

# SMOOTHING INVESTMENT RETURNS

Anthony Asher  
Australian Prudential Regulation Authority  
6 June 2003

## Abstract

*Pensioners want smoothed incomes in retirement but it is doubtful whether they can or should be given an absolute guarantee. Full diversification of assets and smoothing processes within retirement funds and insurance companies can produce more reliable incomes. The paper suggests a smoothing algorithm that unites the concepts of lifestyle investment processes and traditional actuarial smoothing and allows for further flexibility.*

## 1 The Need

It is taken as axiomatic that most retired people want a predictable or smooth income stream, payable at monthly or more frequently. A smoothing mechanism is taken to be a method used by a retirement fund or insurance company to absorb fluctuations in market values in order to provide smoothed benefits.

### 1.1 Defined contribution arrangements

The move from defined benefit (DB) to defined contribution (DC) superannuation schemes in many countries means that a growing proportion of retirement income depends on investment market returns. The issue has been discussed, inter alia, by Knox (1993), Khorasaneh (1995) and Andrew (1995). This transfer of investment risk from employers to fund members can be seen to have two components.

The first is the risk that the rate of investment return will not provide the desired retirement income in the long term. An increase of only 1% p.a. in the investment earnings of a DC retirement fund will produce increases of over 30% of pension payable over a 60 span of membership. Estimates of the long term net real rate of return vary in a range from about 1% to 5%. It can be managed by using relative conservative assumptions to plan savings for retirement, and adjusting these over time by changing consumption and by deferring or accelerating retirement. Deferral can make a significant as each year can increase the pension by some 10%.

The second element of the risk arises from short term fluctuations in investment markets. Accepted wisdom is that equity returns will outstrip alternative fixed interest investments over the long run and therefore offer the best return for retirement investments. Siegel's (1998) conclusions are largely valid even after recent drops in market price. The price is significant volatility. Of course, the long term rate is also reduced in such circumstances, but short term volatility is more difficult to manage.

This paper discusses ways of managing this short term risk.

## 1.2 Macro economics and demography

Most of the arguments for and against DC transfers are catalogued in Barr (2001) and Holzmann & Stiglitz (2001) and elsewhere. This section suggests both types of arrangements are necessary.

In macro-economic terms (ignoring foreign transfers), pensions must ultimately be funded from one of the elements of national income:

- personal remuneration,
- income from investments interest, rents and profits,
- depreciation.

In South Africa the ratio between these was 56:29:15 in 1999;<sup>1</sup> in developed economies with better-educated workforces, the ratio is closer to 70:15:15.<sup>2</sup>

These proportions can be compared with the proportion of pensioners in a population. If we assume that pensioners can be expected to absorb a pro rata share of the national income. People over 65 will account for some 15% of the population if life expectancy averages 75 and there is no population growth. This percentage reduces to a mere 5% if the population has been growing at 3% annually for some time, but can increase to 25% if the population has been declining at 2% for many years.

What is clear is that cash flows for pensioners cannot come entirely from investment income. The whole of company profits 15% of national income before tax and retentions) plus reasonable contributions from active members of about 10% of national income) would not be sufficient to make up pensions for 25% of the population.

The present value of these benefits is enormous. If people are to retire on 70% of their pre-retirement income, and have a life expectancy at retirement age of 20 years, then the present value of their pension at retirement is some 10 times their income - at a real rate of return of some 3%. Depending on the shape of the population pyramid, the average working person may have accumulated 3 or four times their income; the average retired person would have somewhat more. This means that a country's liability for retirement incomes may be 5 times total personal income - or over 3 times GNP. This may be more than the total capitalization of most domestic stock markets, all government debt and all property put together.

Retirement funds will therefore not be able to find sufficient assets in the private sector to fund their liabilities. Attempts to do so will lead to unsustainable increases in equity prices. The results in Davis and Li (2002) show that share prices are susceptible to demographic shifts. This suggests that recent share price bubbles could serve as a warning. It also means that, even if it were not for the advantages of diversification they offer, government issued assets of one sort or other, of which we could see pay-as-you-go (PG) arrangements as a type, are necessary to allow pensioners to accumulate rights to a pension.

