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The Central Exposed to Risk as a Hedging Strategy: A Case Study of a Kenyan Pension Scheme

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Abstract

This study aims at estimating the CER[1] of the members of the pension scheme under study, and establishing how it can be used to determine which mode of exit is more prevalent in the scheme, by analyzing their probabilities of occurrence at exact ages, of the members of the scheme. This shall assist the office manage risks that could be caused by such unprecedented exits and increase their returns. While the vast majority of companies have used CER in determining their vulnerability to running at a loss, this practice is still a challenge to many pension institutions in Kenya. Members of the pension scheme withdrew from the plan due to various reasons including death, retirement, termination/dismissal and resignation. The findings were presented in form of tables, charts and narratives. It is expected that these findings shall assist the pension's office to manage risks due to exits and increase returns from the member's contributions.

Keywords: Central Exposed to Risk, Force of Decrement, Poisson Model, Defined Contribution, Defined Benefit

1. Introduction

Every employed citizen of the country is required by law to register to a pension plan, designed to provide an income upon retirement. The main types of plans are DC[2] (where members' and employers' contributions are fixed either as a percentage of pensionable earnings or as shilling amount.) and DB[3] (where the benefits which are ordinarily determined by the schemes rules are defined in advance.) pension schemes, with the main objective of saving now to provide an income at retirement to the member. Increased number of pension funds in the country saw the formation of an oversight authority, RBA[4], whose creation is part of an on-going financial reform process in the country's economy geared at mobilizing domestic saving, developing country's capital markets and enhancing economic development. The RBA governed by the Retirement Benefits Act, is mandated with management and alleviation of old-age poverty through enhanced saving for the retirement.

Pension funds have been classified as the principal source of retirement income to millions of pensioners in the world (Sze 2008). These funds are also the most important to the GDP[5] of countries and significant source of capital in financial markets (Omondi, 2008). A global pension crisis has however emerged in the past two years owing to the depressed financial markets.

Earlier, Lindert (1994) and Curtler & Johnson (2004) had traced the earliest pension fund system to Germany, where they credited former German Chancellor Otto Von Bismarck for enacting a compulsory savings program for workers in large firms who were exposed to the socialism ideologies. Perotti & Schwienbacher (2008) adds that the Bismarck pension fund system was financed through worker and employer contributions, attracted taxation incentives and paid retirement benefits once the worker reached the age of 65. Lindert (1994) had earlier stated that the pension fund contributions under this system were invested in financial securities. This system however had no provision for pension entitlement to personal representatives in case of death, it was mainly restricted to the civil servants and war veterans and many workers did not live to enjoy the retirement benefits as life expectancy was 60 years (Lindert, 1994).

Later, Perotti & Schwienbacher (2008) described the Bismarck pension fund system as a "social security program" defined as a "comprehensive retirement program covering many production workers." The development of pension fund systems was a reaction to the political and economic shocks affecting the world during the Victorian period (see Perotti & Schwienbacher 2008; Ambatchsheer 2007a:12). The resultant loss of jobs, suspension of various currencies and the stock market crisis of 1929 prompted governments to create policies to cater for their working populations which consequently led to the formation of the modern pension fund systems (Perotti & Schwienbacher 2008). As pension fund systems developed, economic and political shocks affected their sustainability in different countries (Meyer 2004; Newmann 2005) and so the only institutions that could be trusted to secure retirement funds were the governments

[1] Central Exposed to Risk
[2] Defined Contribution
[3] Defined Benefit
[4] Retirement Benefit Authority
[5] Gross Domestic Product

Pension fund systems in Kenya were first put in place after independence in 1963. The first post independent pension fund body, the NSSF[6], was established in 1965 (RBA, 2000). Prior to reforms, the pension fund system provided for benefits once a worker retired on attaining the mandatory retirement age of 55 (RBA, 2006). The guarantee was fixed as the worker's full basic salary throughout his life or that of the widow as the law did not envisage a situation where the wife would support the husband. This law was embodied in the NSSF Act and the Pensions Act (Cap 189).

