The Devil is in the Detail

Technical matters to consider when deciding between a Defined Benefit and. Defined Contribution National Pension Scheme

Dutkiewicz, C; Gladwin, A; Birt, R; Clark, C; Bisho, S

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Abstract

This technical paper outlines a modeling exercise undertaken to assess various national pension benefit designs. The authors used a stochastic asset-liability model to help understand the trade-offs between different systems. This exercise highlighted a number of decisions that need to be made in specifying the final design. The success of whichever design is used in a country depends on the detail of its implementation. Thus, these decisions need to be taken consciously with a good understanding of their impact on the system in the long term.

Key words:

Defined Benefit, Defined Contribution, National Pension Plan, Retirement Reform, Social Security

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1 Introduction

1.1.1 The South African government embarked on a process of reforming the South African retirement and social security environment in 2007. This process has been a long time coming, most notably preceded by the Committee of Inquiry into a Comprehensive System of Social Security, the Taylor Commission, of 2002[1].

> **the devil's in the detail** the details of a matter are its most problematic aspect
>
> Oxford English Dictionary

1.1.2 In his foreword to a Department of Social Development research paper (2006), the Minister Dr ZST Skweyiya stated that these developments would "be informed by the five guiding principles adopted by the International Labour Organisation: These principles are:

- The extension of coverage to all members of the population;
- Protection against poverty in old age, during disability or on death of the wage earner for members of the population;
- Provision of an income, and replacement of lost earnings as a result of voluntary or involuntary retirement for all those who have contributed;
- Adjustment of this income to take account of inflation and, at least to some extent, of the general rise in living standards; (and)
- Creation of an environment for the development of additional voluntary provisions for retirement income."

Actuarial Society Position

1.1.3 The Actuarial Society recognises the need for reform and supports the intentions of the reform process[2]. The Society has contributed significantly to previous developments in the regulation of the retirement environment and has performed industry research on key topics. As a professional body, the Society strives to provide impartial advice based on technical research and analysis rather than only supporting one viewpoint. The professional actuarial

[1] Taylor Commission, 2002

[2] Actuarial Society of South Africa, Retirement and Social Security Reform Task Force, Position Statement, January 2009

training and conduct standards will inform the comment on the reform, ensuring that the Society provides a balanced perspective on multiple criteria.

1.1.4 By virtue of their experience and expertise, actuaries are ideally suited to advise on the short and long term financial impact of reform on all stakeholders (citizens, industry and government). Short term financial impacts are generally assessed by economists and public accountants. Longer term impact assessments require the actuarial skill of demographic and financial projections. The objective of the Society is thus to provide research and analysis through financial modeling.

Research Objective

1.1.5 The objective of this paper is to highlight design decision points and illustrate the financial consequences of design options using a stochastic projection model. It is contended that unless one looks closely at the detailed implementation of a benefit design, it is not possible to give an opinion of which design is best. The devil is in the detail.

1.1.6 The initial discussion on benefit design in Section 2 is not intended to be a review of current local or international market practice, but is used to justify the base assumptions of the model used. These assumptions have also been peer reviewed by a large number of practicing actuaries.

1.1.7 The modelling does not cover every available or international benefit design, but covers the key models that have been mentioned publically in 2008. The purpose of this research is to stimulate debate among stakeholders on the best parameters, assumptions and methods to use.

1.1.8 It is furthermore to be used as a basis for communication to a wider audience on the financial consequences of the design options.

1.1.9 Unless otherwise stated, values in this paper are stated in 'real' (2009 Rand) terms. This can be a significant source of difference when compared to other projections that do not remove the impact of inflation.

2 Practicalities of Benefit Design

In this section we delve into the practical implementation of several benefit designs. Sweeping statements about benefit complexity and understandability are premature without evaluating all the consequences of actual implementation. In order to model the complete system, a significant number of decisions are required on the parameters of the benefit design as well as on assumptions on future economic, financial, and demographic variables which will affect the outcomes.

2.1 The State Old Age Grant/Pension

2.1.1 A flat Rand pension is the simplest form of benefit. It is usually intended to alleviate poverty in retirement. In the UK the provision of this benefit started in 1909. On the 1st of January 1909, pensioners queued up (and gave gifts of gratitude to the dispensing clerk) for their 5s per week pension[3]. In South Africa a social pension was introduced by the Old Age Pensions Act of 1928.

2.1.2 From a terminology point of view we will refer to the current State Old Age *Grant* (SOAG) where the benefit is not guaranteed to continue or increase at any defined rate vs. a State Old Age *Pension* (SOAP) which would be guaranteed to all eligible pensioners with some defined increase mechanism.

2.1.3 The SOAG is currently at R1010 per month[4] and paid to 2.2m South Africans[5], having grown in numbers by 13% in the last 10 years.

2.1.4 The replacement ratio effect of the old age grant in 2007 of R870 is detailed in Table 1, based on the Living Standards Measure categorisation of the population[6]:

[3] Salter et al, 2009,

[4] Budget speech 2009

[5] Development Indicators, SA Government 2008

[6] SAARF Living Standards Measure (LSM), 2008. Author's calculations

Table 1: Replacement Ratio of State Grant by LSM band

LSM	Average per month income	Percent of Population	Replacement Ratio
1	1,058	5%	82%
2	1,261	11%	69%
3	1,613	12%	54%
4	2,022	14%	43%
5	2,903	14%	30%
6	4,723	16%	18%
7	7,579	9%	11%
8	10,015	6%	9%
9	13,507	7%	6%
10	20,278	6%	4%

2.1.5 Table 1 indicates that 42% of the population receive a replacement ratio of 40% or higher from just the SOAG, i.e. LSM1-4. Others, such as Burger (2008), suggest that as many as 55% of the population would have a replacement ratio of 40% from the SOAG alone.

2.1.6 Table 2 shows the current open market purchase prices of an annuity of R1010pm. This can be seen as a proxy for the present liability attached to such a pension 'promise'. Thus the state old age grant, assuming it increases with inflation is worth[7] up to R250 000.

Table 2: Purchase Price of an Annuity of R1010pm

Sex	Age	Inflation linked	Non-inflation linked
Male	65	R185 000	R107 000
Male	63	R197 000	R110 000
Male	60	R215 000	R116 000
Female	60	R250 000	R127 000

2.1.7 The impact of retirement age and sex is significant. The change of retirement

[7] Old Mutual quotations 25/3/09.

age for males from 65 to 60 increases the cost by 16%. Females' pensions are 16% more expensive than males'.

2.1.8 It can be argued that state old age pensioners would have worse average mortality than the insured population and therefore the cost of these pensions to the state would be lower. If we assume that the mortality of this population is double that used in pricing these annuities, then the above figures are 26% lower for females and 36% lower for males[8].

2.1.9 Allowing for the worse mortality and the current proportion of claimants (+-60% of the total population over the age of 60), the present value of benefits would be R254bn. If this was a funded defined benefit plan, then this figure would be the liability value of the plan[9]. This figure doubles to R506bn (in 2009 real terms) by 2050[10]. This 'liability' value is to be compared to the 2005 annual cash flow of payments to means tested beneficiaries.[11]

2.1.10 Removing the means test has been modelled by Samson (2007) by increasing the take-up rate to 90% of the eligible population. This increase would increase the present value of benefits to R556bn in 2009 and to R1.1tr in 2050 (in 2009 Rand terms) given the increased number and the assumed improved longevity of beneficiaries.

2.1.11 A further consideration is expenses. Each 0.1% decrease in the annual expenses incurred in providing the annuity would decrease the present value of the annuity provision by 1%[12]. Rusconi (2006) suggests that the South African annuity open market is reasonably priced for its specific 'insured' target market, stating that 'I am not particularly concerned about charges in the non-profit annuity sector'. Goemans (2008) suggests a reduction in yield for expenses of 0.6% in annuity pricing, thus the maximum reduction in annuity price due to cost reduction would be 6%. It would seem therefore that, while always important, the benefits of significant reductions in expenses do not

[8] Author's calculations, using ASSA Annuitant mortality loaded by 100%, real net of expenses return of 1.23%

[9] Using assumptions in Department of Social Development discussion document (2007)

[10] Author's calculations using ASSA2003 Aids model with standard calibration

[11] Department of Social Development discussion document (2007)

[12] Author's calculations. ASSA Annuitant mortality, Base 1.23% net yield

have as big an impact as getting the average mortality correct.

