UNIVERSITY OF NAIROBI

PRICING OF AN EDUCATION AND UNEMPLOYMENT INSURANCE POLICY

A PROJECT PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF POSTGRADUATE DIPLOMA IN ACTUARIAL SCIENCE FROM THE UNIVERSITY OF NAIROBI.

JULY 2014

DECLARATION

I do hereby declare that this work is based on a study I took, with consultation of other people's work, which has been duly recognized.

I certify that this is my original work and has not been presented in any other institution.

Signed:

NAME	REGISTRATION NUMBER	SIGNATURE	DATE
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In the presence of my supervisors:

Prof. Patrick Weke ________________________ ________________________

Ms. Caroline Ogutu ________________________ ________________________

ABSTRACT

The purpose of this project is to price an education and unemployment insurance cover. The idea was informed by the high demand for higher education and the high unemployment rates in Kenya. This culminates the financial distress associated with the effects of unemployment. The first phase of the project involves an overview of the education system in Kenya as well as the nature of the existing education and unemployment insurance covers. Chapter two is on literature review which outlines the previous work and research done concerning both education and unemployment insurance covers. Chapter three outlines the methodology used. It also outlines the assumptions used in the model. The distribution used is a 3-parameter Frechet distribution which was settled for after carrying out statistical tests on the data. We relate the properties of the distribution of choice to our data in order to evaluate the parameters. In this case the easy fit software will be used.

The fourth chapter involves the data and results analysis. It analyzes all the results obtained from the proposed model and shows their relation to the underlying data and at the same time carrying out statistical tests necessary to ascertain the appropriateness of our model. The chapter further introduces the actuarial concept of benefit valuation and shows how we incorporate the concept to our model in order to come up with an acceptable pricing model for our policy cover.

ACKNOWLEDGEMENT

I give thanks to God Almighty for giving me the strength and wisdom to complete this project.

I wish to thank my family for giving me the financial and moral support. Special thanks also go to my supervisors Prof. Patrick Weke and Ms. Caroline Ogutu for their patience, guidance and input from the very initial stages to the final parts of this project.

In addition, I sincerely thank all lecturers in the School of Mathematics, University of Nairobi for their dedication in sharing the academic knowledge, not forgetting my classmates who encouraged me and corrected me accordingly.

DEDICATION

I dedicate this work to my dear mum, dad and my brothers for their invaluable sacrifice to ensure I achieve my dream.

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CHAPTER ONE: INTRODUCTION

1.0 INTRODUCTION

Education is the process of receiving or giving systematic instructions, especially at a school, college or university. The process of educating a child involves many stakeholders but it is the role of the parent or guardian of the child to offer financial support to their children by paying among other things school fees for their kids.

It is the expectation of most of the parents and their children that immediately after completing college, the child will secure a well-paying job or become self-employed. However, this may not be the case always due to the high number of graduates and few employment slots available. This leads to an increase in the level of unemployment in a country.

Unemployment occurs when a person who is actively searching for a job is unable to find one. It is often used as a measure of the health of an economy. The most frequently cited measure of unemployment is the unemployment rate which is the number of unemployed persons divided by the total labor force.

Unemployment is catastrophic: it increases susceptibility to malnutrition, illness, mental stress, and loss of self-esteem, leading to depression and increased rates of mortality; can decrease the overall well-being for both parents and children; and it significantly hurts the financial position of the parents and children, especially children. A person staying for long without being employed may eventually be discouraged and loose hope in life. Moreover, unemployment has adverse effects to the rate of growth of the economy as a whole because part of the useful resources of the country, specifically human capital, lies unutilized which deters economic development.

1.1 BACKGROUND

1.1.1 EDUCATION

Education is said to exist even before any form of recording information was discovered where education was achieved through demonstration and copying as the young learned from their elders. During the Zhou Dynasty (551–479 B.C.E.), Confucius, the famed Chinese philosopher, greatly impacted the overall curriculum focus of formal education and shaped educational values even through present-day systems. Later, the world's oldest known alphabet was developed in central Egypt around 2000 BC. Developments of similar kind followed and at the end education was adopted in the whole world. This is evident today by the existence of a formal education system where children as young as three years today are able to attend school. It is important to note that this system of education is not universal but differs from country to country. However, there are more similarities in the different education systems than differences.

In most countries, for example Kenya, children as young as three years old are put in a pre-school program popularly referred to as early childhood education where they are introduced to the school setup. Those who pass this stage are immediately enrolled into primary school where they graduate from one class to another for eight years according to their performance. In class eight, the pupils sit for a common national exam in which they are awarded with Kenya Certificate of Primary Education. The results in this exam are used as a basis of selection in posting the pupils to various Secondary schools in the country. Those who succeed in securing a slot report to their respective secondary schools for o-levels or they are admitted to a secondary school of their preference for the same. In this stage, these students graduate from one form to another again depending on their performance. In their last form, that is form four, these students sit for another national exam where they are awarded with the Kenya Certificate of Secondary

Education. The results in this exam are then used as a basis for admitting the said students into universities and colleges to do various courses depending on their selection and qualification. The duration of the course varies from one course to another. The program of universities is complex, hence their calendar of activities and academic programmes are organized in special calendar years known as academic years where one academic year is made up of two semesters.

1.1.2 UNEMPLOYMENT

After completing University, popularly known as the end of the 8-4-4 system, the graduates may choose to either join the corporate world by looking for jobs or open up businesses and become self-employed; or go back the university, for higher education at the postgraduate level. However, due to the impediment of lack of capital for those who prefer to open up businesses and become self-employed and lack of college fees for those wishing to further their studies, most of the fresh graduates are left with only one open alternative, that of looking for a job where most of them end up.

Due to the few available employment slots coupled with the large number of graduates released each year by the increasing number of universities most of them end up being unemployed. The high number of those being unemployed per year increases the annual rate of unemployment every year. This is accelerated by the low level of investment in the country due to unfavorable conditions such as high banking lending rates and poor government policies.

1.1.3 EDUCATION AND UNEMPLOYMENT INSURANCE

The origin of insurance dates back in 2100B.C when the Babylonians developed ‘the code of Hammurabi’ which was practiced by the Mediterranean sailing merchants to guarantee safe arrival of their goods by sea and caravan. According to the code, if a merchant received a loan to fund his shipment, he would pay the lender an additional sum in exchange for the lender's guarantee to cancel the loan should the shipment be stolen or lost at sea. As history progressed, the need for insurance increased. The Phoenicians and Greeks used insurance for their seaborne commerce. The Romans then followed by introducing the first burial insurance. A major breakthrough was made in 1688 that accelerated the development of the insurance industry. This was the formation of the first insurance company, the Lloyds of London whose main policy was the marine cover. This was after the 'Great Fire of London' in 1666 when 13,200 houses were destroyed and societies were formed to pool money for losses.

