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Editor: Conrad Beyers
Department of Actuarial Science
University of Pretoria
Private Bag X20, Hatfield, 0028, South Africa
Tel: +27 (0)12 420 3488
Email: *saaj@actuarialsociety.org.za*

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Suitability of the 2.5% net discount rate for quantum of damage calculations in South Africa

By FF Koning, JP Swanepoel, JD Brits and E Maré

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ABSTRACT

This study is on the 2.5% real discount rate used to calculate the lump sum payment in the event of a compensation claim. The aptness of this 2.5% real discount rate is assessed through a statistical analysis of government bonds and inflation data over the past 59 years. The investigation yields evidence that the discount rate over the last 59 years may be mean reverting and would be a good approximation to use in the future. Also, an interesting relationship was found between the introduction of inflation targeting in the year 2000 and the stationarity of the series. It must be considered that the timing and duration of variation from the 2.5% cannot be predicted, but reversion to the series mean seems to always occur. The practice of using the 2.5% in the South African context is also compared to other practices globally. Finally, circumstances for the departure from the 2.5% discount rate are investigated, with some suggestions.

KEYWORDS

Discount rate, risk discount rate (RDR), net discount rate, liability claims, damages, loss of income (LOI), loss of support (LOS)

CONTACT DETAILS

Frans Frederik Koning, Actuarial Quantification Services; Cell: 082 454 0362;
Email: koningf@ufs.ac.za
JP Swanepoel, First National Bank; Cell: 079 525 4006; Email: jpswanepoel1312@gmail.com
Johan David Brits, First National Bank; Cell: 081 011 2012; Email: johanbrits96@gmail.com
Eben Maré, Absa Asset Management; Email: eben.mare@up.ac.za

1. INTRODUCTION

1.1 In the event of a claim for the loss of future income, the commonly used practice worldwide is to award a single lump sum to the claimant as compensation for the future loss. This award represents the present value of the differences between future income with and without the claim event occurring, such as an accident or death. Future income is assumed to increase at inflation, and then discounted to the present at the risk discount rate. The resultant real discount rate applied to the lost future income is therefore of critical importance, since it will have a great impact on the size of the loss calculated. This discount rate is often based on assumptions about the characteristics of the claimant and the nature of the loss.

1.2 The current South African industry real default liability discount rate of 2.5% is based on the difference between the implied risk discount rate of the backing assets of a prudent investment portfolio, assumed to be South African government bonds, and the inflation rate. This research sets out to do a comprehensive statistical analysis of the difference between the two variables over a period of 59 years, using monthly data. The purpose is to determine if government bonds consistently exceeded CPI inflation by an average of 2.5% over the longer term, and then to investigate the periods and triggers of such periods where this was not the case. The aim is to validate the 2.5% assumption currently in use and to assess and explain any major fluctuations from it.

1.3 This paper also investigates how the socio-economic position of individuals will impact their expected risk preference and expected investment return on their likely investment portfolio, from which their risk discount rate would be derived. This is done to determine what factors should be considered when departing from the 2.5% base discount rate for each individual. The practices in other countries on this matter are considered and the reasons behind them investigated. These are compared to the South African setting to see whether adjustments should be required to ensure a more appropriate compensation is awarded to each claimant.

2. LITERATURE STUDY

The core concepts of this study are defined below, followed by the factors that influenced the South African inflation rate and government bond yields over the recent past of 59 years. An explanation is given of the expected effect of the socio-economic position of individuals on their investment preferences. Finally, the socio-economic landscape of South Africa is discussed and the practices used in various countries to set the discount rate are explained and considered as a South African alternative.

2.1 Socio-economic position and Gini coefficient

2.1.1 SOCIO-ECONOMIC POSITION

Socio-economic position refers to the "social and economic factors that influence what positions individuals or groups hold within the structure of a society" (Galobardes et al., 2006: 1).

2.1.2 GINI COEFFICIENT

> The Gini coefficient can be interpreted as the percentage of inequality represented in the population with respect to the given resource. (Catalano et al., 2009: 1).

This percentage of inequality is represented in a coefficient that ranges from 0 to 1, with 0 indicating perfect equality and 1 the exact opposite. The Gini coefficient is usually used to quantify the level of income inequality in a population (Catalano et al., 2009).

2.2 Historical South African government bond yields and inflation

Since the discount rate is based on the difference between inflation and government bond yields, the economic factors that caused the variation of these two values in the 59 years from 1960 up to the start of 2019 in the South African context are explained. The analysis is performed over the past 59 year since the data source with the longest uninterrupted available data points was 59 years.

2.2.1 KEY EVENTS THAT AFFECTED THE SOUTH AFRICAN ECONOMY AND ITS EFFECT ON GOVERNMENT BOND YIELDS AND INFLATION FROM 1970 TO 1994

2.2.1.1 The South African GDP leading up to 1974 grew at an average of 4.9 percent per year. In the years 1974 to 1987, the average GDP growth slowed down to 1.8 percent per year. One explanation of the slowed economic growth (Levy, 1999) was the OPEC nations applying an oil embargo which started in 1973 at the same time as a worldwide oil crisis.

2.2.1.2 Two other noteworthy factors beyond the oil shocks affected the South African economy at this time. The first was the labour shortage that South Africa faced in the early 1970s. The second was an increased outflow of foreign capital from the South African economy which averaged 2.3% of the GDP from 1976–1980 (Levy, 1999). This outflow could be ascribed to the political unrest caused by the Soweto riots in 1976 which drew international attention. The dire economic position extended into the 1980s when the South African economy fell into a recession between 1984 and 1985 and a state of emergency was declared in 1985 (Hefti & Staehelin-Witt, 1986: 3).

2.2.1.3 Shortly after former South African president, PW Botha, delivered his infamous “Rubicon” speech in 1985, Chase Manhattan Bank declared that it would not be rolling over its short-term loans with the South African government. Other lenders soon followed, initiating a liquidity crisis (Giliomee, 1985: 38). At this time the appeal of investing into South Africa diminished due the increased financial risk caused by political unrest and economic instability (Levy, 1999). This drastic decrease in investment in the South African economy saw government bond yields rise in order to retain some investors.

2.2.1.4 The significant increase in the South African inflation rate from 1970 to 1980 can be ascribed to oil price shocks of the time (Nowak & Ricci, 2005: 190). However, the South African inflation remained high despite its trading partners experiencing disinflation from 1980 to 1990. This was due to a loose monetary policy adopted to stimulate economic activity which came at the cost of increased inflation (Nowak & Ricci, 2005).

2.2.2 KEY EVENTS THAT AFFECTED GOVERNMENT BOND YIELDS AND INFLATION FROM 1994 UNTIL 2019

2.2.2.1 During the mid-1990s, the South African Reserve Bank (SARB) introduced inflation targeting informally by targeting the money supply as the primary way of combating inflation (Nowak & Ricci, 2005). The SARB formalised the inflation-targeting regime in 2000. This caused "a substantial decline in the inflation differential with trading partner countries" (Nowak & Ricci, 2005).

2.2.2.2 After 1994, the government improved fiscal transparency and predictability and monetary policy has become more transparent and accountable (Nowak & Ricci, 2005: 195). These improvements led to an increase in investor confidence. This can be observed in the steady improvement of South Africa's sovereign debt rating by major credit ratings agencies from 1994 until 2008.[1]

2.2.2.3 However, in 2012 South African sovereign debt was gradually downgraded until Standard & Poor's downgraded South Africa's sovereign debt to sub-investment grade (or junk status) in April 2017 with Fitch to follow soon thereafter.[2] Slowed economic growth and a political agenda which overshadowed policy-making led to the downgrade.[3]

2.2.2.4 In the post-1994 era the largest variations in the discount rate were mainly caused by the rapid changes in inflation. Government bond yields caused some variation but were mainly dominated by the effects of the inflation-targeting strategies.

2.3 Effect of socioeconomic position on expected individual investment preferences

2.3.1 When setting the lump sum compensation amount, Koch (1993) notes that the future payments compensated for should be reduced for the advantage of being received earlier. The extent of this advantage and hence reduction required could however be differently contested by each claimant. As a result, the court would aim to objectivise this advantage by observing that "the claimant should mitigate his damages by profitably investing the compensation money" (Koch, 1993). The resulting expected investment return could serve as a measure of the advantage of early receipt of the compensation payments and their resulting reduction. According to Koch (1993), the personal investment idiosyncrasies of a claimant should not be considered in this regard, but rather the investment decisions adopted by "the reasonable man who is neither too cautious nor too reckless".

2.3.2 However, the South African context (see section 2.4) creates a socio-economic setting where the definition of a "reasonable man" and his generally accepted investment decisions may differ significantly between groups of individuals. As a result, the factors affecting the investment preferences of a claimant are discussed here as they could influence the investment decisions made and the resulting expected investment return earned by the claimant.

1 https://businesstech.co.za/news/finance/213641/one-graph-showing-south-africas-credit-rating-history-1994-2017/

2 Fitch downgrades SA to junk status. https://ewn.co.za/2017/04/07/breaking-fitch-downgrades-south-africa-to-junk-status

3 Donnelley, L (2017). https://mg.co.za/article/2017-11-25-global-credit-ratings-agency-has-downgraded-south-africa-to-junk-status/

2.3.3 It is important to understand the needs and socio-economic characteristics of the claimant as this will most likely influence the investment returns earned by the claimant on the awarded amount (Edwards, 1975: 342). An allowance for the net rate of return that the claimant can earn on an awarded lump sum must be set according to the return earned on an investment portfolio with an appropriate level of risk. Fairgrieve & Gauci (2016) describe this "risk" as the liquidity preference of the involved individual. They explicitly distinguish the difference in liquidity preference of individuals based on two socio-economic characteristics: age and level of wealth. Several other characteristics also influence the liquidity preference and risk aversion of individuals.

2.3.4 Impoverished individuals, especially in developing countries, have been found to be more risk averse than wealthier individuals and "were more likely to choose smaller and earlier monetary rewards over larger, delayed ones" (Haushofer & Fehr, 2014: 862).

2.3.4.1 The difference in risk preference for individuals of different levels of wealth can indeed be ascribed to liquidity constraints. This is observed since poorer individuals face much higher interest credit rates and receive more constrained amounts of credit than wealthier individuals. The higher cost of capital and the expectation of future liquidity constraints will lead to safer investment decisions. These investment decisions are not necessarily made due to higher risk aversion, but rather due to the need to alleviate liquidity constraints (Haushofer & Fehr, 2014).

