressed by this study are:

- whether the PDI is a robust, reproducible measure for portfolio diversification (compared to the residual variance method), and
- if the PDI can assist portfolio managers construct funds (or assist in changing the composition of existing funds) to reduce or minimise portfolio risk, while limiting the reduction in the return of the portfolio.

1.2 Research objectives

The aims of this study are twofold. First, establishing whether or not the PDI is a good diversification measure relative to the residual variance method (which is often and widely used to measure diversification). Second, determining whether the PDI can be used as a tool by fund managers to assist in constructing funds (or changing the composition of existing funds) to reduce portfolio risk without reducing the portfolio return.

This study will start by providing some insight into modern portfolio theory with its most prominent elements: risk, return and diversification, enjoying special attention. Furthermore, the study will engage in generic discussions on risk measurement, performance ratios and other issue which involve portfolio management.

Although there is a large amount of research related to diversification and a number of new research papers aimed at improving the science of portfolio diversification, a very small amount of academic literature exists about the PDI. The PDI is a new measure which aims to improve the methodology of portfolio diversification measurement as it is free of a market index influence (Gopi *et al.*, 2006:4). This study aims to replicate some of the findings of previous investigations as well as contribute towards the academic literature regarding portfolio diversification and more specifically the PDI.

1.3 Benefits of the research

The study will aim to investigate the following:

- as the PDI is free of overall market index influences, this “new” measure could improve on traditional approaches used to measure portfolio diversification, because the latter remains inexact, and
- whether the PDI can be used by fund managers as a tool to either aid in constructing portfolios or, change the composition of existing portfolios in order to reduce (or minimise) portfolio risk without a concomitant reduction in portfolio return.

The results of the study are important because:

- the PDI may prove to be a novel as well as a *better* approach in which to measure portfolio diversification than existing diversification measures, and

- the PDI may also prove to be yet another tool for use by portfolio managers as it measures the degree of diversification that specific shares adds to portfolios while also being able to quantify the diversification of a fund after fund adjustments (i.e. either fund composition or the weighting structure).

The study may also be of interest and benefit to:

(Mostly) South African investors and portfolio managers who daily seek new and improved methods in which to measure and improve the diversification of the portfolio being managed (as the study is conducted primarily within the South African market).

Portfolio managers outside of South Africa, as this “new” diversification measure is, as stated, free of market index influence and could possibly be used in practice globally.

1.4 Study methodology

Chapter 2 and 3 will focus on a literature study with an overview of modern portfolio theory. The key concepts of portfolio theory, namely risk, return and diversification will be explored and discussed. These topics are building blocks of portfolio management whilst also being the main elements of this study and focus of the empirical study. Hereafter, various approaches to risk measurement as well as performance ratios will be examined. Risk and portfolio performance are of utmost importance to the process and science of portfolio management – the core of this study – and these topics also have central roles in the empirical study. Several topics relating to (mutual) funds or unit trusts and hedge funds, among others; the legislation of such funds and the differences between different kinds of funds will be discussed, as funds are in essence portfolios, which are once again tied to portfolio management.

The study will conclude with a two-part empirical analysis; the first is aimed at solving the study’s first problem statement of whether the PDI is a good measure for portfolio diversification? In this part (Chapter 6) of the empirical analysis the PDI will go “head-to-head” with the “traditional” method of measuring diversification: the residual variance method. The second part (Chapter 7) of the empirical analysis will aim to address the question of whether the PDI can be used by fund managers to achieve better portfolio di-

versification and return by utilising the PDI as a tool. In both of these parts of the empirical analysis, performance ratios will play an important role.

1.5 Exposition of chapters

Chapter 2 - Modern Portfolio Theory: The purpose of this chapter is to present the key concepts of portfolio theory and portfolio management. The chapters that follow will delve deeper into the main concepts of importance and thereby effectively build a progressive line of information and background, moving towards the empirical study. This chapter will focus on the origin and history of portfolio theory while the important concepts of risk and return will be discussed in the context of the efficient frontier (which enjoys a key role in portfolio management). The next topic of this chapter will be Capital Market Theory and the assumptions thereof as it builds on the concepts of risky assets and the efficient frontier. This chapter also presents what impact a risk-free asset has on a portfolio when combined with risky assets as not all portfolios consist exclusively of risky assets. All these topics are important as they are the central and the most important concepts of portfolio theory. This chapter therefore continues where Chapter 1 ended, to elaborate on the main topics while the chapters that follow will aim to provide relevant information going forward towards the empirical study.

Chapter 3 – Diversification of risk: The broad aim of this chapter is to expand and elaborate on the third key element (or concept) of portfolio management: diversification, and hence its title. The topics discussed in this chapter (and those of the previous chapters) will provide information relative to the main focus of the study and the empirical study to be discussed Chapters 6 and 7. This chapter also continues to expand on the important concepts of risk and return, as discussed in the previous chapter, with detailed discussions regarding the different measurement approaches of both these concepts. Another important topic discussed in this chapter is portfolio construction. This topic will be developed in a step-by-step manner in order to explain the concepts fully. It is important to note that this topic is included and thoroughly covered as portfolio construction is a critical element of this study's empirical study. Thus, the purpose of this chapter is not only to elaborate and expand on the relevant key concepts, but also to delve deeper into the rele-

vant concepts of diversification and topics. Diversification is the third of portfolio management's (and this study's) most central and important concepts.

Chapter 4 – Markets, Funds and Performance Measures: This chapter will cover the topics of markets, funds and performance measures in order to further progress in the discussion of the most relevant topics surrounding portfolio management with an emphasis on diversification. Security markets will be this chapter's first focus as the assets which make up a portfolio are traded in these markets. The Efficient Market Hypothesis is of utmost importance as far as markets are concerned, thus the classification of markets and the characteristics of good markets will also be explored. Funds are at times traded in the form of Exchange Traded Funds (ETFs) while a combination of assets makes up a fund. For these reasons funds and other topics related to funds will be the second focus of this chapter. Some of the topics relating to funds include: historical developments, different types of funds and the South African fund industry. It is important for investors to measure the performance of their investments, hence the third focus of this chapter; fund performance. The discussion relating to fund performance includes a number of different performance measures which will also be used in the empirical study in Chapters 6 and 7. These performance measures are an important, influential topic of this study. This chapter concludes with a brief background discussion of asset allocation, benchmarks and indices. As these topics are not the main focus of this study, a detailed discussion is not needed, but these topics are nevertheless relevant so they are included and discussed.

Chapter 5 – Portfolio Diversification Index (PDI): Although the PDI will be touched on in chapters prior to Chapter 5 (especially Chapter 3), this chapter will discuss the PDI measure in more detail as it is a relatively new and unknown measure of diversification. This chapter will also explain how the PDI is calculated and the way in which it should be interpreted. This chapter is of utmost importance as the PDI is the main diversification tool, and the main focus of this study is to ascertain whether the PDI is a good diversification measure (compared to the residual variance method which is widely recognised and used by fund managers). Without the complete understanding of the PDI measure, this study would be incomplete.

Chapter 6 – Empirical study of the PDI as a diversification measure: This chapter will present the techniques and methodologies to achieve the first objective of the study. It will also present the results of the empirical study, specifically those relevant to the first objective of whether the PDI is a good measure of diversification (compared to the residual variance method).

Chapter 7 – PDI as a fund management tool: This chapter will present the empirical study (and results) of whether the PDI can be used as a tool by portfolio managers to aid in the construction of investment portfolios or the customisation of existing funds, i.e. the management of portfolios in order to achieve increased portfolio diversification without dramatically affecting (decreasing) returns.

Chapter 8 – Conclusion: This chapter will provide a conclusion while further research possibilities will also be suggested.

1.6 Limitations of the study

The limitations of this study, which will become clear as the study progresses, include the following:

- Research and literature regarding the PDI are very limited indeed.
- The hedge fund industry was not highly regulated in the past (globally but especially in South Africa), so the availability of historical information and data is severely limited.
- The availability of appropriate data e.g. investment funds, market indexes, etc., in terms of frequency and range, is limited in some cases.

1.7 Speech and reference

For practical purposes the entire study will refer to all third persons in the masculine form (regardless of gender) when referring to investors and portfolio or fund managers.

Chapter 2

Modern Portfolio Theory

2.1 Introduction

This chapter's purpose is to serve as an introduction to portfolio theory or modern portfolio theory as it is often referred to. Portfolio theory is the main focus of this chapter as this study focuses on diversification which is mainly used in a portfolio setting while portfolios will also be constructed in later chapters. Portfolio theory is also key and relevant to portfolio management. The information provided in this chapter is thus of relevance to the understanding of investments, investment portfolios and ultimately *optimal* investment portfolios, the end game of every (rational) investor.

Besides providing some background to portfolio theory, this chapter will also discuss the important concepts of risk and return as these two concepts are the chief elements of a portfolio as well as portfolio management. The information presented here will be valuable as in later chapters, it will be demonstrated how portfolio risk and return are calculated. The efficient frontier will be discussed as it is the optimal set of asset combinations (in terms of risk and return) and of importance for rational investors. As the Capital Market Theory expands upon Markowitz's Portfolio Theory it also deserves a discussion along with the Capital Asset Pricing Model (a pricing model for risky assets and an important topic in Modern Portfolio Theory). Lastly, the concept of a risk-free asset will be presented while the situation of combining such an asset with a risky portfolio will be included in this discussion.

As Markowitz Portfolio Theory is such an important element of portfolio management and a building block of this study, some background on its origination and development will also be explored throughout this chapter. This chapter will, provide background on relevant building blocks as the remainder of this study focuses on diversification and topics relevant to portfolio management. This chapter will, however, commence with a general discussion of portfolio theory including its origin.

2.2 Overview

While Modern Portfolio Theory has been around since the 1950s it is only one of many tools investors employ to manage portfolios. This theory is the philosophical opposite of traditional share picking, created by economists trying to understand the market as a whole (in contrast to business analysts investigating the reasons making each investment opportunity unique) (Moneychimp, 1997:1). The objective of modern portfolio theory is to find a balance between risk and return by identifying the acceptable level of risk tolerance and then to find a portfolio with the maximum expected return for that specific risk level.

Portfolio theory in its basic form was originated by Markowitz in the early 1950's and it was improved upon by Sharpe (1964), although Modern Portfolio Theory is based on the culmination of work of a number of researchers (Correia, Flynn, Uliana & Wormald, 2000:90). Markowitz (1952) was one of the first to attempt to quantify risk and demonstrate quantitatively how risk is reduced for investors by using portfolio diversification. Markowitz (1952) was also the originator of the "efficient portfolio"¹ concept. According to Markowitz (1952), the variance of the rate of return (on an asset) is a meaningful measure of portfolio risk under a certain set of assumptions (Bodie *et al.*, 2002:223). These assumptions are as follows (Reilly & Brown, 2006:202):

- for a given level of risk, investors will aim to maximise the level of return,
- the deviation from expected returns is used to estimate the risk level of a portfolio or investment,
- an investment opportunity for an investor is evaluated by the probability distribution of the expected returns over a period of time,
- investors maximise one-period expected utility, and their utility curves demonstrate diminishing marginal utility of wealth, and
- an investor's utility curve is a function of risk and return only.

¹ An efficient portfolio is defined as the portfolio "with the highest expected return for a given level of risk" (Bodie *et al.*, 2005:371). The efficient frontier will be discussed in Section 2.5

Ultimately Modern Portfolio Theory (MPT) proposes in which manner rational investors will use diversification in order to achieve optimisation of the owned portfolio and also how a risky asset should be priced (Reilly & Brown, 2006:167). Under the above-mentioned assumptions, a single portfolio of assets is considered efficient if no other portfolio of assets with the same (or lower) risk offers higher expected returns, or the same (or higher) expected returns with lower risk (Reilly & Brown, 2006:202).

As a brief overview of portfolio theory and some assumptions have been presented, the next two sections will shift focus to the two principal concepts of any portfolio: risk and return.

2.3 Return

An investor or portfolio manager invests in order to obtain or receive a return on his investment. This section thus briefly presents the concept of return, as return is the “payoff” or compensation the investor or portfolio manager receives for accepting a certain level of risk.

The expected return (on a portfolio) is the weighted average of the expected rates of return for the individual assets in the portfolio (Reilly & Brown, 2006:203). These weights are proportional to the total value of the individual assets. Generally, the calculation of the expected rate (for a portfolio) of return would be (Reilly & Brown, 2006:204):

$$E(R) = \sum_{i=1}^n w_i R_i \quad (2.1)$$

where:

w_i is the weight of an individual asset in the portfolio and

R_i is the expected rate of return for asset i .

For example, a two asset portfolio consisting of asset X and asset Y (assuming equal weighting), where asset X yields a return of 35% and asset Y yields 15%, will yield a return of 25% (i.e. the simple average) over the investment period. This simple example illustrates how the return of a portfolio is calculated which is important as in the chapters to follow the focus will shift towards portfolios and funds, where the return of these port-

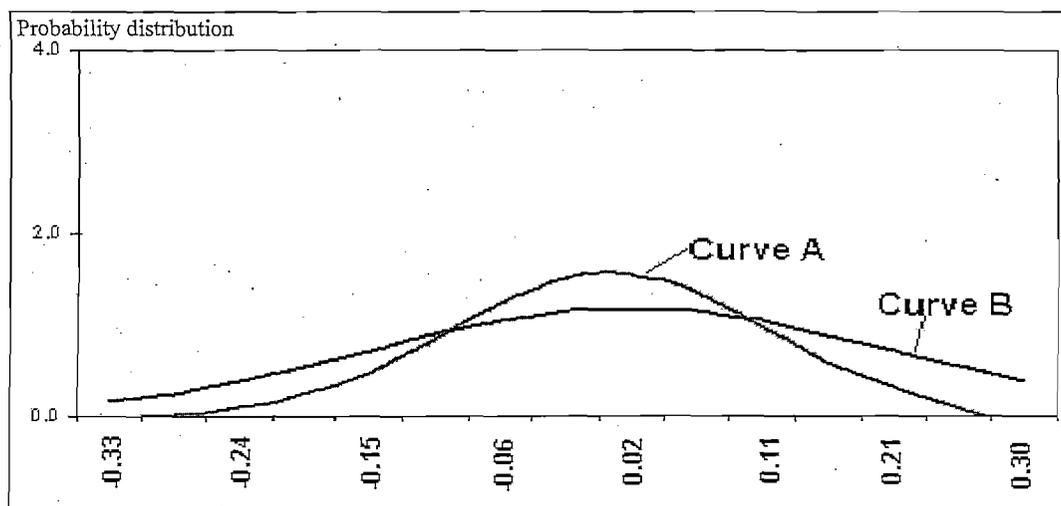
folios is calculated in a similar fashion. Knowledge on how to calculate the return of a portfolio is furthermore of key importance, as the objective of any investment portfolio is to receive a (certain) return. As was made clear in this section, return is the reward or compensation received by the risk-bearer and thus the subsequent section will focus on the other key element of a portfolio: risk.

2.4 Risk

A probability distribution is a graphical illustration of the risk associated with an asset. This probability distribution illustrates the dispersion of the realised returns around the mean of the expected return. As the level of dispersion increases, the level or risk of the specific asset also increases (D'Ambrosio, 1976:301).

The curve, in Figure 2.1, with the low dispersion (Curve A) represents the probability distribution of a low variance asset, thus an asset with low risk. The curve with the high dispersion (Curve B) in contrast, represents the probability distribution of an asset with a high variance i.e. a high risk. The reason why the curve with the low dispersion has a lower risk than the curve with the high dispersion is because the returns on the high risk asset (curve with high dispersion) will be more dispersed or scattered around a central value (normally this would be the mean rate of return or expected rate of return).

Figure 2.1: Probability distribution of two assets with different risk levels.



Source: Lind, Marchal and Wathen (2008:229).

Standard deviation is the standardised measure of variance around a mean (in fact, it is the square root of the variance). Stated differently, the standard deviation is a measure of a set of data's dispersion from its mean (Investorwords, 1997f:1). The standard deviation is denoted with the lower case sigma, and is often referred to as the volatility. Standard deviation of a portfolio is calculated with the following equation (Hull, 2000:424):

$$\sigma = \sqrt{\sum_{i=1}^n w_i^2 \sigma_i^2 + \sum_{i=1}^n \sum_{j=1}^n w_i w_j Cov_{ij}} \quad (2.2)$$

where:

$i \neq j$

w_i is the weight of an individual asset in the portfolio,

σ_i is the volatility of asset i and

Cov_{ij} is the covariance matrix of assets i and j .

Equation 2.2 indicates that the portfolio volatility is a function of the individual assets' return variances, their weight in the portfolio and the correlation between asset returns. It should be noted that the variance of the portfolio is also a function of the covariance of the assets included in the portfolio, and thus when a portfolio is constructed the average covariance with other assets in the portfolio should be considered (noted) and not just the variance of the individual asset (Hattingh, 2004:8).

Portfolio management is concerned with managing a set of combined investments in an optimal and structured manner and thus the efficient frontier which combines risk and return, will be subsequently discussed.

2.5 The efficient frontier

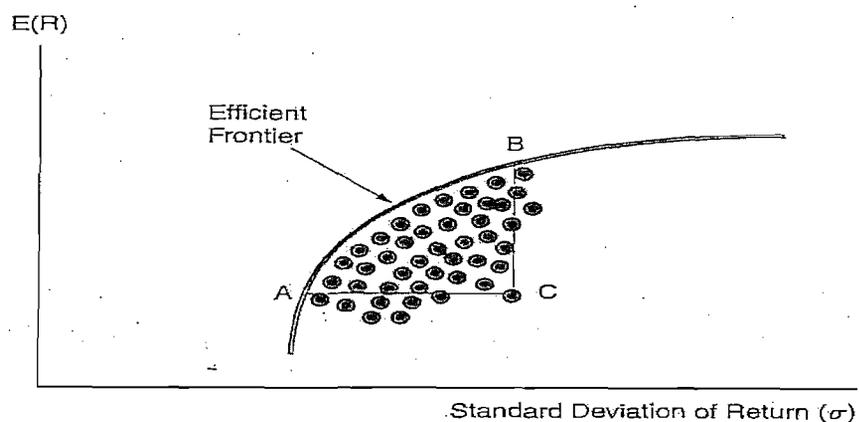
It is in any investor's best interest to manage his investment portfolio in an optimal manner. It is in this respect that the efficient frontier becomes important as a useful concept.

Every possible asset combination can be plotted in a risk-return space while the collection of all such possible portfolios defines a region in this space. The line which delimits the upper edge of this region from the remainder of the space is known as the "efficient fron-

tier". Along this line the combinations represent portfolios with the lowest (minimum) risk for a given level of return. Thus, for a given amount of risk the portfolio lying on the efficient frontier represents the combination with the best possible (maximum) return (Hattingh, 2004:8).

In Figure 2.2 the efficient frontier is indicated with return on the Y -axis and risk (in terms of standard deviation) on the X -axis. The region *above* the efficient frontier is unachievable by holding risky assets alone while portfolios lying in the region below the frontier are suboptimal. Thus, a portfolio on the frontier will be held by the rational investor and represents that set of portfolios which has the maximum rate of return for every given level of risk (or the minimum risk for every level of return).

Figure 2.2: The efficient frontier.

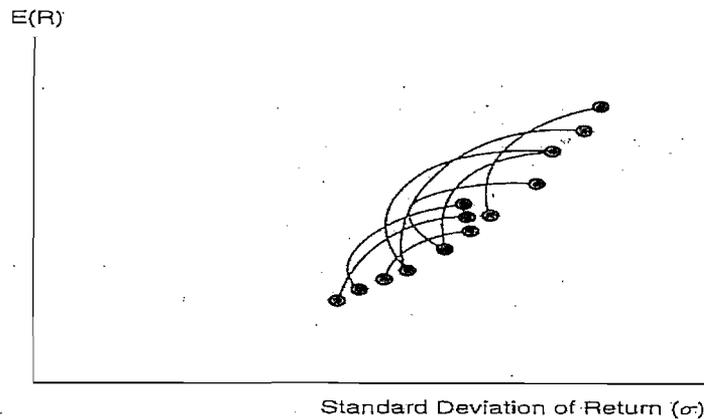


Source: Reilly and Brown (2006:221).

Figure 2.3 illustrates a hypothetical example of a graph that may derive different risk and return scenarios resulting from different combinations of two assets (Reilly & Brown, 2006:220).

According to Hattingh (2004:10) the benefits associated with diversification lead investors to believe that the efficient frontier will be made up of investment portfolios rather than individual assets, but not in extreme scenarios or cases where a portfolio consists of only one asset.

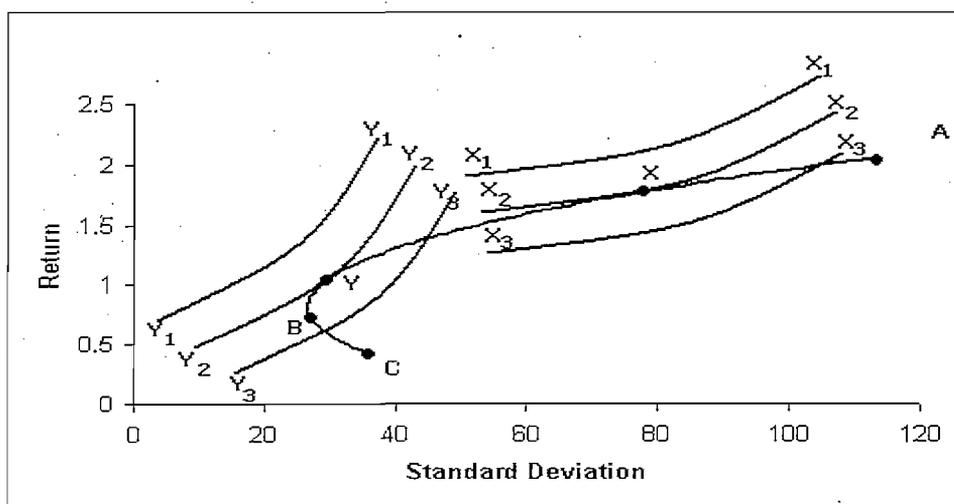
Figure 2.3: Risk/Return combinations of two assets.



Source: Reilly and Brown (2006:220).

Based on an investor's utility curve he will invest in a combination of assets (portfolios) that fall along the efficient frontier. The utility curves of the investors are functions of both expected variance and expected return and they indicate the trade-off between the risk and return that investors are willing to make. Stevenson and Jennings (1976:233) stated that the optimal portfolio on the efficient frontier lies at the point of tangency between the efficient frontier and the curve with the highest possible utility. This is illustrated in Figure 2.4.

Figure 2.4: Efficient Frontier and Utility Curves.



Source: Correia *et al.*, (2003:4-13).

Correia *et al.*, (2003:4-13) stated that the following can be seen from Figure 2.4:

- Three discrete indifference curves (utility curves) of investor X are X_1 , X_2 and X_3 . The curves proceed in an upward and leftward direction, depicting the increasing return being sought for increased risk. The risk preference of the investor is re-presented by the slope of the curve. Curve X_1 does not encounter any investment opportunity, while curve X_2 is the first to contact the opportunity set of feasible portfolios on the efficient frontier, although it offers less utility. Curve X_3 meets the efficient frontier at two points, but as curve X_2 offers a higher utility level, the investor will select to invest in portfolio X.
- The indifference curves (utility curves) of investor Y (Y_1 , Y_2 and Y_3) represent the utility curves of a more risk-averse investor than investor X. This is because the utility curves of investor Y are steeper than those of investor X and thus a greater return is required for accepting each unit of risk than X. Hattingh (2004:11) stated that a risk-averse investor will thus require the return to increase by a substantial margin with an increase in the risk level, compared to a less risk-averse investor.

A utility score which is based on expected risk and return is assigned to competing investment portfolios by investors (Bodie *et al.*, 2002: 157). A higher utility score is assigned to portfolios with attractive risk-return signatures while the utility score of a portfolio will increase if the expected return increases. This utility score will thus decrease if the expected risk increases. Thus the utility score can be used by investors to differentiate (and ultimately make an investment decision) between competing investment(s) (portfolios).

The focus up to now has been mainly on the Markowitz Portfolio Theory and the most important concepts of portfolio theory. As the Capital Market Theory essentially builds on the theory of Markowitz, specifically the concepts of risky assets and the efficient frontier, it deserves attention. The following section will thus focus on the Capital Market Theory.

2.6 Capital Market Theory

As the Capital Market Theory is an extension of the Markowitz theory, while also being very practical in modern times due to the incorporated use of the required rate of return, the Capital Market Theory will be explored.

The development of the Capital Market Theory and the CAPM is generally attributed to Sharpe (1964) as well as Lintner (1965) and Mossin (1966) (who arrived at similar asset pricing models independently) (Ivkovic, 2007:1). The Capital Market Theory builds on the Markowitz theory by expanding the concepts of risky assets and the efficient frontier further. According to Hattingh (2004:12) various studies have been performed to address some of the shortfalls identified. The need for large amounts of information is one of the major shortfalls identified, specifically as information regarding the risk and return characteristics of each asset considered is needed, as well as information relating to the covariance of each asset pair.

The Markowitz efficient investor will choose a portfolio that will offer the maximum return for the minimum risk in order to maximise the portfolio returns (the first assumption of the Capital Market Theory), while the Capital Market Theory's final product, the Capital Asset Pricing Model (CAPM), allows the investor to estimate the required rate of return for any risky asset and use it in the process of the investment decision (Ivkovic, 2007:1). The CAPM will be explained in more detail in the following section as its incorporated use of the required rate of return is very useful in the current and modern investment environment. This is as it allows modern investors to set a benchmark of performance for their investments.

2.6.1 Capital Asset Pricing Model

The Capital Market Theory (CMT) extends portfolio theory and develops a model for pricing all risky assets. The Capital Asset Pricing Model (CAPM) is the final product of the Capital Market Theory (CMT) and allows the investor to determine the required rate of return for any risky asset and use it in the investment decision process.

This model is important as it helps the investor value an asset by providing an appropriate discount rate which can be used in any valuation model (Reilly & Brown, 2006:239). If

the investor has an estimate of the rate of return of an investment, the investor can compare the estimate to the required rate of return implied by the CAPM and in this manner determine whether the asset is under, over or correctly valued. The result of this process can be used as information and input by the investor to make a sophisticated and informed investment decision.

The CAPM derives the required return (discount rate) for an asset in a market, given the risk-free rate available for investors and the level of risk (for the market as a whole). The CAPM is usually expressed as (Reilly & Brown, 2006:240):

$$E(R_i) = RFR + \beta_i(R_M - RFR) \quad (2.3)$$

where:

β_i is $\frac{Cov_{i,M}}{\sigma_M^2}$, where $Cov_{i,M}$ is the covariance of asset i with the market portfolio,

RFR is the risk free rate and

R_M is the expected return on the market as a whole.

After the expected return is calculated, the future cash flows (of the asset) can be discounted to their present value. The Capital Market Theory does, however, have a number of assumptions that are added on to the Markowitz Portfolio Theory and will be presented in the next section.

2.6.2 Assumptions of the Capital Market Theory (CMT)

The CMT essentially continues where the Markowitz Portfolio Theory left off and thus it operates within a similar set of assumptions, adding only a few new assumptions (Ivkovic, 2007:1). The assumptions of the CMT, listed below, only provide an overview of the theory (Ivkovic, 2007:1):

- All investors are assumed to be Markowitz efficient investors with each investor aiming for their individual or respective points on the efficient frontier (depending on their individual risk and return situation).
- All efficient investors will have access to borrowed funds or have the power to acquire funds at the risk-free rate. It should, however, be noted that there might be

problems or issues with borrowing funds at the risk-free rate, as borrowing at this rate assumes no profit for the lender. There might, however, be other ways to pay back the lender, which may result in the limited availability of borrowed funds at the risk-free rate.

- The theory assumes that all investors have homogeneous expectations; they estimate identical probability distributions for future rates of return.
- Lastly, the theory assumes that capital markets are in equilibrium. This not only means that there is no inflation or that inflation effects are fully expected, but also that all the supply has met all the demand and that all the assets on the Capital Market Line have been priced properly on a risk adjusted basis.

It is also important to discuss the concept of a “risk-free asset” as this idea is essential to pricing models while also having several implications for the Markowitz portfolio model, which forms an integral part of portfolio management and construction.

2.6.3 The risk-free asset

The concept of a risk-free asset is essential to pricing models and has several implications for the Markowitz portfolio model. By including such (risk-free) assets, a number of developments in asset pricing have been sparked.

A risky asset can be defined as “*one from which future returns are uncertain*” (Reilly & Brown, 2006:236). This uncertainty (or risk) is measured by the variance or standard deviation of expected returns. However, the return of a risk-free asset is certain and thus the standard deviation of the expected return is zero. “*It may also be proved that the covariance of these assets with any other asset or portfolio of assets will be equal to zero*” (Hattin, 2004:14.)

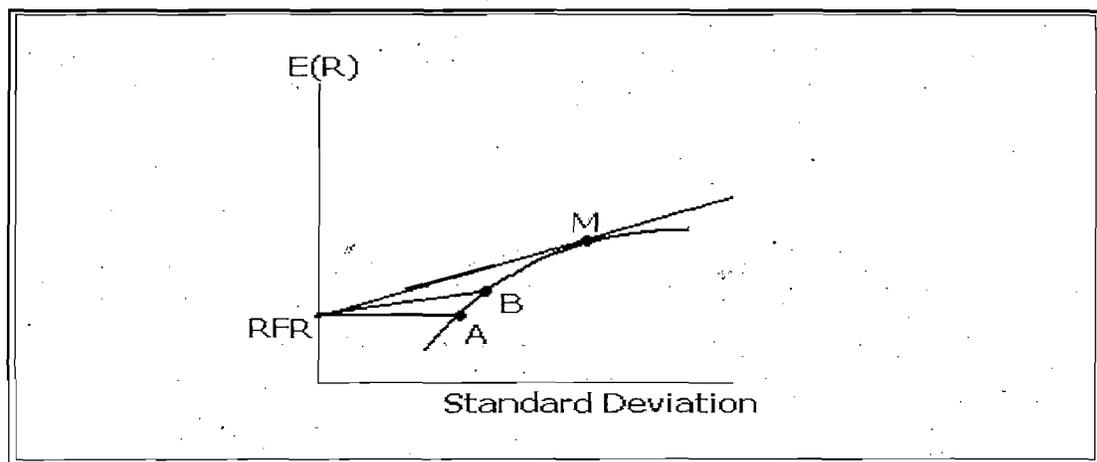
When a risk-free asset is included in an existing portfolio the effects are as follows (Hattin, 2004:15):

- the portfolio’s generated rate of return stays the weighted average of the returns generated by the assets included in the portfolio, and

- a portfolio which combines a risk-free asset with risky assets' standard deviation is the standard deviation of the risky asset portfolio.

Figure 2.5 illustrates how the above mentioned effects may be drawn in order to illustrate possible risk and return signatures. Investors will be able to attain any point along lines RFR-A and RFR-B simply by investing a part of their wealth in the risky-portfolio and a part in the risk-free asset on the efficient frontier. This refers to either portfolio A or portfolio B. Any combination on these lines (RFR-A and RFR-B) dominates all risky portfolios on the efficient frontier that fall below this point, as these portfolios have equal variance and higher return rates than any portfolio on the original efficient frontier which falls below the selected portfolio. It is also the case that all portfolios situated on line RFR-B will dominate the portfolios on line RFR-A (Hattingh, 2004:16).

Figure 2.5: Combining a Risky Portfolio and a Risk-Free Asset.



Source: Reilly and Brown (2000:290).

At the tangency point (line from RFR to the efficient frontier), portfolio M will dominate all portfolios below that point, because portfolio M is situated at the point of tangency with the efficient frontier. All investors will therefore aim to invest in portfolios that lie on line RFR-M (also referred to as the Capital Market Line (CML)). This portfolio contains all risky assets (not only shares) and is known as the market portfolio while it also represents a completely diversified portfolio. It should be noted that the CML becomes the new efficient frontier as all investors will aim for points on the CML (Hattingh, 2004:16).

Thus far this introductory chapter has focused on portfolio theory and its most important elements (risk and return) as these are the building blocks of this study. This chapter forms the starting point of information required which is relevant to the chief focus of this study, for instance, the Markowitz Portfolio Theory (MPT) and Capital Market Theory (CMT) are principles employed by portfolio managers to construct and manage investment portfolios. Section 2.7 will emphasise why portfolio theory is important and significant for this study.

2.7 Portfolio theory and its significance for this study

It is important to emphasise the significance of portfolio theory for this study as portfolio management (and the associated theory) is a main theme. This section will briefly embellish this significance.

Portfolio theory principles not only have a substantial impact on the remainder of this study, but also provide the necessary background. It is important to understand the pieces of the puzzle before the puzzle can be built; and built with success.

It should, however, also be noted that the focus of the study will be diversification and the methods and measures used to measure the degree thereof within a portfolio. Specifically, a new diversification measure will be evaluated while this new measure of diversification will also do battle against a widely used, efficient diversification measure – the residual variance method. The other objective of this study, (which will be mainly addressed in the empirical study), is to determine whether or not this new diversification measure can be used as a tool by fund managers.

The outcome and results of this study will be of interest to both professional and non-professional investors whom use diversification as a tool to reduce risk within their investment portfolios.

2.8 Summary

This chapter provided a literature review of Modern Portfolio Theory, and elaborated upon Markowitz Portfolio Theory as the basis for Modern Portfolio Theory. Also discussed were later developments in portfolio theory which included Capital Market Theory, amongst others.

Markowitz theory indicated that both risk and return should be considered when a portfolio is constructed while prior to his recommendations most investors constructed their portfolios based on expected return or, at best, separate considerations of risk and return. An important concept that arose from this chapter was that Markowitz identified an appropriate risk measure (variance), in a setting of portfolio management and construction. Furthermore, Markowitz theory has enabled investors to derive efficient frontiers which allow them to determine optimal portfolios given their risk preferences.

This chapter also considered the Capital Market Theory and the concept of the risk-free asset. As the Capital Market Theory's final product, the CAPM was also introduced. Furthermore, the efficient frontier and utility curve were explored while it became clear that the rational investor should (and should want to) hold the optimal portfolio as determined by the efficient frontier and tangency line.

With the necessary literature and background relating to portfolio theory discussed in this chapter, subsequent chapters will shift the focus on to portfolio diversification, portfolio performance and the measurements thereof. The topics that will be covered and discussed in the literature section of this study are the most relevant topics considering the study's main theme of portfolio management and the type of empirical study undertaken. This literature study will thus not only provide the necessary background relevant to understanding portfolio management and diversification, but it will also aid in the clarification as to how all this ties together in order to ascertain whether or not the PDI is a good diversification measure. In addition, the literature study will assist in answering the question as to whether the PDI may be used as a fund management tool by fund managers to aid in constructing and managing portfolios.

Chapter 3

Diversification of risk

3.1 Introduction

Investors are faced with the task of selecting and acquiring good investments, but they also need to consider the trade-off between risk and return and how they are going to combine different investments in portfolios to optimise their returns.

The aim of this chapter is to expand and elaborate upon the third key element of portfolio management, namely diversification. The objective of diversification is to reduce and ultimately eliminate risk, which in turn is also one of the three central concepts of portfolio management. The topics and concepts discussed in this chapter are thus important as they are further building blocks of investment portfolios and the management thereof. This chapter will also elaborate upon the concepts of risk and return in a more sophisticated and detailed manner. In addition, the measurement of these key portfolio elements will be discussed as well as portfolio construction – a chief component on the performance of investment portfolios. The discussion regarding portfolio construction will be done in a practical “step-by-step” manner in order to explain how each step fits into the process and to clearly understand each step's importance, but also to assist in the understanding of the importance of portfolio construction as a whole.

This chapter provides the necessary background in order to understand the processes and theoretical principals used in this study's empirical investigation. Since the empirical study focuses mainly on risk and return a thorough overview of these concepts is relevant. Furthermore, as diversification is the third and other key element of investment portfolios, the management of these portfolios (diversification itself) will be discussed in detail.

The concept of risk will be the first of the concepts or elements that will be explained in this chapter. Among the relevant topics of risk that will be discussed will be the definition of risk, the various types of risk, how risk is measured and also how risk and return are connected.

3.2 Risk

3.2.1 What is Risk?

Risk has many forms, including operational risk, financial risk; liquidity risk and reputation risk, but for the purpose of this study risk may be defined as the uncertainty of a future outcome (Mehra & Hemming, 2003:1) or more specifically “*the uncertainty that an investment will earn its expected return*” (Reilly & Brown, 2006:12). Mason, Lind and Marchal (1997:99) stated that the larger the range of expected returns of an asset, the larger the dispersion of the returns and the riskier the asset. This definition is important, as investments – and thus investment returns and the reliability of these returns – are a chief focus of this study.

Before the elements associated with risk are discussed, it should be noted that risk can be divided into financial and non-financial risk. The distinguishing factor between non-financial risk and financial risk is that there can be no financial benefit from an increased exposure to non-financial risk.

- **Non-financial risk:** can also be referred to as “pure” risk and is the exposure to uncertainty which has a non-monetary outcome (Marx, Mpofu, Nortjé & van de Venter, 2006:7). This type of risk is faced by individuals in the forms of health and safety risk.
- **Financial risk:** is the probability of an event which will have a negative financial implication (loss). This type of risk is associated with investments, as investors face the risk of an unexpected decline in the value of their investments (Marx *et al.*, 2006:7).

The risk associated with an asset or a portfolio of assets furthermore consists of two elements (types) of risk, namely:

- **Systematic risk:** This risk has a market-wide effect and thus influences a large number of assets and according to Marx *et al.*, (2006:6) includes general economic conditions, the impact of monetary and fiscal policies, inflation, political and other events that effect all companies. Systematic risk can not be diversified away completely.

- **Unsystematic risk:** “*Unsystematic risk is unique or asset specific risk that influences a single asset or a small group of assets*” (Smith, 2006:5.) Systematic risk can be diversified away within a portfolio.

Systematic risk although still a risk, can not be influenced by diversification in a direct manner. The subsequent section will focus on other risk types for the sake of completeness.

3.2.2 Risk types

The preceding section explained the relevance of unsystematic risk to the outcome of this study. It is, however, important to take notice of other types of risk that exist even though these do not play a direct role in this study nor are they this study’s main focus.

There are different types of risks but the term “risk” is in fact a collective term embracing a number of different types of concepts. Risk is generally regarded as a loss of principal. The following are some types of risks (Hattingh, 2004:20):

- Business risk.
- Country risk.
- Exchange rate risk.
- Financial risk.
- Interest rate risk.
- Market risk.
- Purchasing power risk.
- Reinvestment risk.

Although some of these risks might influence an investment, such as reinvestment risk, these risks are not the main focus of this study.

3.2.3 Risk measurement

It is insufficient for investors and portfolio managers to merely recognise risk in these sophisticated and complex financial times. It is also important to be able to measure these

risks and thus ultimately manage them. This section will discuss how to measure risk in both a broader content but also in ways specific to the investment (portfolio) environment. This section is relevant to this study as these methods will be used in the empirical study while also being the measurement tools used by portfolio managers in practice.

3.2.3.1 Volatility

The most established measure of risk is standard deviation, commonly referred to by investors as “volatility”. This measure of risk was Markowitz’s definition and it has been the standard in the institutional investment community ever since (Grinold & Kahn, 2000:44). Standard deviation is defined as “a measure of risk or dispersion around a mean” (Elton, Gruber, Brown & Goetzmann, 2003:44) and is the square root of the variance (Reilly & Brown, 2006:16). Thus, the standard deviation is a measure of dispersion around a mean value. A larger dispersion around a mean value would be indicative of more variability and thus a greater degree of risk.

The equation for calculating the standard deviation may be represented as follows (Reilly & Brown, 2006:34):

$$\sigma_i = \sqrt{\sum_{i=1}^n P_i [R_i - E(R_i)]^2} \quad (3.1)$$

where:

n = the number of observations,

σ_i = standard deviation,

$P(s)$ = probability of scenario s ,

R_i = possible return on asset and

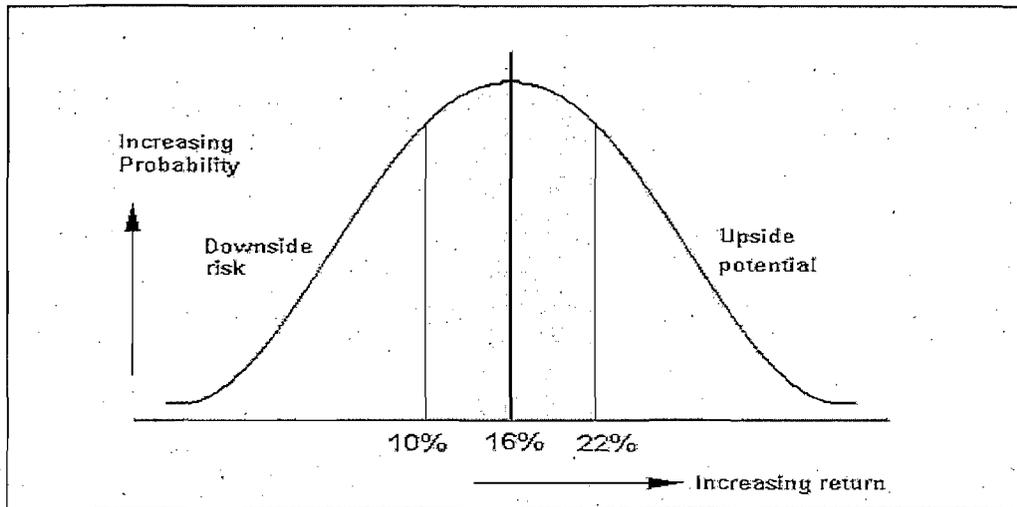
$E(R_i)$ = expected or realised return on asset.

The standard deviation can also be calculated as being the positive square root of the variance (see Equation 3.2).

According to Dobbins *et al.*, (1996:6) approximately 68% of all occurrences should lie within one standard deviation, on average, on either side of the expected outcome. In

Figure 3.1, this implies that 68% of the observations should fall within the 10% to 22% range with the implied standard deviation being 6%. This is only true if the returns are normally distributed.

Figure 3.1: Probability Distribution.



Source: Dobbins *et al.*, (1996:6).

Variance is defined as (Reilly & Brown, 2006:33):

$$\sigma_i^2 = \sum_{i=1}^n P_i [R_i - E(R_i)]^2 \quad (3.2)$$

where:

σ^2 = variance.

Hattingh (2004:22) draws attention to the fact that this measurement of risk is based on historic performance of the asset and that there is thus no guarantee that the risk characteristics of the asset will remain constant. Investors should thus use as much historical data as possible to eliminate this shortfall.

Bodie *et al.*, (2005:176) stated that “*the risk of individual assets in a portfolio must be measured in context of the effect of their return on overall portfolio variability.*” Because the amount of risk associated with a portfolio is dependent on the extent to which the assets in a given portfolio move together, the assumption can be made that the risk of a portfolio is not simply the weighted average risk of the assets within the portfolio (Hat-

tingh, 2004:23). The degree to which different assets move in relation to each other is known as “covariance” and will be discussed in the subsequent section. The following section will also focus on the topic of covariance in a portfolio setting as this is of importance to this study.

3.2.3.2 Covariance

Covariance is the measure used to measure how much the returns of two risky assets move in tandem (Bodie *et al.*, 2005:176). The equation used to measure the covariance of two assets is (Bodie *et al.*, 2005:177):

$$Cov_{AB} = \sum_s \Pr(s)[r_A - E(r_A)][r_B - E(r_B)] \quad (3.3)$$

where:

$\Pr(s)$ = probability of scenario s ,

r_A = realised return on asset A,

r_B = realised return on asset B,

$E(r_A)$ = expected return on asset A and

$E(r_B)$ = expected return on asset B.

From this it is evident that the covariance of a portfolio is reliant on two factors, namely:

- variability (standard deviation) of the individual assets, and
- the relationship (correlation) between different assets included in the portfolio.

The following equation relates the covariance to the correlation coefficient (Bodie *et al.*, 2005:177):

$$\rho_{AB} = \frac{Cov_{AB}}{\sigma_A \sigma_B} \quad (3.4)$$

where:

ρ_{AB} = the correlation coefficient between (the returns of) assets A and B.

For a three-asset portfolio, the portfolio standard deviation may be calculated by using the following equation (Hattingh, 2004:24):

$$\sigma_{port}^2 = W_A^2 \sigma_A^2 + W_B^2 \sigma_B^2 + W_C^2 \sigma_C^2 + 2W_A W_B \text{Cov}_{AB} + 2W_A W_C \text{Cov}_{AC} + 2W_B W_C \text{Cov}_{BC} \quad (3.5)$$

$$\sigma = \sqrt{\sigma_{port}^2} \quad (3.6)$$

where:

W_x = the weight of each asset in the portfolio,

σ_x^2 = the variance of asset X and

Cov_{xy} = the covariance between the returns of assets X and Y.

These equations indicate that factors such as the asset weight, the standard deviation and the correlation of the asset with other assets present in the portfolio, are all important in the calculation of the portfolio's variance.

Although this study employs volatility as a primary measure of risk, many other measurements have come to the forefront as portfolio theory has evolved and become more sophisticated. These other measures of risk –will be discussed in subsequent sections.

3.3 Further risk measurements

Knowledge regarding volatility and correlations is important in order to understand, calculate and apply performance measures such as Value-at-Risk (VaR), Sharpe and Sortino ratios accurately and correctly. This section will discuss some of these measures as they are widely used and are used exclusively in Chapters 5 through 7. This section also highlights the characteristics of these methods.

3.3.1 Other volatility measures

3.3.1.1 Moving average

Moving average is a technical analysis term used to analyse time series data (Investopedia, 2008c:1). This technique can also be employed as a generic smoothing operation (data need not be of time series variety), as it is often used to smooth out short-term fluctuations resulting in longer term trends being highlighted. Two different moving average

methods will be discussed subsequently, namely the Simple Moving Average and the Exponentially Moving Average while a discussion on GARCH will complete the section on volatility measures.

3.3.1.1.1 Simple Moving Average (SMA)

A Simple Moving Average (SMA) is a mean value as calculated over a rolling previous period of fixed length, thus it is the average share price, for example, over a certain period and is often referred to as “moving average” (Investopedia, 2008g:1). It is referred to as “moving” since as each new entry (price) is added, the oldest entry (price) is discarded. A drawback of a moving average is that it lags behind the latest price action. This is simply a result of the nature of its smoothing: An SMA specifically can lag to an undesirable extent with old prices (which are dropped out of the series) having too much of an influence on the calculation. This problem can be corrected by providing extra weights to recent (newer) prices (Botha, 2005:66). Two of the methods that incorporate these extra weights are the Weighted Moving Average and the Exponentially Moving Average.

- **Measuring SMA:**

A t-period average price of a return series is first established. The sum of the squares of the differences between each period’s return and that of the average is calculated for the full t-periods. The SMA is a valuable model as it is used as the volatility model in Value-at-Risk (VaR) studies. The SMA is given by (Botha, 2005:64):

$$\sigma = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (r_t - \bar{r}_a)^2} \quad (3.7)$$

where:

σ is the SMA volatility measure,

T is the number of observations,

r_t is the observation at time index t and

\bar{r}_a is the mean or expected value of all observations.

The SMA does, however, have some disadvantages. The most important of these are (Botha, 2005:65):

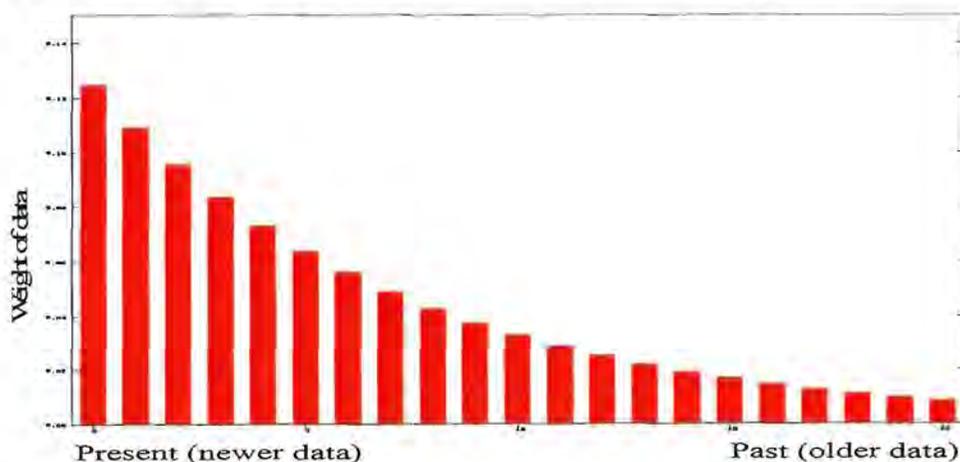
- The time order of observations is ignored.
- A large increase in the price is not recorded. The SMA has a memory-loss function as such sudden price surges are not manifested quantitatively in the SMA (Botha, 2005:64).
- All observations have equal weights.