Today, insurance has grown hugely to be among the big industries characterizing an economic setup. Modern insurance is now defined as a mechanism where people exposed to the same risk are pooled together contributing into a mutual fund that will be used to compensate those who incur the specified risk. In this case, insurance is viewed as a financial product that provides protection against financial losses by pooling the resources of policy holders.

Therefore, an insurance company, usually referred to as the insurer, agrees to pay out monies in form of compensation upon the occurrence of specified events that would lead to a financial loss. Whereas, policy holders are those who purchase the insurance policy from the insurer and agree to make regular payments known as premiums in order to indemnify themselves against future unexpected loss. The beneficiary of the policy/ the insured on the other hand is the one who receives the benefits of the policy in the event that the covered risk occurs or the policy matures. The beneficiary might also be the policy holder or a different person depending on the type of the policy.

There are two basic types of insurance, namely; life insurance and general insurance. Life insurance transfers the financial risks associated with death of the policy holder to an insurance company. General insurance on the other hand transfers the risk to an insurer for personal matters other than life insurance. For example, property and casualty insurance transfers the risk of damage to your personal property to an insurance company so that you don't have to pay out of pocket for any property damage covered under the terms of the insurance policy.

A child education policy is a life insurance product specially designed as a savings tool to provide an amount of money when your child reaches the age of entry into college (18 years and above). The funds can be utilized to partly meet your child's higher education expenses. Also, if you opt for a payor benefit rider, an education policy provides the assurance that, in the event of an untimely demise of the parents or legal guardian, the child will have access to funds to help finance his/her education expenses.

An unemployment policy is an insurance product that one can buy to cover them or their loved ones in the event that they end up being unemployed. Currently, no unemployment insurance cover is available for purchase by individuals in Kenya. However, various governments have unemployment benefit schemes that make social welfare payments to their unemployed citizens. The payments may be made directly by the government or the payments may be secured by contracts with the insurance company. These payments are often small covering only basic needs.

This study seeks to merge both unemployment policy and education cover to form an hybrid product known as The Education and Unemployment Insurance policy.

1.2 PROBLEM STATEMENT

Before the year 2003, it was the responsibility of every parent in Kenya to bear the financial burden of educating their children. This was to change in the same year following a new political dispensation when the government introduced free primary education. This was a great relief to the parents which was evidenced by the high enrollment witnessed in the same year at the primary level. Five years later down the line, the government boosted the education sector again by introducing subsidized secondary education. This did not only increase the level of enrolment but also helped curb the increasing number of secondary school dropouts due to lack of school fees. This is enough proof that the burden of educating a child is not only heavy but also risky to the parents due to uncertainty in the future availability of the school fees.

This study seeks to supplement the efforts of the government by introducing 'The Education and Unemployment Insurance policy' to not only ensure that our young generation access higher education but also are covered in the event that they fail to secure a job. In the study, we will come up with a model and develop the pricing formula for the policy.

1.3 OBJECTIVES

The overall objective of this project is to come up with a prolific price (premium) to charge education and unemployment insurance policy holders in a bid to increase enrolment into higher institutions of learning and reduce the current unemployment rates.

The following are the specific objectives the study seeks to achieve:

- Determination of amount of education benefits.
- Determination of the distribution of best fit for the unemployment rates.
- Determination of the pricing formula to be used in computation of premiums.

- To reduce the current rate of unemployment by stirring the aggressiveness of the fresh graduates.

1.4 SIGNIFICANCE OF THE STUDY

The project will set up a benchmark for future pricing of policy involving analysis of unemployment rates. It will also contribute to long-term solution to social and financial consequences of unemployment. Additionally, it will bridge up knowledge and expertise transfer in the insurance pricing of education and unemployment policy which is a new product in the industry.

1.5 JUSTIFICATION OF THE STUDY

This study will add value to the following stakeholders:

- **Academicians**

This project will be a source of literature to academicians and scholars especially Actuarial Science and Statistics students. It will act as a reference point for researchers wishing to delve into pricing and modeling an insurance policy since it will create more understanding on general pricing of a policy to the national economy.

- **Students and their Guardians**

Education and unemployment insurance cover indemnifies guardians from financial stress in the event that they are unable to raise enough school fees to finance higher education for their students. The policy also pays benefits to the covered students in the event that they complete college and fail to secure a job or they are unable to start their own businesses.

- **Insurance institution**

Insurance acts as a risk instrument to mitigate any loss suffered. Thus as a provider of this risk based management tool, the insurer, will benefit from premiums charged to parents. It's also an alternative to the already existing education insurance policy.

CHAPTER TWO: LITERATURE REVIEW

2.0 EDUCATION INSURANCE

The idea of education insurance is not new. In fact, it is among the earliest life insurance products. This type of policy is most common in countries like Kenya where the cost of quality education is very high. In most cases, the policy is designed as a savings tool to provide an amount of money when the child reaches the age for entry into college. The benefits are in form of school fees paid to the respective higher education institution to cater for the child's educational expenses. In this case, the parent/ legal guardian is the policy owner while the child is the beneficiary. This policy also provides an option for a payor benefit rider, where following the untimely demise of the policy owner, the beneficiary will have access to the funds to help finance their studies.

Research from various insurance companies providing this cover shows that in its design, the policy holder provides the current annual cost of the expected course of the beneficiary together with its duration and depending on the insurance company's expected annual percentage increment in the fees, the life office will calculate the estimated benefits to be paid. The discounted value of the benefits, popularly known as the present value of the benefits will then be equated to present value of the contributions in order to determine the amount of premiums to be paid by the policy owner.

2.1 UNEMPLOYMENT INSURANCE

Very little research has been carried out in the area of unemployment insurance with the few available publications on the above area revolving around state unemployment insurance provided by various governments mostly of developed countries to benefit their citizens. Malinvaud (1977) while reviewing literature on unemployment insurance notes that unemployment insurance is a "special case" of insurance contract in that it is compulsory and is wholly operated by the government. In this set up, unemployment insurance is considered as a social program whose main goal is to provide unemployment benefits to partially replace lost earnings for previously working individuals who become involuntarily unemployed and who are able, available and actively seeking for employment. The program specifications differ from country to country. None the less, a common factor in most countries is the way the contributions to the unemployment insurance fund are mobilized. Most of the unemployment insurance schemes charge a flat percentage of the worker's income earned between some minimum and maximum levels. However, this is not a fair premium since all employees are not exposed to the same level of unemployment risk. For example, the unemployment risk for judges is low since the older they grow in the field, the more knowledgeable they become in law.