2.3.5 Individuals with a higher level of attained education can be considered less risk averse than individuals with lower levels of attained education (Grable, 2000: 628).

2.3.5.1 Observations indicate that a higher educational qualification enables an individual to assess the probable risks and benefits of investing more accurately. An investor with a higher educational degree will thus be less risk averse and as a result it is expected that the individual will make investment decisions with a higher expected return. (Chattopadhyay & Dasgupta, 2015: 607; 618).

2.3.6 Individuals, who can invest larger amounts, are usually less risk averse than those who invest smaller amounts of capital (Chattopadhyay & Dasgupta, 2015).

2.3.6.1 The increased level of funds available for investment will increase an individual's ability to take on more risk since the range of investment options at the investor's disposal will increase. The increased ability to take on more risk is then expected to lead to an increased willingness to take on more risk (Riley Jr & Chow, 2016: 35).

2.3.7 Individuals with a higher occupational status exhibit lower levels of risk aversion than individuals with a lower occupational status (Grable, 2000).

2.3.7.1 Individuals with a higher occupation level are expected to have a higher level of disposable income and can thus afford to take on more investment risks. Also, individuals who follow a professional occupation tend to have lower risk aversion than those engaging in non-professional occupations (Chattopadhyay & Dasgupta, 2015).

2.3.8 It is apparent from the above that income level, education, occupation, and investment size of individuals are factors that could have a significant influence on the chosen discount rate.

2.4 The current South African socio-economic landscape

2.4.1 In the South African context, distinction between individuals can be made regarding the extreme unequal distribution of two, among several, indicators of socio-economic position: Education and wealth.

2.4.1.1 The World Bank has recently described South Africa as "one of the most unequal countries in the world by any measure". According to the World Bank, South Africa was found to have a Gini coefficient of 0.63 in 2015, the highest in the world. It has also displayed levels of wealth inequality that exceeded its level of income inequality. This prominent inequality is evident when observing that 71% of net household wealth is held by the top 10% of households while 7% of the net household wealth was held by the bottom 60% households (The World Bank & Statistics SA, 2018: xv)

2.4.1.2 South Africa's education system also produces a very unequally educated society. With the exception of a wealthy minority, most South African pupils cannot read, write and preform calculations according to the appropriate grade level (Spaull, 2013: 2). This is evident in the fact that South Africa's educational inequality is "much higher than its income inequality would suggest" (Crouch et al., 2008: 2). The South African Gini coefficient for education was 0.560 in 2010 and ranked 132nd most unequal out of 146 countries that participated in the study to determine global education inequality (Ziesemer, 2016).

2.4.2 Stark differences exist in the socio-economic positions of individuals in South Africa when considering the indicators of income and education. It is also clear that the socio-economic position of an individual influences the risk preference and investment needs and hence expected investment returns earned by individuals.

2.4.3 The next section refers to the practices accepted in South Africa and other countries to determine the discount rate. The aptness of current industry practice and the possible alternatives available to ensure an appropriate discount rate is chosen are assessed.

2.5 Accepted practices to calculate the discount rate in different countries

The countries chosen as comparatives to the South African practice are Canada, Hong Kong, and the United States of America. Hong Kong and Canada were chosen since these countries have unique practices when setting the discount rate compared to other countries on which literature could be found. The possibility of considering these practices in the South African case is worth investigating. The practice of the United States is similar to South Africa's since the discount rate is set in most states by a court ruling and expert evidence provided. The practices in the United States could provide some insights into possible alterations that can be made in South African practice. Practices of other developing countries with similar socio-economic conditions as South Africa would also have been considered but very little and incomprehensive literature is available on any such countries.

2.5.1 SOUTH AFRICA

2.5.1.1 In South African courts no specific statutory laws have been put into place to govern the quantum of damages calculation. South African courts "readily admit and frequently insist on actuarial testimony" when calculating the compensation of future losses.

As a result, the court allows for a great deal of flexibility when deciding on a method of calculating the compensation and do not wish to apply rigid regulations to it (Du Plessis, 2012: 5–9).

2.5.1.2 Thus, in the South African case actuaries have a good opportunity to contextualise the applied discount rate to ensure the fairest compensation is determined.

2.5.1.3 According to Fairgrieve & Gauci (2017: 53), in the South African case, the discount rate is calculated based on the allowance for the net rate of return expected to be earned by the claimant on the lump sum awarded. This expected return accounts for the investment portfolio that will meet the specific investment needs and risk appetite of the claimant. The particular circumstances of the claimant should be taken into account to determine their specific needs.

2.5.1.4 Although this is the case, it is argued by Fairgrieve & Gauci (2017) that even the most extensive analysis of a claimant's circumstances (for our study, socio-economic context) would not yield the application of the correct calculation. The result is a similar basis applied to all claimants regardless of circumstances.

2.5.1.5 This belief is evidently applied in practice: South African actuaries generally apply a discount rate of 2.5% to 2.73% to all cases (Koch, 2011: 113). This rate is based on recommendations made in the Quantum yearbook and originates from the assumed minimum risk real rate of return earned in South Africa.

2.5.2 Canada

2.5.2.1 According to the Report to the Civil Rules Committee on rules 53.09 and 53.10 of April 27, 2020, Ontario Canada have been using a two-tier approach for losses before and after 15 years. The 2.5% real rate is the current rate for losses after 15 years. The initial 15 years would use the real rate of interest on long-term Government of Canada real return bonds, with possible adjustments and a floor of 0%. (Feldman et al., 2020).

2.5.2.2 The Ontario Civil Rules committee is compelled to review the applied discount rate at least every four years and the most recent review has left the interest rates at 0.5% for the 15-year period that follows the start of the trail, increased from 0% since 2020 The rate used for any later period remains at 2.5% since 2000.[4]

2.5.2.3 There was also an evidence-based adjustment made to the risk discount rate, where evidence of the claimant was produced in court, in order to adjust the discount rate. However, the latest report in 2020 suggested that the two-tiered system be transformed into a single-tier system, and the ability of the judicial system to change the discount rate based on evidence should be eliminated. They also recommended that no different discount rates should be used for different kinds of damages, and specifically referred to the use of a different rate for medical damages (Feldman et al., 2020).

4 Courts of Justice Act (Ontario) RRO 1990 Regulation 194: Calculation of Awards for Future Pecuniary Damages Rules 53.09(1) and (2) Rules of Civil Procedure (2022)

2.5.3 HONG KONG

2.5.3.1 Until 2013 Hong Kong followed the accepted practice as in Wales and England to allow for a discount rate between 4%–5% as applied by the English common law principles laid down by the House of Lords (Chan & Chan, 2015: 511).

2.5.3.2 In 2013 however, the Hong Kong court gave two claimants, Li Ka Wai and Yuen Hiu Tung, an opportunity to investigate the validity of the 4.5% discount rate. As a result of the investigation the court ruled that different interest rates should apply to claimants with different financial needs, especially with reference to the time period of these needs (Bowers, 2013).

2.5.3.3 The structure of selecting the discount rate is currently set to allow for three different interest rates based on the future time period in which the claimant's future financial needs or liabilities occur (Fairgrieve & Gauci, 2017). These are:

— For the time period of 0–5 years, a rate of –0.5% per annum was accepted.
— For the time period of 5–10 years, a rate of 1% per annum was accepted.
— For the time period exceeding 10 years, a rate of 2.5% was accepted.

2.5.3.4 These rates were set according to the varying investment returns earned on portfolios set up to specifically meet the various liquidity preferences of these investors. These portfolios were made up of proportional investments in high quality bonds, blue chip stocks, Hong Kong Government Exchange Fund Notes and time deposits.

2.5.3.5 This decision was also based on the practice in the state of Ontario, Canada, as described above, but was altered to match the availability of certain investment instruments in the Hong Kongese context.

2.5.4 UNITED STATES OF AMERICA

2.5.4.1 In some states of the country the discount rate is set either by statute or prescribed by case law or the jury. In most states expert evidence is allowed to lead the discount rate set by the court. This has resulted in different decisions being made on deciding the applied discount rate. These include a rate or 0% as a result of assuming future inflation to be equal to future interest rates. Another assumption entailed the rate of interest should be based on "the best and safest investments". It has also been assumed that the claimant should be entitled to a risk-free stream of income if the lost income is assumed to be earned with certainty in the future if the damage did not occur (Whittaker, 2018).

2.5.4.2 In most states allowance is made for expert evidence to be used when setting a suitable discount rate. Currently members of the National Association of Forensic Economists are of the opinion that a rate of 1.36% is suitable to apply with respect to a 30-year loss period (Whittaker, 2018).

2.6 Approaches to determine a fair liability discount rate

2.6.1 The fair amount to award to a claimant is difficult to determine, since the goal is to put the claimant in the same financial position as if the loss event had not occurred (although in practice this is rarely the case). Several factors need to be kept in mind.

2.6.2 The first factor is the concept of the disutility of delayed payment, which Robert J. Koch explains in Chapter 8 of his thesis (Koch, 1993). It simply states that people will generally prefer a payment made now rather than a payment at a later date, even if this amount has been adjusted for inflation. Awarding a lump sum to the claimant already puts the claimant in a better position than what would have been the case if the loss event had not occurred. Therefore, this amount will need to be adjusted. Koch explains: "Future payments, however, when compensated by a present lump sum, will be reduced for the advantage of being received earlier." (Koch, 1993).

2.6.3 However, one can also argue that the lump sum would need to be adjusted to allow for future inflation. Keeping all these factors in mind we need to find a rate that would adjust the lump sum which would reflect a fair value to all parties involved.

2.6.4 Assuming that the claimant would invest the lump sum, the expected rate of return, as Koch states: "will include what the investor requires to offset inflation and also to offset the risks attaching to the investment". Koch goes on to explain that this expected rate of return is referred to as the nominal rate of return. To focus specifically on the pure risk element of the return, we use the real rate of return which takes inflation into account.

2.6.5 Using the real rate of return as a discount rate to adjust the present lump sum amount would ignore the individual circumstances of the claimant. However, this would introduce a consistent measure by which the lump sum would be discounted for all claimants. In chapter 8 of Koch's thesis, he states that: "The expected return on the investment would then be the measure, for compensation purposes, of the utility of the time value of money".