The pension fund system in Kenya has been supervised by the independent Authority, RBA, since 2000, which oversees the 1997 RBA Act that brought about regulation, protection and structure to the pension fund industry. The RBA continues working to develop the industry and advise the government on pension policy reforms.

Kenya's pension fund system embraces four components namely the NSSF, CSPS[7], ORS[8] and IRS[9]. Overally, the system is estimated to cover 15% of the labor force and to have accumulated assets of 18% of the GDP (Kakwani et al. 2006). The pension fund system covers an estimated 2 million workers leaving an estimated 5 million workers uninsured under any retirement scheme, of which at least 10% are at or near the retirement age (Kakwani et al. 2006).

The NSSF is a public provident fund (pays benefits as a lump sum) that covers an estimated 800 000 members in both the formal and informal sectors (Stewart & Yermo 2009). The NSSF contributions are mandatory for employees in firms with 5 or more employees, whereby members contribute 5% of their monthly earnings subject to a maximum of Ksh. 200 (US$ 2.7) that is matched by an equal contribution by the employer (Stewart & Yermo 2009). According to the Kenyan RBA, the employees are allowed to contribute more on voluntary basis to a maximum of Ksh. 1,000 (US$ 13.3) per month. The old-age pension benefits are available to those aged 55 who have retired from active employment (Stewart & Yermo 2009).

The CSPS covers civil servants, judiciary employees, military personnel, armed forces, teachers and parliamentarians (Kakwani et al. 2006). The scheme provides benefits including old age pension, injury and compensation, survival benefits, dependency pension for 5 years after death of a pensioner, disability pension (military only) and gratuities in the form of lump sums. The CSPS had 125 000 members by December 2006 and the government expenditure amount to Ksh. 12.5 billion (US$ 178.6 million), about 4.7% of the government budget (Kakwani et al. 2006).

ORS's were established by employers to act as vehicles for accumulation of retirement savings for the employees (RBA, 2000). The ORS can be operated on defined benefit or on defined contribution ideologies but in Kenya the defined contribution is the predominant design (RBA, 2008). Although there is no compulsion for employers to set up the ORS, once established, the fund falls under the mandate of the Retirement Benefits Authority and must comply with the laid down regulations. The ORS are estimated to cover an estimated 3% of the working population in Kenya (RBA, 2008)

IRS's are run by financial institutions mainly insurance companies which provide an avenue for saving where employers do not have their own schemes, and for workers who wish to make additional voluntary contributions (RBA, 2009). By the close of 2009, RBA had registered 21 IRS that covered an estimated 2% of the working population. RBA (2009) points out the gap filled by the IRS where the number of employees is so small forming an ORS would not be financially viable.

The concepts and principles of Central Exposed to Risk in Kenya are yet to be incorporated and adopted by most pension companies in management of risks and return increments. There are notable applications of Central Exposed to Risk in many companies all over the world, for instance a study by Scott (2000) showed that some motor vehicle industries use the Central Exposed to Risk estimating the dependent probabilities of exit by either accidents or mechanical breakdown of vehicles at their exact ages in the industries.

A research by RBA indicates that most Kenyans who began their retirement as early as 1990 are outliving their savings. Moreover, early retirees barely get their compensation due to inadequate actuarial framework (Kenya and UNESCO 2006). The 2004 pensioners' survey carried out by RBA reveals that about 41% of retirees changed their jobs but only 24.4% of them transferred their benefit to the new employer's scheme and only 7.1% deferred the benefit in the original scheme.

A case study carried out by CAPRA[10] only used the Central Exposed to Risk to develop a disaster risk information platform for raising risk management awareness in the region. The probabilistic techniques were applied to the analysis of earthquakes, tsunamis, hurricanes, floods, landslides and volcanoes. This study intensified in determining the regions with high vulnerability to a variety of natural hazards.