Beenstock (1985) was the first to toss his mind in pricing of unemployment insurance when he developed a model to solve the problem. In his model he diversified the unemployment risk and assumed that the unemployment benefits are deterministic. According to the model, the unemployment insurance contract would automatically be enacted when a person starts working and the insured was required to pay premiums right from the onset of their employment. They would then receive unemployment benefits in the event that they become involuntarily unemployed until they secure another job if this occurs before the contract expires. To be able to determine the amount of premiums payable for the cover, Beenstock assumed that the insurer has identified various risk groups, just as is the case in car insurance, and considered each risk group as a stationary fund. Since the benefits are deterministic, then equating the discounted value of the benefits gives the amount of premiums payable.

Bronars (1985) uses capital asset pricing model to determine the fair premiums in a theoretical model of a hypothetical regulated private market for unemployment insurance. Bronars improved on the existing work of Beenstock by undiversifying the unemployment risk and specifying an appropriate risk-adjusted interest rate for the unemployment insurance. He goes further to stress that the model can be used to analyze coinsurance of aggregate unemployment risk.

Bronars model was adopted by Beenstock and Brasse (1986), when they applied it in Britain. Further research courtesy of Blake and Beenstock (1988) led to the development of a more generalized Unemployment Insurance model by allowing the unemployment probability to be stochastic. This model was however not successful since it failed to estimate the unemployment benefits according to the duration of unemployment.

The unfortunate failure of Blake and Beenstock (1988) motivated Hwei-Lin Chuang and Min-Teh Yu (2010) to extend the work of Bronars (1985) by incorporating survival analysis with a more general form to measure the unemployment duration and to derive the fair premium rate for the Unemployment Insurance Program. In their study they used data from the unemployment insurance program in Taiwan. In the development of the model, the Weibull distribution was used to estimate the average unemployment duration while the capital asset pricing model was used to determine the interest rate used to discount the benefits.

The above studies however, fail to address the threat of unemployment for fresh graduates from college where the effects of unemployment are more and sometimes very devastating. In this study, we explore how we can eliminate both the risk of education and unemployment of fresh graduates. This can be dealt with by developing a new insurance product dubbed ‘Education and

Unemployment Insurance.’ Check the following chapter for a detailed methodology on how to determine the premiums payable by the policy holders.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter deals with the detailed explanation of the model to be used in our study along with the different approach and methods used to conceptualize the objectives of the study.it also outlines the assumptions taken in order to enable us come up with the model that suits our data.

The policy offers two benefits, namely, the education benefit and the unemployment benefit. The education benefit is guaranteed provided the beneficiary is alive. This therefore implies that payment of education benefits will depend on the probability of survival of the beneficiary. Since the benefits will be paid in form of annual annuities to the beneficiary's learning institution as school fees, we will assume that the fees will increase at a rate g per annum from the time the policy is effected.

Payment of the unemployment benefits depends on probability of survival and probability of unemployment. We assume that the probabilities of survival and unemployment are independent.

3.1 Choice of model:

By considering unemployment as failure and time of receiving unemployment benefits as time of failure, the problem of estimating the probability of unemployment can be viewed as a survivorship problem with the life in consideration being that of the graduate to be. Therefore, survival distributions can describe almost perfectly the future employability of the fresh graduate.

After fitting the data of unemployment rates into various distributions using the easy fit software, the Kenyan unemployment rates were found to follow the Frechet distribution with three parameters. The decision was arrived at after comparing the Kolmogorov, Anderson and Chi-squared statistics yielded by the data under various fit distributions as further outlined in the data analysis section that follows. Moreover, reality tends to support the fitness of the three-parameter Frechet distribution. By first considering how the hazard varies, the frequency of unemployment rates is high in the lower rates and then decreases with increase in the rate which is a characteristic of the hazard function of the three-parameter Frechet distribution.

3.1.1 Three-parameter Frechet distribution:

The three-parameter Frechet distribution is a continuous probability distribution for non-negative random variables. It is characterized by three parameters $\alpha > 0$, $\beta > 0$ and $\lambda \geq 0$, where α is the shape parameters, β is the scale parameter and λ is the location parameter. When $\lambda = 0$, then we have a two-parameter Frechet distribution.

For a random variable u, the probability density function, cumulative density function and moments for the three-parameter Frechet distribution can be defined as:

Probability density function:

The probability density function (PDF) is the probability that the variable, which in our case is U, takes the value u, that is, $f\left(u\right) = P(\mathrm{U} = u)$

$$f\left(u\right) = \begin{cases} \frac{\alpha}{\beta}\left(\frac{\beta}{u-\lambda}\right)^{\alpha+1} \exp\left(-\left(\frac{\beta}{u-\lambda}\right)^{\alpha}\right), & \alpha>0,\ \beta>0,\ \lambda>0,\ \mathrm{u}\geq\lambda \\ 0, & elsewhere \end{cases} \tag{3.1}$$

Cumulative density function:

The cumulative distribution function (CDF) is the probability that the variable takes on a value less than or equal to u, that is, $F(u) = P(U \le u) = \int_{-\infty}^{u} f(t)\,dt$

$$F(u) = \begin{cases} \exp\left(-\left(\frac{\beta}{u-\lambda}\right)^{\alpha}\right), & \alpha>0,\ \beta>0,\ \lambda>0,\ u\ge\lambda \\ 0, & \text{elsewhere} \end{cases} \tag{3.2}$$

Moments:

$$E(u) = \int u\, f(u)\, du = \begin{cases} \lambda+\beta\,\Gamma\left(1-\frac{1}{\alpha}\right), & \text{for } \alpha>1 \\ \infty, & \text{otherwise} \end{cases} \tag{3.3}$$

$$\operatorname{var}(u) = \begin{cases} \beta^2\left(\Gamma\left(1-\frac{2}{\alpha}\right)-\left(\Gamma\left(1-\frac{1}{\alpha}\right)\right)^2\right), & \text{for } \alpha>2 \\ \infty, & \text{otherwise} \end{cases} \tag{3.4}$$

Median:

$$Median = \lambda + \frac{\beta}{\sqrt[\alpha]{\log_e(2)}} \tag{3.5}$$

Three-parameter Frechet distribution as a survival distribution:

The survival function (or reliability function) is the probability that the variable takes on a value greater than t.

$$s(t) = P(U > t) = 1 - F(t) = 1 - \exp\left(-\left(\frac{\beta}{t-\lambda}\right)^{\alpha}\right) \qquad (3.6)$$

The hazard function (also known as the failure rate) is the ratio of the probability density function to the survival function:

$$h(t) = \frac{f(t)}{s(t)} = \frac{\alpha\beta^{\alpha}}{[t-\lambda]\left[\left[\exp\left(\frac{\beta}{t-\lambda}\right)^{\alpha}\right]-1\right]} \qquad (3.7)$$

The hazard function is used in reliability applications to describe the instantaneous failure rate at any point in time.