2.1.12 In the United Kingdom, it is believed[13] that pensioners should benefit from 'current productivity and economic growth'. Indeed the International Labour Organisation's five principles include this concept[14]. 'Current productivity' would imply that pension increases should be in line with salary inflation rather than consumer price inflation (CPI). Salary inflation is often assumed to be 1.5% to 2% greater than inflation. Benefitting from economic growth would imply increases 3-4% greater than inflation[15]. Increasing the SOAG in payment by 2% above inflation would increase the present value of this payment by 20%. Increases of 4% above inflation increase the present value by 52%.

2.1.13 Regularly increasing benefit entitlement ensures that new claimants receive the desired replacement ratio with reference to their pre-retirement income. To achieve this, increases need to be in line with salary inflation. Those experiencing salary inflation lower than average would benefit in replacement ratio terms since the benefit is increasing faster than their salary. Similarly, those with higher than average salary increases would experience reduced replacement ratios.

2.1.14 Increases in benefits-in-payment ensure that claimants' real pensions do not decrease. To achieve this, increases need to be in line with consumer price inflation. This may well need to be in line with pensioner price inflation, which is often higher than consumer inflation as measured by consumer price inflation. Increases higher than price inflation would see the claimants' real standards of living increase year by year. This has a strong social improvement and poverty alleviation consequence.

2.1.15 An important lesson from other markets and private pension funds is the risk associated with guaranteeing certain increases. The SOAG increasing at somewhere above consumer inflation towards salary inflation or economic

[13] Slater et al 2009

[14] As quoted by Skweyiya (2006)

[15] Development Indicators, pg. 6, 2004-2007 and government target of 3%. Note that current per capita real GDP growth is likely to be close to zero under current economic conditions. The implication of deflation on pension increases is not considered in this paper.

growth rate is beneficial to the beneficiaries, but onerous and expensive to the fiscus.

2.1.16 There is an important debate on equity: equity in benefit or equity in cost. The state pension age is being equalised at 60 for men and women, thus removing this 'discrimination'. The state grant is thus equitable in terms of benefit between men and women, but this necessarily means that women are effectively paid more than males since they, on average, live longer than men. As per the above figures, this has been modelled as a 16% greater cost of benefit per female compared to male.

2.1.17 There are further considerations that have not been addressed here. Barr and Diamond (2008), highlight that '(a)nalysis needs to reflect diversity in social values, individual preferences, and economic situations within a country'.

2.1.18 In summary there are several decisions:

1. Whether or not to clearly define or guarantee the method of benefit increases.
2. What annual increase to give – none, consumer inflation, salary inflation or GDP growth.
3. Whether to have equity in benefit amount or benefit cost, i.e. in the amount that the claimant receives per month, or in the total cost to the fiscus.
4. The appropriate level of means test for this benefit: none, median, mean average earnings or some other figure
5. The absolute level of the monthly pension (and hence the targeted replacement ratio for different income groups).

2.2 Implementation of Defined Benefit

2.2.1 The generic defined benefit fund design requires the development of the following formula to be applied to calculate each member's benefits:

Benefit = Accrual x Service x Salary

2.2.2 For example, a typical South African private fund might have the following:

- Accrual as 2%
- Service as years of membership of the fund
- Salary as the average of the last 3 year's salary before retirement
- Thus someone earning R120 000pa working for this company for 30 years might get a pension of: 2% x 30 years x 120 000 = R72 000 per annum

2.2.3 A survey by Bosenberg of these factors in 1985[16], almost 25 years ago, in the heyday of employer run defined benefit funds, showed the following common benefit design options:

- Accrual of 2%
- 2 year averaging of final salary
- Normal Retirement Age of 65
- An objective to increase pensions at 60% of inflation
- Withdrawal benefits of contributions accumulated with 6% interest per annum.

It is now well known that the withdrawal benefits were the most inequitable part of this design whereby the withdrawing member was paid a benefit lower than the actuarial reserve held for his or her retirement benefits.

2.2.4 The biennial Sanlam survey of retirement funds stopped looking at Defined Benefit funds in 2004, stating that "Defined Benefit funds have become increasing unattractive and the introduction of surplus legislation is considered by many to be the final nail in the coffin."[17] Thus the 2002 survey is

[16] Bosenberg, Actuarial Society Convention 1985 as quoted by Asher (1987)

[17] 2004 Sanlam Survey on Retirement Benefits, introduction by Kobus Hanekom

the last source of data.

2.2.5 In order to fully specify a defined benefit system, one needs to define the elements as shown in Table 3.

Table 3: Key Parameters of Defined Benefit benefit calculation

Parameter	Options
Accrual	This is the amount of benefit accrued for each year of service. This is typically in the order of 1-2%.
Service	This is the term of employment, of contribution, or life or whatever other definition is desired.
Salary	This is the definition of salary to be used in the formula.
Escalation of pension	Inflation will cause the purchasing power of any pension to decrease over time. In order to maintain the standard of living of an individual living on the pension, pension plans will generally escalate that pension at some rate.
Benefit on death	This refers to what happens to the accumulated funds in respective of a member should that member die before retirement. Options are to pay out between zero and the full actuarial reserve held for this member. Benefits higher than actuarial reserve would be subsidised from retirement benefits, and this is left to discussions on risk benefits.
Normal Retirement Age	The age at which most people are expected retire and therefore the age at which benefits are targeted.

Accrual

2.2.6 In a typical South African private defined benefit fund this would be 2%. In the work done for the government Interdepartmental Task Team in 2007 by Rusconi (200&), this was set at 0.75% based on a contribution rate of 6%.

2.2.7 The 2002 Sanlam Survey analysed the most common accrual rates as shown in Table 4.

Table 4: 2002 Sanlam Survey Accrual Rates

Accrual Rate	% of funds
1.82% (1/55) or less	11%
2.00% (1/50)	68%
2.22% (1/45)	11%
2.50% (1/40)	11%
More than 2.50%	0%

2.2.8 The Government Employees Pension Fund (GEPF) has an effective accrual rate that ranges from 2.2-2.54% depending on sex, service, and salary. Higher accrual rates result for females, shorter service members and lower income members.

2.2.9 A fixed accrual rate leaves little room for manoeuvring on affordability later. A flexible accrual rate can effectively be used as a safety valve for solvency purposes and also to ensure other types of equity between members.

2.2.10 As a general rule, the accrual rate for a low salary-increase career should be higher than the accrual rate for a higher salary-increase over a career. This can be understood by realising that the higher salary increase individual pays relatively low contributions early on in their career.

2.2.11 There is evidence in South Africa of large scale experience of lower lifetime salary increases for lower paid/blue collar workers, then that of white collar workers where merit increases can be dramatically higher. The result of this in a national system would be that the scheme accrual rate will be lower than it should be for low increase members. This implies a cross-subsidy from lower income/lower escalation members to high income/high escalation members.

Service

2.2.12 For a private pension fund, this is often the years of employment, although it might be slightly less where entrance to the pension fund is delayed after commencement of employment and service is length of membership of the pension fund.

2.2.13 In a national system this is a design choice. In terms of equity (a benefit accrues when a contribution is paid) this could be the time during which the member contributed to the fund. This would more closely align the funding with the benefit.

2.2.14 However, considerations here are that temporary unemployment, or employment in sectors not covered by a national fund, reduces the benefit and the net replacement ratio. Should the member be credited for these non-contributory years, then there will be a cross-subsidy from contributing members to non-contributing members.

2.2.15 The need for uniformity between government employees and private sector employees is also important to ensure those employees who change from one to the other are treated in a straightforward and fair manner.

Salary

2.2.16 The definition of Salary refers to two elements: firstly the monetary value of salary used; and secondly the period of time over which salary is averaged to get to the definition of Salary.

2.2.17 A typical private defined benefit fund would define Salary as the *final* salary calculated as the average salary over the last three years of service. A longer period reduces the final pension and net replacement ratio; however it deals better with fluctuations in salary. The GEPF uses the average of the last 24 months salaries.

2.2.18 The 2002 Sanlam Survey analysed the final salary averaging periods as shown in Table 5.

Table 5: 2002 Sanlam Survey Final Salary Averaging Periods

Definition of average salary	% of funds
Last Month	7%
Last Year	11%
Last two year	25%
Last three years	36%
Last four years	7%
Last five years	0%

2.2.19 In a national system where the provider of the pensions is separate from the employer, there is the moral hazard that employers can vastly increase employees' salaries close to retirement and, for a small salary cost, effectively vastly increase the lifetime value of the benefits received. A way to avoid this is to use a career average salary definition.