2.6.6 Deciding on which investments classes would be a fair assumption to base the real return on is a difficult task on its own and is discussed later on in this paper.

2.7 Using CPI inflation and government bond yields to calculate the real rate of return

2.7.1 To calculate the real return at a certain point in time, a proxy for inflation would be needed. In chapter 8 of Koch's thesis, he mentions: "The consumer price index as published by the Department of Statistics, despite its many weaknesses, is generally accepted as the fair reflection of the rate of inflation". Since the CPI is the most widely used measure of inflation, this was decided to be the most appropriate measure. See also the work by Dimson et al. (2009) which confirms this practice from a global perspective.

2.7.2 There is difficulty in choosing an appropriate investment index on which to base the nominal rate of return, since any choice made can be debated. Koch describes the yield index on fixed interest securities as a "barometer" of the investment opportunities at the time of investment. He also goes on to explain that: "It is submitted that if fairness is to be achieved the award that is made for damages should have regard to the state of the market at the time that the award is made". Since the yield on fixed interest securities would then be a good proxy for the market conditions at the time the investment would have been made, government bond yields were chosen as the measure on which to base the statistical analysis.

3. STATISTICAL ANALYSIS OF THE 2.5% DISCOUNT RATE

3.1 Although there are different approaches in determining the liability discount rate to be used in quantum damages calculations (see sections 2.6 and 2.7), this section tests the statistical appropriateness of the 2.5% discount rate used in practise as an ex-ante real return based on a risk-free investment.

3.2 This section only looks at the statistical significance in using the real return on fixed interest securities; a later section of this paper focuses more on the socio-economic factors that one needs to consider when setting a discount rate.

3.3 Using South-African asset class results from Firer & McCleod (1999), Firer & Staunton (2002) and extended by Dimson et al. (2016) for the period 1900–2015, we observe that the annualised total return for bonds, adjusted for inflation (i.e., real returns) amounted to 1.8% p.a. on a geometric return basis and 2.3% on an arithmetic mean basis with a standard deviation of 10.5% and standard error of the mean of 1.0%.

3.4 It is important to understand that the above result considers real returns on an ex-post basis. On an ex-ante basis, which we consider below, we need to understand that we observe nominal bond returns and will be subject to realised inflation. From an analysis perspective, we need to form a view on inflation.

3.5 Mankiw & Reis (2002, 2006) describe a model of dynamic price adjustment in the economy based on the assumption that information dissemination is slow throughout the population and expectations are formed based on past data. Döpke et al. (2008) find a period of roughly 18 months for European households to update information. Kabundi et al. (2015) find that economic agents in South Africa, for example, have heterogeneous inflation expectation beliefs with anchoring i.e., expectations linked to lagged inflation, displayed by individual price setters. Their work is extended by Miyajima & Yetman (2018) who describe anchoring of inflation expectations by unions and businesses.

3.6 Following the line of reasoning above, we therefore consider nominal bond returns adjusted by the current inflation rate in the analysis below. This line of reasoning is consistent with investors assessing real asset class returns on an ex-ante basis while using the current inflation rate as an estimate of future realised inflation. Given the comments by Bauer & McCarthy (2015) and Fisher et al. (2002) this is seen as a pragmatic approach.

3.7 Time frame of the analysis

For this study both returns on government bonds and inflation data dating from 1 January 1960 to 1 December 2018, as obtained from I_Net, were used for the analysis of the discount rate. This is a period of approximately 59 years in monthly values. For visualisation purposes, Figures 1 and 2 illustrate government bonds and inflation respectively.

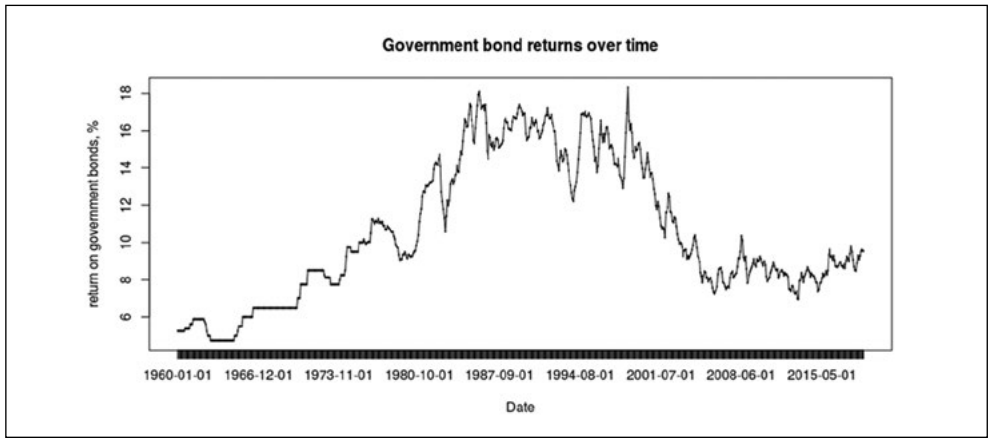

FIGURE 1. Return on government bonds over the past 59 years

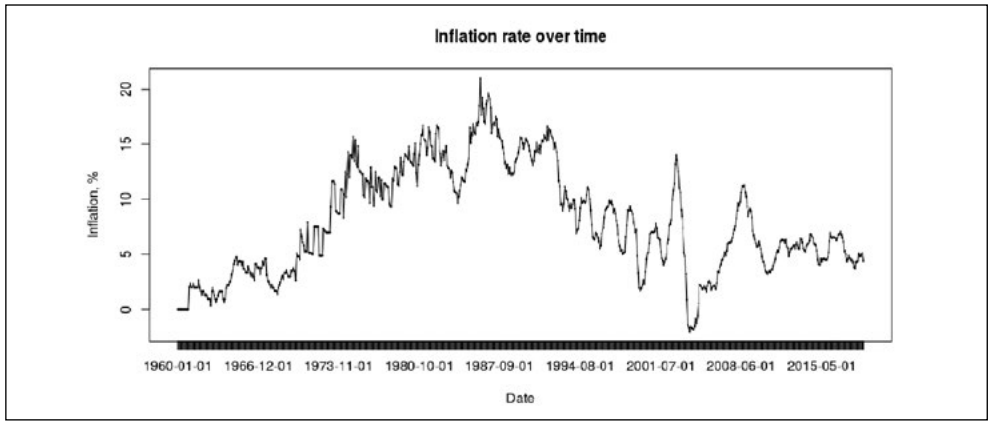

FIGURE 2. Inflation over the past 59 years

3.8 Method for calculating the discount rate

The method used for calculating the implied base discount rate is given by the formula,

$$r = \frac{(1+g)}{(1+i)} - 1,$$

where g is the return on government bonds and i the level of inflation.

3.9 Statistical analysis of implied discount rates

3.9.1 The discount rate r was calculated for each monthly entry of the government bond yields and inflation data. By plotting these rates over time and adding the 2.5% discount rate for reference, Figure 3 is obtained.

3.9.2 The mean real discount rate over the 59-year period was calculated and yielded a surprising result of 2.4972%, which for all practical purposes is equal to the 2.5%.

The significance of this result lies in the fact that the 2.5% that has been used for decades based on sound actuarial arguments, yet never statistically confirmed, was in fact remarkably accurate. From Figure 3, it is evident that from a visual perspective the 2.5% discount rate assumption in industry seems reasonable over long periods of time.

3.9.3 The geometric mean discount rate over the 59-year period was also calculated and yielded a result of 2.4452%. This is still close enough to the 2.5% rate currently in use. The long periods above and below the mean now requires attention.

3.9.4 The geometric averages over visual variation periods are calculated and shown in Figure 4.

3.9.5 The average from 1960 to 1973 was relatively stable around the 2.5% rate. The sharp decline in the average from 1973 to 1994 could be attributed to the numerous events such as labour shortages, Soweto riots, sanctions and recession that took place in the period leading up to the 1994 elections, as discussed in Section 2.2.1. Similarly, the steep incline in the average from 1994 to 2008 can be related to the factors discussed in

FIGURE 3. Discount rate over the past 59 years

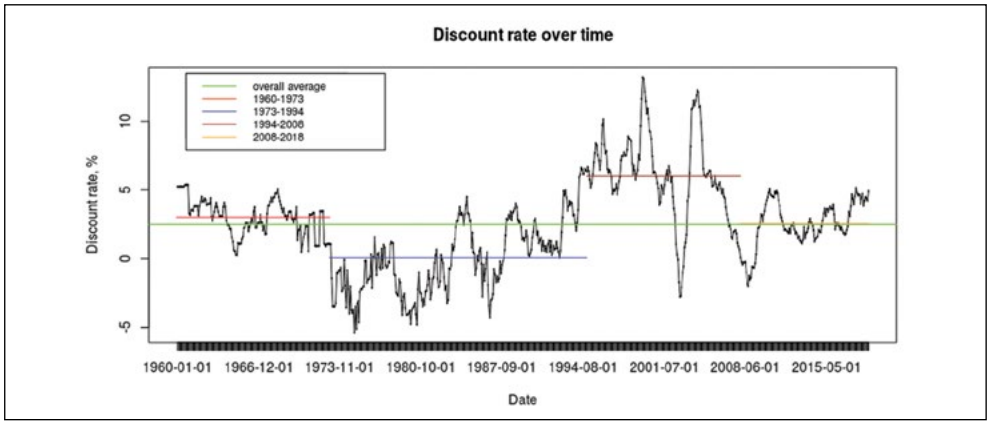

FIGURE 4. Geometric averages of the different periods

Section 2.2.2. The average stabilised around the 2.5% discount rate from 2008 onwards. Figure 5 visually illustrates all the factors that coincided with key turning points in the South African economy, some acting as trigger events for changes to the discount rate.