3.2 Parameter estimation:

The data to be used in analysis comprises of Kenyan unemployment rates from the year 1991 to 2013 which was fitted into various distributions using easy fit software. The software was also able to estimate values of all the three parameters as will be outlined in the Data analysis section.

3.3 Time series and Regression Analysis:

3.3.1 Time series analysis

The additive time series model is used to forecast the future values a variable will take based on the historical data about the variable. This model is appropriate for time series data where the amplitude of both the seasonal and irregular (error) variations do not change the level of the trend rises or falls as will be illustrated in the next section. In the additive decomposition, the time series data is assumed to contain the trend, seasonal, cyclical and irregular components such that the time series value X (t) at time t is given by:

$$x(t) = T_t + C_t + S_t + \varepsilon_t \quad (3.8)$$

Where

T_t is the trend component

C_t is the cyclical component

S_t is the seasonal component

ε_t is the irregular component.

The trend component represents the general pattern of the data while the other three components account for variations around the trend. The following process is followed in forecasting data using the additive time series model:

- ❖ Obtain an n-period moving average (M.A) or a n-period centered moving average (C.M.A) of the original observations to factor out Irregularity and Seasonality. This implies that the M.A and C.M.A represent the trend and cyclical components. The value of n in obtaining the M.As' depends on the nature of the data.

- ❖ Subtract the M.As' ($T_t + C_t$) from the data. The difference is equal to ($S_t + \varepsilon_t$).
- ❖ Remove the Irregularity I_t component from ($S_t + \varepsilon_t$) by computing the average for each of the seasons.
- ❖ The averaged seasonal estimates should add up to zero. If they do not, we must normalize them by subtracting from each an average of all the seasonal components.
- ❖ Deseasonlize the data by subtracting from it their respective seasonal components.
- ❖ Perform the proper regression analysis on the deseasonlized data to obtain the appropriate model of the trend.
- ❖ An estimate or forecast for any period can be found by adding together the estimates for the various components as outlined in equation 3.8 above.

3.3.2 Quadratic Regression Analysis

Regression analysis is an approach for modeling the relationship between a scalar dependent variable, say x and one or more explanatory variables denoted by t. When more than one explanatory variable is involved, the model is called a multiple regression model as opposed to a simple regression case where only one explanatory model is involved. This study involves the use of quadratic regression model which is a type of simple regression model where the highest power of the explanatory variable t is two. Given a data set $\{ x_{i,} t_i \}_{i=1}^{n}$ of n statistical units, a quadratic regression model assumes that the relationship between the regress and the regressors is quadratic with a disturbance term of error variable ε – an unobserved random variable that adds noise to the quadratic relationship between the regress and the regressors.

Thus, the model is of the form:

$$x_i = \theta_1 t_i^2 + \theta_2 t_i + \varepsilon, \quad i=1,2,...,n \qquad (3.9)$$

3.4 Assumptions:

- Unemployment rates in both males and females are equal to the total unemployment rate.
- The probabilities of unemployment and survival are independent.
- The labour force in Kenya is made up of only graduates from colleges and universities
- Unemployment rates are as from time t=1 to time t=28 are as forecasted in the time series model.

3.5 Pricing of the policy:

We use actuarial present values for the estimation of premiums (to price the policy cover) for a given level of education and unemployment benefits, say S_e and S_u respectively.

Given the unemployment rate U_i and the probability density function (pdf) of the unemployment rate f(u), we can evaluate the MPV (mean present value) of benefits given the annual growth rate of college fees as g% per annum and the duration of the course of the beneficiary. We can later apply the equation of value to calculate premiums under a specific plan of premium payment, say annual payments in advance.

The unemployment benefits can only be received for a maximum of two years from the graduation date in the event that the beneficiary is unfortunately unemployed during the two years after which no further benefits can be claimed. This is a measure intended to curtail voluntary unemployment for allure of the benefits gained hence nullifying the moral hazard aspect associated with this particular policy cover.

CHAPTER FOUR: DATA ANALYSIS

This chapter deals with the detailed application of the proposed models as described in the modeling chapter along with the different methods and formulae used to conceptualize the objectives of the study.

4.0 DATA

Source of data:

- Kenya National Bureau of Statistics
- World Bank – Kenyan data
- "http://www.tradingeconomics.com/kenya/unemployment-rate"

The data used in this research is a combination of the above sources depending on availability.

The data in the table below was analyzed using Time series model in Microsoft excel platform to determine the unemployment rates from time t=1 to t=28.

YEAR	UNEMPLOYMENT RATE (%)
1991	10.10
1992	10.20
1993	6.96
1994	6.96
1995	9.90
1996	9.90
1997	9.90
1998	9.80
1999	14.60
2000	14.60
2001	11.30
2002	11.30
2003	13.40
2004	13.40
2005	12.70

2006	12.70
2007	12.70
2008	25.10
2009	25.10
2010	27.90
2011	40.00
2012	40.00
2013	40.00

Table 4.1: Data used in the model

The first column shows the year while the second column shows the unemployment rate as a percentage of the labour force.

A line plot of the unemployment rates against time clearly shows that this is time series data as illustrated below

