

OPTIMAL ASSET ALLOCATION FOR RETIREMENT FUNDS: A
SOUTH AFRICAN PERSPECTIVE

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BY
CARYN WENDY WEPENER
WPNCAR002

SUPERVISOR: DARRON WEST

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Abstract

This paper aims to determine the optimal asset allocation for South African retirement funds under the constraints of Regulation 28. Regulation 28 allows retirement funds to invest a maximum of 25% into offshore assets. Within this offshore allocation, retirement funds are able to invest in a range of international assets, including developed market and emerging market equities. This study, based on data from 1995 to 2013, uses mean variance optimisation as well as optimisation using the Omega ratio to determine the optimal portfolio. The Omega Ratio has an added advantage over the mean variance optimisation as it is able to include information on higher moments of a distribution rather than just the first two moments, being mean and variance. Both models find that it is beneficial for South African investors to invest in international assets as the optimal portfolio determined by both models allocates the full 25% to offshore assets. Neither model finds evidence to include emerging market equities in the portfolios of South African investors, rather favouring developed market equities. This paper also finds that the limits imposed by Regulation 28 lead to suboptimal portfolios as a slightly higher efficient frontier is achievable if the constraints are relaxed.

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CHAPTER 1: INTRODUCTION

Retirement fund assets account for a large portion of assets globally. The Towers Watson Global Pension Assets Study (2014) covers the 13 major pension markets in the world. According to this study, pension assets in these 13 countries total USD 31,980 billion and account for 83.4% of GDP in these economies. South Africa is one of the smaller constituents included in the study.

Pension fund trustees are responsible for the management decisions of pension funds and attempt to grow the assets under management. The investments typically have a long time horizon and therefore, trustees try to invest in a mix of assets that will grow the portfolio in the long term. At the very least, the asset mix should provide returns that outperform inflation over the long term in order for investors to achieve real growth in assets. Pension funds are generally very large in size and the domestic markets are often too small in size to offer real growth opportunities. Pension funds often don't have the volume to trade actively in domestic markets. This leads to trustees allocating some funds to offshore assets. Within the offshore allocation, investment can be made into range of financial assets in developed economies as well as in emerging market economies.

Emerging market economies are defined as countries with low to middle per capita income as measured by the World Bank. Emerging markets, such as China, India and South Africa, have exhibited significant growth over the past few years. These emerging economies have been driven by massive population growth and the "rise of a robust and savings-orientated middle class" (AGF, 2012). While South Africa is classified as an emerging economy, it is Africa's largest economy and its growth is mainly driven by the abundance of natural resources. South Africa is one of the world's biggest producers of platinum, gold and chromium. The resource sector has the largest representation in the South African economy. Being an emerging market economy, it is affected by many of the factors that affect emerging economies as well as global factors.

Modern portfolio theory hypothesizes that there are benefits from diversification. The investment framework is based on the concept of portfolio construction that aims to maximise expected return while simultaneously reducing investment risk (Fabozzi, Gupta & Markowitz, 2002, quoted by Mangram, 2013: 60). The South African investment universe is relatively small and highly concentrated. The JSE All Share Index represents 165 stocks while the S&P 500 Index represents 500 stocks. Due to South Africa being a resource driven economy, the JSE Top 40 Index is heavily weighted in resource stocks and only a small portion of stocks are liquid. South African companies are greatly affected by factors outside of South Africa. This is evident from the fact the JSE All Share Index is highly correlated to the MSCI Emerging Market Index (Refer to figure 2.11.2).

South African retirement funds are governed by Regulation 28 of section 36 of the Pension Fund Act. The regulation sets maximum investment limits for the exposure to certain asset classes, such as equities and international assets. While South African retirement funds have been moving to defined contribution schemes from defined benefit schemes since the 1980s, the biggest pension fund is the Government Employees Pension Fund (GEPF) which is still a defined benefit scheme. The move from defined benefit to defined contribution pension fund is likely to result in “more emphasis on investment strategies based on maximising risk-adjusted returns rather than on asset-liability immunisation” (Chan-Lau, 2004: 24). This means that investors are likely to invest in asset classes that will maximise their expected returns in the long run.

This paper aims to determine the optimal allocation to international assets for South African retirement funds given the restraint of 25% imposed by Regulation 28. Within the offshore allocation, SA retirement funds can allocate funds to international equities in both developed and emerging markets. This study will seek to determine the optimal allocation for SA retirement funds to assets both locally and abroad. This paper will also review the impact of the Regulation 28 constraints on the optimal asset allocation for SA retirement funds.

CHAPTER 2: LITERATURE REVIEW

This chapter contains a review of research that has been conducted on the topic of investment by retirement funds into offshore assets within developed and emerging markets. This chapter begins with a discussion on asset allocation and modern portfolio theory and examines the case for investing in different asset classes. This chapter then reviews various studies done on retirement funds investing in assets outside of their borders. It reviews South African specific studies done on allocation to offshore assets. It discusses the Regulation 28 limits and provides an overview of some criticisms of the constraints on asset allocation. It also reviews literature written on retirement funds investing into emerging markets.

2.1. An Overview of Asset Allocation

Harry Markowitz built the foundation for Modern Portfolio Theory. He reviewed the impact of a number of securities on portfolio diversification and their covariance relationships.

Basic portfolio selection theory examines the idea of portfolio diversification which “aims to properly select a weighted collection of investment assets that together exhibit lower risk factors than investment in any individual asset or singular asset class” (Mangram, 2013: 60). Investors are able to increase return and reduce overall risk by investing in assets that have low correlation to each other.

The efficient frontier represents the best combination of asset classes within an investment portfolio (Mangram, 2013: 66). The portfolios that lie along the efficient frontier will have the highest expected return for a given level of risk. According to Markowitz and modern portfolio theory, rational investors will want to invest in portfolios that lie along the efficient frontier (Mangram, 2013: 67).

Odier and Solnik (1993) explained how previous studies on US mutual funds had shown that “an average of roughly 90% of the monthly variation of returns on a large sample of U.S. mutual funds is explained by asset allocation, while only 10% is explained by security selection”.

Brinson, Singer and Beebower’s study (1991) reviewed the determinants of portfolio performance. This study was an update of their original work published in 1986. They divided returns into three components, namely asset allocation policy, security selection and active asset allocation. Based on data from 1977 to 1987 from 82 pension funds, they found that “investment policy explained, on average, 91.5 per cent of the variation in quarterly total plan returns” (Brinson, Singer and Beebower, 1991: 45), while active asset allocation and security selection accounted for only a small portion of the variance of returns. Ibbotson (2000: 7) argues that the impact of asset allocation on returns depends on “an individual’s investing style”. For long term passive investors, asset allocation

is the most important factor while for investors who trade more frequently, it has less of an impact (Ibbotson, 2000: 7).

A portfolio's risk comes from two sources of risk, systemic and unsystemic risk. While systemic risk or market risk is inherent in portfolios, diversification can assist in reducing the unsystemic risk by investing in complementary assets that reduce overall portfolio risk.

There is evidence that portfolios with long time horizons should allocate funds to equities due to the notion of time diversification. Blanchett, Finke & Pfau (2013)'s study found that it was optimal to have a higher allocation to equities for investors with long time horizons. Their study which reviewed data from 20 countries over 113 years found that the results persisted for all risk aversion levels as well as across countries. Pension funds are typically long term in nature and therefore, asset allocation can play an important role in long term performance.

2.2. Benefits of Investing in International Assets:

Investing in international assets increases the pool of assets available to investors. Investors are able to invest in complementary assets that have the potential to reduce the overall risk of the portfolio. In terms of modern portfolio theory, the addition of international assets has the potential to shift the efficient frontier as the investment opportunities have increased.

According to Solnik and McLeavey (2004, Quoted by Pfau, 2008: 7), some diversification benefit comes from the fact that domestic assets are more greatly affected by different country specific shocks than international assets and therefore, they tend to have lower correlations with domestic assets even after accounting for currency risk. The concept is that the enhancement in the risk-return of the portfolio will outweigh the additional volatility from currency movements.

For emerging economies, international assets often provide a hedge against country specific weakness as when local conditions are poor, the exchange rate tends to depreciate which makes the returns from the offshore assets more valuable in base currency (Pfau, 2008: 10). Given South Africa's political history, signs of political weakness have a negative effect on the Rand. South Africa is also negatively affected by mining problems, such as strikes and mining deaths. This was clearly evident in the 2012 Marikana mining disaster, which saw the Rand depreciate for South African specific reasons. Holding international assets at the time would have benefitted SA retirement funds as they would have help offset some of the South African specific weakness.

The inclusion of offshore assets may allow large pension funds to trade actively as there is greater volume. The domestic market may not be able to handle the demands of a large institutional

investor (Pfau, 2008: 8). This is a potential issue in smaller emerging market economies where local markets tend to be small relative to the size of local institutional assets. Active trading opportunities can increase the potential for alpha generation. Large growth in institutional assets can increase the risk of asset price bubbles as “increased assets chase a limited number of securities” (Chan-Lau, 2004: 20)

It could be argued that international diversification helps protect against “imported” inflation because a devaluing currency results in a higher cost of imported goods, causing prices to increase domestically (Griffin, 1998: 65). A devaluing currency will result in the international assets becoming more valuable and would help offset the rise of domestic prices. This infers that countries that engage greatly in international trade would benefit more from investing in international assets. Griffin (1998) finds strong support for this argument.

Previous studies have found evidence that investors in less developed countries have more to gain from international diversification. Chiou (2005: 1) aimed to quantify the gain from international diversification by measuring the “increase in risk-adjusted premium by investing the maximum Sharpe Ratio (MSR) portfolio and the reduction in volatility by investing the minimum-variance portfolio (MVP) for investors in each country”. His research, based on data for the period 1998 to 2004, found that investors in less developed countries, especially those in East Asia and Latin America, had more to gain from both regional and global diversification than developed countries. It should be noted that while his study included 21 developed countries and 13 developing countries, it did not include any African countries.

Driessen and Laeven (2005) also find evidence that the largest benefits of international diversification are for investors in developing countries, even after factoring in currency effects. Their study based on the standard Markowitz mean-variance framework finds that benefits are the most significant for countries that have high country risk. They used monthly data for the period 1985 to 2002 and found that the inclusion of international assets increases the average Sharpe ratio of the 52 developed and developing countries included in the study. When short sale constraints were imposed, they found that the Sharpe ratio decreased from an average of 21% to about 18%. The Sharpe ratio without offshore assets is 10%. This means that there are benefits to international diversification irrespective of whether short selling is allowed. They found that diversification benefits had decreased for most countries over the sample period, which is mainly a result of increased correlation between local and global indices and the decreased variance of local indices (Driessen and Laeven, 2005: 6).

Jiang, Ma & Yunbi's study (2010) is based on the in sample and out of sample performance of a series of optimal portfolios from the perspective of Chinese investors for the period 1999 to 2009. China is an emerging economy like South Africa. Using the in sample returns and risk adjusted returns, they find that international diversification can lower portfolio risk, especially when investing in developed and Euro-American markets. When using the out of sample expected returns and risk adjusted returns, they find that Chinese investors can only benefit if they invest in emerging markets rather than in developed markets.

While previous studies indicate that there are benefits from investing in offshore assets, especially for less developed economies, many countries exhibit a home bias. Lewis (1996) states that in practice, investors diversify their portfolios into foreign assets less than is predicted by standard theoretical models. Relative to the optimal portfolio on the efficient frontier, they tend to be overweight domestic assets relative to international assets even though they could benefit from higher allocation to offshore assets.

2.3. Home Bias

While there is evidence that international diversification can be beneficial to investors, there tends to be a home bias. While various studies have tried to explain the home bias, there doesn't seem to be one answer to the phenomenon. Some of the possible explanations are the hedging of domestic risk, costs of foreign investments, information asymmetries, lack of corporate governance and transparency in other markets and some behavioural biases to domestic assets (Sercu and Vanpee, 2007: 17). As mentioned, South Africa retirement funds are restricted by the Regulation 28 restraints which impose a home bias as the majority of the portfolio has to be invested in local assets. This imposed bias to local assets may not be optimal.

2.4. Disadvantages of Investing in International Assets

While there seems to be evidence of the benefits of international diversification, there are some potential cases against investing outside of one's borders.

Solnik (2002) questioned whether international diversification was beneficial given increased globalisation of companies. His study found that companies are being more globally priced and that a company is affected by factors outside of the country where its headquarters are found (Solnik, 2002: 32). He finds that countries are becoming more integrated and there has been significant growth in cross border merger and acquisition activities and therefore, an efficient market should value companies in terms of their global composition (Solnik, 2002: 30).

While increased globalisation is affecting asset prices, Solnik still argues the benefit of investing internationally. Solnik (2002: 33) finds that by investing domestically only, the portfolio could be suboptimal as certain industries may not be properly represented. From a South African perspective, the South African stock market is dominated by resource stocks and therefore, a purely domestic portfolio would be overweight this sector relative to others. This could lead to a suboptimal portfolio as portfolios would be skewed towards specific sectors. Chiou (2005: 8) argues that the increased financial integration of financial markets does not completely negate the benefits of diversification as “the difference of cultures, natural endowments, and legal systems among markets cause the dispersion of returns among markets”.