2.2.20 However, the problem with a career average salary is that, due to relatively high levels of inflation and salary inflation, the career average salary will be significantly reduced due to earlier year's salaries. For instance, assuming general inflation of 6% and salary inflation of 7.5%, a member's starting salary of R12 000pa at age 20 would be expected to rise to R310 000pa at retirement at 65. This is R23 000pa in real terms (i.e. In Rand value comparable to the starting salary). The career average salary would be R93 000pa.

2.2.21 We thus introduce the concept of a revalued career average salary where each year's salary is revalued at retirement to give a 'fairer' real value of career average salary. In the above example this would give a salary of R310 000pa. In reality this would be expected to be different from the final salary as actual salary increases would not necessarily have matched the revaluation rate.

2.2.22 In Rusconi (2007) Salary is defined as a revalued career average salary. He assumes an average of CPIX and salary escalations for the revaluation rate.

2.2.23 In the UK national system Salary was defined as the best 20 years earnings under the SERPS scheme. According to Salter et al (2008), '(i)t therefore benefited women, carers and other groups who might have a restricted career of paid employment.'

2.2.24 A typical private pension fund may define Salary as the cash component of a package, or maybe the total cost to company before pension fund contributions. This leaves open the question of what do we do about bonuses, 13th cheques, commission related pay, hourly pay, overtime, deferred compensation, non-cash benefits etc.

2.2.25 In private pension funds in South Africa, attempts have often been made to define Salary in as broad a measure as possible to maximise the tax benefit of pension fund contributions. The 2002 Sanlam Survey provided the following information on included elements of remuneration: 36% of funds included annual bonus, 28% included car allowance, 5% included commission and 3% included other bonuses. Funds were split almost equally between remuneration being defined as cost to company versus other definitions.

2.2.26 Where the national system is seen as penal, employers and employees will have an incentive to redesign salary to reduce the effective rate of

contribution. Measures similar to those experienced in the tax environment would be required to define what 'pensionable salary' is for the purposes of the national compulsory contribution.

2.2.27 In a national system there is also a gap between the decision on salary increases and the cost of benefits that this causes. So an employer can hike an individual's salary close to retirement and effectively enhance their benefits, the cost of which is borne by the national fund, not by that employer.

2.2.28 The definition of salary is difficult for unemployed people reaching retirement age. At present labour force participation and unemployment rates, more than 50%[18] of retirees would not be employed.

Pension Escalations

2.2.29 The pension escalation rate is a major determinant of the cost of benefits provided and the ability of the pension to retain its real purchasing power.

2.2.30 The 2002 Sanlam Survey showed that 35% of funds targeted a 75% of CPI escalation, while 47% targeted 100% of CPI escalation. 41% of funds also had specific additional exercises to 'catch-up' pensions in line with inflation since retirement.

2.2.31 The GEPF has an objective, subject to affordability by the plan, of 75% of inflation[19] with a minimum pension in payment of 75% of the original pension increased with full inflation[20].

Benefit on Death

2.2.32 In a private pension fund, the actuarial reserve held for the member is often returned on death. This may or may not be in addition to a death benefit, or the death benefit may be a multiple of salary less the actuarial reserve, i.e. the total benefit is the multiple of salary.

2.2.33 The national scheme may or may not have separate death benefits. From the

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[18] Statistics South Africa, Labour Force Survey Historical Revision March Series 2001-2007

[19] We will ignore at this point the issue of which inflation rate is appropriate to use – CPI, CPIX as published by Stats SA, or some 'pensioner' inflation that more accurately shows the actual increase in goods and services that are consumed by pensioners, e.g. a higher proportion of medical inflation which is often higher than general inflation.

[20] This minimum kicks in after 20 years at an inflation rate of 6% and in 13 years at 10% inflation.

point of view of the Defined Benefit fund build-up, we need to consider whether the actuarial reserve (the accumulated funds in respect of a particular member's benefit) is paid as a death benefit. To do so ensures equity in terms of contributions – the member has contributed towards their retirement, but will not retire and therefore their savings are restored to their beneficiaries.

2.2.34 Not paying a benefit on death would be a cross-subsidy from the early deaths to the retirees. It dramatically increases the possible accrual rate or alternatively decreases the contribution rate. It is estimated that there is on average a 40% chance of a new workforce entrant surviving to retirement and that the average service at retirement (i.e. allowing for unemployment) is about 25 years.[21] Not returning the accumulated reserve on death increases the affordable accrual by 60%. This is therefore a significant design element.

2.2.35 Again due to the lower mortality of higher paid workers, the cross-subsidy of not returning funds on death is from lower paid to higher paid workers.

2.2.36 The various government papers on the topic, including Rusconi (2007), ignore this design assumption, in fact implicitly assuming that the actuarial reserve is paid out on death.

2.2.37 This paper does not consider further whether this return on death should be in the form of a lump sum or an annuity to surviving dependents.

Contribution Rate

2.2.38 In this paper we consider a 10% contribution rate. Rusconi (2007) assumes a 6% contribution rate.

2.2.39 The definition of *member* versus *employer* contributions is important. From a financial modelling point of view it does not matter, but from a tax efficiency and presentation of salary/contributions/cost to company point of view it does matter. Current pension fund contribution designs are designed to maximise the tax efficiency of contributions. For example contributions to provident funds are usually paid by the employer as employee contributions to provident funds are not tax deductible.

[21] Dutkiewicz, C "Balance of benefits between unemployment, death and retirement", Unpublished research 2009

Normal Retirement Age

2.2.40 The 2002 Sanlam survey shows the following spread of Normal Retirement Ages: 44-49% were age 65, 16% age 63 and 35-33% age 60 (the range being female to male). The GEPF has a default age of 60[22].

2.2.41 The later the Normal Retirement Age, the higher the accrual rate can be. Affordable benefits will be higher overall because pensionable service is longer, the accrual rate is higher and contributions are paid for longer.

2.2.42 It can however be questioned as to what extent people actually do retire at the Normal Retirement Age.

2.2.43 It is worth noting that, due to the lower mortality of females, the equivalent benefit at a given age costs 16% more for females than for males. Any scheme with unisex contribution rates and retirement ages effectively cross-subsidies in favour of females. This principle holds for any variations on mortality, e.g. lower income groups with higher mortality will cross-subsidise higher income groups with lower mortality.

2.2.44 At present the state old age grant pension age is being standardised to 60. This is in comparison to other countries such as the UK which, due to improving mortality, are slowly increasing pension age.

2.2.45 In the context of a private fund, early retirement is allowed with a reduction in benefit. This is since the funds accumulated for that individual are lower than for someone retiring at Normal Retirement Age, and the effective cost of pension is higher. The 2002 Sanlam Survey shows this reduction to typically be 0.25% per month.

2.2.46 The issue of enhancing pensions for ill-health has been the subject of a Pension Fund Adjudicator ruling. The 2002 Sanlam Survey shows that funds are equally split between no reduction, actuarial basis for reduction and a fixed or fluctuating reduction (which is most typically 0.5% per month).

2.2.47 In private funds the issue of late retiring is also addressed whereby late retirees have their pension enhanced to recognise the increased duration of contribution and the reduced cost of the annuity due to the anticipated shorter period of retirement. According to the 2002 Sanlam Survey, this is typically of the order of 1% per month.

[22] GEPF member booklet

2.2.48 It is assumed that a national scheme would have a defined retirement age and thus the above three issues are not considered further.

Cash Option

2.2.49 Current and historical South African defined benefit pension fund design has allowed for a portion to be taken in cash. This cash portion is most typically 1/3rd of the value of the pension[23]. In the GEPF this is specified as a 'gratuity' and an annuity portion.

2.2.50 There are two decisions here: firstly what proportion to allow to be taken as cash ("commuted") and secondly at what rate of commutation. Many funds have their own tables of commutation rates, but these are typically rates approximating the present value of future monthly pension benefits given up. These are set to either be equitable to the member, or to protect the fund. Factors in the range of 14-18 for each R1pa of pension would currently approximate open market purchased annuity rates.[24]

2.2.51 Note however that the equity of these rates would change over time in line with annuity rates which further depend on interest rates, inflation and the expectations of future inflation and interest rates, i.e. fixed commutation rates are not neutral in terms of cost or equity.

2.2.52 The pros and cons of these cash options are not considered further here. However one of the portfolios modelled allows for investment strategies that differentiate between a one third cash portion and a two thirds annuity purchase option.

Cross-Subsidies

2.2.53 A key social consideration of a system is the issue of cross-subsidies. Taylor (2002) suggests Defined Benefit plans are bad because of 'opaque' cross subsidies from 'poor and unlucky [to] the rich and lucky'.

