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Analysis of the Impact of the Economy on Pensions in a Defined Contribution Scheme

Dr. Martin Osawaru Omorodion
Department Of Actuarial Science, Joseph Ayo Babalola University, Ikeji Arakeji Osun State Nigeria

Abstract: *Retires depend solely on the final salaries and length of service in order to determine their pensions at retirement. In a defined contribution scheme the accumulated investments over the working life of the retiree is used to purchase pensions depending upon the annuity value at retirement.*
In a boom period the economy yields good investment returns. The investment return drops as the economy gets weak and also the discounting rate prevailing affects the annuity value calculated actuarially.
This paper examines the relationship between pensions and the prevailing economic conditions considering investment returns and discounting rates. The assumed investment returns on all assets are 8%, 10%, 10% and 12% per annum and the discounting rates are 9%, 10%, 11%, 12% and 13% to reflect various states of the economy.
The analysis is done for 3 lives aged 25, 35 and 45years with 35, 25, 15 years of service left before retirement. Comparisons are made. It is found that pension value is more than twice its value when investment return and discounting rates are 14% each compared to when investment return is 8% and discounting rate is 9%
Retirees faces pension risk due to the state of the economy.
Key Words: *Discounting rate, investment return, Pension Length of Service, annuity.*

I. Introduction

In a defined contribution scheme contributions which are obtained as a percentage contribution from salaries or emolument are invested in investment outlets such as equities or fixed interest securities over the working period of the employee. In a boom period the economy yields good investment returns, the investment return drops as the economy gets weak.

Also the discounting rate is similarly determined by the prevailing economic conditions. Annuity cost are mainly determined by the life table functions and the discounting rate. Hence the quantum of pensions a retire receives after retirement would be determined principally by the pensions the accumulated investments can buy at retirement from the prevailing annuity rates.

Considerable short fall in the market values of the investment will leave the retirees with a short-fall in pensions which may not be sufficient to meet the financial needs of the retiree. In this paper we intend to show the relationship between pensions and the prevailing economic conditions considering investment returns and discounting rates.

II. Literature Review

Minton and Millier in their paper "Pension plans still at risk from Global Economic Downturn considered the embedding pension risk in an overall framework, measuring risk against clear and consistence metrics and the balance short-term volatility with long-term goal". They emphasized the need to implement clearly defined, consistent metrics that evaluate the interaction of pension assets and liabilities.

In their paper, they indicated that from a survey conducted covering nearly 42 million plan participants, the findings reveal that 'the risk that receive the most attention are typically asset-centric and easiest to model measure (i.e. asset allocation, meeting return goals and assets-liability mismatch).

Lowery in his paper 'the future of retirement and employee benefits' stressed on the challenges faced by employers and pension providers on "the volatility in the financial markets and increasing longevity impact defined benefit plan funding as well as defined contribution plan outcomes"

Assumption

1. Employees are entitled to salary increments every years and by a fixed percentage e.g. 6% per annum
2. 15% of salary remains the total contributions to the scheme throughout the working period of the employee.
3. Annuity payment are actuarially fixed
4. The assumes rates of investment returns on all assets are 8%, 10%, 12%, and 14% per annum.
5. The assumed discounting rates are 9%, 10%, 11%, 12%, 13% and 14% per annum.
6. Life table used has life expectancy of 15.61 years at age 60

III. Methodology

If s is the annual salary increment and i is the rate of assets return per annum, then a yearly investment of 1 for in years will amount to $S_{\overline{n}|}^{i}$ after n years where

$S_{\overline{n}|}^{i}$ = 1 + (1+ i) + (1+ i)^{i} + ………… (1+ i)$^{n-1}$

And with a yearly salary increment of s% (percent), asset accumulation will amount to

$(1+i)^n + (1+l)^{n-1}(1+s) + ------- + (1+i)(1+s)^{n-i} + (1+s)^n$

If S>i

$(1+i)^n \left[1 + \left(\frac{1+s}{1+i}\right) + ------- + \left(\frac{(1+s)}{(1+2)}\right)^{n-i} + \left(\frac{1+s}{1+2}\right)^n\right]$

Let $1 + i" = \frac{1+s}{1+i}$

Hence $(1+i")\,(1+i) = 1+s,$

$i"(1+i") = s - i$

$i" = \frac{(s-i)}{(1+i)}$

If i> s,

$i" = \left(\frac{i-s}{1+s}\right)$

Hence with salary increment yearly asset accumulation will amount to

$Sn\urcorner^{ii}(1+i)^n, S > i \ or \ Sn\urcorner^{ii}(1+s)^n \ if \ i > s.$

Also let l_x be the number of lives serving at age x form l_0, the number of lives at birth.

Let v be the rate of discount.