It could be reasoned that international assets need not be included in a country with many multinational companies as these global companies provide significant exposure for domestic investors. Rowland and Tesar (1998) tried to determine whether the inclusion of multinational companies would shift the efficient frontier for investors domiciled in seven developed countries, namely the United States, United Kingdom, Japan, Canada, France, Germany and Italy. They did not find sufficient evidence to reject the null hypothesis that the inclusion of multinationals to a purely domestic portfolio fails to shift the efficient frontier. They found weak evidence to support the hypothesis that US multinationals provided diversification benefits for US investors during the sample period. This could help in explaining some of the home bias found in the United States. They found that in most countries it was beneficial to include offshore assets to a portfolio that already had exposure to multinationals. The inclusion of international assets significantly shifted the efficient frontier in most countries and in most time periods (Rowland & Tesar, 1998: 2).

There is an argument that investing in international assets increases risk because some countries may have higher volatility than the domestic market. Currency risk could also add a level of volatility to the portfolio. Odier and Solnik (1993) found that these risks are largely diversified away because of the low correlations between the domestic and international assets and this results in the global portfolio having overall lower risk. It should be noted that they found that during periods of increased volatility, correlations tend to increase which would negate some of the diversification benefits when they are needed most (Odier and Solnik, 1993: 72). Currency risk can be managed through currency hedging but such a hedging mechanism can be costly in terms of performance and transaction costs (Odier and Solnik, 1993: 67). A currency hedge is also time consuming as it involves constant rebalancing. The costs involved may not exceed the potential benefits.

It has been claimed that international diversification is costly due to increased transaction costs. Odier and Solnik (1993:63) argued that financial market integration has led to a reduction in

transaction costs as well as made good quality information more accessible. Tesar and Werner (1995, quoted by Sercu and Vanpee, 2007:21) find that the turnover rate on foreign equity is higher than on domestic equity, which is inconsistent with higher transaction costs.

It could be argued that the optimal portfolio as determined by Modern Portfolio Theory may not be achievable due to the lack of investibility of certain countries (Chiou, 2005: 4). Pension funds are able to invest in index tracker funds which are very liquid and therefore, can gain exposure to certain regions without being concerned about risks. Index tracking strategies allow retirement funds to invest in a basket of emerging economies rather than a few risky ones. This helps guard against concentration risk in a few markets that have high risk. Index trackers generally have lower costs, which is an added advantage.

2.5. The case for Investing in Offshore Assets for Retirement Funds

As Modern Portfolio Theory implies, investors can benefit from investing in a range of assets. Various studies have been done on the benefits of investing outside of a country's borders. While the global economy becomes more integrated as a result of globalisation, there are still benefits from investing in international assets. There are various cases that find benefits for retirement funds investing into offshore assets.

Burtless' (2007) aimed to determine whether cross border investing would have been beneficial to retirement investors in eight large industrialized countries. He used data from 1927 to 2005. Investors in these countries made periodic contributions to a defined contribution retirement fund over a long time period. He used standard optimisation methods to find efficient portfolios that offered various levels of risk and expected return. His study, which limited the investment spectrum to local and international stocks and bonds, found that retirement investors in all countries who invested in a global portfolio which was along the efficient frontier could obtain greater average returns with lower risk of small pensions than investors whose portfolio only consisted of domestic assets (Burtless, 2007). He also finds that expected performance can be improved through investing in equities, both local and foreign. He found that when investors shift from more conservative to more risky portfolios, their allocation to equities as well as offshore assets increases (Burtless, 2007: 21). He found that offshore assets played a major part in asset allocation for investors in all eight countries, regardless of analysis period and risk profile (Burtless, 2007: 23).

Pfau (2009) focused on public pension systems in Pakistan, an emerging economy. Pfau (2009) examined the effect of including international assets on Pakistan pensions by analysing historical data and his paper aimed to determine whether the inclusion of international assets increased

expected returns and decreased volatility. Pfau's analysis is based on a standard mean variance portfolio selection framework, whereby investors aim to maximise their utility and therefore, will seek a portfolio on the efficient frontier. He used annual data for the returns at year end for the period running from 1993 to 2006. His study is limited to five asset classes (in base currency), namely Pakistan stocks, Pakistan government bonds, Pakistan government bills, world stocks and world bonds. He also included inflation data to determine the effect on real returns for a Pakistani investor.

Pfau (2009: 10) used various risk aversion parameters to determine the optimal portfolio. An aggressive investor would have a risk aversion coefficient of 1, while a conservative investor would have a risk aversion coefficient of 5 or more. Pension funds tend to be quite risk averse and therefore, would probably have a coefficient of 5. His study concluded that pension funds in Pakistan would significantly benefit from international diversification in terms of increased expected return and decreased volatility. Pfau's (2009: 14) research found that the most aggressive investor would allocate a large portion of the assets to world stocks (59.6%), followed by local bonds (27.1%) and local stocks (13.3%). More conservative investors allocate fewer assets to stocks and more to bonds (51.7% local bonds, world stocks 45.3%. world bonds 2.6% and local stocks 0.4%).

Pfau's (2008) study on emerging market pension funds found that on average, half of the portfolios of emerging markets should be allocated to international assets. Using standard mean-variance portfolio selection framework and modern portfolio theory, his paper aimed to determine the optimal allocation to various assets classes. He limited the investment universe to four assets classes, namely domestic stocks, domestic fixed income assets, world stocks and world bonds. While he notes that there are some limitations to the mean optimisation model, he concludes that countries can benefit from international diversification. He estimates that the cost, on average, of prohibiting diversification from international assets, is a 21% reduction in returns (Pfau, 2008: 6).

Kumara and Pfau (2011) aimed to quantify the impact of restricting international assets from the portfolios of emerging market retirement funds using data ranging from 1988 to 1998. They found the addition of international assets can be beneficial for investors ranging from conservative to aggressive risk profiles (Kumara & Pfau, 2011: 1). By analysing 25 emerging market countries using a Monte Carlo bootstrap method, they found strong evidence to support the inclusion of international assets in the majority of emerging market pension funds. South Africa was included in the study and they found that the optimal unconstrained allocation to international assets was 40% (Kumara & Pfau, 2011: 9).

2.6. Regulation 28

South African retirement funds are subject to quantitative investment limits set by Regulation 28 of section 36 of the Pension Fund Act. These quantitative limits are meant to ensure maximum portfolio diversification as pension fund trustees are restricted from investing all of the funds into one risky asset class. The Regulation 28 limits were updated in July 2011. The new legislation increased the allowed offshore exposure from a 20% to 25% maximum limit.

The main constraints are as follows:

- No more than 75% may be invested in equities
- No more than 25% may be invested in listed property
- No more than 25% may be invested offshore
- No more than 25% may be invested in immovable property
- No more than 10% may be invested in commodities
- No more than 15% may be invested in hedge funds and private equity funds

2.7. Criticisms of Constraints

While the quantitative limits imposed by Regulation 28 are meant to safe guard the investor, there are some arguments against the use of these constraints. These constraints are rigid and may lead to suboptimal portfolios by restricting the allocation to various asset classes (Chan-Lau, 2004: 21).

With retirement funds globally moving to a Defined Contribution scheme, there is added pressure on the retirement saver to grow his assets to the maximum possible value before retirement. If the restrictions imposed by Regulation 28 impact negatively on performance, these restrictions are not in the best interests of retirement funds.

While Davis and Hu (2009) acknowledge that placing quantitative restrictions on assets can reduce moral hazard by limiting exposure to risky assets, they argue that it leads to sub optimal portfolios which are below the efficient frontier. They argue that the restrictions focus on risk and liquidity of individual assets rather than the portfolio as a whole and that diversification can benefit investors by lowering default risk and price volatility (Davis & Hu, 2009: 36). Regulation 28 appears to be in opposition to Modern Portfolio Theory which looks at reducing overall portfolio risk by investing in complementary assets rather than focusing on the risk of individual asset classes.

Pink's (1989: 308) study tested the impact of a 10% restriction on foreign assets on the performance of Canadian mutual funds. He compared the performance of funds that had a 10% restriction (RRSP eligible) against funds that were not subject to the 10% restriction (RRSP ineligible). He found that, in

general, the restriction resulted in inferior performance as, on average, the RRSP eligible funds had lower Sharpe Reward to Variability Ratios and lower Trevor Reward to Volatility Ratios. Pfau's (2009: 15) study (2009) based on pension funds in Pakistan finds that investment constraints can reduce returns while increasing risk. For investors with risk aversion coefficients of 5 or less, they are forced to accept lower expected returns with higher volatility while highly conservative investors are able to find portfolios with lower volatility but at the expense of lower returns than would have been achieved without the constraints. Pfau's (2008: 20) study on pension funds in emerging market countries finds that for more risk averse investors "on average, without international investments, investors must accept a 21.3 percent reduction in their portfolio returns, though this would be accompanied by an average 20.7 reduction in risk". The findings are skewed by Argentina and Brazil, where the optimal weighting is nearly 100% in cash. This is due to the effect that hyperinflation has on the volatility of domestic returns (Pfau, 2008: 20).

While government imposes these limits to protect investors against investing all assets in a risky investment, it may lead to sub optimal asset allocation and will negatively impact on performance over the long term. Davis and Hu (2009:40) find that establishing prudent person rules, whereby investors are required to follow prudent investment policies and practices, to be superior to rigid quantitative restrictions.

A potential problem is that while Regulation 28 imposes limits on investment into certain asset classes, it does not protect investors from investing in highly inappropriate investments. Regulation 28 sets the limits but it does not propose due diligence standards on the investments allowed in the retirement fund. Investors could be subjected to investments that are not in line with their long term investment objectives. As long as limits are not breached, the pension funds are compliant with the legislation. It does not stop investors from being invested in high risk or speculative investments.

With more retirement funds moving to a defined contribution funds, the onus has shifted to the investor to save enough for retirement. This means that investors should be invested in the most appropriate growth assets so that the funds achieve real growth over the long term. Investors with very long time horizons to retirement should have a high equity allocation as they have the time horizon to handle the volatility associated with equities. Regulation 28 limits the equity allocation to 75%, which could have a negative effect on long term returns. Regulation 28 doesn't limit trustees from investing too conservatively. The consequence of this is that investors run the risk of not achieving real growth over the long term. Regulation 28 allows retirement funds to invest 100% of the funds into cash. In South Africa, cash underperforms inflation over the long term and therefore,

investors invested in such a conservative portfolio will see capital erosion over the long term as their capital will underperform inflation and erode their purchasing power.

While Regulation 28 was drafted with investors' interests in mind, it appears that the restrictions could negate potential benefits by leading to sub optimal portfolios. Retirement funds have a long term time horizon and the impact of sub optimal portfolios could be substantial over the long term.

2.8. The Case for International Diversification: A South African Pension Perspective

Bradfield and Munro's (2011) study aimed to determine the optimal allocation to foreign assets for SA retirement funds given the Regulation 28 limit of 25%. They built an efficient frontier framework using data from 1971 to 2010. Their method involved graphing two efficient frontiers, one that included offshore assets and one that excluded offshore assets. This allowed them to evaluate the inclusion of offshore assets in terms of the overall risk. Their study was limited to six asset classes, namely SA bonds, SA equity, SA property, foreign cash, foreign bonds and foreign equity.

They found that the inclusion of offshore assets moved the efficient frontier to the left as well as substantially upward. This means that including offshore assets would decrease the overall risk while also significantly enhancing returns. Their study also reviewed the optimal portfolio weights at different levels of risk. They found an inverse relationship between total risk and percentage of foreign assets. As the allocation to foreign assets decreased, the total risk of the portfolio increased.

They performed non-parametric optimization, with target returns ranging from CPI + 0% to CPI +8%. They found that foreign bonds dominated the foreign asset allocation. This is mainly due to the fact that SA equity has a historical negative correlation with the Rand. In Rand terms, foreign equity is positively correlated with SA equity while Foreign bonds have a negative correlation. This means that there are greater diversification benefits from allocating funds to foreign bonds. Their study found that it is beneficial for SA pension funds to include an allocation of 25% to offshore assets mainly due to the entrenched currency effect (Bradfield & Munro, 2011: 3).

Bradfield, Munro and Hendricks's (2010) previous study also concluded that it would have been optimal to allocate the maximum percentage to offshore assets. This study was conducted when the maximum offshore limit was 20%. Using non parametric optimisation and data from 1997 to 2010, they found compelling evidence that the optimal allocation to offshore assets was at the 20% limit. They also found convincing evidence that more should be allocated to offshore assets than allowed by Regulation 28 (Bradfield, Munro & Hendricks, 2010: 7).

Bradfield and Munro found compelling evidence of the diversification benefits of including offshore assets in a portfolio. Both studies find substantial evidence in favour of allocating the full allocation as allowed by Regulation 28 to offshore assets.