2.2.54 Private pension fund arrangements include many cross-subsidies. Asher (1987) [25]points out that late-joining members, receiving the same accrual as other members, are unfairly advantaged.

2.2.55 Thompson (1989) argued for enhancements to low pensions though better

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[23] Provident Funds provide a 100% cash default option

[24] Old Mutual quoted annuity rates 28/3/09

[25] Asher, TASSA 1987 pg 87

than average pensioner increases to those with the lowest pensions. His work started at a minimum annual pension of R2400 (R12 000 in 2009 terms).

Data Requirements

2.2.56 Some of the key data required to be stored are listed in Table 6.

Table 6: Defined Benefit Data Requirements

Data Item	Data required to be stored
Static Data	Name, ID, date of birth, address, bank account
Revalued Career Average Salary	Every month's salary and its date from start of working career until retirement, i.e. 40 years of monthly salary data.
Service	Each start and end date of employment with specific employers.

Affordability of Benefits

2.2.57 Consider that in any pension plan there are 4 elements:

- Contributions: Whether employee or employer, they are the actual contributions made to the plan each month
- Investment returns earned on invested contributions. These can be positive and negative, but typically are assumed to be positive based on long term investment market experiences
- Benefits paid from the fund to retirees
- Expenses of running the fund.

2.2.58 Since benefits and expenses have to be paid out of the fund, and all that comes into the fund is contributions and investment returns, we conclude that[26]:

[26] Boyken, 2008, pg 7

Contributions + Investment Returns

=

Benefits + Expenses

2.2.59 Any action then influences one of these items and MUST ultimately have a corresponding change in another item. For instance an increase in benefits requires an increase in contributions. An administrative setup that is more expensive will require higher contributions. Better than expected investment returns can result in higher benefits. Similarly, a reduction in investment returns (either temporary because of market downturn, or longer term due to prescribed asset holdings) will translate into lower benefits and/or increased contributions.

2.2.60 Taylor (2001), states that the following principles of investment are important[27]:

- Sustainability: legal rights of investor not likely to be compromised
- Matching: investments must be capable of paying benefits when due
- Efficiency: expected risk vs. return of the investment
- Transparency: implicit subsidies or indirect taxes should be transparent
- Diversification: investment principle of diversification to improve risk/return

2.2.61 Taylor continues[28] to list the following four objectives:

- "The ratio [of benefits to contributions] should be actuarially fair in that it would consider the relative costs of people's benefits, and depend on actual investment returns.
- The ratio should be as predictable as possible – when considered in real terms.
- It would also seem desirable for pensioners to participate in any overall change in the standard of living in the country
- The ratio should be as objectively determined as possible, and certainly not subject to the discretion of interested parties."

[27] Taylor, pg 241

[28] Taylor, pg. 256

2.3 Complications

2.3.1 Within the workings of the Defined Benefit fund there are a number of detailed definitions required to ensure equity between members. Subtleties around these definitions can have a major impact on the long term solvency of the plan as well as to the relative fairness between members.

Funded vs. Unfunded

2.3.2 A full debate on the relative merits of funded vs. unfunded plans is beyond the scope of this paper. Political, economic and social consequences of these decisions need to be borne in mind.

2.3.3 Many national retirement systems have been unfunded. Current pension payments are paid directly out of the fiscus. In effect this means that the current working population are directly paying the current retirees.

2.3.4 Where the demographic mix changes significantly over time, there may be periods where the burden on the current working population is large (i.e. when there are relatively more retirees). This is unsustainable in the longer term resulting ultimately in a reduction of benefits (which is inequitable to later retirees) or an increase in taxes with its consequent political and economic consequences. For example, during 2005 significant public debate in California centred on the rapidly increasing contribution rates for the state pension plans (Boyken 2008).

2.3.5 On the other hand, funded systems require the administrative capability to collect contributions and invest them, efficiently and effectively.

2.3.6 Political risk is associated with this as government has the control to redirect these funds to government or national aims. The contributions made are designed to grow with investment growth to provide a pension for the contributors. Any redirection of these funds away from an optimum long term growth investment strategy is to the detriment of the pension system, i.e. will lead to deficits or poorer benefits, but to the benefit of the country in other areas.

2.3.7 The issue of surpluses and deficits has been, and will continue to be, a major source of friction between stakeholders. Where a national fund is found to be in deficit, this can be seen as a national debt and dealt with as such by sovereign rating agencies. Surpluses on the other hand are very attractive for

all stakeholders to grab for their own. The design of the system needs to clearly articulate the levels of deficit or surplus to be tolerated and the corrective mechanisms to deal with them.

Early and Late Retirement

2.3.8 Since the accrual rate is set such that over an extended period of time, retirees will largely cost the plan what has been funded for that retiree, early and late retirees pose a problem in terms of equity.

2.3.9 Early Retirement: Early retirees are likely to draw benefit for longer while having made fewer contributions. Thus they should have a lower benefit unless cross-subsidised by other members.

2.3.10 Late Retirement: Similarly, late retirees are likely to draw benefits for shorter while having made more contributions. They should therefore have an increased pension unless their funds are used to cross-subsidise other members.

2.3.11 Ill-health retirement: another aspect specifically detailed in private pension plans is the notion of ill-health early retirement. Whether this would be allowed in a national system is unclear. This discussion would also need to extend to disability benefits. This is beyond the scope of this paper.

Member versus employer contributions

2.3.12 From a financial point of view, the source of the contributions makes no difference. A contribution of 15% from employer, 7.5% from both employer and employee or 15% from the employee is a 15% contribution and comes from the expenditure of the employer – either directly as a 15% payment, or as a deduction from the employee's salary.

2.3.13 Complications arise with the tax treatment of contributions and therefore the preference for making them employer or employee. The regulator will set the tax treatment to favour one or other method and to limit the possibility of abuse of the system. For instance in South African provident funds, employee contributions are not tax deductible. Common practice is therefore for the employer to pay the full contribution and get a tax deduction.

2.3.14 Contention can result as the understanding of rights to the funds and decisions on these funds depends on who is deemed to 'own' the contributions. An employer who has paid additional contributions to a defined benefit fund may think they have rights to the surplus in such a fund

since it was the employer's contributions. An employee contributing to a fund may expect to have a say over their investment because they were his or her contributions, not the employers.

Other

2.3.15 Break-in-service: The definition of service above is an important consideration. Again since the accrual rate is set to broadly fund a full pension at normal retirement, any gaps in contributions mean that the member has contributed less than 'normal' members. Thus their pension should be reduced by defining service as contributory service.

2.3.16 Fluctuating Salary: Defined Benefit plans work in terms of equity and financial solvency with reasonably stable earnings. Wildly fluctuating earnings are problematic because it is difficult to predict the future value of contributions (and hence set appropriate accrual rates). Unintentional cross-subsidies arise where the value of contributions differs significantly from that of the final salary pension received for some members.

2.3.17 Impact on employment of older workers: Without adjustments for late and early retirement, it is in an individual's interest to retire at Normal Retirement Age – this impacts on employment patterns. Barr and Diamond (2008) suggest that early retirements do not do much for unemployment of younger workers.

2.3.18 Impact of delayed work: Potential workers who delay entering the workforce due to continued education would potentially be penalised by the system.

2.4 Implementation of Defined Contribution

2.4.1 A defined contribution scheme operates more like a bank account, or collective investment scheme. The member's contributions are invested collectively and the actual investment return is allocated to that member's benefit. The total fund value (fund credit) is then applied to purchase an annuity at retirement.

2.4.2 Decisions are required on a number of items listed in Table 7.

Table 7: Key Defined Contribution Benefit Parameters

Option	Decisions
Investment Options	How many and what type of options to allow.
Allocation of Returns	How much of the actual asset value growth to allocate to an individual.
Annuitisation Options	At what rates and how to convert the resulting lump sum into a pension.

Investment Options

2.4.3 A key detail of the Defined Contribution design is the investment option selected. This may be selected in one of a number of ways:

- Everyone has the same investment option.
- Investment options change over the life of the individual according to their age (life staging).
- Individuals have the ability to select an investment portfolio(s) from a small or long list of options.

2.4.4 This last option is prevalent in current individual retirement annuities and in many countries' national systems around the world.

2.4.5 A long list of investment options has been criticised[29] with research showing that a longer list of options results in less active selection by members, thereby relying more heavily on the default option.