According to Botha (2005:65) recent data have greater importance for volatility forecasting than older data and thus Botha (2005:65) recommends that more recent data should receive greater weights than older data. The Exponentially Weighted Moving Average – a model of ARIMA (Auto Regressive Integrated Moving Average) mould – operates according to this design and will be discussed in the next section.

3.3.1.1.2 Exponentially Moving Average (EMA)

An Exponentially Moving Average (EMA) is similar to a SMA but is an ARIMA model which assigns more weight to the most recent data than to older data, as indicated in Figure 3.2. Stated differently, the EMA applies weighting factors which decrease exponentially (Wikipedia, 2007:1). This is done in such a way that the weighting for each “day” decreases exponentially without discarding older observations completely. The EMA is also known as “Exponentially Weighted Moving Average” (EWMA).

Figure 3.2: Example of weight decrease as used in the EMA approach.



Source: Wikipedia (2007:1).

The primary problem with SMA models is that recent observations should receive more weight than older observations (Investopedia, 2008g:1). This correction is done in the EMA model type and thus this type of model reacts faster to recent price changes than SMA.

Botha (2005) used the approach of J.P. Morgan RiskMetrics© for estimating and forecasting volatility which uses Exponentially Weighted Moving Average (EWMA) (JP Morgan, 1996:68).

One of the EWMA models' improvements over the SMA model is that it has a memory of past occurrences. According to Botha (2005:65) it "remembers" a fraction of its past by a calculated factor, λ . This "remembering" factor ensures the EWMA or the EMA is a good indicator of the historic price movement (Botha, 2005:65). This meets the statement of earlier on the EMA that the model assigns larger, higher or heavier weights to the most recent observations or data, in order to estimate the volatility. This model captures the important features of volatility when focusing on historical observations: this model applies the highest weights to the fraction of the past (which is "remembered" by the model).

The EMA model does, however, depend on the parameter λ , known as the decay factor. This parameter ($0 < \lambda < 1$) defines a relative weight $(1 - \lambda)$ which is assigned to the most recent volatility while the weight of λ is applied to the most recent price return (Botha, 2005:65). The higher the value (i.e., closer to 1), the less the most recent data affects the current dispersion estimation. In addition, the higher the value (i.e., closer to 1), the faster the dispersion returns to the previous level after strong return change (Botha, 2005:66). The EWMA model may also be represented as: (Hull, 2000:240):

$$\sigma_t^2 = (1 - \lambda) \cdot \sum_{i=1}^{\infty} \lambda^{i-1} \times r_{t-i}^2 \quad (3.8)$$

where:

λ is the decay factor,

σ_t^2 is the t^{th} period variance and

r_{t-1}^2 is the t-1th period squared return.

It should be remembered that volatility is a measure of risk while the purpose of diversification is to reduce the risk to an acceptable level of risk (in order to suit investors' risk profiles).

3.3.1.2 Generalised Autoregressive Conditional Heteroscedasticity (GARCH)

As the risk of different financial products is estimated by the return volatility of the asset, the accurate measurement of volatility is of utmost importance. This section will focus on GARCH as an improved measure of risk. GARCH can be broken down as follows (Mathworks, 1984:1):

- Autoregressive – describes a feedback process that includes or integrates past observations into the present.
- Conditional – conditional refers to a dependence on the observations of the immediate past.
- Heteroscedasticity – refers to time-varying variance.

Thus GARCH is a method that includes past variances in explaining future variances (Mathworks, 1984:1). Furthermore, GARCH is a time-series technique that is used to model the serial dependence of volatility. A time series is heteroscedastic (the variances vary with time) when it has a GARCH effect and homoscedastic (the variances are constant with time) when it does not have a GARCH effect. The GARCH model is a weighted average of past squared residuals, but has declining weights which approach but never equal zero (Engle, 2001:159).

GARCH is a useful technique as it provides accurate forecasts of variances and covariances of asset returns through its ability to model time-varying conditional variances. GARCH effects are highly significant in equity markets for (a) individual shares, (b) share portfolios and indices and (c) equity future markets. GARCH models are further useful as they can also be applied to a wide range of fields such as (Mathworks, 1984:1):

- Risk Management.
- Portfolio management and asset allocation.

- Option pricing.
- Foreign exchange.
- The term structure of interest rates.
- To examine the relationship between long- and short-term interest rates.
- To analyse time-varying risk premiums (as the uncertainty for rates over different horizons changes over time).
- To model foreign exchange markets.

GARCH models, however, do fail in some instances as GARCH is specifically designed to model time-varying conditional variances, thus the model fails to capture the fat tails observed in asset return series completely (Kwan, Li & Ng, 2005:1). In order to compensate for the limitation of heteroscedasticity, which does explain some of the fat tail behaviour, fat-tailed distributions have been introduced to GARCH modelling (Palandri, 2004:1). This, however, falls outside the scope of this study.

GARCH variance is given by (Hull, 2000:241):

$$\sigma_n^2 = \gamma V_L + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2 \quad (3.9)$$

where:

γ is the weight of V_L ,

V_L is the long-run variance rate,

u_{n-1} is the most recent daily % change in the market variable,

α is the weight of u_{n-1}^2 ,

β is the weight of σ_{n-1}^2 and

$\gamma + \alpha + \beta = 1$.

GARCH is a modern and sophisticated volatility measurement tool that is widely used in the industry. Since GARCH is not used in this study, a high level discussion will not be necessary.

The subsequent section will focus on the concept of correlation. The co-movement (covariance) between assets in a portfolio is important when measuring the risk of a portfolio.

3.3.2 Other measures of correlation

This section introduces correlation as a measure of co-movement amongst variables and also discusses additional correlation measures, specifically Pearson's Correlation.

It should be remembered that correlation reflects the degree to which the variables are correlated (related) to each other (Gujurati, 2006:61). Correlation values range from -1.0 to +1.0. A positive sign indicates that the two securities involved move upward and downward together simultaneously. If the sign is negative the two securities move in opposite direction simultaneously. A correlation of 0.0 is an indication that the two returns of the securities are independent of each other. The strength of the relationship between two securities' returns is indicated by the magnitude of the correlation coefficient (Marx *et al.*, 2006:250). The maximum risk reduction is achieved when the returns of two securities move exactly oppositely to each other (correlation is -1.0).

To calculate the correlation between two assets (securities) the equation below can be used (Marx *et al.*, 2006:250):

$$\text{Correlation}(r) = \frac{\text{Covariance}_{A,B}}{\sigma_A \cdot \sigma_B} \quad (3.10)$$

where:

σ is the standard deviation of asset return.

Equation 3.10 indicates the (linear) relationship between two variables, with the investor being able to use this information when constructing or customising an investment portfolio.

The Pearson Product Moment Correlation (Pearson's Correlation) is another and most common measure of correlation (Botha, 2005:69). As is the case with correlation in the broader sense, the degree of linear relationship among two variables is measured by Pearson's Correlation. If the correlation has a plus or minus one, it indicates perfect positive

or negative relationship respectively between the two variables. A zero once again indicates that there is no linear relationship between the two variables. Pearson's Correlation is calculated as follows (Hull, 2000:242):

$$\rho = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (x_t - \bar{x}) \cdot (y_t - \bar{y})} \quad (3.11)$$

where:

ρ is Pearson's correlation coefficient,

T represents the total observation period,

x_t and y_t are the two return variables (generated from two price series) and

\bar{x} and \bar{y} are the averages of the two different return variables.

Note that Exponentially Weighted Moving Average correlation adjusts faster and more acutely to a sudden change in an instruments return, than the Simple Moving Average method. This was shown in Sections 3.3.1.1.2 and 3.3.1.1.3 and should be noted, but the decision as to which to use will depend on the situation at hand.

Furthermore, it is important to note that correlation is also used along with volatility to measure beta, hence the following focus will be on the concept of beta as it also has a role in portfolio theory and portfolio management.

3.3.3 Beta

Beta is a measure of a security's or portfolio's return volatility, or systematic risk, in relation to the rest of the market (Reilly & Brown, 2006:240). Beta is also known as the "beta coefficient" (Investopedia, 2008b:1).

A regression analysis is used to calculate beta with a beta of 1 indicating that the particular share or asset's return moves with the market while a beta of less than 1 is indicative of a share or asset that is less volatile than the market. Furthermore, if beta is greater than 1 it means that the particular share's price is more volatile than the market. For example, if a share's beta is 1.4 the particular share is theoretically 40% more volatile than the

market while if the share's beta is 0.8, the share is 20% less volatile compared to the market (Investopedia, 2008b:1).

The following are needed in order to estimate beta:

- The returns for the assets.
- The returns for the benchmark (market portfolio).

In order to calculate beta the following equation may be used. (Bodie *et al.*, 2006:283):

$$\beta_i = \frac{\text{Cov}(r_i, r_M)}{\sigma_M^2} \quad (3.12)$$

where:

(Cov) between r_i (returns of the i^{th} instrument) and r_M (market return) is given by (Botha, 2005:73):

$$\text{Cov}(r_i, r_M) = \rho_{i,M} \sigma_i \sigma_M \quad (3.13)$$

where:

σ_i is the volatility of the returns of the i^{th} instrument,

σ_M is the volatility of the market returns and

$\rho_{i,M}$ is the correlation between returns of the i^{th} instrument.

It is important to remember that the accuracy of the volatility and correlation determines the accuracy of the beta estimate (Botha, 2005:74). Thus both volatility and correlation are key components of the beta calculation. Inaccurate beta estimates will in turn manifest themselves in inaccurate measurements of risk while ultimately this inaccurate information will be used by an investor to make investment decisions. Since diversification involves risk reduction, and since no rational investor would prefer to hold the market when the market declines, beta is an important measure to judge how well an investor is diversified compared to the market (Investopedia, 2008b). The next section will discuss the concept of alpha where the differences between the two will also be examined.

3.3.4 Alpha

Alpha, denoted by α , is also known as excess return and is a risk-adjusted measure which measures the difference between the estimated return and the expected (required) return (Reilly & Brown, 2006:243). As α represents a fund's excess return, it refers to a scenario where the fund generates a return even though the underlying market itself is motionless (Reilly & Brown, 2006:243). Thus α is commonly used to assess the performance of a fund manager as it is the return in excess of a benchmark (Bodie *et al.*, 2005:328).

The alpha coefficient, denoted by α_i , is a parameter of the Capital Asset Pricing Model (CAPM) which was discussed in Section 2.6.1. In an efficient market, the expected value of α is equal to the risk-free asset's return: $E(\alpha_i) = r_f$. The alpha coefficient can thus be used to determine if a fund or portfolio manager has created or destroyed value. This is explained further by the points below:

- $\alpha_i > r_f$ value has been created
- $\alpha_i = r_f$ value has not been created or destroyed
- $\alpha_i < r_f$ value has been destroyed

where:

α_i is the alpha and

r_f is the return of the risk-free asset.

The difference between α_i and r_f is known as Jensen's alpha. Table 3.1 presents the differences between alpha and beta.

Table 3.1: Differences between alpha and beta.

Alpha	Beta
Reflects investing skill of fund manager	Is the fund's return relative to that of the market
It is more expensive due to the skill involved from the fund manager	Indexing
Performance fees are charged above high base fees, i.e. higher fees are paid relative to beta	Inexpensive

Source: Botha (2005:75).

Alpha and/or Jensen's alpha is thus a simple and quick manner in which to determine whether or not the fund or portfolio manager is creating or destroying value and will be useful in situations where portfolios are actively managed (Botha, 2005:76). This, however, falls outside the scope of this study.

It is also of importance to explain the concept of "risk premium" and how it ties together with portfolio theory. The following section will discuss this as in theory an investor should be compensated for bearing greater or more risk. Beta also has a role to play with regard to the risk premium while systematic (market) risk plays a leading role when risk premium is involved.

3.3.5 Risk premium and portfolio theory

The work by Markowitz (1952, 1959) and Sharpe (1964) (Chapter 2) in portfolio and Capital Market Theory provided alternative views of risk. Both Markowitz and Sharpe indicated that an external market measure of risk should be used by investors. As all rational, profit-maximising investors want to hold a completely diversified market portfolio of risky assets (under specific assumptions), investors will borrow and lend to reach a level of risk that is consistent with their risk preferences (Reilly & Brown, 2006:23).

It should be remembered that the relevant risk measure (under these conditions) for an individual asset is its co-movement with the market portfolio (Reilly & Brown, 2006:23).

This co-movement (of the asset with the market) is measured by an asset's covariance with the market portfolio and is better known as systematic risk, "*the portion of an individual asset's total variance attributable to the variability of the total market portfolio*" (Reilly & Brown, 2006:23). These same individual assets have variance that is unrelated to the market portfolio (asset's non-market variance) that is due to the assets' unique features. This non-market variance is referred to as unsystematic risk and considered unimportant for it is eliminated in a large diversified portfolio. Reilly and Brown (2006:24) stated that "*the risk premium for an individual earning asset is a function of the assets' systematic risk with aggregate market portfolio of risky assets.*" As was showed and discussed in Section 3.3.3, beta is the measure of an asset's systematic risk and can be calculated or estimated as follows (Reilly & Brown, 2006:24):

$$\text{Risk Premium} = f(\text{Systematic market risk}) \quad (3.14)$$

Risk premium will be examined in Section 3.4.2 while systematic- and (versus) unsystematic risk will be discussed on in Section 3.7.6. This discussion on risk premium is ultimately of importance as an investor could like to receive additional compensation for taking on additional uncertainty i.e., risk.

The most relevant risk measures along with other measures of importance to portfolio theory have been discussed. The subsequent focus will be return as it is the other key element of portfolio theory and portfolio management.

3.4 Return

This section will focus on the concept of return and some concepts relative to return, such as the measurement of return.

3.4.1 Overview

Reilly and Brown (2006:6) define an investment as "*the current commitment of dollars for a period of time in order to derive future payments that will compensate the investor for (1) the time the funds are committed, (2) the expected rate of inflation, and (3) the uncertainty of the future payments*". Return is defined by Marx *et al.*, (2006:7) as "*the sum of cash dividends, interest and any capital appreciation or loss from an investment.*"

Thus return is the ratio of money lost or gained by an investor on an investment in relation to the amount of money invested over a specific time interval.

The rate of return or return demanded by an investor is known as the required rate of return and is the minimum return an investor should accept to compensate him for the deferring consumption (Marx *et al.*, 2006:4). The CAPM is very useful as it incorporates the required rate of return which implies that an investor can plan, calculate and execute his investment decision better, as the investor knows how much return he must receive to obtain his objective. The next section focuses on the required rate of return.

3.4.2 Required rate of return

The required rate of return is defined as “*the rate of return needed to induce investors or companies to invest in something*” (Investopedia, 2008e:1).

Furthermore, the required rate of return consists of three components. Reilly and Brown (2006:18) stated that the sum of these three components is the required rate of return.

These components (Marx *et al.*, 2006:4):

- The time value of money during the investment period.
- The expected rate of inflation during the investment period.
- The risk involved.

The Real Risk-Free Rate (RRFR) has to be taken into consideration when analysing the required rate of return of a given investor. Reilly and Brown (2006:18) define the Real Risk-Free Rate as “*the basic interest rate, assuming no inflation and no uncertainty about future flows.*” In essence the RRFR is thus the rate of return demanded by an investor if the investor knew (with certainty) *what* cash flows he would receive and *when*. This rate of return, the RRFR, is influenced by two factors as identified by Reilly and Brown (2006:19), with one being subjective and the other objective. The subjective factor is the time preferences of investors while the objective factor is identified as the available investment opportunities in the economy. Greater probability of opportunity cost is the result of longer time or investment horizons and thus investors will want a higher level of return (Hattingh, 2004:25).

In addition, Reilly and Brown (2006:19) stated that (nominal) rates of interest (NRFR) that prevail in the market are determined by real interest rates with the addition of factors that will affect the nominal rate of interest, (e.g. expected rate of inflation).

An investment is risk-free when the investor is certain about the amount and also the timing of the expected returns. Most investors, however, require higher returns on their investments (if they are of the opinion that there is uncertainty regarding the expected rate of return). The increase in the required rate of return over the NRFR is known as the risk premium (RP) (see Section 3.3.5) and represents the composite of all uncertainty although some fundamental elements or sources are identifiable. Some of these elements include (Reilly & Brown, 2006:24):

- Business risk,
- Financial risk,
- Liquidity risk,
- Exchange rate risk and
- Country risk.

The required (expected) rate of return may be calculated using (Reilly & Brown, 2006:475):

$$k_i = RFR + \beta_i(R_m - RFR) \quad (3.15)$$

where:

k_i = required rate of return on asset i ,

RFR = nominal risk-free rate of return,

R_m = market return and

β = beta of the asset.

Beta, β , (Equation 3.12) is a measure of the extent to which an asset moves relative to the market (Elton *et al.*, 2003:137). Thus beta measures the covariance between the returns of assets and the market returns. The market portfolio (the portfolio consisting of all

the risky assets) therefore has a beta coefficient of 1 while an asset with a beta of more than one will have high levels of systematic risk. In contrast, an asset with a low or a negative beta has low levels of systematic risk.

To conclude this section, the combination of the risk, the expected level of inflation for the investment period and the time value of money during the same period together make up the required rate of return for an investor. In modern financial times combined with the number of investment products to choose from, it is important for any investor to plan his investment. The required rate of return aids this process while forming an integral part of portfolio theory and management, making it a core focus point for this study.

3.4.3 Measurement of return

Bodie *et al.*, (2002:174) stated that “*the mean or expected return of an asset is a probability-weighted average of its return in all scenarios.*” and that the equation may be written:

$$E(r) = \sum_s \Pr(s)r(s) \quad (3.16)$$

where:

$E(r)$ = mean rate of return of an asset,

$\Pr(s)$ = probability of scenario s .

$r(s)$ = return in scenario s .

According to Reilly and Brown (2006:12) the rate of return for a portfolio of assets or investments is a weighted average of the rates of return of each of the assets included in the portfolio. Thus an investor should use the weighted average return of all the assets in the portfolio, when calculating the return generated by a portfolio. If a portfolio, for example, consists only of two assets (assuming equal weights) with asset X yielding a return of 25% while asset Y yields 13%, the portfolio will yield a 19% return over the investment period. Equation 3.17 illustrates the calculation of the portfolio return (Hattin, 2004:27):

$$\bar{R}_{\text{port}} = W_x r_x + W_y r_y + \dots + W_\infty r_\infty \quad (3.17)$$

where:

W = weight of the asset in the portfolio,

x = portfolio x ,

y = portfolio y and

\bar{R}_{port} = mean rate of return of the portfolio.

An investor would like to be informed of the amount of return he is receiving from his investment, especially if the investor is taking on additional uncertainty in the form of risk. Thus the measurement of return is of importance to every investor who is aiming to obtain the maximum level of return. Furthermore, without knowing how much return is being obtained (and thus not measuring the level of return from the investment) the investor would not have any information to compare with the level of return of other investments. This will ultimately end with the investor not knowing whether he is receiving the maximum or optimal level of return for the given level of risk. In an investment portfolio setting it is just as important to measure return then risk and thus this section also focused on how to measure or estimate return in such a setting. The measurement of return will also play a very important role in the empirical study in Chapter 6.

Both the two most important elements of portfolio theory and/or management have now been discussed. The question of how these two elements are tied together will be examined in the following section.

3.5 The connection between risk and return

The relationship between risk and return is known as the trade-off and refers to the principle that potential return rises with an increase in risk (Reilly & Brown, 2006:25). Invested money may render higher profits only if it is subject to the possibility of being lost. It is important to note that an investor cannot have the one without the other, thus it can be said that there is an invisible balance between risk and return. The mere thought of risk can give investors sleepless nights as risk is something investors encounter everyday, but through careful financial planning, risk can be managed. In an investment environ-

ment, balancing risk and return can be a complex operation or task as all investors aim to maximise their return (Hattingh, 2004:28).

An important issue to bear in mind, specifically on investments, is that return can be achieved in two ways. The first way involves the appreciation of the share price, thus capital profits. This involves an investor purchasing a share at a price of, for example, R10 per share. The investor then sells the shares for R12 per share thereby making a return or profit of R2 per share (assuming no transaction or brokerage fees and exchange taxes etc.). The second way in which an investor may receive returns is in the form of dividends, but as this study will not focus on this element an example is not needed. The objective for an investor will be to find an appropriate balance between risk and return – one that generates (some or adequate) profit but allows the investor to sleep at night. People differ and because of this, different investors will have different risk profiles or appetites. Investors should and need to determine their individual risk preferences while aiming to minimise their risk exposure at their required rate of return. According to Corgel, Ling and Smith (2001:149) investors are risk averse and because of this, the relationship between risk (as measured by standard deviation) and return is positive. Dobbins *et al.*, (1996:9) stated that “*the capital asset pricing model shows that the expected return of an investment is a positive linear function of market risk (measured by beta)*”.

Investors who are risk averse reject investment portfolios that are fair game (prospects that have a zero risk premium) or worse according to Bodie *et al.*, (2002:157). Thus a risk averse investor will only accept prospects offering a positive risk premium. According to the Markowitz Portfolio Theory, investors have utility curves (see Section 2.5) which are functions of risk and return.

Bodie *et al.*, (2002:157) stated that “[*m*]any particular “scoring” systems are legitimate.” The function below is one often used by the Chartered Financial Analyst Institute and assigns a portfolio with expected return, $E(r)$, and variance, σ^2 , to obtain a utility score (Bodie *et al.*, 2005:168):

$$U = E(r) - 0.005 \cdot A \cdot \sigma^2 \quad (3.18)$$

where:

U = utility score and

A = an index of the investors risk aversion.

Large values of “A” are an indication of a greater degree of risk aversion while the utility score derived in this manner should be compared to the rate of return offered by investments which are risk-free (Hattingh, 2004:28). As this utility score function is not the focus of this study, no further detail will be explored.

In the previous section, both risk and return were discussed as well as the way in which these concepts are linked. It was established that an investor would require or expect a higher level or return for taking on additional risk while investors also have utility curves that are in fact functions of both risk and return. It was also established that due to the fact that people differ, different investors have different risk preferences and/or profiles and thus take on (and/or are comfortable with) different levels of risk.

The next focus of this chapter will be portfolio construction as in the empirical section of this study knowledge of constructing portfolio will be valuable even though this is not the main focus of this study. The risk and return concepts are furthermore both very prominent during the portfolio construction process as well as in the principles of portfolio construction.

3.6 Portfolio Construction

3.6.1 Introduction

It is accepted that investors aim to maximise their return (for a given level of risk), alternatively investors (should) aim to minimise the risk for a given level of return. This is achieved by constructing a portfolio of assets which (as a whole) is subject to the investors’ risk appetite (or profile).

Portfolios do not only include shares and other marketable securities, but items such as real estate, alternative investments (art, coins, antiques, etc.); foreign shares and bonds, etc. (Reilly & Brown, 2006:257).

Investors are risk averse (Section 3.5) and thus the relationship between risk and return is a positive one. It is also true that if investors are faced with a choice between two assets that promise the same level of return the investors will choose the asset with the lower

risk. A higher level of risk will only be accepted by investors if the level of potential return is higher, thus compensating them for taking on a higher degree (or level) of uncertainty (risk). Investors should thus consider different investments based on their specific risk and return “matrix” or profile, when constructing portfolios of diversified nature (Hattingh, 2004:29).

This section will focus on portfolio construction and topics relevant to it and will be put forward in a simple “step-by-step” manner in order to explain the concepts and process easily.

3.6.2 Capital Market Line (CML) construction

The Capital Market Line is the result when the market portfolio and the risk-free asset are combined (Bodie *et al.*, 2005:210).

Bodie *et al.*, (2005:197) stated that the makeup of a portfolio is subject to a number of decisions being made on one of the following three levels:

- The capital allocation – the choice between investing in a risk-free asset and a risky asset portfolio.
- The asset allocation – the distribution of risky investments across different asset classes (construction of the optimal risky asset portfolio) and
- Security selection – the choice of particular securities held within each asset class.

It should be noted that this section is only concerned with the first of the choices named above and that the aim of this section is to find the balance between investing in a risky portfolio and a risk-free asset.

For the purpose of illustration some assumptions need to be made and are as follow:

- Throughout the exercise or illustration the risky portfolio’s composition remains constant.
- The risky portfolio consists of two assets, namely two mutual funds or unit trusts. One of these funds is invested in equities while the other is invested in bonds.

- The risky portfolio's allocation between the two assets is 60% invested in equities and 40% in bonds.
- The allocation or mix between equities and bonds remains constant, while any shift of funds will be from the risky portfolio to the risk-free asset and vice versa.
- The risky portfolio essentially becomes a risky asset and
- Bodie *et al.*, (2005:200) stated that it is acceptable and common practice to view treasury bills as risk-free assets, thus this illustration will comply with this.

For the illustration which follows, the following values will be used:

r_{RA} = return of risky asset.

r_f = return on the risk-free asset, assumed to be 8%.

y = portion (%) of the portfolio invested in asset RA (Risky Asset).

C = the complete portfolio (the total % invested).

$(1 - y)$ = portion (%) of the portfolio invested in the risk-free asset (f).

$E(r_{RA})$ = expected return on the risky asset, assumed to be 20%.

σ_{RA} = standard deviation of the risky asset, assumed to be 27%.

Applying the reasoning and the equations on portfolio return and variance the expected return on portfolio C, which is the complete portfolio, is calculated as follows:

$$\begin{aligned}
 E(r_c) &= [y \times E(r_{RA})] + [(1 - y) \times E(r_f)] \\
 &= y(20) + (1 - y)(8) \\
 &= 8 + 12y
 \end{aligned}
 \tag{3.19}$$

The base rate of the entire portfolio is equal to r_f and the portfolio is expected to earn a risk premium which is dependent on the position of the risky asset and the risk premium of the risky portfolio.

The risk (standard deviation) of the complete portfolio (portfolio C) could be calculated by utilising (Hattingh, 2004:32):

$$\sigma_C = y \cdot \sigma_{RA} \tag{3.20}$$

where:

σ_C = standard deviation of the portfolio,

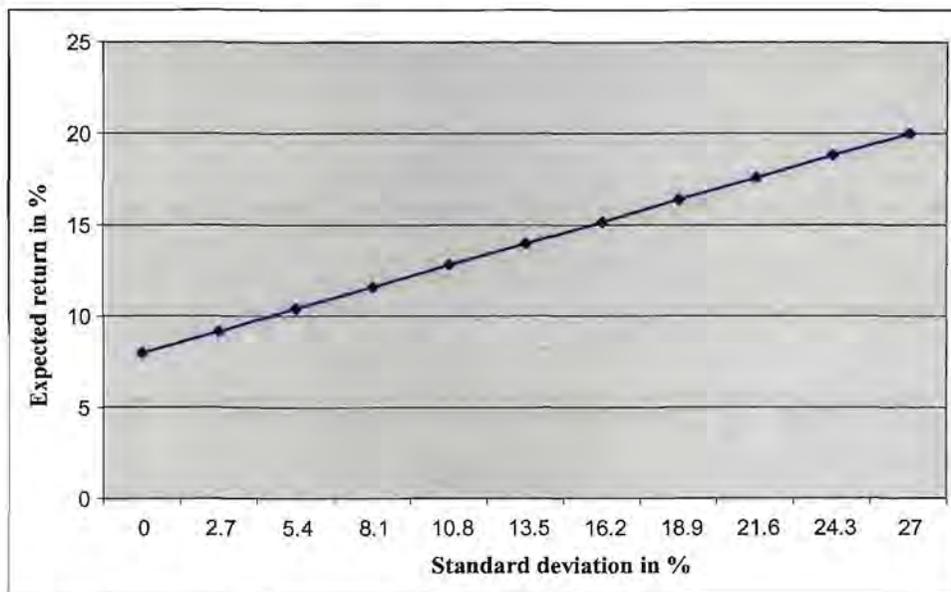
σ_{RA} = standard deviation of the risky asset and

y = weight of risky asset in portfolio.

From Equation 3.20 it can be concluded that the standard deviation or risk of a portfolio will be a function of the standard deviation of the risky asset (RA) and its weighting in the portfolio, when a risky asset and a risk-free asset are incorporated into a portfolio.

Figure 3.3 illustrates the relationship between standard deviation and expected return for the entire portfolio given different weightings in the risky asset (RA).

Figure 3.3: The Relationship between Risk and Return.



Source: Compiled by the author.

Figure 3.3 was constructed using data from Table 3.2.

Table 3.2: Test Data #1.

λ	Standard Deviation (C)	$E(r)$ complete
0	0	8
0.1	2.7	9.2
0.2	5.4	10.4
0.3	8.1	11.6
0.4	10.8	12.8
0.5	13.5	14
0.6	16.2	15.2
0.7	18.9	16.4
0.8	21.6	17.6
0.9	24.3	18.8
1	27	20

Source: Compiled by the author.

Investors need to determine the optimum combination or mix between investing in the risk-free asset (F) and the risky asset (RA) after determining the CML (as shown in Figure 3.3).

Assuming three different risk aversion levels (A levels), namely five, three and one, and then by combining these A levels with the information in Table 3.2, the following utility levels (U) can be calculated (Equation 3.18 is used to calculate the U as discussed in Section 3.5).

It is apparent that the optimum level of investment in the risky asset (RA) will differ as the risk aversion level (A level) changes (see Table 3.3). A level of $A = 5$ represents a relatively high risk aversion while an A level of 1 is indicative of an investor with a large risk appetite and thus less risk averse compared to that of a level 5 investor.

Table 3.3: Test Data #2.

Y	A=5	A=3	A=1
0	8	8	8
0.1	9.018	9.091	9.164
0.2	9.671	9.963	10.254
0.3	9.96	10.616	11.272
0.4	9.884	11.05	12.217
0.5	9.444	11.266	13.089
0.6	8.639	11.263	13.888
0.7	7.47	11.042	14.614
0.8	5.936	10.602	15.267
0.9	4.038	9.943	15.848
1	1.775	9.065	16.355

Source: Compiled by the author.

Based on the data presented investors with an A level equal to 5 should use a weighting of approximately 30% in the risky asset while an investor with an A level of 3 should carry approximately 60% in the risk-free asset. The weighting for A = 1 should be 100% in asset RA.

The following equation may be used to calculate the maximum utility level (Hattingh, 2004:34):

$$MaxU_y = E(r_c) - 0.005A\sigma_c^2 = r_f + (y \times (E(r_p) - r_f)) - 0.005Ay^2\sigma_p^2 \quad (3.21)$$

Equation 3.21 should be differentiated as follows (Hattingh, 2004:35):

$$y^* = \frac{E(r_p) - r_f}{0.01A\sigma_p^2} \quad (3.22)$$

In order to calculate the optimum weightings the relevant information must thus be substituted into Equation 3.22:

A = 5: 32.9% in the risky asset and 67.1% in the risk-free asset.

A = 3: 54.9% in the risky asset and 45.1% in asset F.

A = 1: 100% in the risky asset.

This section focused on capital allocation as it is a part of the makeup of a portfolio. This was done by using an illustrative example (“step-by-step”) of how an investor, with a specific risk preference or profile, would go about allocating capital in both the risky and risk-free asset. The following section will continue with this discussion by expanding on the process of portfolio construction. An investor would like to hold an optimal portfolio and thus the subsequent section will focus on this topic while the part that diversification plays in portfolio management becomes very apparent in this next section.

3.7 Diversification

3.7.1 Introduction and overview

This section will consider the determination of the optimal balance or mix between the risk-free asset and the “optimal” risky portfolio. Besides defining diversification other topics that will be touched on include: the origin and use of diversification, benefits of diversification and methods of diversification.

3.7.2 Definition of diversification

Since the origin of portfolio design (currently known as Modern Portfolio Theory), diversification has been a central theme with one of its core objectives being combining assets into the portfolio (Markowitz, 1952). The risk faced by investors can be altered by diversifying the portfolio. In other words, some of the risk present in the portfolio can be eliminated by holding different assets (with imperfect correlations) in the portfolio (Hattigh, 2004:35).

Diversification is, by definition, a portfolio strategy designed to reduce exposure to risk by combining different assets with low correlation of return (Reilly & Brown, 2006:70).

Gopi *et al.*, (2006:1) defines a well diversified portfolio as “*one where the return, and consequently the risk, arises from as many unrelated (or independent) sources as possible.*”

Dobbins *et al.*, (1996:12) stated that spreading risk, i.e., diversification, makes sense, as it removes unique, specific or diversifiable risk.

A key characteristic of diversification is that it reduces both downside and upside potential which results in a more consistent performance. This characteristic is the result due to not all the returns of the asset classes changing at the same time and rate (Hattingh, 2004:36). The following sections of the chapter will focus on different aspects of diversification, including the origin, use and benefit thereof.

3.7.3 Origin of diversification

Diversification is a common sense concept with the theoretical foundations introduced by Markowitz (1952, 1959) and confirmed by Sharpe (1964). According to Lhabitant and Learned (2002:26), Markowitz's initial assumption highlighted the fact that most of the concern surrounding a portfolio was regarding only two elements of a portfolio, the expected return and the risk of the portfolio. The mean rate of return measured the expected return while the risk was measured by the standard deviation. Lhabitant and Learned (2002:26) stated that a quadratic programming algorithm was suggested by Markowitz to calculate the optimum combination of assets of a portfolio. This was done, because when assets were combined in a portfolio their correlation often determines the largest part of the total risk, rather than the individual volatilities. Due to the lack of computing power in the 1950's this algorithm was considered useless but the formulation did, however, contribute directly to the Capital Asset Pricing Model (CAPM) which was introduced by Sharpe (1964), Lintner (1965) and Mossin (1966). The respective work done by Sharpe (1964), Lintner (1965) and Mossin (1966) outlined the partitioning of risk into systematic- and unsystematic risk.

The diversification term has been defined and its origin discussed, but diversification has other uses. The following section will focus on answering the question of the benefits surrounding diversification.

3.7.4 Use of diversification

The definition of portfolio diversification stated that it is a portfolio strategy which reduces the risk exposure by combining different assets within a portfolio (which returns

are unlikely to move in the same direction) (Investorwords, 1997c:1). The primary key to the successfulness of this strategy is a low correlation between the returns of the portfolio's assets. For instance, if a portfolio consists of two assets namely share A and share B, the correlation between the returns of share A and share B should be as low as possible if diversification is the goal. By minimising the correlation between the returns of share A and share B, the portfolio manager or investor achieves lower volatility in the portfolio returns (Hattingh, 2004:41).

In order to diversify successfully two aspects are of the utmost importance. The first being that the investment returns should not move together, thus the investment returns should have a low or negative correlation. Furthermore, the degree of diversification increases as the number of the investments or securities in the portfolio increases (Smith, 2006:7), but only to a specific point which will be touched on in Section 3.7.9. Mutual funds² also often provide greater diversification than individual securities while index³ funds are an alternative to mutual funds. The topic of indices will be focused on in Section 3.9.2., while the discussion surrounding the use of diversification continues with the outlining of diversification types.

Two types of diversification can be identified (Keffer, 2003:1):

- Effective diversification: Effective diversification is merely when the asset returns move in opposite directions.
- Ineffective diversification: Ineffective diversification is the opposite of effective diversification and refers to the situation in which the asset returns move in the same direction.

The two types of diversification, named above, merely indicates that the process of diversification can either be effective, i.e., successful or ineffective, i.e., not successful. Diversification is used by many investors and/or portfolio managers whom wish to reduce the risk exposure in their respective portfolios.

² Mutual funds pool the funds of investors while investors receive a prorated share of the total funds in proportion to the size of their investment (Reilly & Brown, 2006:65).

³ An index fund mimics the performance of the index it is named after (its portfolio composition is identical to the index) (Bodie *et al.*, 2005:52).

3.7.5 How diversification affects the portfolio

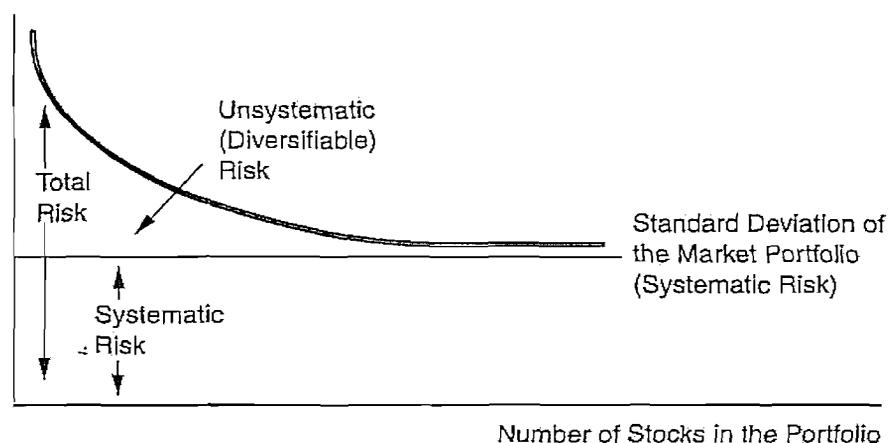
Correia *et al.*, (2003:4-1) stated that when an investment is made by an investor at a certain time, no certainty exists regarding which investments will fail and which will succeed. In this situation it is most sensible to diversify into a number of (different) investments in the expectation that the successful investments will at least compensate (the investor) for the investments that were not successful. Hattingh (2004:39) concluded that diversification is the simplest (though not the most exact) form of hedging.

Furthermore, Correia *et al.*, (2003:4-15) stated that the process of diversification has the effect of reducing the variability of portfolio returns while this opinion is shared by Hattingh (2004:39) by stating that when various assets, with “imperfect correlations” are included into a portfolio it will reduce the general level or risk of that particular portfolio.

The diversification process ultimately serves to eliminate all unique or unsystematic risk from a portfolio although the standard deviation (of a portfolio) will eventually reach the level of the market portfolio (where all unsystematic risk will be diversified away), but systematic risk (market risk) will still remain.

Figure 3.4 illustrates the effect of diversification on the risk level of a portfolio.

Figure 3.4: Systematic and Unsystematic risk.



Source: Reilly and Brown (2000:293).

The objective of diversification is to eliminate unsystematic risk from an investment portfolio, systematic risk, however, will still remain as it can not be diversified away. The

following section focuses on systematic and unsystematic risk as it is directly connected to diversification of an investment portfolio.

3.7.6 Systematic versus unsystematic risk

Before attention is turned to the discussion regarding systematic versus unsystematic risk it is important to note that risk can be divided into financial and non-financial risk. Non-financial risk is also referred to as pure risk and is the exposure to uncertainty which has a non-monetary outcome (Marx *et al.*, 2006:7). Individuals face this type of risk everyday like smoking (health risk) and speeding (safety risk). The distinguishing factor between non-financial risk and financial risk is the fact that there can be no financial benefit from an increased exposure to non-financial risk. Financial risk is the probability of an event which will have a negative financial implication, thus a loss. This type of risk is associated with investments, as investors face the risk of an unexpected decline in the value of their investments (Marx *et al.*, 2006:7).

Now that financial risk has been distinguished from non-financial risk the focus will turn to systematic versus unsystematic risk. There are two types of risk with regard to a portfolio of assets, namely (Marx *et al.*, 2006:6):

- Systematic risk.
- Unsystematic risk.

Systematic risk influences a large number of assets as it has a market-wide effect. Examples of systematic risk include interest rates, inflation and Gross Domestic Product (GDP) as these are general economic conditions which affect nearly all companies to some degree, as was mentioned above (Marx *et al.*, 2006:6). This type of risk can not be diversified away and is also known as non-diversifiable risk.

“Unsystematic risk is unique or asset specific risk that influences a single asset or a small group of assets” (Smith, 2006:5). News that is specific to one share or a group of companies, such as the loss of a patent is an example of unsystematic risk. The reasoning behind this is that factors that influence one asset will not necessarily affect other assets in the same manner and the result of the influence on all the assets should counteract one another (Hattingh, 2004:36). Systematic risk can, however, be diversified away.

Thus diversification is the process of constructing a portfolio in such a way or manner that the portfolio contains or consists of different types of assets with the specific objective of eliminating the risks associated with any individual assets. According to Correia *et al.*, (2003:4-15) investors will hope that the variability of a particular asset's returns will be offset (to some degree) by the variability of another asset's returns in the portfolio.

3.7.7 Methods of diversifying

There are seven ways in which investors can diversify a portfolio. These are (Hattingh, 2004:37; Anon, 2007:1):

- Diversify across different asset classes,
- Investors should gain exposure to different sectors of a market,
- Investors should gain exposure to different entities (providers, suppliers) within the same market sector,
- Investors should diversify the portfolio by exposing the portfolio to different investment styles,
- Diversify the portfolio across different investment avenues,
- Investors should also gain global exposure, and
- Investors should diversify across time horizons.

Each of the manners named above will be briefly elaborated upon.

- **Different asset classes**

This is the first step in diversifying a portfolio and requires the investor to allocate the funds in his portfolio to different assets, such as shares, fixed income securities (instruments), gold and real estate. The selection between the different assets constitutes the first tier of confinement to the investor's risk preference according to Hattingh (2004:37). This method of diversification works as the risk associated with different assets is not of the same magnitude, thus this method grants stability to the portfolio by making it resistant to the unpredictability and eradication of the market.

Hattingh (2004:37) states that different assets respond differently to the same variable, like an interest rate change for example. The idea is that assets should be entirely autonomous in their movement and/or response to influencing factors. This, however, ideal is not the case very often as there tends to be some form of inter-relation between the movements of different asset classes (Hattingh, 2004:37).

- **Different market sectors**

This method focuses on investing in different sectors or industries within a particular market. This manner of diversification is supported by Reilly and Brown (2000:440) in their discussion relating to the Top-down approach to equity valuation by stating that: “*alternative industries react to economic changes at different points in the business cycle.*” Thus exposure to different sectors within a market will ease or lessen the effect of the change of a particular variable on the investor’s portfolio (Hattingh, 2004:38).

- **Different entities**

Investors whom invest in different entities within the same industry reduce the effect of risk associated within a specific entity, such as financial- and business risk. Thus investors should ensure that their investments are spread across various asset management companies, for example, as it will not only lessen the financial- and business risk but provide exposure to different investment styles and processes (Hattingh, 2004:38).

- **Different investment styles**

Investors whom gain exposure to different investment styles eliminate or reduce the bias nested in a single investment style and this should produce better investment decisions and also better diversification (Hattingh, 2004:38).

A number of investment styles exist which will provide the investor with the opportunity of making investment decisions. Some of these include (Mitchell, 2006:1):

- Growth,
- Value,
- Momentum,
- Income,

- Capatilisation,
- Fundamental,
- Investment based on technical analysis, and
- Event driven investment.

- **Different investment avenues**

There is a need to diversify across investment avenues, paths or approaches within each asset class (Anon, 2007:1). An example of this is for the investor or portfolio manager with an equity portfolio to structure the portfolio with direct equity investments, investments in mutual funds (unit trusts) and insurance plans. An insurance portfolio could, for example, hold a combination of endowment plans and term plans (Anon, 2007:1).

- **Gain global exposure**

In the sophisticated state of financial markets, investors now have the option to invest globally with ease.

Reilly and Brown (2006:79) stated that for an investor to gain exposure to assets both locally and internationally will “*almost certainly reduce the risk of the portfolio and can possibly increase its average return.*”

- **Different time horizons**

Each investment portfolio that is held by an investor should ideally serve or feed to a specific need (of the investor) but also run over an appropriate and corresponding time horizon or period (Anon, 2007:1). For example, investors could have short-term, medium-term and long-term goals and each of these goals should be supported by a portfolio with the investments contained in these portfolios aligned with the corresponding time frames. Fixed income instruments could, for instance, dominate the short-term portfolios (Anon, 2007:1).

3.7.8 Benefits of diversification

Like any method, diversification must have some sort of benefit(s) to justify its use. Section 3.7.7 discussed different methods of diversification while the previous section’s fo-

cus was on the effect diversification has on a portfolio. The benefits of diversification include:

- The potential to increase long term returns through minimising risk. By reducing market volatility, a negative effect, the risk in the portfolio is minimised (AIM, 2000:2).
- The effect of a single adverse price movement is lessened (by diversification) due to the fact that the loss will be offset by the gains made on other assets (Hattingh, 2006:41).
- The structuring of portfolios in a manner that ultimately reflect the investor's risk profile and thus allows the investor to plan his financial position (Hattingh, 2004:41).
- Peace of mind for the investor (AIM, 2000:2).

Hatting (2006:41) stated that it is important to note that in order to gain the maximum amount of diversification it is advisable (for investors) to include assets in their portfolio with low positive or negative correlations.

In Section 3.6.3.3 diversification and its definition have been discussed. Information presented to the market, however, has a varying impact or effect for each share and the prices of these shares exhibit different behavioral characteristics. The fact that the prices of the shares are not perfectly correlated means that the risk exposure can be reduced if the investor so wishes. The risk relation between shares can be identified by studying the volatility of returns for each share over a period of time. These shares need to be combined into a portfolio and the standard deviation of the portfolio needs to be re-calculated. The benefit of diversification can be more clearly expressed by means of an illustration of the characteristics of a portfolio containing three prominent US shares. It is important to note that in Table 3.4 the combinations of the return of two shares, for example, IBM and Alcoa is 50% of each, thus 50% IBM and 50% Alcoa.

Table 3.4: Monthly returns on three prominent United States shares (in percent).

Month	IBM	Alcoa	GM	IBM & Alcoa	GM & Alcoa	GM & IBM
1	12.05	14.09	25.2	13.07	19.65	18.63
2	15.27	2.96	2.86	9.121	9.12	9.07
3	-4.12	7.19	5.45	1.54	1.54	0.67
4	1.57	24.39	4.56	12.98	12.98	3.07
5	3.16	0.06	3.72	1.61	1.61	3.44
6	-2.79	6.52	0.29	1.87	1.87	-1.25
7	-8.97	-8.75	5.38	-8.86	-8.86	-1.8
8	-1.18	2.82	-2.97	0.82	0.82	-2.08
9	1.07	13.97	1.52	-6.45	-6.45	1.3
10	12.75	-8.06	10.75	2.35	2.35	11.75
11	7.48	-0.7	3.79	3.39	3.39	5.64
12	-0.94	8.8	1.32	3.93	3.93	0.19
Mean Return	2.95	2.95	5.16	2.95	4.05	4.05
σ	7.15	10.06	6.83	6.32	6.69	6.02

Correlation coefficients

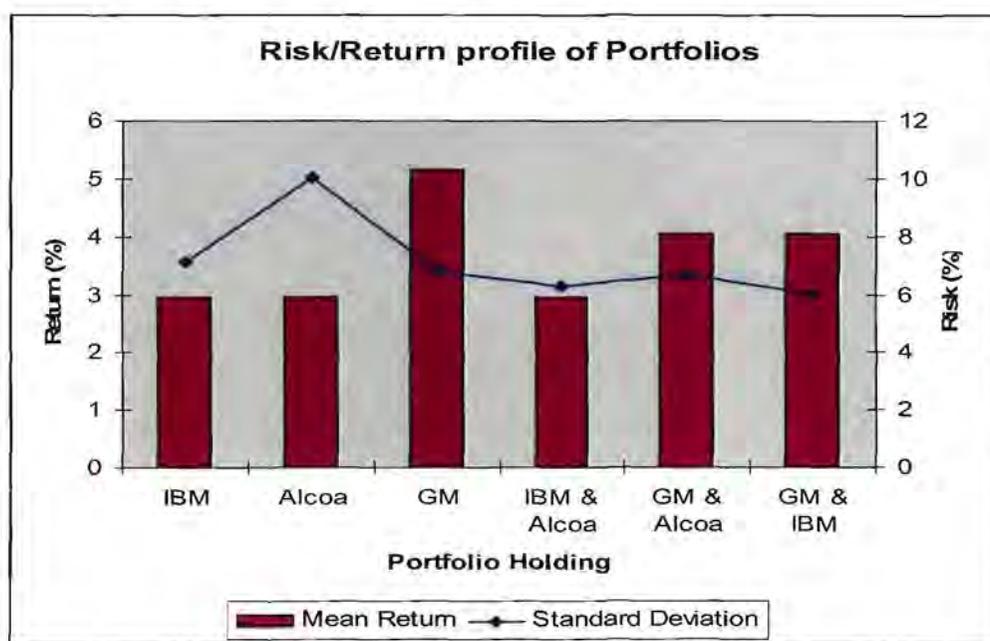
IBM & Alcoa	0.05
GM & Alcoa	0.22
GM & IBM	0.48

Source: Elton *et al.*, (2003:52):

Figure 3.5 illustrates the relationship between the characteristics of risk and return of alone standing investments and a portfolio of shares. Figure 3.5 shows that, for a given level of return, the overall risk of the investment is reduced by combining shares in a portfolio. This fact is indicated by the lower differential between the mean and the standard deviation in the combined portfolio. A specific scenario can be illustrated by study-

ing Table 3.4 above. The portfolio comprising of IBM and Alcoa has a standard deviation of 6.32%, which is less than 8.6%, the simple weighted average of the standard deviation of the shares individually (assuming an equal weighting in the portfolio).