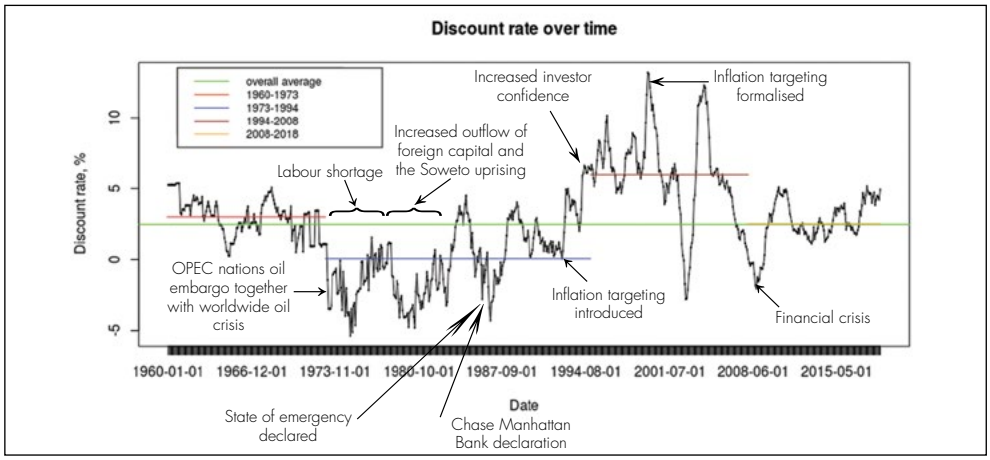

FIGURE 5. Key turning points in the South African economy

3.9.6 From the results in Figure 5, we can see that the South African economic and political landscape did not stabilise after the 1994 period. One can assume that the variation in the discount rate will continue into the future, but most of the variation seems to occur around the 2.5% rate and it seems that even after long periods of higher or lower variation, it eventually reverts to the 2.5%.

3.9.7 For the above statement to be statistically valid, the series will have to be mean reverting, meaning that the series will eventually revert to its mean after a period of deviation. To test this, the Augmented Dickey–Fuller (ADF) test and a Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test was performed on the data to test for weak stationarity (Kwiatkowski et al., 1992).

3.9.8 The ADF test has a null hypothesis that there is a unit root present, implying non-stationarity in the time series sample with an alternative hypothesis that the series is trend-stationary. The KPSS test has a null hypothesis that the time series sample is trend-stationary with an alternative hypothesis that the sample is not stationary. The Phillips-Perron (PP) test has a null hypothesis that there is a unit root present and an alternative hypothesis that the series is stationary. The ADF and PP tests' alternative hypotheses and the KPSS test null hypothesis are the similar in this context and should not be confused to have the same null and alternative hypotheses. The three tests yielded the following contradictory results:

— ADF: p-value = 0.01 stationary
— KPSS: p-value = 0.01 non-stationary

3.9.9 The indicated p-value for the ADF test is very small meaning that the null hypothesis cannot be accepted, and concluding that the series is stationary. The p-value for

the KPSS test was also very small which meant that the null hypothesis could also not be accepted, but meaning that the series is not stationary. These two tests produced contradicting results so further investigation is needed. The next step in finding out if the series is stationary is to plot the autocorrelation functions and the partial autocorrelation function, shown in Figure 6.

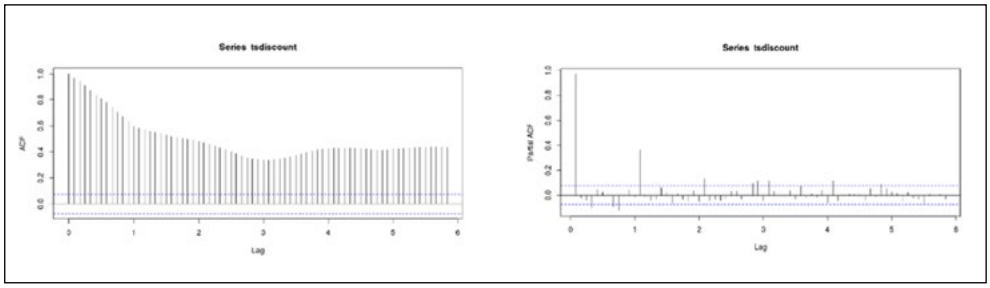

FIGURE 6. Correlograms of the series

3.9.10 The autocorrelation function has large significant lags that decrease but are still significant even at high lag values. This is a clear indicator that the series is not trend-stationary (Kestel, 2011). These are analysed using power spectra (plots of variance in time series data versus frequency. This was in contradiction with the Dickey Fuller unit root test. Although higher order autocorrelations are evident, the ADF test will remain well behaved (DeJong et al., 1992).

3.9.11 The results of the stationarity tests and the correlograms produced greater statistical evidence against the assertion of stationarity than in favour of it. Hence the possibility that the series varies around the mean cannot be confirmed statistically. However, when visually assessing the data, two proposed structural breaks (Hansen, 2001) can be observed. Figure 7 illustrates this.

3.9.12 To test if the proposed structural breaks were significant, the Chow test

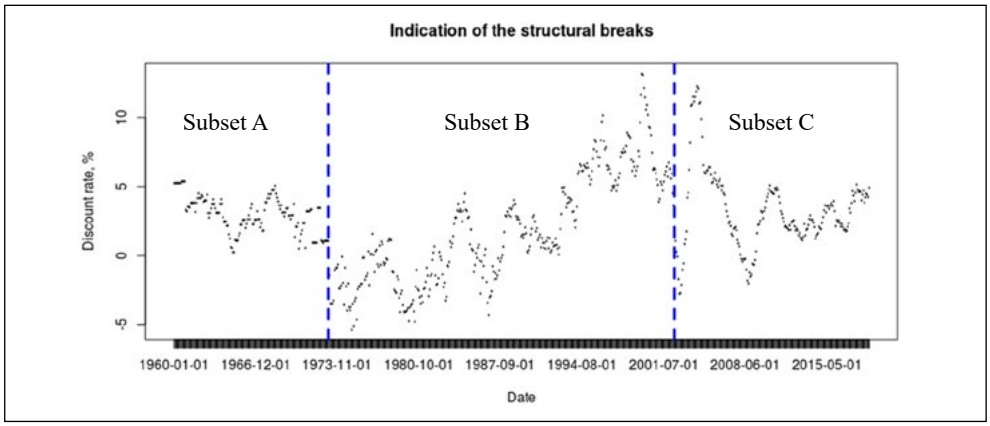

FIGURE 7. Structural breaks in the time series

(Morley, 2006) was done and Chow statistics were obtained for each of the breaks. The formula to calculate the Chow statistic is as follows:

$$F = \frac{\frac{RSS_P - RSS_A - RSS_B}{k}}{\frac{RSS_A + RSS_B}{n-2k}}$$

where each of the above values can be defined as:

— RSS_A is defined as the residual sum of squares using only subsample A in regression model.
— RSS_B is defined as the residual sum of squares using only subsample B in regression model.
— RSS_p is defined as the residual sum of squares using the entire pooled sample.

3.9.13 To calculate the Chow statistic for the two breaks, subsets A and B were taken as the respective subsamples in the formula for the first test statistic, and the next test statistic used B and C as subsamples.

3.9.14 The Chow statistic was then compared to the critical F value to determine if the structural breaks were significant. The following results were obtained for the Chow statistics and the critical F value.

— Chow statistic for first break: 470.20
— Chow statistic for second break: 190.72
— F critical value for first break: 1.24
— F critical value for second break: 1.23

3.9.15 Both Chow statistics are significantly larger than the critical values meaning that both structural breaks are significant.

3.9.16 Next, each individual part of the breaks was tested for stationarity using the ADF and KPSS tests on all three individual parts to see if any part of the time series is mean reverting. This yielded the following if the p-values are compared to a 5% confidence level.

For subset A:

— ADF test p-value of 0.3645 non-stationary
— KPSS test p-value of 0.01 non-stationary

For subset B:

— ADF test p-value of 0.07423 non-stationary
— KPSS test p-value of 0.01 non-stationary

For subset C:

— ADF test p-value of 0.01 stationary
— KPSS test p-value of 0.1 stationary

3.9.17 From the results of the stationary tests it can be seen that the only stationary part is subset C. An interesting occurrence is that after inflation targeting was formalised in

the year 2000, the series became stationary. This could be a coincidence, but it would be worth investigating this in a separate study. When looking at the series it is apparent that, although there is a large amount of variation, there is some mean reversion present, at least over the last 19 years, with this mean equal to 2.5%. To demonstrate this, the discount rate over the period with the mean and a two standard deviation interval is plotted in Figure 8.

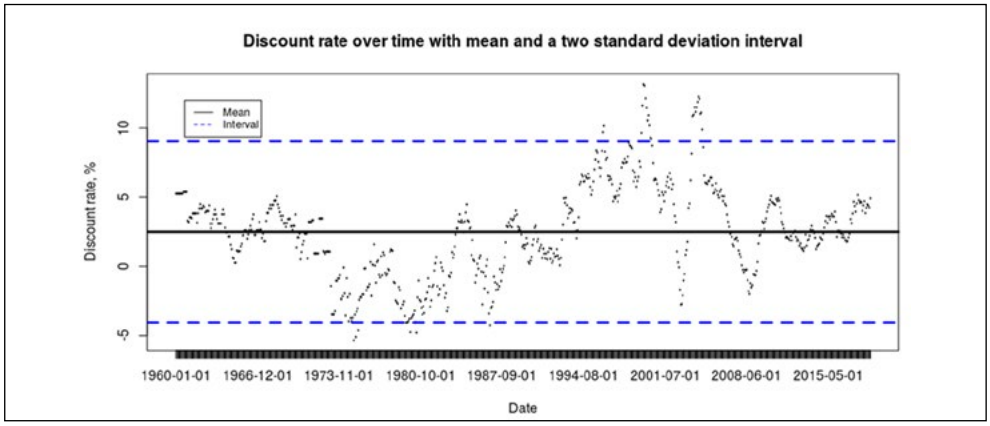

FIGURE 8. Geometric mean of the series with two standard deviation intervals

3.9.18 In Figure 8, it is shown that the discount rate only broke through the interval on a handful of occasions during the 1970–2009 period which relates to the various factors discussed in the literature study. Keeping in mind that the two standard deviations is only used with normal distributions, this provides some evidence that the series varies around the mean and that the 2.5% rate is a sensible rate to use in the future.

3.9.19 Future periods of large variation will be present in the data and structural breaks might occur that would compromise the mean reverting properties of the series, but it is important to note that the length of these large variation time periods cannot be predicted, but are likely to be temporary. The data have shown that the series will eventually revert to the mean of approximately 2.5%. More weight to the argument is produced by the period after the year 2000 when inflation targeting was introduced, and the series was found to be mean reverting. With inflation targeting not expected to change soon, it might be appropriate to apply the 2.5% discount rate going forward.