[29] Shiller (2000), Thaler&Sunstein (2008)

Allocation of Returns

2.4.6 In the defined contribution benefit design, investment returns, or growth, is added to the accumulated funds each year in addition to new contributions. The growth allocated may be the actual increase, or decrease, in the value of a basket of assets backing the funds. There are several decisions here:

- What basket of assets to use,
- Whether to actually invest in this basket of assets or not, and
- Whether to allocate the growth exactly in line with asset value growth, or some other amount.

2.4.7 Of relevance is an option that in some way smoothes or guarantees investment returns over time. This is commonly known as a Smoothed Bonus or Guaranteed Fund in the private sector. High returns are held back in good times and poor returns supplemented in poor times. In the current (2008-09) financial crisis, the benefit of this design is evident. However there is considerable complexity and decision-making behind the scenes in this design and there are debates with regard to equity, sustainability and transparency.

2.4.8 Equity issues occur because some generations of investors will get returns lower than actually earned and some generations will get more. There is then in effect a cross-subsidy from one generation to another. This could equally be seen as solidarity between generations. Volatility of investment returns makes this pooling concept complex to implement.

2.4.9 Rusconi (2007) and others do not address the point of the death benefit from this defined contribution fund. The implicit assumption is that these funds are paid out as a benefit to dependants on death. If the fund is not returned on death, then other pensioners can have their investment return augmented by the 'death credit'.

2.4.10 It is important to note at this point, that a defined benefit revalued career average fund is very similar in fund value, financial management and data requirement to a smoothed defined contribution fund. The accrual rate is then equivalent to the smoothing in the investment returns, i.e. it fluctuates. There are other differences, particularly in the communication of benefits and perception of the fund that need to be considered.

Annuitisation

2.4.11 The fund build-up under a defined contribution plan then needs to provide for a pension at retirement. Currently within pension funds, one third is paid out in cash at tax free or tax favourable rates and the balance is used to purchase an annuity.

2.4.12 Until the advent of a living annuity, the only options were an annuity paid by the pension fund, or an annuity purchased from a life office. The pension fund or life office takes the longevity and investment risk and guarantees to pay the pension until death.

2.4.13 Variations include inflation-linked annuities, guaranteed escalation annuities, guaranteed terms and joint life annuities.

2.4.14 For a national fund it is not clear which of these are preferable. The one third cash may still make sense as there could well be a need to pay off debt and relocate after retirement.

2.4.15 It can be argued that the pension should escalate with inflation. For the same purchase price (fund value), an inflation linked annuity is 50-60% of the initial payment under a level annuity[30]. It can be shown[31] that in pure financial terms (i.e. the real value of each payment), that the level annuity payment is more than the inflation linked annuity for 9 years, and the total value of the benefits (i.e. the present value of all future payments) is higher for 18 years. Thus the individual is better off with a level annuity if they live for less than 18 years into retirement.

2.4.16 It has also been correctly stated that no pension option can make-up for inadequate retirement savings. It is then argued that if one has inadequate savings, one must downscale one's lifestyle, but it is easier to slowly reduce one's lifestyle (by inflation per annum), then to take a once off 50% downscaling in lifestyle.

2.4.17 From an international perspective, it is estimated by Cannon and Tonks[32] (2008) that 70% of purchased annuities in the UK are level.

2.4.18 For a national pension system we need to consider:

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[30] Old Mutual Quotes Package, March 2009

[31] Dutkiewicz, Levin, Dukhi (2007)

[32] Cannon and Tonks, Pg. 28

- Who will take the annuitisation risk – the national fund, or private institutions
- What annuity rates will be used for annuitisation
- Whether these rates will differentiate by the key factors that would impact annuity prices.

2.4.19 Annuity rates depend on assumptions of interest rates (usually associated with bond yields or swap curves), inflation, escalation rates, mortality rates and expenses. Mortality rates in turn are affected by the mix of gender and socio-economic level.

2.4.20 An important consideration is that annuity rates change with changes in interest rates on an immediate and consistent rate. Thus defined contribution investment strategies can be devised whereby the fund fluctuation will be matched by fluctuations in the annuity rate – hence providing greater certainty of annuity outcome over the one to five year period before retirement. Any modelling exercise of a national system needs to model these correctly. In particular the interest rate used must be consistent.

2.4.21 This paper will not consider annuity rates further as this is a very broad subject requiring a paper of its own.

Data Requirements

2.4.22 Under a Defined Contribution plan the most important piece of information is the current fund value. However, it is likely that a member could reasonably query his or her value at any point of time. Thus historical data of how the fund is built up would be required. Table 8 provides a comparison of the data required between a Defined Contribution plan and a Defined Benefit Revalued Career Average Salary. The ultimate data requirement is not vastly different, nor the complexity of explaining how the benefit is calculated.

Table 8: Summary of Data Requirements

	Defined Contribution	Defined Benefit
Static Data	Name, ID, date of birth, address, bank account	
Data Requirement at any point in time	Accumulated fund	Date of birth, accrued service, current salary, current revalued average salary
Data Requirement for purposes of individual recalculation	Date and amount of each contribution, daily investment returns.	Date and salary level of each contribution, accrual rate for each salary period, salary revaluation factors

In this section we have considered the technical issues that need to be thought through in the implementation of a national pension fund. It is not until one has thought through the detail of implementation that one can form an opinion on which system would be best. In addition to the technical aspects, one would also have to evaluate the non-technical aspects – human behaviour, public acceptance, regulation – before concluding on an optimum system.

The next section takes this technical analysis one step further, by using stochastic modelling to show the relative risk and returns to net replacement ratios of different benefit designs.

3 Modelling the Benefit Designs

In this section we outline the results of a stochastic modelling exercise to demonstrate the possible and likely outcomes of various benefit designs. The full model parameterisation and design is detailed in the Appendix.

Net Replacement Ratio (NRR) = Initial Pension/ Final Salary

3.1 Model Points

3.1.1 Modelling was done by selecting an individual member and projecting the likely course of their benefit from entry to the workforce until retirement.

3.1.2 The member is a female who enters the fund at the age of 25 and leaves at the Normal Retirement Age, which is assumed to be 60 years old. It is assumed that there are no employment gaps and that she remains in the fund for the entire 35 years of her working life. The member is also eligible for a universal state old age pension.

3.1.3 In order to allow for varying member income groups, four income model points have been incorporated into the model i.e. member groups earning a starting salary of R25 000 pa, R50 000 pa, R150 000 pa and R250 000 pa respectively.

3.1.4 The following are the Defined Benefit and Defined Contribution pension funding schemes analysed in the model:

1. Defined Benefit - Final Salary
2. Defined Benefit - Revalued Career Average Earnings
3. Defined Contribution with balanced market-linked investment
4. Defined Contribution with explicit smoothing of investment returns
5. Defined Contribution with smoothing and capital guarantees on investment returns

6. Defined Contribution with life staged investment portfolio

3.2 Methodology

3.2.1 Performance Measures: The model generated 2 500 stochastic projections and calculated the Net Replacement Ratio (NRR) for the various model points and funding structures.

3.2.2 The investment return of the member was then calculated as the median of the Net Replacement Ratio values and the investment risk as the standard deviation of the Net Replacement Ratio values.

3.2.3 Accrual Rate Adjustment: For the defined benefit designs, the initial accrual rate is adjusted periodically based on solvency reviews. The solvency calculations are done every 5 years, except in the five years preceding the Normal Retirement Age they are done on an annual basis.

3.2.4 The solvency level is calculated as the ratio of the current value of the accumulated fund over the current value of the liabilities, i.e. solvency = accumulated fund/accrued liability. The accrued liabilities are calculated using the past accrual factors, long-term gilt yields and a pension that increases at 5% per annum. The solvency calculation uses the assets at market value.

3.2.5 Based on the solvency calculations the prospective accrual factor is adjusted as follows:

- If the solvency is between 80% and 130% no adjustment takes place.
- If the solvency is below 80% then the prospective accrual factor will be adjusted such that the solvency goes up to 80%.
- If the solvency is above 130% then the prospective accrual factor will be adjusted such that the solvency goes down to 130%.
- However the accrual factor cannot change by more than 5% in one go or by more than 20% overall.

3.3 Output – Risk Return Profiles

3.3.1 The following four figures show the member's risk return profile for the various income model points and scheme funding options under consideration.