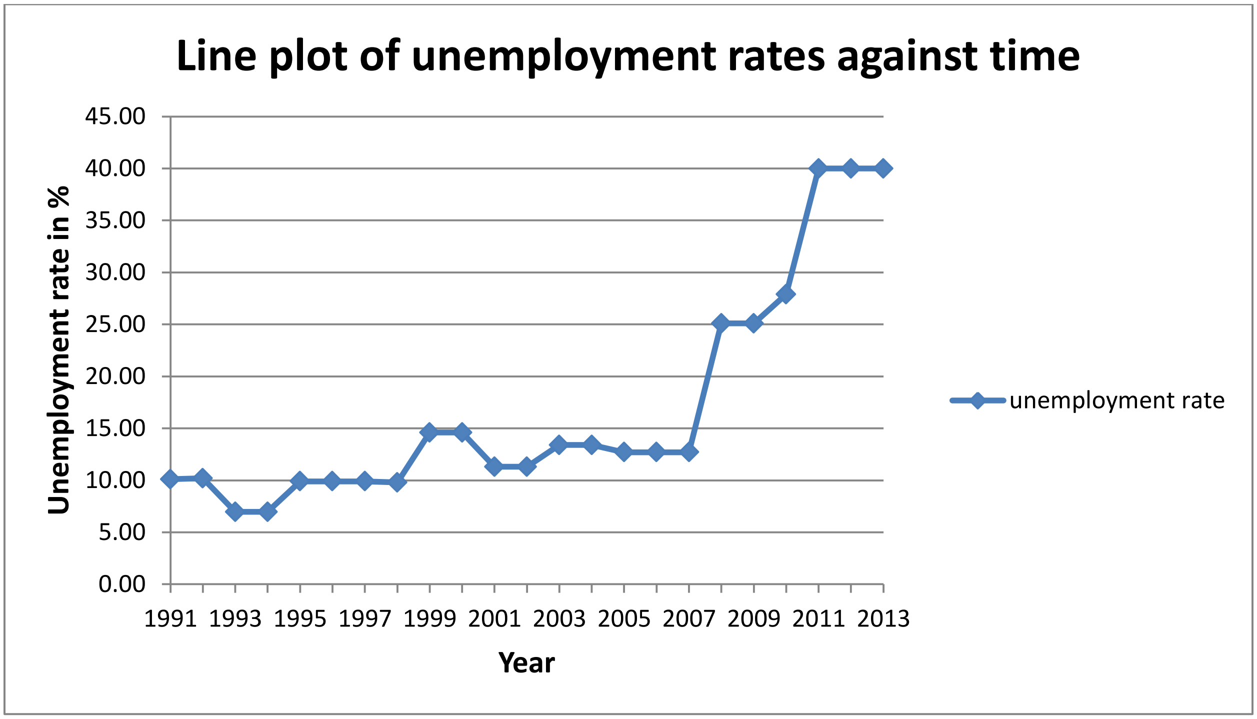

Figure 4.1: Line plot of unemployment rates against time

4.1 Results from time series analysis:

	UNEMPLOYMENT RATE		MA(3)		Seasonal		Trend	Forecast
YEAR	Y(t)	t	$T_t + C_t$	$S_t + I_t$	S_t	D_t	X(t)	U_t
1991	10.10	1.00			-0.01	10.11	12.22	12.21
1992	10.20	2.00	9.09	1.11	-1.09	11.29	10.91	9.82
1993	6.96	3.00	8.04	-1.08	1.11	5.85	9.85	10.96
1994	6.96	4.00	7.94	-0.98	-0.01	6.97	9.04	9.03
1995	9.90	5.00	8.92	0.98	-1.09	10.99	8.48	7.38
1996	9.90	6.00	9.90	0.00	1.11	8.79	8.16	9.27
1997	9.90	7.00	9.87	0.03	-0.01	9.91	8.09	8.08
1998	9.80	8.00	11.43	-1.63	-1.09	10.89	8.28	7.18
1999	14.60	9.00	13.00	1.60	1.11	13.49	8.71	9.80
2000	14.60	10.00	13.50	1.10	-0.01	14.61	9.38	9.36
2001	11.30	11.00	12.40	-1.10	-1.09	12.39	10.31	9.21
2002	11.30	12.00	12.00	-0.70	1.11	10.19	11.48	12.58
2003	13.40	13.00	12.70	0.70	-0.01	13.41	12.91	12.88
2004	13.40	14.00	13.17	0.23	-1.09	14.49	14.58	13.47
2005	12.70	15.00	12.93	-0.23	1.11	11.59	16.50	17.58
2006	12.70	16.00	12.70	0.00	-0.01	12.71	18.67	18.63
2007	12.70	17.00	16.83	-4.13	-1.09	13.79	21.08	19.96
2008	25.10	18.00	20.97	4.13	1.11	23.99	23.75	24.82
2009	25.10	19.00	26.03	-0.93	-0.01	25.11	26.66	26.62

2010	27.90	20.00	31.00	-3.10	-1.09	28.99	29.83	28.69
2011	40.00	21.00	35.97	4.03	1.11	38.89	33.24	34.30
2012	40.00	22.00	40.00	0.00	-0.01	40.01	36.89	36.83
2013	40.00	23.00			-1.09	41.09	40.80	39.66
2014		24.00			1.11		44.96	46.01
2015		25.00			-0.01		49.36	49.29
2016		26.00			-1.09		54.01	52.85
2017		27.00			1.11		58.91	59.95
2018		28.00			-0.01		64.06	63.97

Table 4.2: Results from time series analysis

Data is first smoothed by computing a 3-period moving average. This is achieved by use of the average function in excel and the results are as outlined in the third column of the above table. The moving average factors out the trend and cyclical components from the data. Subtracting this from the original unemployment rates we remain with the seasonal and irregular components in column four. A further average of these components per season isolates the seasonal component as shown in the table below:

Season	S_t
1	-0.01
2	-1.09
3	1.11
total	0.00

Table 4.3: Seasonal Indices

Clearly, according to the above table, the sum of the seasonal indices is zero; hence there is no need for normalization.

The data is then deseasonalized by subtracting the seasonal component and the difference is as shown in column seven of table 4.2. Quadratic regression is then carried out on the deseasonalized data to determine the trend of the data as shown in the plot below.