2.9. The Case For Investing Into Emerging Markets

The case for including emerging market assets in a portfolio is mainly based on two factors, high growth trajectory resulting in higher average returns and low correlations with developed markets such as the US which reduces overall portfolio risk (Jorion & Miller, 1997, Quoted by Kumar, 2011: 2). Harvey (1994a) presents another reason to invest in emerging markets based on the predictability of emerging market returns. His research found that emerging market returns were predictable based on a number of global and country-specific variables (Harvey, 1994a: 24).

Conover, Jensen & Johnson (2002: 86) state that for US investors, the benefits from international investment stem from “risk reduction from the relatively low correlations between national equities and the higher returns that been realized in certain non-US markets”. They used a mean variance framework to determine the optimal allocation to international assets for US investors as well as the benefits derived from investing in emerging market assets. They found that it was beneficial for US investors to invest in emerging markets as the addition of these assets added 1.5% to 2% a year of additional return to each risk level along the efficient frontier (Conover, Jensen & Johnson, 2002: 93). They found that the efficient frontier that included emerging market assets was superior as it allowed US investors to attain risk-reward combinations that would not have been achievable with a portfolio invested purely in developed market assets (Conover, Jensen & Johnson, 2002: 91).

Li, Sarkar and Wang’s study (2003) examined the diversification benefits for US investors, subject to constraints such as short selling. Using Bayesian inference, they conclude that the diversification benefits of emerging market equities remain substantial for US investors even after accounting for short sale constraints (Li, Sarkar & Wang, 2003: 59). They also find that the integration of world equity markets has reduced the diversification benefits from emerging markets but it has not completely eliminated the benefits (Li, Sarkar & Wang, 2003: 78).

Chan-Lau (2004) focused on investment into emerging markets and he proposed that pension funds are able to benefit from investing in emerging markets from a strategic asset allocation perspective as well as from a tactical asset allocation perspective (Chan Lau, 2004: 5). Strategic asset allocation is based on a long term view and is supported by modern portfolio theory and the fact that investors can benefit from the inclusion of imperfectly correlated assets. Pension funds can also benefit tactical perspective by taking short term or tactical bets on emerging market assets. From a South

African perspective, the South African stock market is dominated by resource stocks and therefore, adding international assets into the portfolio has the potential to reduce the unsystematic risk. South African retirement funds are able to invest in other industries that have a small representation in the South African market, for example, the information technology sector. They are able to take tactical bets by investing in other industries that have a higher representation in other emerging markets.

Harvey (1994b) explored the concept of allocating funds to emerging markets using six portfolio strategies. He reviewed a strategy based on developed markets only, a strategy based on developed and emerging markets and a strategy based respectively on developed and emerging markets with a 20% cap on emerging market exposure. For each case, he looks at two possible strategies: holding the global minimum variance portfolio and holding the portfolio with a target annualised volatility of 16%. Harvey (1994b) ran the analysis using conditional asset allocation which requires forecasting variables to model. His study is done from the perspective of a US investor as all returns are represented in US Dollar terms. His sample included data on 21 developed markets and 20 emerging markets, using data for the period 1980 to 1992. His analysis found that the addition of emerging markets resulted in the curve moving to a lower standard deviation range and higher mean (Harvey, 1994b: 11). This was evident even when the 20% cap on emerging market exposure was imposed. His research found that the strategies that allocated assets to emerging markets consistently outperformed those strategies that only invested in developed market assets (Harvey, 1994b: 20).

Dagli, Sivri and Bank's study (2011) focused on Turkey and diversification benefits from investing in other emerging markets. Like South Africa, Turkey is a constituent of the MSCI Emerging Market Index. Their study explored the long run relationship between Turkey and 20 other emerging markets, including South Africa, using data from 1994 to 2010. By using the Johansen technique, their research found that there are benefits to investing in other emerging countries that do not have pairwise relationships with Turkey as the inclusion of these markets will reduce systemic risk. They did not find evidence that investing in all emerging markets was beneficial for Turkish investors; only specific markets added some benefit.

Kumar (2011: 2) argues that emerging markets did not fare well during the 1998 global financial crisis and therefore, did not offer the diversification benefits at a time when they were needed most. His study reviews the inclusion of CBOE's volatility index, VIX Index, rather than emerging markets as a better hedge due to its negative correlation with the US stock market. The VIX Index "reflects the expected near term volatility (30 days) implied in stock index option prices" (Kumar, 2011: 3). His study finds that the minimum variance portfolios that include the VIX have higher Sharpe Ratios than

the portfolios that include emerging markets and therefore, offer more diversification benefit (Kumar, 2011: 3).

While there is evidence that emerging markets provide some diversification benefits, most studies are done from the perspective of a developed market investor, such as a US investor. The low correlations between developed market equities and emerging market equities provide a basis for the diversification benefits. For investors in emerging markets, the benefit from investing from investing into other emerging markets is likely to stem rather from the higher expected returns in other emerging economies as correlations are higher.

2.10 Investing Into Emerging Markets – A South Africa Perspective

Bradfield, Munro and Silverman (2011) reviewed the inclusion of emerging market assets in portfolios from a South African investor's perspective. They did not find compelling evidence to include emerging market assets in a South African portfolio. Using data from January 1971 to December 2010, they found that the MSCI Emerging Market Index in Rand terms moves closely with the JSE All Share Index (ALSI), implying a strong correlation between the two and therefore, investing in emerging markets offers little benefit from a diversification perspective (Bradfield, Munro & Silverman, 2011: 3).

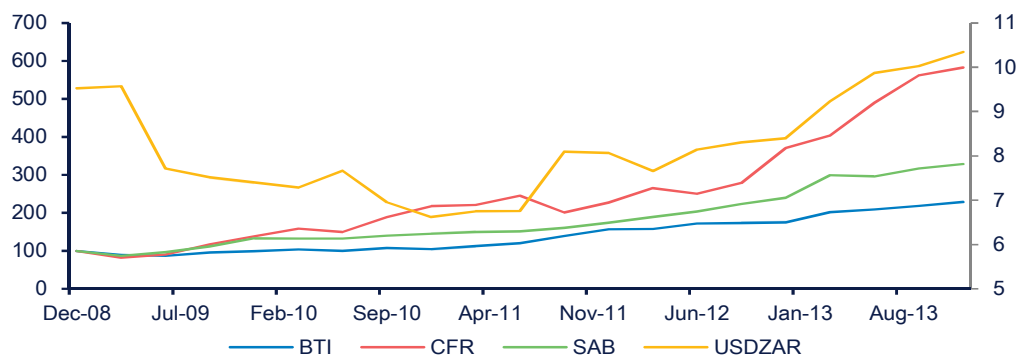
They also found that the ALSI is more correlated to the MSCI Emerging Market Index when the ALSI is falling and has a higher correlation when the ALSI is rising, implying that the currencies of other emerging economies tend to co-move with the Rand (Bradfield, Munro & Silverman, 2011: 3). This could be explained by contagion in emerging markets as events in other emerging markets tend to have an impact on South African stocks.

From a diversification and volatility perspective, they find that investing into developed markets would be more beneficial to South African investors as correlations are lower and developed markets are less volatile and therefore, would result in lower overall portfolio risk. From a return perspective, they found that investors were not compensated enough in the past for the additional risk associated with emerging markets. Their analysis found that South Africa investors would require an additional expected return of 38% over that of a balanced portfolio before they consider investing in emerging markets (Bradfield, Munro & Silverman, 2011: 5).

2.11 South Africa and International Equity Markets

As a result of increased globalisation, there is an increasing number of South African companies deriving a significant portion of their earnings outside of South Africa. A few examples of these companies are SAB Miller (SAB), Richemont (CHR) and British American Tobacco (BTI). These companies are known as Rand Hedge stocks as they benefit from Rand weakness. Investors in these companies benefit from their offshore exposure as the company's revenue increases when the Rand weakens. Below is a chart of the performance of SAB, CHF and BTI from the end of 2008 to end of 2013. These companies have performed well during times of Rand weakness to the US Dollar.

Figure 2.11.1: South African Rand Hedge Stocks and Rand/USD Exchange Rate:

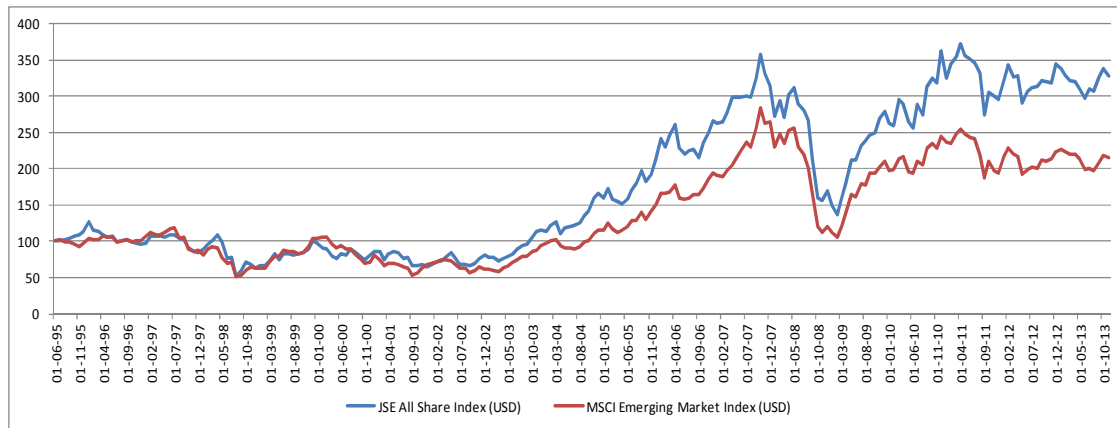


Source: I-Net Bridge

Given that South African investors can gain offshore exposure by investing in a few locally listed stocks, it could be argued that investors need not invest offshore as they can gain sufficient diversification by investing locally. As discussed earlier in this paper, previous studies provide weak evidence to support the hypothesis that multinational companies provide sufficient offshore exposure for domestic investors.

Below is a chart of the JSE All Share Index in USD and the MSCI Emerging Market Index in USD. As can be seen, the two indices track each other quite closely and therefore are correlated. It should be noted that South Africa currently has a 7% weighting in the MSCI Emerging Market Index.

Figure 2.11.2: Monthly Performance of JSE All Share in USD and the MSCI Emerging Market Index in USD



Source: Bloomberg

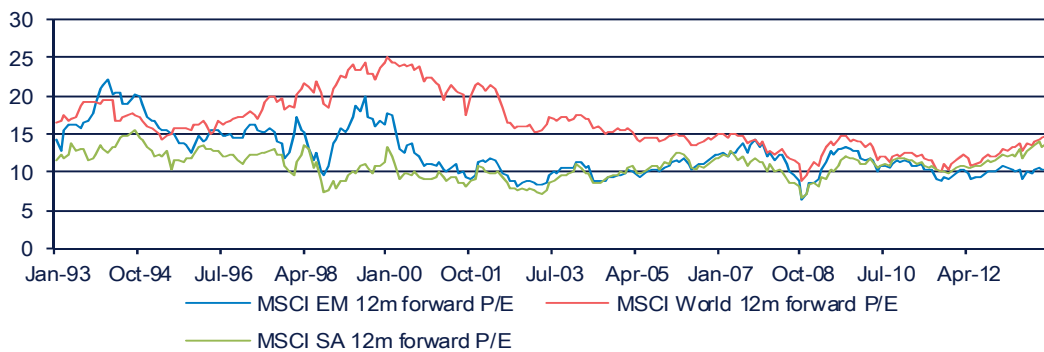
Figure 2.11.3 shows the 12 month forward Price to Earnings Ratio of the MSCI World Index and the MSCI Emerging Market Index for the period 1989 to 2013. As can be seen, the MSCI Emerging Market Index is trading on a lower Price to Earnings Ratio than the MSCI World Index. This implies that emerging markets could be offering value relative to developed markets on a purely valuation basis. Figure 2.11.4 shows the 12 month forward Price to Earnings Ratio of the MSCI World Index, the MSCI Emerging Market Index and the MSCI South Africa Index for the period 1995 to 2013. As can be seen, the MSCI Emerging Market Index is trading at a lower Price to Earnings ratio than developed market equities and South Africa equities and therefore, could be an investment opportunity for South African investors. Even though the JSE All Share Index is highly correlated to the MSCI Emerging Market Index in USD, emerging markets could be an attractive investment for South African investors from a valuation perspective.

Figure 2.11.3: 12 Month Forward Price to Earnings Ratios of the MSCI Emerging Market Index and the MSCI World Index (1989 to 2013)



Source: Datastream

Figure 2.11.4: 12 Month Forward Price to Earnings Ratios of the MSCI Emerging Market Index, MSCI SA Index and the MSCI World Index (1993 to 2013)



Source: Datastream

The International Monetary Fund’s (IMF) 2014 world economic outlook report predicts higher growth over the next two years for emerging countries relative to developed countries. Table 2.11.3 shows the growth figures for 2011 and 2012 and the growth estimates for 2014 and 2015. As can be seen, over the past two years, emerging market countries have grown at a faster pace than advanced /developed market countries. The IMF forecasts higher growth in developing economies for the next two years. Emerging economies are also set to grow at a higher rate than the South African economy for the next two years. The main contributor to growth is “Developing Asia”. The higher growth expectations could provide a basis for investing in emerging economies for South African investors.