Figure 3.5: Risk/ Return profile of portfolios.



Source: Elton *et al.*, (2003:52).

The “imperfect” correlation (of 0.5) between the share returns reduces the overall level of risk in the portfolio. Thus the benefits of diversification become greater when the correlation between share returns become lower. The purpose of diversification is thus to reduce the standard deviation of the total portfolio (Hattingh, 2004:35).

Investors can diversify away unsystematic risk, according to the CAPM and its restrictive assumptions, with no reward for bearing such risk and so diversification plays a central theme or role in portfolio construction. Investors, however, give little attention to the degree of diversification required, but accept that it is necessary to achieve a well balanced portfolio and put their minds at ease (Rudin & Morgan, 2006:81).

The subsequent section will focus on the concept of concentration and the effect it has on an investment portfolio, but also how it affects the portfolio’s diversification.

3.7.9 Concentration

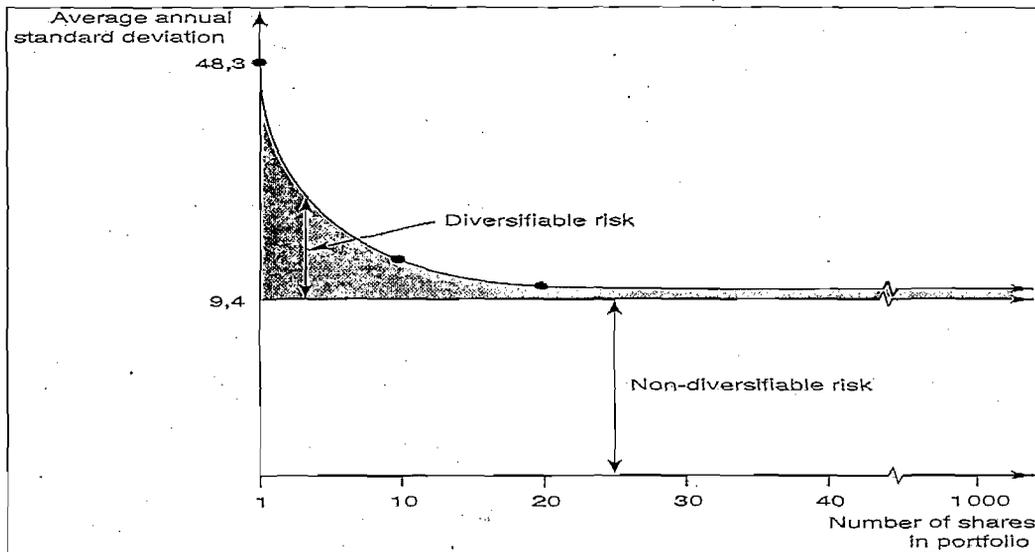
The preceding section explains that the purpose of diversification is to reduce the risk exposure of a portfolio by combining different assets which have low correlation in terms of returns. It should, however, be noted that diversification assumes a portfolio of shares with imperfect correlations (Elton *et al.*, 2003:51). When considering this assumption, the average covariance of the portfolio decreases as the number of shares in the portfolio increase, hence the portfolio risk is reduced. The aim of this section is to discuss concentration, thus the question which investors also ask is: How many shares are needed to construct a completely diversified portfolio?

According to Smith (2006:6) concentration refers to "*the extent to which portfolio weights skew away from an equally weighted portfolio*". Statman (1987:362) is of the opinion that a portfolio consisting of at least 30 shares for a borrower and 40 shares for an investor is sufficient for it to be well diversified. Smith (2006:7) stated that the standard deviation of the portfolio matches the standard deviation of a market portfolio, where all the unsystematic risk has been diversified away, when the portfolio consists of around 20 shares. This results in all the unsystematic risk being diversified away and is illustrated in Figure 3.6. Mitra and Gassen (1981:565) found that a 15 share portfolio diversified away most of the unsystematic risk and that the portfolio's total risk approached the risk of the market portfolio, which by definition only contains systematic risk.

Earlier results regarding the amount of appropriate shares included in the portfolio do not concur with the results obtained by Statman (1987). Most of these studies are based on simulations of equally weighted portfolios (Smith, 2006:7) and are of the opinion that the benefits of diversification for portfolios are exhausted when the number of shares reaches 10 or 15 (Statman, 1987:362). This is supported by Evans and Archer (1968) in that the benefits of diversification are virtually exhausted when a portfolio contains approximately 10 shares. By the discussion thus far regarding the minimum number of shares that a portfolio should contain to reduce most of the unsystematic risk, it is clear that there is no concrete number and/or conclusion. For further reading regarding concentration see Gassen and Mitra (1981), Statman (1987) and Evans and Archer (1968). It is, however, important to note that when perfect positive correlation exists between individual shares,

no reduction in risk is achieved and furthermore that although perfect negative correlation can totally eliminate portfolio risk, such a situation is rarely found.

Figure 3.6: Number of shares in a well diversified portfolio.



Source: Smith (2006:7).

It is also known that the risk of a portfolio is related to the covariance of the underlying assets and the portfolio weighting structure (Bradfield & Kgomari, 2004). This weighting structure of the portfolio is a determinant factor of the portfolio's concentration.

Concentration can be measured by implementing the Herfindahl-Hirschman Index (HHI) according to Hovenkamp (1993:332), although the Richard Roll measure is also a concentration measure. The HHI (see Section 3.7.10.2) is, however, better known and widely used in academic literature (Smith, 2006:8).

The subsequent section will focus on different diversification measures while the calculation of concentration will also be discussed as this sections' discussion showed that portfolio concentration influences diversification of a portfolio to some degree.

3.7.10 Measuring diversification

Today's volatile share market reinforces the importance of diversification while the popularity of mutual funds (unit trusts) indicates investors' interest in being diversified. How

do investors, however, know if they are diversified (or how is the diversification of a portfolio measured).

As explained in Section 3.7, an investor should use diversification among several assets and asset classes to enhance returns and also reduce risk, because investments in different assets do not generally move together. Although investors accept and realise that diversification is a necessity they give little attention to the amount of diversification necessary.

3.7.10.1 Traditional diversification measures

Measures of diversification are, at the extremes, either naïve or very technical. Sharpe, for example, introduced a complex measure of portfolio diversification in 1972 that may be difficult for investors to interpret and apply. This portfolio diversification by Sharpe requires estimates of each share or security's non-market risk relative to that of a typical share or security (Cresson, 2002:3). The problem is that values of relative non-market risk are not freely available.

Traditionally, diversification is measured relative to a market index by regressing the portfolio returns against the market index (Gopi *et al.*, 2006:4). This is arguably the most widely used measure of diversification. The residual variance represents the extent of diversification still achievable in the particular portfolio. The smaller the residual variance, the more diversified the portfolio (Gopi *et al.*, 2006:4). However, if the market itself is not well diversified this traditional method used in practice provides an imperfect result (Smith, 2006:3). This tends to be even more so in highly concentrated markets, of which South Africa is such a market. The Portfolio Diversification Index (PDI), which is a quantitative measure of diversification, overcomes the problem of market influence. The PDI will be touched on in Section 3.7.10.3.4 as the different manners in which to measure diversification is discussed in this section. The PDI will, however, be discussed in detail in Chapter 5.

Another approach which aims to provide diversification info of a portfolio uses a correlation matrix of asset historical returns (Dopfel, 2003; Toikka *et al.*, 2004) while another method uses a number of cluster analyses (Lhabitant, 2004). These methods are unfortunately not of great use to the investor as not one of them delivers a quantitative measure of portfolio diversification.

3.7.10.2 Herfindahl-Hirschman Index (HHI)

The Herfindahl-Hirschman Index (HHI) is commonly accepted as a measure of concentration (Smith, 2006:8). The HHI is calculated by squaring the investment weights of each share or security in a portfolio and then summing the results. The HHI is computed as follows (Smith, 2006:8):

$$HHI = \sum_{i=1}^N W_i^2 \quad (3.23)$$

where:

N is the number of assets and

W_i the weight of the i th share in the portfolio.

3.7.10.3 Other diversification measures

3.7.10.3.1 Concentration Coefficient

The Concentration Coefficient (CC) measures portfolio concentration in terms of asset weights (Gravity Investments, 2007a:1). The CC is defined as (Gravity Investments, 2007a:1):

$$CC_i^P \equiv \frac{1}{\sum_{i=1}^N (w_{i,t}^P)^2} \quad (3.24)$$

where:

P = the portfolio,

N = the number of assets in the portfolio and

$w_{i,t}^P$ = the weight of the i th share in the portfolio at time t .

An equally weighted portfolio will have a CC equal to the number of assets while as the portfolio become more concentrated in certain assets the CC will proportionally decline.

3.7.10.3.2 Intra-Portfolio Correlation (IPC)

This method is a manner in which to quantify diversification and uses a weighted average intra-portfolio correlation. The statistic is calculated as follows (Gravity Investments, 2007b:1):

$$IPC = \frac{\sum_i \sum_j X_i X_j p_{ij}}{\sum_i \sum_j X_i X_j} \quad i \neq j \quad (3.25)$$

where:

IPC = the intra-portfolio correlation,

X_i = the fraction invested in asset i ,

X_j = the fraction invested in asset j and

p_{ij} = the correlation between asset i and j .

The IPC has a range from -1 to 1, with -1 being indicative of the most diversified and 1 being the least. The summation of all unrivalled non-diagonal values in the matrix is represented by the numerator while the denominator represents the portfolio weight minus the weight of unimportant diagonal weights. According to Gravity Investments (2007b:1) this is the case as diagonal weights apply only to assets themselves and not to the assets' relationships.

The IPC takes on the range of correlation value and can ultimately be conveyed in a relative format (percentage) in order to be uniform and for the sake of simple and easy reading. Table 3.5 presents an example of what a specific IPC value translates to, in terms of the percentage diversifiable risk removed (from the portfolio).

Table 3.5: IPC values.

IPC	% of diversifiable risk removed
1	0.00%
0.75	12.50%
0.5	25.00%
0.25	37.50%
0	50.00%
-0.25	62.50%
-0.5	75.00%
-0.75	87.50%
-1	100%

Source: Gravity Investments (2007b:1).

3.7.10.3.3 IPC3

According to Gravity Investments (2007c:1) the IPC3 is perhaps the best single measure of diversification. It computes the concentration coefficient and then calculates a concentration coefficient of the IPC values. This result or value obtained renders a basis for comparing portfolio diversification among different portfolios (Gravity Investments, 2007c:1). The CC (Section 3.7.10.3.1) can rationalise for security risk but not market risk while the IPC (Section 3.7.10.3.2) can account for market risk but not for security risk. Gravity Investments (2007:1) stated that a proper measure should account for both, since both these risks are diversifiable.

The IPC3 takes the following form (Gravity Investments, 2007c:1):

$$IPC3 = \frac{CC}{(1 - IPC\%)} \quad (3.26)$$

where:

CC is the Concentration Coefficient as calculated by the CC (Section 3.7.10.3.1) and

IPC is the Intra-Portfolio Correlation as calculated by the IPC (Section 3.7.10.3.2).

3.7.10.3.4 Portfolio Diversification Index (PDI)

This section on the PDI will briefly discuss this relatively new measure as it is a method to measure the degree of diversification. It will, however, be discussed in more detail in Chapter 5.

As explained in Chapter 1 and in Section 3.7.10.1, the problem with diversification measures is that they are not free from the influences of the market index.

A relative new measure of diversification, PDI, evaluates the diversification of a portfolio quantitatively and also overcomes the problem of market influence faced by other methods (Gopi *et al.*, 2006:4).

A diversification measure which is free from market influence of any market indices was proposed by Rudin and Morgan (2006). This measure, known as PDI, is constructed using principal component analysis (PCA). “*The PCA quantifies the number of truly independent factors in a portfolio*” (Smith, 2006:12). The diversification properties of a portfolio are then conveyed by means of the relative strength of these factors (Smith, 2006:12).

The PDI enables portfolio managers to compare diversification across different portfolios and/or over different time periods, while also ascertaining whether the addition of new securities improve diversification of a specific portfolio and by how much. The equation for the PDI is as follows (Rudin & Morgan, 2006:82):

$$PDI = 2 \sum_{k=1}^N kW_k - 1 \quad (3.27)$$

where:

N is the number of assets and

W_k is the percentage contribution of factor k to total volatility.

This section has focused on different methods to measure diversification albeit some being relatively new and others being mainly used through sophisticated computer programmes, like the IPC and IPC3 measures. This section does, however, carry a great deal of importance as diversification will be continuously measured in the empirical study.

Diversification in the broader sense has now been thoroughly discussed along with relevant and important topics. The following section will focus on the construction of portfolios, specifically the construction of the optimal risky portfolio. A portfolio consisting of two assets will firstly be focused on where after the focus will shift towards the construction of complete portfolio's.

3.8 Construction of the optimal risky portfolio

3.8.1 Introduction

This section will continue in line with Section 3.6 and 3.7 as it discusses the optimal balance between the risk-free asset and the “optimal risky portfolio”. Firstly, the effects of diversification on a portfolio containing two assets (excluding a risk-free asset) will be adjudicated. Thereafter, a portfolio which includes a risk-free, asset will be constructed. It is important to note that this discussion is important as the principles of portfolio construction are valuable to portfolio management. This section is of value as it clarifies (from a different viewpoint) how risk and return interact in a portfolio setting. Furthermore, it is important to understand the effects that both a risky and a risk-free asset have in an investment portfolio and how it affects the investor or fund manager. This section can thus be seen as a discussion on how to construct an investment portfolio in an optimal manner to suit a specific risk preference.

3.8.2 Portfolio of two assets

The following assumptions are made for this section:

- The portfolio consists only of an equity portion or asset (E) and a debt portion or instrument (D).
- The debt asset has an expected return, $E(r_d)$, of 14% and a standard deviation, σ_d , of 22%.
- The equity asset has an expected return, $E(r_e)$, of 9% and a standard deviation, σ_e , of 14%.
- The assets have a covariance of 72.

- The correlation coefficient (ρ) is 0.30.

Using the equations for calculating the portfolio's expected return and its standard deviation, Table 3.6 was produced.

Table 3.6: Standard deviation for given correlations and weights.

Wd	We	E(r) portfolio	Correlation = -1	Correlation = 0.0	Correlation = 0.30	Correlation = 1
0%	100%	14.00%	22.00	19.85	22.00	22.00
10%	90%	13.50%	18.40	19.85	20.26	21.20
20%	80%	13.00%	14.80	17.82	18.63	20.40
30%	70%	12.50%	11.20	15.96	17.13	19.60
40%	60%	12.00%	7.60	14.34	15.81	18.80
50%	50%	11.50%	4.00	13.04	14.70	18.00
60%	40%	11.00%	0.40	12.17	13.87	17.20
70%	30%	10.50%	3.20	11.82	13.36	16.40
80%	20%	10.00%	6.80	12.03	13.20	15.60
90%	10%	9.50%	10.40	12.79	13.43	14.80
100%	0%	9.00%	14.00	14.00	14.00	14.00

Source: Compiled by the author.

In Table 3.6 Wd represents the weight of debt in the portfolio while We is representative of the weight of equity in the portfolio. From Table 3.6 it is clear that the following weights are the optimum⁴ weightings for the given correlation:

Correlation = -1 : Approximately 60% debt and 40% equity.

Correlation = 0 : Approximately 70% debt and 30% equity.

Correlation = 0.30 : Approximately 80% debt and 20% equity.

The weights above provide a brief estimation of what percentage an investor should invest in each of the asset classes (equity and debt) according to the correlation at hand, in

⁴Optimum weights refer to the fact that the weights represent the minimum standard deviation of the portfolio.

order to invest optimally and/or achieve an optimal portfolio. These weights were drawn from Table 3.6 (the highlighted areas). For example, if an investor had R1000 to invest he would thus invest 70% in debt and 30% in equity (assuming a correlation of 0).

The following equation may be used for determining the minimum variance portfolio weighting to a more precise level (Hattingh, 2004:42):

$$W_{\min}(\text{Asset}_d) = \frac{\sigma_e^2 - \text{Cov}_{de}}{\sigma_d^2 + \sigma_e^2 - 2\text{Cov}_{de}} \quad (3.28)$$

$$W_{\min}(\text{Asset}_e) = (1 - W_{\min}(\text{Asset}_d)) \quad (3.29)$$

where:

W is the weight of the asset in the portfolio,

σ_x^2 is the variance of asset x and

Cov_{de} is the covariance between asset d and asset e .

By using Equations 3.28 and 3.29 the minimisation problem can be solved and yields the optimum weightings given the correlation as follows:

Correlation = -1 : Approximately 67.5% debt and 32.5% equity.

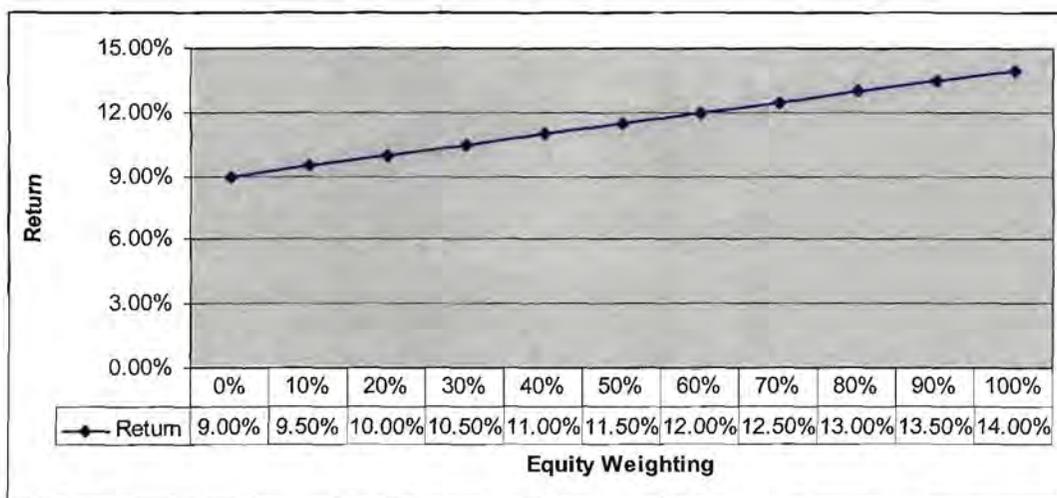
Correlation = 0 : Approximately 71.1% debt and 28.9% equity.

Correlation = 0.30 : Approximately 76.9% debt and 23.1% equity.

These percentages thus indicate more precisely how much an investor must invest in each of the two asset classes in order to construct and “balance” the portfolio optimally. For example, if an investor had R1000 to invest, he would invest 71.1% in debt and 28.9% in equity (assuming a correlation of 0).

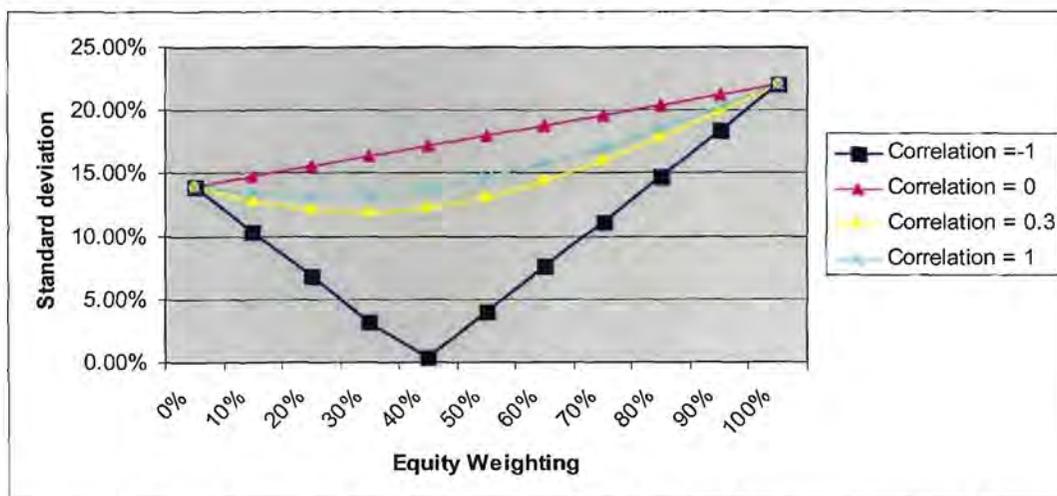
Figure 3.7 illustrates a graphical representation of the expected return on the total portfolio for the different weightings while Figure 3.8 is a representation of the standard deviation of the complete portfolio for different weightings in the assets.

Figure 3.7: Expected return of the portfolio assuming different equity weights.



Source: Compiled by the author.

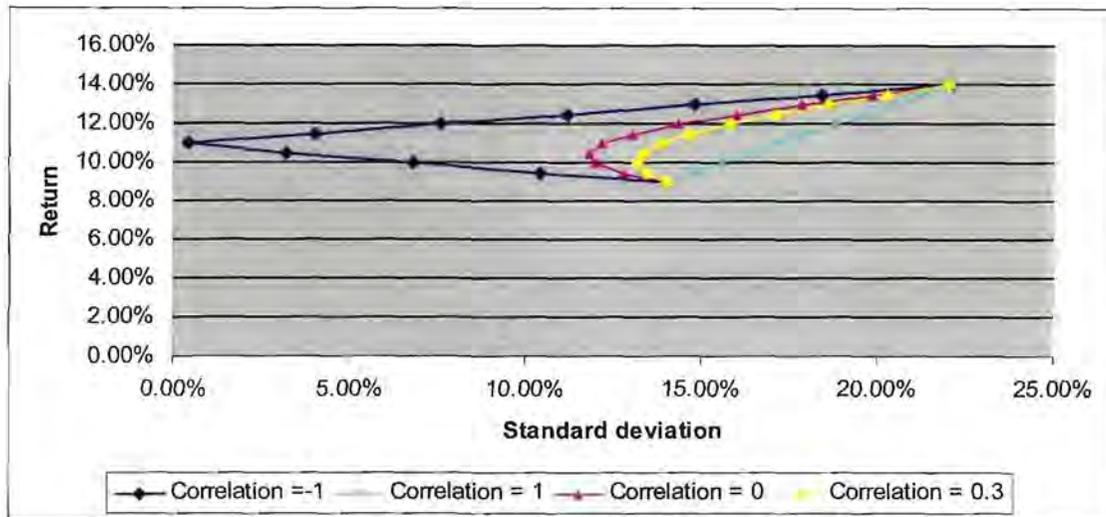
Figure 3.8: Standard deviation of the portfolio assuming different equity weights.



Source: Compiled by the author.

The information in Figure 3.7 and Figure 3.8 is combined into Figure 3.9. Figure 3.9 allows investors to target the portfolios which provide the highest return for a given level of risk or those portfolios that provide the lowest level of risk for a given level of return. Figure 3.9 thus represents the Markowitz efficient frontier.

Figure 3.9: Efficient frontiers given different correlations.



Source: Compiled by the author.

The discussion of this section showed that the capital allocation between different asset classes can easily be determined in order to achieve the highest level of return for a given level of risk. This is important as any rational investor would like to receive the highest return for the level of risk taken on while this process or calculation shows how to construct an investment portfolio to achieve this. The following section will expand on this section by adding a risk-free asset to the equation.

3.9 Constructing complete portfolios

3.9.1 Introduction

Under normal circumstances investors will have to construct the optimal risky portfolio and combine it with the risk-free asset to construct a complete portfolio as investors are not just faced with the option of investing in either the risk-free asset or the risky portfolio.

The risky opportunity set with the highest feasible payoff between risk and return will form a tangent with the CML (Section 3.5.2). The aim of this process or exercise is to identify the invested weight in equity and debt which results in maximising the slope of the CML. If this is achieved the investment portfolio will be optimally constructed or set-

up and the investor will receive the highest level of return for a given level of risk, which is determined by the investor.

3.9.2 Determining the weights

The subsequent mathematical procedure may be used to solve the problem of determining the weighting between equities and bonds. It should be noted that the same assumptions with regard to the covariance, variance and the expected return as mentioned in Section 3.8.2 will be used in this exercise. A further assumption is made that the risk-free asset has a yield return of 6%.

The objective function will be (Bodie *et al.*, 2005:203):

$$\text{Max } S_p = \frac{E(r_p) - r_f}{\sigma_p} \quad (3.30)$$

where:

S_p is the slope of the CML.

The following equation may be used to calculate the expected return of the risky portfolio (Bodie *et al.*, 2005:237):

$$E(r_p) = W_d E(r_d) + W_e E(r_e) \quad (3.31)$$

$$E(r_p) = W_d \cdot 9 + W_e \cdot 14$$

where:

$E(r_p)$ is the expected return of the portfolio,

W_x is the weight invested in asset x (Section 3.8.2) and

$E(r_x)$ is the expected return for asset x (Section 3.8.2).

The portfolio's variance may be calculated by using the following equation (Bodie *et al.*, 2005:237):

$$\sigma_{\text{port}}^2 = [W_d^2 \sigma_d^2 + W_e^2 \sigma_e^2] + 2[W_d W_e \sigma_d \sigma_e \rho_{de}] \quad (3.32)$$

$$\sigma_{\text{port}}^2 = [W_d^2 196 + W_e^2 484] + 2[W_d W_e 308 \rho_{de}]$$

where:

W_x is the weight invested in asset x ,

σ_x^2 is the variance of asset x ,

σ_x is the standard deviation of asset x and

ρ is the correlation coefficient.

$$W_d = \frac{[E(r_d) - r_f] \times \sigma_e^2 - [E(r_e) - r_f] \times \text{Cov}_{de}}{[E(r_d) - r_f] \times \sigma_e^2 + [E(r_e) - r_f] \times \sigma_d^2 - [(E(r_d) - r_f) + (E(r_e) - r_f)] \times \text{Cov}_{de}} \quad (3.33)$$

By substituting the relevant information (Section 3.8.2) into Equation 3.33 yields that the optimal risky portfolio will have an asset weighting as follows:

Equity : Weight of 39.3%

Debt : Weight of 60.7%.

When the maximisation equation is solved, the Sharpe ratio (S_p) = 0.45.

According to Hattingh (2004:46), the investor's portfolio consisting of both risky and risk-free assets, thus a complete portfolio will be a function of the investor's risk aversion. Equation 3.34 can be used to solve the weighting problem of the complete portfolio (Bodie *et al.*, 2005:206):

$$y^* = \frac{E(r_p) - r_f}{0.01 \cdot A \cdot \sigma_p^2} \quad (3.34)$$

If risk aversion coefficients of $A = 4$ and $A = 5$ are assumed, the following results are obtained for the complete portfolio mix (with D representing debt and E representing equity):

$A = 4$: Percentage invested in risky portfolio = 83.2% (D = 50.5% and E = 32.7%)

Percentage invested in risk-free asset = 100% - 83.28% = 16.8%.

$A = 5$: Percentage invested in risky portfolio = 66.5% (D = 40.4% and E = 26.2%)

Percentage invested in risk-free asset = 100% - 66.5% = 33.5%.

Investors have different levels of risk aversion and thus each investor has a unique asset allocation. Hattingh (2004:47) argues that return objectives should be considered together with risk tolerance.

3.10 Summary

Chapter 3 builds on Chapter 2 as it considers and discusses the primary concepts of effective portfolio construction, namely:

- Risk,
- Return, and
- Diversification.

The aim or objective of this chapter was to broadly expand on diversification which is the third key element of portfolio management and portfolio construction. This chapter, along with the previous chapter, provides some of the most important concepts relevant to portfolio management. Chapter 2 focused on portfolio theory while this chapter expanded on where Chapter 2 ended, while focusing on the three key or cornerstone concepts of investment portfolio management: risk, return and diversification.

This chapter started with the focus on risk, with different types of risks being identified and how risk ties into portfolio theory. The chapter identified standard deviation and variance as the appropriate measures of risk in an investment environment while the following measurements of risk were also discussed:

- Volatility,
- Covariance,
- GARCH,
- Correlation, and
- Alpha and beta.

The chapter also identified that the risk of a portfolio is not only a function of weighted standard deviations or variances of the individual assets, but also the co-movement of the asset returns (measured by covariance). Furthermore, the highest degree of portfolio di-

versification is provided by the combination of assets with low positive or negative correlations, with assets in the existing portfolio. The chapter also identifies two major components of risk, namely systematic and unsystematic risk.

Return was the second general focus on this chapter where required rate of return, measurement of return and the relationship between risk and return was discussed. The topic of return is of utmost importance in an investment environment or setting as return and/or return performance is the ultimate goal or objective of any investment.

Thirdly, the concept of diversification was discussed as diversification not only has the objective to reduce risk but also plays a part in the portfolio setting, as investors opt to construct portfolio as combining investments in essence diversifies and ultimately reduces risk. In this section of the chapter the origin, use, benefits and methods of diversification was brought forward while concentration and diversification measures were also included. The section on portfolio construction provided a practical application of the theories which were discussed.

Through the topics covered in the previous chapter, the most important and relevant topics were discussed. These discussions will be of great use when the empirical section is presented as this information provides background and some more sophisticated detail on the issue in the empirical study.

It can be concluded that return is the ultimate objective of any investment, but that risks are tied to returns. Investors often opt to construct portfolios of investments compared to having all their investments in one place or space. If the correct investments are combined with each other, the amount of risk (of the portfolio) can be reduced. It is furthermore of great importance to note that investors are different, but that they also invest for different goals and reasons. By the fact that investors differ and invest for different goals and reasons, the risk tolerance, profiles or appetite of investors differ. This chapter showed, through a practical application process, that it is possible to determine the optimal manner or combination to invest for a specific risk profile or preference. This can be translated into the management of the investments and/or investment portfolio in order to achieve the optimal (i.e., the maximum return for a given level or risk (which depends on the risk profile of the investor)).

The following chapter will turn its attention to the topics of markets, funds and performance measures.

Chapter 4

Markets, Funds and Performance Measures

4.1 Introduction

This chapter will focus on the topics of market, fund and performance measures (of investments and/or investment portfolios). Markets will be discussed as the assets that make up the investment portfolio are investments (owned by the investor) that are traded and priced in markets. It is thus important for any investor to have some knowledge of what a market is and also how markets operate. The second discussion will involve funds, as investors can also buy funds, unit trusts or hedge funds for example. In terms of this study it is also important to understand funds, specifically unit trusts, as the empirical study is based on these. The third focus of this chapter is that of performance measures. It was made clear in Chapters 2 and 3 that return is the ultimate goal of any investment but investors and portfolio managers need to be informed about how their investments are performing on an ongoing basis. It is thus important to be able to determine the performance of these investments. The discussion regarding the performance measures will mainly focus on risk adjusted performance measures as they will be predominantly used in the empirical study.

The information of this chapter, along with the topics of Chapters 2 and 3, will provide the necessary background to understand the investment environment (specifically in terms of investment portfolios). Furthermore, this chapter will explain the different performance measurements and each of their characteristics as they will be used in the empirical study as comparative analysis tools. These performance measures will thus be used in order to determine if the PDI is indeed a good measure of portfolio diversification and if the measure can be used as a tool by a fund or portfolio manager to construct or customise portfolios.

4.2 Security Markets

4.2.1 Introduction

This section will discuss markets, focusing mainly on security markets as shares and other financial instruments are traded in these markets. The discussion surrounding mar-

kets will provide information regarding what a market is, types of markets, classification of markets and the characteristics of a good market. The Efficient Market Hypothesis will also be elaborated on.

4.2.2 Market definition

Reilly and Brown (2006:105) define a market as “*the means through which buyers and sellers are brought together to aid in the transfer of goods and/or services*”. Marx *et al.*, (2006:21) identify key elements of the market definition, namely:

- The goods and services being transferred are not necessarily owned by the market,
- The reality or existence of a market is not dependent or subject on the existence of a physical location, and
- A market’s operations or functions are not limited to one specific product or service.

It is also important to focus on the South African environment as the empirical study is conducted in this environment. A number of different “official” markets exist within the South African environment, these include:

- Equity market - “*is part of the capital market. Capital markets are markets in which institutions, corporations, companies and governments raise long-term funds to finance capital investments and expansion projects*” (Goodspeed, 2003:47).
- Money market - “*that part of the financial market which deals in instruments with maturities ranging from one day to one year...*” (Goodspeed, 2003:41).
- Bond market - falls under the capital market. All types of bonds are traded in the bond market, whether on an exchange or over-the-counter (Investorwords, 1997b:1).
- FX market - “*the financial market where currencies are bought and sold*” (Goodspeed, 2003:36).
- Derivative market - instruments which derive their value from the “prices” of underlying assets are traded in the derivative market (Goodspeed, 2003:53).

An investment portfolio can contain financial instruments that are traded in any or all of these markets. This study focuses on the equity market. This is the case as the empirical study uses growth type unit trusts, which mainly invests in equities. Growth type unit trusts do, however, contain financial instruments of a nature other than equity that are traded in a different market. It should, however, be noted that the unit trust funds used in the empirical study only contain equity.

The following section focuses on the characteristic(s) that make a market a “good” market.

4.2.3 Characteristics of a good market

Reilly and Brown (2006:105) establish the following as elements that characterises a good market:

- **Information availability:** Investors or market entrants that enter the market aspire and aim to do so at a price which is justified by prevailing supply and demand. This necessitates information which is accurate and timely, information of past or historic transactions and current factors such as outstanding bids and offers.

Availability of information also implies that (Hattingh, 2004:93):

- there are a number of information sources available,
 - there is an interest in the asset,
 - an adequate number of investors will be interested and follow the performance of the asset, thereby creating a need for information,
 - low transactions costs: Markets are made more efficient when lower transaction costs are the norm.
- **Liquidity:** This relates to the ability to turn an asset into cash quickly without making a significant concession over purchase price (D’Ambrosio, 1976:368). Marketability on the other hand is “*the ability to turn an asset into cash quickly without making a significant concession over current market price*” (D’Ambrosio, 1976:369), and

- **External or informational efficiency:** This points to the market's ability to reflect all the information relating to supply and demand factors accurately in the price of the asset.

Although many markets exist, it is not a given that all these markets are good markets. The characteristic(s) named above should be present and/or active in order for any market to be seen or characterised as a good market. Furthermore, even if all or some of the characteristics are not present in a specific market, it does not make that market a "bad" market as these characteristics are idealistic.

4.2.4 Classification of markets

This section will briefly differentiate between the ways into which markets are classified. This is of importance or relevant as some of these classifications or practices are practiced in the South African environment while shares are traded in both the primary and secondary market. There are a number of ways to classify markets. According to Elton *et al.*, (2003:31) markets can be classified in the following four ways:

- **Primary or Secondary**

Primary markets are security markets where new issues of securities are sold whereas a secondary market is a market where securities are resold.

- **Call or Continuous**

In a call market trading takes place at specific time intervals. Furthermore, a call market can be divided into a verbal market or a market where computers are used. Continues market on the other hand are markets where trading takes place on a continuous basis.

- **Dealer or broker**

In a broker market a broker acts as an agent for an investor and buys and sells securities on the investor's behalf. In a dealer market investor's trades are not made directly with other investors but with the dealer, thus the dealer serves as an intermediary between buyers and sellers.

- **Human or electronic**

Markets can be classified by the means of trading execution, thus is the trading executed by humans or electronically?

4.2.5 Efficient Markets

The discussion in this section will focus on the Efficient Market Hypothesis (EMH) as it is very important to fully understand the concept of markets. Assumptions do exist with regard to efficient markets and this section will present these assumptions. The assumptions are (Marx *et al.*, 2006:31):

- the market needs a large number of independent, competing, profit-maximising participants who value securities,
- new information regarding securities comes to the market in a random fashion.
- competing investors attempt to adjust security prices rapidly in order to reflect the effect of the new information, and
- the expected return implicit in the current price of the security should reflect its risk.

The ideal is to have a fully efficient market, thus a market which has all the characteristics of a good market (Section 4.2.4) and most importantly where prices of securities adjust rapidly to new information. The Efficient Market Hypothesis (EMH), which will be the focus of the following section, does however have some assumptions which were named in this section as they are important for the discussion of EMH.

4.2.6 Efficient Market Hypothesis (EMH)

The efficient market theory is a very important element of investment theory as it deals, *inter alia*, with the three forms of the Efficient Market Hypothesis (EMH): (a) the weak, (b) semi-strong and (c) strong forms.

Fama (1960) argues that, in an active market with informed participants assets will be priced in such a way that it reflects available information on the asset (Hattingh, 2004:94).

Fama (1965:4) defines an “efficient” market as “*a market where there are large numbers of rational profit-maximisers actively competing, with each trying to predict future market values of individual securities, and where important current information is almost freely available to all participants. In an efficient market, competition among the many intelligent participants leads to a situation where, at any point in time, actual prices of individual securities already reflects the effects of information based both on events that have already occurred and on events which, as of now, the market expects to take place in the future. In other words, in an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value.*”

Marx *et al.*, (2006:31) adds that in an “efficient” market the prices of securities adjust rapidly to the arrival of new information. This implies that all the information about a certain security is reflected in the security’s current price.

The three forms of market efficiency differ by their notions of what is meant by the term “all available information”. Each of the EMH forms will be briefly discussed in the subsequent sections.

4.2.6.1 Weak form EMH

The weak form hypothesis assumes that share prices already reflect all the information that can be derived by examining market trading data, history of past prices or trading volume (Bodie *et al.*, 2005:373). Because it assumes that current market prices already reflect all past returns and any additional or other security market information, this hypothesis suggests that past rates of return and other historical market data should have no relationship with future rates of return. Thus investors who rely on historic information to perform security or asset analyses will not enjoy superior returns.

Historic information may be used to determine the perceived risk/return characteristics of an asset (Hattingh, 2004:96).

4.2.6.2 Semi-strong form EMH

This form of the EMH assumes that security prices adjust quickly to the release of all public information (Reilly & Brown, 2006:172). Therefore it is not possible to use such public information to make excess returns.

The semi-strong form of the EMH encompasses the weak form of the EMH, because all the market information considered by the weak form hypothesis is public. Public information also includes non-market information, such as earnings and dividend announcements and news about the economy. This hypothesis implies that investors who base their decisions on important new information after it has been made public should not derive above average risk-adjusted profits from their transactions (Hattingh, 2004:96). This is because the security price will already reflect all such public information.

4.2.6.3 Strong form EMH

The strong form EMH contends that share prices reflect all information from public and private sources fully (Reilly & Brown, 2006:172). Thus no investor group has monopolistic access to information relevant to the determination of prices. Furthermore, no investor or groups of investors should be able to outperform the market even if he has access to “privileged” information. It should be noted that this form of the EMH encompasses both the weak and the semi-strong form of the hypothesis. This form of the EMH implies that investors will not be compensated for risk in excess of the market risk, thus emphasising the importance of effective portfolio management and diversification.

The EMH does, however, have some implications which will be discussed in the following section.

4.2.6.4 Implications of the EMH

The EMH has numerous implications for individual investors, financial analysts, portfolio managers and institutions on an array of fronts of their investment activity, ranging from technical- to fundamental analysis. As this study’s main focus is on portfolio management and the effect of diversification on the risk levels of portfolios, the focus of this section will be on the implications of the EMH on portfolio management.

An important and critical implication of the EMH on portfolio management is the assumption that only unavoidable risk is rewarded by the market (Hattingh, 2004:97). The implication of this is that investors should not expect to earn returns for risks taken which may be diversified away.

According to Stevenson and Jennings (1976:312) the EMH suggests that a passive portfolio management strategy should be followed by investors. As portfolio managers find it difficult to outperform the market consistently, the rationale behind this is that portfolio managers hire superior and inferior analysts, whose “recommendation-performance” frequently neutralise each other. Reilly and Brown (2006:194) stated that portfolio managers with access to superior analysts with unique insight should follow these analysts’ recommendations. It is important to note is that Reilly and Brown (2006:194) further recommend that portfolio managers without access to superior analysts should construct their portfolios to comply with their clients’ risk preferences, minimise transaction costs and diversify their portfolio completely. This implies that the average investor should base his portfolio construction on these guidelines.

The EMH has an extensive impact on the management of investment portfolios. The following section will move away from the EMH discussion and discuss markets in a broader sense. The focus of the following discussion will be on existing markets, specifically the difference between traditional and semi-traditional markets.

4.2.7 Existing markets

This section will expand on the previous sections and will discuss existing markets with connection to the characteristics of a good and efficient market. Existing markets will be grouped into “traditional markets” and “semi-traditional markets” while the discrepancies will become clear as the discussion continues. This topic is relevant as shares and other financial instruments are traded in traditional markets while semi-traditional markets will also be briefly discussed in order to clarify the difference between traditional and semi-traditional.

4.2.7.1 Bond and equity markets (Traditional markets)

Both equity and bond markets may be classified under the term traditional markets with the following characteristics of such markets:

- These types of markets are characterised by having multiple institutional and individual investors participating in the market with each investor believing that he will be able to outperform the overall market (Hattingh, 2004:98),

- Investors have access to large amounts of information, for example economic forecasts, newspaper articles, reports from stockbrokers, and the investors having the current market price of all quoted securities while also having access or channels to past price movements (Dobbins *et al.*, 1994:17), and
- In such highly competitive and informed markets, investor can anticipate that prices will fully reflect all available information and that prices will adjust rapidly, according to Dobbins *et al.*, (1994:16).

By comparing these characteristics of “traditional” markets with the requirements or conditions of an efficient market, it can be concluded that traditional markets are highly efficient. Dobbins *et al.*, (1994:17) argues that there is an abundance of evidence supporting the belief that equity and bond markets obey the strong form of the EMH. At the least, the semi-strong form of the EMH.

In order to understand the difference between a traditional market and a semi-traditional market, the next section will briefly focus on a semi-traditional market.

4.2.7.2 Real estate markets (Semi-traditional markets)

Although the real estate market is a very active one, it is not as developed as the “traditional” markets and thus the real estate market may be classified as a “semi-traditional” market: Some of the key characteristics of this market and the assets traded in the market are (Hattingh, 2004:99):

- Not a standardised investment. No two properties are precisely the same and thus their value will not be determined on precisely the same set of factors,
- Information tends to be poor. Information regarding the property market tends to be imperfect while the prices of transactions are not always made public,
- No organised market. There is no centralised market by which transactions are handled,
- Large individual values. Large capital investment is needed for direct property investments. The ownership of property investments thus tends to be dominated by high-worth individuals and institutions, and

- Can be improved by active management. The performance of the property can be improved by the investor, as the investor has the ability to take certain actions while this is not the case for assets traded in the "traditional" markets.

The introduction of property unit trusts and property loan share companies has injected some liquidity and formality into this market, but the direct property market does remain unorganised to a large extent according to Hattingh (2004:99).

If the characteristic of the property market or "semi-traditional" market, as it falls into this sub-category or division, is compared to the requirements of efficient markets it can be concluded that this market will fall under the semi-strong form of the EMH. The reason for this is that according to Viruly (as quoted by Hattingh, 2004:100) the information and the flow thereof tends to be poor, although the market has a large number of competing participants. Hattingh (2004:100) argues that investors with superior sources of information should be able to make superior investments or investment decisions based on that information.

4.2.8 Summary

It can be concluded that markets are complex to some extent and that not all markets operate in precisely the same manner. It is also in the best interests of every investor to have knowledge of markets and how they operate. Although markets do not directly play a role in the empirical study, the funds (for example unit trust which are analysed in the empirical study) and/or shares are traded in these markets, thus the discussion of markets. It was shown that markets can influence portfolio managers or investors in the manner they manage their investments and the investment decisions they make. The discussion of markets thus provides a clearer, bigger picture in terms of this study and the topics relevant to it as it expands on the necessary background information.

The next section will focus on funds as the elements contained in these funds, for example shares and/or bonds, and/or the funds themselves are traded in the markets already discussed.

4.3 Funds

4.3.1 Introduction to funds

This section will discuss funds in general while looking at different types of funds and the differences between them, the development of these funds and lastly their different benefits. All this information is to serve as an understanding of funds as it is diversification's objective to reduce risk in these funds, and as diversification is the main theme of this study, funds constitute a related topic. It is important to discuss the topic of funds as funds are made up of a variety of financial instruments like shares and bonds. This section discusses the background of funds.

There are two main types of funds: (a) open-end and (b) closed-end (Anon, s.a.:1). An unlimited number of shares or units are issued by open-end funds with investors being able to buy shares from and sell them back to the fund company. Thus, the same number of shares in an open-end fund are increased and decreased respectively as they are bought and sold back and forth from the company. In contrast to open-end funds a closed-end fund issues a fixed number of shares or units and no more than the number of shares issued are sold. These types of funds thus have fixed capital structures and investors wishing to invest in these funds after all the shares have been sold (for the first time) must acquire shares from shareholders that are willing to sell them in the market. The shares or units of closed-end funds are listed on a stock-exchange and OTC markets, as for open-end mutual funds to be bought and sold by and from the company that is sponsoring, administering or managing the fund (Anon, s.a.:1). As a result the corresponding share or unit price of a closed-end fund is a function of existing supply and demand in the market and not just the fund's net capital value. Unit trust investments or unit trusts, as they are better known, are another kind of closed-end fund as the unit trust or management company of the unit trust issues a fixed number of shares or units that are sold by the trust's sponsor. The income of these sales is used to buy shares and/or bonds (which are kept until maturity) for the trust. Contrary to an open-end or closed-end fund there is no activity relating to share negotiation in the portfolio and thus no active management of the trust. This, in turn, leads to lower management fees, but this might not always be the case.

There are a variety of “other” investments available to investors. The following investments are worth mentioning (Marx *et al.*, 2006:13):

- Unit trusts (as mentioned in the previous paragraph),
- Investment trusts,
- Hedge funds, and
- Participating bonds schemes.

The following section will introduce and define two types of funds, namely hedge funds and mutual funds of which unit trusts (unit investment trusts) fall under. The aim of discussing these two types of funds is to provide background information of what these funds are but also to differentiate between the two types. The information given in this discussion will be of value as the empirical study analyses and focuses on unit trust investment funds (which is one of the types that will be discussed).

4.3.2 Definition of hedge funds and mutual funds

4.3.2.1 Hedge fund

According to the Financial Services Authority (UK) there is no truly accepted or universal definition of a “hedge fund”, though it refers to a pooled investment vehicle which is organised privately and administered by professional investment managers (Vaughan & Dechert, 2003:1). The hedge fund regulations define a hedge fund briefly as “*a sophisticated financial instrument used to bet or hedge against falls and rises in share markets and currencies*” (Bowman, 2007:1). According to Nicholas (1999:243) the term “hedge fund” was coined in the 1950’s to describe any investment fund that used short selling, incentive fees and leverage.

The term “hedge fund” is also used to distinguish these funds from retail investment funds (for example mutual funds⁵) which the general public has access to. Such retail funds are normally highly regulated in relation to hedge funds, although the Financial Services Board (FSB) promulgated new regulations regarding hedge funds in South Africa (Bowman, 2007:1). The new regulations took shape under the Financial Advisory

⁵ See Section 4.3.2.2

and Intermediary Services Act (FAIS) in 2002 and in August 2007 under the Hedge Fund Regulations (Bowman, 2007:1). Stricter rules were set for hedge fund managers, by the Hedge Fund Regulations, with the aim of offering both information and protection to investors.

In contrast to retail funds, hedge funds are only limited by the terms of the contracts governing the specific fund. Hedge funds are also able to follow more complicated and specialised investment strategies due to the fact that they may be short or long and derivative contracts may be entered into (Hedgeco, 2008:1). Typically, hedge funds invest on behalf of high-net-worth institutions and/or individuals. Apart from taking positions whose returns are not closely correlated to the broader financial markets, hedge funds also offer an absolute return investment objective, also known as a target rate of return which is not benchmark or index-based (Botha, 2005:9). Hedge funds are sometimes referred to as “alternative investment strategies” as the manager of the fund uses different skill-based strategies compared to the traditional manager (Botha, 2005:9). It should, however, be noted that hedge funds are a category within the alternative investment sphere and it is not to be taken for granted that reference to “alternative investments” refers to hedge funds. Hedge fund managers will invest in similar asset sectors as traditional investors, but hedge fund managers will use different strategies which are skill-based (Botha, 2005:9).

According to Mergence (2008:5) hedge funds normally incorporate: shorting, leverage and alternative opportunities, while hedge funds can be:

- Directional,
- Market neutral,
- Event driven,
- Arbitrage oriented, and
- Systematically driven, etc.

Section 4.3.4 will discuss the development of hedge funds, while Section 4.3.3 will focus on the differences between hedge funds and mutual funds.

4.3.2.2 Mutual fund

Evans (2007:1) defines a mutual fund as “*an investment vehicle which allows a group of many different investors to pool their money together with a clear financial objective – to make money*”. Mutual funds consist of investments in securities such as shares, bonds and money market instruments which are managed by a professional or group of professionals known as money, fund or portfolio managers. It is important to note that “*a mutual fund’s portfolio is structured and maintained to match the investment objectives stated in its prospectus*” (Investopedia, 2008d:1).