This is another version of Barr's argument that funded arrangements are also susceptible to demographic stresses. It also highlights the strains on government finance that a PG arrangement makes. Even if governments are able to guarantee benefits with a present value of a multiple of GNP, would it be a reasonable application of their financial power to

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<sup>1</sup> South African Reserve Bank Quarterly Bulletin 12/2000 S-129. Income from investment appears however to be overstated as it includes significant informal sector business "profits" more properly classified as remuneration.

<sup>2</sup> *Economic Trends Annual Supplement*, National Statistics, London shows a ratio of this order on page 29.

do so? It is difficult to argue the case given that the benefits are skewed so heavily in favour of the wealthy.

The conclusion is that a fair and sustainable approach to pension funding requires a mix of assets. The arguments for some government provision that will reduce investment risks either in the form of a PG scheme (or by issuing suitable inflation protected instruments) are overwhelming, but this leaves pensioners exposed to some residual risk of asset value fluctuations.

### **1.3 Alternative instruments**

A variety of instruments are required to access the different elements of national income. Risk diversification for both investors and recipients suggests further variety is necessary.

Private retirement funds, in Anglophone countries especially, initially invested in fixed interest stocks, mortgages and property. Equity investment became very important in the latter part of last century. In the last two decades, these have been augmented with inflation-linked stocks and a variety of synthetic options. Investment returns were frequently smoothed or guaranteed by employer or insurance policy arrangements.

Public sector funds were initially all DB, but recent developments include notional DC arrangements that are more actuarially fair.

Income linked assets could be added to the alternatives. These would have the advantage of giving pensioners a share in general prosperity – or otherwise. Notional DC benefits have been introduced in Sweden with a return equal to the increase in a wage index. Governments could offer a wage linked bond for voluntary private funds.

Private sector alternatives could tap into housing cash flows as suggested in Asher (1994) or higher education as initially suggested by Friedman and Kuznets (1945). The latter has formed a model for a variety of public and private schemes, but provide diversification alternatives only if the return – and not just the repayments – are linked to income.

The greater the diversification of the underlying assets, the lower the rate of investment risk. However, short term market fluctuations still remain a problem as asset prices will depend on supply and demand at the time.

### **1.4 Employer guarantees for retirement funds**

The problem can be addressed by applying a DB mechanism such that employers ensure pensions are smooth by absorbing both profit and loss on the underlying investments. Such a guarantee is equivalent to a secured loan by the fund to the employer at a guaranteed rate.

A more careful analysis of the risks inherent in these guarantees, especially to smaller and less capital-intensive firms, is one of the reasons for the decline of DB funds.

Stronger employers and government, as an employer, have the capacity to offer such guarantees and it is something of a puzzle that employees of such organizations have chosen to shift to DC funds. The option is however not open to employees of less well capitalised organisations and the self-employed.

## **2 Current Methods of Smoothing**

The two main methods of smoothing within financial institutions involve switching assets as retirement approaches, and using a smoothed credit or bonus rate to pass investments returns through to policyholders or members.

### **2.1 Switching to guaranteed assets**

Many DC arrangements, even if they are largely invested in equities before retirement, switch to fixed, or inflation protected, annuities at retirement. These annuities are matched by investing in fixed interest or inflation linked stocks.

A common approach, as discussed by Booth and Yakoubov (2000), is to phase in the switch to more stable investments, rather than make it at a single date. As they find however, the success of such a strategy depends on the availability of suitable long term indexed linked instruments, and foregoes the additional return that appears to be available on equities. It does however clearly reduce the volatility of investment returns.