3.10 Analysis of the yield curves of South African, Hong Kong and Canadian government bonds

3.10.1 Data are analysed to determine whether setting the discount rate according to the term of the future loss, similar to Hong Kong and parts of Canada (2.5), is relevant in South Africa. This investigates whether the returns earned on investments will differ for investments with differing terms.

3.10.2 To determine this, the yields earned on government bonds with different terms are compared for each of these three countries. Clear differences between the yields of

bonds with different terms would indicate that the use of different interest rates for each term is appropriate.

3.10.3 The historic yields earned on government bonds with different terms which include 5, 10, 15 and 20 years for South Africa, Hong Kong and Canada respectively were plotted on the same graph in Figure 9 to determine whether distinct differences in the yields rates could be seen.

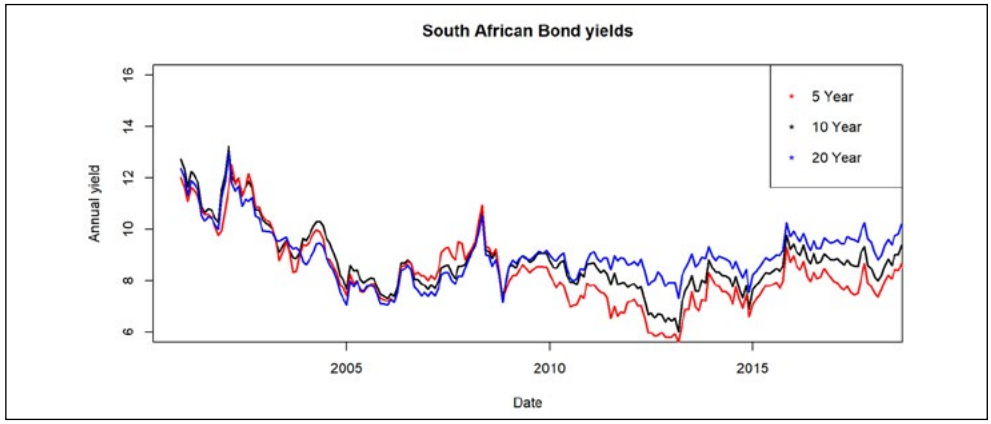

FIGURE 9. South African 5-, 10- and 20-year bond yields

3.10.4 From the plots in Figures 9 to 11, a clear and consistent difference between the yields of bonds with different terms can be seen in the case of Hong Kong and Canada compared to South Africa. In the South African case, the yields on longer term bonds do not consistently exceed that of shorter-term bonds in the time period from 2000 to 2009, indicating that a flat term structure existed in this time period. From 2009 the difference between the yields of the different South African bonds became clearer, which indicated that a steep yield curve, similar to that of Canada and Hong Kong, could be seen.

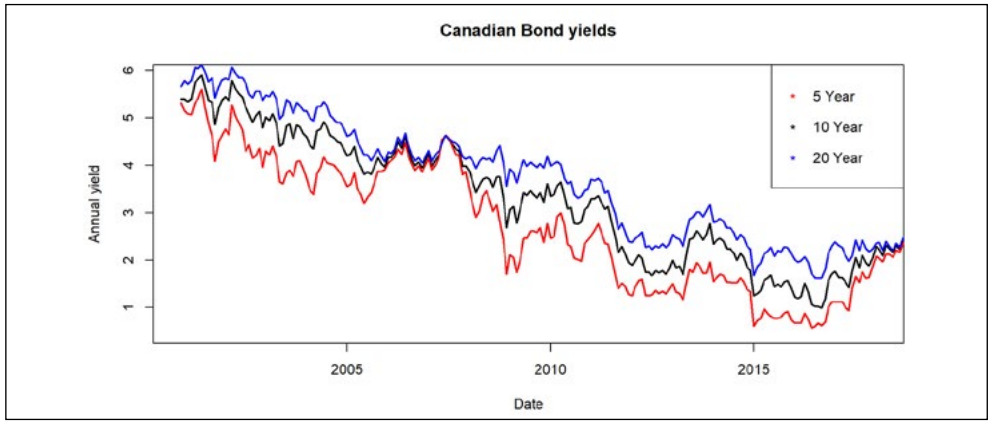

FIGURE 10. Canadian 5-, 10- and 20-year bond yields

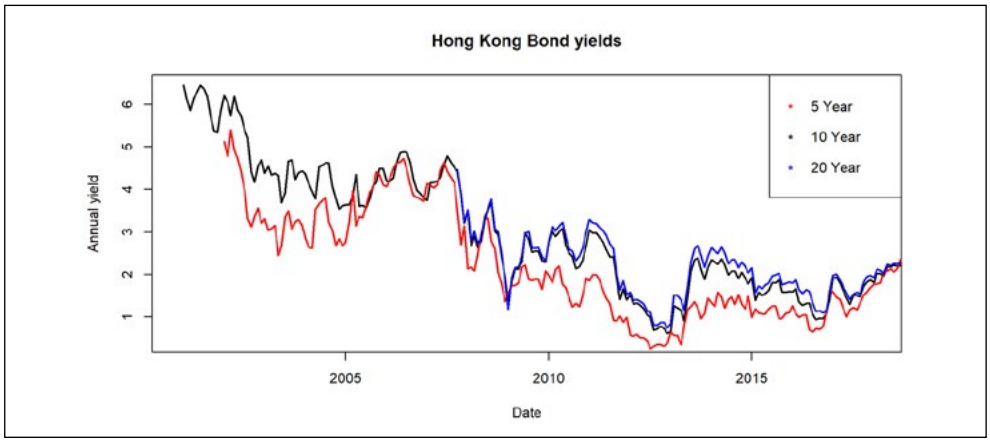

FIGURE 11. Hong Kong 5-, 10- and 15-year bond yields

3.10.5 For the period from 2009 until present, consideration should also be given to the proportional size of the differences between the yields of bonds with different terms for these three countries. To determine this proportional difference, plots for the three bonds of each country based on the following formula were made:

$$Proportional\ Difference = \frac{Yield\ on\ Bond\ A - Yield\ on\ Bond\ B}{Yield\ on\ Bond\ B}$$

3.10.6 The following plots were made in Figure 12. The proportional difference between long- and short-term bonds for each country were:

— South Africa: 20- and 5-year bonds
— Canada: 20- and 5-year bonds
— Hong Kong: 15- and 5-year bonds

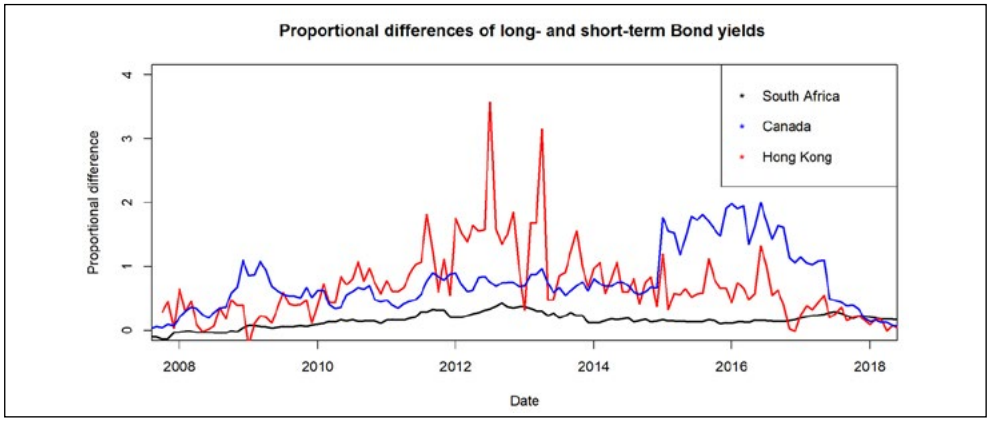

FIGURE 12. Proportional differences between long- and short-term bond yields.

The proportional difference between medium- and short-term bonds for each country were (Figure 13):

— South Africa: 10- and 5-year bonds
— Canada: 10- and 5-year bonds
— Hong Kong: 10- and 5-year bonds

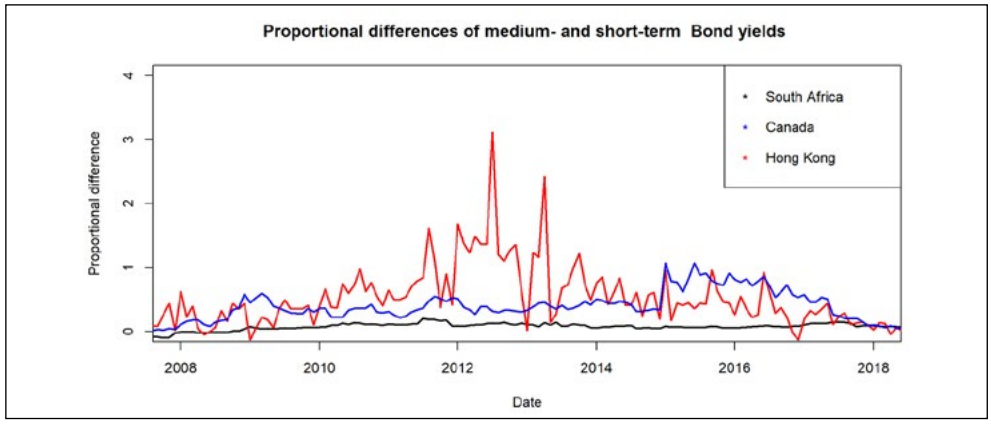

FIGURE 13. Proportional differences between medium- and short-term bond yields

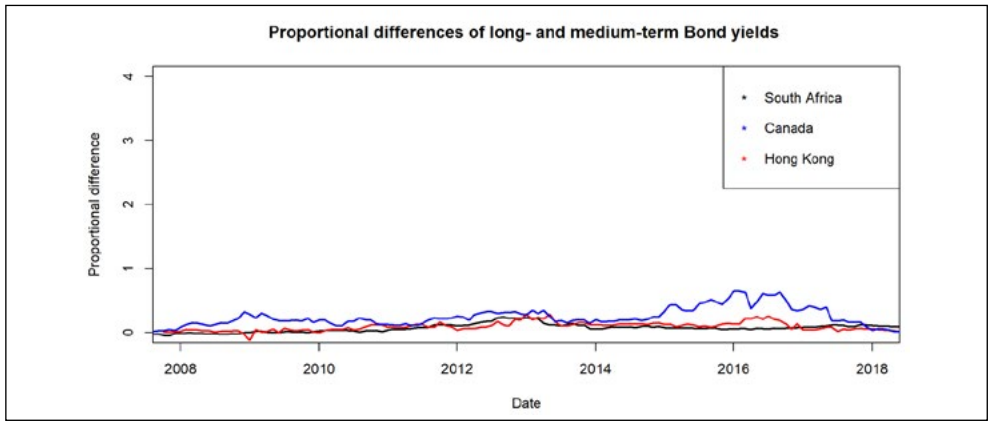

FIGURE 14. Proportional differences between long- and medium-term bond yields

The difference between long- and medium-term bonds (Figure 14) were:

— South Africa: 20- and 10-year bonds
— Canada: 20- and 10-year bonds
— Hong Kong: 15- and 10-year bonds

3.10.7 From Figures 12 to 14 a much larger proportional difference is seen between the yields on bonds from Canada and Hong Kong compared to those of South Africa when 20- and 10-year bonds are compared to 5-year bonds. When 20- and 10-year bonds are

compared, the proportional difference between the yields of each country are quite similar. This indicates that although a more distinctive difference between bonds of different terms can be seen in the South African case from 2009, this difference does not have the same proportional size as in the case of Canada and Hong Kong.