In South Africa, when funds are pooled together this investment scheme is known as collective investment(s) (schemes) (CIS). Collective investment schemes are regulated by the Collective Investment Schemes Control Act, Act No. 15 of 2002 and this act is managed by the Financial Services Board (FSB) (Goosen, 2007:1). Unit trusts are an example of a collective investment scheme.

According to Marx *et al.*, (2006:13) unit trust companies receive money from investors, issue sub-shares (units) to these investors, pool the money and invest it on behalf of unit holders in diversified portfolios consisting of various securities.

Investment trusts receive money from investors after selling ordinary shares of the company to these investors. The money received from the investors is pooled and invested in various securities on the behalf of the investors. In investment trusts the investors are called the participants of the share plan.

In this study the focus will be on unit trusts, which falls under collective investment schemes (CIS).

4.3.3 Differences between funds

This section will briefly explain the differences between firstly, unit trusts and investment trusts and secondly, unit trusts and hedge funds.

4.3.3.1 Unit trusts versus investment trusts

In the previous section, both unit trusts and investment trusts were briefly defined. Table 4.1 presents the differences between unit trusts and investment trusts.

Table 4.1: Differences between unit trusts and investment trusts.

Unit trusts	Investment trusts
May not invest more than 5% in any one security	Freedom to invest in accordance with the investment strategy of the trust
Not listed on an exchange	Listed share on the exchange
Price determined by trust deed and depends on value of underlying securities	Price determined by supply and demand

Source: Marx *et al.*, (2006:14).

4.3.3.2 Unit trust versus hedge fund

The previous section presented the differences between unit trusts and investment trusts.

Table 4.2 presents the differences between unit trusts and hedge funds.

Table 4.2: Differences between unit trusts and hedge funds.

Unit trust	Hedge fund
May not invest more than 5% of its assets in any one security	Freedom to invest in accordance with the investment strategy of the fund
Managed by a fund manager, who gets paid regardless of whether investors gain or lose	Managed by a general partner who earns fees based only on investors' profits, not losses
Allowed to advertise	Not allowed to advertise
Available to the general public by prospectus	Available to high net worth individuals and institutions (satisfying certain requirements) by a confidential offering memorandum and partnership agreement
Traded daily	Illiquid, may not be able to redeem at any time
Small fee to redeem	Usually a lock-in period to prevent aborting any strategy
No limit on the number of investors who can invest in the fund	A private pool of investment capital, limited to the partners

Source: Marx *et al.*, (2006:14).

It is important to highlight the main differences between unit trusts and hedge funds, as presented in Table 4.2. The first remarkable difference between the two types of funds is liquidity. Unit trusts are traded daily and thus are very liquid while hedge funds are very illiquid. The second difference is that hedge funds are available to high net worth individuals and institutions while unit trusts are available to the general public. This might lead to an assumption that hedge funds require a much larger investment than unit trusts.

The discussion to follow will focus on the historical development of funds and will discuss both the development of hedge funds and unit trusts. This section will only serve as background information and is included for the sake of completeness.

4.3.4 The historical development of funds

This section will focus specifically on the origin and development of hedge funds and unit trusts.

4.3.4.1 Hedge funds

Jones, a sociologist, formed the first absolute return or “hedge fund” in 1949, although many “investment pools” existed (Mergence, 2008:6). Jones worked on an assignment for Fortune Magazine, which investigated the fundamental and technical research on forecasting the share market. The trading methods that Jones came across while working on this assignment interested him immensely, and ultimately a personal concept of an investment fund became Jones’ goal. Jones’ greatest notoriety originates from the innovation that, if a specific limited partnership is structured correctly it would be exempt from regulatory control under the Investment Company Act of 1940. Managers would be allowed to use techniques such as short-selling and leverage (which bind other mutual funds) thanks to Jones’ exemption.

The Investment Partnership which was set up in the U.S.A by Jones employed an investment technique that involved buying “undervalued” shares while also selling “overvalued” shares short to remove general market risk (Botha, 2005:11). In 1966 an article in Fortune Magazine outlined his strategy and its 87% out-performance of conventional funds (Mergence, 2008:6).

Botha (2005:11) stated that hedge funds experienced periods of rapid growth since their inception while Mergence (2008:6) stated that by 1968 there were 140 hedge funds. Since their inception into the financial markets, hedge funds have evolved into elaborate and complex investment vehicles. The overall instrument complexity and investment size have had phenomenal growth (Botha, 2005:11). The following section will discuss the origins of the unit trusts.

4.3.4.2 Unit trusts

The unit trust or collective investment schemes did not develop out of nothing and that there are a large amount of historical events that led to the development thereof, but this is not the focus of this study, (see Sin (1997) for a detailed discussion). It is, however,

important to note that “*a necessary characteristic of any collective investment vehicle is the passive part played by investors in the conduct of the investment activities of the vehicle*” (Sin, 1997:7). Sin (1997:7) continues that this involves that the money providers (investors) and the money managers be separated and by this the “trust” is a natural candidate, as it has the ability to separate the title and management of properties from their beneficial enjoyment.

The modern form of unit trust in Britain has its origin in the U.S.A (Sin, 1997:27). The trust’s first notable use was as an alternative to incorporation and was called the “business trust”, “Massachusetts trust”, or “common law trust” while a logical extension of the trust was (and still is) used as a vehicle for collective investment. This use of the trust for collective investments did not take off in England or any other common law country (that modelled on the English statutory regulation of unit trusts). The form of the trust that did influence succeeding developments in England was the unit investment trust that originated in 1924 as a result of the desire of an American businessman to increase the public ownership of his company (Sin, 1997:28). The shares of the American company were selling at \$400 each, where after he ‘deposited’ a share to his bank in exchange for ten bankers’ receipts which represented pro rata interests (Sin, 1997:28). This form, however, did not gain immediate popularity while the fateful crash of October 1929 and the Great Depression shattered the value of shares in such investment companies and the investing public linked the proportion of their losses to abuses and malpractices in the management of such companies (Sin, 1997:28). Investors did, however, turn to the unit trust investment because the management was eliminated. The end result was that the unit trust, with the management company given the power to change the underlying portfolio, emerged in America. In 1930 the American fixed unit trust was first marketed in Britain although comments from the Financial News and The Economist were negative (Sin, 1997:29). In August 1930, International Investment Deposit Certificates (units from a Switzerland fixed unit trust which had Société Internationale de Placements as its manager and the Union Bank of Switzerland as its trustee) were marketed in Britain (Sin, 1997:29). Discussions also took place between a London broker and the manager of a company, Municipal and General Securities Company Limited (controlled by an American company JG White & Co. Inc., which was the marketing agent of the American fixed trust). The

First British Fixed Trust was formed under a trust deed dated 22 April 1931 with Municipal and Securities Limited as the manager and the Lloyds Bank as the trustee. The American Fixed Trust consisted of 24 shares of leading companies in a fixed portfolio, that during its lifespan of 20 years was not changed (Wikipedia, 2008:1).

The unit trust industry in South Africa started in 1965 with a single fund (Meyer-Pretorius & Wolmarans, 2006:49). This first fund (Sage) was established to offer the ordinary investor a convenient product which allowed assets to be professionally managed, the risk spread across a broad portfolio of shares, provided the investor with the ability to liquidate the investment at short notice, required low initial investment amounts and ensured both low cost and tax effectiveness, compared to other product available at the time (Meyer-Pretorius & Wolmarans, 2006:50).

The unit trust industry in South Africa has grown tremendously as assets of more than R415 billion were controlled in December 2005 compared to the R600 000 in 1965 (Meyer-Pretorius & Wolmarans, 2006:51). At the time of writing (April 2008), Equinox (1999b:1) stated that there are 30 unit trust management companies in South Africa offering over 830 different unit-trusts. The South African unit trust industry was valued at R415 billion by Meyer-Pretorius and Wolmarans (2006:51) in December 2005.

From its inception to 1970, the South African unit trust industry grew at an average rate of 259% per annum, but during the 1970s the industry growth was very slow due to the crash of May 1969 (Meyer-Pretorius & Wolmarans, 2006:52). It took the industry about 10 years to recover to levels prior to the May 1969 crash. During the second half of the 1980s the unit trust industry increased from 17% to around 37%, until the minor crash in 1987. Meyer-Pretorius and Wolmarans (2006:52) continues by stating that if the outliers are omitted and the average compounded growth rate calculated for the period 1970 to 2005, the rate is 22,34%, which is about 8% higher than the growth of the general economy.

Today, unit trusts offer the investor the ability to invest in a mix of the primary asset classes (equities, bonds, listed property and short-term money market instruments). There is also a broad choice of funds offering combinations of both capital growth and income

across different sectors of the market (Equinox, 1999b:1). Some funds are also designed to benefit specifically from sector rotation and market timing.

At the end of September 2007 there were a total number of 788 unit trusts in South Africa. This grew to 831 unit trusts by the end of December 2007 with the total assets amounting to R648,78 billion (Unit trust survey, 2008:1).

A discussion that focuses on the advantages and disadvantages of both hedge funds and unit trusts will aid and support the topic of funds. The next section will thus focus on these advantages and disadvantages.

4.3.5 Advantages and disadvantages of hedge funds and unit trusts

The previous section focused on the development of both hedge- and mutual funds. This section will briefly focus on the advantages and disadvantages of both hedge funds and unit trusts. Although this information is not directly linked to the main theme of this study, it adds background information and ultimately clarifies the differences between these funds as well as how each of these funds suit an investor's specific investment needs.

4.3.5.1 Advantages of hedge funds

Research sponsored by Lehman Brothers showed that hedge funds have the following benefits (Schneeweis, Kazemi & Martin, 2001:6):

- Traditional methods of risk assessment, style analysis and asset allocation can be used for hedge funds,
- The performance of actual multi-manager portfolios is reflected by hedge fund indices,
- Portfolio creation in the traditional manner indicates the importance of hedge funds in obtaining optimal portfolio performance,
- The analysis of asset allocation is an indication of the benefit of certain hedge fund strategies in diversifying share and bond portfolios,

- Due to the sensitivity of hedge funds to different market factors some hedge funds may be regarded as a diversifying tool for portfolios comprising of traditional instruments, and
- Some fund asset strategies are seen as primary return enhancers to traditional portfolios due to sensitivity of those funds to the same market factors as traditional investments.

4.3.5.2 Disadvantages of hedge funds

The following points are identified as disadvantages of hedge funds (Mergence, 2008:14):

- (Lack of) liquidity is a concern,
- Costs,
- Lack of regulation and the impact of this on confidence was and may still be a debate-able issue even though these funds are regulated as from 2007,
- Excessive leverage/ concentration risk,
- Lack of disclosure and transparency,
- Lack of due and correct consideration, and
- Not explicitly integrated in current investment allocations.

4.3.5.3 Advantages of unit trusts

The advantages of unit trust include the following (JEFC, 2006:1):

- Unit trusts provide diversification for (smaller) investors who may not otherwise have access to a wide range of investments,
- Because each unit represents a pro-rata share of an entire portfolio, unit trusts provide diversification in a manageable manner,
- Because an investor can cash in all or part of his/her investment if necessary, it provides accessibility and liquidity,

- Investment decisions are made by qualified portfolio managers. These portfolio managers also manage the unit trusts,
- Unit trusts provide complete transparency in that prices are published daily in the newspapers and performance figures are easily available enabling comparison with similar funds,
- The unit trust industry in South Africa is strictly regulated by the Collective Investment Schemes Control Act (CISCA), and the interests of investors are protected by the management company's trustees. The Association of Unit Trusts (AUT) has also been formed by the industry to encourage self-regulation,
- The average returns from unit trusts companies compare very well with returns from more traditional investment products, and
- Unit trusts are a very low cost and convenient manner of investing in markets which the investor would otherwise have found difficult to access.

4.3.5.4 Disadvantages of unit trusts

Disadvantages of unit trusts include amongst others (JEFC, 2006:1):

- Certain costs are involved because professionals administer the unit trusts,
- As unit trusts are generally medium to long-term investments, unit trust may not suit all investors,
- Investors can be enticed to redeem their unit trusts in the short-term, and
- The volatility of the investment, as prices fluctuate daily according to market movements, may not suit all investors' needs.

Both hedge funds and unit trusts are managed by qualified portfolio or fund managers. In addition, unit trusts have the advantage of being more liquid than hedge funds. Unit trusts are more highly regulated than hedge funds, in that hedge funds were not regulated in South Africa in the past. This has, however, changed as hedge funds will be more highly regulated (in South Africa) in the future through the hedge fund regulations. Both hedge funds and unit trusts are able to assist in diversifying an investor's portfolio while both of these types of funds are already used for this purpose.

The following discussion will focus on the types or styles of both hedge funds and unit trusts. This discussion will help further to understand both types of funds and how they can or are used.

4.3.6 Types and styles of hedge funds and unit trusts

This section will briefly focus on different types, styles or strategies, as it is often referred to, of hedge funds and unit trusts.

4.3.6.1 Types, styles or strategies of hedge funds

The following are some types or styles of hedge funds in South Africa (Mergence, 2008:11):

- **Equity long/short:** Long and short securities with varying degrees of exposure and leverage (normally a low degree). In terms of the number of hedge funds and the amount of money under management, this strategy or style is one of the most popular (CMP, s.a.:1). The overall portfolio may have either a long or a short bias and this style relies on superior share selection,
- **Equity market neutral:** These strategies or styles are primarily used for arbitrage or hedging with the objective being returns with low or no correlation to shares. Hedging involves investing in securities (long and short) with the objective of low net market exposure. Long positions which are undervalued are selected while short positions which are overvalued are also selected,

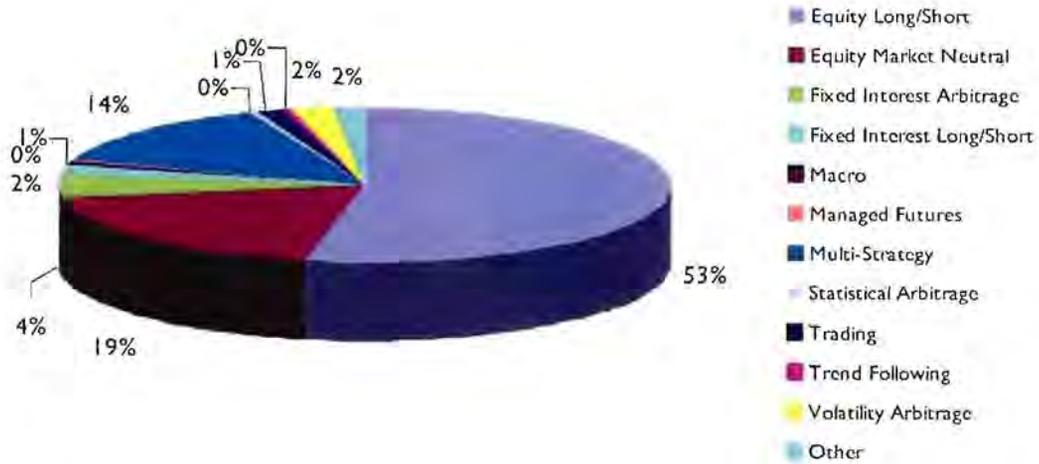
Arbitrage strategies attempt to take advantage of price discrepancies between paired securities. Arbitrage may be divided into relative value arbitrage, convertible arbitrage, fixed income arbitrage, merger arbitrage and capital structure arbitrage,
- **Fixed income arbitrage:** This strategy attempts to profit from arbitrage opportunities in interest rate securities. The investor would assume opposing market positions in order to take advantage of small price discrepancies while also limiting interest rate risk. This strategy is primarily used by investment banks and hedge funds. The swap-spread arbitrage is the most common fixed-income arbitrage

strategy where opposing long and short positions in swaps and treasury bonds are taken,

- **Fixed income long/short:** This strategy attempts to hedge out interest rate risk by using futures, swaps and by taking short positions,
- **Macro:** Also referred to as “Global Macro”. This is an opportunistic “top-down” approach where trades are based on major chances in the global economy, including interest rates, currencies and political changes of specific countries. Macro strategies use moderate amounts of leverage,
- **Volatility arbitrage:** The objective is to take advantage of differences between the implied volatility of the option or security and a forecast of future realised volatility of the option or security’s underlier. Thus, volatility is used as the unit of relative measure in volatility arbitrage and not the price as is the case with arbitrage in general,
- **Multi strategy:** This strategy or style is diversified by employing various strategies at the same time to realise short-and long-term gains. This style allows the manager to adjust the weighting of the different strategies to best capitalise on current investment opportunities, and
- **Trading:** This strategy encompasses a lot of different factors but in essence it is a strategic strategy that has a focus on systematic factors such as inflation and interest rates. The(se) factors normally drive returns.

Figure 4.1 provides a graphical breakdown of the different strategies as per assets under management in the South African hedge fund market as at October 2007 while Figure 4.2 presents the change in assets under management per strategy (in South Africa) also as at October 2007.

Figure 4.1: Breakdown of strategies per assets under management.



Source: Mergence (2008:12).

From Figure 4.1 it is clear that the hedge fund type or strategy most invested in (in South Africa) is of an equity long/short nature. The equity market neutral is the second largest and /or most popular as 19% is under management in this strategy.

Figure 4.2: Change in assets under management per strategy.



Source: Mergence (2008:13).

Figure 4.2 shows that the amount of assets under management in the equity long/short has declined from 72% in 2004 to 53% in 2007. The assets being managed under the equity market neutral strategy has increased from 13% in 2004 to 19% in 2007. The multi-strategy has shown the largest increase of assets being managed under any of the strate-

gies as it increased from 0% in 2004 to 14% in 2007. This might be an indication that hedge fund investors are or have been diversifying more, as the assets under management of the multi-strategy has largely increased while the equity long/short has declined along with the fixed interest arbitrage strategy among others. The unit trust types will be the focus of the following section.

4.3.6.2 Types of unit trusts

Firstly, unit trusts can be distinguished in terms of local funds and international funds, however, it is important to note that unit trusts typically have more than 75% of their market value invested in local markets. International investment is currently limited (by regulations) to a maximum of 15% of the total local assets managed by the unit trust management company (Business Report, 2008:1).

Secondly, unit trusts can be divided into three broad types of funds (Sharenet, 2004:1):

- **General equity funds:** These types of funds provide investors with growth by investing in a spread of different shares, across all sectors of the JSE. These types of funds are less risky than specialist equity funds,
- **Income funds:** These types of funds are reasonably secure investments in government shares, gilts and fixed interest securities. These funds provide income with a regular payment rather than high capital growth over a long time period, and
- **Specialist equity funds:** These types of funds, like general equity funds, focus more on growth instead of income. Investments can be in a specific sector of the market, like the industrial or retail sector. The risk of these types of funds is higher, because the growth of the funds depends solely on the performance of a single sector of the market.

Besides the broad classification of unit trusts in South Africa, investors can also invest in the following funds (Business Report, 2008:1):

- **Fund of funds:** These types of funds invest in the units of other funds or unit trusts, however, they may not have more than 20% exposure to any one fund.

These types of funds are however more costly than investing directly in the underlying unit trust,

- **Fixed interest funds:** These types of funds refer to all the interest-bearing financial assets and include income- and bond funds. Bond funds offer exposure to the bond and money market while income funds are subjected to more restrictions in the form of investment boundaries. The aim of these funds is to provide steady income and total returns in excess of the money market while capital preservation has a high priority,
- **Managed funds:** These funds offer a flexible or a balanced exposure to the different asset classes. Prudential funds also fall under managed funds and have to adhere to the Pensions Funds Act prudential guidelines, and
- **Money market funds:** These funds do not invest in money market instruments or bonds which have a maturity of more than a year. These funds also offer investors a higher interest rate alternative to traditional bank savings vehicles while also being used regularly to park money for a short time.

This section has distinguished between domestic or local funds and international or foreign funds while Section 4.3.6.1 discussed the different styles or strategies of hedge funds in South Africa.

4.3.7 Fund industry in South Africa

This section will elaborate on the fund industry in South Africa with specific attention going firstly to the hedge fund industry where after the unit trust industry will be focused on. This discussion on the fund industry will serve as background information as well as present how both fund industries have changed and/or grown. The legislation surrounding both these industries will also be discussed as this is becoming more important not only to investors but also for the industries and its wellbeing and sustainability.

4.3.7.1 Hedge fund industry in South Africa

According to Hamilton (s.a.:1) the introduction of hedge funds into the South African investment market has been a great success, despite the initial concerns about the lack of a regulatory framework. Lizelle Steyn, manager of alternative investments at Nedgroup

Investments, stated that the unregulated environment is not deterring new hedge fund operations from opening their doors (Nedgroup Investments, 2005:1).

Traditional investment schemes or collective investment schemes operating in South Africa are regulated by the Financial Services Board (FSB) under the Collective Investment Schemes Control Act (CISCA), but the CISCA contains restrictions (Goosen 2007:1). As a result of these restrictions placed on collective investments and because hedge funds normally provide hedge fund managers with broad investment powers to pursue their strategies, most hedge funds have chosen to operate as unregulated outside of CISCA and the regulated investment environment (Goosen, 2007:1).

In August 2007 the Financial Services Board (FSB) promulgated new regulations (“the Hedge Fund Regulations”) relating to hedge funds in South Africa, under the Financial Advisory and Intermediary Services Act, 2002 (Bowman, 2007:1). These regulations set stricter rules for hedge fund managers with the objective or aim of providing protection and information to investors. Furthermore, the hedge fund regulations generally seek to ensure that all applicant hedge fund managers are assessed on their risk management processes, their operational ability and the types of investors of the fund (Bowman, 2007:1). The essence of the hedge funds regulations is to place greater emphasis on the experience and qualifications of hedge fund financial service providers or more commonly known as hedge fund managers. Thus, the regulations only regulate hedge fund managers and not the actual product being sold or bought (Bowman, 2007:1).

Some members of the industry believe the regulation will help raise awareness and also the image of hedge funds, while others might have concerns that the final result will be an industry divided between regulated and unregulated managers and products (Anon, 2008:1).

In the absence of regulation, institutional investors have preferred to invest through funds of hedge funds in order to benefit from their due diligence capabilities. This is the case as these funds accounted for almost 60% of the total single manager assets at the end of June 2007, according to Liebenberg, recent chief executive of fund of hedge funds manager Clade Investment Management (Hedgemediia, 2008:1). Liebenberg (Hedgemediia, 2008:1) stated that “*we probably have one of the best self-regulated industries in the*

world". Liebenberg (Hedgemia, 2008:2) continues by stating that South Africa has great levels of transparency and a high degree of compliance with international best practices.

South African hedge funds are currently making use of independent third-party administrators, but this is now changing as a formal regulation system of the industry is coming into effect after years of discussion. The regulator (Financial Services Board (FSB)) has set a deadline for hedge fund managers to apply for a license that will give them the classification of hedge funds managers (Bowman, 2007:1).

The result of the hedge fund industry's sense of responsibility, despite the shortcomings of regulation, is that the industry grew from about R2 billion (10 funds) in 2002 to an estimated R20 billion (around 130 single strategy funds) in 2007 (Hamilton, s.a.:1).

Figure 4.3 presents the pathways for investors to invest in hedge funds. As the information presented in Figure 4.3 is not known by many investors it is informative and of value to investors.

Mergence Africa Investments is of the opinion that the following three factors are restrictions in the South African hedge funds market (Mergence, 2008:9):

- **South African legislation**

The issue with South African legislation in terms of hedge funds is that in the past hedge funds were not regulated by a central regulator like the Financial Services Board, although many hedge funds regulated themselves. As this is changing and improving it might result in the hedge fund industry and market growing more rapidly and consistently.

- **Misconceptions**

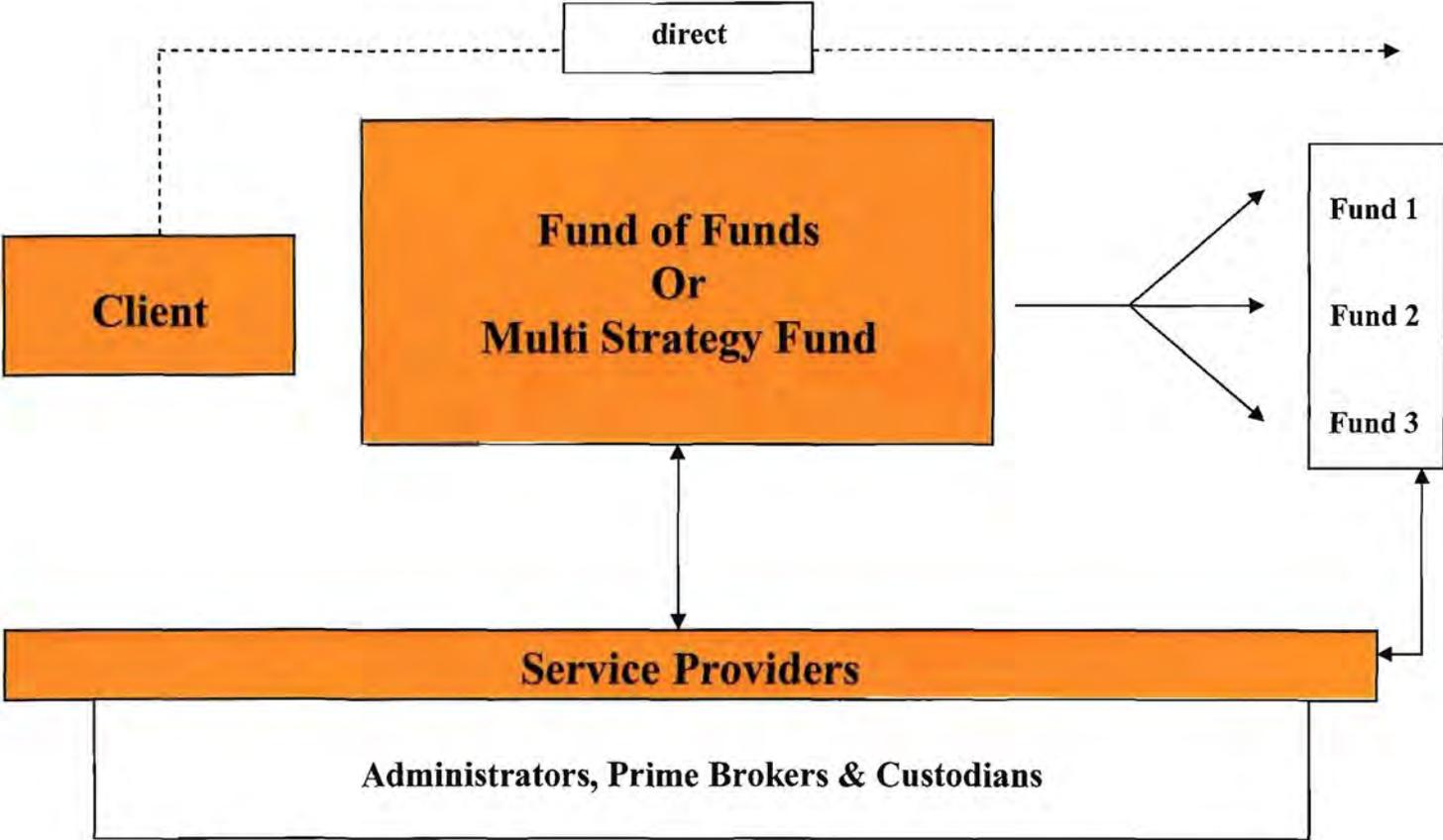
Misconceptions of hedge funds (i.e., what hedge funds are and how they operate) by the public might be a restriction on the South African hedge fund industry and market.

- **Mandate limits**

Mandate limits of hedge funds and hedge fund managers that are set incorrectly or unrealistically can have a restrictive influence on the South African hedge fund industry and market.

As this section has focused on the hedge fund industry in South Africa, the next section will discuss the unit trust industry in South Africa.

Figure 4.3: Access to SA hedge funds.



Source: Mergence (2008:10).

4.3.7.2 Unit trust industry in South Africa

From the start of the unit trust industry in South Africa in 1965, the number of funds (unit trusts) has grown to 855 at the end of the second quarter of 2008 according to the July 17, 2008 press release by the Association of Collective Investments (ACI, 2008a:2). This saw an 11 fund increase from the first quarter of 2008. Net inflows reached the R10 billion mark from R3,9 billion in the previous three months, but market assets dipped from R659 billion to R656 billion (ACI, 2008a:1).

By December 2005, there were 567 unit trusts with total assets valued at more than R415 billion (Meyer-Pretorius & Wolmarans, 2006:50).

Tables 4.3 and 4.4 indicate a snapshot of the investment industry as at 31 March 2008.

Table 4.3: Local statistics (31 March 2008).

Local	
Assets under management	R658 573m
Sales	R135 899m
Repurchases	R132 38m
Net inflows	R3 861m
Number of funds	844

Source: ACI (2008a:3).

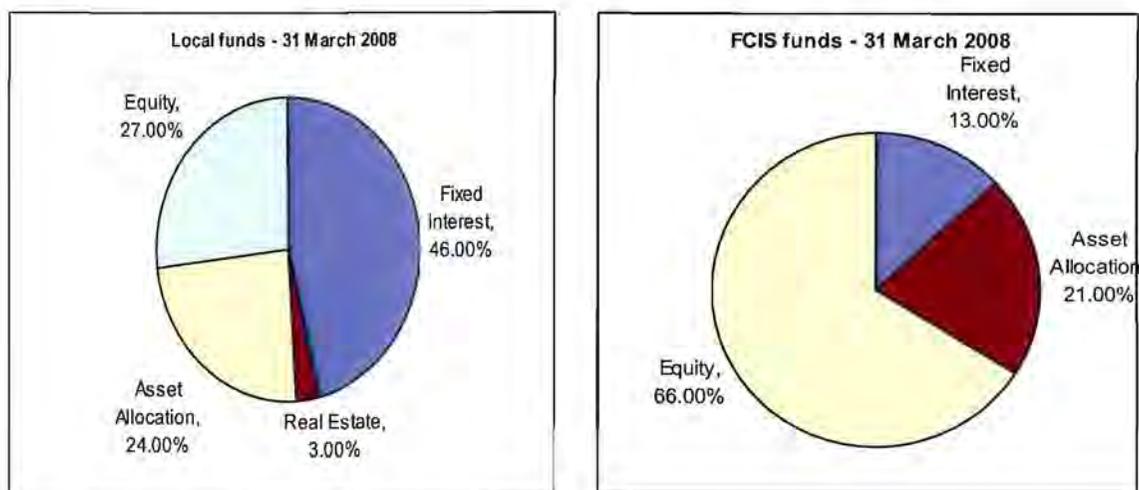
Table 4.4: Foreign statistics (31 March 2008).

Foreign	
Assets under management	R117 871m
Sales	R5 614m
Repurchases	R6 200m
Net inflows	(R586m)
Number of funds	369

Source: ACI (2008a:3).

The two pie charts in Figure 4.4, present the figures in Tables 4.3 and 4.4 graphically. The first of the pie charts in Figure 4.4 shows that fixed interest was very popular with investors in the local front by the end of the second quarter of 2008. This might have been because of the (relatively) high(er) interest rates which made the money market a popular sector.

Figure 4.4: Local and Foreign funds distributions as at 31 March 2008.



Source: ACI (2008a:3).

Over time the types of securities in which South African unit trusts invest have changed although equity fund assets still represent the mass of all worldwide mutual fund assets according to the International Investment Fund Association (Meyer-Pretorius & Wolmarans, 2006:53). At the end of 1980, all but one of the 12 South African funds were an equity funds. The one fund of a non-equity nature was the Standard Bank Extra Income fund which was also the first non-equity fund in South Africa. This fund was launched in 1978 and was a fixed interest fund. In 1997, after many years of resistance from the banking sector (which had a monopoly on the investment of short-term funds), South African money market unit trusts were introduced. By mid-2005 the number of money market funds increased to 26 and these funds represented 33% of the total assets of the industry.

Table 4.5 presents the breakdown of the South African unit trust industry as at end September 2008.

Table 4.5: Summary of South African collective investment industry.

	Total Assets	No of funds						
	Rm		Rm		Rm		Rm	
	Sep-08		Jun-08		Mar-08		Dec-07	
Domestic Funds								
Equity	139,874	202	161,518	198	164,908	195	176,574	192
Asset Allocation	138,628	354	144,342	346	147,686	344	146,984	341
Real Estate	17,148	29	13,744	28	18,188	29	20,571	29
Fixed interest	309,293	147	288,337	146	277,132	140	265,494	138
Subtotal	604,943	732	607,940	718	607,914	708	609,623	700
Worldwide Funds								
Equity	532	6	696	6	706	6	633	6
Asset Allocation	6,911	26	7,207	24	7,410	22	6,868	20
SUBTOTAL	7,443	32	8,116	30	9,116	28	7,501	26
Foreign Funds								
Equity	16,666	5	19,916	40	20,849	5	18,806	37
Asset Allocation	14,246	5	15,506	41	15,911	5	12,810	43
Fixed interest	4,149	3	4,773	26	5,783	3	4,724	25
Subtotal	35,061	12	40,196	107	42,544	708	36,339	105
Total	647,446	872	656,039	855	646,032	844	653,463	831
JSE Market Capitalisation	4,557,791		5,950,333		5,793,634		5,696,829	
Equity holdings as % of market capitalisation	4.01		3.41		3.82		4.38	

Source: ACI (2008b:1).

Meyer-Pretorius and Wolmarans (2006:64) suggest the following to offer investors more value:

- Reducing operating costs: The only manner in which to enhance the returns of unit trust investors is to reduce the portfolio turnover costs. The reduction of management fees and sales commissions by substituting or introducing a performance-based fee may be possible,
- Educating South African investors: South African investors need to be educated about fund selection risk, asset allocation, potential returns and also the costs involved. The fact that unit trusts are long-term investments also needs to be communicated to investors, and
- Changing investment strategies: The suggestion is that the industry could once again focus on diversified funds with solid objectives and long-term strategies. Marketing strategies could be used to prove (to investors) that unit trust investments' long-term performance could improve if buy-and-hold strategies are followed and adhered, instead of trading unit trusts over the short-term.

In 2005 South Africa was ranked 22nd out of 41 countries in terms of the dollar value of the assets under management, ahead of countries such as Russia, Mexico and New Zealand (Meyer-Pretorius & Wolmarans, 2006:50). At the end of 2007 South Africa was ranked 24th out of 44 countries in terms of the dollar value of the assets under management (ICI, 2008:1). If the South African unit trust industry's growth rates continue as it has in the past and investor demand continues alongside, one can only assume a positive future for this industry.

The South African collective investment industry is growing consistently as there were 855 unit trusts at the end of July 2008 and R658 573 million worth of assets under management at the same date. Furthermore, it seems as if money market funds are reasonably popular since its inception into the South African market in 1997. It can be concluded that the South African collective investment industry seems to be in good health as it is gaining popularity and growing consistently.

The third focus of this chapter, fund performance and specifically fund or investment performance measures, will be the focus of the following section.

4.4 Fund Performance

4.4.1 Introduction

This section will focus on how fund performance is measured and evaluated. There will be focused on fund performance measures or ratios like the Sharpe ratio and the Treynor measure while the discussion of evaluation will focus on benchmarks and indices. This discussion is of importance for this study as the majority of these measures will be used in the empirical study. The aim of this section is thus to provide information on these performance measures and explain them in terms of how they operate and what they measure.

4.4.2 Performance measures

4.4.2.1 Introduction to performance measures

A number of different performance measures exist whilst each fund, unit trust or hedge fund has its own and unique objective. It is for this reason that different funds' performances are measured differently although some of the performance measures are used more commonly and are more widely known than others. The performance of different funds is also measured against different benchmarks, because different funds and fund managers have different objectives and performance targets. The topics of benchmarks will, however, be discussed in Section 4.6.

According to Botha (2005:38) simple risk and return measures that measure performance can not cope with the demand of the financial environment which is becoming increasingly complex. Section 3.4.2 discussed return, but before returns can be meaningfully compared they need to be adjusted for risk (Section 3.2). The most commonly used risk adjustment for portfolio returns is to compare the returns of investments with similar risk characteristics (Bodie *et al.*, 2005:866). Comparing the performance of managers with similar investment styles are also a useful manner to evaluate performance, though this process may at times be misleading. For example, a situation might arise where some managers may concentrate on aggressive growth shares while others may be more focused on high dividend shares. In this case the risk/return evaluation will be very difficult to perform as two very different management strategies are involved.

Before the risk/return relationship can be measured by any method, it is important that both terms are defined and understood. Risk and return was defined in Chapter 2 and the calcu-

lation of return discussed, while risk is often measured as the standard deviation of return (Section 3.2.3). The subsequent section will focus on different performance ratios used by managers with standard deviation being the first focus.

4.4.2.2 Standard deviation

As standard deviation was discussed in Chapter 3 it will be very briefly touched on in this section.

Two measures of possible risk (uncertainty) exist in the theoretical side of portfolio theory: the variance and the standard deviation. Standard deviation is a measure of variability or risk, i.e. how dispersed out the data is and is mostly denoted with the letter σ (lower case sigma). It measures how the probability distribution is centred around the mean (expected) (Marx *et al.*, 2006:8).

The standard deviation is a risk measure used by investment professionals and it measures an investment's variability of returns. This measure is at times referred to as a narrow measure and that it has limited use unless it is used in conjunction with the Sharpe ratio. At times the standard deviation is criticised as being an inadequate measure of risk, because although investors dislike variability, investors dislike losses even more but will be quite happy to receive unexpected gains (Simons, 1998:36). One manner to meet this objective is to calculate a measure of downside variability, thus a measure that would account for losses but not gains.

4.4.2.3 Sharpe ratio

The Sharpe ratio is the most commonly used measure of risk-adjusted performance and although it has near complete acceptance among academics and institutional investors, it is not well known among the public and financial advisors (Simons, 1998:38). The measure uses the excess return (or risk premium) and standard deviation of a fund to calculate the reward per unit of risk (Botha, 2005:40). The higher the Sharpe ratio of a fund, the better the risk-adjusted performance of the specific fund.

The Sharpe ratio divides the average portfolio excess return over the sample period by the standard deviation of returns over that period (Bodie *et al.*, 2005:868).

It is calculated as follows (Bodie *et al.*, 2005:868):

$$\text{Sharpe Ratio} = \frac{(r_p - \bar{r}_f)}{\sigma_p} \quad (4.1)$$

where:

r_p represents the portfolio return,

r_f is the return of the benchmark and

σ_p is the standard deviation of the portfolio returns.

Typically the benchmark, as in Equation 4.1 will represent a risk-free investment alternative like a treasury bond. The Sharpe ratio is thus a risk-adjusted performance measure which tells the investor how well the return of an asset compensates for the degree of risk taken. It should be noted that a high Sharpe ratio is preferred to a low ratio (the higher the Sharpe ratio the better the fund's historical risk-adjusted performance). The Sharpe ratio is, however, affected by leverage although it was originally thought not to be the case (Botha, 2005:41). According to Fulks (1998:1) funds become more leveraged when the returns and the standard deviation do not increase at the same rate. This results in a decreasing Sharpe ratio. The Sharpe ratio is a good measure which evaluates the manager of a specific fund on both diversification and rate of return basis (Reilly & Brown, 2006:1048), and also a good measure to compare funds with, although the Sortino ratio needs to be considered alongside it (Botha, 2005:41) as the Sortino ratio is an extension of the Sharpe ratio.

4.4.2.4 Treynor measure

This measure or ratio was developed by Treynor in 1965 (Reilly & Brown, 2006:1043). Treynor's measure like the Sharpe ratio gives (calculates) the excess return per unit of risk, however, it uses systematic risk while the Sharpe ratio uses total risk. The Treynor measure is calculated by using the equation below (Bodie *et al.*, 2005:868):

$$T = \frac{(\bar{r}_p - \bar{r}_f)}{\beta_p} \quad (4.2)$$

where:

\bar{r}_p is the average portfolio rate of return for a specific time period,

\bar{r}_f is the average rate of return on a risk-free investment for the same time period and

β_p is the slope of the fund's characteristic line during that time period (indication of portfolio's relative volatility).

As the numerator is the risk premium and the denominator is a measure of risk, the total expression presents the portfolio's risk premium return per unit of risk. It should be remembered that beta measures systematic risk and is not an indication of the portfolio's diversification. Again, the higher the T value (Treynor measure result) the better for all investors (regardless of their risk preferences). It should be noted that the Treynor measure, Sharpe ratio and Jensen measure are all often used to rank the performance of fund or portfolio managers (Reilly & Brown, 2006:1049).

4.4.2.5 Sortino ratio

"A variation of the Sharpe ratio which differentiates harmful volatility from volatility in general by replacing standard deviation with downside deviation in the denominator. The Sortino ratio measures the return to "bad" volatility. This ratio allows investors to assess risk in a better manner than simply looking at excess returns to total volatility, since such a measure does not consider how often the price of the security rises as opposed to how often it falls." (Investorwords, 1997e:1).

The Sortino ratio uses downside semi-variance instead of standard deviation in the denominator and is thus a ratio that measures the return deviation below a minimal acceptable rate (as determined by the portfolio or fund manager). The Sortino ratio is calculated by subtracting the risk-free rate from the portfolio return, divided by the downside deviation. This is shown in the equation below (Botha, 2005:42):

$$\text{Sortino Ratio} = \frac{(r_p - r_b)}{\sigma_d} \quad (4.3)$$

where:

r_p is the return of the portfolio,

r_b is the return of the benchmark or risk-free rate and

σ_d is the downside volatility of the portfolio returns.

The Sortino ratio is thus the actual rate of return in excess of the rate of return of the investor (per unit of downside risk).

The Sharpe ratio is used far more in the hedge fund environment as opposed to the Sortino ratio (Investorwords, 1997e:1). The fact that the Sharpe ratio uses standard deviation may be a reason, as the standard deviation is a more traditional volatility measure. The Sortino ratio on the other hand is used more by funds with the least risk tolerance (Botha, 2005:42).

4.4.2.6 Jensen measure

This measure is very similar to the measures discussed above as it is based on the CAPM. According to Reilly and Brown (2006:1049) the expected one-period return on any security or portfolio is calculated as follows by all CAPM versions (Reilly & Brown, 2006:1049):

$$E(R_j) = RFR + \beta_j [E(R_M) - RFR] \quad (4.4)$$

where:

$E(R_j)$ is the expected security or portfolio j 's return,

$E(R_M)$ is the expected return on the market portfolio of risky assets,

RFR is the one period risk-free interest rate and

β_j is the systematic risk for the security or portfolio j .

As the expected return and risk-free return vary for different periods, the investor will be concerned with the time series of expected rates of return for the specific security or portfolio.

The Jensen measure contrasts with the Sharpe and Treynor measures, which examine the average returns for the total period for all variables (the market, the portfolio and the risk-free asset), as it requires different risk-free rates for each time interval during the sample period (Reilly & Brown, 2006:1050). Reilly and Brown (2006:1050) state that the fund's annual return less the return on risk-free assets for each year should be examined and related to the annual return on the market portfolio less the same risk-free rate, if the performance of the fund manager over e.g. a 10-year period (using yearly intervals) is to be examined.

The Jensen measure (like the Treynor measure) does not directly consider the portfolio manager's ability to diversify as it calculates risk premiums in terms of systematic risk (Reilly & Brown, 2006:1051). Furthermore, "*Jensen's analysis of mutual fund performance indicated that complete diversification was a reasonable assumption for funds that are correlated with the market at rates above 0.90*" (Reilly & Brown, 2006:1051).

4.4.2.7 Information ratio

The information ratio performance measure is also known as the Appraisal ratio and it is defined as the "*average return in excess of that of a comparison or benchmark portfolio divided by the standard deviation of this excess return*" (Reilly & Brown, 2006:1051). Otherwise stated the information ratio divides the portfolio alpha by the portfolio's nonsystematic risk ("tracking error") (Bodie *et al.*, 2005:868). Thus this measure measures abnormal return per unit of risk. The information ratio is defined as "*the highest ratio of annual residual return to residual risk that the manager can obtain*" (Grinold & Kahn, 2000:113.). The information ratio is given by (Reilly & Brown, 2006:1051):

$$IR_k = \frac{\bar{R}_k - \bar{R}_b}{\sigma_{ER}} = \frac{ER_k}{\sigma_{ER}} \quad (4.5)$$

where:

IR_k is the Information ratio for portfolio k ,

\bar{R}_k is portfolio k 's average return during the specified time period,

\bar{R}_b is the benchmark's average return during the period,

σ_{ER} is the standard deviation of the excess return during the period and

ER_k is the excess return for portfolio k .

According to Reilly and Brown (2006:1051) the excess return in the numerator represents the ability of the investor to generate a portfolio return which differs from the benchmark return (against which the manager's performance is measured). According to Grinold and Kahn (2000:114) a reasonable information ratio should range between 0.50 and 1.00, with 0.50 being good, and 1.00 being exceptional.

The information ratio, however, is not a very popular measure amongst hedge funds for the reason that opinions surrounding appropriate benchmarks differ (Botha, 2005:44).

4.4.2.8 Omega ratio

Although investors are mostly concerned with average volatility, larger moves of a portfolio's returns are of more concern to investors. Large outliers (in both tails of their distributions) are commonly associated with hedge fund returns, depending on the investment strategy used (Botha, 2006:5). Hedge funds' return distributions are non-normal and thus their performance can not be evaluated within a mean-variance framework as a measurement tool, which acknowledges several order moments of the distribution function, is required.

The Omega function or ratio (depending on how it is used) is a relatively recent development which is based on interpretations of existing performance measurement techniques. This measure divides returns into both losses and gains above and below a return threshold and ultimately determines the probability-weighted ratio of returns above and below this threshold (Botha, 2006:6). The Omega ratio is given by (Botha, 2006:6):

$$\Omega(r) = \frac{\int_{\tau}^{\infty} (1 - F(R_i)) dR}{\int_{-\infty}^{\infty} f(R_i) dR} \quad (4.6)$$

where:

$\Omega(r)$ represents the Omega ratio evaluated at a chosen threshold, τ ,

$F(\cdot)$ is the cumulative density function for the total returns on an investment and

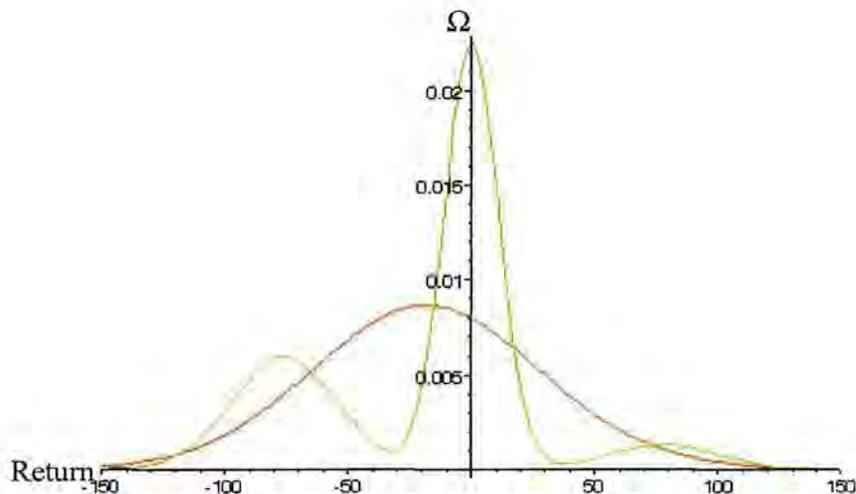
R_i is the random one-period return on an investment or fund.

The Omega measure is different to most performance ratios as the ratio expresses gains to losses rather than in the form of (expected) return/risk. This, however, results in the Omega being sensitive to the potential for excess returns and not only the mean return. Because the measure acknowledges and considers the entire distribution function of the specific investment it is very well suited for use as a performance evaluator of hedge funds (Botha, 2006:6). It should be noted that at least 40-50 observations are necessary in order to obtain stable results, as the ratio is sensitive to sample size. Another point worth noting is that the

level of the threshold is selected by the practitioner with no level being “better” than another (Botha, 2006:6). The threshold level selected merely reflects a particular risk preference.

Botha (2006:1) stated that the Omega is a superior measure to both the Sharpe and Sortino ratios while Keating and Shadwick (2002:2) are of the opinion that the Omega is a better risk measure than both the Sharpe ratio and the Jensen measure. The Omega function according to Botha (2006:6) is simply the Omega ratio evaluated at all threshold levels from the highest to the lowest observed return. Figure 4.5 is an example of the Omega function.

Figure 4.5: Example of an Omega function.



Source: Keating & Shadwick (2002:12).