### **2.2 Smoothed bonuses**

#### **2.2.1 Delaying action**

One approach to smoothing investment returns is to delay the decision to change credit rates until the end of some time period. This is not as alarming as it first appears. Unit trusts will normally delay transacting until the end of a day. Many DC funds will allocate units at the end of a month, and a number will apply the same rate for a year at a time. In almost every case, however, they will reserve the right to calculate unit prices, or change the credit rate, at an intervening time if market conditions change and some participants may be disadvantaged.

This type of smoothing is however more of an administrative convenience than a method to address market fluctuations.

#### **2.2.2 Using the actuarial valuation of assets**

A traditional actuarial approach to smooth the credit rate (and in DB retirement funds to smooth the employer's contribution) is to smooth the value of assets. Head *et al* (2000) provides a useful description of their development and justification in the context of DB funds. The most common approach in the UK is the discounting dividends at the actuarial valuation rate. Other approaches would normally involve some averaging of the market value of assets over a period. To the extent that this differs from the market value, it is arguably unrealistic. A common response would be that the smooth actuarial value represents a more accurate estimate of the long term value of assets than the market price at a particular time, which may be overly influenced by the needs or views of those who happen to be transacting at that time.

Three major problems arise. The first is the possibility of anti-selection. Incoming policyholders or members benefit if the difference between market and actuarial value is positive; maturing policyholders and exiting members gain when it is negative. To the extent that any group has the option to increase its contributions or leave early, so they can appropriate a portion of this surplus.

The second is that market values below actuarial values expose the company or fund to the risk of insolvency. Fund trustees and company managers are therefore reluctant to

allow this difference to become significant, which reduces their ability to cushion falls in benefit payments – which is the original reason for smoothing.

As a result, most smoothing involves reducing returns when market values rise rapidly, and the tendency is for smoothing reserves to build up with no obvious methodology of release. In the absence of protection for policyholders or members, the resulting surplus is open to expropriation by stronger parties.

Clay *et al* discuss the question in the context of UK with-profit policies, and make various recommendations as to disclosure and the protection of vulnerable parties.

### **2.2.3 Alternative algorithms**

Thomson (1997) suggests an algorithm that optimises measures of smoothness and solvency in order to produce an investment policy, and crediting rate for a defined contribution fund. The results are satisfactory in that they do appear to avoid negative bonuses (which are not easily understood by members) but produce more volatile bonus rates than would be common practice.

Khorasane and Ng (2000) suggest an arrangement where the contributions made on behalf of active members are explicitly reallocated to retiring members in order to allow for smoother returns. As pointed out in the discussion by Sze, this approach may not appear to be fair particularly if investment returns are poor and the fund is declining.

## **3 An new algorithm**

This paper suggests an alternative algorithm that is based on achieving the smoothing as the realisation of a set of forward contracts of different durations.

### **3.1 The basic version**

#### **3.1.1 Description**

We can take a maturing investment policy invested in a life insurance fund as an example. The position of a member of a DC fund is almost identical from an investment position.

If the policy were directly linked to the unit values of an underlying asset portfolio, the maturity payout would depend on the market price of the units attached. The payout could be smoothed if the maturing policyholder were to enter into series of forward or future contracts (each for part of the maturity value) in each of the months prior to maturity. For purposes of illustration, assume the smoothing will take place over 60 months.

The remaining policyholders in the life fund would be the obvious counterparties to the forward contracts. When the payouts on policies maturing (or likely to claim) in the next five years is small relative to the size of the fund, then the fund as a whole could be counterparty. Alternatively, policyholders wishing to increase their exposure to volatile investment markets could be specifically allocated. Younger policyholders may be liquidity constrained - unable to borrow - and may want greater exposure to higher yielding equities. To the extent that the surrender values of their policies are sufficiently large to serve as a margin, one could allocate the long position on the forward contracts to them.

If the payouts on policies maturing (or likely to claim) in the next five years is large relative to the size of the fund, then it may be necessary to enter into future contracts in a suitable future's market.

The problem may be dominated by tax considerations, which may also lead to participation by the insurance company's shareholders.