Figure 2.11.3. IMF Growth Forecasts

IMF Growth Forecasts	2012	2013	2014	2015
World Output	3.1%	3.0%	3.7%	3.9%
Advanced Economies	1.4%	1.3%	2.2%	2.3%
Emerging Market and Developing Economies	4.9%	4.7%	5.1%	5.4%
South Africa	2.5%	1.8%	2.8%	3.3%

Source: IMF World Economic Update 2014

2.12 Portfolio Construction

There are various methods available that can be used to determine the optimal portfolio. Mean variance optimisation is commonly used but it has a few shortfalls that are discussed below. This study will also include an alternative optimisation model that uses the Omega Ratio to determine the optimal portfolio. While mean variance optimisation focuses on the first two moments of the distribution (mean and variance), the Omega ratio incorporates all higher moments.

2.12.1 Mean Variance Optimisation

There are various methods that can be used to assess the impact of international diversification and mean variance optimization is often used. Mean variance optimization is a method that determines the optimal portfolio to be the one that maximises the Sharpe Ratio. It stems from the work of Harry Markowitz which is based on the idea that “portfolio selection should be based on overall risk-reward characteristics” (Mangram, 2013: 61). The Sharpe Ratio is defined as the expected excess return of a portfolio divided by the risk of the portfolio (Grinold and Kahn, 1999 :32) and therefore, is a measure of the risk adjusted return of a portfolio.

While mean variance optimization is a useful research tool, it has a few shortcomings that should be noted. The model assumes that the return distribution is normally distributed which may not be an accurate description of the data. The risk and return estimates generated by the model are subject to estimation error. The model will result in overweight positions in asset classes that have large estimated returns, small variances and negative correlations (Michaud, 1989: 46).

The model requires expected return estimates to be inputted for all assets. While historical data is often used to forecast future expected returns, it could lead to suboptimal allocations as the past is not always the best predictor of the future. If a particular asset class rallied during the period under

consideration and historical expected returns are used, the model will allocate a substantial weighting to that asset class as it has a higher expected return. Implied expected returns, which are based on current market data, can be used instead of historical returns. These are forward looking rather than backward looking.

Mean variance optimisation is time dependent, which means that the model will produce different results for different time periods. The model is also sensitive to changes as a small change in the expected return estimates could result in a large change in the optimal weightings. The model is also dependent on covariance between the asset classes which is based on past data, which may not be indicative of the future as covariances change over time.

2.12.2 Optimisation Using the Omega Ratio

As highlighted above, mean variance optimisation has a few shortfalls. A second model was compiled to validate the results of the mean variance optimisation model. Bradfield and Munro (2011) used non parametric optimisation to determine the optimal asset classes weights at various thresholds. They determined the weightings at thresholds of CPI plus a target. The thresholds ranged from CPI plus 0% to CPI plus 8%. Their study tried to determine the asset class weights that had the best probability of outperforming inflation plus a target. In line with this methodology, a second model which uses the Omega ratio to determine the optimal portfolio was included in this study.

While mean variance optimisation chooses the portfolio with the highest Sharpe ratio, this model determines the optimal portfolio by choosing the one that has the highest Omega ratio. The Omega measure was introduced by Shadwick and Keating in 2002 and is a “ratio of probability weighted returns above the threshold level to probability weighted returns below the threshold level” (Ramani, 2013). Shadwick and Keating (2002: 2) state that the Omega Ratio “provides a risk-reward evaluation of a returns distribution which incorporates the beneficial impact of gains as well as the detrimental effect of losses, relative to an individual’s loss threshold”.

The mathematical formula for the Omega Ratio is:

$$\Omega(r) := \frac{\int_a^b [1 - F(x)] dx}{\int_a^b F(x) dx} .$$

While mean variance optimisation assumes a normal return distribution, the Omega ratio makes no assumptions about the form of the distribution. The Omega ratio has an advantage over mean

variance optimisation in that it takes into account the higher moments of a distribution such as skewness and kurtosis, rather than just the first two moments, being the mean and variance. The Omega ratio takes into account tail risk events, which are low probability events that will have high impact on the portfolio. Higher Omega ratios are preferred over lower ones as higher ratios indicate that the outperformance of the portfolio is higher than underperformance relative to the threshold over the period. One criticism of the model is that it uses historical performance to calculate the portfolio's performance relative to the threshold.

2.13 Conclusion:

While previous asset allocation studies have focused on pension funds investing funds into international assets, there remains scope for further research from a South African perspective. This study aims to build on the previous work done by Bradfield and Munro on optimal asset allocation for South African investors. Modern Portfolio Theory hypothesises that there are benefits from diversification by investing in a pool of complementary assets. The previous literature tends to support the argument that investing in offshore assets is beneficial for both developed and developing countries. While there is evidence that investing in emerging market equities can be advantageous for developed market countries, the evidence is not compelling for emerging market countries. This is mainly due to the correlations between emerging markets. Developed markets in general have a low correlation with emerging markets which makes them attractive in terms of potential diversification benefits. This paper aims to determine the optimal asset allocation for South African retirement funds. This paper aims to build on previous studies by including emerging market equities as well developed market equities into the optimisation model to determine whether it would be optimal for South African pension funds to invest in emerging market equities given the high correlation between the MSCI Emerging Market Index and JSE All Share Index in USD. This paper will also review the impact of the Regulation 28 constraints on the optimal asset allocation for South African retirement funds.

CHAPTER 3: DATA AND METHODOLOGY

3.1. Introduction

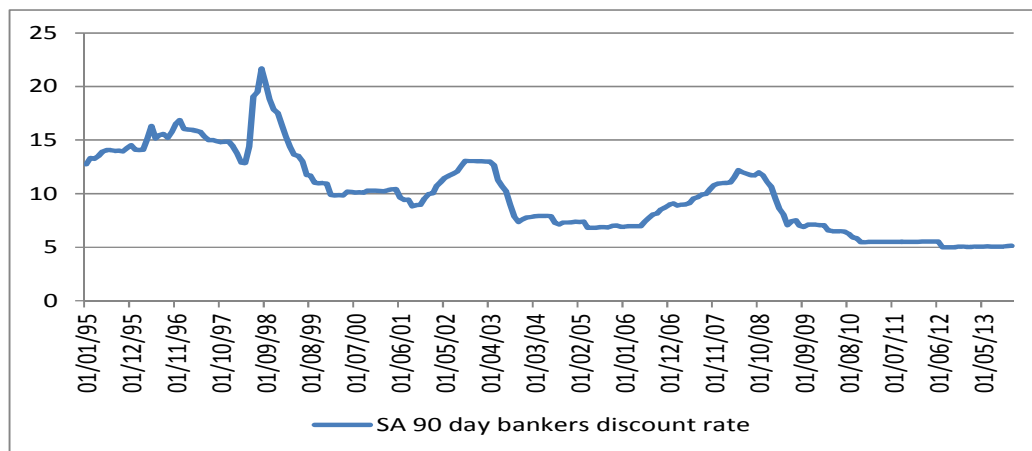
This chapter provides an overview of the data as well as the methodology used in the study to compile the optimum portfolios for South African retirement funds. This chapter includes an overview of the calculations of the expected returns used in the models as well as a discussion on the calculation of the equity risk premium.

3.2. Data

This study includes 7 asset classes. Domestically, retirement funds can invest in equity, bonds and property. Internationally, they can invest in developed market and emerging market equity and global bonds as well as cash. As this study is from the perspective of a South African investor, all returns are in Rand terms. Total return data, which includes interest and dividends, was used for all asset classes.

Local cash is treated as the risk free asset and therefore, is not included in the model weights. The risk free rate is forward looking and therefore, the average of the long bond yield and current cash rate (represented by the 30 day bankers discount rate) was used as the risk free rate. This is due to the fact that the cash rate in South Africa is currently at historically low levels due to the recent global financial crisis. The graph below shows the South African cash rate from 1995 to 2013.

Figure 3.2.1 : SA cash rates from 1995 to 2013



Source: I-Net Bridge

It is likely that interest rates will increase in the long term as the global economy recovers. The long bond yield as represented by the yield curve is a guide to future interest rates and therefore, the

average of the SA long bond yield and the cash rate was used to estimate the risk free rate going forward.

The time period under review is 1995 to 2013. Before 1990, South Africa was governed by the Apartheid regime. Since the abolishment of Apartheid and the start of democracy, South Africa has undergone significant structural and political changes. Since the early 90s, South Africa is more open to foreign investment and trade. Exchange controls have also been gradually relaxed which has allowed more foreign investment into South Africa and opened up the economy to globalisation. The years post 1994, when South Africa, became a democracy, are likely to be more indicative of the South African economic environment going forward. While Bradfield and Munro (2011) used data from 1971, the data for the MSCI Emerging Market Index is only available from the end of 1987. The composition of the index at the beginning of the 1990s is very different to the current composition. The index initially consisted of eight countries (Mexico, Argentina, Brazil, Chile, Jordan, Malaysia, Thailand and the Philippines), it is now representative of 21 emerging countries. South Africa joined the index in 1995 at a weighting of 14.81%, the weighting has now decreased to 7.4%.

The data also excludes the period when South African bonds were subject to the prescribed assets policy. This policy forced South African retirement funds to invest a portion of their assets in government debt. The policy was abolished in 1989.

The following assets were included in the study, namely local equity, local bonds, local property, offshore equity in both developed countries, offshore equity in developing countries, global bonds and offshore cash. These assets provide a proxy for the investment universe that South African retirement funds can invest in.

- Local Equity:
 - JSE All Share Index (Total Return). Source: I-Net Bridge
 - The JSE All Share Index was used as a proxy for South African equities as it represents about 165 mid to large cap stocks listed on the South African stock exchange.

- Local Bonds:
 - JSE All Bond Index (ALBI). Source: I-Net Bridge
 - This index was used as a proxy for South African bonds. It represents the top 20 vanilla bonds ranked by market capitalisation and liquidity.

- Local Property:
 - Property Loan Stock Index. Source: I-Net Bridge
 - This Index was included as a proxy for South African property. It represents property loan stocks that are listed on the JSE All Share Index.

- Offshore Equity: Developed Markets
 - MSCI World Index (MXWO). Source: Bloomberg
 - This index includes large and mid-cap companies in 23 developed market countries. It has 1,610 constituents with the largest country weight being the United States (54.39%).
 - This index is a proxy for developed market equities.

- Offshore Equity: Developing Markets
 - MSCI Emerging Market Index. Source: Bloomberg
 - This index includes large and mid-cap companies in 21 emerging market countries. It has 824 constituents with the largest country weight being China (19.8%). South Africa has a weighting of 7.4% in the index.
 - This index is a proxy for developing market equities.

- Offshore bonds:
 - JP Morgan Global Aggregate Bond Index. Source Bloomberg.
 - This index consists of investment grade bonds in both developed and emerging markets.
 - This index was used as a proxy for global bonds.

- Offshore Cash: US 3 month treasuries. Source: Bloomberg.
 - US 3 month treasuries provide a proxy for short term cash rates in the US. It is a proxy for offshore cash.

The monthly log returns for each asset class in the study were calculated for a period of 18 years. The offshore indices were obtained from Bloomberg and I-Net Bridge and converted to Rand log returns using monthly exchange rates for the period.

3.3 Hypothesis

This study aims to determine the optimal allocation to various asset classes given the constraints of Regulation 28. South African retirement funds are able to invest in domestic assets (minimum of 75%) and international assets (maximum of 25%). Within offshore assets, it aims to determine whether South Africa retirement funds should allocate some of the 25% maximum offshore allocation to emerging market equities, developed market equities or a combination of both.

3.4 Methodology

The method used to determine the optimal asset allocation is mean variance optimisation as well as optimisation using the Omega ratio. Details of these methods were highlighted in sections 2.12.1 and 2.12.2 above.

As mentioned previously, historical data is often not the best predictor of future returns. The model is likely to overweight an asset class that has rallied during the period under consideration. Recently, domestic equities had been at depressed levels due to a global financial crisis and rallied from a low base. The performance seen over the past few years is unlikely to be seen going forward. This study used implied expected returns as predictors of future returns.

Two optimisation models using both methods were run using data from January 1995 to November 2013. The first optimisation model was run using the Regulation 28 constraints. The second model relaxed the constraints.