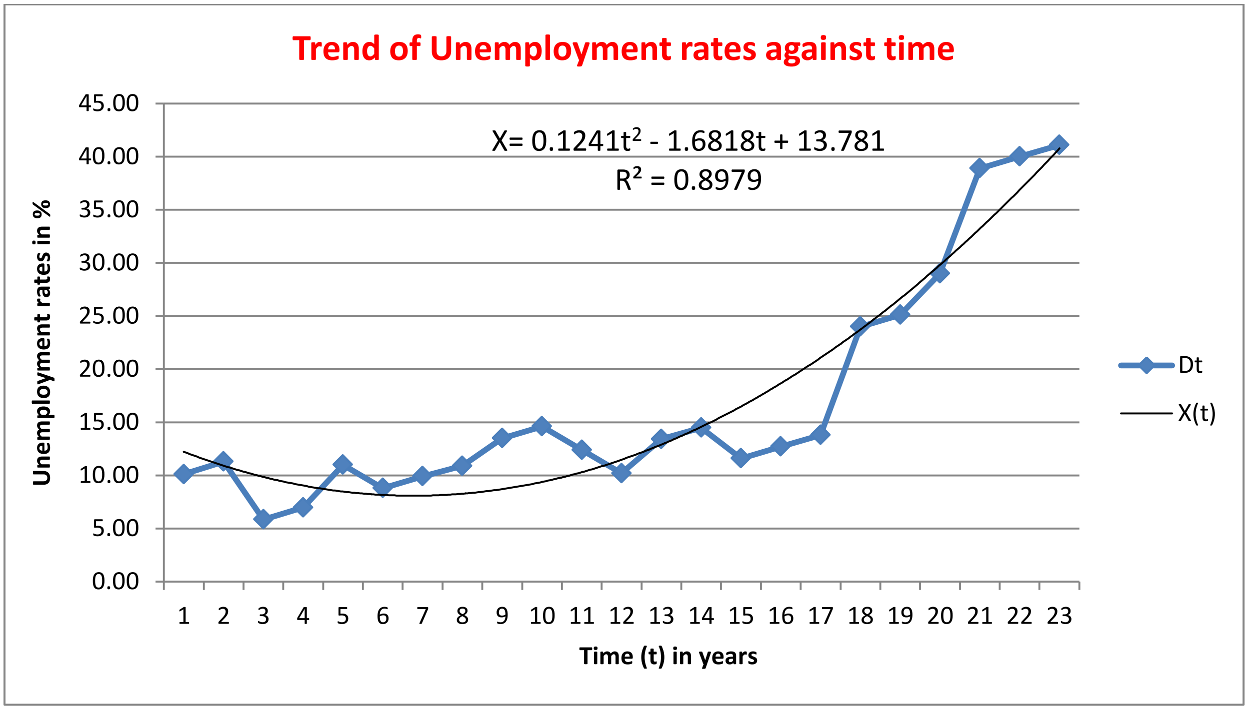

Figure 4.2: Regression plot of the Trend component.

Since the coefficient of determination is greater than 0.85, then the trend line describes the data well. We replace for the values of t in the regression equation to get the trend component for each time point. These values are calculated in column 8 of table 4.2. Adding the Trend component to the seasonal component at any time t gives us the time series value at time t as shown in column 9 of table 4.2. This is because the cyclical component is equal to zero.

4.2 Probability fit of the data

The unemployment rates were fitted into sixty one probability distributions using easy fit software. In a bid to determine which distribution best fits the data, goodness of fit was carried out using three statistical tests, which are Kolmogorov Smirnov, Anderson Darling and Chi-squared test; and ranked according to the tests as outlined in the table below.

Goodness of Fit – Summary

#	**Distribution**	**Kolmogorov Smirnov**		**Anderson Darling**		**Chi-Squared**	
		Statistic	Rank	Statistic	Rank	Statistic	Rank
1	Beta	0.32149	43	5.9391	47	1.8551	10
2	Burr	0.13166	1	0.59555	1	0.54718	4
3	Burr (4P)	0.13359	2	0.60107	2	0.54076	2
4	Cauchy	0.21663	20	2.0848	25	0.72886	6
5	Chi-Squared	0.29549	39	4.6018	42	7.0499	38
6	Chi-Squared (2P)	0.28258	34	2.3129	28	6.7205	35
7	Dagum	0.49712	57	8.5299	54	14.696	50
8	Dagum (4P)	0.21372	19	1.317	17	2.2775	13
9	Erlang	0.342	47	3.0127	37	5.1238	29
10	Error	0.33913	46	2.6043	33	6.4736	33
11	Error Function	0.74338	58	27.397	58	48.907	52
12	Exponential	0.35323	51	3.0401	38	12.586	49
13	Exponential (2P)	0.20251	16	6.1955	48	3.0365	19
14	Fatigue Life	0.24929	25	1.3869	19	4.7088	28
15	Fatigue Life (3P)	0.1797	10	0.8002	11	3.1384	21
16	Frechet	0.20101	13	0.78778	10	3.4766	25
17	Frechet (3P)	0.1512	3	0.66195	3	0.54145	3
18	Gamma	0.24387	24	1.4852	20	4.3003	27
19	Gamma (3P)	0.18806	11	4.6257	43	2.8912	17

20	Gen. Extreme Value	0.16417	6	0.76215	8	3.1026	20
21	Gen. Gamma	0.27678	33	1.6977	22	4.2174	26
22	Gen. Gamma (4P)	0.28792	37	9.0219	56	N/A	
23	Gen. Pareto	0.18819	12	8.0184	50	N/A	
24	Gumbel Max	0.26203	31	1.6114	21	10.503	43
25	Gumbel Min	0.39226	54	5.2901	45	11.237	45
26	Hypersecant	0.34479	48	2.6962	34	6.728	36
27	Inv. Gaussian	0.21822	22	1.1332	16	3.0226	18
28	Inv. Gaussian (3P)	0.16791	8	0.75251	7	3.1754	22
29	Johnson SB	0.25111	26	8.4215	53	N/A	
30	Kumaraswamy	0.25126	27	3.131	39	5.8462	30
31	Laplace	0.37039	52	3.1877	40	7.5402	39
32	Levy	0.43027	55	6.3344	49	10.659	44
33	Levy (2P)	0.25962	29	2.2188	27	1.1906	7
34	Log-Gamma	0.20877	18	0.99603	12	2.8346	16
35	Log-Logistic	0.2016	14	1.0955	15	1.7389	9
36	Log-Logistic (3P)	0.15945	5	0.68528	5	0.59844	5
37	Log-Pearson 3	0.17887	9	0.77399	9	3.1887	23
38	Logistic	0.33554	45	2.5462	32	6.512	34
39	Lognormal	0.23512	23	1.3177	18	1.5823	8
40	Lognormal (3P)	0.16478	7	0.74071	6	3.2209	24
41	Nakagami	0.25442	28	1.9107	23	11.818	47
42	Normal	0.32437	44	2.482	31	6.1717	32
43	Pareto	0.28503	35	4.385	41	2.437	15
44	Pareto 2	0.34688	50	2.9693	36	12.585	48
45	Pearson 5	0.20268	17	1.0143	13	1.9527	12
46	Pearson 5 (3P)	0.15401	4	0.68217	4	0.53181	1
47	Pearson 6	0.20198	15	1.0305	14	1.9289	11
48	Pearson 6 (4P)	0.28693	36	2.3328	29	2.3614	14
49	Pert	0.3128	41	2.3494	30	8.2101	41

50	Power Function	0.26953	32	8.8494	55	N/A	
51	Rayleigh	0.29528	38	2.1281	26	6.916	37
52	Rayleigh (2P)	0.34555	49	2.7737	35	8.0384	40
53	Reciprocal	0.31548	42	8.3555	52	6.0942	31
54	Rice	0.46388	56	5.5027	46	21.656	51
55	Student's t	0.98999	59	103.56	59	2490.0	53
56	Triangular	0.38238	53	5.1701	44	11.761	46
57	Uniform	0.30129	40	12.292	57	N/A	
58	Weibull	0.25968	30	1.9956	24	9.6867	42
59	Weibull (3P)	0.21741	21	8.3021	51	N/A	
60	Erlang (3P)	No fit					
61	Johnson SU	No fit					

Table 4.4: Ranking of distribution fits.