3.10.8 It can be concluded that the term structure of South African bond yields differs from the term structure of Canadian and Hong Kongese bond yields based on two factors: the consistency of the gap between the yields of bonds with different terms and the proportional size of the gap between these yields. Hence the conclusion can be made that the practice of dividing the discount rate into a set of different rates based on the future time period of the loss as done in Hong Kong and Canada, will not be relevant in the South African case yet. The relevance of such a practice in future can however not be excluded. The term structure of South African bond yields can be monitored to determine if the consistent gap between the yields of bonds with different terms continues and if the proportional difference between the yields increases. If this is the case, an alteration to the practice can be considered.

4. POSSIBLE ADJUSTMENT TO THE BASE DISCOUNT RATE FROM CLAIMANT CHARACTERISTICS

4.1 The relevance of government bonds

4.1.1 From the above analysis, it can be concluded that the assumption that government bonds will exceed inflation by 2.5% in the future is the best deterministic result to use in the calculation of the quantum of damages. This could be used as a base rate from which small adjustments are possible depending on the characteristics of the claimant.

4.1.2 The assumption that all claimants can and should invest the awarded lump sum in government bonds is contestable. Although government bonds are considered a reasonably safe security, there are many issues regarding government bonds that render them irrelevant to some investors as an investment choice, and debatable if they would have similar returns on their alternatives. The issues around bonds include the size of government bonds, lack of liquidity of such an investment and lack of investment knowledge (Edwards,1975: 345).

4.1.3 Hence, a suggestion is made that investment decisions that are assumed to be made by a claimant with the awarded lump sum should reflect the ability and need of a claimant to invest in government bonds as well as alternative investment instruments. The assumed investment decision made will greatly affect the expected return earned on the lump sum and hence the discount rate applied to the lost future earnings of the claimant.

4.2 Finding an accurate discount rate

4.2.1 Although Fairgrieve & Gauci (2017) contest the usefulness of adjusting the discount rate applied according to the specific needs and characteristics of the claimant, the literature described in sections 2.3 and 2.4 suggests a need to take the socio-economic position of claimants into consideration when determining the discount rate to ensure fair compensation. This should be done since claimants with different socio-economic positions will have diverging investment needs and abilities and this should be considered when selecting the applied discount rate.

4.2.2 A lack of similar investigations done into such a practice in other countries can be attributed to the uniqueness of the South African socio-economic context, as mentioned in section 2.4.

4.2.3 From the literature study it was found that the level of income, education, occupational status and the size of investment are prominent factors affecting the expected investment returns earned by investors. These factors could thus be considered when contextualising the discount rate.

4.3 Suggested future research

4.3.1 Future research into division of claimants into segments according to their socio-economic position and hence their investment preferences is suggested, possibly dividing claimants according to the Paterson Job Grading System. This system is suggested since it provides an objective measure of skill level and income level that is widely in use, understood and accepted in the South African practice.

4.3.2 The Paterson Job Grading System is used to analytically evaluate jobs based on an employee's ability to make decisions (Diamond, 2019). This system divides jobs into six different decision-making bands according to the complexity of decisions made by the employee. The complexity of the decisions made by the employee is closely related to the skill level of the employee. Hence the skill level of the employees in each decision-making band is explicitly indicated in the system. This system is used to define pay scales and thus determines the income level of an employee.

4.3.3 The Paterson Grading System is suggested as an appropriate system to use to classify the socio-economic position of a claimant since it considers the relevant socio-economic factors identified in the literature study (2.3) that influence investor preference.

4.3.4 This proposed research could include consideration of a reduction in the net discount rate of this paper for unskilled or semi-skilled, and even an addition for the highly skilled.

5. CONCLUSION

The statistical analysis suggests that the 2.5% industry discount rate is in reality a very sound base rate, with statistical mean reversion to the 2.5% average since the year 2000, when inflation targeting was introduced. Deviations above and below the 2.5% do occur over time, but damage calculations are often done over 20–60 years of future life span, and the current research confirms the current 2.5% as the best standard over the longer term.

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APPENDIX 1

CODE

```
library("tseries")

GovBonds<- read.csv("Government Bond yield.csv")
CPI<- read.csv("ZA CPI.csv")
Inflation <- CPI

plot(GovBonds, xlab = "Date", ylab = "return on government bonds, %", main = "Government bond
returns over time")
lines(GovBonds)
plot(CPI)
Inflation[1:12,2] <- 0
for (i in 13:708) {

 Inflation[i,2]<- ((CPI[i,2]-CPI[i-12,2])/CPI[i-12,2])*100
}

plot(Inflation, xlab = "Date", ylab = "Inflation, %", main = "Inflation rate over time")
lines(Inflation)

Diff<- CPI
Diff[,2]<- GovBonds[,2]-Inflation[,2]

vecdiff<- c(Diff[,2])
vecdate<- seq(1,708,1)

summary(regression <- lm(vecdiff~vecdate))

plot(Diff, xlab = "Date", ylab = "Discount rate,%", main = "Difference between Government bonds
and Inflation" )
lines(Diff)
curve(0.0047505*x+0.9056766 , from = 1, to = 708, add = TRUE, col = "blue")
legend(x = 600, y=13, c("Best fit line"), col=c("blue"), lty=1, cex=0.8)

Discountrate <- Inflation
Discountrate[,2]<- ((1+(GovBonds[,2]/100))/(1+(Inflation[,2]/100))-1)*100

curve(0.0047505*x+0.9056766 , from = 1, to = 708, add = TRUE, col = "red")

vecdiscount<- c(Discountrate[,2])

summary(regression <- lm(vecdiscount~vecdate))
```



```
plot(Discountrate, xlab = “Date”, ylab = “Discount rate, %”, main = “Discount rate over time” )
lines(Discountrate)
abline(a=2.5, b=0, col = “red”)
curve(0.0047505*x+0.9056766 , from = 1, to = 708, add = TRUE, col = “blue”)
legend(x = 10, y=10, c(“2.5%”, “best fit line”), col=c(“red”,”blue”), lty=1, cex=0.8)

tsdiscount<- ts(Discountrate$ZAFCPIALLMINMEI,frequency = 12)
pacf(tsdiscount)
acf(tsdiscount)

#looks like there is a seasonal component but it is very small as to make a difference in the actual
usage of the discount rate

#Now checking if I can see trends of high and low periods
geoaverage<- (prod(1+(Discountrate$ZAFCPIALLMINMEI)/100)^(1/708)-1)*100
OverallAverage <- geoaverage
Average1960to1973<- (prod(1+(Discountrate[0:157,2])/100)^(1/157)-1)*100
Average1973to1994<- (prod(1+(Discountrate[158:420,2])/100)^(1/262)-1)*100
Average1994to2008<- (prod(1+(Discountrate[421:577,2])/100)^(1/156)-1)*100
Average2008to2018<- (prod(1+(Discountrate[578:708,2])/100)^(1/130)-1)*100

plot(Discountrate, xlab = “Date”, ylab = “Discount rate, %”, main = “Discount rate over time” , type
= “l”)
lines(Discountrate)
abline(a=OverallAverage, b=0, col = “green”)

segments(y0 = Average1960to1973, x0= 0 , x1 = 157, y1 = Average1960to1973,col =”red”)
segments(y0 = Average1973to1994, x0= 157 , x1 = 420, y1 = Average1973to1994,col =”blue”)
segments(y0 = Average1994to2008, x0= 420 , x1 = 577, y1 = Average1994to2008,col =”brown”)
segments(y0 = Average2008to2018, x0= 577 , x1 = 708, y1 = Average2008to2018,col =”orange”)

legend(x = 10, y=13.5, c(“overall average”,”1960-1973”, “1973-1994”,”1994-2008”,”2008-2018”),
col=c(“green”,”red”,”blue”,”brown”, “orange”), lty=1, cex=0.8)

#Dickey fuller test

adf.test(diff(tsdiscount))
plot(diff(tsdiscount))

acf(tsdiscount,70)
pacf(diff(tsdiscount))
kpss.test(tsdiscount)

CPIpart <- CPI[100:200,]
```

```
#structural breaks

plot(Discountrate)

nobreak<- ts(Discountrate$ZAFCPIALLMINMEI)

sb1<- ts(Discountrate[1:158,]$ZAFCPIALLMINMEI)

plot(sb1)

sb2<- ts(Discountrate[158:510,]$ZAFCPIALLMINMEI)

plot(sb2)

sb3<- ts(Discountrate[510:708,]$ZAFCPIALLMINMEI)

plot(sb3)

rNoBreak <- lm(nobreak~vecdate)

rsb1 <- lm(sb1~vecdate[1:158])
rsb2 <- lm(sb2~vecdate[158:510])
rsb3 <- lm(sb3~vecdate[510:708])

plot(Discountrate)

curve(rsb1$coefficients[2]*x+rsb1$coefficients[1] , from = 1, to = 158, add = TRUE, col = “red”)
curve(rsb2$coefficients[2]*x+rsb2$coefficients[1] , from = 158, to = 510, add = TRUE, col = “blue”)
curve(rsb3$coefficients[2]*x+rsb3$coefficients[1] , from = 510, to = 708, add = TRUE, col = “green”)
curve(rsbpart1$coefficients[2]*x+rsbpart1$coefficients[1] , from = 1, to = 510, add = TRUE, col =
“purple”)
curve(rsbpart2$coefficients[2]*x+rsbpart2$coefficients[1] , from = 158, to = 708, add = TRUE, col =
“black”)

sbpart1<- ts(Discountrate[1:510,]$ZAFCPIALLMINMEI)
sbpart2<- ts(Discountrate[158:708,]$ZAFCPIALLMINMEI)

rsbpart1 <- lm(sbpart1~vecdate[1:510])
rsbpart2 <- lm(sbpart2~vecdate[158:708])

rss1<- sum(residuals(rsb1)^2)
rss2<- sum(residuals(rsb2)^2)
rss3<- sum(residuals(rsb3)^2)
rssp1<- sum(residuals(rsbpart1)^2)
rssp2<- sum(residuals(rsbpart2)^2)
```

```
Chowstat1<- ((rssp1-(rss1+rss2))/2)/((rss1+rss2)/(rsb1$df+rsb2$df-4))
fcrit1<-qf(.95,df1=rsb1$df,df2=rsb2$df)

Chowstat2<- ((rssp2-(rss2+rss3))/2)/((rss2+rss3)/(rsb2$df+rsb3$df-4))
fcrit2<-qf(.95,df1=rsb1$df,df2=rsb2$df)

kpss.test(sb3)
adf.test(sb3)

#plotting 2 standard deviations around the mean

upperbound<- OverallAverage+ sd(Discountrate$ZAFCPIALLMINMEI)
lowerbound<- OverallAverage- sd(Discountrate$ZAFCPIALLMINMEI)

plot(Discountrate)
curve(OverallAverage + 0*x , from = 1, to = 708, add = TRUE, col = “blue”)
curve(upperbound + 0*x, from = 1, to = 708, add = TRUE, col = “green”, type = “l”)
curve(lowerbound + 0*x , from = 1, to = 708, add = TRUE, col = “green”,type = “l” )
```