Attention has not been given into examining some other application areas of Central Exposed to Risk. For

[6] National Social Security Fund
[7] Civil Servants Pension Scheme
[8] Occupational Retirement Schemes
[9] Individual Retirement Schemes
[10] Central American Risk Assessment

example, little attention has been paid to its application in determining the probabilities of occurrence of different modes of decrement in pension plans.

Members of a pension scheme comprise of members present and active only at a given calendar year. A member is deemed to have exited the scheme in case of death, resignation from active employment, when one is terminated/dismissed from active employment and if he/she has retired. Pension schemes therefore have records of its members from time of entry to time of exit. However, it's hypothesized that major mode of exit in pension schemes is through death or retirement even though it's not clear which modes of exit is prevalent among the members. It's therefore essential to investigate which mode of exit is more predominant and examine which age-group these exits occur. To establish this, a study of person years of exposure is necessary otherwise known as central exposure to risk.
Any pension office is interested in minimizing risks associated with unprecedented exits of pensioners from the scheme. To ascertain vulnerability to losses that may arise following these exits, pension office require a well defined guideline or model which captures the probabilities of exits from the pension scheme at exact age or cohort . The Central exposed to risk is essentially a valid model in this area and provides a more elaborate framework for establishing the prevalent modes of exits from pension scheme and for determining the risk time between age-groups under observation.

1.1. Organization of the Paper

The paper is split up into the following sections: In section two, a review on some empirical models is done including presentations of their mathematical forms. Results are then presented in section three, which includes the various tests done. The results are presented in figures and tables. Based on the results obtained in section three, conclusions are made in the final section, including recommendations.

2. Some Empirical Review

2.1. The Binomial Model

Ideally, we observe n identically distributed, independent lives aged x for exactly 1 year, we record the numbers d_x who die. Using the notation set up for the discrete model, a life dies with probability q_x within the year. Hence D_x, the random variable the random variable representing the numbers dying in the year conditional on n alive at the beginning of the year, has distribution

$$D_x \sim B(n, q_x) \tag{1}$$

Giving a maximum likelihood estimator

$$\hat{q}_x = D_x \Big/ n \tag{2}$$

With variance

$$Var(\hat{q}_x) = q_x(1-q_x) \Big/ n \tag{3}$$

Where using usual notation we have set $l_x = n$. The trouble is of course that with real data we may observe the i^{th} life in an interval (a_i, b_i), $0 < a_i < b_i < 1$. In this case

$$\Pr(D_{X_i} = 1) = b_{i-a_i} q_{x+a_i} \tag{4}$$

2.2. Poisson Model

Poisson distribution is a classic distribution normally used to model the number of rare events occurring during some period of time. In the study, it was assumed that N individuals were observed. Further, it was assumed that the force mortality was μ and E_x^c was used to denote the observed waiting time (central exposed to risk). The Poisson model is then given by the assumption that D has Poisson distribution with parameter μE_x^c such that

$$P(D = d) = e^{-\mu E_x^c} (\mu E_x^c)^d \Big/ d! \tag{1}$$

This gave the distribution function of the rates of decrement.

2.2 Estimation of force of decrement

This was obtained by calculating the likelihood of observing the decrements, d, if true value of hazard rate is μ. This yielded

$$L(\mu) = e^{-\mu E_x^c} (\mu E_x^c)^d \Big/ d! \tag{2}$$

Taking the natural logarithm of (2) gives;

$$LogL(\mu) = d(\log \mu + \log E_x^c) - \mu E_x^c - \log d! \tag{3}$$

Differentiating (3) with respect to μ and equating to zero;

$$\frac{\partial}{\partial \mu} L(\mu) = d \Big/ \mu - E_x^c = 0$$
$$\Rightarrow \mu = d \Big/ E_x^c \tag{4}$$

Thus

$$\mu_x = d_x \Big/ E_x^c \tag{5}$$

The central exposed to risk, E_x^c, for a life aged x is the time from date A to date B where date A is the latest of: The date of reaching age label x, the start of the investigation and the date of entry, date B is the earliest of: The date of reaching age label x+, the end of the investigation and the date of exit.