Annuity a_x payable at age n

$\sum_{t=0} \frac{L_x + tV^t}{L_x}$

$\sum_{t=0} \frac{Lx+t}{Lx} - \frac{V^{x+t}}{v^x} = \sum_{t=0}^{\infty} \frac{D_{x+t}}{D_x}$

where v = $(1+i)^{-1}$ and $D_x = L_x v^x$

Hence an employee on a salary of A per annum with a salary increment who has n more years before retirement will have accumulated assets at retirement = O.15 A $s_{\overline{n}|}^{ii}$.

the value of annuity at age 60 is a_{60} then the pension payment yearly will be

$$P = \frac{O.15\ A\ s_{\overline{n}|}^{ii}}{\ddot{a}_{60}}$$

Probability that a life aged x survives to age $x + t$ is $\frac{L_{x+t}}{L_x}$

IV. Findings

Table 1: Accumulated Assets Investment Return

AGE	8%	10%	12%	14%
25yrs	16.976	32.400	60.873	113.101
35yrs	4.395	6.975	10.944	17.036
45yrs	1.198	1.502	1.967	2.566

Table 2: Percentage Relationship of Assets with 14% as Rate Investment Return

AGE	8%	10%	12%	14%
25yrs	15.01	28.645	53.822	100%
35yrs	25.798	40.943	64.240	100%
45yrs	46.687	58.535	76.656	100%

The accumulated assets is only 15.01% at 8% investment return of the accumulated assets at 14% investment return for a life age 25 who has 35 working years to retirement. It is 25.798% for a life aged 35years who has 25 working years ahead, and for a life age 45 years, the accumulated assets at 8% return is 46.687% of the accumulated assets with an investment return at 14% working. The ratio improves as the years to retirement decreases. In a weak economy an employee who has many working years ahead to retirement will loose considerably as accumulated assets for pension purchases will be grossly insufficient. (The difference in the pension purchased at age 25 with 8% investment return is virtually meaniless compared to what can be purchased with 14% investment return,)

Table 3: Annuity Value Per Discounting rate

Discounting rate	Annuity Value	Percentage 9% as Base
9%	7.547	100%
10%	7.014	92.928%
11%	6.635	87.916%
12%	6.205	82.3185
13%	5.952	78.8665
14%	5.654	74.917%

The annuity value at 14% discounting reduces to 74.917% of the rate at 9% discounting rate. At the economy booms, the discounting increases and annuity cost reduces.

Table 4: Pensions with 8% Investment Return

AGE	Discounting rate					
	9%	10%	11%	12%	13%	14%
25yrs	2.250	2.42	2.559	2.734	2.852	3.002
35yrs	0.582	0.627	0.662	0.708	0.738	0.777
45yrs	0.159	0.171	0.181	0.193	0.201	0.212

Table 5: Pension with 10% Investment Return

AGE	Discounting rate					
	9%	10%	11%	12%	13%	14%
25yrs	4.293	4.619	4.883	5.222	5.444	5.730
35yrs	0.924	1.560	1.649	1.764	1.839	1.936
45yrs	0.199	0.214	0.226	0.242	0.252	0.266

Table 6: Pension with 12% Investment Return

AGE	Discounting rate					
	9%	10%	11%	12%	13%	14%
25yrs	8.066	8.679	9.175	9.810	10.227	10.766
35yrs	1.450	1.560	1.649	1.764	1.839	1.936
45yrs	0.2611	0.281	0.297	0.317	0.331	0.348

Table 7: Pension with 14% Investment return

AGE	Discounting rate					
	9%	10%	11%	12%	13%	14%
25yrs	14.986	16.125	17.072	18/228	19.002	20.004
35yrs	2.257	2.429	2.571	2.746	2.862	3.013
45yrs	0.340	0.366	0.387	0.414	0.431	0.454

Table 8: Age 25: 35 years Service

Investment Return	Discounting rate					
	9%	10%	11%	12%	13%	14%
8%	1.0	1.076	1.137	1.215	1.268	1.334
10%	1.908	2.084	2.170	2.321	2.420	2.547
12%	3.585	3.857	4.078	4.36	4.545	4.785
14%	6.660	7.167	7.588	8.101	8.445	8.891

Table 9: Age 35: 25 years Service

Investment Return	Discounting Rate					
	9%	10%	11%	12%	13%	14%
8%	1.0	1.077	1.37	1.216	1.26	1.335
10%	1.587	2.680	2.833	3.031	3.160	3.326
12%	2.492	2.680	2.883	3.031	3.16	3.326
14%	3.878	4.174	4.918	4.118	4.918	5.177

Table 10: Age 45: 15 years Service

Investment Return	Discounting rate					
	9%	**10%**	**11%**	**12%**	**13%**	**14%**
8%	1.0	1.075	1.138	1.214	1.264	1.333
10%	1.252	1.346	1.421	1.522	1.585	1.673
12%	1.642	1.767	1.868	1.994	2.082	2.189
14%	2.138	2.302	2.434	2.604	2.711	2.855

From table 8, the pensions purchased rises from the pension value when 8% investment return and a discounting rate of 9%, until it is 87.891 times when the investment return is 14% and discounting rate 14% for a life age 25 years with 35 years of service left to retirement.

From table 9, the pensions purchased rises from the pension value when it is 8% investment return and a discounting rate of 9%, until it is 5.177 times, for a life aged 35 years with 25 years of service left to retirement.

Similarly form the table 10, the pension value rises from the pension value when it is 8% investment return to when it is 2.855 times when the investment return is 14% and a discounting rate is 14% for a life aged 45years.

The difference of 8.891 times for 35 years service to retirement reduces to 5.177 times for 25 years to retirement service and finally it becomes 2.855 times for 15years service to retirement. The impact of the economy is considerable with a long number of years of service to retirement

V. Conclusion

In a defined contribution scheme the impact of the economy is considerable on the quantum of pensions received, with very low investment returns and low discounting rates the retiree receives a much smaller pensions. The amount of pensions increases when the economy is booming. The asset accumulated in a booming economy is much more than when the economy is struggling and this is what is used to purchase the annuities which is also dependent on the discounting rate.

In a struggling economy employees will have to embark on voluntary contributions that will enhance the accumulated assets at retirement in order to have adequate pensions at retirement. This will mitigate the pension risk due to the state of the economy

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