The estimated parameters according to various fits is as outlined in the table below

Fitting Results

#	**Distribution**	**Parameters**
1	Beta	α_1=0.30819 α_2=0.71703 a=6.96 b=40.0
2	Burr	k=0.23341 α=8.5438 β=9.1545
3	Burr (4P)	k=0.22428 α=9.1999 β=9.7054 γ=-0.60753
4	Cauchy	σ=2.5456 μ=11.606
5	Chi-Squared	ν=16
6	Chi-Squared (2P)	ν=35 γ=-18.841
7	Dagum	k=205.71 α=2.7744 β=1.1495
8	Dagum (4P)	k=0.65137 α=1.5314 β=8.4844 γ=6.9542
9	Erlang	m=2 β=6.7088
10	Error	k=1.4828 σ=10.645 μ=16.892

11	Error Function	h=0.06642
12	Exponential	λ=0.0592
13	Exponential (2P)	λ=0.10068 γ=6.96
14	Fatigue Life	α=0.53517 β=14.8
15	Fatigue Life (3P)	α=0.94421 β=7.8725 γ=5.5348
16	Frechet	α=2.1472 β=10.853
17	Frechet (3P)	α=2.0132 β=8.7807 γ=2.461
18	Gamma	α=2.5179 β=6.7088
19	Gamma (3P)	α=0.96977 β=9.3748 γ=6.96
20	Gen. Extreme Value	k=0.36664 σ=4.7981 μ=11.43
21	Gen. Gamma	k=1.0849 α=2.794 β=6.7088
22	Gen. Gamma (4P)	k=1.1104 α=0.60475 β=13.079 γ=6.96
23	Gen. Pareto	k=0.1997 σ=7.7326 μ=7.2301
24	Gumbel Max	σ=8.3002 μ=12.101
25	Gumbel Min	σ=8.3002 μ=21.683
26	Hypersecant	σ=10.645 μ=16.892
27	Inv. Gaussian	λ=42.533 μ=16.892
28	Inv. Gaussian (3P)	λ=12.242 μ=11.655 γ=5.2371
29	Johnson SB	γ=0.95475 δ=0.34418 λ=37.538 ξ=9.1166
30	Kumaraswamy	α_1=0.53633 α_2=1.4247 a=6.96 b=44.187
31	Laplace	λ=0.13285 μ=16.892
32	Levy	σ=12.925
33	Levy (2P)	σ=3.702 γ=6.2827
34	Log-Gamma	α=25.278 β=0.10585
35	Log-Logistic	α=2.9331 β=13.87
36	Log-Logistic (3P)	α=1.7317 β=6.5992 γ=6.3395
37	Log-Pearson 3	α=5.5651 β=0.2256 γ=1.4203

38	Logistic	σ=5.8692 μ=16.892
39	Lognormal	σ=0.52051 μ=2.6758
40	Lognormal (3P)	σ=0.92755 μ=1.9875 γ=5.8766
41	Nakagami	m=0.58364 Ω=393.74
42	Normal	σ=10.645 μ=16.892
43	Pareto	α=1.3594 β=6.96
44	Pareto 2	α=156.8 β=2696.3
45	Pearson 5	α=4.4479 β=57.491
46	Pearson 5 (3P)	α=2.3217 β=17.8 γ=4.1441
47	Pearson 6	α_1=200.83 α_2=4.5871 β=0.29625
48	Pearson 6 (4P)	α_1=0.90846 α_2=2.6483 β=17.215 γ=6.9598
49	Pert	m=6.94 a=6.94 b=79.763
50	Power Function	α=0.48551 a=6.96 b=43.203
51	Rayleigh	σ=13.478
52	Rayleigh (2P)	σ=13.2 γ=1.3978
53	Reciprocal	a=6.96 b=40.0
54	Rice	ν=1.2888E-5 σ=18.195
55	Student's t	ν=2
56	Triangular	m=6.96 a=6.96 b=45.552
57	Uniform	a=-1.5463 b=35.331
58	Weibull	α=1.9582 β=18.151
59	Weibull (3P)	α=0.92926 β=8.453 γ=6.96
60	Erlang (3P)	No fit
61	Johnson SU	No fit

Table 4.5: Estimated distribution parameters.

4.3 Justification of the model used

The problem of testing whether some given observations follow a particular distribution is a classical problem. However, based on the ranking according to the statistical tests and the requirement of a positive domain for the unemployment rates, the three-parameter Frechet distribution, which ranked third in all the tests, happened to be the best fit distribution for the data.

Moreover, the humped hazard plot of the 3-parameter Frechet distribution shown below implies that the unemployment rate tends to cluster around rates lower than twenty percent which is evidenced in the data.