Empirical Results

Data used in the analysis were obtained from a pension scheme in Kenya for different age groups over the years. R.gui was used to analyze the data. Figure (1) shows a comparison of exit modes at different ages.

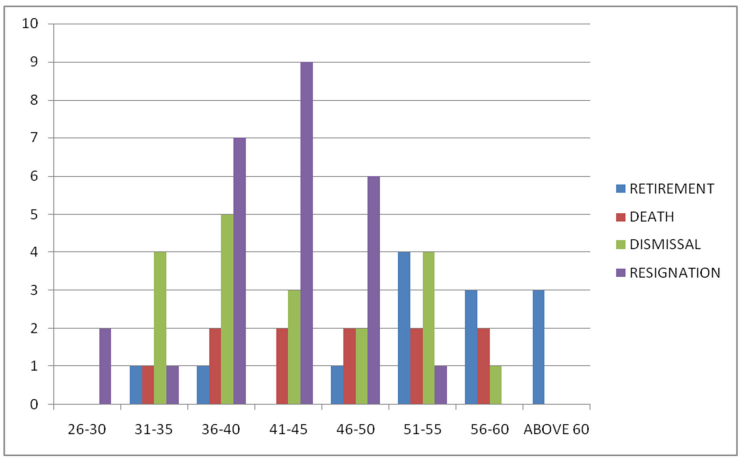

Figure 1: Bar graph showing different modes of exits at various age groups

The most prevalent mode of exit is resignation as shown and was dominant at age groups 26-30, 36-40, 41-45 and 46-50. The age group 41-45 recorded the highest mode of exit through resignation. The mode of exit via retirement recorded lower numbers at lower age groups before 50 years and rose gradually towards normal retirement age of 60 years. At age group 51-55 there were a slightly higher recorded numbers of exits through retirement as individuals seek early retirement. The resignation exits are presented in figure (2).

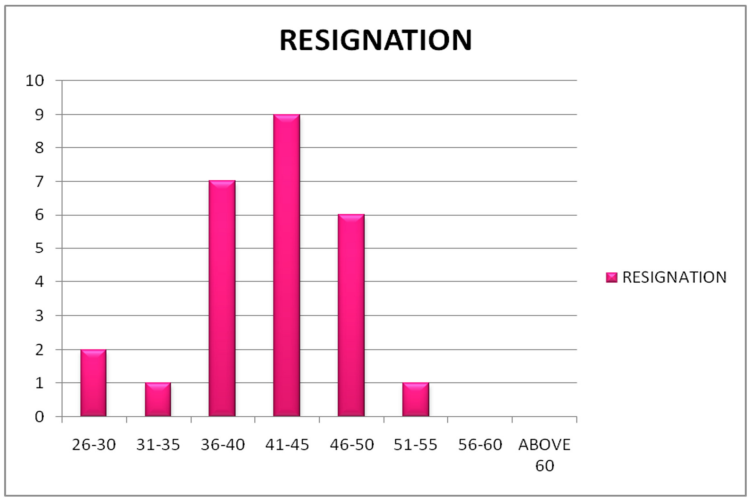

Figure 2: Mode of exit through resignation at various age groups

From a sample size of 148 observations, there were a total of 69 decrements of which 13 were due to retirement, 26 due to resignation, 11 deaths and 19 were termination/dismissal; resignation reporting the highest number. UDD assumption shall be made for the death exits, allowing the inclusion of all exits in the exposed to risk until the end of the year of age, which shall coincide with the sample size. However, the exact population exposed to risk is of interest, which is less than the sample size. The approach to this is to estimate the expected waiting time, whose realization is the central exposed to risk. An examination of the central exposed to risk yielded figure (3).