Botha (2006:6) stated that in order to understand the shape of the Omega function and the information provided by it, it is instructive to consider the extremes of the function. Botha (2006:6) continued by stating that to the left of the X -axis origin, (as the threshold value is chosen to be increasingly negative) fewer and fewer returns will count as losses in the data set. The threshold will be lower than the lowest return (at some point) in the data set, at which the ratio tends to infinity as the denominator in Equation 4.6 becomes 0. The sooner the ratio heads for infinity, the less risky the portfolio is on the downside as this means that there are few, or not very large, negative returns. When moving to the right of the X -axis origin, increasingly fewer returns greater than the threshold are found while eventually no returns greater than the threshold are found. Botha (2006:6) stated that at this point the

numerator (and thus the ratio) becomes 0. The potential for positive returns or gains becomes greater the slower the Omega ratio tends to 0. In general the steeper the slope of the Omega function (in the downside), the lower the risk. For further reading on the Omega ratio and function (measured at all thresholds) refer to Polakow *et al.*, (2005), Urbani (2005), Kazemi *et al.*, (2003) and sources therein.

4.4.2.9 Summary

There are a wide variety of measures, each measuring something slightly different. It should be noted that the discussion regarding performance measures does not include all existing performance measures, but only the measures most relevant to this study. Some of the performance measures which are discussed will be used in the empirical study as a ranking based comparison tool. Of the tools discussed, standard deviation is a very widely used and recognised measure of risk and will be used in the empirical study. The Sharpe ratio, as discussed in Section 4.4.1.2, is also regarded highly by fund or portfolio managers as a valuable tool. The relatively new Omega function or ratio is, however, gaining the support of portfolio and investment managers as it is very easy to calculate while it also incorporates large amounts of information. The Omega is also flexible and is being used by more and more investment professionals in order to gain insight and perform in-depth analysis. The Omega will be extensively used in the empirical study as it is not only a relatively new measure which shows potential, but also as many investment professionals support it as the best risk measure to date.

This section examined different fund performance ratios or measures. In the following section, asset allocation will be briefly discussed as it was pointed out in Chapters 2 and 3 that asset allocation plays an important and large role in portfolio construction as well as portfolio management.

4.5 Asset Allocation

4.5.1 Introduction

This discussion on asset allocation is of interest as asset allocation has an impact and is relevant to portfolio construction but also to portfolio management. This section is thus additional information that is relevant to this study as asset allocation is related to portfolio management. However, as asset allocation is not the main focus of this study it will only

be discussed briefly. Asset allocation will firstly be defined whereafter it will be explained briefly. Lastly, some academic studies regarding asset allocation will be presented.

4.5.2 Asset allocation defined

Asset allocation is defined by Reilly and Brown (2006:37) as *“the process of deciding how to distribute an investor’s wealth among different countries and asset classes for investment purposes.”*

In the definition above “asset class”, is defined as follows (Reilly & Brown, 2006:37):

“an asset class is comprised of securities that have similar characteristics, attributes, and risk/return relationships.”

The term “asset allocation” is defined differently by different parties, but there is no benefit in examining a large number of different definitions as this might only create confusion. A more complete definition of the term might, however, be useful. Asset allocation is more completely defined as (Investorwords, 1997a:1):

“the process of dividing investments among different kinds of assets, such as share, bonds, real estate and cash, to optimize the risk/reward tradeoff based on an individual’s or institution’s specific situation and goals.”

The next step would be to allocate a precise and optimal amount or weight to each asset class in order to ensure an optimal investment portfolio is the result. The term “optimal” refers to achieving the maximum return for a given level of risk.

4.5.3 Brief explanation of asset allocation

As the best performing asset is not easily predicted by investors and the performance of assets varies yearly, however, the idea behind “asset allocation” is to mix different classes of assets to meet the investment objectives of the investor. It can otherwise be stated that “asset allocation” is the notion of different asset classes offering non-correlated returns, which reduces the overall risk (in terms of return variability for a given level of expected return) by means of diversification. The correlation between security returns not only affects the asset allocation decision as the correlation between the different asset classes has an impact on the diversification of an investment portfolio. In order to reduce the risk of the investment portfolio, effective diversification is needed. Informed diversification decisions must thus be made based on the principles of diversification, of which asset alloca-

tion is part. In short, effective and optimal asset allocation has a substantial impact on achieving effective diversification in an investment portfolio.

Asset allocation is an investment strategy with an objective of balancing risk and reward by means of apportioning a portfolio's assets according to the investors' risk appetite or tolerance, goal and investment horizon. It should be remembered that the four main asset classes (cash, fixed-income, equity and property) do not have the same levels of risk and return, thus each of these asset classes will behave differently over time and thus asset allocation provides investors with exposure to a spread of investments.

Although there is no general formula for the correct asset allocation for each investor, most financial professionals agree that asset allocation is one of the most important investment decisions made by investors (Investopedia, 2008a:1).

To further explain different asset classes, a categorical example is required. Different asset classes include:

- Shares: large-cap or small-cap; value or growth; domestic, foreign, emerging markets,
- Bonds: junk or investment grade; government or corporate; insurance, intermediate, long-term, short-term; domestic, foreign, emerging markets,
- Cash,
- Foreign currency,
- Real estate,
- Precious Metals,
- Natural resources,
- Collectables (art or wine), and
- Others.

Equity investments can be broken down into additional asset classes. It is important to focus on equity investments as this study is mainly concerned with equities. Equities may be distinguished by:

- Blend, growth, value,

- Small-cap, mid-cap, large-cap,
- Foreign or emerging markets, and
- Real Estate Investment Trust (REIT).

Asset allocation plays a vital role in diversifying an investment portfolio. Effective and optimal asset allocation also translates into a more (or better) diversified portfolio.

The importance of asset allocation has been explained and discussed on many occasions by academics. The following section will discuss the academic studies concerning asset allocation.

4.5.4 Academic studies regarding asset allocation

A study in 1986 by Brinson, Hood and Beebower (BHB) and a follow-up study in 1991 found that simple asset allocation worked just as effectively as, if not better than, professional managers (e.g. pension funds). This study, known as the BHB study, is often referred to by financial advisors to support the view that asset allocation is more important than all other concerns (Brinson, Hood & Beebower, 1986:50).

Another study followed in 2000 by Ibbotson and Kaplan that used five asset classes consisting of: small-cap US shares, large-cap US shares, non-US shares, US bonds and cash (Ibbotson, 2000:1). Ten years of 94 US balanced mutual funds returns versus corresponding indexed returns were examined. The actual returns once again failed to outperform the returns generated by the index, even after proper adjustment for index running costs were made. Hereafter a paper by Statman in 2000 found that a hypothetical advisor with perfect foresight in “tactical” asset allocation performed 8.1% better per year (Statman, 2000:1). (The same parameters, as in the BHB study, were used in Statman’s paper).

In the studies discussed above many questions were raised surrounding the variance. Statman (2000), however, concluded that the variance does not explain performance and that asset allocation is movement along the efficient frontier, while tactical asset allocation is the movement of the efficient frontier. It is, however, clear that a great deal can be learned from past studies and that asset allocation should be considered important for portfolio construction and management. The following discussion of this chapter will focus on indices and benchmarks, as indices are often used as performance benchmarks for both funds and for the managers managing the funds. The second reason for the discussion of indices

and benchmarks is that a market index is traditionally used (regression analysis) to measure fund or portfolio diversification (Smith, 2006:2).

4.6 Indices and benchmarks

4.6.1 Introduction

The previous section discussed the fact that benchmarks and indices are important and relevant to this study. A market index is often used to measure the diversification of a fund or portfolio by regressing the returns of a fund against the returns of the market index. Secondly, an index is often used to act as a performance benchmark for funds and the managers managing the funds (JSE, 2005c:1). This discussion, however relevant, will be brief as this information is for background purposes.

4.6.2 Definition of an index

A market index is defined as “*an index which is designed to measure price changes of an overall market, such as the share market or the bond market*” (Investorwords, 1997d:1).

Another definition of an index is “*a statistical measure of the changes in a portfolio of shares representing a portion of the overall market*” (London Stock Exchange, 2008:1). Furthermore, it is of value to be aware that the primary purpose of an index is to reflect the aggregate movement of the market it represents and thus that a single index value would be without meaning if it is not compared to a previous value (JSE, 2005c:1).

4.6.3 Uses of indices

Just as the All Share Index (ALSI) is used in the South African market, indices can be used as a benchmark and thus the indices will act as a proxy for companies listed on the Johannesburg Stock Exchange (JSE). Furthermore, indices can also be used for performance measurement, for example, the Industrial Index can be used to measure the performance of the industrial sector. Fund management companies generally set the manager of a specific fund (which is administered and managed by the company) a benchmark in terms of performance. The goal of the fund manager could possibly be to equal the performance of a

specific market index, for example the FTSE/JSE⁶ Shareholder Weighted Index (SWIX) and thus this market index acts as a performance benchmark (JSE, 2005c:1).

Indices are calculated from different base values, thus the percentage change is of more importance than the actual numerical value. It should be noted that technically an investor can not actually invest in an index, but the investor can invest in products like Exchange Traded Funds (ETFs) or derivatives which are based on these indices. Arguably the most well known EFT in South Africa is the SATRIX range which includes the SATRIX40, SATRIX FINI and SATRIX INDI amongst others. The ETFs thus provide investors with another diversification instrument, but as this is not the focus of this study they will not be discussed.

This section has explained the uses of an index or indices briefly while Section 4.6.1 defined an index. The subsequent section will focus on how a benchmark is determined as indices are at times used as benchmarks.

4.6.4 Benchmark determination

A benchmark is defined as follows (Dictionary.com, 2006:1):

- *“a standard of excellence, achievement, etc., against which similar things must be measured or judged.”*
- *“any standard or reference by which other can be measured or judged.”*

As an index (or indices) is often used as benchmarks for the performance of both investment funds and the managers managing the funds, it is important to understand what properties constitute an effective benchmark. It is important to understand this as the fund manager or company managing the fund normally sets (decides) on the benchmark(s) for a fund. The following are properties of effective benchmarks (Philbin, 2005:1):

- **Investable:** The option should exist to invest in the benchmark as an alternative to the portfolio under consideration,
- **Unambiguous:** The easiest manner in which to ensure ambiguity for a benchmark is by clearly defining the identities and weights of securities or factor exposures,

⁶ The FTSE/JSE Africa Index is a result of a joint venture between the JSE Limited (JSE) and the FTSE Group (FTSE) (JSE, 2005c:1). The FTSE Group calculates over 120,000 indices covering more than 77 countries and all major asset classes (FTSE, 2008:1).

- **Measurable:** The return should be readily available or calculable,
- **Appropriate:** The benchmark's main characteristics should be consistent with those of the portfolio being measured against it and/or reflect the manager's style,
- **Informed option:** The investments in the benchmark and how they perform are understood, so the performance of the portfolio against the benchmark can be explained, and
- **Specified in advance:** The benchmark and its constituents should be known by all interested parties before an evaluation period begins.

4.6.5 Summary

The discussion of indices and benchmarks has mentioned that indices are important to investment funds as these indices are used to gauge performance for both the funds themselves as well as the fund managers. Furthermore, an index is used by the residual variance method of measuring diversification as this method uses a regression analysis of the fund returns and (versus) the returns of a market index.

4.7 Conclusion

This chapter discussed a number of topics with the main and broad discussion focusing on markets, funds and performance measures.

Markets was included and discussed in this chapter as the elements that make up a portfolio or fund are traded in markets. A good market was defined while the elements or characteristics that make up a good market were also touched on. Markets were classified and the concept of efficient markets discussed, where after the Efficient Market Hypothesis and the three forms of the EMH were discussed and differentiated.

The discussion surrounding funds also covered several topics, although these topics are all relevant and important in some manner to the broader discussion of funds. The discussion regarding funds focused on hedge funds, mutual funds and also more specifically unit trusts. These different types of funds were not only defined, their origins were discussed, and they were also differentiated from each other. The advantages and disadvantages that the different types of funds offer further differentiated the funds. Lastly, the different types or styles relevant to each specific fund were focused on.

The discussion relating to fund performance touched on a number of different well known and widely used performance measures. Omega was also included in this section even though this measure is relatively new, the measure has won acclaim from a number of areas.

The closing part of this chapter briefly focused on asset allocation, indices, benchmarks and how they fit into the diversification and portfolio picture or setting.

The aim of this chapter was to provide background on a number of topics which are related and important to portfolio management and this study. Markets were discussed as the financial instruments that funds or portfolios consist of are traded in these markets (EFTs). From this discussion it is clear that different markets exist and that markets can operate in different manners. The ideal or perfect market is what is strived for, but even though no market is perfect the aim is to have a market that is as efficient as possible. The discussion regarding markets would provide valuable to any (potential) investor even though markets are not the main focus of this study.

It is shown in the discussion regarding funds that there are a large number of different funds to choose from, both locally and abroad and that funds have become complex and sophisticated in the manner they are constructed. It is also very apparent that each fund has a specific aim (for example consisting of specific financial instruments or achieving a specific return) and is thus managed accordingly. It is also important to highlight that the South African fund industry is prospering and that the tightened hedge fund regulations will aid in the industry's future growth. The discussion on funds is important to any investor and also to this study as funds (unit trusts) will be analysed and involved throughout the empirical study.

The last focus of this chapter was performance measures or ratios. A number of performance measures were discussed, each being different with its distinct advantages and disadvantages. Most of the performance measures discussed in this chapter will be used in the empirical study in aid of this study's objective and thus the inclusion of this topic.

The following chapter will discuss the main focus of this study, namely the PDI.

Chapter 5

Portfolio Diversification Index

5.1 Introduction

This chapter will present the relatively new diversification measure known as the Portfolio Diversification Index (PDI). The objective of this study is to determine both if the PDI is a good diversification measure and if it can be used as a tool by fund managers when constructing and managing portfolios. It is important to note that the PDI also enables portfolio managers to compare diversification across different portfolios and different time periods, while also ascertaining whether the addition of new securities improves the diversification of a specific portfolio and by how much.

The previous chapters discussed the most relevant information in support of understanding the aspects of investments, portfolio theory, portfolio management and diversification. The aim of this chapter is thus to explain how the PDI is constructed or calculated and also how it should be interpreted.

This chapter also carries importance as the PDI will be extensively used in the empirical study, which will be discussed in Chapters 6 and 7.

This chapter will firstly discuss some past studies on diversification where after an introduction to PDI will follow which will briefly provide some background information on the PDI measure. This background section is important as it serves as the foundation for understanding the PDI.

5.2 Past diversification studies

The largest number of studies about diversification consider the benefits and advantages of portfolio diversification. A number of these studies do deliver semi-quantitative methods which at times provide a vivid picture of diversification (Smith, 2006:11). Sophisticated models like the GARCH model do, however, provide a better and clearer picture than other methods. It is furthermore debateable if any of these methods provide a concrete measure of diversification.

A correlation matrix of asset historical returns is one manner which attempts to provide a portfolio diversification picture (Dophel, 2003; Toikka *et al.*, 2004) while Lhabitant (2004)

makes use of different types of cluster analysis. These measures, however, do not provide a quantitative measure of portfolio diversification (Smith, 2006:12).

The subsequent section will introduce the PDI, with the sections that follow continuously introducing the elements pertaining to the construction and interpretation of the index.

5.3 Background to the PDI

The traditional and most widely used (in practice) method of measuring diversification is measured relative to a market index (the residual variance method), but if the market index itself is not properly diversified it could be problematic in the sense that the diversification measure would not be reliable. A new measure of diversification, PDI, evaluates the diversification of a portfolio quantitatively and also overcomes the problem of market influence faced by other methods, specifically the “traditional” residual variance method (Smith, 2006:12).

This “new” diversification measure, which is free from market influence or any market indices, was proposed by Rudin and Morgan (2006). This measure, known as the Portfolio Diversification Index (PDI), is constructed using Principal Component Analysis (PCA). “*The PCA quantifies the number of truly independent factors in a portfolio*” (Smith, 2006:12.) The diversification properties of a portfolio are then conveyed by means of the relative strength of these factors (Smith, 2006:12).

The PDI enables portfolio managers to compare diversification across different portfolios and over different time periods, while also ascertaining whether the addition of new securities improves the diversification of a specific portfolio and by how much (marginal PDI) (Smith, 2006:12). The PDI is therefore a very valuable measure to any portfolio manager who wishes to compare diversification across different portfolios and different time periods. Furthermore, as the PDI can be used to ascertain whether the addition of a new security or securities improves the diversification of a particular portfolio while also quantifying the magnitude, makes the PDI even more useful and valuable. The latter will be explored and analysed in Chapter 7.

Principal Component Analysis (PCA) forms an integral part of the PDI’s construction and is the focus of the next section.

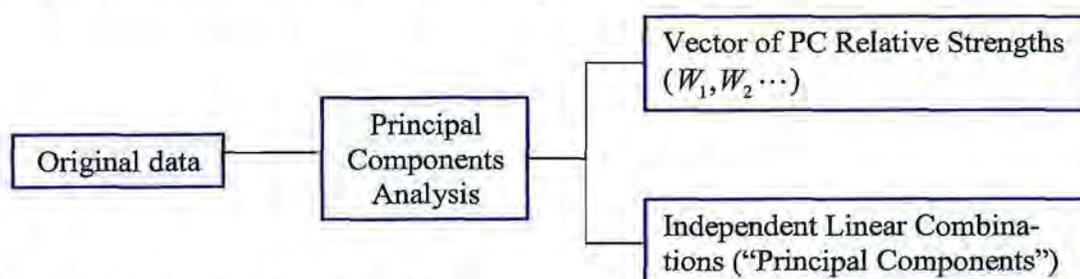
5.4 Principal Component Analysis (PCA)

The Principal Component Analysis (PCA) is important as it is used to construct the PDI. This section will focus on PCA and the mechanics thereof.

Principle components were first proposed by Pearson (1901) while Hotelling (1933) is credited with further development thereof. PCA has been used in hedge fund studies before, starting with work by Fung and Hsieh (1997). PCA is a mathematical procedure that transforms correlated variables into the same number of uncorrelated variables, referred to as principal components (Jolliffe, 1986:337). *“The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible”* (Rudin & Morgan, 2006:82). It should be noted that the focus is not on the factors or variables themselves, but only on the makeup of their relative strength and how that strength delivers the diversification characteristics of a portfolio. One great advantage the PCA has is that it reduces the problem of diversification by reducing the number of variables (usually significantly less than N) without losing diversification information (Smith, 2006:12). This is supported by Jolliffe (2002:1) who explained that the central idea of PCA is to reduce the dimensionality of a set of interrelated variables, while as much variation as possible is retained. This results in information which is more manageable for a portfolio manager and might in, a practical sense, be time saving.

PCA transforms correlated variables into uncorrelated variables (Figure 5.1), which are known as principal components and these principal components are ordered in such a way that the first variable accounts for as much of the variation in the data as possible. Each successive component then accounts for as much of the remaining variation as possible (Smith, 2006:13).

Figure 5.1: Schematic of Principal Components Analysis.



Source: Rudin and Morgan (2006:82).

PCA can be conducted on either covariance or correlation matrixes, although Rudin and Morgan (2006:82) regarded a correlation matrix inappropriate for quantitative portfolio analysis because of its radical inefficiency. For the purpose of this study the absolute contribution of each share to the variance of a portfolio must be determined. Thus, the historical returns are weighted by the actual portfolio weights (at a specific point in time which remains fixed) and a covariance matrix used for the analysis.

The vector, $\hat{r}^{(k)} = \{\hat{r}_t^{(k)}\}$, will represent the returns with (k) representing the number of a particular share. A covariance matrix (C) of share returns must now be calculated using the return vectors. Equation 5.1 must be used for this calculation (Smith, 2006:13):

$$C_{k,l} = \text{Cov}(\hat{r}^{(k)}\hat{r}^{(l)}) \quad (5.1)$$

where:

$\text{Cov}(\hat{r}^{(k)}, \hat{r}^{(l)})$ is a covariance of vectors $(\hat{r}^{(k)})$ and $(\hat{r}^{(l)})$.

The eigenvalues $\hat{\lambda}_k$, and eigenvectors \hat{e}_k of the covariance matrix (C) are needed in order to evaluate the principal components (Anton & Rorres, 1994). By definition, the eigenvalues $\hat{\lambda}_k$ and eigenvectors \hat{e}_k are solutions to Equation 5.2 while \hat{I} is an identity matrix⁷ (Smith, 2006:13):

$$(\hat{C} - \hat{\lambda}_k \hat{I})\hat{e}_k = 0 \quad (5.2)$$

According to Jolliffe (2002:1) the eigenvalues (principal components) which are generated are uncorrelated and ordered so that the first few retain most of the variation present in all of the original variables, thus they are ordered by declining variance, $\lambda_1 \geq \lambda_2 \geq \dots \lambda_N$. For a detailed review of PCA and its applications see Jolliffe (2002) or Rencher (1998).

PCA ultimately presents the picture of diversification in such a way that it can be used to construct the PDI, which is a comprehensive and single measure of portfolio diversification. The following section will continue with the discussion and explanation regarding the process of constructing the PDI.

⁷ The identity matrix of size n, is the n-by-n square matrix of with ones on the main diagonal and zeros elsewhere (Renchor, 1998:400).

5.5 Portfolio Diversification Index construction

This section will discuss the construction of the PDI.

The next step is to calculate the percentage of the total variance that each component has in the portfolio. Equation 5.3 states the percentage of the total variance (relative strength) attributed to the i -th component (Rudin and Morgan, 2006:89):

$$W_i = \frac{\lambda_i}{\sum_{k=1}^N \lambda_k} \quad (5.3)$$

where:

W_i is the percentage of the total variance attributed to the i -th component and the sum of the weights is always equal to 1.

The principal components of the portfolio and their relative strengths are evaluated by PCA when the historical returns of the portfolio composition are known. The vector of the component's relative strengths indicates how many truly independent components the chosen portfolio has and also what their relative strength are (Smith, 2006:14). The vector mentioned above provides complete information about the diversification magnitude of the portfolio. Rudin and Morgan (2006:82) define the PDI as in Equation 3.27:

$$PDI = 2 \sum_{k=1}^N k W_k - 1$$

where:

N is the number of assets and

W_k is the percentage contribution of factor k to total volatility.

The PDI is defined by (Smith, 2006:14) as “*a centre of mass of the principal components relative strengths vector.*” This means that the PDI is the centre of gravity or the balancing point of the independent components (Gopi *et al.*, 2006:6). The diversification properties are thus summarised into a single variable by the PDI.

According to Smith (2006:14) the PDI assists with portfolio design while managers are also able to assess whether the addition of new securities to the portfolio improves the diversification of the portfolio and by how much. The PDI can thus be used by managers to

diversify a portfolio to a desired level. Chapter 7 will explore whether or not the PDI can indeed be used as a tool by portfolio managers in aiding portfolio construction or when a portfolio is customised (the composition of an existing portfolio changed).

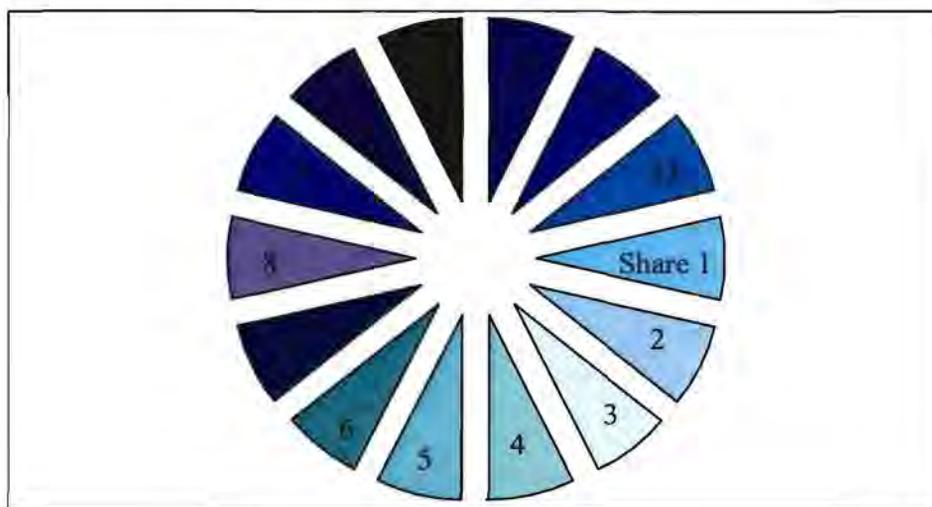
As the discussion regarding the construction of the PDI and also the components needed to construct the PDI is complete, the interpretation and further explanation of the PDI will be the next focus.

5.5.1 Further explanation of the PDI

The further explanation of the PDI will make use of a number of illustrations to explain the PDI clearly.

When the returns and risks associated with a certain portfolio arise from numerous different uncorrelated sources, the portfolio will be a highly diversified one. A highly diversified portfolio with many uncorrelated, equally weighted components is presented in Figure 5.2. It is important to note that each of the different, equally weighted components (shares) contribute to the volatility of the portfolio (Gopi *et al.*, 2006:5).

Figure 5.2: Graphical representation of a well diversified portfolio.



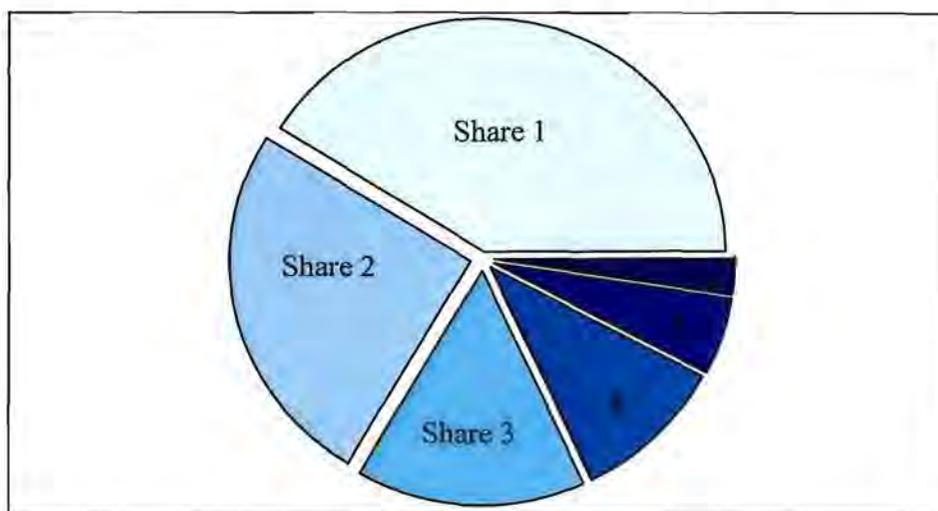
Source: Gopi *et al.*, (2006:5).

Concentration is, however, a major problem that affects the level of diversification and is discussed in Section 3.5.5. Traditionally, the diversification of portfolios is measured relative to a market index, however, when the market is concentrated (the Johannesburg Stock Exchange for example) portfolios are likely to be less diversified with less sources of vola-

tility (Smith, 2006:15). This situation is presented in Figure 5.3 from which it can be seen that when concentration is high within a portfolio the portfolio is less diversified and as a result the volatility sources are fewer, which in turn leads to higher (portfolio) risk (Smith, 2006:14).

The following section will continue with the explanation of the PDI although the focus will shift towards the interpretation of the PDI.

Figure 5.3: Graphical representation of a less diversified portfolio.



Source: Gopi *et al.*, (2006:6).

5.5.2 Explanation and interpretation of the PDI

“The PDI essentially evaluates the effective number of truly independent components within a portfolio” (Rudin & Morgan, 2006:81). As Section 5.5 on the construction of the PDI stated, Rudin and Morgan (2006:82) define their PDI as:

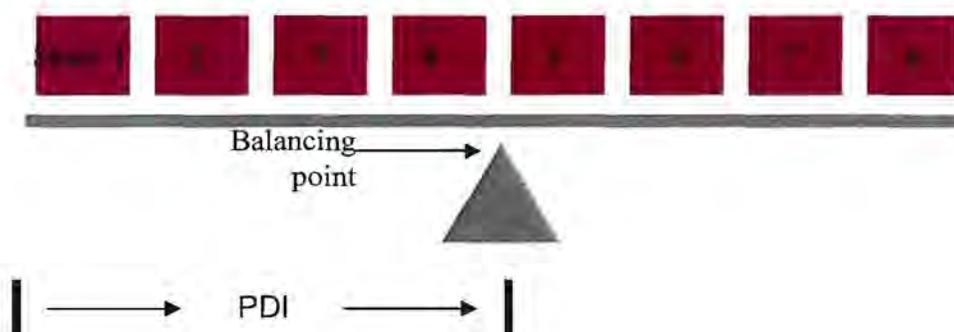
$$PDI = 2 \sum_{k=1}^N kW_k - 1$$

In Equation 3.27, N is the number of assets in the portfolio while λ_k (Equation 5.3) is the percentage contribution of factor k to the total volatility.

Thus the PDI measures how “front-loaded” the vector is and ultimately summarises the properties of diversification into one statistic.

According to Jolliffe (2002:1) the principal components are uncorrelated and are ordered (positioned) by declining variance. The contributions of the factors to the variability of the portfolio are ranked from 1 to N in decreasing order. The magnitude of the eigenvalue is known as the height and represents the degree of its contribution to the volatility. Figure 5.4 indicates the balancing point of such a portfolio with the hypothetical case of equal factors. As a result of the equal factors, the balancing point is in the middle (Gopi *et al.*, 2006:7). The balancing point of the portfolio should be as far over to the right as possible, indicating the largest number of independent factors (of the portfolio).

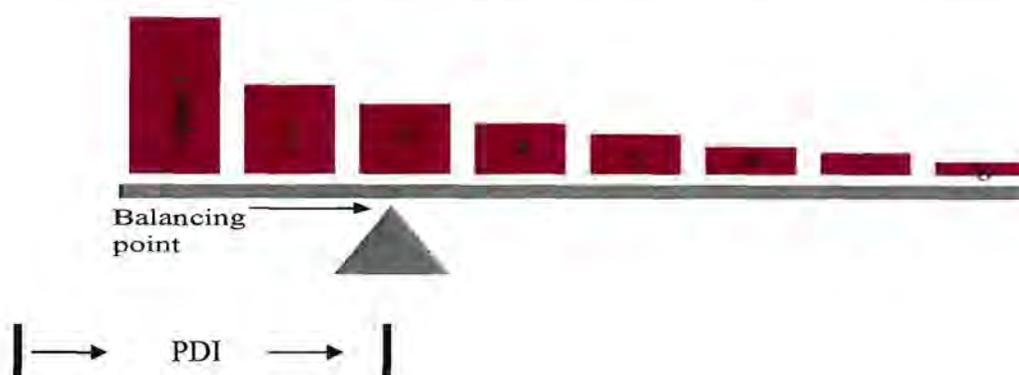
Figure 5.4: The maximum PDI in a hypothetical perfectly diversified portfolio.



Source: Gopi *et al.*, (2006:7).

Note that Figure 5.4 represents a diversification picture of an unrealistic hypothetical portfolio and the blocks in Figures 5.4 and 5.5 represent the components, for example shares, of this hypothetical portfolio. The problem of concentration has been discussed previously in Section 3.5.5 and in a market such as the Johannesburg Stock Exchange, the volatility contribution of the large factors is likely to be far more than the contribution of the smaller factors (Smith, 2006:16). The first few factors would thus dominate causing the balancing point to shift to the left as illustrated in Figure 5.5.

Figure 5.5: PDI in a hypothetical portfolio influenced by concentrated factors.



Source: Gopi *et al.*, (2006:7).

It can be concluded that a portfolio with a smaller PDI is the result of a less diversified portfolio.

The PDI has the following properties according to (Rudin & Morgan, 2006:82):

- a portfolio dominated by a single factor is completely undiversified, ($W_1 \approx 1, W_2 \leq k \leq N \approx 0$), and has a PDI = 1,
- a portfolio which is ideally (completely) diversified ($(W_k \approx 1/N$ for all k), will have a PDI = N, where N is the number of assets in the portfolio, and
- any positive change in front-loading (explanatory power moves from W_k with higher k to W_k with lower k) reduces the index.

It is clear that a high(er) PDI score is an indication of a more diversified portfolio. The term “high(er)” refers to a PDI score approaching N (the number of assets in the portfolio). A low(er) PDI score is then an indication of a less diversified portfolio with a PDI score of one being indicative of a completely undiversified portfolio. As indicated in Section 5.5.2 the PDI score indicates the effective number of truly independent components within a portfolio. For example, if a portfolio consisting of 30 assets has a PDI score of four it is an indication that the particular portfolio contains four truly independent components. It is also true that if portfolio X has a PDI score of five and portfolio Y has a PDI score of seven, portfolio Y is more diversified than portfolio X as it has a higher PDI score.

5.6 Process to construct the PDI

This section will briefly set out the process to construct the PDI. The same process was followed for the empirical study (see Chapter 6). The required data will first be named whereafter the procedure to construct the PDI will be named.

The data required in order to calculate the PDI are:

- current compositions of the fund under investigation, and
- return history of all the shares held in the fund being investigated.

The procedure to calculate the PDI is:

- construct a column consisting of the time series of share returns, which make up the fund, multiplied by the respective weight of the N shares in the fund,
- conduct a Principal Component Analysis (PCA) on the covariance matrix of these series giving a series of uncorrelated factors (eigenvalues) that represent the volatility of the returns is the result of the PCA,
- order these factors from most to least significant, and
- substitute these factors into the PDI formula (Equation 3.27).

The following section will explain the two approaches in measuring the PDI as it is important to understand the difference between the two approaches.

5.7 Two different PDI approaches

In addition (and for the sake of completeness) it is important to mention that the paper by Rudin and Morgan (2006) proposes or describes two approaches to measure the PDI: (a) one for a portfolio and (b) one for a collection of assets without considering any particular portfolio. The difference between the calculations is shown in Table 5.1.

The main difference between the two approaches is the use of a covariance matrix in a portfolio setting and the use of a correlation matrix in a portfolio-free setting. This is because the interaction between the elements (financial instruments or assets) which make up a portfolio are of importance, especially for the diversification of the portfolio.

Table 5.1: Two approaches to measuring the PDI.

	PDI Measure	
	Portfolio	Portfolio-Free
Step 1	Find a time-series of asset returns times portfolio weight for each asset in the portfolio.	Find a time-series of returns for each asset.
Step 2	Find the covariance matrix of the time-series columns in step 1.	Find the correlation matrix of the time-series columns in step 1.
Step 3	Perform a PCA of the covariance matrix.	Perform a PCA of the correlation matrix.
Step 4	Order the eigenvalues from largest to smallest.	Order the eigenvalues from largest to smallest.
Step 5	Substitute the values into the PDI formula.	Substitute the values into the PDI formula.

Source: Gopi *et al.*, (2006:18).

The following section will focus on marginal portfolio diversification (by utilising PDI) as this can be used to ascertain how much diversification (in PDI terms) a certain asset adds or destroys in an existing portfolio. Marginal portfolio diversification will also be used in Chapter 7.

5.8 Marginal portfolio diversification

The PDI can also be used as a “marginal” calculation: marginal portfolio diversification, to determine how much (additional) diversification is gained (or lost) by adding shares to the portfolio (Smith, 2006:21). The marginal portfolio diversification concept can thus be used by portfolio managers as a tool when constructing or customising (changing the composition of) an existing portfolio. This concept will be presented in Chapter 7.

Rudin and Morgan (2006:87) argue that PDI can make an important contribution to understanding and measuring diversification in portfolio management, as it captures one number which is the essence of the diversification of a portfolio or of a wide asset universe, while it can be used across both assets and time.

Marginal portfolio diversification can be defined as (Smith, 2006:21):

$$\text{Marginal PD}(K) = \text{PDI}(\text{Poolsize} = K) - \text{PDI}(\text{Poolsize} = K - 1) \quad (5.4)$$

where:

K is the number of assets in the portfolio.

Equation 5.4 shows that marginal portfolio diversification is calculated by subtracting the PDI score of the portfolio from which a certain asset has been removed from, from the PDI score of the same portfolio before the (same) asset was removed (Smith, 2006:21).

5.9 Summary

The aim of this chapter was to explain the PDI in more detail, specifically how it is constructed and how it should be interpreted. A detailed explanation of the PDI is necessary as it is this study's objective to ascertain whether or not the PDI is a good diversification measure (compared to the traditional residual variance method) and secondly if the PDI can be used as a tool by fund managers.

The PDI will be extensively used in Chapters 6 and 7 and thus this chapter provides the necessary information regarding the PDI in order to understand how the PDI works as well as how it should be interpreted.

The first focus of this chapter was on some past diversification studies. It is important to note that previous studies also found the correlation of the assets' historical returns important to diversification. Some background information on the PDI was thereafter discussed and served as an introduction to the PDI. This introduction to PDI made it clear that the PDI quantifies the number of independent factors in a portfolio. The main advantage of PCA is that it reduces the problem of diversification by reducing the number of variables while this in turn makes life easier for fund managers. The construction of the PDI was the next focus of this chapter. The rest of the chapter discussed how the PDI should be interpreted while also using illustrations to explain how concentration affects diversification. The final two topics of this chapter focused on (1) the two approaches to measure the PDI and (2) the marginal portfolio diversification concept by using PDI.

To conclude, the PDI evaluates the effective number of truly independent components within a portfolio while at the same time determining the balancing point of these independent components and then ultimately assigning a diversification score to the portfolio

ranging from 1 to N , where N = the number of assets in the portfolio. Furthermore, a high PDI score is preferred to a low PDI score. The PDI and its components will be incorporated practically in Chapters 6 and 7 in order to find a result for this study's objectives.

Chapter 6

Empirical study of the PDI as diversification measure

6.1 Introduction

This chapter will present the empirical study in order to ascertain whether or not the PDI is a good measure of diversification compared to the “traditional” residual variance method. The techniques used and performed will be discussed and the results presented. This chapter will also incorporate a number of performance measures (see Chapter 4) as they will aid in achieving the objective of this study.

This chapter will thus focus on the first objective of whether or not the PDI is indeed a good diversification measure and the PDI will go “head-to-head” against the traditional diversification method known as the residual variance method. There is, however, no statistical manner in which to gauge whether or not the PDI is a good or useful measure of diversification compared to the residual variance method, which is widely used in practice. The method used to ascertain results can be referred to as a ranking comparison method, where the ranking (of the funds) results of the performance methods are compared to the ranking results of the two diversification measures or methods (PDI and residual variance). Although the two diversification measures and the performance measures or ratios are not directly comparable as the measures measure different concepts, this concept of testing is adopted for there is no statistical method to do so. The central ideal is to ascertain whether or not the PDI is (better) in line with the (ranking) results of the performance measures, than the residual variance method. As concentration also has an impact on portfolio diversification the concentration ranking results will also be presented and compared against.

It is, once again, important to note that the research seeks to meet two objectives:

- Use of a new diversification measure, namely the PDI, to establish whether this new measure is a good measure compared the traditional diversification measure (residual variance method). The Herfindahl-Hirschman Index (HHI) will also be calculated in order to draw conclusions regarding concentration.
- Determining whether the PDI can be used as a tool to assist fund managers to improve the diversification and/or return of the respective funds under their manage-

ment. Thus, whether or not the PDI can be used as a tool by fund managers when constructing or customising (changing the composition) an existing portfolio.

Chapter 7 will focus on the second objective of this study of whether the PDI can be used as a tool by fund managers, especially when constructing or customising an existing portfolio.

6.2 Background and information for the empirical study

6.2.1 Introduction to the empirical study

The empirical research is conducted using three (randomly) selected growth funds (South African unit trusts) which were selected out of the entire South African unit trust growth fund sector. These funds will only be referred to as “Fund A”, “Fund B” and “Fund C”. An additional two funds (South African unit trusts) were also included in the research and it should be noted that these were not randomly selected, as they were chosen to act as comparisons. The first of these was the best performing growth fund in South Africa in return terms for the preceding five years according to Equinox (1999a:1), while the second of these funds was the best overall performing South African unit trust for the preceding five years. These funds are included in the research to compare how the three (randomly) selected funds match-up against these funds in terms of diversification and performance. These additional two funds, which are South African industry leaders in terms of growth funds and unit trusts (overall) respectively, can thus be seen as a benchmark for the three selected growth funds and will be referred to as “Fund D” and “Fund E”. It is important to note that Fund E is, however, not a growth fund but a small cap fund. The number of shares contained in each of the growth fund is shown in Table 6.1.

Table 6.1: Number of shares in each fund.

Fund Name	Number of shares
Fund A	33
Fund B	50
Fund C	34
Fund D	38
Fund E	50

Source: Compiled by the author.

Due to the fact that hedge funds were not effectively regulated during the past, data and performance information of these funds are not freely and consistently available, this methodological study will therefore focus on South African unit trusts which are well regulated in the form of the Collective Investment Schemes Control Act 45 of 2002. Unit trusts were discussed in detail in Chapter 4, where the difference between unit trusts and mutual funds are also detailed. Furthermore, it should be noted that in this chapter “fund” and “growth fund” refers to “unit trust” but also that “growth fund” is a certain type of unit trust.

6.2.2 The data

6.2.2.1 The funds

As explained in Section 6.2.1 all the funds in this empirical study are South African unit trusts. Section 6.2.1 also pointed out that Fund A, B, C and D are of growth fund type and that Fund D was the best performing growth type unit trust in South Africa in terms of five year performance (at the time of this study). Fund E, although the best performing unit trust in South Africa in terms of five year performance (at the time of this study), is not a growth fund type but a fund of a small cap nature. Both Fund D and E are included in this study in order to act as a comparison as they are respectively the best performing growth fund and the best fund overall in the South African unit trust market. It is also important to note that the average four year (1 July 2003 – 30 June 2007) risk-free rate (8.12%) of the R153 (South African government bond) was used as the risk-free rate.

6.2.2.2 PDI data

The historical weekly closing prices of the shares comprising the five funds over the preceding four year period, 1 July 2003 to 30 June 2007, were obtained from McGregor BFA.⁸ It is important to take note that all funds being analysed are based on the equity component holding only and that all cash and bonds are excluded from the portfolios. Furthermore, all the shares contained in the funds are selected from shares listed on the Johannesburg Stock Exchange while shares from all sectors could be included in the funds. Table 6.2 presents the sectors in which each fund is invested in as at 31 March 2007.

Besides the historic returns (calculated from the weekly closing prices) of each fund which was needed to construct the PDI, the composition or component weights for each fund are also a key part of the PDI construction or calculation process. The weight of each share in each fund was taken at 31 March 2007, as this date was not only the most recent but also the most reliable⁹ date available. The composition of the five funds was sourced from the Unit Trusts Survey (Department of Financial Management at the University of Pretoria). The PDI is calculated using the historic four year weekly returns for the period 1 July 2003 to 30 June 2007.

Table 6.2: Invested sectors of each fund.

Sector	Fund A	Fund B	Fund C	Fund D	Fund E
Apparel retailers	X	X	X	X	
Asset managers					X
Auto parts			X		
Automobiles			X		
Banks		X	X	X	
Broadcasting and entertainment		X	X		
Broadline retailers	X	X	X	X	X
Building materials and fixtures		X		X	X
Business support services	X	X	X	X	
Business training and employment agencies	X				X
Clothing and accessories	X	X	X	X	
Commercial vehicle and trucks					X
Computer services	X			X	X

⁸ McGregorBFA is a provider of stock market, fundamental research data and news to the financial sector and the corporate market (<http://www.mcgregorbfa.com/Default.aspx>, 2008:1).

⁹ With "reliable" is meant that this date provided the most "complete" data and/or information.

Sector	Fund A	Fund B	Fund C	Fund D	Fund E
Consumer electronics			X		
Consumer finance	X		X		
Distillers and vintners			X		
Diversified industrials	X	X		X	X
Electrical components and equipment		X		X	X
Electronic equipment					X
Farming and fishing		X	X		X
Fixed line telecommunications		X	X		
Food products	X	X		X	
Food retailers and wholesalers	X	X		X	
Furnishings	X	X	X	X	
Gambling				X	X
General mining	X	X	X	X	X
Gold mining	X	X	X		
Health care providers		X		X	
Heavy construction	X	X	X	X	X
Home improvement retailers	X	X	X		X
Industrial machinery			X		X
Industrial suppliers					X
Integrated oil and gas	X	X	X		
Investment services	X	X	X	X	X
Life insurance	X	X		X	
Marine transportation				X	X
Mobile telecommunications		X	X	X	
Paper	X	X	X		
Pharmaceuticals				X	
Platinum and precious metals	X	X	X	X	X
Property and casualty insurance			X		
Restaurants and bars				X	X
Specialty chemicals			X		X
Steel		X	X	X	
Transportation services		X	X		X
Waste and disposable services				X	X

Source: JSE (2005b:1).

Furthermore, a proxy was used for any “missing” or incomplete data, i.e. closing prices. This is due to the fact that some shares were not yet listed on the Johannesburg Stock Exchange (due to the time span of this empirical study) or that no closing prices were available. This problem was solved by backfilling these dates with a sector proxy. This proxy

comprises the returns of the sector that the share (which required backfilling) hails from the Johannesburg Stock Exchange. Thus, if, for example, Anglo American had missing data, the returns from the platinum sector were used to fill these gaps. This backfill method is used as the focus of this dissertation is the PDI and not on methods to estimate a covariance matrix in the presence of missing data.

6.2.2.3 Fund closing prices

It is important to note that a proxy was used for Fund C for the period 1 July 2003 to 31 March 2004 as data for this period were not available. The reason for the unavailability of data for this period was because Fund C was managed by two different fund management companies from 1 July 2003 to 31 March 2004 with the ruling fund management company (at that time) being acquired by another. The proxy used for Fund C during this period is an average of Fund A and Fund B's weekly closing prices for the corresponding week. As from 1 April 2004 to 31 June 2007 the correct weekly closing prices were used for Fund C as the second fund management company was acquired by a new (third) fund management company which managed Fund C until 31 June 2007. Thus it is important to note Fund C's proxy and that it should be taken into consideration when interpreting and analysing the results. This proxy, however, complicates the interpretation of the results as it is not 100% certain whether it is responsible for any unrealistic or unexpected results.

Section 6.4.1.1 is one area where this proxy might have played a role as Fund C performed phenomenally well in the first year of this study (July 2003 to June 2004).

6.3 PDI versus traditional diversification measures

The subsequent section will discuss how the PDI measure is calculated for this study while the PDI results will also be presented. Hereafter the focus will shift towards the traditional method of diversification namely, the residual variance method and its results. These two methods will be discussed, calculated and their results presented as these methods are to be compared to each other throughout this chapter. The aim of comparing these two diversification methods and their results is to be able to draw a conclusion about this study's objectives. This section will lastly focus on concentration and present the Herfindahl-Hirschman Index (HHI) along with the HHI results for each of the funds in this study. The concentration measure in the HHI will aid in ascertaining the objective of this study of whether or not the PDI is a good measure of diversification compared to the residual variance method.

6.3.1 The calculation of the Portfolio Diversification Index (PDI)

The data required and the process to calculate the PDI was presented in section 5.6. The PDI results are presented in the subsequent section.

6.3.2 The PDI results

The methodology as discussed in Chapter 5 and Section 6.3.1 was applied in this section. This section will present the results obtained for the PDI where after the results will be interpreted. In Section 6.3.5 the PDI results will be compared to the results of the residual variance method. Table 6.3 shows the results from the PDI calculation for each of the 5 unit trusts.

Table 6.3: The PDI results.

Fund	PDI	Fund Ranking
A	4.44	4
B	7.68	2
C	1.02	5
D	12.70	1
E	6.51	3

Source: Compiled by the author.

Gopi *et al.*, (2006:7) stated that for a completely undiversified portfolio which is dominated by a single factor the PDI =1, but for a completely diversified portfolio the PDI = the number of assets in the portfolio (N). Thus, the smaller the PDI measure the less diversified the particular portfolio, while a more diversified portfolio will conversely have a larger PDI measure.

The PDI results in Table 6.3, show that Fund D is by far the most diversified of the funds included in this study while Fund C is the least diversified. It is clear from Table 6.3 that none of the funds are completely diversified. For example, for Fund D (the most diversified of the funds in this study) to be completely diversified should have a PDI = 38, not 12.7. Another observation is that the PDI "scores" of all the funds analysed in this dissertation are closer to a PDI score (result) of 1 than the preferred PDI score which is the number

of shares within the portfolio. Table 6.4 is merely Table 6.3 (the PDI results) in sorted order from best to worst.

Table 6.4: PDI results of each fund in sorted order.

Fund	PDI	Fund Ranking
D	12.71	1
B	7.68	2
E	6.51	3
A	4.44	4
C	1.02	5

Source: Compiled by the author.

For the remainder of this chapter many of the results will be presented in sorted order, (i.e., from best to worst) according to the result of the method criteria. The results in Table 6.4 show that Fund D is the most diversified fund of all the funds included in the analysis, while Fund C is the least diversified. The subsequent section will use the traditional measure of diversification and present the results.