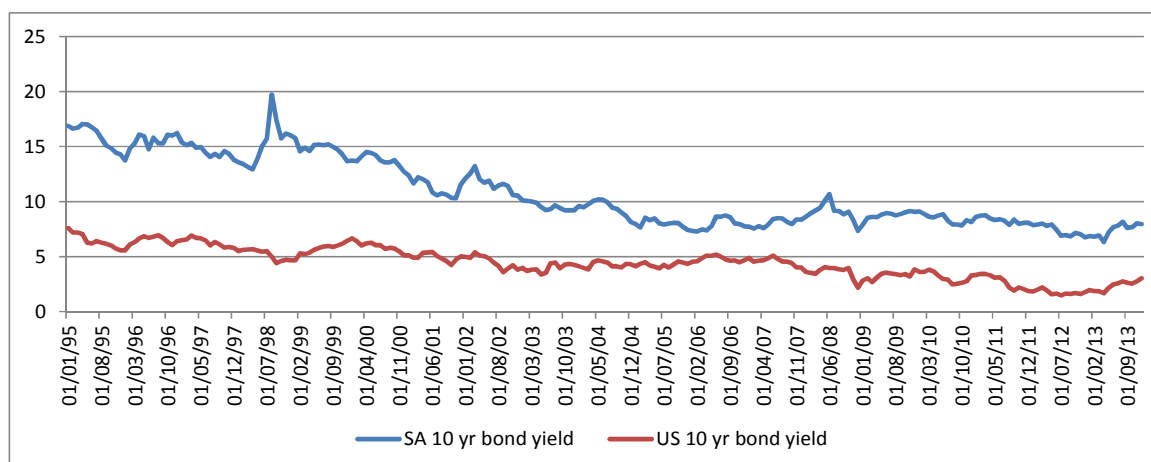
The analysis does not include transaction costs. The weights of each of the asset classes are greater than or equal to one therefore, the model prohibits short selling.

3.4.1. Expected Return Forecasts

The expected returns were estimated using the Capital Asset Pricing Model. All expected returns are in Rand terms and therefore, a forward looking view on the Rand was factored into the returns. The offshore assets are US Dollar referenced and therefore, the Rand's future performance against the USD was factored into the forecast returns in Rands.

An indication of future Rand performance is given by the difference between the long bond yield in the US and the long bond yield in South Africa. This is based on the concept of interest rate parity. As can be seen in the figure below, the differential is currently around 5% which indicates that Rand should depreciate by 5% over the long term relative to the USD.

Figure 3.4.1: SA 10 Year Bond Yield and the US 10 Year Bond Yield (from 1995 to 2013)



Source: I-Net Bridge

For the offshore equity indices, a risk premium was added to the expected returns. The equity risk premium is the additional risk that investors require over the risk free rate. The long bond yield in the USD is currently around 3%.

The expected return for emerging market equity is higher than for developed market equities to reflect the higher risk of emerging markets. Emerging market equities have higher volatility than developed market equities and therefore, investors will expect a higher return to be compensated for the additional risk. This is reflected by a higher Beta.

3.4.2 Beta

The Betas were calculated using the monthly logged returns for each index in USD against the MSCI World Index in USD, which is a proxy for developed market equities. The data was sourced from Bloomberg and I-Net Bridge. The Beta estimate of emerging market equities to developed market equities was calculated by regressing the monthly logged returns of the MSCI World Index in USD against the MSCI Emerging Market Index in USD. The Beta estimate of South African equities to developed market equities was calculated by regressing the monthly logged returns of the MSCI World Index in USD against the JSE All Share Index in USD.

The beta for developed market equities is 1. The beta for SA stocks in USD relative to developed markets is estimated to be 1.25, which is based on the beta for the period 1995 to 2013. The Beta for emerging market equities is also estimated to be 1.32 which is line with the fact that the JSE All Share Index in USD tracks the MSCI Emerging Market Index in USD quite closely.

3.4.3 Estimating the Equity Risk Premiums

Damodaran's study (2013) reviewed 3 different of methods of estimating the equity risk premium.

- Survey subgroups of investors and managers to gauge their views on future equity returns.
- Use an historical premium based on past equity performance relative to riskless assets, such as long term bond yields
- Use an implied premium which is forward looking and based on current asset prices

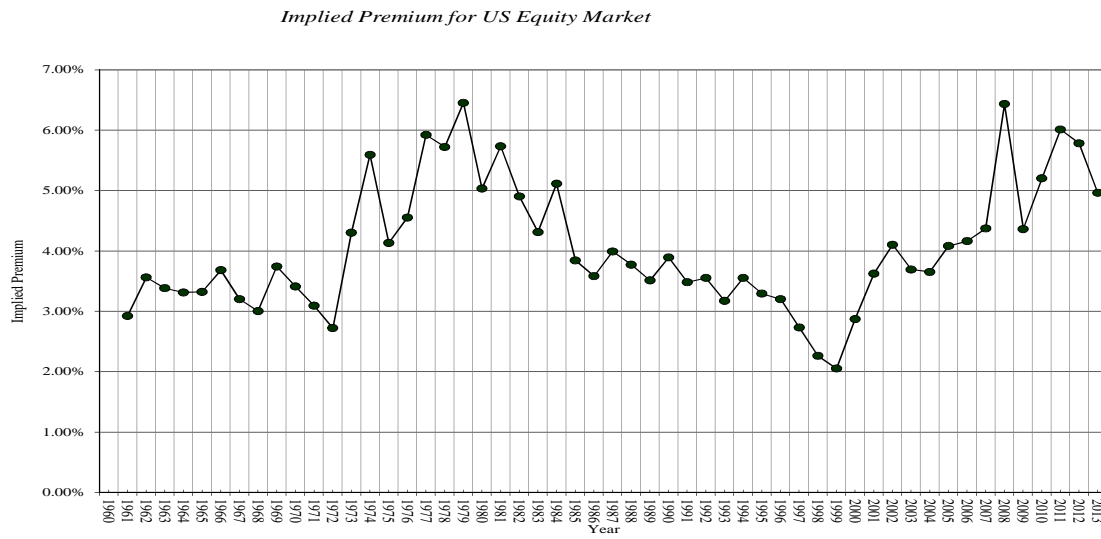
While surveys are a way to gauge investor's opinion on stock market returns going forward, they tend to be focused on the short term and are dependent on the questions included in the survey. There tends to be a high level of variance in the answers and therefore, is of limited use to forecast expects returns for pension funds which have long time horizons (Modugno, 2012: 10).

Historical returns can have high variance and therefore tend to have high standard error. If historical returns are used, it is better to use the geometric mean over the arithmetic mean if the projection period is long term as is the case for pension funds. While the use of historical returns is commonly used to estimate long term forward looking equity returns, it may not be the optimal measure. Data is not stationary as the mean and standard deviation change over time and therefore, the past is not likely a good indicator of the future.

While there isn't consensus on which method is the best, the implied equity risk premium is potentially a better estimate of forward equity premiums as it uses current market conditions to make assumptions about the future. Historical data is backward looking and relies on mean reversion for future returns. Pension funds have a long horizon and therefore, the predictive ability of the equity risk premium is important and thus, the implied equity risk premium appears to be the most appropriate measure.

The equity risk premium is estimated to be 5%, which is based on Damodaran's implied premium (Figure 3.4.3.1). Damodaran computes the implied equity risk premium by using a two stage Free Cash Flow to Equity (FCFE) model, which uses cash flow as a measure of potential dividends. The model is based on the assumption that the cash flows grow during the growth stage of five years at the analyst's growth estimate (4.28%). During the stable growth stage, the cash flows are assumed to grow at the risk free which is represented by the US long bond yield (3%).

Figure 3.4.3.1: Implied Premium for the US Equity Market (1960 to 2013)



Source: Damodaran (2014)

3.4.4 Expected Return Calculations

Expected return for equities in Rands = Risk free rate in USD + Beta (Equity premium) + currency depreciation

Developed Market Equity = 3% + 1(5%) + 5% = 13%

Emerging Market Equity = 3% + 1.32(5%) + 5% = 15%

Global bonds = 3% + 5% currency depreciation = 8%

SA Equity = 3% + 1.25(5%) + 5% = 14%

The expected return for SA bonds is estimated to be 8%, which is based on the current long bond yield in SA.

The cash rates in the US currently range from 0 to 0.25%. The return in Rands would be the currency depreciation of 5%.

The expected return for SA property:

The expected return for SA property is estimated to be 8.7%. This expected return for SA property is based on the following calculation:

Risk free rate + ALSI beta*(expected ALSI excess return) + bond beta*(expected bond excess return).

The monthly excess returns for property, cash and bonds were calculated for the period 1995 to 2013. This is the excess return of each asset class over cash. The excess property returns were regressed against the excess returns for equities and bonds to calculate the Betas. The correlation between the excess returns of bonds and equities is very low (0.3), indicating low multicollinearity.

The expected ALSI excess return is calculated as the expected return (14.6%) less the risk free rate of 6.4% = 8.2%.

The expected Bond excess return is calculated as the expected return (7.7%) less the risk free rate of 6.4% = 1.3%.

Table: Betas of the excess equity return and the excess bond return

	<i>Coefficients</i>
Intercept	0.004835268
Excess equity return	0.123765615
Excess bond return	1.031210454

Therefore, the expected return for SA property is calculated as follows:

$$6.4\% + 0.12 (8.2) + 1.03 (1.3) = 8.7\%$$

Expected Returns

Emerging Market Equity	15%
Developed Market Equity	13%
Global Bonds	8%
US Cash	5%
SA Equity	14%
SA Bonds	8%
SA Property	9%

CHAPTER 4: PRESENTATION AND ANALYSIS OF DATA

4.1 Introduction

This chapter provides a presentation and analysis of the results obtained by the standard mean variance optimisation model and the optimisation model using Omega. Graphical representations of the results are provided. Both optimisation models include two scenarios: one in which the Regulation 28 constraints are satisfied and one in which the model is unconstrained by the Regulation 28 limits. Both models do not allow short selling.

4.2 Correlation Matrix and Standard Deviation (1995 to 2013) – Rand Returns

Figure 4.2.1 below shows the correlation matrix of the returns of the seven asset classes in Rands. Emerging market equity has a higher positive correlation with local equity than developed market equities. Developed market equities seem to be more compelling from a diversification viewpoint.

Figure 4.2.2 below shows the standard deviation of each asset class for the period 1995 to 2013. As can be seen, emerging market equities have the highest standard deviation (22%), followed by South African equities (20%). Developed market equities, represented by the MSCI World Index, have a lower standard deviation (17%) than local and emerging market equities.

From a correlation and standard deviation viewpoint, developed market equities seem to be more attractive in terms of diversification for South African investors. They have lower correlation with South African markets and have a lower standard deviation than South African equities which implies lower risk.

South African equity, bonds and property have a negative correlation with the USD Rand exchange rate.

Figure 4.2.3 shows the mean returns in Rands for the seven asset classes during the period. The highest return was attained by local property (19%) while emerging market equities achieved the lowest return (7%).

Figure 4.2.1: Correlation Matrix (Rand Returns)

	<i>MSCI World Index</i>	<i>Emerging Market Equity</i>	<i>Global Bond Index</i>	<i>U.S. cash</i>	<i>SA equity</i>	<i>SA bonds</i>	<i>SA property</i>	<i>SA cash</i>	<i>USD ZAR</i>
MSCI World Index	1.00								
Emerging Market Equity	0.82	1.00							
Global Bond Index	0.52	0.24	1.00						
U.S. cash	0.53	0.23	0.93	1.00					
SA equity	0.48	0.63	-0.13	-0.15	1.00				
SA bonds	-0.15	0.07	-0.34	-0.41	0.31	1.00			
SA property	-0.07	0.08	-0.31	-0.35	0.31	0.56	1.00		
SA cash	-0.02	-0.16	0.07	0.06	-0.17	0.09	-0.14	1.00	
USD ZAR	0.53	0.23	0.93	1.00	-0.15	-0.41	-0.35	0.04	1.00

Figure 4.2.2: Standard Deviation and Correlation of Asset Classes with the South African Equity Market

	<i>MSCI World Index</i>	<i>Emerging Market Equity</i>	<i>Global Bond Index</i>	<i>U.S. cash</i>	<i>SA equity</i>	<i>SA bonds</i>	<i>SA property</i>
Standard Deviation	17%	22%	15%	16%	20%	8%	16%
Correlation with SA equity market	0.48	0.63	-0.13	-0.15	1.00	0.31	0.31

Figure 4.2.3: Mean Rand Returns (January 1995 to Nov 2013)

	<i>MSCI World Index</i>	<i>Emerging Market Equity</i>	<i>Global Bond Index</i>	<i>U.S. cash</i>	<i>SA equity</i>	<i>SA bonds</i>	<i>SA property</i>
Mean Return	13%	7%	11%	8%	15%	13%	19%

4.3 Mean Variance Optimisation with Regulation 28 Constraints

This model was compiled using the Regulation 28 constraints. The maximum exposure to offshore assets is 25% and the maximum exposure to equities is 75%. Listed property assets are limited to a maximum exposure of 25%.

As shown above, the asset that has the lowest expected return is USD cash at 5%. Given the maximum offshore constraint of 25%, only 25% can be allocated to this asset class. Given the Regulation 28 constraints, the model targets expected returns of 8% and higher. The table (4.3.1) below shows the optimal asset allocation for the target expected returns ranging from 8% to 12%. As can be seen, the model allocates the maximum percentage allowed of 25% to offshore assets for all target portfolio returns.