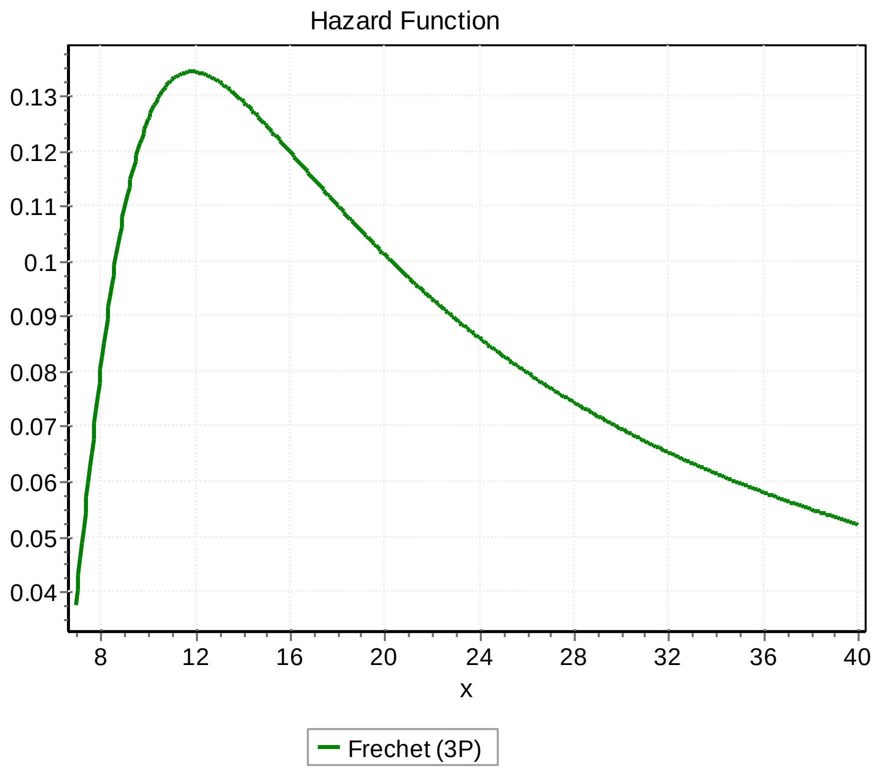

Figure 4.3: Hazard plot of the data

A further analysis of the Goodness of Fit details outlined below stresses that the 3-parameter Frechet distribution is the best distribution to describe the data. This is because for the five values of α, the p-value is greater than α hence we fail to reject the null hypothesis that the unemployment rates follow the 3-parameter Frechet distribution. Additionally, the statistic in each case does not lie above the critical value.

Goodness of Fit - Details

Frechet (3P)					
Kolmogorov-Smirnov					
Sample Size Statistic P-Value Rank	23 0.1512 0.61568 3				
α	0.2	0.1	0.05	0.02	0.01
Critical Value	0.21645	0.24746	0.2749	0.30728	0.32954
Reject?	No	No	No	No	No
Anderson-Darling					
Sample Size Statistic Rank	23 0.66195 3				
α	0.2	0.1	0.05	0.02	0.01
Critical Value	1.3749	1.9286	2.5018	3.2892	3.9074
Reject?	No	No	No	No	No
Chi-Squared					
Deg. of freedom Statistic P-Value Rank	2 0.54145 0.76283 3				
α	0.2	0.1	0.05	0.02	0.01
Critical Value	3.2189	4.6052	5.9915	7.824	9.2103
Reject?	No	No	No	No	No

Table 4.6: Goodness of fit test

4.4 Premium calculation

We use the actuarial present values for the estimation of premiums for a given level of benefit. With the symbols retaining their actuarial meaning the MPV of benefits payable is:

$$\text{MPV}_{\text{EDUCATION}}\ \text{Benefits} = v^k F(1+g)^k \ddot{a}_{x_2:\overline{n_2}|} \tag{4.1}$$

$$\text{MPV}_{\text{UNEMPLOYMENT}}\ \text{Benefits} = v^{k+n_2} 12S\ \ddot{a}^{(m)}_{x_2+n_2:\ u_{k+n_2}\ :\overline{2}|} \tag{4.2}$$

Where

F is the annual school fees for the preferred course of the beneficiary at the date the policy is effected.

k is the number of years from the date the policy is effected to when the first education benefits are received.

g is the estimated annual increment rate of the school fees e.g some insurance firms take g to be 5%.

x_2 is the age of the beneficiary at the time of receipt of the first education benefits.

n_2 duration of the preferred course of the beneficiary.

s is the amount of unemployment benefits to be received per month.

$\ddot{a}^{(m)}_{x_2+\mathrm{n}_2:\ u_{k+n_2}\ :\overline{2}|}$ is an annuity of an amount 1 per month for two years that depends on both the probability of survival and probability of unemployment.

Assuming that the probabilities of survival and unemployment are independent, then the annuity can be calculated as shown below:

$$\ddot{a}^{(m)}_{x_2+\mathrm{n}_2:\ u_{k+n_2}\ :\overline{2}|} = \sum_{t=0}^{24} \frac{1}{m} v^{\frac{t}{m}} {}_{\frac{t}{m}}p_{x_2+n_2}\, h\left(u_{k+n_2+\frac{t}{m}} \right) \qquad (4.3)$$

Where

m=12 if the unemployment benefits are received per month.

${}_{\frac{t}{m}}p_{x_2+n_2}$ is the probability that a life aged $x_2 + n_2$ survives for $x_2 + n_2 + \frac{t}{m}$ years.

$h\left(u_{k+n_2+\frac{t}{m}} \right)$ is the hazard rate when unemployment is equal to $u_{k+n_2+\frac{t}{m}}$.

Given that the premiums are payable annually in advance, the M.P.V of premiums can be calculated. Assuming there are no expenses involved, the M.P.V for premiums is:

$$\text{MPV Premiums} = P\ \ddot{a}_{x_1:\overline{n_1}|} \qquad (4.4)$$

Where:

x_1 is the age of the policy holder

P the premium

n_1 the number of premiums to be paid

$\ddot{a}_{x_1:\overline{n_1}|}$ is a mortality function and can be evaluated using appropriate actuarial mortality tables.

Therefore in a simple case where there are no expenses involved, the equation of value will be:

MPV Premiums = MPV Benefits

$$P\ \ddot{a}_{x_1:\overline{n_1}|} = v^k F(1+g)^k \ddot{a}_{x_2:\overline{n_2}|} + v^{k+n_2} 12S\ \ddot{a}^{(m)}_{x_2+n_2:\ u_{k+n_2}\ :\overline{2}|} \quad (4.5)$$

Making P, the subject of the formula gives the amount of premiums to be paid.

Note that, the symbols $\ddot{a}_{x_1:\overline{n_1}|}$, $\ddot{a}_{x_2:\overline{n_2}|}$ and v^k retain their actuarial meaning and definition.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.0 CONCLUSION

From the time series forecast, it is clear that unemployment rates are on the rise and have devastating effects hence the need for a cushion against the risk.

The amount of education benefits depend on the annual percentage increase rate g, hence g must be estimated appropriately to avoid inconvenience on either party, that is, the insurer or the insured.

The fear that the product may pose a moral hazard is nullified by limiting the period of receipt of the unemployment benefits to two years. This will motivate the beneficiaries to be more aggressive to ensure that the secure a job before the lapse of the two covered years.

Having successfully fitted the 3-parameter Frechet distribution to the Kenyan unemployment rates then it is evident that the product is realistic for the Kenyan market.

5.1 RECOMMENDATIONS

In order to counter the rising unemployment rates in the country, the study recommends that fresh graduates from colleges and universities should aim at opening up new businesses (become self-employed) rather than crowding the job market thus further increasing the unemployment rates in the country.

To make the study more inclusive, further research should be carried out to cover those who are employed, so that they receive unemployment benefits in the event that they involuntarily become unemployed. This could maybe be achieved by pricing the policy as an American option.

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