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'Where angels fear to tread'—Reflections on the role of an actuary as expert witness in the Land Claims Court

By MW Lowther

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ABSTRACT
In this paper, the author reflects on his experiences of giving expert actuarial witness in the Land Claims Court regarding the calculation of financial compensation as an alternative to the restoration of dispossessed land. As no specific formula for compensation has been legislated in South Africa's land reform programme, relevant case histories are examined in which the common law has been developed. The technical, ethical and professional inputs which an actuary can provide are reviewed. The author concludes that actuaries are well suited to assist the Land Claims Court to resolve the potentially large number of claims, and that this will be in the public interest.

KEYWORDS
Land reform, land restitution, compensation, professionalism

CONTACT DETAILS
Mickey Lowther, University of Cape Town; Email: actuary@mweb.co.za

1. INTRODUCTION

1.1 In the early years of this century, I was approached to give input into a novel matter for actuaries—the calculation of compensation as equitable redress for land dispossessed in the 1900s as a result of unfair racial practices. So little precedent existed that the claimants engaged three actuaries to give their opinions on methodology!

1.2 Since then, I have given expert testimony in a number of claims for compensation in terms of the Restitution of Land Rights Act. This paper has emerged from my reflections on these experiences, and could inform an actuary asked to give evidence.

1.3 I consider that actuaries are ideally placed to serve the public interest in these matters, not just for the calculations (which are mainly straightforward) but also because our services are delivered in terms of our 'professional promise' to be technically correct and up-to-date, ethical, and subject to professional oversight. The presentation of this work at the Convention of the Actuarial Society of South Africa in October 2021, and its subsequent publication, contributes to the third strand of the professional promise—members of the profession gathered to examine these and other potential approaches to compensation.

1.4 The paper may also be of interest to the lawyers and property valuers involved in compensation matters, as little research seems to have been published on the specific subject of compensation calculations.

1.5 Section 2 positions land restitution as one of the three elements of South Africa's land reform policy. Section 3 sets out the relevant legislation, including the option for dispossessed persons to claim financial compensation instead of restoration of their land. This legislation does not lay down detailed rules for the calculation of compensation, so Section 4 reviews court cases which have created common law.

1.6 Section 5 looks at the data and calculations that may be needed by an actuary or other expert asked to assist the Court in these matters. Section 6 considers the broader requirements of the expert, and why actuaries can serve the public interest by delivering this service according to their 'professional promise'. This section concludes where 'angels fear to tread'—the tricky area of how far the actuary, as an expert witness serving the Court, can go in recommending and justifying methodology.

2. THE LAND REFORM PROGRAMME

2.1 'Post-colonial societies must grapple with redress. A usual feature of colonial conquest is the dislocation of conquered people from their land.' (Ngcukaitobi, 2021: xi) In its 'Ready to Govern' policy document, the African National Congress set out the three elements of its land redress policy—land restitution, land redistribution and land tenure reform. 'A new system of just and secure property rights must be created, one which is regarded as legitimate by the whole population' (ANC, 1993).

2.2 With respect to *land restitution*, a Commission for the Restitution of Land Rights would be established to restore land to South Africans dispossessed by discriminatory legislation since 1913. The adjudication of these claims was expected to be finished by 1999. Provision was made for 'equitable redress' as an alternative to land restoration. This could take the form of financial compensation, and issues and methodologies around the calculation of such compensation are the subject of this paper. However, it is useful to outline briefly the other two elements of the land reform policy, to place such calculations in perspective.

2.3 The *land redistribution* initiative aimed to provide residential and productive land to those who needed it but could not afford it. The goal was to redistribute 30% of agricultural land by 1999 (based on an estimate of 6% of land being sold per annum in recent years). Both market and non-market mechanisms were to be used to acquire and distribute property such as vacant government land, land already on sale, under-utilised land and, in certain cases, expropriated land.

2.4 The third and perhaps most challenging tier was *land tenure*. The land rights of millions of South Africans who hold their land in customary tenure in the former homelands, in informal settlements and on transferred land are uncertain (Beinart et al., 2017). These authors identified many different types of off-register tenure needing to be reformed, each with a different legal status (ibid: 25).

2.5 In 1996, the final Constitution was adopted by Parliament (Act 108 of 1996).[1] The three tiers of land reform were facilitated, particularly by Section 25. Property was defined to include land and the State was mandated to take measures to achieve equitable access to land. Section 25 reads as follows:

> (1) No one may be deprived of property except in terms of law of general application, and no law may permit arbitrary deprivation of property.
>
> (2) Property may be expropriated only in terms of law of general application—
>
> (a) for a public purpose or in the public interest; and
>
> (b) subject to compensation, the amount of which and the time and manner of payment of which have either been agreed to by those affected or decided or approved by a court.
>
> (3) The amount of the compensation and the time and manner of payment must be just and equitable, reflecting an equitable balance between the public interest and the interests of those affected, having regard to all relevant circumstances, including—
>
> (a) the current use of the property;
>
> (b) the history of the acquisition and use of the property;
>
> (c) the market value of the property;
>
> (d) the extent of direct state investment and subsidy in the acquisition and beneficial capital improvement of the property; and

1 Constitution of the Republic of South Africa Act [No. 108 of 1996]

(e) the purpose of the expropriation.

(4) For the purposes of this section—

(a) the public interest includes the nation's commitment to land reform, and to reforms to bring about equitable access to all South Africa's natural resources; and

(b) property is not limited to land.

(5) The state must take reasonable legislative and other measures, within its available resources, to foster conditions which enable citizens to gain access to land on an equitable basis.

(6) A person or community whose tenure of land is legally insecure as a result of past racially discriminatory laws or practices is entitled, to the extent provided by an Act of Parliament, either to tenure which is legally secure or to comparable redress.

(7) A person or community dispossessed of property after 19 June 1913 as a result of past racially discriminatory laws or practices is entitled, to the extent provided by an Act of Parliament, either to restitution of that property or to equitable redress.

(8) No provision of this section may impede the state from taking legislative and other measures to achieve land, water and related reform, in order to redress the results of past racial discrimination, provided that any departure from the provisions of this section is in accordance with the provisions of section 36(1).

(9) Parliament must enact the legislation referred to in subsection (6).

2.6 Now, 25 years later, much has happened in the land reform programme, which is far from complete. The successes and difficulties in land redistribution and tenure reform lie outside the scope of this paper, so the next section provides more exposition on the land restitution process, prior to the sections which concentrate on the calculation of compensation.

3. LAND RESTITUTION

3.1 As mandated by the 1996 Constitution, the Restitution of Land Rights Act (LRA)[2] was duly enacted, and amended from time to time thereafter. (The 2014 amendments were subsequently invalidated by the Constitutional Court, as discussed below.) The LRA provided for the restitution of rights in land to persons or communities dispossessed of such rights after 1913 as a result of past racially discriminatory laws or practices.

3.2 In terms of the LRA, the Commission for the Restitution of Land Rights (CRLR) was created, along with the Land Claims Court (LCC). The CRLR would receive and process claims. Where the CRLR could not resolve a claim, it would be referred to the LCC, which had the power to determine all matters, including the award of equitable redress, such as the payment of compensation, instead of restoration. The LCC has a broader, more inquisitorial mandate than the High Court—for example, hearsay evidence may be accepted, and the Court

2 Restitution of Land Rights Act [No. 22 of 1994]

may take its own initiative to gather evidence and fashion new remedies. As the Court stated in *Phillips*:[3]

> The LCC has a strict and true discretion and enjoys wide adjudicative remedial powers conferred under Section 33 [of the LRA]

3.3 In the LRA, 'restitution of a right in land' is defined as the restoration of a right in land, or equitable redress; and 'equitable redress' is defined as the payment of compensation, or the grant of alternative land, when restoration of land is not feasible.

3.4 Section 2(2) provides that restitution is not available if just and equitable compensation, as contemplated in S25 of the Constitution, and calculated at the time of dispossession, had been received.