As the target expected return increases, the model allocates more of the offshore allocation to the MSCI World Index, which represents developed market equities. At an expected return of 11.5% and higher, the model allocates the full 25% offshore weighting to developed market equities. The model does not allocate any assets to emerging market equities. As mentioned previously, South African equity is highly correlated to emerging market equities and therefore, offers little diversification benefits. The expected return offered by emerging markets does not warrant its inclusion in the model, given the lack of diversification it offers. The results are in line with the findings of Bradfield, Munro and Silverman who did not find compelling evidence to include emerging market assets in a South African portfolio.

As the target expected return increases, the model allocates fewer assets to offshore cash and offshore bonds. While offshore cash and bonds in Rands have a negative correlation with South African equity and therefore offer some diversification benefits, they have lower expected returns than the equity classes. At higher levels of target portfolio returns, the model allocates more assets to equities which have higher expected returns in order to achieve higher target returns.

Within the local asset allocation, as the expected return increases, the allocation to South African equities increases while the allocation to bonds decreases. Equities have higher expected returns and therefore, have the ability to target higher portfolio returns. As the target return increases, the model allocates more assets to equities, both domestically and internationally. At a target return of 8%, the equity allocation is 8%. At a target return of 12%, the equity allocation increases to 70%.

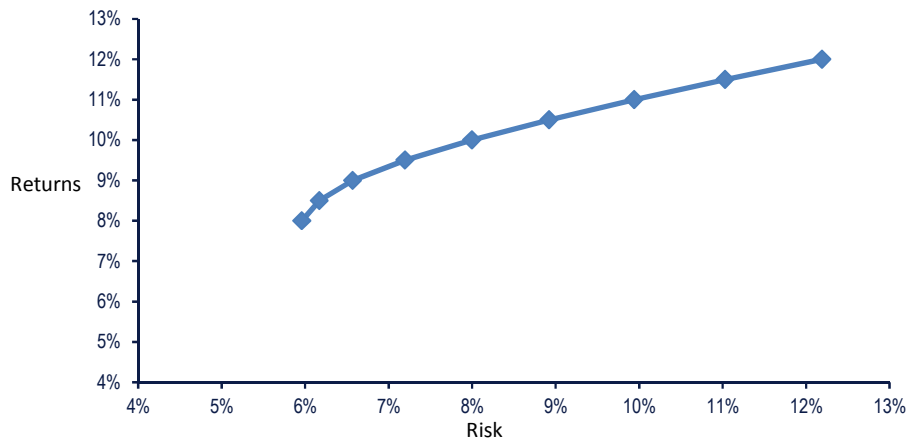
As seen in the table 4.3.1 below, portfolios with higher returns have higher standard deviations. This is consistent with the fact that the portfolios with higher target returns have higher allocations to riskier assets such as equities.

Table 4.3.1: Asset Allocation With Regulation 28 Constraints

Expected Return	Standard Deviation	MSCI World	MSCI Emerging	Global Bond	U.S. Cash	SA Equity	SA Bonds	SA	Total	Local	Offshore
		Index	Market Index	Index				Property			
8.0%	6.0	2%	0%	13%	10%	6%	68%	2%	100%	75%	25%
8.5%	6.2	5%	0%	20%	0%	7%	67%	1%	100%	75%	25%
9.0%	6.6	9%	0%	16%	0%	12%	62%	1%	100%	75%	25%
9.5%	7.2	12%	0%	13%	0%	17%	57%	2%	100%	75%	25%
10.0%	8.0	16%	0%	9%	0%	21%	52%	2%	100%	75%	25%
10.5%	8.9	20%	0%	5%	0%	26%	47%	2%	100%	75%	25%
11.0%	9.9	24%	0%	1%	0%	31%	42%	2%	100%	75%	25%
11.5%	11.0	25%	0%	0%	0%	37%	35%	2%	100%	75%	25%
12.0%	12.2	25%	0%	0%	0%	45%	27%	3%	100%	75%	25%

The efficient frontier below represents the set of optimal portfolios that offers the lowest risk for a given level of expected return. Below is the efficient frontier for portfolios that are constrained by the Regulation 28 limits. As target returns increase, risk increases. The portfolio risk is estimated by the standard deviation of the portfolio.

Figure 4.3.2: Efficient Frontier



4.4 Mean Variance Optimisation with No Regulation 28 Constraints

The table below shows the asset allocation for the model which is unconstrained by the Regulation 28 limits.

The table 4.4.1 below illustrates that as the target portfolio expected return increases, the allocation to offshore assets increases. At a target portfolio return of 12%, the model allocates nearly half of the assets to offshore (44%). As the target portfolio expected return increases, the allocation to offshore equity increases.

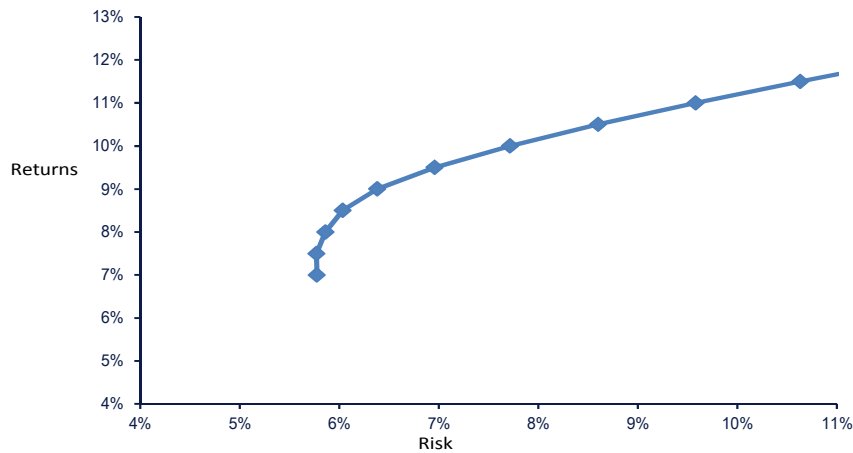
As the target return increases, the allocation to equities increases. At a target return of 7%, the equity allocation is very low at a mere 1%. At a target return of 12%, the equity allocation increases to 73%. The model does not allocate any assets to emerging market equities, which is consistent with previous research that indicates that emerging market equities offer limited diversification benefits for South African investors.

At lower target returns, local bonds and offshore cash dominate the optimal asset allocation. At higher target returns, developed market equity and local bonds and equities dominate the asset allocation.

Table 4.4.1: Asset Allocation Without Regulation 28 Constraints

Expected Return	Standard Deviation	MSCI World	MSCI Emerging	Global Bond	U.S. Cash	SA Equity	SA Bonds	SA	Total	Local	Offshore
		Index	Market Index	Index				Property			
7.0%	5.8	0%	0%	0%	29%	1%	67%	3%	100%	71%	29%
7.5%	5.8	4%	0%	5%	21%	2%	65%	3%	100%	70%	30%
8.0%	5.9	7%	0%	14%	10%	2%	64%	3%	100%	69%	31%
8.5%	6.0	10%	0%	23%	0%	3%	62%	3%	100%	67%	33%
9.0%	6.4	15%	0%	19%	0%	6%	56%	3%	100%	66%	34%
9.5%	7.0	20%	0%	16%	0%	10%	51%	3%	100%	64%	36%
10.0%	7.7	25%	0%	13%	0%	14%	45%	4%	100%	63%	37%
10.5%	8.6	30%	0%	10%	0%	18%	39%	4%	100%	61%	39%
11.0%	9.6	34%	0%	6%	0%	21%	33%	5%	100%	59%	41%
11.5%	10.6	39%	0%	3%	0%	25%	27%	5%	100%	58%	42%
12.0%	11.7	44%	0%	0%	0%	29%	21%	6%	100%	56%	44%

Figure 4. 4.2: Efficient Frontier

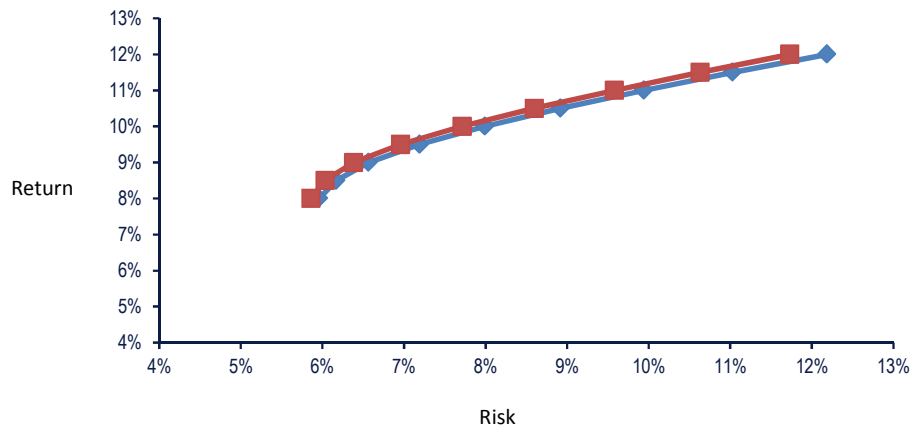


4.5 Efficient Frontier

The figure below shows the efficient frontier for the Regulation 28 portfolio and the portfolio that is unconstrained by Regulation 28 on the same graph. The red line represents the portfolio that is unconstrained by Regulation 28 while the blue line represents the Regulation 28 compliant portfolio. As can be seen, the unconstrained portfolio produces a slightly higher efficient frontier. This is due to the fact that the model is allowed to allocate more assets to asset classes that offer higher expected returns, such as equities. At each expected return, the unconstrained model has a higher Sharpe ratio than the Regulation 28 compliant portfolio.

Regulation 28 imposes a home bias for South African investors. South African retirement funds are forced to invest more into local assets than is optimal. Without the constraints, the model allocates nearly half of the assets to offshore assets at a target return of 12%. While regulation 28 is meant to protect investors, it produces an efficient frontier which is lower. Rational investors would prefer an efficient frontier which is higher as they can achieve higher expected returns for the same level of risk. Regulation 28 focuses too much on the risk of individual asset classes rather the overall risk of the portfolio. Due to imperfect correlations, the right mix of asset classes will reduce overall risk.

Figure 4.5.1: Combined Efficient Frontier



4.6. Optimal Portfolio

The optimal portfolio is the portfolio along the efficient frontier that maximises the Sharpe Ratio. The Sharpe ratio is a measure of the risk adjusted return.

For Regulation 28 compliant portfolio, the maximum Sharpe ratio is 0.46, which corresponds with a target portfolio return of 11%. At this return, the model allocates 24% to developed market equities, 1% to offshore bonds, 31% to local equities, 42% to local bonds and 2% to local property.

For portfolio that is unconstrained by the Regulation 28 limits, the maximum Sharpe ratio is 0.48, which corresponds with a target portfolio return of 11%. At this return, the model allocates 34% to developed market equities, 6% to offshore bonds, 21% to local equities, 33% to local bonds and 5% to local property.

Both models allocate capital to the same asset classes. Neither optimal portfolio allocates funds to emerging market equities or offshore cash. As shown above, emerging market equities offer little diversification for South African investors based on the high correlation with local equities and the high standard deviation. The expected return was not sufficient enough to warrant its inclusion in the optimal portfolio, given its lack of diversification benefits from an overall risk viewpoint.

The optimal unconstrained model allocates slightly more to equities (54% for the Regulation 28 compliant portfolio and 56% for the unconstrained portfolio). A high equity allocation is line with Blanchett, Finke & Pfau's study (2013) that finds that portfolios with long term time horizons should have higher allocation to equities.

As shown in figure 4.2.2, local bonds are the asset class in the model with the lowest standard deviation (8%). In terms of diversification, allocation to local bonds will lower the overall portfolio risk. Local bonds have a lower expected return than equities and therefore, the model allocates more to equities and less to bonds at higher portfolio expected returns.

4.7 Optimisation Model Using the Omega Measure

The model uses monthly return data for the asset classes from 1995 to 2013. The threshold is a target level above inflation. It ranges from a target of inflation plus 0% to inflation plus 10%. The model includes monthly CPI data as an estimate for the inflation level during the period. Retirement funds have a long time horizon and therefore, the assets need to grow at a rate above inflation in order to attain real growth and maintain the purchasing power of the assets.

The monthly outperformance of the portfolio is calculated relative to the threshold. The portfolio outperforms the threshold if it has yielded a return that is higher than the target of CPI plus a set percentage over inflation. The Omega ratio is the sum of the monthly relative outperformance divided by the relative underperformance over the period. A caveat of the model is that it uses historical returns to work out the portfolio's performance relative to the threshold. As mentioned earlier, past performance is not often the best predictor of future performance of asset classes and the model tends to overweight assets that have performed well during the period. The optimal portfolio is the one that maximises the Omega ratio. The optimisation model is set to determine the optimal portfolio weights for each asset class at each threshold that will maximise the Omega ratio. i.e. maximise the outperformance relative to the underperformance.