### 3.1.2 Forwards and futures

Determining forward prices is relatively simple. Entering into a contract to buy an asset at a particular price in a year's time is equivalent to borrowing money to buy the asset now, and repaying the loan at the end of the year. Similarly, the counterparty could sell the asset now and put the money on deposit. The forward price of the asset should therefore be the current market price plus a year's interest.

The rate of interest to use will depend on the bargaining power of the participants, tax, expenses, credit risks and market conditions. The terms on similar listed future contracts will give the implicit interest rates to use. The market in the necessary long-term future contracts is relatively thin, but short term rates will give an indication of the important considerations.

The starting point in determining a fair rate would normally be the rate of return on riskless government stock – the standard assumption of financial economics. This is equivalent to assuming that the main market participants were holders of some of this stock and were investing and could effectively borrow at this rate (by selling stock). Short participants in future contracts are however taking counterparty risk, so some margin should be added. Tax and market expectations also mean that the interest rates implicit in future prices differ from the riskless rate.

On the other hand, the policyholders taking the long positions would be subject to very much higher rates were they to borrow. They should however not be charged more than the implicit rates in quoted future prices. This would suggest that the interest rates should be similar to those for a good quality corporate bond.

### 3.1.3 Smoothed maturity value

The smoothed payout at maturity of those units that had been committed to forward contracts would be determined by the following formula –

$$\sum_{t=1}^n U_{-t} P_{-t} (1 + i_{-t})^t \quad (1)$$

Where: maturity takes place at  $t = 0$

$n$  is the smoothing period

$U_t$  is the number of units committed to forward contracts at time  $t$

$P_t$  is the market price of the units at time  $t$ , including reinvested dividends

$i_{-t}$  is the spot rate of interest of term  $t$  at time  $-t$

Insurers, or the policyholders, could choose an appropriate value for the smoothing period  $n$ , and formula for  $U_t$ .

An obvious formula would be:

$$U_{-t} = 1/(t+1) * \text{No of Units held, but not committed at } -t \quad (2)$$

which would provide for an equal averaging over the  $n$  periods for a single premium policy, but would involve a shorter weighting for a policy where units were still be

accumulated. If equal weighting was wanted in such cases, some adjustment would need to be made for unpaid premiums.

### 3.1.4 Anti-selection

This approach allows for the determination of fair, market consistent, surrender values without anti-selection risks. The forward prices can be worked backwards to determine their current market value for purposes of surrender, or to allow for contracts with a term shorter than the smoothing term to participate in the smoothing. The surrender value at time k before maturity will be:

$$\sum_{t=k}^n U_{-t} P_{-t} (1 + i_{-t})^t / (1 + i_{-k})^k + [TU_{-k} - \sum_{t=k}^n U_{-t}] * P_k \quad (3)$$

Where: time 0 would be the planned maturity date,

$$0 < k < n$$

$TU_k$  is the total number of units allocated to the policy at time k.

### 3.1.5 Effects

It can be seen that the smoothed return is be equivalent to that obtained by “lifestyle” disinvesting from equities, and buying fixed interest assets as maturity approaches. As discussed in 2.1 above, this forgoes the advantages of higher equity returns, if they indeed are a high as assumed in Booth and Yakoubov.

The proposed algorithm has however some additional advantages. The first is that it will be relatively easy to administer and will save costs of dealing in the market. Depending on the interest rates used, it is also likely to give a somewhat higher return to departing policyholders and provide good value for the counterparties. As the investments of the life fund can be in the highest yielding investments for the whole life of the contract, there is no loss of return.

This in turn suggests that the logical conclusion of the arguments of Booth and Yakoubov would be that life funds should enter into long positions in future contracts in order to augment returns at younger ages.

## 3.2 Alternative instruments

The other advantage of this approach is that it becomes possible to create new instruments. Most obviously, it is possible to create forward contracts for the terms required even if they are not available in investments markets.

It also becomes possible to create new alternative instruments within the life or retirement fund.