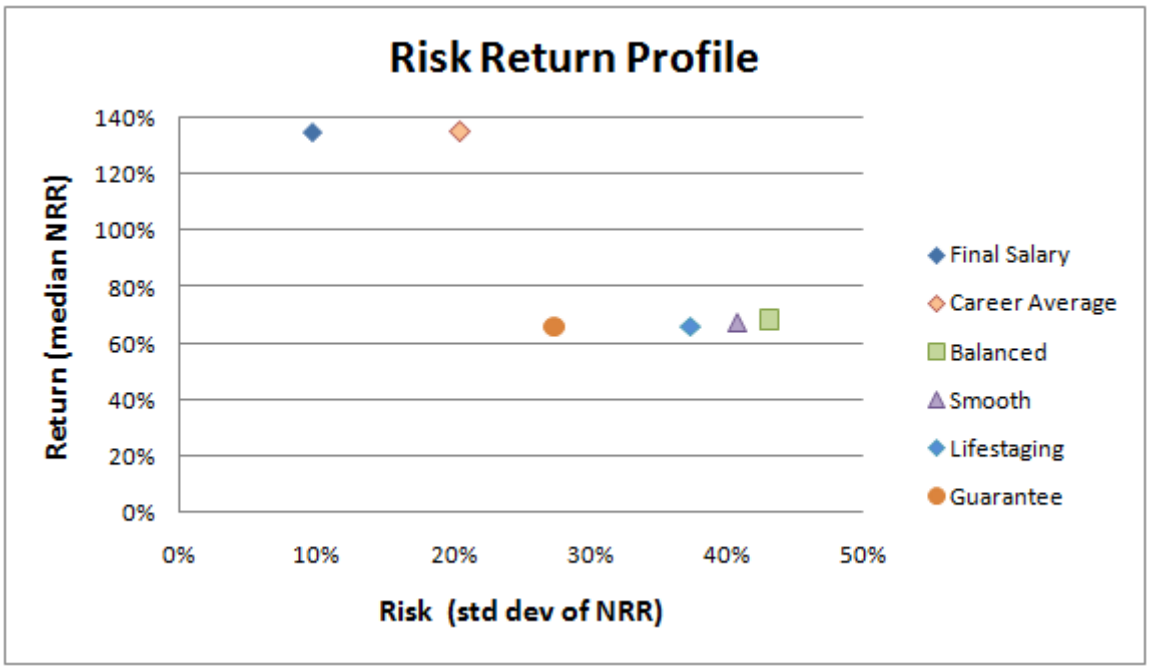

Figure 1: Starting Salary R25 000pa

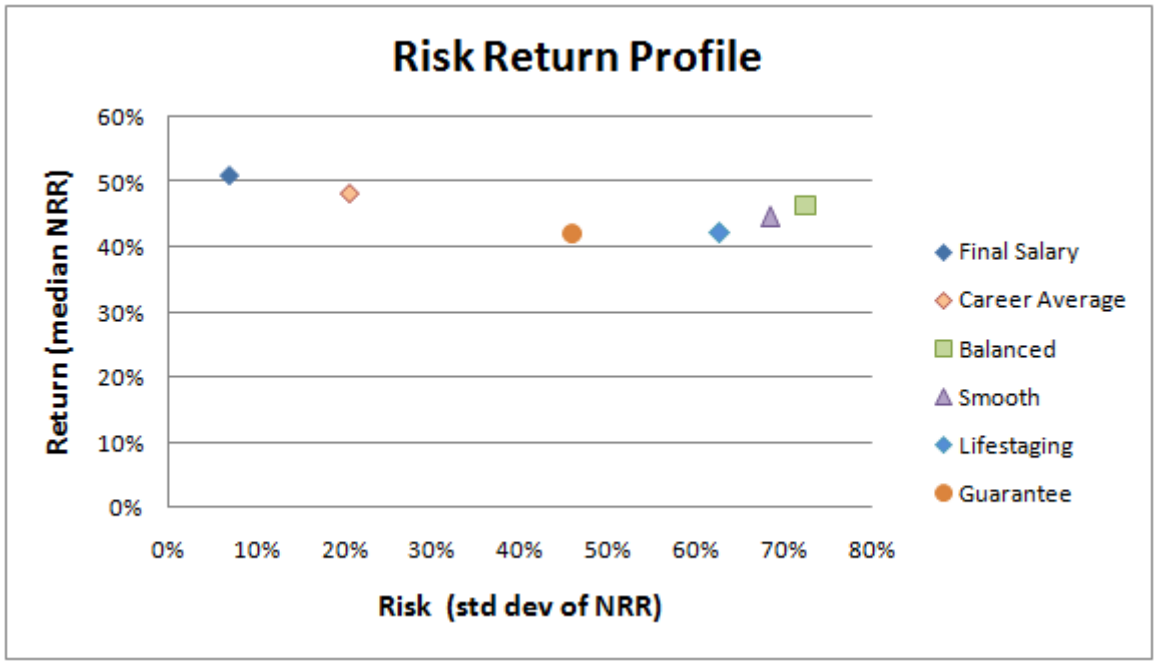

Figure 2: Starting Salary R50 000pa

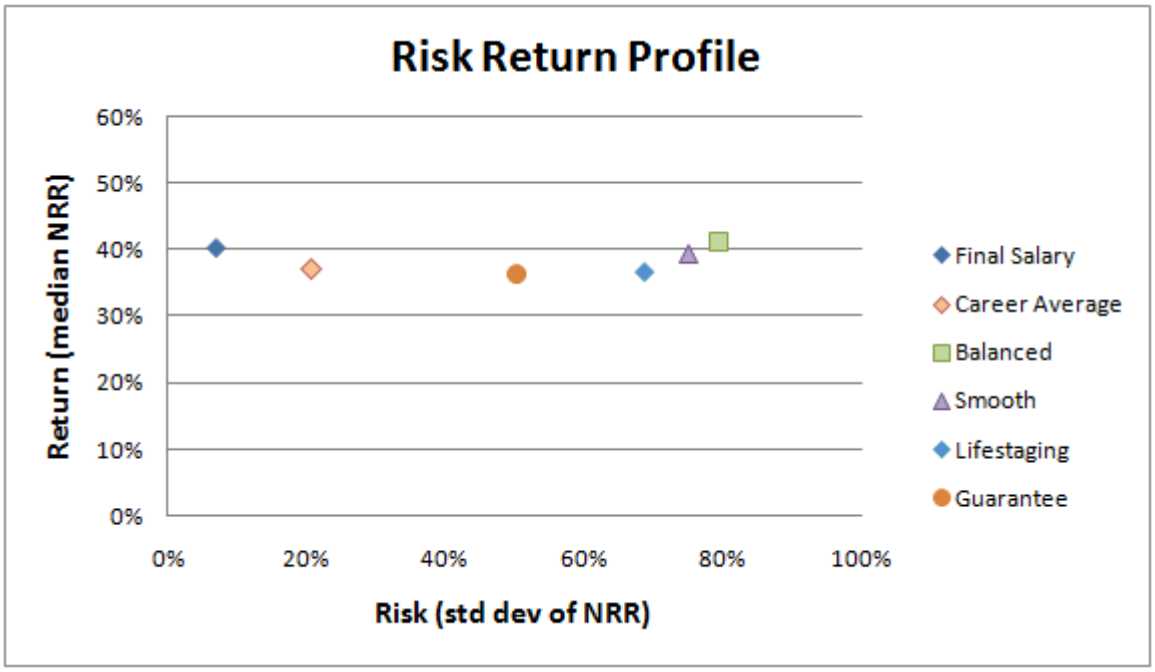

Figure 3: Starting Salary R150 000pa

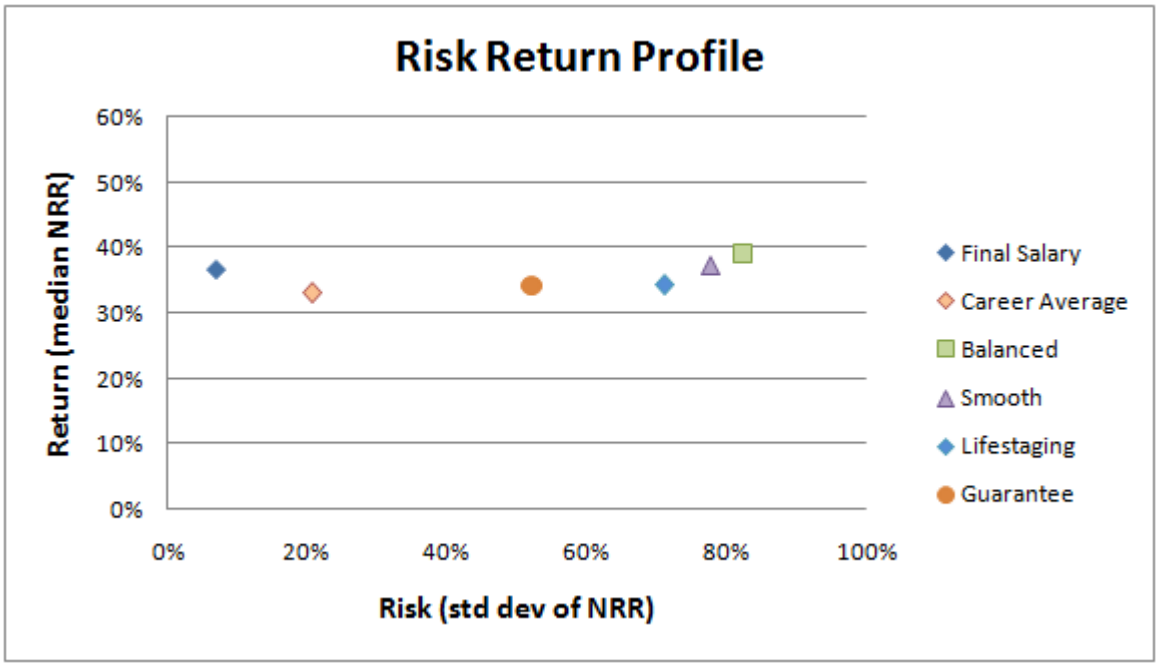

Figure 4: Starting Salary R250 000pa

Defined Benefit Fund: Final Salary vs. Revalued Career Average

3.3.2 The output shows that the final salary scheme yields a higher expected return than the career average scheme, at a lower volatility on returns. This is the case for all the income model points.

3.3.3 This result can be explained by looking at the formula for Net Replacement Ratio, i.e. NRR = initial pension ÷ final salary. For a revalued career-average salary member, dramatic increases in the salary close to retirement will increase the final salary significantly without a major impact on the pension thus significantly decreasing the Net Replacement Ratio. However with a final salary scheme member, dramatic increases in the salary close to retirement will increase both the final salary and the pension thus having a negligible effect on the Net Replacement Ratio.

3.3.4 Large salary increases that occur close to retirement therefore cause the career average scheme to have a lower expected return and a higher volatility than the final salary scheme.

Defined Contribution Funds

3.3.5 The risk return profile of the Defined Contribution funds is determined by the investment mandate of the scheme option. A scheme option with a riskier investment strategy will have a higher expected return.

3.3.6 The Defined Contribution scheme options in order of descending risk and hence in order of descending expected return is as follows:

1. Balanced Market Linked Investment option (highest risk & highest expected return)
2. Smooth Bonus option
3. Life staging option
4. Smooth Bonus plus guarantee option (lowest risk & lowest expected return)

3.3.7 The ordering of 1, 2 and 4 seem reasonably intuitive based on conventional investment wisdom, but the order of 2 and 3 is not immediately obvious.

Defined Benefit vs. Defined Contribution

3.3.8 For a given income model point, both Defined Benefit fund options provide a higher expected return and maintain a lower volatility than all the Defined Contribution Fund options.

3.3.9 This is due to the fact that Defined Benefit fund pensions are promised from the outset and therefore they are not as susceptible to investment risk as the

Defined Contribution options, other than the solvency adjustment of accrual rates. Thus Defined Benefit members will experience volatility of result only in the more extreme investment environments.

40% Net Replacement Ratio Target

3.3.10 The following table shows how frequently the Net Replacement Ratio will fall below the targeted 40% level. The frequency is quantified by probabilities i.e. Probability (Net Replacement Ratio<40%).

Income Model Point	Final Salary	Career Average	Balanced	Smooth	Life staging	Guarantee
R 25 000 p.a.	0%	0%	0%	0%	0%	0%
R 50 000 p.a.	18%	23%	38%	41%	46%	45%
R 150 000 p.a.	39%	59%	48%	51%	56%	56%
R 250 000 p.a.	100%	68%	51%	54%	59%	59%

3.3.11 For the lowest income earner the Net Replacement Ratio never falls below 40% because the state old age grant, which is large relative to the final salary. As the income level increases the Net Replacement Ratio will fall below 40% more frequently, as the SOAG portion becomes relatively smaller and the variable portion (which is funded by the member's contribution) becomes larger.

3.3.12 For the Defined Contribution schemes, the Net Replacement Ratio for options with riskier investment strategies is less likely to fall below 40%. This is because the options with riskier investment strategies have a higher expected return.

In this section we have outlined the numerical output from a stochastic projection model of six national pension fund design options. In the next section we will make some brief concluding remarks about the research and further research that is required.

4 Conclusion

4.1.1 The design of a national pension system is a complex process. The conflicting macro-economic, micro financial and social impact consequences need to be balanced. Barr and Diamond (2008) are at pains to point out that there is no perfect system, no 'first-best' option. They suggest adopting a 'second-best' option that is manageable by the country's infrastructure.