6.3.3 Traditional diversification measure

This “traditional diversification” measure as it is referred to by Gopi *et al.*, (2006:4), is an important measure of fund diversification according to Panwar and Madhuranthi (2006:4). According to Gopi *et al.*, (2006:4) “*traditionally the extent to which a portfolio is diversified is measured relative to the market index.*” In essence this involves calculating a regression of the portfolio returns against the returns of the market index (Gopi *et al.*, 2006:4). The extent of diversification still achievable in the portfolio will be represented by the variance of the residuals. In short, the residual variance thus measures the diversifiable risk remaining in the portfolio and by sticking to tradition, the smaller the residual variance, the more diversified the portfolio. Panwar and Madhuranthi (2006:3) make another important statement in that “*residual variance tends to decrease as the number of shares held by the mutual fund increases.*”

If the market index itself is not appropriately diversified (across industries), a serious problem, however, arises. Smaller markets have a higher tendency of having high market index

concentrations and a high concentration in a few industries can overpower the diversification effect of other industries. In South Africa, the problems of concentration are widespread, especially in the resource sector, where Gopi *et al.*, (2006:4) recognise that local customised benchmarks reflect a down-weighting of resource shares.

The method used to “compare” the PDI against is of a traditional nature and involves fitting a regression of portfolio returns against the returns of the market index. This OLS regression analysis is done from 1 July 2003 to 30 June 2007, which is the same time period used as for the PDI analysis, for comparative reasons. The weekly closing prices¹⁰ for the unit trust or funds being analysed are required as is the weekly closing points or returns for the market index. The Johannesburg Stock Exchange All Share Index (ALSI) is taken as the market index for this study and only equity was included in the regression analysis. The results for this analysis can be viewed in the following section (Section 6.3.4).

The process to obtain the degree of fund diversification by using a regression analysis (traditional method) is as follows:

- the weekly returns of the five unit trusts must be calculated (using the weekly closing prices),
- the weekly returns of the market index must be calculated (again the weekly closing points are used to obtain the weekly returns),
- the returns of each of the five unit trusts must be regressed against the market index, in this case the JSE All Share Index (ALSI), and
- the regression results are then traditionally interpreted as follows: the smaller the residual variance, the more diversified the portfolio (or unit trust).

6.3.4 Results of the traditional diversification measure

In the previous section the traditional manner in which to measure diversification within a portfolio was discussed. The residual variance represents the diversifiable risk remaining in the specific portfolio, with a small residual variance being indicative of a diversified portfolio. The results of the regression analysis are as follows:

¹⁰ Closing prices of unit trusts are sourced from McGregor BFA.

Table 6.5: Residual variance of each fund.

Fund	Residual Variance
A	5.55E-04
B	5.84E-02
C	3.16E-03
D	4.90E-04
E	4.61E-04

Source: Compiled by the author.

Table 6.6 presents the residual variance of each fund in descending order.

Table 6.6: Residual variance of each fund in sorted order.

Fund	Residual Variance
E	4.61E-04
D	4.90E-04
A	5.55E-04
C	3.16E-03
B	5.84E-02

Source: Compiled by the author.

Thus by viewing Tables 6.5 and 6.6 it can be concluded that Fund E is the most diversified (as it has the smallest residual variance) of the funds included in this dissertation while Fund B is the least diversified (largest residual variance). From Tables 6.5 and 6.6 it is also clear that there is a large degree of difference (in terms of diversification) between Funds E, D, A and Funds C and B.

The next section will compare the results of the PDI and the residual variance method with each other in order to ascertain if there is any difference or similarities between the results of the two diversification measures.

6.3.5 Comparison of PDI and traditional diversification measure results

A comparison of the PDI and traditional diversification measure's results will be presented in this section.

Table 6.7, presents the results of the two diversification measures side by side with the best referring to the most diversified fund and the worst referring to the least diversified fund.

Table 6.7: PDI and traditional diversification measure results.

PDI		Traditional Diversification Measure	
PDI Score	Fund	Fund	Residual Variance
12.7	D	E	4.61E-04
7.68	B	D	4.90E-04
6.51	E	A	5.55E-04
4.44	A	C	3.16E-03
1.02	C	B	5.84E-02

Source: Compiled by the author.

From Table 6.7, it can be concluded that the two diversification measures do not agree. Table 6.7 shows that the PDI measure assesses Fund D as the best diversified fund, while the traditional diversification method assesses Fund E as the most diversified. The benefit of the results being different is that if the results were exactly the same, the PDI measure would have little use (as it then provides the same results as a method that is already tried, tested and proven). It is important to note that the traditional measure is a very convenient and user-friendly measure, as it is less time consuming and easier to calculate than the PDI.

As the analysis thus far can not provide conclusive proof that the PDI is a better diversification measure compared to the traditional diversification measure, different performance measures will be introduced to help achieve the study's objective. The following section will bring concentration into the picture.

6.3.6 Concentration

In theory, as more shares are added to the portfolio, the average covariance of the portfolio declines which reduces the risk within the portfolio. In fact, the portfolio risk will decrease

as more assets or shares with low covariance (shares that behave independently) are added to the portfolio (Smith, 2006:9). In fact, the risk of a portfolio is, however, not only related to the covariance of the underlying assets, but also by the weighting structure of the portfolio (Smith, 2006:8). In the previous section, residual variance and its use was presented, but residual variance is not only useful for measuring fund diversification. Panwar and Madhumathi (2006:4) argue that the number of holdings held by the fund and the percentage of assets in the top ten holdings can prove useful in gaining insight into portfolio diversification. Panwar and Madhumanthi (2006:4) stated that this is the case, because when the number of companies (shares) held by the fund is lower or the percentage of assets invested in the top ten holdings is higher, the fund is more concentrated in a few companies and the fund is more susceptible to market fluctuations in these holdings. The analysis thus far has not proved that the PDI is a good diversification measure compared to the traditional diversification measure. It is for this reason that additional performance measures will be introduced to prove the usefulness of the PDI. Concentration will be the first additional measure or phenomenon introduced as it might provide some clarity in achieving or solving the objective of this study.

In order to draw conclusions about the concentration of the unit trusts, the Herfindahl-Hirschman Index (HHI) will be used as the concentration measure. The Herfindahl-Hirschman Index (HHI) is described by Hovenkamp (1993:332) as a concentration measure and is also known merely as the Herfindahl index. The HHI is shown in Equation 3.22 where W_i represents the i^{th} shares investment weight (Smith, 2006:18):

$$\text{HHI} = \sum_{i=1}^N W_i^2$$

where:

N is the number of assets and

W_i , the weight of the i th share in the portfolio.

The HHI is calculated by summing the square of the investment weights in a portfolio. As stated in Section 3.5.5, the Richard Roll measure can also be used to measure concentration, but the HHI is widely used in academic literature. According to Stallman (2004:1) the higher the concentration of a particular fund the less diversified it will be, thus an inverse

relationship exists between concentration and diversification. The results of the HHI will be presented in the subsequent section.

6.3.7 Concentration results

Table 6.8 presents the concentration results as was calculated by the HHI.

Table 6.8: Concentration results.

Fund Name	HHI
A	4.21%
B	3.71%
C	5.22%
D	2.88%
E	2.25%
ALSI	5.18%

Source: Compiled by the author.

It can be concluded that Fund C is the most concentrated of all the funds while Fund E is the least concentrated compared to the others. Smith (2006:25) stated that there is a statistical significant relationship between concentration and diversification and that this relationship is inverse. Thus the level of diversification will decrease as the concentration level increases, and vice versa. The concentration results from Table 6.8 thus show (in theory) that Fund E is the most diversified while Fund C has the lowest degree of diversification, as an increase in concentration (in theory) increases risk and visa versa. Also note that the JSE All Share Index (ALSI), which acts as the market index for the regression analysis, has a concentration index of 5.18% while Smith (2006:25) found the ALSI (market capitalisation weighted) to have a concentration of 5.35%. The same study by Smith (2006:25) found that the ALSI (market capitalisation weighted) had a PDI score of 4.00. Compared with the funds in this dissertation the ALSI (market index) is the most concentrated.

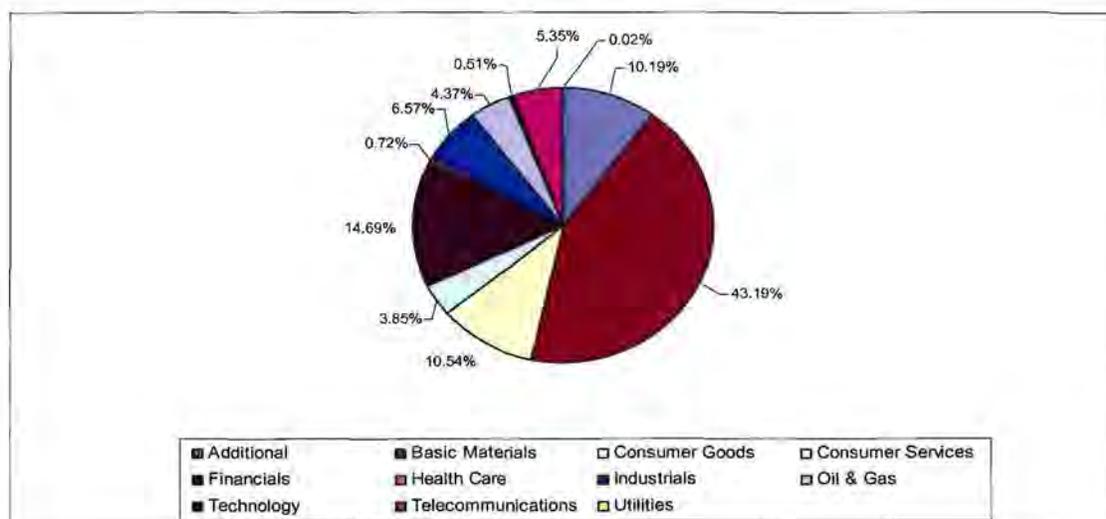
By comparing the concentration results with the results of the diversification measures, PDI and residual variance, the fund which is most concentrated should be the fund which is least diversified and vice versa. The comparison of the concentration and the diversifica-

tion results does, however, not provide concrete conclusions about the effectiveness of the two diversification measures. Furthermore, the question remains whether concentration is the most appropriate method to distinguish between the two diversification methods. Another question is whether or not the PDI is in line with the inverse relationship theory. The following section will investigate whether this is indeed the case.

6.3.8 The effect of concentration on diversification

The fact that the concept of concentration has received little attention in academic literature in the past is, according to Bradfield and Kgomari (2004), the result of most finance research emanating from the New York Stock Exchange, which when compared to smaller markets has a far more even distribution of market capitalisation (Smith, 2006:24). It is, however, no secret that the Johannesburg Stock Exchange is a smaller market where concentration does play a role. An example by Smith (2006:24) stated that 90% of the ALSI index weight comprises approximately 50 of the 162 shares that make up the index. It is for this reason that South African portfolios are typically not equally weighted but instead tend to follow market capitalisation weights. According to the Johannesburg Stock Exchange, the market capitalisation according to industry for 1 March 2008 was as indicated by Figure 6.1 (JSE, 2008:1). This figure provides a good view of the South African market capitalisation and it is clear from Figure 6.1 that the basic materials industry has a market capitalisation of 43.19% and is by far the largest.

Figure 6.1: South African market capitalisation by industry (1 March 2008).



Source: JSE (2008:1).

Table 6.9: Fund concentration & PDI results.

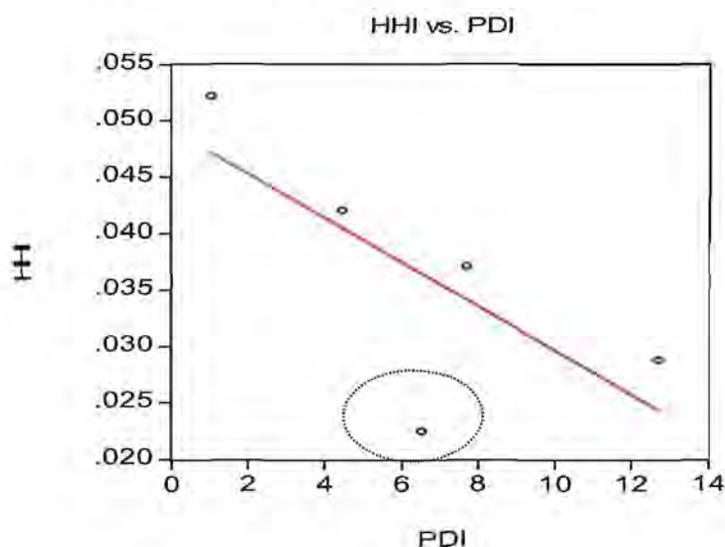
Fund	PDI	Concentration (HHI)
A	4.44	4.21%
B	7.68	3.71%
C	1.02	5.22%
D	12.70	2.88%
E	6.51	2.25%

Source: Compiled by the author.

Table 6.9 shows that it is difficult to determine if the expected inverse relationship between diversification and concentration actually exists. For this to be the case, it should be expected that a high PDI score and a low percentage of concentration and vice versa should exist. Fund D, for example, has a relatively high PDI score while also having a low concentration percentage (relative to the other funds), but when comparing the PDI and HHI results for funds B and E it is more difficult to justify this reasoning.

To answer the question of whether or not the PDI measure is in line with the expected inverse relationship between diversification and concentration a regression analysis is needed. The regression analysis not only indicates the relationship between diversification and concentration, but the significance of the relationship is also indicated. Figure 6.2 represents the relationship between PDI (diversification) and HHI (concentration). It is evident from the regression results that a significant relationship exists between diversification and concentration. As expected, the relationship is inverse and thus, as the concentration measure increases, the level of diversification (PDI score) decreases. The estimating equation for the regression analysis is $Y = -271.52 + 16.39X$ and the $R^2 = 0.53$. Adjusted $R^2 = 0.37$, t-stat = -1.84 and p value = 0.16. The dependent variable (Y) is diversification (PDI), while the independent variable (X) is concentration (HHI). Note that the OLS regression analysis was conducted using Eviews®, a statistical software package.

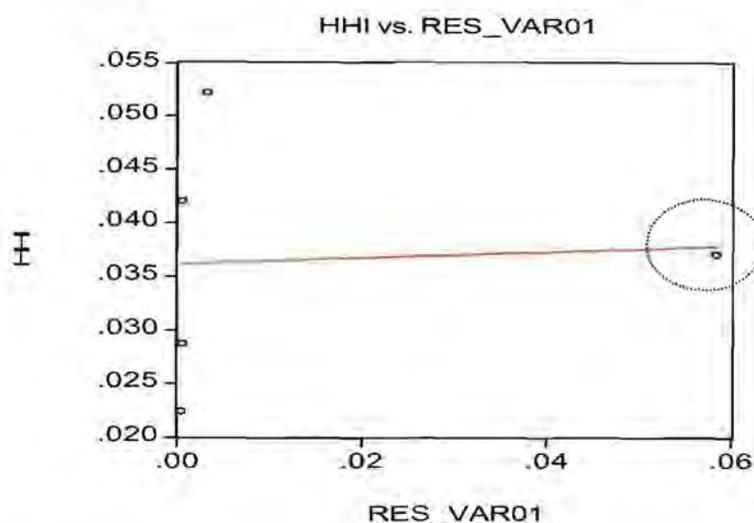
Figure 6.2: Relationship between PDI and HHI.



Source: Compiled by the author.

For the sake of completeness the results of a regression analysis are presented below in Figure 6.3 to indicate the relationship between residual variance (which is used as the traditional diversification measure) and the HHI (concentration measure). Once again the diversification (residual variance) is the dependent variable (Y) while the independent variable (X) is concentration (HHI). The estimating equation for this regression is $Y = 0.14 + 0.007X$ and the $R^2 = 0.004022$. The p value = 0.92, the t -stat = 0.11 and the adjusted $R^2 = -0.33$. From the regression results it can be seen that the relationship between residual variance and HHI is positive, which is not in line with the expected theory and a negative relationship. The reason for this is unknown, but as this is not the main focus of this study it will not be dwelled on. If Fund E (the circled point in Figure 6.2) is, however, discarded the inverse relationship between the remaining four funds' (intersection) points is very strong and in line with the expected theory. Once again this OLS regression analysis was conducted by using the Eviews© statistical software package. Refer to the appendix for the full results.

Figure 6.3: Relationship between residual variance and HHI.



Source: Compiled by the author.

After calculating the regression of residual variance versus concentration and comparing the results of the PDI versus concentration regression it was shown that the PDI measure is indeed in line with the theory of the expected relationship between diversification and concentration. This conclusion, however, along with the comparative results of the PDI and residual variance does not provide prove that the PDI is a good (or as good a) diversification measure compared with the traditional diversification measure, even though the results of the residual variance and concentration regression are not in line with theory. Theory suggests that an inverse relationship should exist between diversification and residual variance, but substantial conclusions can not be drawn from these results. It is also known that the residual variance method is widely used by fund managers to measure the degree of diversification. For the sake of completeness it should be noted that the outlier (circled point) in Figure 6.3 represents Fund B.

6.4 Fund Performance

Before performance measures or ratios are presented to assist in ascertaining whether or not the PDI is a good diversification measure compared to the traditional diversification measure, the performance of the funds used in this dissertation will be presented. Although this is not the primary focus of this study, it might provide additional information. The per-

formance of the ALSI, which serves as the benchmark, will also be presented where applicable and available.

6.4.1 Return performance

6.4.1.1 Annual return performance

Table 6.10 and Figure 6.4 present the annual return (geometric) of each of the funds as well as the benchmark (ALSI). The topic of returns and methods of calculating returns were discussed in Chapters 2 and 3.

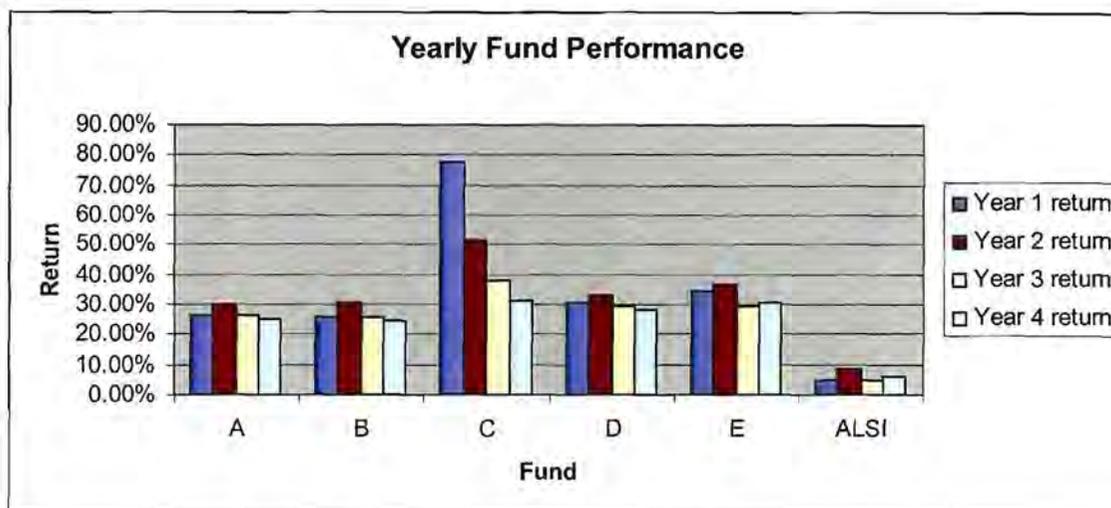
Table 6.10: Annual fund and benchmark returns.

Fund	Year 1	Year 2	Year 3	Year 4
A	26.25%	29.93%	26.31%	25.08%
B	25.72%	30.47%	25.48%	24.66%
C	77.49%	51.19%	38.19%	31.23%
D	30.67%	33.22%	29.50%	28.21%
E	34.48%	37.01%	29.44%	30.35%
ALSI	4.99%	8.31%	5.14%	6.11%

Source: Compiled by the author.

**Returns are calculated as geometric annual return.*

Figure 6.4: Annual fund and benchmark returns.



Source: Compiled by the author.

When viewing the results in terms of returns, it is clear that Fund C outperformed the other funds by a very large margin in year 1. During the first year under analysis Fund C achieved 77.49% return, which is high and somewhat puzzling. The proxy used for Fund C, as was explained in Section 6.2.2, might explain the phenomenal good performance of Fund C during the first and the second year.

6.4.1.2 Compounded (aggregate) fund and benchmark performance

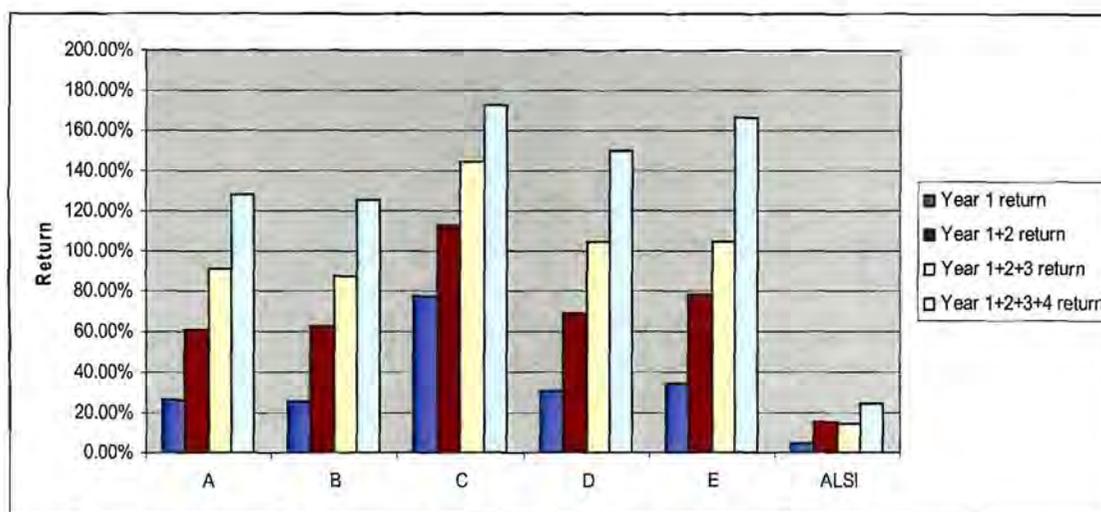
This section presents the performance of the funds and the benchmark in terms of compounded returns. Thus, for example, the return presented for year 2 is the sum of returns for year 1 and year 2. The compound returns provide an indication of capital fund growth over the four year period studied. Table 6.11 and Figure 6.5 present the compounded performance of the funds and the benchmark.

Table 6.11: Compounded yearly returns.

Fund	Year 1	Year 2	Year 3	Year 4
A	26.25%	61.33%	90.96%	128.47%
B	25.72%	62.56%	87.48%	125.67%
C	77.49%	112.80%	144.91%	172.81%
D	30.67%	68.89%	104.60%	150.31%
E	34.48%	77.77%	104.32%	166.10%
ALSI	4.99%	15.70%	14.89%	24.48%

Source: Compiled by the author.

Figure 6.5: Compounded yearly returns.



Source: Compiled by the author.

Now that performance has been presented for all the funds and the benchmark, the following sections will introduce further performance measures.

6.4.2 Performance measures or ratios

This section presents the results of the fund performance measures or ratios. Standard deviation will be presented first with the Sharpe ratio, Sortino ratio, Omega ratio and Treynor measure to follow. Each of these ratios has different attributes, strong points and weak-

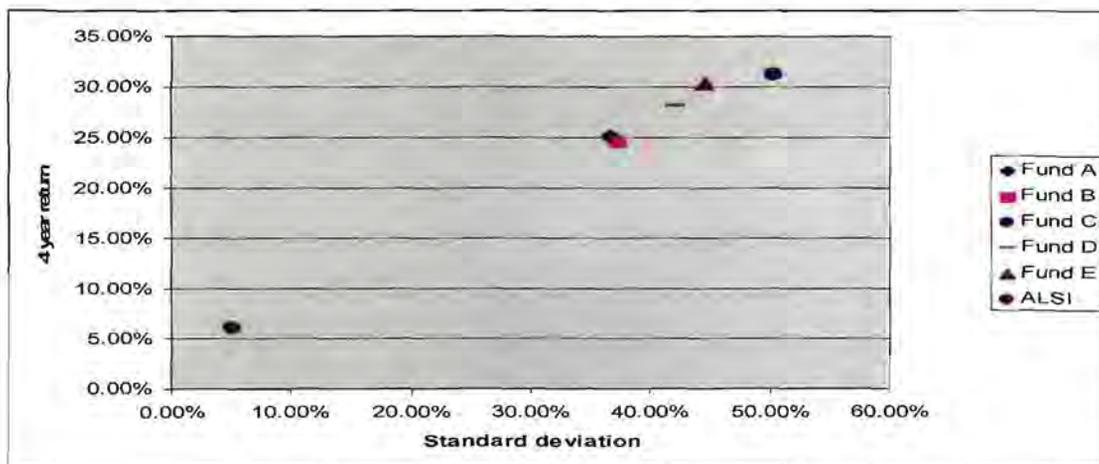
nesses. The reason for inclusion of each of the ratios has been explained in Chapter 4, although the core concept of each measure or ratio will be briefly repeated in this section.

It should, however, be noted that the performance measures, measure different concepts. For example, the Sharpe ratio measures the reward per unit of risk while the Treynor measure measures the portfolio's risk premium per unit of risk. This means that the different performance measures are not directly comparable. Furthermore, it should be remembered that these measures are performance measures and not diversification measures, thus they cannot be used directly in comparison to diversification measures like the PDI.

6.4.2.1 Standard deviation

Section 3.2.3.1 stated that the standard deviation is based on the deviation from the mean. Refer to Section 4.4.2.2 where the standard deviation is also discussed. The standard deviation of a return series is often referred to as the volatility of the return series. Figure 6.6 presents a volatility matrix, which is simply a graphical presentation of the relationship between return and volatility. In this volatility matrix, the four year annual return of each fund is compared to its 4 year return volatility.

Figure 6.6: Four year compound returns versus four year volatilities.



Source: Compiled by the author.

Table 6.12 shows the standard deviation for each fund in both weekly volatility- and annual volatility formats. A lower standard deviation is an indication of lower volatility and is generally the desire, if risk wants to be kept to a minimum. The annual volatility (bottom

part of Table 6.12) is calculated by annualising the weekly volatility (top part of Table 6.12).

Table 6.12: Standard deviation results.

<i>Standard deviation (weekly)</i>				
Fund	Year 1	Year 2	Year 3	Year 4
A	9.90%	16.64%	28.57%	36.56%
B	8.90%	18.93%	29.13%	37.17%
C	28.68%	38.42%	43.36%	50.18%
D	10.18%	20.49%	32.45%	42.03%
E	10.05%	24.06%	34.35%	44.53%
ALSI	2.84%	3.19%	4.56%	5.17%
<i>Standard deviation (annual)</i>				
Fund	Year 1	Year 2	Year 3	Year 4
A	71.38%	119.99%	206.05%	263.66%
B	64.19%	136.50%	210.05%	268.02%
C	206.83%	277.02%	312.69%	361.86%
D	73.41%	147.77%	234.00%	303.08%
E	72.50%	173.53%	247.69%	321.09%
ALSI	20.50%	22.99%	32.91%	37.31%

Source: Compiled by the author.

The standard deviation results show that there is a definite trade-off between high returns and high volatility as the ALSI has a low return and a low standard deviation, while Fund C, for instance, has both a high return and standard deviation. If the risk factor (in terms of standard deviation or volatility) is compared between, for example, Fund C and Fund A, Fund C will have a higher risk rating than Fund A. Comparing the standard deviation results with the results of the two diversification measures, PDI and residual variance, the

PDI score or risk rating of Fund C is in line with that of the standard deviation while the residual variance only rates Fund C as the second most “risky” fund. The largest deviation in terms of these results comes in the results of Fund E, where the residual variance rates this fund as the most diversified, but according to standard deviation this fund has the largest volatility. The PDI, however, rates this fund as having more risk than the residual variance method suggests. Table 6.13 provides some degree of comparison between the results of the two diversification measures and standard deviation results (when these results are ranked). It is important to note that in Table 6.13 best refers to the fund with the least risk while worst refers to the most risk. The funds are ranked in this manner in Table 6.13 while this manner of presentation will continue throughout this chapter, because it is the objective of diversification to reduce and eventually eliminate the unsystematic risk (Mitra & Gassen, 1981:533).

Table 6.13: Comparative ranking results (Standard deviation).

Ranking key	Std dev ranking	PDI ranking	Res Var ranking
Best (Least risk)	A	D	E
	B	B	D
	D	E	A
	E	A	C
Worst (Most risk)	C	C	B

Source: Compiled by the author.

Although standard deviation is one of the most used measures of risk it makes no distinction between upside and downside deviation (Botha, 2005:42). Botha (2005:42) used the example that an investment with monthly returns of -5% and + 5% will have the same standard deviation as another investment with 0% the one month and +10% in the following. Further performance measures will be introduced in the sections to follow as no conclusion can be drawn from the standard deviation results. The Sharpe ratio, which uses a non directional-biased measurement of volatility to adjust for risk, will be calculated next.

6.4.2.2 Sharpe ratio

As the Sharpe ratio (Section 4.4.2.5) is a risk-adjusted performance measure it will be of great use in achieving the first objective of this study. It should be remembered that the Sharpe ratio uses a fund's standard deviation and excess return to determine the reward per unit of risk. The Sharpe ratio calculation involves the ratio of the excess return over the sample period divided by the standard deviation of the sample period returns. The higher the Sharpe ratio for a specific fund the better the fund's "risk-adjusted" performance (Botha, 2005:40). Botha (2005:42) further stated that when comparing funds the Sharpe ratio is a good measure, but that the Sortino ratio needs to be considered alongside the Sharpe ratio. The Sortino ratio will be considered in Section 6.4.2.3 and the results of the two measures will also be combined. Table 6.14 presents the results of the Sharpe ratio over the four year period while Figure 6.7 presents the Sharpe ratio results in a more comparative setting.

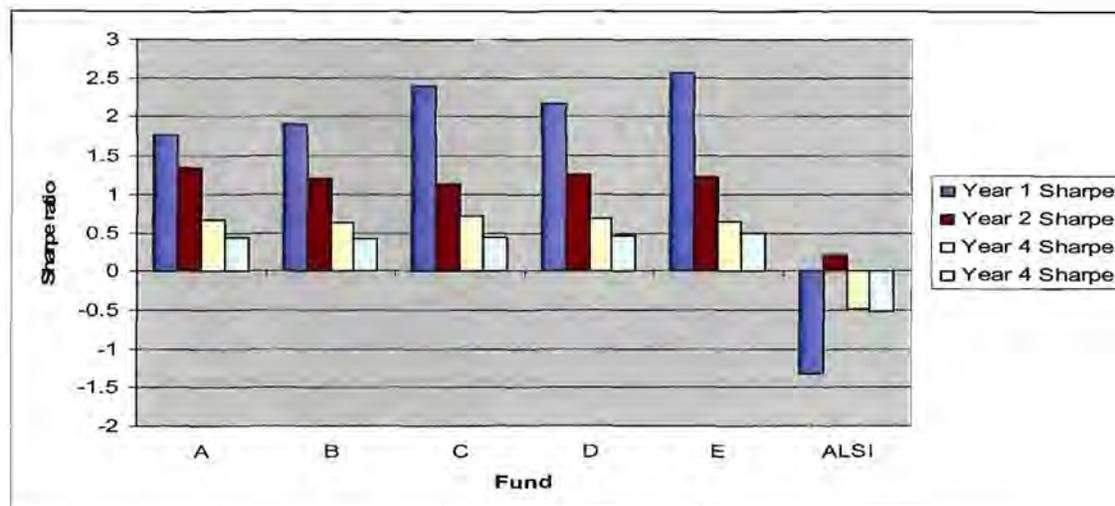
Table 6.14: Sharpe ratio results.

Fund	Year 1	Year 2	Year 3	Year 4
A	1.77	1.34	0.66	0.45
B	1.91	1.21	0.62	0.43
C	2.40	1.13	0.71	0.45
D	2.16	1.25	0.68	0.46
E	2.56	1.22	0.64	0.48
ALSI	-1.31	0.22	-0.48	-0.52

Source: Compiled by the author.

For the Sharpe ratio calculation the risk-free rate (RFR) is used and not the benchmark (ALSI which may also be used). The risk-free rate used for the Sharpe ratio is the yield on the R153 (South African Government Bond). Looking at the Sharpe ratio of the 4 years, all the funds outperformed the benchmark in terms of reward per unit of risk.

Figure 6.7: Sharpe ratio trends.



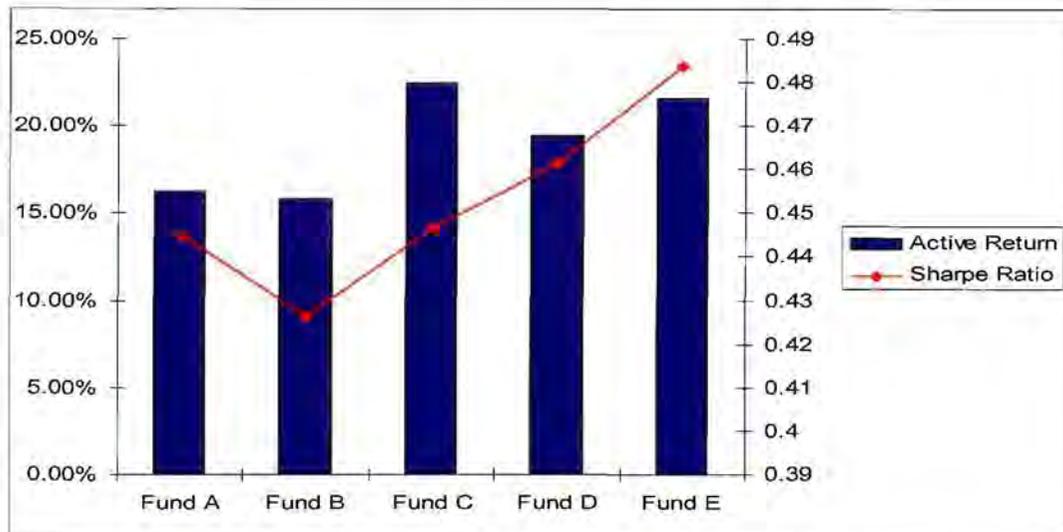
Source: Compiled by the author.

Among the different funds all performed within touching distance of each other, when performance is measured by means of the Sharpe ratio. In year one Fund E's Sharpe ratio outperformed the other funds, but as explained in Section 6.2.1 this fund (Fund E) is not a growth fund but a small cap fund. Over the four year period Fund E also came out as the best fund, i.e., the fund that offers the most reward per unit of risk.

Figure 6.8 present the active or excess return versus the Sharpe ratio. From Figure 6.8 Fund E provides the investor with the highest reward per unit of risk while Fund B is the least rewarding per unit of risk. Although the Sharpe ratio should be viewed alongside the Sortino ratio (Botha, 2005:42) a comparison of the Sharpe ratio results with the two diversification measures can be seen in Table 6.15. Table 6.15 refers to the best fund according to the measuring criteria as indicated in the headings of Table 6.15. It should, however, be noted that the Sharpe ratio (performance measure) and the two diversification measures, measure two different aspects and thus they are not directly comparable. This study does, however, aim to establish whether or not the PDI is a good measure of diversification compared to the traditional diversification method. The comparison of these methods must be viewed from a viewpoint that a higher Sharpe ratio indicates the fund which provides the most reward per unit of risk and thus can be perceived as the fund with the least risk. Furthermore, it was mentioned that according to theory a more diversified fund is a less risky fund and as Fund E has the highest Sharpe ratio it is the fund with the highest return

per unit of risk, i.e., according to the Sharpe ratio Fund E is the most diversified as it is less risky relative to the other funds.

Figure 6.8: Four year active (excess) return compared with Sharpe ratio.



Source: Compiled by the author.

* 4 year Sharpe ratio used in Figure 6.8

Table 6.15: Comparative ranking results (Sharpe ratio).

	RANKING		
	Sharpe	PDI	Res Var
Best	E	D	E
	D	B	D
	C	E	A
	A	A	C
Worst	B	C	B

Source: Compiled by the author.

According to the ranking results presented in Table 6.15, the traditional method of measuring diversification (residual variance) is more in line with the Sharpe ratio results although this is a relative comparison as the measures are not directly comparable.

It was stated earlier in Section 4.4.2.3 that the Sharpe ratio uses a non directional-biased measurement of volatility to adjust for risk, but this concept has, however, been criticised as it may “punish” a fund for a short period of exceptionally high performance (in terms of return). The Sortino ratio, on the other hand, only measures the downside volatility and will be introduced in the next section.

To conclude the section on the Sharpe ratio it should be noted that the Modigliani measure is not included in this study even though it is a measure of substance. The Modigliani measure expresses a fund’s performance relative to the market in percentage terms (Veerasley, 2008:15). Thus, the Modigliani measure is the equivalent to the returns a particular fund would have achieved if the fund had the same risk as the market index (for a fund with any given risk and return) (Veerasley, 2008:15). The reasons for the non-inclusion of the Modigliani measure are two fold (Simons, 1998:40):

- *“As the Modigliani measure is very new, it remains to be seen if it will meet with more understanding and acceptance than the Sharpe ratio”*, and
- when ranking mutual funds (unit trust), any rankings based on the Sharpe ratio and Modigliani measure will be the same, as long as the same benchmark is used (which is the case in this study).

6.4.2.3 Sortino ratio

The preceding section presented the Sharpe ratio and the results of applying the Sharpe ratio to the funds used in this study. It was also stated that the Sharpe ratio penalises both up- and downside volatility equally. Although the Sortino ratio (Section 4.4.2.5) is a modified version of the Sharpe ratio it only penalises the returns which fall below a specified rate or target. The Sortino ratio thus measures the actual rate of return in excess of the investor specified or target rate of return, per unit of downside risk. According to Botha (2005:43) funds that use the Sortino ratio are the funds with the least tolerance for risk, thus these funds will value good diversification as they aim to reduce risk. A large Sortino ratio is an indication of a low risk of large losses occurring (Investorwords, 1997e:1).

In Table 6.16 the results of the Sortino ratio is presented and by viewing the four year results it is clear that Fund E and Fund C are ranked first and second respectively according to the Sortino ratio. Again, it should be noted that the proxy used for Fund C might be influential in the results obtained.

Table 6.16: Sortino ratio results.

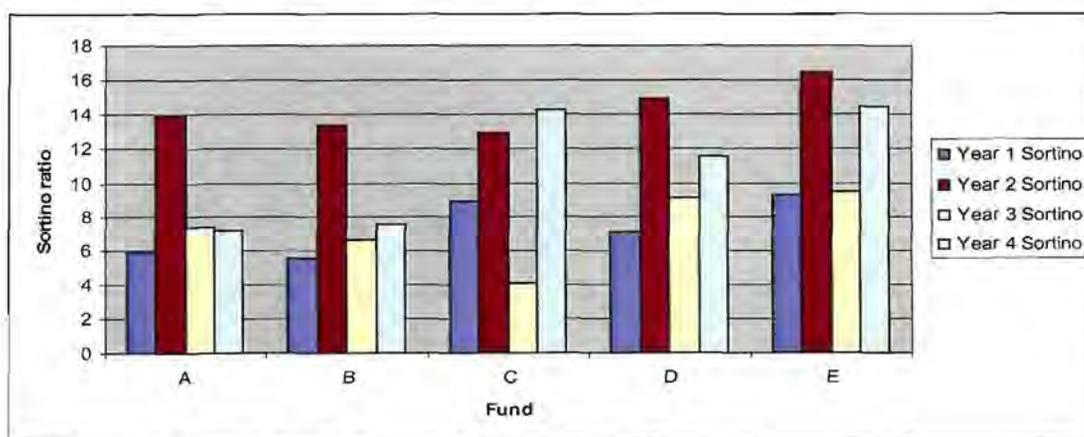
Fund	Year 1	Year 2	Year 3	Year 4
A	5.98	13.88	7.40	7.23
B	5.59	13.36	6.70	7.57
C	8.96	12.90	4.15	14.25
D	7.16	14.89	9.17	11.53
E	9.30	16.46	9.52	14.39

Source: Compiled by the author.

As with the Sharpe ratio, the yield of the R153 (South African Government bond) was used as the risk-free rate or required rate of return for calculating the Sortino ratio as this rate can be obtained by the investor with minimal risk.

Figure 6.9 shows that Fund E (small cap fund) again performed the best compared with the other funds. It can be concluded that Fund E has the lowest risk of a large loss occurring within the funds present in this study. Fund D also performed admirably each year relative to the other funds. The interesting thing to note is the good performance of all the funds in year two compared to the other years. This might be due to the fact that the All Share index (ALSI) underwent a period of phenomenal and rapid growth from the beginning of 2004. From 2004 to the end of 2005 the ALSI increased from approximately 12500 to 18500.

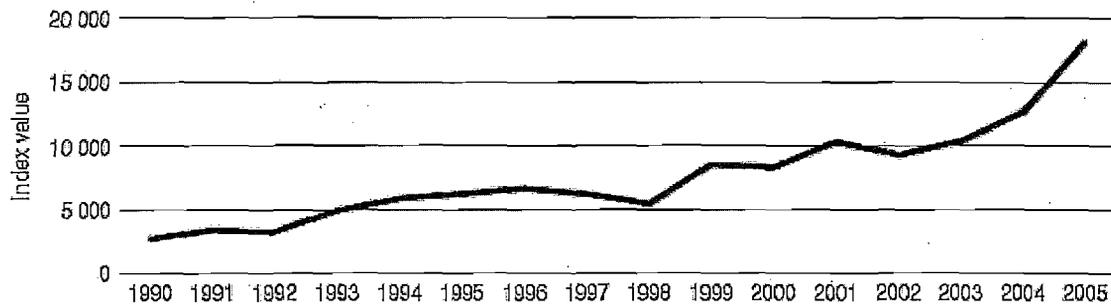
Figure 6.9: Sortino ratio results.



Source: Compiled by the author.

Figure 6.10 presents the performance of the ALSI from 1990 to December 2005.

Figure 6.10: ALSI performance 1990 to December 2005.



Source: JSE (2005a:1).

Table 6.17 presents how the two diversification measures compare with the results of the Sortino ratio, but it should be remembered (as with the Sharpe ratio) these ratios measure different aspects and the results are thus not directly comparable.

Table 6.17: Comparative ranking results (Sortino ratio).

	RANKING		
	Sortino	PDI	Res Var
Best	E	D	E
	C	B	D
	D	E	A
	B	A	C
Worst	A	C	B

Source: Compiled by the author.

Table 6.17 aims only to represent and not directly compare the results of the two diversification measures and the results of the Sortino ratio in a ranking table. Thus the table's objective is to only present how well the two diversification measures align with the Sortino ratio without drawing a direct conclusion about the comparison. As can be seen from Table 6.17, the alignment with the Sortino ratio results is not very good from either one of the diversification measures.

However, as mentioned in Section 6.4.2.2 the Sortino ratio and Sharpe ratio must be considered alongside each other. The results of these two measures will now be combined together in a ranking manner and compared to the results of the two diversification measures, as done in Tables 6.17 and 6.15. For the combination of the Sortino ratio and Sharpe ratio results each of the fund's four year ratios will be averaged. The results of this are presented in Table 6.18.

Table 6.18: Combined Sortino and Sharpe results (four year).

	Fund A	Fund B	Fund C	Fund D	Fund E
Sharpe ratio	0.45	0.43	0.45	0.46	0.48
Sortino ratio	7.23	7.57	14.25	11.53	14.39
Average	3.84	4.00	7.35	6.00	7.44
Ranking	5	4	2	3	1

Source: Compiled by the author.

Table 6.18 indicates that on account of the average of the Sharpe ratio and Sortino ratio results, Fund E has the highest average. It should be noted that a higher value or ratio is preferred for both the Sharpe- and Sortino ratio. Table 6.18 also indicates how the funds rank according to the average Sortino- and Sharpe ratio score (1 being the best and 5 being the worst). The combined ranking of the funds are in unison with the ranking results of the Sortino ratio (see Table 6.17). When the average ranking results of each fund is used instead of the ratio results, the outcome of the combined ranking is exactly the same as in Table 6.18.

No concrete conclusion(s) can be drawn from the Sortino and/or the Sharpe ratio results that aid the objective of this study, in ascertaining whether or not the PDI is a good diversification measure in comparison to the residual variance method. Further performance methods will hence be calculated.

Another measure that is widely used as a risk-adjusted measure is the Treynor measure and will be calculated in the next section.

6.4.2.4 Treynor measure

The Sharpe ratio measures the reward per unit of risk, while the Sortino ratio measures the reward per unit of downside risk. The Treynor measure measures the portfolio's risk premium per unit of risk (see Section 4.4.2.4). Thus it is a measurement of the return earned in excess of that which could have been earned on a riskless investment. The Sharpe measure or ratio uses the standard deviation of returns as the measure of total risk, whereas the Treynor measure uses beta (systematic risk) (Reilly & Brown, 2006:1048). Therefore the Sharpe measure evaluates the portfolio manager on the basis of both rate of return performance and diversification. The two measures (Sharpe and Treynor) will give identical rankings, for a completely diversified portfolio (a portfolio without unsystematic risk), because the total variance of the completely diversified portfolio is its systematic variance (Reilly & Brown, 2006:1048). In contrast, a poorly diversified portfolio could have a high Treynor measure ranking, but a much lower Sharpe measure ranking. Any difference in the rank will come directly from a difference in diversification. It should be noted that these two measures provide complementary, yet different, information, but both measures should be used (Reilly & Brown, 2006:1049). Both these measures, however, have a disadvantage in that they produce relative, but not absolute, rankings of portfolio performance. As the Treynor measure or ratio measures the excess return over a risk-less investment, a risk free instrument is needed to represent a risk-free interest rate. The R153 (government bond) was again used for this purpose.

Table 6.19 presents the results of the Treynor measure and by observing this table it is clear that none of the funds performed with great consistency. Fund C, however, was the most consistent performer, but again the proxy could be a role-player in the results. A higher Treynor measure (value) is indicative of a larger slope and a better portfolio for all investors (regardless of their risk preferences) (Reilly & Brown, 2006:1045). Figure 6.11 presents the results of the Treynor measure.

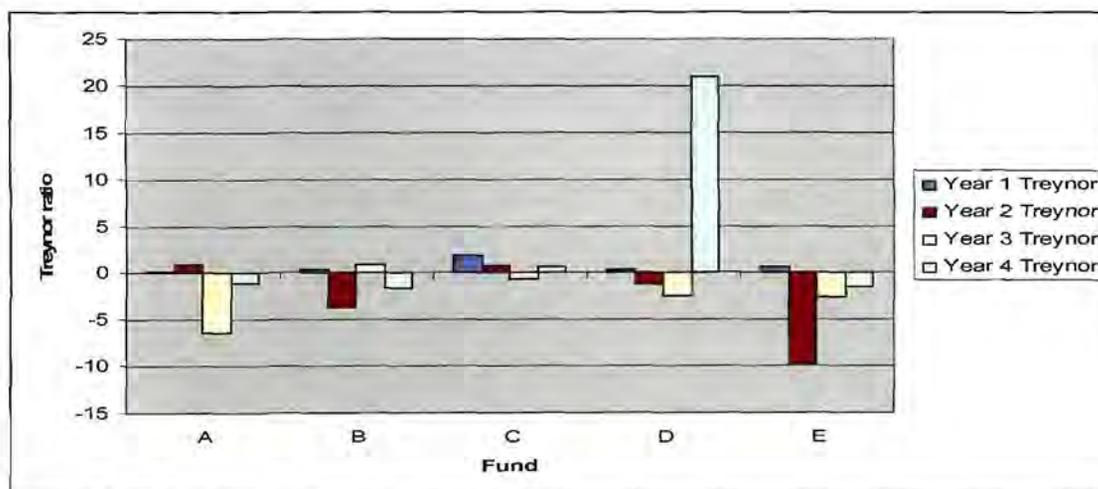
Table 6.19: Treynor measure results.

Fund	Year 1	Year 2	Year 3	Year 4
A	0.19	0.87	-6.39	-1.00
B	0.27	-3.75	0.82	-1.57
C	1.87	0.76	-0.59	0.63
D	0.29	-1.17	-2.51	21.02
E	0.56	-9.80	-2.65	-1.46

Source: Compiled by the author.

The results of the Treynor measure of the funds indicate not only that consistency (in terms of the Treynor measure) was a problem, but also in at least one of the four years each of the funds performed negatively (in terms of Treynor). Fund C is, however, the most consistent performer, but the proxy used for this fund could have played a role. In year four, Fund D performed phenomenally well as can be seen from Figure 6.11. A comparison of results is presented in Table 6.20.

Figure 6.11: Treynor measure results.



Source: Compiled by the author.

Table 6.20: Comparative ranking results (Treydor measure).

	RANKING		
	Treynor	PDI	Res Var
Best	D	D	E
	C	B	D
	A	E	A
	E	A	C
Worst	B	C	B

Source: Compiled by the the author.

From Table 6.20 it can be seen that the comparative ranking results between the Treynor measure and the two diversification measures are not similar. The Treynor measure does rank Fund D as the best fund, as does the PDI. While the Treynor measure ranks Fund B as the worst which is also the case with the traditional diversification method. Once again it should be noted that these ranking results are not directly comparable as the measures measure different aspects.