Table 4.7.1 shows a summary of the results of optimisation model constrained by the Regulation 28 limits. The highest Omega ratio (2.39) is at the threshold of inflation plus 0%. As shown in table 4.7.2, the optimal asset class weights at this threshold are as follows: 6% developed market equity, 19% global bonds, 5% local equity, 55% local bonds and 15% local property. The optimal portfolio allocates the full 25% weighting as allowed by Regulation 28 to offshore assets and therefore, provides further evidence that retirement funds should allocate the full weighting of 25% to offshore assets. As can be seen below, this model does not allocate any assets to emerging market equities. This is consistent with the results obtained by the mean variance optimisation model.

As mentioned, the model uses historical returns to calculate the portfolio's performance relative to the threshold. During the period, local property was the best performing asset class and as a result, the model allocates the full weighting as allowed by Regulation 28 of 25% to thresholds of inflation plus 1% and higher. At thresholds of inflation plus 8% and above, the model allocates weightings

only to domestic assets. The model allocates a high percentage to equities at higher thresholds as equities have higher historical returns and therefore, the higher thresholds are only achievable with high equity weightings. The additional allocation to local equities is mainly at the expense of local bonds which had lower returns during the period but also lower volatility.

The expected returns in table 4.7.1 are calculated by multiplying the expected returns by the portfolio weights at each threshold. The expected returns are the same expected returns used by the mean variance optimisation model. The optimal portfolio which is constrained by Regulation 28 has an expected return of 8.6%.

Table 4.7.1: Optimisation model constrained by Regulation 28 limits – Omega Ratios at different thresholds.

Target	E(R)	Equity allocation	Omega
0	8.6%	11.0%	2.3922
1%	8.6%	9.6%	2.1425
2%	8.6%	10.3%	1.9313
3%	8.7%	11.4%	1.7421
4%	8.8%	12.7%	1.5716
5%	8.9%	13.9%	1.4170
6%	9.2%	19.6%	1.2787
7%	10.5%	39.6%	1.1669
8%	12.9%	75.0%	1.0994
9%	12.9%	75.0%	1.0484
10%	12.9%	75.0%	0.9998

Table 4.7.2: The optimal asset allocation at each threshold for a portfolio constrained by Regulation 28 limits

Target of Inflation Plus:	Developed market equity	Emerging market equity	Global bond index	U.S. cash	SA equity	SA bonds	SA property	Total	Local	Offshore
	0%	6%	0%	19%	0%	5%	55%	15%	100%	75%
1%	6%	0%	19%	0%	4%	46%	25%	100%	75%	25%
2%	7%	0%	18%	0%	4%	46%	25%	100%	75%	25%
3%	5%	0%	20%	0%	7%	43%	25%	100%	75%	25%
4%	4%	0%	21%	0%	9%	41%	25%	100%	75%	25%
5%	4%	0%	21%	0%	10%	40%	25%	100%	75%	25%
6%	8%	0%	17%	0%	11%	39%	25%	100%	75%	25%
7%	9%	0%	6%	0%	31%	29%	25%	100%	85%	15%
8%	0%	0%	0%	0%	75%	0%	25%	100%	100%	0%
9%	0%	0%	0%	0%	75%	0%	25%	100%	100%	0%
10%	0%	0%	0%	0%	75%	0%	25%	100%	100%	0%

Table 4.7.3 shows a summary of the results of optimisation model unconstrained by the Regulation 28 limits. The highest Omega ratio (2.4) is at the threshold of inflation plus 0%. As shown in table 4.7.4, the optimal asset class weights at this threshold are as follows: 8% developed market equity,

20% global bonds, 4% local equity, 51% local bonds and 17% local property. As can be seen, the model does not allocate any assets due to emerging market equities, further building the case against the diversification benefit that they add to the portfolios of South African investors. The Omega ratio decreases as the equity and property allocation increases. This is due to the higher risk of these asset classes. There is a greater chance of underperforming the target at higher thresholds.

The unconstrained model allocates 100% to property at higher thresholds. As mentioned, this is due to the fact that the model uses historical return data and local property significantly outperformed all other asset classes during the period.

Table 4.7.3: Optimisation model unconstrained by Regulation 28 limits – Omega Ratios at different thresholds.

Target	E(R)	Equity allocation	Omega
0	8.6%	11.8%	2.4058
1%	8.7%	11.4%	2.1616
2%	8.7%	10.9%	1.9526
3%	8.9%	11.8%	1.7716
4%	9.0%	12.9%	1.6209
5%	9.1%	12.6%	1.5068
6%	9.1%	10.9%	1.4122
7%	8.9%	3.5%	1.3397
8%	8.7%	0.0%	1.2787
9%	8.7%	0.0%	1.2209
10%	8.7%	0.0%	1.1656

Table 4.7.4: The optimal asset allocation at each threshold for a portfolio unconstrained by Regulation 28 limits

Target of Inflation Plus:	Developed market equity	Emerging market equity	Global bond index	U.S. cash	SA equity	SA bonds	SA property	Total	Local	Offshore
	0%	8%	0%	20%	0%	4%	51%	17%		
1%	9%	0%	21%	0%	2%	39%	28%	100%	70%	30%
2%	8%	0%	23%	0%	3%	32%	34%	100%	70%	30%
3%	8%	0%	23%	0%	4%	24%	41%	100%	69%	31%
4%	11%	0%	21%	0%	2%	17%	49%	100%	68%	32%
5%	13%	0%	18%	0%	0%	0%	70%	100%	70%	30%
6%	11%	0%	11%	0%	0%	0%	78%	100%	78%	22%
7%	3%	0%	0%	0%	0%	0%	97%	100%	97%	3%
8%	0%	0%	0%	0%	0%	0%	100%	100%	100%	0%
9%	0%	0%	0%	0%	0%	0%	100%	100%	100%	0%

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The main purpose of this study is to determine the optimal asset allocation for South African retirement funds under the constraints of Regulation 28 of the pension fund act. Modern portfolio theory hypothesises that there are benefits from investing in a basket of complementary assets that will lower overall risk. This study also aimed to determine whether South African pension funds should allocate part of their offshore asset allocation to developed market equities, emerging market equities or a combination of both.

Two optimisation models were reviewed, mean variance optimisation and optimisation using the Omega ratio. Mean variance optimisation determines the optimal portfolio which is based on the highest Sharpe Ratio while optimisation using the Omega Ratio determines the optimal portfolio to be the one that maximises the Omega Ratio. Mean variance optimisation focuses on the first two moments of a distribution is based on the assumption that the returns are normally distributed. The Omega ratio is able to include higher moments of a distribution such as skewness and kurtosis and does not make any assumptions about the form of the distribution.

The mean variance optimisation model which is constrained by the Regulation limits found that the optimal asset allocation is as follows: 24% to developed market equities, 1% to offshore bonds, 31% to local equities, 42% to local bonds and 2% to local property. The optimisation model using the Omega Ratio which is constrained by the Regulation limits found that the optimal asset allocation is as follows: 6% developed market equity, 19% global bonds, 5% local equity, 55% local bonds and 15% local property.

The models found different optimal asset allocations as they are trying to achieve different objectives. Mean variance optimisation finds that the optimal portfolio is the one that maximises the risk adjusted return while the optimisation models which uses the Omega Ratio tried to determine the optimal asset allocation that will maximise the outperformance relative to a threshold, in this case inflation plus a target. The Omega Ratio generally declines as more ambitious thresholds are set because the risk of underperforming the threshold increases.

While the two models found different optimal asset allocations, there are some common findings. Neither model allocated assets to emerging market equities, therefore providing evidence that emerging markets offer little diversification benefit for South African investors. Both models favour developed market equities over emerging market equities. Both models allocate the full 25% allowed weighting to offshore assets, therefore providing evidence that it is optimal for South

African retirements to invest in offshore assets. In order to gain the maximum benefit, investors should invest the maximum into offshore assets as allowed by the Regulation 28 constraints.

This study also found that Regulation 28 leads to sub optimal portfolios as a slightly higher efficient frontier is achievable if the constraints are relaxed. While Regulation 28 is meant to protect investors, the constraints lead to sub optimal portfolios as investors are able to achieve a higher expected return with the same level of risk if the constraints are relaxed.

There is scope for further studies to be done on optimal asset allocation for South African retirement funds. There is a vast amount of literature on developed countries, such as the US, investing into international assets and emerging markets. Being an emerging economy, South Africa is affected by different factors to developed markets and therefore, the results for developed markets are often not applicable to South Africa.

Further analysis could include more assets classes in the optimisation model such as alternative investments and private equity. This study limited the scope to seven asset classes. Further studies could also analyse the inclusion of frontier markets as well as emerging market equities. An analysis of individual emerging markets could also be done, rather than investing in an emerging market index. A lifecycle asset allocation analysis could be done that models a retirement investor in various life stages to retirement rather assuming a static asset allocation for the period. Currency hedging and short selling were not addressed in this study and therefore, further analysis on asset allocation could factor in these two elements.

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ANNEXURES:

Figure: Regression Analysis: Excess SA Property returns over SA Bonds and Cash

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.589772035
R Square	0.347831053
Adjusted R Square	0.342008116
Standard Error	0.038065833
Observations	227

ANOVA					
	df	SS	MS	F	Significance F
Regression	2	0.173111906	0.086555953	59.73464	1.6156E-21
Residual	224	0.324577718	0.001449008		
Total	226	0.497689625			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.004835268	0.0025447	1.90013288	0.0587	-0.000179345	0.009849881	-0.000179345	0.009849881
Excess equity return	0.123765615	0.046900151	2.638917219	0.008901	0.031343667	0.216187564	0.031343667	0.216187564
Excess bond return	1.031210454	0.11302459	9.123770805	4.31E-17	0.808482964	1.253937944	0.808482964	1.253937944

Figure: Sharpe Ratios – Regulation 28 Compliant Portfolio

Sharpe Ratios

Expected Return	Sharpe Ratio	MSCI World Index	MSCI Emerging Market Index	Global Bond Index	U.S. Cash	SA Equity	SA Bonds	SA Property	Total
8.0%	0.2684	2%	0%	13%	10%	6%	68%	2%	100%
8.5%	0.3403	5%	0%	20%	0%	7%	67%	1%	100%
9.0%	0.3957	9%	0%	16%	0%	12%	62%	1%	100%
9.5%	0.4308	12%	0%	13%	0%	17%	57%	2%	100%
10.0%	0.4502	16%	0%	9%	0%	21%	52%	2%	100%
10.5%	0.4595	20%	0%	5%	0%	26%	47%	2%	100%
11.0%	0.4627	24%	0%	1%	0%	31%	42%	2%	100%
11.5%	0.4623	25%	0%	0%	0%	37%	35%	2%	100%
12.0%	0.4594	25%	0%	0%	0%	45%	27%	3%	100%

Figure: Sharpe Ratios – Unconstrained Portfolio

Expected Return	Sharpe Ratio	MSCI World Index	MSCI Emerging Market Index	Global Bond Index	U.S. Cash	SA Equity	SA Bonds	SA Property	Total
5.0%	-0.0883	0%	0%	0%	100%	0%	0%	0%	100%
5.5%	-0.0578	0%	0%	17%	83%	0%	0%	0%	100%
6.0%	-0.0261	0%	0%	33%	67%	0%	0%	0%	100%
6.5%	0.0150	0%	0%	0%	44%	0%	56%	0%	100%
7.0%	0.1039	0%	0%	0%	29%	1%	67%	3%	100%
7.5%	0.1906	4%	0%	5%	21%	2%	65%	3%	100%
8.0%	0.2730	7%	0%	14%	10%	2%	64%	3%	100%
8.5%	0.3480	10%	0%	23%	0%	3%	62%	3%	100%
9.0%	0.4074	15%	0%	19%	0%	6%	56%	3%	100%
9.5%	0.4454	20%	0%	16%	0%	10%	51%	3%	100%
10.0%	0.4667	25%	0%	13%	0%	14%	45%	4%	100%
10.5%	0.4767	30%	0%	10%	0%	18%	39%	4%	100%
11.0%	0.4801	34%	0%	6%	0%	21%	33%	5%	100%
11.5%	0.4797	39%	0%	3%	0%	25%	27%	5%	100%
12.0%	0.4773	44%	0%	0%	0%	29%	21%	6%	100%

Figure: Covariance Matrix – Asset Classes in Rands

	MSCI World Index	Emerging market equity	Global bond index	U.S. cash	SA equity	SA bonds	SA property
MSCI World Index	0.002334	0.002497	0.001077	0.001173	0.001308496	-0.00017	-0.00015
MSCI Emerging Market Index	0.002497	0.003969	0.000659	0.000664	0.002245334	0.000106	0.000228
Global bond index	0.001077	0.000659	0.001864	0.00183	-0.000324628	-0.00035	-0.00061
U.S. cash	0.001173	0.000664	0.00183	0.002086	-0.000390568	-0.00044	-0.00074
SA equity	0.001308	0.002245	-0.00032	-0.00039	0.003217146	0.000425	0.00082
SA bonds	-0.00017	0.000106	-0.00035	-0.00044	0.000424543	0.000569	0.000618
SA property	-0.00015	0.000228	-0.00061	-0.00074	0.000819783	0.000618	0.002157