4.1.2 In this research we have demonstrated a number of hidden dynamics within the design of various systems. Importantly there are cross-subsidies in unintended directions.

4.1.3 The results of the stochastic model run indicate the strong impact of the defined Rand based state old age grant for lower income earners. It also illustrates the risk/return trade off of various investment strategies.

4.1.4 This research has not dealt with the important issue of transitional arrangements. This will be the reality for at least 30 years before the first cohort of new-entrants to the workforce retire having only belonged to the national scheme their whole life.

Next Steps

4.1.5 It is the author's conclusion that the stakeholders in this decision still need more detailed technical analysis of the impact of various options. These stakeholders should include representation of current and future pensioners, taxpayers and beneficiaries.

4.1.6 Further analysis is required to illustrate the combined impact of current pension fund build-up in combination with the new national system.

4.1.7 The Actuarial Society is the ideal organisation to provide this detailed analysis in an unbiased, professional and technically deep manner.

5 Appendix: Stochastic Model

This section outlines the assumptions and methodology used for the stochastic projection of economic determinants of the assets and liabilities under the various different benefit designs.

5.1 Asset Projection Model

5.1.1 Future interest rates and investment returns were produced using a real-world (as opposed to risk-neutral) economic scenario generator. Consistent with current market best practice, the software and calibrations required for this were provided by a specialist external economic scenario provider.

5.1.2 Interest Rate Model: One of the reasons a specialist provider was chosen (as opposed to using more simple random walk modelling) was that a "proper" interest rate model was considered important when comparing different annuity types at different times in the future.

5.1.3 For these purposes, the Two Factor Black Karasinski interest rate model was used. In this model:

- Short-term interest rates are assumed to be lognormal.
- Future interest rates are path dependent.
- The interest rate process is made up of two stochastic elements.
- Future interest rates are always positive.

5.1.4 In this way the interest rate process should be economically consistent (the average return on cash should reflect the shape of the initial yield curve), and exhibit some volatility.

5.1.5 The bond yield curve as at 31 December 2008 was used as the starting point for the projections. Returns were projected monthly for 35 years, and 2500 return scenarios were generated.

5.1.6 Bond Returns: Yield curves get derived at each future time-step from the projected short-term interest rates. From this local bond returns can be calculated. For these purposes it is assumed a portfolio of 20-year bonds, with coupon rates reset to par at each time step, is always held.

5.1.7 An important point is that because we don't assume a buy-and-hold bond strategy, one doesn't earn the fixed initial yield to maturity of the bonds.

Because of the downward sloping shape of the initial yield curve (the SA bond curve as at 31 December 2008), interest rates are expected to fall and one is expected to make bond capital gains. One then purchases another 20-year par bond, this time at a lower yield. A bond return in excess of cash returns thus emerges as the yield curve continues to fall.

5.1.8 Risky Asset Class Returns: Returns on "risky" asset classes (i.e. assets other than local cash and local bonds) are modelled as lognormal risk premiums in addition to the returns on local cash. The modelling here only uses bond and SA equity returns, and for SA equities an annual arithmetic mean risk premium (above local cash) of 4.5% was assumed.

5.2 Assumptions

5.2.1 The Career Average Salary is revalued based on the long-term salary inflation assumption of 6% pa, i.e. 1.5% above consumer inflation.

5.2.2 The model assumes that all individuals, regardless of their income or funding structure, will receive an equal state old age grant of R 107 363 per annum. This amount is calculated using inflation forecast figures for the 35 year working period and the current state old age grant of R 12 120 per annum.