### 3.2.1 Inflation linked

Inflation linked instruments of appropriate term are created by the formula:

$$\sum_{t=0}^n U_{-t} P_{-t} (1 + r_{-t})^t (CPI_0 / CPI_{-t}) \quad (4)$$

Where:

$CPI_t$  is the consumer price index at time t

$r_{-t}$  is the spot real rate for term t at time -t

### 3.2.2 Other linkages

But there is no reason to stop there. Inflation could be replaced by a wage index, GDP per capita, or any other suitable index that allowed pensioners to participate in a country's overall prosperity. In each case, the real rate of interest would need to be suitably adjusted to take into account perceptions of the relative stability and growth of the index.

### 3.2.3 Dividend links

A method that does suggest itself, given the actuarial approach to smoothing, was to use an index of dividend growth and the dividend yield. This yields the formula:

$$\sum_{t=k}^n U_{-t} P_{-t} (1+d/y_{-t})^t (Dividend\ index_0 / Dividend\ index_t) \quad (5)$$

Where:  $d/y_{-t}$  is the dividend yield on a share index, and

$Dividend\ index_t$  is an index indicating the rate of growth in dividends

Now change the units so that dividends are no longer reinvested such that:

$$P_t * d/y_t = Dividend\ index_t \quad (6)$$

### 3.2.4 Reconciliation with actuarial values.

This last thought takes us to the following development:

$$\begin{aligned} & \sum_{t=k}^n U_{-t} P_{-t} (Dividend\ index_0 / Dividend\ index_t) \\ &= \sum_{t=k}^n U_{-t} (Dividend\ index_0 / d/y_{-t}) \end{aligned} \quad (7)$$

$$= P_0 * d/y_0 * \sum_{t=k}^n U_{-t} / d/y_{-t} \quad (8)$$

$$\leq P_0 * d/y_0 / (Average\ d/y) \quad (9)$$

$$\approx P_0 * d/y_0 / (Long\ term\ d/y) \text{ or } Actuarial\ Value \quad (10)$$

The inequality (9) is greater if the dividend yields vary significantly. The conclusion from this development is that the actuarial value is not an unreasonable approximation to an average of forward contracts – if the degree of variability in (9) compensates for the absence of the dividend yield in equation (5).

## 3.3 An illustration

The graphs in the appendix examine the effects of applying this algorithm in South African over the past 3 decades.

### **3.3.1 Smoothing achieved**

Given relatively high and volatile rates of inflation, nominal spot rates was inappropriate so equation (4) in section 3.2.1 was used. A value of  $n = 60$  months was used.

The results shown in the first graph in the appendix are encouraging. It shows payouts at six monthly intervals of an investment of 1 per month for ten years. The large payouts in the eighties especially reflect two decades of inflation in excess of 15% p.a. Maturing smoothed policyholders would have received much smoother returns than linked policyholders. They would have been protected from much of the share market slump of the seventies, and the sharper stock market cracks of 1982, 1992 and 1998. They would not however have benefited from all the euphoria of the late seventies, the mid eighties and early nineties.

The results do not appear to be particularly sensitive to adjustments in the smoothing term and formula.

This was to be expected. If we were using a single premium policy and the forward contracts were spread equally over 60 months, the monthly variance in payout (ignoring the effect of interest rate changes) would be reduced to  $1/\sqrt{60}$  or about 13% of that of an unsmoothed return.

### **3.3.2 A problem with actuarial values**

It was shown in 3.2.4 above that the actuarial values based on dividend yields seemed a reasonable approximation to this smoothing algorithm. The second graph in the appendix shows the real values of the all share index, and the actuarial value of the assets if the assets are valued by treating the real dividend index as a perpetuity at 4%. The actuarial value may be made more or less consistent with forward pricing. Smooth it is not. It may be smoother in more diversified markets, and there may be ways of ad hoc adjustment, but it does not appear suitable for smoothing in South Africa at least. It does not therefore appear to be an entirely appropriate basis for smoothing.