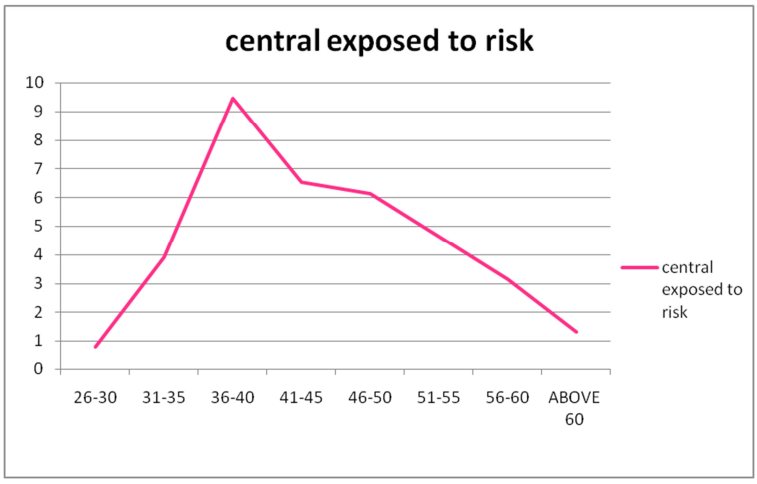

Figure 3: Central exposed to risk verses age group x

The central exposed to risk is low at the age group 26 to 30 and rises steadily to age group 36 to 40 which is at peak. From the peak, it decreased gradually to retirement age at 60. This shows that the exposure of the members of this pension scheme to the risk of decrement increases steadily from age group 26-30 reaching maximum at age group 36-40, then decreases gradually to normal retirement at age 60. For a fund manager, this is an indication that an hedging strategy needs to be developed for these groups of pensioners. A caussionary fund may be established to shield the fund from exposure to downside risk.
To estimate the instanteneous exit rate, the force of decrement, estimated as μ_x , were calculated. The plot is presented in figure (4).

The force of decrement was highest between age group 26-30 and relatively high between age groups 41-45, 51-55 and age group above 60 years and hence the rate of exit from the pension scheme was higher between these age groups. It was relatively lower between age groups 31-35, 46-50, 56-60 and lowest between age group 36-40 suggesting that this age groups experienced a lower force of decrement, which was lowest at age group 36-40.

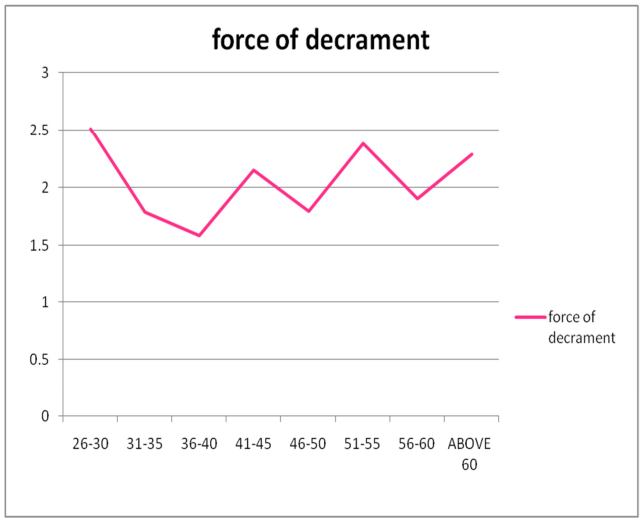

Figure 4: Force of decrement at different age groups

Conclusion

Pension schemes are bedeviled with the problem of elaborate framework of establishing person years of exposure otherwise known as central exposed to risk and the most prevalent mode of exits from the pension scheme. There may be failure by pension to anticipate major exit as and when they occur at an appropriate time. This failure may lead to low allocation of finances which does not match the number of exits at given time and thus affect the running of the pension system.

Pension systems require a well-grounded framework to be used to establish with a given degree of accuracy, the anticipated number of exits of pensioners and at what age. To be able to do so, pension scheme should adopt Central Exposed to risk method, which captures these projection aspects of the pension system evidenced by the study.

To be able to make this method efficient in meeting this demand, further studies should be carried out to establish how to minimize the weaknesses of Poisson model, which was the basis of the study. The binomial model can be tested for the same study.

To establish how the Pension schemes returns are affected, further studies should be carried out to establish the relationship between pensioners' exits. This was not captured in the study.

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