Investment & Inflation

5.2.3 A simple portfolio of equities, bonds and cash is assumed, with allocations to each asset class for each investment structure, with mean inflation of 4.5%, and returns such that the mean return is inflation plus 7% for equities, 3% for bonds and 2% for cash. The input for each scenario for the performance of the underlying assets and the inflation has been generated by the Barrie and Hibbert Economic Scenario Generator and is used in the model.

5.2.4 The model built is based on following three underlying investment strategies varying by asset allocation:

1. Balanced:
   The strategic allocation is 70% Equities, 20% Bonds and 10% Cash. The model has been structured with inbuilt maximum and minimum investment strategy allocations, (65% - 75%) can be allocated to Equities, (15% – 25%) to Bonds and the balance will be allocated to Cash where these limits are breached. The portfolio maintains the asset allocation within these parameters but does not rebalance otherwise.

2. Life Staging:
   This portfolio starts out as the balanced portfolio, but switches to an asset allocation of 2/3rd Bonds and 1/3rd Cash to match the ultimate liability, i.e. 2/3rds annuity and 1/3rd cash. It is used for the life staging option under the Defined Contribution scheme.

5.2.5 The model is capable of running simulations on the investment return and salary inflation for a member, given their income model point (i.e. salary level) and modelled pension funding structure. It produced 2500 scenarios for the purpose of this analysis. Allowances for normal asset management costs and any charges for smoothing and guarantees are accommodated for in calculations, the assumed level (per annum) of these costs and charges are tabulated below.

Table 9: Asset Management Costs

	Asset Management Cost (pa)
Equities	0.11%
Bonds	0.08%
Cash	0.05%

Table 10: Capital Charges

	Capital Charges (pa)
Balanced Fund	0%
Smooth	0.20%
Smooth & Capital Guarantee	0.75%

5.2.6 Defined Benefit: The contributions of both Defined Benefit funds (i.e. revalued career average earnings and final salary) are invested in the balanced portfolio and will remain there in perpetuity.

5.2.7 The initial accrual rate for both Defined Benefit options is 0.75%. This rate will be adjusted periodically and separately for each option, based on solvency reviews.

5.2.8 The pensionable salary for the revalued career average option is calculated as the average annual earnings in excess of R 12 000, revalued at CPI inflation + 1.5% per annum. For the final salary option it is calculated as the annual earnings, in excess of R 12 000, for the year preceding retirement.

5.2.9 Setting the accrual rate: The following assumptions have been used to

determine the accrual rate:

- Inflation: 4.5%pa
- Salary inflation: 1.5%pa real (not age dependant at this stage)
- Contribution Rate: 10% of qualifying salary (this is consistent with the rate assumed for the Defined Contribution model)
- Qualifying salary: annual salary in excess of R12 000 (note that the lower limit for Qualifying salary is increased each year in line with the salary inflation assumption)
- Starting age: 20, with 100% employment until Retirement Age
- Retirement Age: 65
- Benefit on pre-retirement death and withdrawal: return of actuarial reserve, i.e. death and withdrawal (e.g. disability or emigration) are assumed to have no effect.
- Investment Return: 4.2% real (based on an assumed constant split between equities, bonds and cash of 70 / 20 / 10; real returns for equities, bonds and cash of 7%, 3% and 2%; and net returns of 6.89%, 2.92% and 1.95%)
- Contingency (or risk) margin: 0.5% (deduction from investment return)
- Mortality for annuitisation: PA(90) (with qx = (40% of male qx) + (60% of female qx))
- Interest for annuitisation: 2.87% (this is the net discount rate derived from assuming an investment return of 3%pa real (or 7.5%pa nominal) and inflationary increases of 4.5%pa)
- Tax is ignored

5.2.10 These assumptions produce an accrual rate of 0.75% which results in a 24% replacement ratio for someone with a starting salary of R112 000pa, (who works from age 20 to age 65). A lower starting salary produces a lower replacement ratio (e.g. for R60 000 it is 22%). However, the relationship between starting salary and replacement ratio is reversed when a SOAG-type payment is added.

5.2.11 Note that mean per capita income in 2005 was R1514 per month, while the median was R484 per month.[33] Allowing for 4 years of increases at 2% per

[33] Government Development Indicators 2008

annum, these become R1638pm (almost R20 000pa) and R524 (R6300pa) respectively.

5.2.12 Defined Contribution: The contributions of all the Defined Contribution options are invested in the balanced portfolio. They remain in this portfolio until retirement for all the options except life staging.

5.2.13 The features unique to each option are outlined as follows:

1. Defined Contribution with balanced market-linked investment: The value of the fund fluctuates in line with the market and members share immediately in the performance of the underlying investment.
2. Defined Contribution with explicit smoothing: The returns yielded by the underlying portfolio are realized by the fund in the form of bonuses that are smoothed over time.
3. Defined Contribution with smoothing and capital guarantee: The returns yielded by the underlying portfolio are realized by the fund in the form of smoothed bonuses. Furthermore 70% of the capital and 50% of the declared bonuses are fully guaranteed.
4. Defined Contribution with life staging only: Life staging adopts a strategy that becomes more conservative as retirement approaches, starting from seven years before retirement. The assets will be moved gradually from the balanced portfolio into cash and bonds. This is done with the intention of having a portfolio that has one third invested in cash and the other two thirds in bonds at retirement.

5.3 Detailed Model Output

Model Point	1
Starting Salary	R 25 000 p.a.

Strategy:	Final Salary	Career Average	Balanced	Smooth	Life staging	Guarantee
Return	134.89%	135.41%	68.58%	67.56%	66.06%	65.92%
Std Dev	9.73%	20.48%	43.20%	40.83%	37.36%	27.37%

Model Point	2
Starting Salary	R 50 000 p.a.

Strategy	Final Salary	Career Average	Balanced	Smooth	Life staging	Guarantee
Return	51.01%	48.27%	46.53%	44.82%	42.30%	42.07%
Std Dev	7.08%	20.64%	72.57%	68.59%	62.77%	45.97%

Model Point	3
Starting Salary	R 150 000 p.a.

Strategy	Final Salary	Career Average	Balanced	Smooth	Life staging	Guarantee
Return	40.40%	37.16%	41.34%	39.46%	36.71%	36.45%
Std Dev	6.96%	20.75%	79.48%	75.12%	68.74%	50.35%

Model Point	4
Starting Salary	R 250 000 p.a.

Strategy	Final Salary	Career Average	Balanced	Smooth	Life staging	Guarantee
Return	36.66%	33.24%	39.27%	37.32%	34.47%	34.21%
Std Dev	6.93%	20.80%	82.24%	77.74%	71.14%	52.10%

5.4 Confidence Intervals

5.4.1 The following tables show the 90% confidence intervals for the Net Replacement Ratio and the corresponding mean.

Model Point	1
Starting Salary	R 25 000 p.a.

	Mean	Confidence Interval
Final Salary	134.0%	[117.23% ; 147.18%]
Career Average	134.0%	[117.23% ; 170.04%]
Balanced	79.1%	[55.78% ; 127.94%]
Smooth	77.5%	[55.46% ; 123.35%]
Life staging	74.9%	[55.05% ; 116.05%]
Guarantee	73.1%	[55.67% ; 110.92%]

Model Point	2
Starting Salary	R 50 000 p.a.

	Mean	Confidence Interval
Final Salary	47.4%	[32.02% ; 53.50%]
Career Average	52.2%	[32.02% ; 84.77%]
Balanced	64.2%	[25.02% ; 146.26%]
Smooth	61.5%	[24.50% ; 138.55%]
Life staging	57.1%	[23.81% ; 126.29%]
Guarantee	54.2%	[24.84% ; 117.67%]

Model Point	3
Starting Salary	R 150 000 p.a.

	Mean	Confidence Interval
Final Salary	36.4%	[20.96% ; 41.55%]
Career Average	41.1%	[20.92% ; 73.83%]
Balanced	60.7%	[17.79% ; 150.58%]
Smooth	57.7%	[17.21% ; 142.13%]
Life staging	52.9%	[16.46% ; 128.69%]
Guarantee	49.7%	[17.59% ; 119.26%]

Model Point	4
Starting Salary	R 250 000 p.a.

	Mean	Confidence Interval
Final Salary	32.5%	[17.11% ; 37.32%]
Career Average	37.2%	[17.03% ; 70.06%]
Balanced	59.3%	[14.89% ; 152.30%]
Smooth	56.2%	[14.30% ; 143.56%]
Life staging	51.2%	[13.52% ; 129.66%]
Guarantee	47.9%	[14.69% ; 119.90%]

6 Appendix: References

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