6.4.2.5 Omega ratio

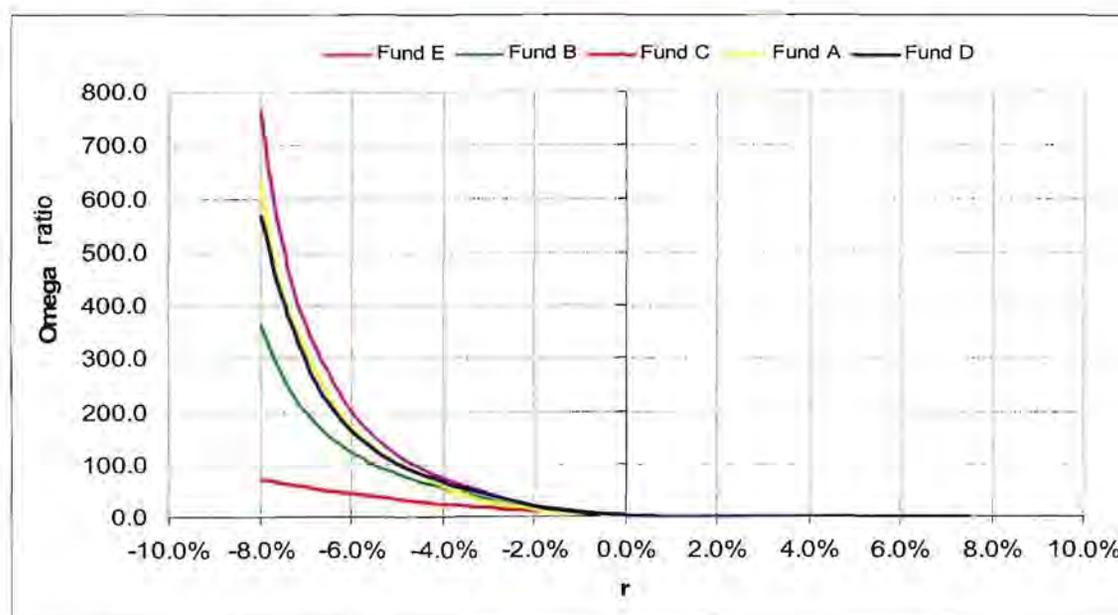
Since the Omega ratio was introduced in 2002 it has become increasingly popular. It is based on interpretations of existing performance measurement techniques as discussed in Section 4.4.2.8. The reason for this may be that the ratio is intuitive and easy to compute. The Omega ratio is more sophisticated than an alpha ratio and can also be seen as the successor of the Sharpe or Jensen ratios (Wilson, 2007:1). Botha (2006:1) shares this view by stating that the Omega is a superior measure to both the Sharpe and Sortino ratios while Keating and Knowles (2004:1) are of the opinion that the Omega ratio or statistic can be used as an alternative to the Sharpe ratio as a risk-adjusted performance measure.

As explained in Section 4.4.2.8, the Omega ratio divides returns into both losses and gains above and below a return threshold and determines the probability-weighted ratio of returns above and below this threshold (Botha, 2006:6). For a given threshold or target level of return (r) the Omega ratio is the weighted gain/loss ratio relative to r (Wilson, 2007:1). All the information (all the moments of the distribution of returns) in a (historical or simu-

lated) return series of a financial instrument is used by the ratio instead of simple figures such as variance and mean. A high Omega means that the right-hand side of the threshold return (i.e. to the right of the threshold) has more dense returns than the left side of the threshold. The Omega ratio is unlike most performance measures as it expresses gains to losses rather than in the form of (expected) return/risk. Furthermore, the threshold level selected is merely a reflection of a particular risk preference (Botha, 2006:6).

This study will focus on the Omega function as it provides the advantage of interpretation relative to the Omega ratio, while also providing a wide view of a portfolio's performance in both the upside and downside. Figure 6.12 presents the Omega results over four years for $-10\% \leq r \leq 10\%$.

Figure 6.12: Omega results #1.



Source: Compiled by the author.

As mentioned in Section 4.4.1.7 the following are important to understand the Omega function (Botha, 2006:6):

- It is instructive to consider the extremes of the function.
- Left of the X -axis origin: As the threshold value is chosen to be increasingly negative, fewer and fewer returns will count as losses in the data. At some point the threshold will be lower than the lowest return in the data, where the denominator

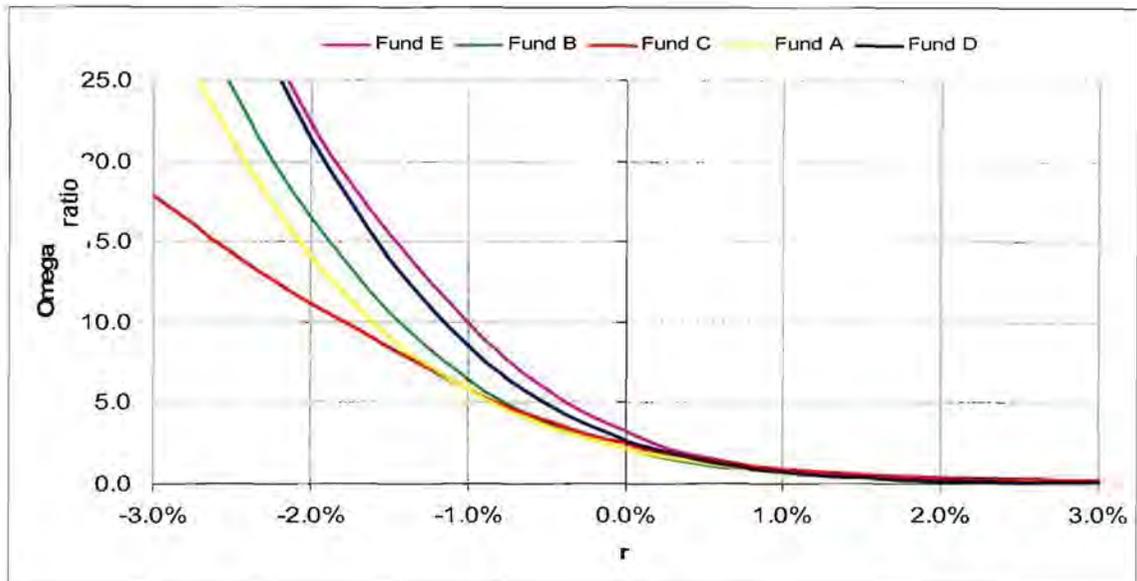
becomes 0 and the Omega ratio tends to infinity. To summarise this, the sooner the ratio heads for infinity, the less risky the portfolio is on the downside as this means that there are few, or not very large, negative returns.

- Right of the X -axis origin: When moving to the right of the X -axis origin, fewer and fewer returns greater than the threshold are found while eventually none are found. At this point the numerator and thus the ratio becomes 0. In short, the slower the Omega ratio tends to 0, the bigger the potential for positive returns.
- From the previous two points it can be concluded that in general the steeper the slope of the Omega function, the lower the risk.

Figure 6.12 shows the Omega results for this study. From the figure above it can be seen that Fund E has the steepest slope followed by Fund A and Fund D. Note the change in positions between Fund A and Fund D from Figure 6.12 to Figure 6.13 (as the upside is approached with a closer/enlarged view). Figure 6.13 focuses on the $-3\% \leq r \leq 3\%$ region. Figure 6.12 shows that Fund E is the fund with the least risk while Fund C has the most amount of risk. The figures that follow will become more focused on certain areas.

In Figure 6.13 Fund C's slope is not very steep compared to the other funds and thus have more outliers or negative returns in the downside than the other funds, which is not good as this increases the risk of the fund. Funds E and D performs the best in the downside as according to the Omega these two funds have the steepest slopes and are thus the least risky of the funds compared to the other funds. In Figure 6.13, all the funds enter the upside similarly, but a more detailed graph will focus on this.

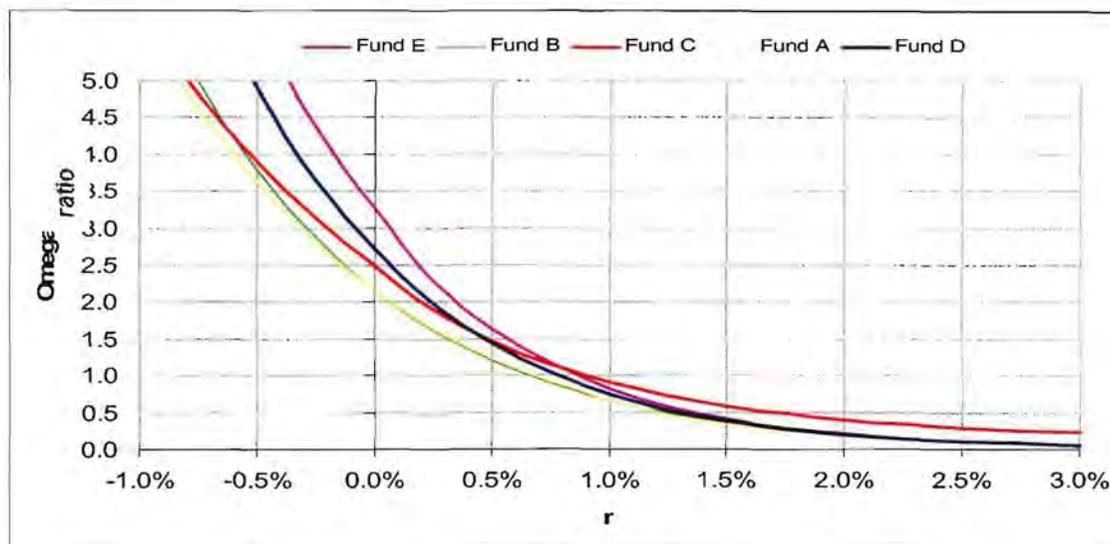
Figure 6.13: Omega results #2.



Source: Compiled by the author.

Figure 6.14 provides a more “zoomed in” view of the Omega results than Figure 6.13, specifically $-1\% \leq r \leq 3\%$. In Figure 6.14 Fund E has a steeper slope than Fund D, while these two funds were very similar in Figure 6.13. This can be because Fund E becomes less risky at a faster rate, than Fund D, as it approaches the upside. Once again Fund E remains the least risky fund while Fund C is better in terms of the downside as it approaches the upside. A few more graphs that present the Omega results might provide even more information. Figure 6.15 will focus on the downside results while Figure 6.16 and 6.17 will focus on the upside results.

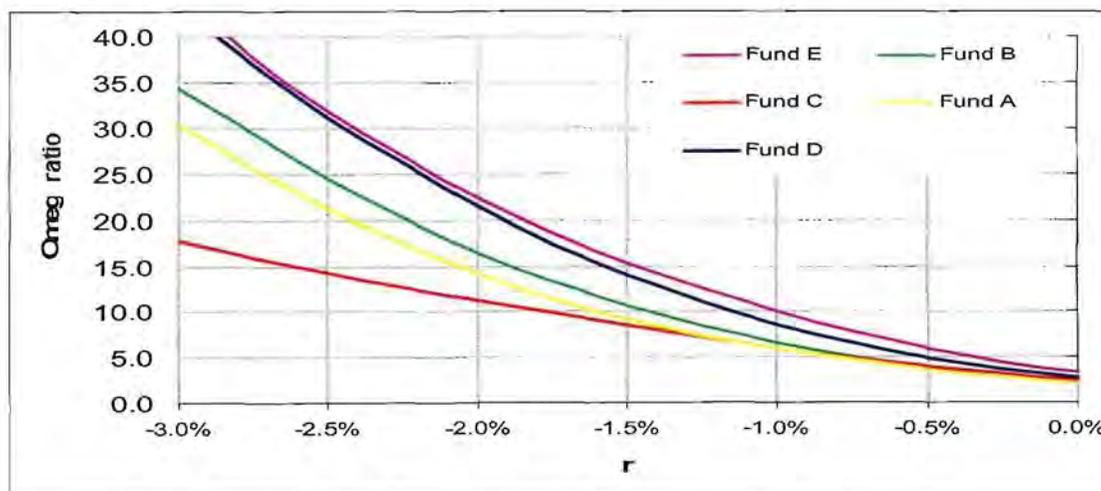
Figure 6.14: Omega results #3.



Source: Compiled by the author.

Figure 6.15 focuses on $-3\% \leq r \leq 0\%$ and $40 \leq \Omega \leq 0$ and indicates that Fund D and E are similar in the downside while Fund C performs poorly in the downside (specifically below -1.5%) compared to the other funds. The desire is for a fund to have the steepest possible slope in the downside. From Figure 6.15 it can be observed that Fund D and E have the steepest slopes and thus have smaller or lesser outliers in the downside than the other funds which means they are the least risky of the funds being analysed.

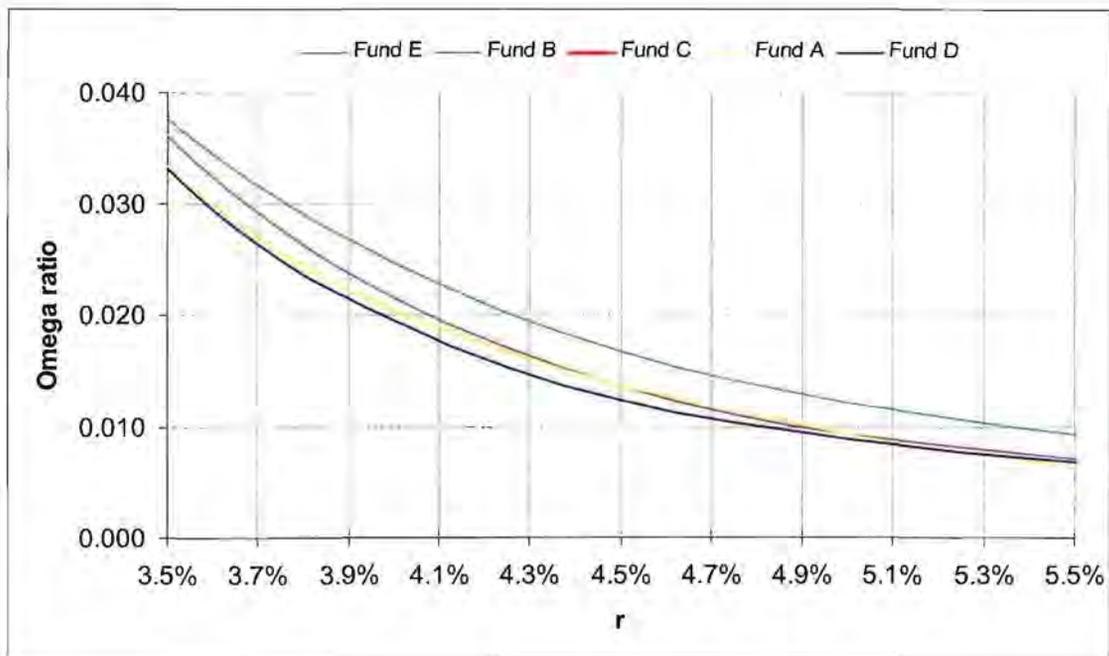
Figure 6.15: Downside Omega results.



Source: Compiled by the author.

Figure 6.16 presents the upside Omega results of the funds, specifically focusing on $3.5\% \leq r \leq 5.5\%$ and $0.04 \leq \Omega \leq 0$. It should be noted that Fund C is not visible in Figure 6.16 as it is well above the funds present in the figure. In the upside the ideal fund must run as long as possible without becoming 0, but it must be remembered that the upside is not the focus as we are interested in risk, which is found in the downside.

Figure 6.16: Section of upside Omega results.



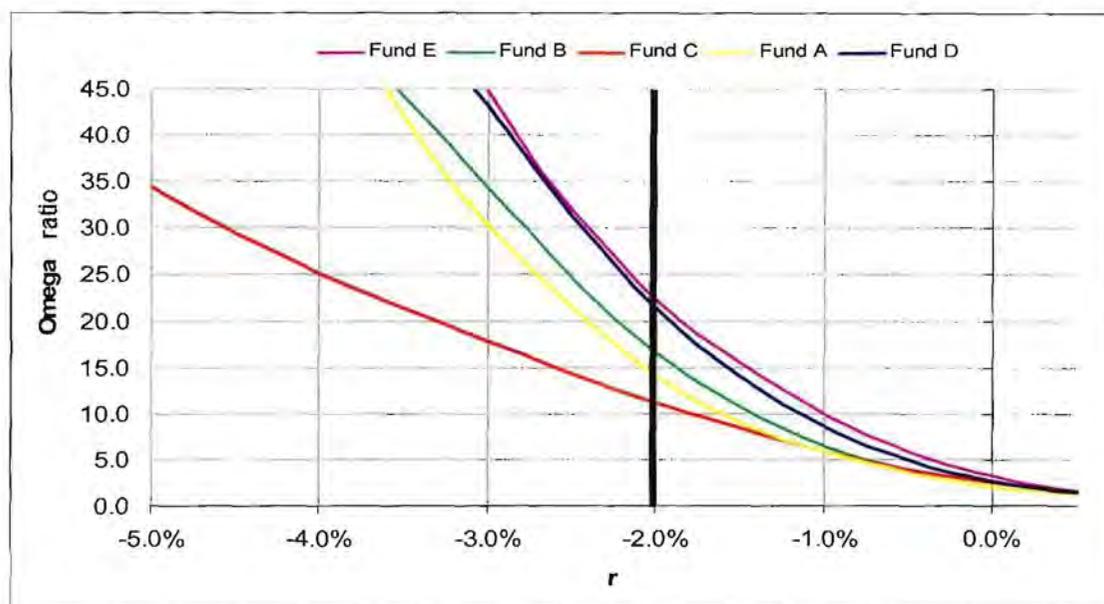
Source: Compiled by the author.

In order to rank the funds in terms of risk to be able to compare the ranking results to the PDI results, a threshold must be specified. For this, a randomly selected negative return which falls in the downside (-2%) will be used as the threshold, because firstly risk for any investor is manifested in negative returns and secondly because the Omega function is effective in judging risk by examining the downside.

6.4.2.5.1 PDI versus Omega (Threshold = -2%)

In Figure 6.17, Fund E is the least risky fund (at a chosen threshold of -2%) as it has the steepest slope while it is very closely followed by Fund D. Fund C is the most risky according to Omega with a chosen threshold of -2%. The funds are ranked in Table 6.21 using an Omega function at a threshold of -2%.

Figure 6.17: Omega at threshold = -2%.



Source: Compiled by the author.

Table 6.21: Omega results in sorted order.

Fund	Omega rank
E	Least risk
D	↓
B	
A	
C	Most risk

Source: Compiled by the author.

Table 6.22 presents the rankings of the funds for both the Omega results and the PDI results.

Table 6.22: Comparative PDI & Omega (threshold = -2%) results.

PDI rank		Omega rank	
Most diversified	D	E	Least risk
↓	B	D	↓
	E	B	
	A	A	
Least diversified	C	C	Most risk

Source: Compiled by the author.

Table 6.22, shows the PDI scores of the funds and the Omega function (as in Figure 6.16). The ideal situation will be that the fund with the highest PDI score (most diversified) will have the steepest slope in the Omega function (least risk). Table 6.23 presents the comparative ranking between the PDI, residual variance and the Omega function (at a threshold = -2%). Note that in Table 6.23 the funds are ranked from best to worst, but it should be remembered that PDI and residual variance measure diversification while the Omega measures risk, which diversification aims to reduce.

Table 6.23: Comparative ranking results (Omega).

	RANKING		
	PDI	Omega	Residual Variance
Best	D	E	E
↓	B	D	D
	E	B	A
	A	A	C
Worst	C	C	B

Source: Compiled by the author.

Table 6.23 shows that the rankings of neither of the diversification measures are precisely in-line with the rankings of the Omega function (at a threshold = -2%), although the two measures do agree with Omega in some instances, with the PDI being more correct than

the residual variance method. Apart from the ranking of Fund E the PDI is fully in-line with the Omega ranking of funds. Table 6.24 shows the ranking results between the PDI, residual variance and the Omega function, but with the exclusion of Fund E.

Table 6.24: Comparative ranking results (adjusted) (Omega).

	RANKING		
	PDI	Omega	Residual Variance
Best	D	D	D
↓	B	B	A
	A	A	C
Worst	C	C	B

Source: Compiled by the author.

It should be remembered that, although the PDI attaches a number to the results, the Omega ranks and evaluates portfolios unequivocally (Keating & Shadwick, 2002:2).

To conclude this section, the results from the PDI are more in-line with the Omega results than are the residual variance methods results. The following section will focus on beta.

6.4.2.6 Beta

Mittra and Gasson (1981:147) stated that systematic risk can be eliminated by selecting a large number of securities with diverse characteristics, a process known as diversification through construction of an efficient portfolio.

As discussed in Section 3.3.3, beta (β) is a measure of volatility or systematic risk and measures the extent to which a given fund's returns vary in line with movements in benchmark (market or index) returns (Botha, 2005:71). It should be noted that because beta measures the variability of a share's rate of return relative to the market return, it measures the systematic return of a share (Mittra & Gassen, 1981:139). Beta (estimated) is calculated by using regression analysis, as was done in this study (ordinary least squares (OLS)) using the Eviews© statistical software package. A $\beta > 1$ is an indication that the portfolio's value or price is more volatile than the specific benchmark used (ALSI in this case). Thus, if a beta of 1.3 is measured, in theory the fund will be 30% more volatile than the bench-

mark, the ALSI. If shares have a $\beta > 1$, these shares offer the possibility of a higher rate of return, but they also pose more risk as is the case if a beta is large and negative. The aim of this study is not to hedge but to reduce risk. Thus, a $\beta = 0$, or as close as possible to zero, is desired. Table 6.24 presents the betas for the funds included in this study.

Table 6.25 indicates that all the funds are less volatile than the benchmark, ALSI, as all the funds have a beta of less than 1. It should be noted that a negative beta might occur even though the fund (or share) and the benchmark have positive returns. This might be the case as lower positive returns of the fund (or share) coincide with the higher positive returns of the benchmark, or vice versa.

Table 6.25: Beta results.

Fund	Year 1	Year 2	Year 3	Year 4
A	0.94	0.26	-0.03	-0.16
B	0.64	-0.06	0.22	-0.10
C	0.37	0.58	-0.53	0.36
D	0.75	-0.22	-0.09	0.01
E	0.46	-0.03	-0.08	-0.15
ALSI	1	1	1	1

Source: Compiled by the author.

Beta has its limitations when it is used as a measure of relative risk as most analyses only consider the magnitude of the measure. As beta is a statistical variable it should be considered with its R^2 . Higher correlation and a stronger relationship between the returns of the benchmark and the fund or share are implied by a higher R^2 . Table 6.26 presents both betas and the R^2 's of the funds.

Table 6.26: Beta and R^2 .

		Year 1	Year 2	Year 3	Year 4
Fund A	Beta	0.94	0.26	-0.03	-0.16
	R^2	0.10	0.02	0.00	0.01
Fund B	Beta	0.64	-0.06	0.22	-0.10
	R^2	0.04	0.00	0.01	0.00
Fund C	Beta	0.37	0.58	-0.53	0.36
	R^2	0.00	0.02	0.01	0.06
Fund D	Beta	0.75	-0.22	-0.09	0.01
	R^2	0.06	0.01	0.00	0.00
Fund E	Beta	0.46	-0.03	-0.08	-0.15
	R^2	0.03	0.00	0.00	0.01

Source: Compiled by the author.

From Table 6.26 it can be seen that none of the R^2 's are highly significant, thus it can be concluded that none of the fund's returns have a high correlation or strong relationship with the benchmark, ALSI. For example, in year four Fund C has a beta of 0.36 and thus entails that 36% of Fund C's volatility is in line with the ALSI, but this beta is not significant (according to its R^2) as only 36% of the funds variability is explained by the benchmark, ALSI. Table 6.27 presents the beta results of the funds, Table 6.28 the beta results in descending order and Table 6.29 the beta fund ranking results compared to the rankings of the funds by the two diversification measures. Note that a $\beta = 0$, or as close to zero as possible, is desired as this is indicative of minimum risk.

Table 6.27: Beta ranking results.

Fund	Beta
A	-0.16
B	-0.10
C	0.36
D	0.01
E	-0.15

Source: Compiled by the author.

Table 6.28: Beta results in sorted order.

Fund	Beta
D	0.01
B	-0.10
E	-0.15
A	-0.16
C	0.36

Source: Compiled by the author.

Table 6.29: Comparative ranking results (Beta).

	RANKING		
	PDI	Beta	Residual Variance
Best (least risk)	D	D	E
↓	B	B	D
	E	E	A
	A	A	C
Worst (most risk)	C	C	B

Source: Compiled by the author.

From Table 6.29 it can be seen that the ranking result of beta and PDI are identical. It is known that beta is used to measure volatility compared to a chosen benchmark for example a market index, but even this “relative” measure is a measure of risk and this risk is systematic risk (inherent in the market) which can not be diversified away. An investor who is risk averse will not welcome an investment which is extremely volatile and though there might be some correlation between volatility and risk, standard deviation might be a better measure of volatility and, ultimately, risk. However, from Table 6.29 which presents the beta results compared to the two diversification measures it can be concluded that PDI and beta are identical.

6.4.2.7 Information ratio

This section will present the results of the Information ratio. Although Section 4.4.2.7 discussed the Information ratio it should be noted that this measure or ratio is not the primary focus of this study and will not feature further in this chapter as this study is not primarily concerned with active fund management.

As stated in Section 4.4.2.7, the Information ratio divides the portfolio alpha by the portfolio’s non-systematic risk, otherwise known as “tracking error” and thus the Information ratio measures abnormal return per unit of risk (Bodie *et al.*, 2005:868). As unsystematic risk can not be diversified away, the process of concept known as diversification, which is the main focus of this study, has no effect on it. Furthermore, it should be noted that the Information ratio is valuable as it provides information on the performance of the portfolio manager. The Information ratio provides this information as the ratio’s numerator represents the ability of the investor or portfolio manager to generate a portfolio return which differs from the return of the chosen and/or applicable benchmark(s) (Reilly & Brown, 2006:1051).

The results of the Information ratio for the funds analysed in this study are presented in Table 6.30. According to Grinold and Kahn (2000:114) a reasonable Information ratio should range between $0.5 \leq IR \leq 1$, with 0.50 being good and 1.00 being exceptional. The JSE All Share Index (ALSI) is used as the benchmark for the Information ratio.

Table 6.30: Information ratio results.

Fund	Year 1	Year 2	Year 3	Year 4
A	2.54	1.51	0.84	0.59
B	2.62	1.32	0.79	0.56
C	2.51	1.17	0.81	0.54
D	2.92	1.36	0.84	0.58
E	3.29	1.31	0.79	0.61

Source: Compiled by the author.

Focusing on the results of year four as presented in Table 6.30, it is clear that all the funds have an Information ratio greater than 0.50, which is interpreted as good by Grinold and Kahn (2000:114). Fund E emerges as the fund with the best Information ratio for the period followed very closely and competitively by all the other funds. As was mentioned earlier in this section, the Information ratio does not fall within this study's primary focus as active portfolio management is not the primary focus of this study. The amount of value a portfolio manager creates or destroys will largely fall under active portfolio management.

Table 6.31: Information ratio results in sorted order.

Ranking key	Fund
Best	E
↓	A
	D
	B
Worst	C

Source: Compiled by the author.

6.4.2.8 Conclusion

This chapter presented the empirical work regarding the PDI and its construction. The first aim of this study (and this chapter) is to ascertain whether or not the PDI is a useful diversification measure compared to the "traditional" residual variance method. As there is no

statistical method in which to gauge whether or not this is indeed the case the PDI was tested “head-to-head” against the residual variance method, which is widely used in practice. This was done by ranking the funds in accordance to the results of a number of different performance measures plus concentration. Although the two diversification and performance measures are not directly comparable (as they measure different concepts), this concept of testing was adopted because there is no statistical method to do so. The idea was to ascertain whether or not the PDI is in line, or even better aligned, with the results of the performance measures, than the residual variance method.

Before a conclusion can be made about the findings and results of this chapter, it is instructive to tabulate all the results into a single table. Table 6.32 presents all the ranking results in such a table while the table also uses colour coding for easy viewing.

Table 6.32: Summary results.

Ranking key	Best	→			Worst
PDI	D	B	E	A	C
Residual Variance	E	D	A	C	B
Concentration	E	D	B	A	C
Std Deviation	A	B	D	E	C
Sharpe	E	D	C	A	B
Sortino	E	C	D	B	A
Sharpe & Sortino Combined	E	C	D	B	A
Treynor	D	C	A	E	B
Omega at -2% threshold	E	D	B	A	C
Beta	D	B	E	A	C
Information Ratio	E	A	D	B	C

Source: Compiled by the author.

From Table 6.32, it can be concluded that neither of the two diversification measures are 100% in-line with any of the performance measures. It should be noted that none of the performance measures measure diversification and thus none of the diversification measures’ results can be directly compared to the results of the performance measures. It should

furthermore be remembered that the objective of diversification is to reduce and eventually eliminate risk, specifically unsystematic risk because systematic risk is inherent in the market and can not be diversified away.

There was no consistent fund ranking from either the PDI or the residual variance method with any of the performance measures. This is, however, clear that the fund ranking results of the PDI and the Omega are the results most aligned, especially when Fund E is omitted from the results.

As Omega is arguably the best ratio of the ratios used in this empirical study in terms of what it measures and especially how it is measured, Omega will be used further in Chapter 7 in aiding the second objective of this study. Chapter 7 will continue by utilising Omega and PDI with the objective of ascertaining whether or not the PDI can be used as a tool by portfolio or fund managers when constructing or customising an existing portfolio.

It, however, remains difficult to determine whether or not the PDI is a better diversification measure than the residual variance method due to the method of testing used and the results obtained. The fact that the PDI and residual variance results differ is, however, an indication that the PDI is a diversification measure worth investigating while this would not be the case if the results of the PDI and residual variance were the same. Similar results would favour the residual variance method as this method is tried and tested while also being less time consuming and less complicated to use and interpret (compared to the PDI). The PDI might be a better measure of diversification compared to the residual variance method, although further research and testing is recommended. The PDI can thus far be viewed as an alternative measure of diversification to the residual variance method.

Chapter 7

Empirical study of the PDI as a fund management tool

7.1 Introduction

This study has two objectives, which are:

- To determine whether or not the PDI is a good measure of diversification compared to the traditional method of measuring diversification, which is the residual variance method. This was focused on and presented in Chapter 6.
- The second objective of this study, and the focus of this chapter, is to ascertain whether the PDI can be used as a fund management tool by fund or portfolio managers when constructing or customising an existing portfolio.

This chapter will also present how the PDI can be used to measure the degree of diversification that a specific share adds to a portfolio by using “marginal” portfolio diversification or “marginal” PDI.

7.2 PDI as a fund management tool

7.2.1 Introduction

The aim of this section is to ascertain whether or not the PDI can be used by portfolio managers as a fund management tool. This section will aim to prove the PDI is an alternative tool to be used by portfolio managers. A scenario will be created to act as an example, while the Omega ratio (Section 4.4.2.8) will be used to evaluate the results.

7.2.2 Scenario

The aim of this section is to use the PDI as a tool in order to improve a fund or portfolio's diversification, i.e. reduce the risk of the portfolio without drastically reducing the return of the portfolio. The Omega ratio will also be used to aid in the evaluation and presentation.

In Section 4.4.2.8 the Omega ratio, a measure of a fund's performance was introduced and the results presented. It was explained in Section 6.4.2.5 that the downside (below 0% return) represents the risk of a fund as no investor welcomes negative returns. It is, however, also known that investors welcome positive returns, but above a certain benchmark - the risk-free rate for example. For this illustration, the downside will be taken as below 0%

although -2% will serve as a point of comparison. Figure 6.12 presents the downside results for all the funds as obtained in Section 6.4.2.5 of this study.

In Section 6.4.2.5 it was explained that the ideal is that the (Omega function) slope should be as steep as possible (in the downside), as this is an indication of few negative returns, while this will also mean less risk (for the portfolio). The objective of diversification is to reduce and eventually eliminate unsystematic risk (Mitra & Gassen, 1981:533). In Section 6.4.2.5 the funds were ranked according to the Omega performance with -2% (return) as the randomly chosen point of comparison. Figure 6.17 presents the Omega at -2% return.

The point of comparison, -2% return, is specifically chosen in the downside, as risk is mainly in the downside while the objective of diversification is to reduce and eventually eliminate risk.

From Figure 6.12 and Figure 6.17 it can be observed that Fund C is far below the other funds in the downside while Fund C's slope is the least steep of all the funds' slopes. Fund C has more risk than the other funds according to the Omega function while the PDI measure shares this sentiment as Fund C has the lowest PDI score of all the funds analysed, with a PDI score of 1.02.

In order to reduce the amount of risk in Fund C, which is the objective of diversification, the (Omega) slope of Fund C must thus improve specifically in the downside. By the results obtained thus far the PDI of Fund C will also improve as the (Omega) slope of the Fund C becomes steeper (improves).

Fund C's current performance is presented in Table 7.1

Table 7.1: Performance of Fund C.

Fund C	
PDI	1.02
HHI	5.22%

Source: Compiled by the author.

In Sections 3.6 and 3.8 the topics of portfolio construction and optimal portfolios were focused on respectively. From the discussion in Section 3.8, it can be concluded that the desired outcome in portfolio management is to optimise the portfolio, i.e. the optimal portfolio.

lio must be obtained. This entails that the weight of each share, which the portfolio consists of, has to be adjusted to obtain the minimum portfolio variance for a given level or return (for the portfolio).

Before Fund C is optimised, using a portfolio optimisation model sourced from Business Spreadsheets,¹¹ the PDI results must be used to identify which shares in Fund C should receive more weighting and which shares should receive less weighting. If the shares in Fund C are weighted as suggested by the PDI results, i.e. the truly independent components or shares receive more weight, then Fund C should be more diversified (than before) given that the shares contained in Fund C remain the same. Table 7.2 presents the shares in Fund C, which according to the PDI are the most independent factors. The PDI of Fund C is 1.02 and indicates that Fund C has only 1 truly independent factor (Impala Platinum Holdings Limited). The shares named in Table 7.2 are, however, the shares which are the most independent factors (or shares) in Fund C.

Table 7.2: Independent factors in Fund C.

Share name
ABSA Group Limited
Ellerine Holdings Limited
Impala Platinum Holdings Limited
Mittal Steel SA Limited
M-Cell (MTN)
Standard Bank Group Limited
Sasol Limited

Source: Compiled by the author.

Table 7.3 represents the shares which are negative in terms of shares which are independent factors in Fund C and can thus be referred to as non-independent factors.

¹¹ Business Spreadsheets – www.business-spreadsheets.com

Table 7.3: Negative independent (non-independent) factors in Fund C.

Share name
Rainbow Chicken Limited
Sappi Limited
Wesco Investments Limited

Source: Compiled by the author.

The shares named in Table 7.3 should thus receive as little (or even no weight) in Fund C as they are non-independent factors in Fund C. These shares will thus influence Fund C's diversification negatively.

The next step is to reassign a weight for each share in Fund C using the information contained in Table 7.2 and Table 7.3. It is modern practice to optimise a portfolio in order to obtain the minimum portfolio variance for a given level of return.

The process is as follows:

- optimise Fund C using the information obtained from the PDI results. The optimisation model will provide the optimal weight for each share in Fund C,
- calculate the weekly returns of Fund C with the "new" (optimal) weights obtained from the optimisation model,
- calculate the Omega with the "new" weekly returns, and
- calculate the PDI with the "new" weekly returns.

The optimisation process will minimise the variance in Fund C for a given level of return. The level of return (required rate of return) that will be used is the RFR + 1% (9.12%), as this is only for illustration purposes where the process and concept is the primary focus. The RFR will be taken as the 4 year average RFR (8.12%) as was done throughout this study. Note that the period under analysis again ranges from 1 July 2003 to 30 June 2007 and that the shares contained in Fund C remain the same as was the case throughout Chapter 6. It is important to note that no proxies are used for this analysis although the "old" or "starting" Omega of Fund C contains a proxy (Section 6.2.2). The minimum weight constraint on each share in Fund C is 0% except for the shares contained in Table 7.2. The

maximum weight constrain is 100% except for the shares contained in Table 7.3. 2000 iterations were run on the portfolio optimisation model. The following section will explain how the minimum and maximum constraints for both the most independent and non-independent factors of Fund C were estimated.

7.2.2.1 Determining the minimum and maximum constraints

This section explains how the minimum and maximum constraints were determined for both the most independent factors and the non-independent factors of Fund C.

The maximum constraint of the most independent factors or shares of Fund C, as named in Table 7.2, is 100% as it is for all the other shares. The minimum constraint for the most independent factors was estimated by optimising Fund C without any constraints and then using the average optimal weight of the seven independent factors as the minimum constraint. The optimisation process used 2000 iterations. Table 7.4 presents the optimal weights for the seven independent factors or shares of Fund C from which the average was used as the minimum constraint for the most independent factors or shares of Fund C.

Table 7.4: Optimal weights for most independent shares.

Share name	Optimal weight
ABSA Group Limited	2.20%
Ellerine Holdings Limited	8.57%
Impala Platinum Holdings Limited	8.24%
Mittal Steel SA Limited	3.13%
M-Cell (MTN)	1.46%
Standard Bank Group Limited	1.89%
Sasol Limited	1.75%
Average weight	3.89%

Source: Compiled by the author.

From Table 7.4 it is clear that the average optimal weight of the seven most independent factors or shares of Fund C is 3.89%. This will thus be used as the minimum constraint for the seven most independent factors or shares of Fund C.

The same procedure was followed to determine the maximum constraint for the three non-independent factors or shares of Fund C. 2000 iterations were also used for this optimisation process. Table 7.5 presents the optimal weights for each of the three non-independent factors or shares of Fund C along with their average optimal weight.

Table 7.5: Optimal weights for non-independent shares.

Share name	Optimal weight
Rainbow Chicken Limited	1.80%
Sappi Limited	5.40%
Wesco Investments Limited	8.64%
Average weight	5.28%

Source: Compiled by the author.

The average optimal weight, as presented in Table 7.5, for the three non-independent factors or shares of Fund C is 5.28%. This will be used as the maximum constraint.

7.2.2.2 Optimisation of Fund C.

The minimum and maximum constraints for the most independent and non-independent factors of Fund C were used as was explained in the preceding section. 2000 iterations were run on the portfolio optimisation model, which was sourced from Business Spreadsheets. Table 7.6 presents the optimal weights as estimated by the optimisation model for both the most independent and non-independent shares of Fund C.

Table 7.6: Optimal weights for Fund C.

Share name	Optimal weight	Constraint
ABSA Group Limited	4.61%	Weight > 3.89%
Ellerine Holdings Limited	5.20%	
Impala Platinum Holdings Limited	10.72%	
Mittal Steel SA Limited	4.37%	
M-Cell (MTN)	5.22%	
Standard Bank Group Limited	6.83%	
Sasol Limited	4.65%	
Rainbow Chicken Limited	1.81%	Weight < 5.28 %
Sappi Limited	5.02%	
Wesco Investments Limited	0.37%	
Total	48.80%	

Source: Compiled by the author.

7.2.3 Scenario results

This section will present the results for this illustrative scenario, specifically focusing on the Omega results and the PDI results.

7.2.3.1 PDI results

Fund C had a PDI score of 1.02 before the fund was optimised by the portfolio optimisation model, which was aided by the PDI. After the optimisation model was run Fund C's PDI score increased to 2.25. This increase in the PDI score of Fund C is an indication that Fund C's degree of diversification increased as a larger PDI is preferred and indicates a larger degree of diversification. The PDI score can range, as explained in Section 5.5.2, from 1 (completely undiversified portfolio) to N (the number of assets in the portfolio) (completely diversified portfolio). The PDI score of Fund C after optimisation (2.25) indicates that Fund C is far from completely diversified as a PDI score of 34 would be the

fund's PDI score if the fund was completely diversified. Fund C is, however, more diversified than before the fund was optimised and the most independent factors or shares identified.

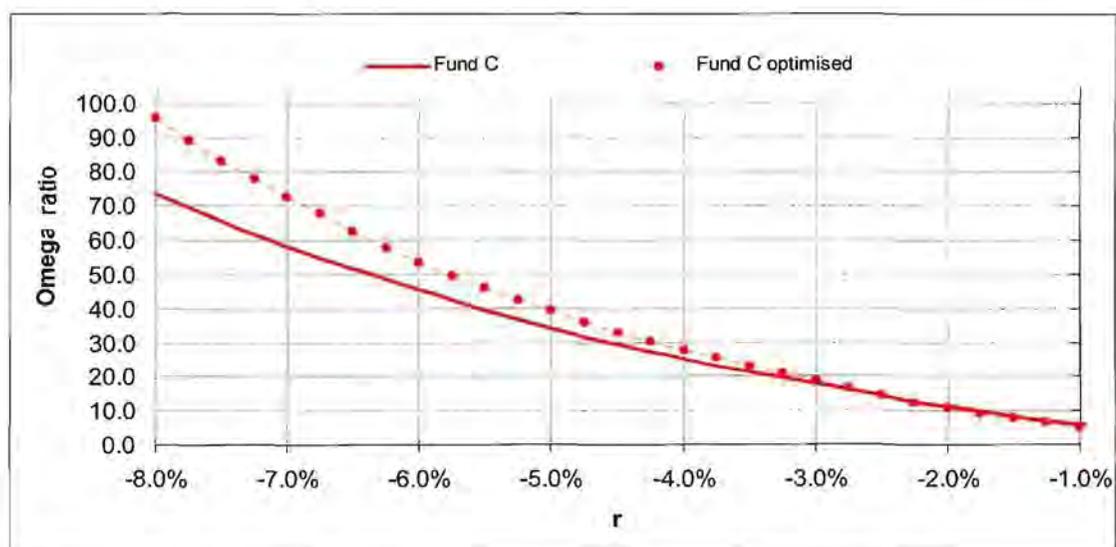
Fund C's HHI has declined to 5,17% from 5,22% before Fund C was optimised with the help of the PDI. The decrease in the concentration of Fund C is also in line with theory. In Section 6.3.6 to 6.3.8 it was explained and presented that concentration and diversification, in theory, should have an inverse relationship. A decrease in Fund C's concentration should thus improve the diversification of Fund C, which is the case as the concentration of Fund C decreased while the PDI score of Fund C increased.

The following section will use Omega to further evaluate the results obtained from this chapter.

7.2.3.2 Omega results

Figure 6.12 presents the Omega results before Fund C is optimised while Figure 7.1 presents the Omega results after the most independent and non-independent shares of Fund C are identified and the fund optimised. Figure 7.2 illustrates Fund C's optimisation results along with the Omega functions of the other funds, where -2% (return) is also used as an evaluation (comparison) point.

Figure 7.1: Fund C's optimised Omega results.

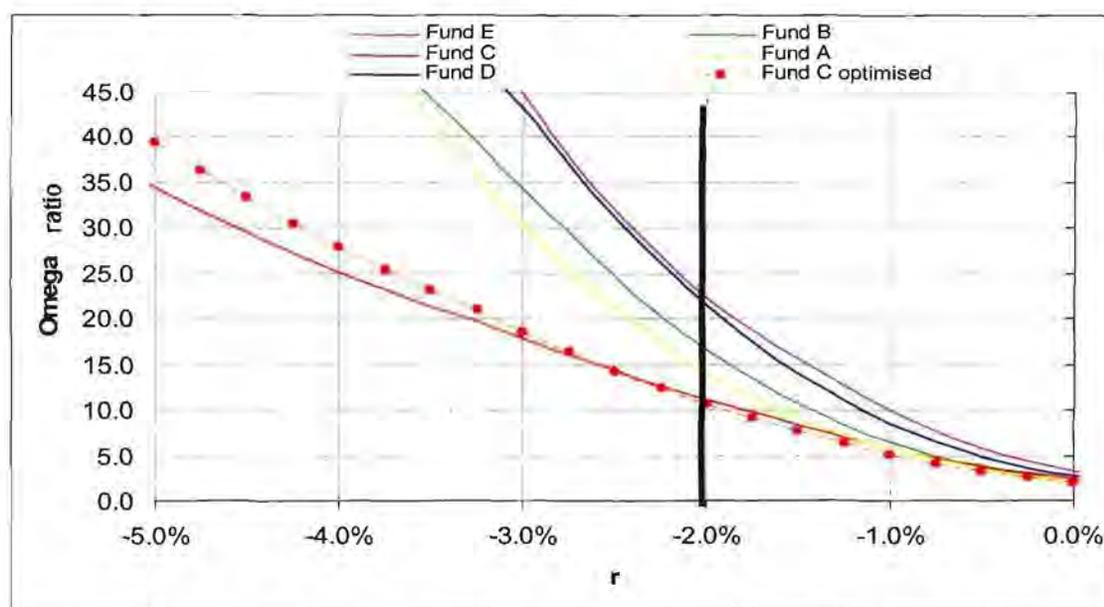


Source: Compiled by the author.

In Figure 7.1 it is clear that the optimisation of Fund C made a difference in the downside as the slope of Fund C improved (became steeper). Fund C is thus clearly less risky after it has been optimised.

In Figure 7.2 it is clear that the optimisation of Fund C made a difference in the downside, especially below -2%. It would have been ideal if the slope of the optimised Fund C became steeper at a faster rate, thus earlier in the downside. The result, however, is still an improvement on Fund C before the optimisation process, which was aided by the PDI. As the slope of Fund C is steeper after optimisation Fund C is less risky which can be attributed to an increase of diversification as the PDI score of Fund C also increased. The following section will elaborate further on the relationship between the results of the Omega and the PDI.

Figure 7.2: Fund C's optimised Omega results at -2%.



Source: Compiled by the author.

7.2.3.3 Relationship between PDI and Omega results

Section 7.2.3.1 presented the PDI results while Section 7.2.3.2 presented the Omega results, both after Fund C was optimised with the assistance of the PDI. This section will evaluate what these results have in common and evaluate the results accordingly.

The PDI score of Fund C improved from 1.02 to 2.25 while the slope of Fund C's Omega function also increased (became steeper) in the downside (where risk is manifested). The empirical study in Chapter 6 made it clear that the Omega and the PDI are in-line with each other. The result of one of these measures can thus be confirmed by the other measure (to some degree) as these two measures are not only in-line with each other, but both these measures are flexible to some extent. A future or further research possibility might focus on the significance between the Omega and the PDI in a statistical manner, but this is not the focus of this study or chapter.

The essence of the concept is that if the slope of Fund C's Omega function increases in the downside, it can be concluded that the PDI can be used as a tool by fund managers as the PDI score of Fund C also increases. The reason for the PDI being referred to as a tool in this case or situation is because the PDI was used to identify the (most) independent and non-independent factors of shares in Fund C. This information was then used assist in determining the optimal Fund C.

The subsequent section will elaborate and focus on the conclusion of this chapter's findings.

7.2.3.4 Summary of the PDI as a fund management tool

The aim of this section was to ascertain whether or not the PDI can be used as a tool by fund or portfolio managers when constructing or customising an existing portfolio. The example in this chapter showed that this is indeed the case and that the PDI can be used as a tool by fund managers when constructing or customising (changing the composition) an existing fund. The PDI results of this section were evaluated by the Omega, as the Omega is the most prominent performance measure as explained in Chapter 6, while the fund ranking results of the PDI were most correctly aligned with the fund ranking results of the Omega (see Sections 6.4.2.5 and 6.4.2.8). The results of this section also showed that the relationship between the PDI and the Omega is a true relationship and that these two measures could be used in tandem or at times as substitutes for one another.

If the positioning of each fund's Omega function (in the downside) is compared to the PDI (score) of the corresponding fund it is clear that only Fund E is incorrectly aligned. If Fund E is, however omitted, as was done in Section 6.4.2.5, the PDI and the Omega (in the

downside) are 100% aligned. This is because the PDI results and the Omega function results (in the downside) have corresponding rankings.