Damodaran’s Equity Risk Premiums

Year	Earnings Yield	Dividend Yield	S&P 500	Earnings	Dividends	Change in Earnings	Change in Dividend	Bill Rate	Bond Rate	Bond-Bill	Smoothed Growth	Implied Premium (DDM)	Analyst Growth Estimate	Implied Premium (FCFE)	ERP/Risk-free Rate
1960	5.34%	3.41%	58.11	3.10	1.98			0.0266	2.76%	0.10%	2.45%				
1961	4.71%	2.85%	71.55	3.37	2.04	8.60%	2.91%	2.13%	2.35%	0.22%	2.41%	2.92%		2.92%	1.24
1962	5.81%	3.40%	63.1	3.67	2.15	8.79%	5.21%	2.73%	3.85%	1.12%	4.05%	3.56%		3.56%	0.92
1963	5.51%	3.13%	75.02	4.13	2.35	12.75%	9.45%	3.12%	4.14%	1.02%	4.96%	3.38%		3.38%	0.82
1964	5.62%	3.05%	84.75	4.76	2.58	15.23%	10.08%	3.54%	4.21%	0.67%	5.13%	3.31%		3.31%	0.79
1965	5.73%	3.06%	92.43	5.30	2.83	11.20%	9.42%	3.93%	4.65%	0.72%	5.46%	3.32%		3.32%	0.71
1966	6.74%	3.59%	80.33	5.41	2.88	2.23%	1.96%	4.76%	4.64%	-0.12%	4.19%	3.68%		3.68%	0.79
1967	5.66%	3.09%	96.47	5.46	2.98	0.85%	3.37%	4.21%	5.70%	1.49%	5.25%	3.20%		3.20%	0.56
1968	5.51%	2.93%	103.86	5.72	3.04	4.81%	2.09%	5.21%	6.16%	0.95%	5.32%	3.00%		3.00%	0.49
1969	6.63%	3.52%	92.06	6.10	3.24	6.66%	6.49%	6.58%	7.88%	1.30%	7.55%	3.74%		3.74%	0.47
1970	5.98%	3.46%	92.15	5.51	3.19	-9.72%	-1.61%	6.53%	6.50%	-0.03%	4.78%	3.41%		3.41%	0.52
1971	5.46%	3.10%	102.09	5.57	3.16	1.15%	-0.74%	4.39%	5.89%	1.50%	4.57%	3.09%		3.09%	0.52
1972	5.23%	2.70%	118.05	6.17	3.19	10.76%	0.71%	3.84%	6.41%	2.57%	5.21%	2.72%		2.72%	0.42
1973	8.16%	3.70%	97.55	7.96	3.61	28.93%	13.24%	6.93%	6.90%	-0.03%	8.30%	4.30%		4.30%	0.62
1974	13.64%	5.43%	68.56	9.35	3.72	17.48%	3.14%	8.00%	7.40%	-0.60%	6.42%	5.59%		5.59%	0.76
1975	8.55%	4.14%	90.19	7.71	3.73	-17.54%	0.30%	5.80%	7.76%	1.96%	5.99%	4.13%		4.13%	0.53
1976	9.07%	3.93%	107.46	9.75	4.22	26.39%	13.10%	5.08%	6.81%	1.73%	8.19%	4.55%		4.55%	0.67
1977	11.43%	5.11%	95.1	10.87	4.86	11.53%	15.07%	5.12%	7.78%	2.66%	9.52%	5.92%		5.92%	0.76
1978	12.11%	5.39%	96.11	11.64	5.18	7.07%	6.60%	7.18%	9.15%	1.97%	8.48%	5.72%		5.72%	0.63
1979	13.48%	5.53%	107.94	14.55	5.97	25.01%	15.23%	10.38%	10.33%	-0.05%	11.70%	6.45%		6.45%	0.62
1980	11.04%	4.74%	135.76	14.99	6.44	3.01%	7.81%	11.24%	12.43%	1.19%	11.01%	5.03%		5.03%	0.40
1981	12.39%	5.57%	122.55	15.18	6.83	1.31%	6.08%	14.71%	13.98%	-0.73%	11.42%	5.73%		5.73%	0.41
1982	9.83%	4.93%	140.64	13.82	6.93	-8.95%	1.58%	10.54%	10.47%	-0.07%	7.96%	4.90%		4.90%	0.47
1983	8.06%	4.32%	164.93	13.29	7.12	-3.84%	2.76%	8.80%	11.80%	3.00%	9.09%	4.31%		4.31%	0.37
1984	10.07%	4.68%	167.24	16.84	7.83	26.69%	9.85%	9.85%	11.51%	1.66%	11.02%	5.11%		5.11%	0.44
1985	7.42%	3.88%	211.28	15.68	8.20	-6.91%	4.74%	7.72%	8.99%	1.27%	7.89%	4.05%	6.75%	3.84%	0.43
1986	5.96%	3.38%	242.17	14.43	8.19	-7.93%	-0.15%	6.16%	7.22%	1.06%	5.54%	3.36%	6.96%	3.58%	0.50
1987	6.49%	3.71%	247.08	16.04	9.17	11.10%	11.99%	5.47%	8.86%	3.39%	9.66%	4.18%	8.58%	3.99%	0.45
1988	8.20%	3.68%	277.22	24.12	10.22	50.42%	11.49%	6.35%	9.14%	2.79%	9.76%	4.12%	7.67%	3.77%	0.41
1989	6.80%	3.32%	353.4	24.32	11.73	0.83%	14.80%	8.37%	7.93%	-0.44%	9.58%	3.85%	7.46%	3.51%	0.44
1990	6.58%	3.74%	330.22	22.65	12.35	-6.87%	5.26%	7.81%	8.07%	0.26%	7.39%	3.92%	7.19%	3.89%	0.48
1991	4.58%	3.11%	417.09	19.30	12.97	-14.79%	5.03%	7.00%	6.70%	-0.30%	6.34%	3.27%	7.81%	3.48%	0.52
1992	4.16%	2.90%	435.71	20.87	12.64	8.13%	-2.59%	5.30%	6.68%	1.38%	4.67%	2.83%	9.83%	3.55%	0.53
1993	4.25%	2.72%	466.45	26.90	12.69	28.89%	0.41%	3.50%	5.79%	2.29%	4.73%	2.74%	8.00%	3.17%	0.55
1994	5.89%	2.91%	459.27	31.75	13.36	18.03%	5.34%	5.00%	7.82%	2.82%	7.23%	3.06%	7.17%	3.55%	0.45
1995	5.74%	2.30%	615.93	37.70	14.17	18.74%	6.00%	3.50%	5.57%	2.07%	5.65%	2.44%	6.50%	3.29%	0.59
1996	4.83%	2.01%	740.74	40.63	14.89	7.77%	5.10%	5.00%	6.41%	1.41%	6.13%	2.11%	7.92%	3.20%	0.50
1997	4.08%	1.60%	970.43	44.09	15.52	8.52%	4.25%	5.35%	5.74%	0.39%	5.45%	1.67%	8.00%	2.73%	0.48
1998	3.11%	1.32%	1229.23	44.27	16.20	0.41%	4.37%	4.33%	4.65%	0.32%	4.60%	1.38%	7.20%	2.26%	0.49
1999	3.07%	1.14%	1469.25	51.68	16.71	16.74%	3.16%	5.37%	6.44%	1.07%	5.75%	1.20%	12.50%	2.05%	0.32
2000	3.94%	1.23%	1320.28	56.13	16.27	8.61%	-2.65%	5.73%	5.11%	-0.62%	3.71%	1.65%	12.00%	2.87%	0.56
2001	3.85%	1.37%	1148.09	38.85	15.74	-30.79%	-3.24%	1.80%	5.05%	3.25%	3.56%	1.73%	10.30%	3.62%	0.72
2002	5.23%	1.83%	879.82	46.04	16.08	18.51%	2.15%	1.20%	3.81%	2.61%	3.57%	2.29%	8.00%	4.10%	1.08
2003	4.87%	1.61%	1111.91	54.69	17.88	18.79%	11.19%	1.00%	4.25%	3.25%	5.35%	2.12%	11.00%	3.69%	0.87
2004	5.58%	1.60%	1211.92	67.68	19.407	23.75%	8.54%	2.18%	4.22%	2.04%	4.90%	2.02%	8.50%	3.65%	0.86
2005	5.47%	1.79%	1248.29	76.45	22.38	12.96%	15.32%	4.31%	4.39%	0.08%	6.16%	2.20%	8.00%	4.08%	0.93
2006	6.18%	1.77%	1418.3	87.72	25.05	14.74%	11.93%	4.88%	4.70%	-0.18%	5.93%	1.97%	12.50%	4.16%	0.89
2007	5.62%	1.89%	1468.36	82.54	27.73	-5.91%	10.70%	3.31%	4.02%	0.71%	5.03%	2.06%	5.00%	4.37%	1.09
2008	7.24%	3.11%	903.25	65.39	28.05	-20.78%	1.15%	1.59%	2.21%	0.62%	2.11%	4.05%	4.00%	6.43%	2.91
2009	5.35%	2.00%	1115.10	59.65	22.31	-8.78%	-20.46%	0.14%	3.84%	3.70%	0.28%	2.60%	7.20%	4.36%	1.14
2010	6.65%	1.84%	1257.64	83.66	23.12	40.25%	3.63%	0.13%	3.29%	3.16%	3.33%	2.24%	6.95%	5.20%	1.58
2011	7.72%	2.07%	1257.60	97.05	26.02	16.01%	12.54%	0.03%	1.88%	1.85%	2.75%	2.71%	7.18%	6.01%	3.20
2012	7.18%	2.13%	1426.19	102.47	30.44	5.58%	16.99%	0.05%	1.76%	1.71%	2.93%	2.47%	5.27%	5.78%	3.28
2013	5.81%	1.96%	1848.36	107.45	36.28	4.86%	19.19%	0.07%	3.04%	2.97%	5.01%	2.03%	4.28%	4.96%	1.63

REGULATION 28: THE NEW PRUDENTIAL LIMITS (Bruce Cameron, 2011).

The main asset class limits and sub-limits on retirement funds in terms of the second draft revision of regulation 28 are:

* **Cash:** 100 percent of retirement fund assets may be held in cash instruments but with sub-limits of 25 percent on deposits with any one local bank and five percent with foreign banks. The definition of cash instruments has been broadened to include Islamic liquidity management financial instruments.

* **Debt:** 100 percent of assets may be held in any South African government-issued or guaranteed debt instruments (bonds) and 75 percent for all other debt instruments. Instruments guaranteed by foreign governments are limited to 10 percent of a fund's assets for each issuer but with the 25-percent limit on all foreign investments coming into play. Other sub-limits that apply include a limit of five percent in any unlisted bond. Sub-limits on listed bonds depend on the size of the bond issuer. For example, there is a limit of 25 percent on bank-issued bonds where the market capitalisation (the number of shares issued multiplied by the share price) of the bank is R20 billion or more, which decreases to 10 percent for banks with a market capitalisation of less than R2 billion. There are tougher restrictions on other corporate bonds (a limit of 50 percent of a retirement fund's assets) and 10 percent in any one bond if it is listed on a securities exchange. Islamic instruments are again included.

* **Equities:** the limit on equities remains at 75 percent, but there is the introduction of limits on individual companies based on their market capitalisation. For example, a fund may invest up to 15 percent of its assets in a company with a market capitalisation of R20 billion or more, but only five percent if the market capitalisation of the company is less than R2 billion.

* **Immovable property:** a retirement fund may invest up to 25 percent in property, including listed real estate companies, with sub-limits on investments in individual entities depending on the size of the entity. For example, only 15 percent of a fund's assets may be invested in a property company or units in a property collective investment scheme if its market capitalisation is more than R10 billion, but only five percent if the market capitalisation is less than R3 billion. Property equity investments are not included in the 75-percent equity limit.

* **Commodities:** a retirement fund may invest up to 10 percent of its assets in commodities. The full 10 percent may be in gold, but there is a limit of five percent in other commodities.

* **Alternative investments:** the overall limit has been increased from 2.5 percent to 15 percent, but hedge funds and private equity funds are each limited to 10 percent, and there are further sub-limits on single entities. For example, five percent may be invested in individual funds of funds but only 2.5 percent in a single private equity or hedge fund.

* **Foreign investments:** there is an overall limit of 25 percent, with offshore investments also being included in the calculations for each asset class.

* **Investment in the business of a participating employer:** as a general rule, this is limited to five percent of the assets of an occupational retirement fund, but 10 percent is permitted with the agreement of the Registrar of Pension Funds.

The regulations prohibit double counting. So the total equity limit of 75 percent applies across asset classes. For example, if five percent of assets are invested in private equity, only 70 percent may be invested in listed equity.