## **3.4 Other issues**

### **3.4.1 Guarantees**

One question that arises is the relationship between with-profit contracts and this approach to smoothing. If the essence of the with-profit approach is participation in pooled experience with a minimum of guarantees, then this approach is entirely consistent. It can be seen as a pooling of investment experience over time.

It also significantly reduces the value and cost of investment guarantees. The exact reduction would have to be the basis of some further research, but the reduction in variance makes it clear that it will be substantial. The point however should be made that the smoothing is relatively short term – five years in the illustration. Guaranteeing long term rates is dangerous as the Japanese life insurers can testify.

### **3.4.2 Application to retirement funds**

The same approach can obviously be applied to DC retirement funds, and to with profit annuities and pensions. It can be applied to the smoothing of lump sum payments and (with greater administrative complexity) to the smoothing of pension payments. Monthly

smoothing would perhaps find little favour, but an annual smoothing could well be acceptable.

There seems no point in applying it to DB funds, however, as the employer would effectively be on both sides of the forward contracts.

#### **4 Conclusion**

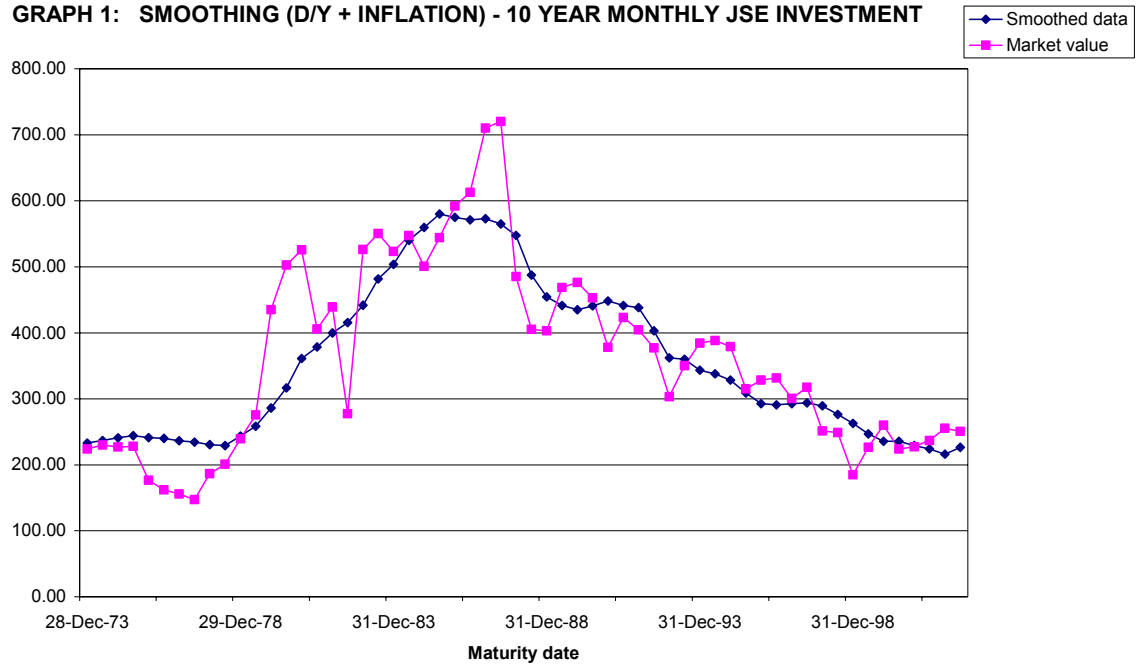
Smoothing using a forward algorithm provides an efficient manner of implementing lifestyle investment strategies, allowing, in the process, the creation of a number of alternative instruments. It can also be reconciled with traditional actuarial methods, and provides a benchmark for determining their fairness by allowing comparisons via future contracts with market conditions.

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## Appendix

**GRAPH 1: SMOOTHING (D/Y + INFLATION) - 10 YEAR MONTHLY JSE INVESTMENT**



**GRAPH 2: SMOOTHING USING D/Y + GROWTH**