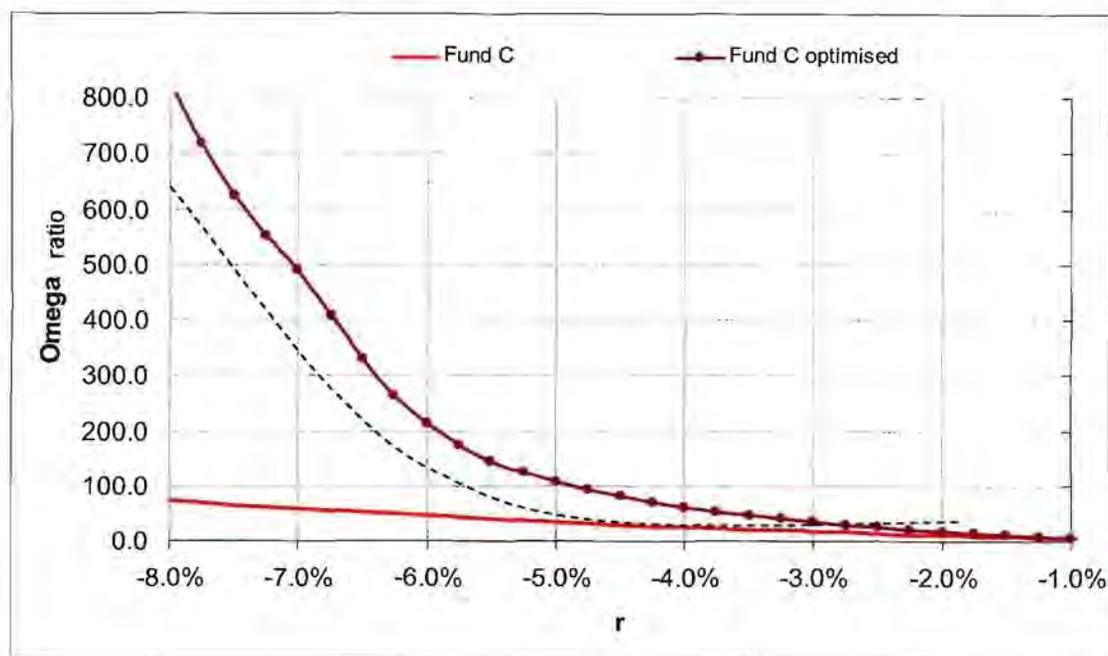
This section of this chapter has asserted that the PDI is yet another tool which a fund manager could use either by itself or in conjunction with other measures, the Omega for example. The PDI is thus an additional tool for a fund manager as it can be used when constructing or customising an existing fund.

7.3 Additional PDI concepts or uses

7.3.1 Possible other uses of the PDI

The PDI is correctly aligned with the Omega function and the PDI “correctly” scores a fund’s diversification so it may be used as an additional tool by fund managers. For instance, a fund manager can incorporate a diversification benchmark for the fund. This benchmark can be incorporated into the Omega function while a benchmark PDI score can also be used. The fund manager would then strive to obtain the diversification benchmark(s) set in either or both the Omega and the PDI. Figure 7.3 illustrates how a benchmark can be incorporated into the Omega function.

Figure 7.3: Omega and diversification benchmark.



Source: Compiled by the author.

The dotted-line, in Figure 7.3, represents a hypothetical diversification benchmark in the Omega function that a fund manager should strive for. The fund's Omega function should be to the right and or above the diversification benchmark, as the benchmark indicates the minimum diversification performance that should be achieved.

Another concept or use of the PDI which might be valuable will be discussed in the next section as it is also this chapter's aim to explain the concept of marginal portfolio diversification

7.3.2 Marginal portfolio diversification

7.3.2.1 Introduction

The objective of this section is to present how the PDI can be used as a tool by a fund manager to measure the degree of diversification that a specific share adds to a portfolio. The most effective and convenient manner in which to measure how much a certain share adds to a portfolio in terms of diversification is to use marginal portfolio diversification or marginal PDI.

The "marginal" concept is a very well-known concept and thus no detail explanation of this concept is necessary. For the sake of completeness, marginal portfolio diversification (marginal PDI) refers to the additional diversification effect an additional security or share has on the portfolio, i.e. marginal portfolio diversification aims to determine how much additional diversification is gained by adding additional share(s) to the portfolio by utilizing the PDI. The marginal estimation or calculation is thus also in PDI terms. Marginal PDI (Equation 6.3) is defined as (Smith, 2006:21):

$$\text{MarginalPD}(K) = \text{PDI}(\text{Poolsize} = K) - \text{PDI}(\text{Poolsize} = K-1)$$

An example will be used to explain the marginal portfolio diversification concept which uses PDI.

7.3.2.2 Scenario

A new fund, which will be referred to as Fund Z, will be constructed for this section of the study. Fund Z consists of 10 shares whereafter the marginal PDI will be calculated to determine the diversification value that a specific share provides to Fund Z.

The newly constructed Fund Z contains the following 10 randomly selected shares from the Johannesburg Stock Exchange (JSE):

- Lewis (LEW)
- MTN (MTN)
- Murray & Roberts Holdings (MUR)
- Mr Price (MPC)
- Old Mutual (OML)
- Pick n Pay (PIK)
- Rand Merchant Bank (RMBH)
- Sasol (SOL)
- Steinhoff International (SHF)
- BHP Billiton (BIL)

The shares that Fund Z comprises of were randomly chosen out of the entire universe of funds which were used in the empirical study of Chapter 6. Once again the period for the calculation is 1 July 2003 to 30 June 2007 while weekly closing prices and returns will also once again be used. The closing prices for the 10 randomly selected shares were sourced from McGregor BFA. Furthermore, as the fund only contains 10 shares, each share is assigned a weight of 10% of the portfolio to constitute an equally weighted portfolio.

The PDI calculation procedure was followed as explained in Section 5.6 while the specifics are as follows:

The data required in order to calculate the marginal PDI are:

- return history of 10 shares.

The procedure to calculate the PDI for Fund Z is:

- construct a column consisting of the time series of share returns, which make up Fund Z, multiplied by the respective weight of the N shares,
- construct a Principal Component Analysis (PCA) on the covariance matrix of these series giving a series of uncorrelated factors (eigenvalues) that represent the volatility of the returns is the result of the PCA,

- order these factors from most to least significant, and
- substitute these factors into the PDI formula (Equation 3.27).

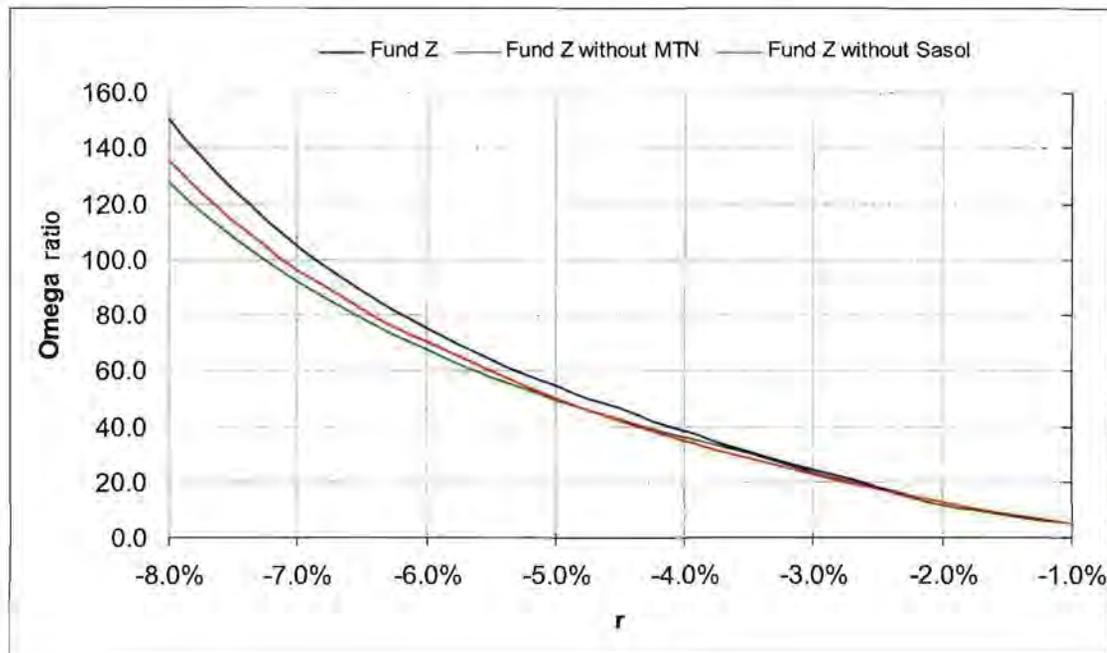
7.3.2.3 Marginal PDI results

Fund Z has a PDI score of 4.09. When the MTN share is removed from Fund Z, the PDI score of the fund declines to 3.63 using marginal PDI formula. Thus it can be concluded that the MTN share contributes 0.46 ($4.09 - 3.63$), in terms of diversification to Fund Z. It should, however, be remembered that the diversification “value” that a specific share, in this case MTN, provides to a fund will differ according to the shares included and how these shares are correlated. The weighting structure will also have an influence. Thus, for this specific combination of shares where each share has a 10% weight in the portfolio, the MTN share contributes positively to the diversification of Fund Z by 0.46 (in terms of PDI score).

If the Sasol share is omitted from Fund Z, the PDI score of Fund Z declines to 3.68. The MTN share is now again included in Fund Z and the each share in the fund has equal weighting. Thus by subtracting the PDI score of Fund Z when the Sasol share was omitted from the original Fund Z, it can be concluded that the Sasol share adds 0.41 to Fund Z in terms of diversification.

A certain share can also be added to the portfolio and the PDI calculation performed to ascertain the amount of diversification this specific share provides to the fund in question. Thus, for example, if a fund manager would like to know if the addition of Standard Bank (share) to Fund Z will provide the fund with better diversification before actually agreeing to the actual trade thereof, the PDI and its marginal calculation would be a valuable asset. As Fund Z will contain 11 shares if the Standard Bank share is added to the fund, the weighting structure of Fund Z must in theory be changed to now accommodate 11 shares and for the portfolio weights to equal 100%. The 11 shares are again equally weighted as with the prior example. The PDI score of Fund Z increased to 4.29 when the Standard Bank share is added and thus the share adds positively to the diversification of Fund Z with a PDI value of 0.20. The addition of a share to a portfolio and the evaluation by the Omega function of the correctness of the PDI result in this process remain to be tested. Figure 7.4 presents the marginal PDI results as evaluated by the Omega.

Figure 7.4: Marginal PDI.



Source: Compiled by the author.

The omission of both the MTN and Sasol shares from Fund Z decreases the diversification of Fund Z as the Omega slope of Fund Z decreases in steepness (in the downside) when these shares are omitted from Fund Z. The PDI score of Fund Z is 3.63 when the MTN share is removed from the fund while the PDI score of Fund Z is 3.68 when the Sasol share is removed from the fund. This means that for the marginal PDI concept to be correct Fund Z's Omega function without the MTN share must be lower or less steep than that of Fund Z without the Sasol share. This is indeed the case in Figure 7.4.

The following section will briefly discuss another manner in which the PDI can be used to add value for portfolio or fund managers.

7.3.3 Return & diversification matrix

If the historic return performance and the PDI (score) of each of the shares or potential shares of a fund are known, the fund manager can present them as in Figure 7.5, which indicates return versus diversification benefits per share.

From Figure 7.5 the fund manager can establish an efficient frontier which will provide a fund consisting of shares that will provide the highest degree of diversification for a certain level of return. Table 7.7 presents the data on which Figure 7.5 is based.

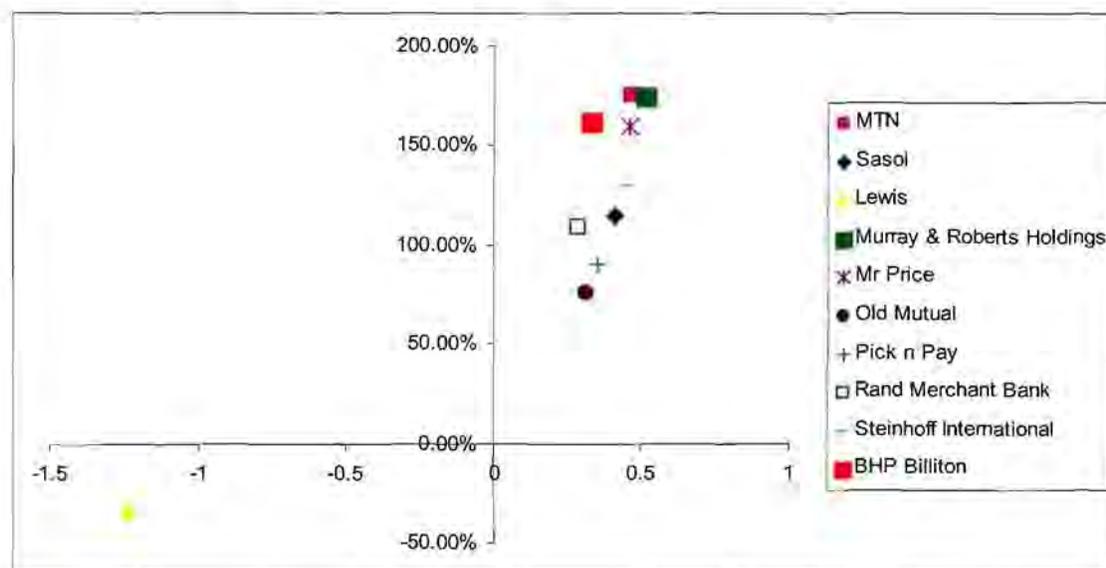
Table 7.7: Four year return versus PDI contribution.

Share Name	4 Year Return	PDI contribution
Lewis	-33.08%	-1.23
MTN	175.91%	0.46
Murray & Roberts Holdings	174.74%	0.51
Mr Price	159.88%	0.46
Old Mutual	76.47%	0.31
Pick n Pay	90.23%	0.35
Rand Merchant Bank	109.53%	0.28
Sasol	114.91%	0.41
Steinhoff International	129.97%	0.46
BHP Billiton	162.15%	0.33

Source: Compiled by the author.

The information from Figure 7.5 indicates that the Lewis share does not contribute positively to the existing portfolio. Note that in Figure 7.5 the *X*-axis is the PDI contribution while the *Y*-axis is the four year return. The Murray & Roberts Holdings share is the one which contributes the most to Fund Z in both return and diversification. Thus, the PDI, when used in a marginal portfolio diversification manner, can be useful for a fund manager.

Figure 7.5: Four year return versus PDI contribution.



Source: Compiled by the author.

7.3.4 Conclusion

The aim of this chapter was to explain how the PDI can be used in a marginal portfolio diversification estimation and thus to be used as a tool in this manner. Section 7.3.2 proved that the PDI can indeed be used as a marginal calculation tool to gauge how much diversification a specific share adds to an existing portfolio. The results of the example used were also evaluated by the Omega function, with the Omega results corresponding to the results from the PDI.

This chapter also explained that the PDI could be used as a diversification benchmark either by itself or with other measures; the Omega function, for example. In addition to this, it was also explained in Section 7.3.3 that the degree of diversification that each share in an existing portfolio adds to a portfolio, which is calculated by using the marginal PDI calculation as discussed in Section 7.3.2, can be combined along with the return performance of the corresponding share to construct a return and diversification matrix. This matrix makes for easy and simple viewing and can be used by fund or portfolio managers when customising funds.

This chapter thus proved that the PDI can be used to ascertain how much diversification a specific share adds to an existing portfolio, but that the PDI can also be used in other ways.

These concepts which were discussed in this section will be of use and add value to a fund manager. It can thus be concluded that the PDI is a relatively flexible diversification measure and that the opportunity exists for the PDI to be customised so as to evaluate other aspects of optimal portfolios.

Chapter 8

Summary, conclusions and suggestions for future research

8.1 Summary

Financial markets in the modern day and age are becoming more complex and more highly developed, thus the tools and analysis used will need to develop along with the financial markets. This study presented a number of concepts, each focusing on a specific topic and each relevant to the chief focuses: portfolio diversification and the relatively new diversification measure, the PDI.

As diversification is mostly of use in a portfolio of assets, the central idea was to discuss and present concepts and elements which are both relevant and important to both diversification and the reduction or elimination of risk, but to also portfolio theory and management.

The various conclusions may be made following the completion of this study, while the following two points briefly summarise the topics covered.

- The first objective of this study was to ascertain whether or not the PDI is a good measure of diversification compared to the “traditional” diversification measure, the residual variance method. The study commenced with an overview of portfolio theory and how it evolved since Markowitz (1952) established that both risk and return should be considered when constructing a portfolio. The study continued by touching on the important aspects of risk and return, including their respective methods of measurements. The next important focus of the study involves diversification and a number of relevant topics relating to it. Portfolio construction was discussed as it affects diversification, and also because diversification is most useful within a portfolio setting. Discussion on markets, funds and fund performance measures followed.
- The last section of this study focused on investigating empirical evidence which would confirm or reject the objectives of this study.

The following discussion will very briefly consider and present some of the most relevant findings of the chapters and the study as a whole.

8.2 Conclusions of the literature study

Both the Markowitz Portfolio Theory (MPT) and the Capital Market Theory (CMT) were discussed in the early part of this study and although the CMT is, in essence, an extension of the Markowitz Portfolio Theory (MPT), the decision was taken to use the Markowitz Theory as the backbone of this study and that it is to be used as the primary portfolio theory for this study. As the Capital Market Theory (CMT) is an extension of the MPT, the discussion and findings of this study would not have been very different, if at all, if the CMT were considered the primary theory. The discussion regarding portfolio theory was used as the starting point. Thereafter further discussions on various concepts followed, relating to portfolio theory and portfolio management in general. The study also included an extensive discussion of both risk and return, as these elements are central to portfolio theory and management. Although a number of risk measures were discussed, standard deviation was identified as the most relevant measure of risk within a portfolio setting, while it is also the most widely used and recognised. The measurement of return also received the attention it deserves, as the goal of any investment is to earn returns, while the relationship between risk and return was briefly touched on.

As diversification is mainly employed within a portfolio of assets, portfolio construction was discussed and some valuable calculations presented, for example the utility score. A brief example on how to calculate the optimal portfolio component weights was presented, while showing how to incorporate this within the investor's personal risk preference. The concept of diversification, (being the main focus along with the measurement thereof), as well as other related concepts, were presented and thoroughly discussed including the way in which the concept of diversification affects a portfolio. The methods of diversification, benefits and reasons why an investor should consider diversification were among the topics explained in Chapter 3. Among the methods to diversify, the study not only presented the "traditional" widely used manner of residual variance and the "new" PDI, but also three other measures namely: the

- Correlation Coefficient,
- Intra-Portfolio Correlation, and
- IPC3.

As these three other diversification methods are not the focus of this study they were not elaborated upon. The study identified that diversification is most commonly used to reduce the risk of an investment portfolio while the ultimate goal is to eliminate unsystematic risk completely.

Chapter 4 focused on markets, funds and fund performance as these topics are all relevant to portfolio management. The reason why markets were briefly discussed is because the elements of which portfolios consist, and in certain cases the funds themselves, Exchange Traded Funds (ETF), are traded in these markets. The study also gave consideration to the characteristics of a good market and the different forms of the Efficient Market Hypothesis (EMH), even though its aim was not to investigate the efficiency of the market in which funds or financial securities are traded. However, various markets were discussed in broad terms and compared with the characteristics of a good market. Not only traditional markets but also semi-traditional markets (e.g. the property market) were discussed briefly in order to provide as much information as deemed necessary in order to sketch a full and clear picture. The findings on this topic appear to be that the markets within which financial securities are traded are highly efficient, and also that these markets subscribe to the strong form of the EMH. While a portfolio of assets is of a fund nature, the concept of funds was discussed in some detail including definitions, types and differences among funds. A reason for the inclusion of the topic surrounding funds is that during the course of the study it became apparent that funds in the modern day setting have become sophisticated and that there are a number of different funds, each being different from the other. The study also found that the fund of “unit trust” nature or type has had a somewhat odd origin as it took some interesting and dramatic events for the unit trust to evolve into the type of fund it is today. Furthermore, it can be concluded from the study that the South African unit trust industry is performing very well compared to the unit trust industry globally and that the South African unit trust industry is growing strongly. The feeling is that the South African hedge fund industry is poised for some strong growth in the future since hedge fund regulation has been put into place. Fund performance is another important concept that is related to the main focus of this study as an investor invests in order to earn returns. Fund performance included not only return performance, but also risk-adjusted measures which were used in the empirical study. Although well-known risk-adjusted performance measures were discussed in Chapter 4, the Omega ratio made a significant impression: some

sources also argue that the Omega ratio is a remarkable measure. Possible reasons for this might be that the Omega ratio employs all the information contained within the return series and that all which is known about the risk and return of a portfolio is contained within the Omega ratio. Benchmarks and indices concluded this section as fund or portfolio managers are generally required to perform to a certain benchmark, while indices were discussed very briefly as investors can purchase an index known as ETF in modern markets.

As the PDI is very much the key concept or topic of this study a brief chapter was dedicated to explaining the PDI, the construction of the PDI and how it should be interpreted. The PDI is considered a superior measure of diversification when a market is highly concentrated (compared to the residual variance method) as the PDI is free of market influence.

To summarise, the literature study presented a large amount of information in order to provide the reader with relevant background, while most of the measures or relevant techniques used in the empirical study were also discussed and presented in the literature beforehand.

8.2 Conclusions of the empirical study

The findings of the empirical study are important and of value to the financial sector. The first objective of the study had the “traditional” and widely used, well-known residual variance method of diversification go “head-to-head” with the new PDI. Although a non-statistical method was used to do the comparison between the two diversification measures, the result may provide some insight not previously known. A fund ranking results method was used to judge whether or not the PDI is indeed a good measure compared to the residual variance method. During the course of the study it became apparent that if the PDI delivered similar results to the residual variance method, it may be concluded that the PDI “works” and measures the diversification of portfolios correctly. If this were the case, fund managers would simply opt for the already widely used and less time consuming residual variance method compared to the more complex and time consuming PDI. Furthermore, the objective of this study was not to determine whether or not the PDI “works” or correctly “scores” (measures diversification) of a portfolio. Concentration as well as the relationship concentration has with diversification was discussed in Chapter 6. Although the OLS regression results of the residual variance method and concentration did not reveal

a negative relationship, it is still accepted that the relationship between diversification and concentration should, in fact, be negative. Neither of the two diversification measures delivered similar results to any of the risk-adjusted performance measures on a consistent basis, although the ranking results of the PDI and the Omega ratio were very similar (although not aligned 100%). It should, however, again be noted that the two diversification measures gauge a totally different concept than any of the risk-adjusted performance measures and that the results are not meant to be directly comparable. The study, however, took the viewpoint of shifting the risk-adjusted performance measures around in such a way that they measured risk in some manner. From all the analysis done in the study it can be concluded that the PDI and the Omega ratio had the most alike results and thus the Omega ratio was used and incorporated into evaluating the results of the second empirical study which focused on the second objective. In terms of the first objective (whether or not the PDI is a good diversification measure compared to the residual variance method) it can be concluded that:

- the PDI may be a good measure of diversification compared to the residual variance method, although this is not a certain fact as no statistical analysis was used. The inclusion of a third diversification measure may provide more insight into which of the PDI or residual variance methods are better measures of diversification. The third diversification measure can thus be incorporated into a similar study which uses ranking comparisons to judge which of the diversification measures are similarly aligned. Currently no ideal diversification measure exists to be used as this third diversification measure although the IPC or IPC3 might be considered,
- the PDI has proved to be an alternative measure of diversification as it delivers results which are different from the results obtained by the residual variance method, and
- the PDI may indeed be the superior diversification measure when a market is of a highly concentrated nature, as the PDI is free from market influence.

The second objective of this study was to ascertain whether or not the PDI can be used as a tool by a fund manager when constructing or customising an existing fund or portfolio. This objective was divided into two sections namely:

- PDI as a fund management tool, and

- marginal portfolio diversification using the PDI.

In the first of the two analyses the PDI was used in conjunction with the Omega ratio to ascertain if a portfolio manager can add the PDI as a tool to his toolbox. A scenario was created to illustrate how the PDI can be of use in improving the diversification of an existing portfolio to reduce the risk profile of the portfolio. A fund which did not (in terms of diversification) perform as well as the other funds was chosen. The aim of this analysis was to ascertain whether the PDI of the chosen, underperforming fund, would increase if the fund were optimised (the optimal weights assigned to each share within the fund) with the aid of the PDI. The PDI was used to ascertain the most independent factors or shares of the fund as well as the factors or shares which were non-independent and impact the diversification of the fund negatively. The most independent factors which were identified by the PDI were then assigned more weight in the fund than the other shares. The fund was optimised by using a portfolio optimisation model incorporating the information obtained from the PDI calculation. The Omega ratio was incorporated to evaluate the results obtained from the first empirical study, as Chapter 6 showed that the PDI and the Omega ratio are correctly aligned. The idea was that if the PDI score of the fund increased, the Omega function slope of the fund should also improve (become steeper) in the downside and this would confirm the improved (increased) diversification of the fund. The result was that the PDI score of the fund increased while the Omega function of the fund also improved in the downside, thereby confirming the result. Therefore, the PDI can be used as a tool by fund managers when constructing or customising an existing fund or portfolio.

The second part of the second empirical study was to determine whether the PDI can be used in a marginal portfolio diversification calculation. The marginal PDI concept focused on how the PDI can be used to ascertain the degree of diversification that a certain share provides to an existing fund. A scenario was constructed to illustrate in a simple manner how the PDI can be used in a marginal portfolio diversification estimation. The result was that the PDI can indeed be used in a marginal portfolio diversification concept. The Omega ratio, which was incorporated to evaluate the results of this analysis, confirmed that the PDI correctly “scores” or measures the amount of diversification that a specific share provides or adds to an existing portfolio. However, there remains some doubt about using the PDI in a marginal portfolio diversification concept when a specific share is added to an existing portfolio.

This study also argues that the PDI can be of value when used differently or “flexed”. For instance, the PDI can be used in conjunction with the marginal portfolio diversification concept to construct a return versus diversification matrix per share for an existing portfolio. This matrix concept is, however, limited, as it only provides information (specifically regarding diversification) of a particular share which is contained within an existing, fixed portfolio. This is the case because the PDI score (or benefit) of each share will change as the composition of the fund or portfolio changes, because as the portfolio composition changes the interaction between the share returns (covariance) change. This matrix can, however, still provide insight into the shares which provide most of the diversification benefit within the existing (current) fund. Furthermore, the PDI and the Omega can be used in conjunction or as substitutes, as these two measures are correctly aligned, while these measures can also be used to evaluate (the results of) one another. The PDI might thus offer fund managers the opportunity to flex (the use of) the PDI to a certain degree, but how far the PDI can be flexed remains the subject of future studies. Ultimately, the PDI is a useful measure of diversification.

8.3 Suggestions for future research

As the PDI is a new measure, it is not surprising that very little research has been done, although it is expected that the amount of work done regarding the PDI will increase as the measure gains some respect in the market.

Suggestions for future research which are more specific to this study may include a very similar study with the inclusion of a third measure of diversification in order to ascertain which one of the two diversification measures (PDI or residual variance) is more “correct” or the better measure. Another possibility might be another study which focuses on the active management setting.

Lastly, possible future research might be to repeat this study, but to further incorporate a statistical method in the empirical study in place of the ranking results method used here.

9. Appendix

Regression results given in tables A.1 and A.2 as used in Section 6.3.8 to analyse the effect of concentration on diversification for the period July 2003 to June 2007.

Table A.1: Summary of regression statistics for PDI against HHI.

Dependent Variable: PDI				
Method: Least Squares				
Included observations: 5				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
HHI	-271.52	147.59	-1.84	0.16
C	16.39	5.60	2.92	0.06
R²	0.53	Mean dependent var	6.47	
Adjusted R²	0.37	S.D. dependent var	4.31	
S.E. of regression	3.41	Akaike info criterion	5.58	
Sum squared resid	34.86	Schwarz criterion	5.42	
Log likelihood	-11.95	F-statistic	3.38	
Durbin-Watson stat.	2.90	Prob(F-statistic)	0.16	

Table A.2: Summary of regression statistics for Residual Variance against HHI.

Dependent Variable: RES_VAR01				
Method: Least Squares				
Included observations: 5				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
HHI	0.14	1.28	0.11	0.92
C	0.01	0.05	0.15	0.89
R-squared	0.00	Mean dependent var		0.01
Adjusted R-squared	-0.33	S.D. dependent var		0.03
S.E. of regression	0.03	Akaike info criterion		-3.92
Sum squared resid	0.00	Schwarz criterion		-4.07
Log likelihood	11.79	F-statistic		0.01
Durbin-Watson stat	2.57	Prob(F-statistic)		0.92

References

- ACI. 2008a. Collective investments inflows rebound to R10 billion in June quarter. Press Release: 17 Jul. <http://www.aci.co.za//secure/Home/NewsAndViews/2008/NewGenericSectionaddedbJaneteNlat040817PMon20080107/Press%20Release%20%2017%20July%202008,%20ACI%20June%20Quarterlies%20Release.pdf> Date of access: 24 Jul. 2008.
- ACI. 2008b. Quarterly statistics for the period ended 30 September 2008. <http://www.aci.co.za/pebble.asp?reid=22> Date of access: 24 Oct. 2008.
- AIM. 2000. The benefits of diversification. http://wealthstrategies.com/pdf/The_Benefits_of_Diversification.pdf Date of access: 12 Mar. 2007.
- ANON. 2000. The benefits of diversification. www.aimfunds.ca/AIM/Resources/MKBDIFE.pdf Date of access: 18 Feb. 2007.
- ANON. 30 Mar. 2007. 5 Ways to diversify your portfolio. Newsgroup: <http://in.rediff.com/moey/2007/marperfin.htm> Date of access: 27 Jun. 2008.
- ANON. 10 Mar. 2008. Regulation ushers in new era for fund industry. Newsgroup: http://www.hedgeweek.com/articles/detail.jsp?content_id=245655 Date of access: 7 Jun. 2008.
- ANON. s.a. The different types of funds. http://www.beginnermoneyinvesting.com/html/the_different_types_of_funds.htm Date of access: 15 Jul. 2008.
- ANTON, H. & RORRES, C. 1994. Elementary linear algebra. 7th ed. New York: Wiley.
- BODIE, Z., KANE, A. & MARCUS, A.J. 2002. Investments. 5th ed. New York: McGraw-Hill.
- BODIE, Z., KANE, A. & MARCUS, A.J. 2005. Investments. 6th ed. New York, NY: McGraw-Hill.
- BOTHA, M. 2005. Risk management in hedge funds. London: NWU Potchefstroom Campus. (Dissertation – M.Com).
- BOTHA, M. 2006. A comparison of South African hedge fund performance measures. *South African Journal of Economics*, 75(3): 459-477.

- BOWMAN. 2007. The hedge fund regulations. <http://www.bowman.co.za/LawArticles/Law-Article.asp?id=2132417225> Date of access: 2 Jun. 2008.
- BRADFIELD, D. & KGOMARI, W. 2004. Concentration: should we be mindful of it? Research report, Cape Town, Cadiz quantitative research. (Unpublished.)
- BRINSON, G.P., RANDOLPH HOOD, L., & BEEBOWER, G.L. 1986. Determinants of portfolio performance. *Financial Analysts Journal*, 42 (4): 45-51, Jul.
- BUSINESS REPORT. 2008. Unit trusts. <http://www.busrep.co.za/index.php?fSetId=301&fSectionId=661> Date of access: 1 July 2008.
- CMP. s.a. Types of hedge fund strategies. <http://www.capmgt.com/strategies.html> Date of access: 9 Jul. 2007.
- CORGEL, J.B., LING, D.C. & SMITH, H.C. 2001. Real estate perspectives: an introduction to real estate. 4th ed. Bogotá: McGraw-Hill.
- CORREIA, C., FLYNN, D., ULIANA, E. & WORMALD, M. 2000. Financial management 4th ed. Cape Town: JUTA.
- CORREIA, C., FLYNN, D. ULIANA, E. & WORMALD, M. 2003. Financial management. 5th ed. s.l.: JUTA.
- CRESSON, J.E. 2002. R^2 : A market-based measure of portfolio and mutual fund diversification. http://www.accessmylibrary.com/coms2/summary_0286-9935351_ITM Date of access: 12 Mar. 2008.
- D'AMBROSIO, C.A. 1976. Principles of modern investments. Toronto: Science Research Associates.
- DICTIONARY.COM. 2006. Benchmark. <http://dictionary.reference.com/browse/benchmark> Date of access: 16 Jul. 2008.
- DOBBINS, R., WITT, S. & FIELDING, J. 1994. Portfolio theory and investment management. 2nd ed. Great Britain: Wiley-Blackwell.
- DOBBINS, R., WITT, S. & FIELDING, J. 1996. Portfolio theory and investment Management: an introduction to modern portfolio theory. Great Britain: Blackwell Business.

- DOPHEL, F.E. 2003. Asset allocation in a lower stock-bond correlation environment. *Journal of Portfolio Management*, 30(1): 25-38, Fall.
- ELTON, E.J., GRUBER, M.J., BROWN, S.J. & GOETZMANN, W.N. 2003. Modern portfolio theory and investment analysis. 6th ed. Hoboken, NJ: Wiley.
- ENGLE, R. 2001. GARCH 101: the use of ARCH/GARCH models in applied econometrics. *Journal of Economic Perspectives*, 15(4):157-168, Fall.
- EQUINOX. 1999a. Fund performances. <http://www.equinox.co.za/unittrusts/funds/fundPerformances.asp> Date of access: 12 Mar. 2007.
- EQUINOX. 1999b. Introduction to unit trusts. <http://www.equinox.co.za/learn/> Date of access: 26 May 2008.
- EVANS, J. 2007. Definition of mutual funds and the importance of diversification. <http://personalfinanceresources.com/37/definition-of-mutual-funds-and-the-importance-of-diversification/> Date of access: 2 Jun. 2008.
- EVANS, J.L. & ARCHER, S.H. 1968. Diversification and the reduction of dispersion: an empirical analysis. *Journal of Finance*, 23(5):761-767, Dec.
- FAMA, E.F. 1965. Random walks in stock market prices. *Financial Analysts Journal*, 51(1): 75-80, Jan/Feb.
- FIRER, C., ROSS, S.A., WESTERFIELD, R.W. & JORDAN, B.D. 2004. Fundamentals of corporate finance. 3rd ed. Berkshire: McGraw-Hill.
- FISCHER, D.E. & JORDAN, R.J. 1975. Security analysis and portfolio management. 3rd ed. London: Prentice-Hall.
- FTSE. 2008. Indices. <http://www.ftse.com> Date of access: 28 Oct. 2008.
- FULKS, B. 1998. The Sharpe ratio. <http://www.miapavia.it/homes/ik2h1b/sr.htm> Date of access: 10 June 2007.
- FUNG, W. & HSIEH, D.A. 1997. Empirical characteristics of dynamic trading strategies: the case of hedge funds. *Review of Financial Studies*, 10: 275-302.
- GOODSPEED, I. 2003. Introduction to financial markets. *SAIFM*, p 63, Jan.

- GOOSEN, E. 2007. Regulation and the hedge fund industry in South Africa. <http://www.hedgefunds-sa.com/Legislation.shtml> Date of access 2 July 2008.
- GOPI, Y., DUGMORE, B. & BRADFIELD, D. 2006. A new measure of portfolio diversification. (Unpublished.)
- GRAVITY INVESTMENTS. 2007a. Concentration Coefficient. <http://www.gravityinvestments.com/diversification.htm> Date of access: 28 Jun. 2008.
- GRAVITY INVESTMENTS. 2007b. Intra-Portfolio Correlation (IPC). <http://www.gravityinvestments.com/diversification.htm> Date of access: 28 Jun. 2008.
- GRAVITY INVESTMENTS. 2007c. IPC3. <http://www.gravityinvestments.com/diversification.htm> Date of access: 28 Jun. 2008.
- GRINOLD, R.C. & KAHN, R.N. 2000. Active portfolio management. 2nd ed. New York: McGraw-Hill.
- GUJARATI, D.N. 2006. Essentials of econometrics. 3rd ed. New York: McGraw-Hill.
- HAMILTON, I. s.a. Industry overview. <http://www.hedgefunds-sa.com/index.shtml> Date of access: 4 Jul. 2008.
- HATTINGH, J.J. 2004. Portfolio management: the use of alternative investments for the purpose of diversification. Johannesburg: RAU. (Dissertation – M.Com).
- HEDGECEO. 2008. Industry overview. <http://www.hedgeco.net/about/aboutus.php> Date of access: 1 Jul. 2008.
- HEDGEMEDIA. 2008. Regulation ushers in new era for fund industry. http://www.alternativeassetadviser.com/articles/detail.jsp?content_id=245655&livehome=true Date of access: 28 May 2008.
- HOTELLING, H. 1933. Analysis of a complex of statistical variables with principal components. *Journal of Educational Psychology*, 24: 298-520.
- HOVENKAMP, H. 1993. Antitrust. 2nd ed. St.Paul, MN: West Publishing.
- HULL, J.C. 2000. Options, futures & other derivatives. 4th ed. New Jersey, NY: Prentice-Hall.

- IBBTSON, R.G. & KAPLAN, P.D. 2000. Does asset allocation policy explain 40, 90 or 100 percent of performance? *The Financial Analyst Journal*, 56(1): 26-33.
- ICI. 2008. 2008. Investment company fact book. http://www.icifactbook.org/fb_data.html#section7 Date of access: 24 Oct. 2008.
- INVESTOPEDIA. 2008a. Asset allocation. http://www.investopedia.com/terms/a/asset_allocation.asp Date of access: 10 Apr. 2007.
- INVESTOPEDIA. 2008b. Beta. <http://www.investopedia.com/terms/b/beta.asp> Date of access: 18 Mar. 2007.
- INVESTOPEDIA. 2008g. Exponential moving average. <http://www.investopedia.com/terms/e/ema.asp> Date of access: 12 Jul. 2007.
- INVESTOPEDIA. 2008c. Moving average. <http://www.investopedia.com/terms/m/movingaverage.asp> Date of access: 12 Jul. 2007.
- INVESTOPEDIA. 2008d. Mutual fund. http://www.investopedia.com/terms/m/mutual_fund.asp Date of access: 22 May 2008.
- INVESTOPEDIA. 2008e. Required rate of return. <http://www.investopedia.com/terms/r/requiredrateofreturn.asp> Date of access: 22 Mar. 2007.
- INVESTOPEDIA. 2008f. Understanding the Sharpe ratio. http://www.investopedia.com/articles/07/sharpe_ratio.asp Date of access: 8 Jun. 2007.
- INVESTOPEDIA. 2008g. Simple moving average. <http://www.investopedia.com/terms/s/sma.asp> Date of access: 12 Jul. 2007.
- INVESTORWORDS. 1997a. Asset allocation. http://www.investorwords.com/275/asset_allocation.html Date of access: 10 Apr. 2007.
- INVESTORWORDS. 1997b. Bond market. http://www.investorwords.com/350/bond_market.html Date of access: 12 Mar. 2008.
- INVESTORWORDS. 1997c. Diversification. <http://www.investorwords.com/1504/diversification.html> Date of access: 4 Apr. 2007.
- INVESTORWORDS. 1997d. Market index. http://www.investorwords.com/2973/market_index.html Date of access: 15 Jul. 2008.

- INVESTORWORDS. 1997e. Sortino ratio. http://www.investorwords.com/5793/Sortino_ratio.html Date of access: 11 Jun. 2007.
- INVESTORWORDS. 1997f. Standard deviation. http://www.investorwords.com/4688/standard_deviation.html Date of access: 3 Mar. 2007.
- IVKOVIC, I. 2007. The capital market theory: where the Markowitz portfolio theory left off. http://portfolio.management.suite101.com/article.cfm/the_capital_market_theory Date of access: 22 Mar. 2007.
- JEFC. 2006. Advantages and disadvantages of unit trusts. <http://www.jefc.co.za/files/advantagesOfUt.pdf> Date of access: 4 Jul. 2008.
- JOLLIFFE, I.T. 1986. Principal component analysis. 1st ed. New York: Springer-Verlag.
- JOLIFFE, I.T. 2002. Principal component analysis. 2nd ed. New York: Springer-Verlag.
- JP MORGAN. 1996. RiskMetrics™ technical document. <http://www.ge.infm.it~ecph/bibliography/RiskMetrics1.pdf> Date of access: 15 Jun. 2007.
- JSE. 2005a. Annual report. <http://www.jse.co.za/docs/arep/2005/index.htm> Date of access: 25 Oct. 2008.
- JSE. 2005b. Financial portal. <http://fin.jse.co.za/findata/advancedsharesearch.asp> Date of access: 25 Oct. 2008.
- JSE. 2005c. Indices for beginners. <http://www.jse.co.za/docs/magazine/Indices%20For%20Beginners.pdf> Date of access: 26 Oct. 2008.
- JSE. 2008. Market capatilisation by industry for March 2008. http://www.jse.co.za/docs/stats/market_profile/20080301-Market_Profile.xls Date of access: 2 Jun. 2008.
- KAPLAN, P.D. & KNOWLES, J.A. 2004. Kappa: a generalized downside risk-adjusted performance measure. <http://www.edge-fund.com/KaKn04.pdf> Date of access: 27 Jul. 2007.
- KEATING, C. & SHADWICK, W.F. 2002. An introduction to Omega. <http://www.aima.org/uploads/2002%5CApr%5Cfinancedevelopmentcentre.pdf> Date of access: 19 Aug. 2008.
- KEFFER, S. 2003. Portfolio diversification and benchmarking. <http://www.physiciansnews.com/finance/1103.html> Date of access: 12 Apr. 2007.

- KWAN, C.K., LI, W.K. & NG, K. 2005. A multivariate threshold GARCH model with time-varying correlations. http://www.ims.nus.edu.sg/Programs/econometrics/files/wkl_paper.pdf Date of access: 13 Sep. 2007.
- LHABITANT, F.S. 2004. Hedge funds: qualitative insights. New York: Wiley.
- LHABITANT, F.S. & LEARNED, M. 2002. Hedge fund diversification: how much is enough? *Journal of Alternative Investments*, 5(1): 23-49.
- LIND, D.A., MARCHAL, W.G. & WATHEN, S.A. 2008. Statistical techniques in business and economics: with global data sets. 13th ed. New York: McGraw-Hill.
- LINTNER, J. 1965. Valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *The Review of Economics and Statistics*, 47 (1): 13-39.
- LONDON STOCK EXCHANGE. 2008. Index. <http://www.londonstockexchange.com/engb/Global/F/glossary/glossaryi.htm> Date of access: 15 Jul. 2008.
- MARKOWITZ, H.M. 1952. Portfolio selection. *Journal of Finance*, 7(1): 77-91.
- MARKOWITZ, H.M. 1959. Portfolio selection: efficient diversification of investments. New Jersey: Wiley.
- MARX, J., MPOFU, R.T., NORTJÉ, A. & VAN DE VENTER, T.W.G. 2006. Investment management. 2nd ed. Pretoria: Van Schaik.
- MASON, R.D., LIND, D.A. & MARCHAL, W.G. 1997. Statistical techniques in business and economics. 10th ed. Bangkok: McGraw-Hill.
- MATHWORKS. 1984. GARCH toolbox. http://sss.mathworks.com/access/helpdesk/help/toolbox/garch/index.html?/access/helpdesk/help/toolbox/garch/f518152.html&http://www.mathworks.com/cgi-bin/texis/webinator/search/?db=MSS&prox=page&rorder=750&rprox=750&rdfreq=500&rwfreq=500&rlead=250&sufs=0&order=r&is_summary_on=1&ResultCount=10&query=garch&submitButtonName=Search Date of access: 18 Sep. 2007.
- MEHRA, S.Y. & HEMMING, R.S. 2003. Benefits of stock portfolio diversification. <http://www.aspecthuntley.com.au/af/news?xsl-newsID=12&xtmlicensee=aspecthuntley> Date of access: 2 Apr. 2007.

- MERGENCE. 2008. Understanding hedge fund investing. <http://www.poa.org.za/conference/Slides/Speakers/Mergence%20Understanding%20Hedge%20Fund%20investing.pdf> Date of access: 25 May 2008.
- MEYER-PRETORIUS, M.C. & WOLMARANS, H.P. 2006. The unit trust industry in South Africa from 1965 to June 2005: are investors better off? *Meditari Accountancy Research*, 14(1): 49-67.
- MITCHELL, L. 2006. A beginner's guide to investment styles. <http://www.moneyweek.com/file/9710/a-beginners-guide-to-investment-styles.html> Date of access: 14 Apr. 2007.
- MITTRA, S. & GASSEN, C. 1981. Investment analysis and portfolio management. New York: Harcourt Brace Jovanovich.
- MONEYCHIMP. 1997. Modern portfolio theory: introduction. <http://www.moneychimp.com/articles/risk/riskintro.htm> Date of access: 12 Jun. 2007.
- MOSSIN, J. 1966. Equilibrium in a capital asset market. *Econometrica*, 34(4): 768-783.
- NEDGROUP INVESTMENTS. 2005. SA's hedge fund industry humming with activity. <http://www.plexcrown.co.za/default.asp?pageID=717210162> Date of access: 1 Jul. 2008.
- NICHOLAS, J.G. 1999. Investing in hedge fund strategies for the new marketplace. s.l., New Jersey: Bloomberg Press.
- PALANDRI, A. 2004. Multivariate GARCH models: inference and evaluation. Duke University, Durham, NC 27708. <http://www.duke.edu/~ap34/mgarch4.pdf> Date of access: 15 Sep. 2007.
- PANWAR, S. & MADHUMANATHI, M. 2006 Characteristics and performance evaluation of selected mutual funds in India. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=876402 Date of access: 12 Jan. 2008.
- PEARSON, K. 1901. On lines and planes of closest fit to systems of points in space. *Philosophical Magazine*, 2(6): 559-572.
- PHILBIN, M. 2005. What makes a good investment benchmark. http://www.creditunions.com/home/articles/template.asp?article_id=1796 Date of access: 16 Jul. 2008.

- REILLY, F.K. & BROWN, K.C. 2000. Investment analysis and portfolio management. 6th ed. Orlando, FL: Dryden Press.
- REILLY, F.K. & BROWN, K.C. 2006. Investment analysis and portfolio management. 8th ed. Mason, OH: Thompson South-Western.
- RENCHER, A.C. 1998. Multivariate statistical inference and applications. New York: Wiley.
- RUDIN, A.M. & MORGAN, J.S. 2006. A portfolio diversification index. *Journal of portfolio management*, 32(2):81-89, Winter.
- SHARENET. 2004. Different types of unit trusts. [http://www.sharenet.co.za/free/library/library/ut\)02.htm](http://www.sharenet.co.za/free/library/library/ut)02.htm) Date of access: 2 Jul. 2008.
- SHARP, W.F. 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19 (3): 425–442.
- SIMONS, K. 1998. Risk-adjusted performance of mutual funds. *New England Economic Review*: 33-48, Sep/Oct.
- SCHEENWEIS, T., KAZEMI, H. & MARTIN, G. 2001. Understanding hedge fund performance: research results and rules for the institutional investor. <http://cisdm.som.umass.edu/research/pdf/understandingperformance.pdf> Date of access: 22 Mar. 2007.
- SIN, K.F. 1997. The legal nature of the unit trust. Oxford: Clarendon Press.
- SMITH, L.I. 2002. A tutorial on principal components analysis. http://www.cs.otago.ac.nz/cosc453/student_tutorials/principal_components.pdf Date of access: 5 Jun. 2007.
- SMITH, D. 2006. A portfolio diversification index as a fund management instrument. Cape Town: UCT. (Report – MBA)
- STALLMAN, C. 2004. Diversification vs. concentration. <http://www.teenanalyst.com/general/diversification.html> Date of access: 2 Jun. 2008.
- STEVENSON, R. & JENNINGS, E. 1976. Fundamentals of investments. Boston: West Publishing Company.
- SOUTH AFRICA. 2002. Collective investment schemes control act 45 of 2002. <http://www.fsb.co.za/> Date of access: 5 May 2008.

- STATMAN, M. 1987. How many stocks make a diversified portfolio? *Journal of financial and quantitative analysis*, 22(3): 353-363, Sep.
- STATMAN, M. 2000. The 93.6% question of financial advisors. *Journal of Investing*, Spring: 16-20.
- STAUM, J. 2002. Simulation in financial engineering. <http://www.informs-cs.org/wsc02papers/203.pdf> Date of access: 15 Sep. 2007.
- TOKKAI, M., TOM, E., BOLDT-CHRISTMAS, M. & BOURGOIS, S. 2004. Why it's a tough market. *CSFB Quantitative Equity Derivates Strategy*, Oct.
- UNIT TRUST SURVEY. 2008. Executive summary. http://www.unittrustsurvey.co.za/index.php?page=news_new Date of access: 24 Oct. 2008.
- VAUGHAN, D.A. & DECHERT, L.L.P. 2003. Selected definitions of "hedge fund". <http://www.sec.gov/spotlight/hedgefunds/hedge-vaughn.htm> Date of access: 12 Jun. 2008.
- VEERNASAMY, D. 2008. A comparative analysis of South Africa's islamic and conventional mutual funds. Johannesburg: WITS (Dissertation – Hons Bcom).
- WIKIPEDIA. 2007. Exponentially moving average. http://en.wikipedia.org/wiki/Exponential_moving_average#Exponential_moving_average Date of access: 14 May 2007.
- WIKIPEDIA. 2008. Unit trusts. http://en.wikipedia.org/wiki/Unit_trust Date of access: 22 May 2008.
- WILSON, R. (Richard@HedgeFundGroup.org) 2007. Omega Ratio: Omega ratio explanation. Discussion group: <http://richard-wilson.blogspot.com/2007/10/omega-ratio.html> Date of access: 27 Jul. 2007.
- WINSTON, L.W. 1998. Financial models using simulations and optimization. New York: Palisade Corporation.