3.5 Section 33 of the LRA directs the LCC to have regard to the following factors in coming to its determinations:

(a) The desirability of providing for restitution of rights in land to any person or community dispossessed as a result of past racially discriminatory laws or practices;
(b) The desirability of remedying past violations of human rights;
(c) The requirements of equity and justice;
(cA) If restoration of a right in land is claimed, the feasibility of such restoration;
(d) The desirability of avoiding major social disruption;
(e) Any affirmative provisions which already exist in respect of the land;
(eA) The amount of compensation or any other consideration received in respect of the dispossession, and the circumstances prevailing at the time of the dispossession;
(eB) The history of the dispossession, the hardship caused, the current use of the land and the history of the acquisition and use of the land;
(eC) In the case of an order for equitable redress in the form of financial compensation, changes over time in the value of money;
(f) Any other factor which the Court may consider relevant and consistent with the spirit and objects of the Constitution, in particular section 9 [*which deals with equality*].

3.6 Of the approximately 80 000 restitution claims submitted by the 1998 deadline, about 75 000 had been settled by 2007 (CRLR, 2007: 3). These statistics are somewhat misleading because urban claims are predominantly small claims by families and tenants, whereas rural claims may be for vast tracts of land by communities of hundreds of people. Most of the unresolved claims were complex rural claims 'involving disputes among claimants, disputes over the jurisdiction of traditional authorities, disputes on the part of landowners, or untraceable claimants' (Xingwana, 2007).

3 *Minister of Rural Development and Land Reform and another* v *Phillips* [2017] ZASCA 1; [2017] 2 All SA 33 (SCA)

3.7 The vast majority of finalised restitutions were (a) for urban land, and (b) by way of financial compensation and not land restoration. The CRLR was empowered to make Standard Settlement Offers of about R40 000 to dispossessed property owners, and about R17 500 to dispossessed former tenants. Although these amounts often bore little relationship to the lost right, claimants generally accepted them, inter alia because of bureaucratic delays in land restoration, the difficulty of restoration where the land use and settlement patterns had changed substantially, and a preference for the utility of cash.

3.8 Bohlin (2004) interviewed two communities which had accepted a financial settlement. Reasons given for taking cash included:

— A cash payment was perceived as a faster and more certain process.
— Restoration would be to the community, with attendant management and resource issues and difficulties.
— The elderly did not want to move again.
— The community's current way of life should be protected.
— They would not be welcome in the restored area.

3.9 Land expert Professor Ben Cousins (2016) goes further and recommends that the restitution process be closed, and most outstanding claims settled by compensation—excluding the relatively few claimants who desire to be genuine producers on land. This would allow the Department of Land Affairs to focus primarily on the larger projects of land redistribution and tenure reform. The restitution process was not designed to develop agricultural production.

3.10 Ngcukaitobi (2021) on the other hand reminds us that restitution is about more than the benefits of using land:

> It is about memory, the public affirmation that black people's pain matters, and the restoration of lost identities. This is why land restoration shall remain the most contentious and the most important of the land reform programmes. (ibid: 116)

3.11 Walker et al. (2010) also see land restitution as bigger and longer than a once-off restoration of a particular piece of land:

> It is increasingly clear that Restitution is best understood as a process, not a one-time event. The restoration of land as the formal settlement of a claim marks not the end of the restitution road, but an early stage in an ongoing and often extremely complex process of community reconstruction. (ibid: 1)

3.12 Land restitution was initially seen as a relatively short-term project, with the bulk of the cases expected to come from post-1948 Group Areas Act[4] dispossessions. The CRLR was provided with only a few staff, who apparently struggle to deal with complex,

4 Group Areas Act [No. 41 of 1950]

often overlapping, rural claims mainly from the early decades of the twentieth century. Throughout the 2000s, government set deadlines for when the process should be finished. In 2014 however, the Land Restitution Amendment Act[5] was enacted, reopening the window for the lodgement of claims. Approximately 160 000 new claims had been made by 2016, when the Constitutional Court declared the Amendment Act invalid, due to lack of proper consultation.[6] The CRLR was interdicted from processing these claims until Parliament followed due process—and although new legislation has not yet been approved, this vast number of claims may sooner or later reach the LCC and need to be decided.

4. FINANCIAL COMPENSATION—CASE HISTORIES

Although there are references to changes in the value of money, and to market value, there is no specific formula in the Constitution or the Land Restitution Act for the calculation of financial compensation as equitable redress. Nor, as far as this researcher is aware, has there been much academic research on how such compensation should be calculated. (Publications on compensation have mainly been with respect to compensation to current landowners in respect of land expropriated for the purposes of restoration.) In practice, the LCC has had to use its discretion to fashion appropriate remedies, guided by the principles set out in Section 25 of the Constitution and Section 33 of the Land Restitution Act. These remedies have on occasion been reviewed and refined on appeal to the Supreme Court and Constitutional Court. This section reviews some relevant cases.

4.1 *Farjas*[7]

4.1.1 The *Farjas* matter was an early claim, at a time when little common law had been developed by the LCC on financial compensation. (In earlier cases, such as the *Highlands Residents* case,[8] the parties had agreed without argument that such compensation would be achieved by adjusting the historic value of the property by changes in the Consumer Price Index.) In *Farjas*, the claimant went to the extent of appointing three expert actuarial witnesses to give their views—based on general principles—on how an agreed historical loss should be revalued to the present. Methods such as rolling up with bond interest rates or market returns on property or equity were suggested, but the LCC ruled that compensation would be calculated as the historical loss, revalued by the Consumer Price Index. This amount was substantially lower than the three actuaries' results.

4.1.2 On appeal to the Supreme Court of Appeal (SCA), that Court quoted Harms ADP in another LCC matter, *Mphela*[9] as follows:

5 Restitution of Land Rights Amendment Act [No. 15 of 2014]

6 *Land Access Movement of South Africa and others* v *Chairperson, National Council of Provinces and others* 2016 (5) SA 635 (CC) (2016(10) BCLR 1277; [2016] ZACC 22)

7 *Farjas (Pty) Ltd* v *Minister of Agriculture and Land Affairs for the Republic of South Africa* [2013] 1 All SA 381 (SCA)

8 Ex parte Former Highlands Residents: In Re: *Ash et al* v *Dept Land Affairs* [2000] 2 All SA (LCC) 26

9 *Haakdoornbult Boerdery CC and others* v *Mphela and others* (553/05) [2007] ZASCA 69; 2008 (7) BCLR 704 (SCA)

> Compensation, to be fair … must recompense. The purpose of giving fair compensation is to put the dispossessed, insofar as money can do it, in the same position as if the land had not been taken. Fair compensation is not always the same as the market value of the property taken; it is but one of the items which must be taken into account when determining what would be fair compensation.

4.1.3 The Court further quoted Moseneke DCJ in *Goedgelegen*[10] as follows:

> Neither liability nor culpability in the conventional sense is a feature of the restoration scheme envisaged by s25(7) of the Constitution and the Restitution Act … The claim … has a reparative and restitutionary character. It is … not compensatory in the civil law sense. Rather, it advances a major public purpose and uses public resources in a manifestly equitable way to deal with egregious and identifiable forms of historic hurt.

4.1.4 Regarding the issue raised on appeal, the Court held that the appellants had not demonstrated that the application of the consumer price index was inappropriate to revalue the undercompensation or, perhaps more accurately, would on the facts of the case lead to an unjust or inequitable result. In its view, an application of compound interest would defeat the purpose of the LRA. It would result in over-compensation. The method is not contemplated in the provisions of the LRA. The compensation awarded must be just and equitable not only to the appellants but also to the members of society who have an interest in the way public resources are utilised.

4.2 *Florence*[11]

4.2.1 The SCA held that the facts in this case were materially indistinguishable from the *Farjas* case. The Court was therefore bound by that decision, i.e. that the LCC is entitled to rely upon the CPI to determine changes in the value of money.

4.2.2 The Court *a quo*[12] noted that:

> One of the paramount criticisms levelled against the use of the CPI in converting the 1970 loss into current day value is that the Florence family will not be able to buy an equivalent house and therefore the use of the CPI will give rise to a discrepancy between the value of financial compensation and restoration. There is no evidence on whether or not the use of the CPI will not be sufficient to buy the Florence family a new house.

4.2.3 The Court *a quo* also distinguished the facts of the case from those of 'the leading international case of *Factory at Chorzow*[13] which deals with the principles applicable to the payment of compensation for the purposes of restitution.' That Court had held that

10 *Department of Land Affairs and other*s v *Goedgelegen Tropical Fruits (Pty) Ltd*. (CCT 69/06) [2007] ZASCA 12; 2007 (10) BCLR 1027 (CC); 2007 (6) SA 199 (CC)
11 *Florence* v *The Government of the RSA* (550/12) [2013] ZASCA 104
12 *Florence* v *Broadcount Investments (Pty) Ltd and others.* LCC 148/08
13 *Factory at Chorzow* (Germ. V Pol.), 1928 P.C.I.J. (ser.A) No.17 (Sept.13)

> … reparation for an illegal act must, as far as possible, wipe out all the consequences of the illegal act and re-establish the situation which would, in all probability, have existed if that act had not been committed … the obligation to restore the undertaking, and if this is not possible, to pay its value at the time of the indemnification … to this must be added that of compensating loss sustained as the result of the seizure.

4.2.4 The Court *a quo* held that a fundamental distinction between the two cases was that the Florence family was dispossessed in terms of a legal act (the Group Areas Act), whereas the dispossession of the *Factory at Chorzow* was an illegal act.

4.3 *Florence* at the Constitutional Court

4.3.1 The *Florence*[14] matter was appealed in the Constitutional Court. The majority held that the primary compensation for dispossession should be the historic value of the land, adjusted by CPI to the present. This was seen to recompense for the dispossession *at the time of the dispossession*, consistent with no compensation being due if adequate compensation had been received at that time. The Court explained its reasoning as follows:

> [131] In my view, the Land Claims Court was correct in calculating the financial loss at the time of the dispossession and for the purpose of placing the Florence family in the same position they would have been in immediately after the dispossession. The starting point and main plank of the Restitution Act is an acknowledgement of widespread dispossession that occurred since 19 June 1913 and the need for equitable redress in the form of restoration of land or financial compensation. The legislation does not warrant an approach that fixes the compensation as if the loss never occurred. Nor does it warrant a full replacement value of the taken subject property.
>
> [132] Section 2(2) of the Land Restitution Act expressly prohibits relief to any person who received just and equitable compensation at the time of the dispossession. This means that the scheme of the Restitution Act makes the time of the dispossession the critical starting point of an assessment of financial compensation. The Government is right in that the purpose of financial compensation is to provide relief to claimants in order to restore them to a position as if they had been adequately compensated immediately after the dispossession. It must be correct that just and equitable financial compensation does not aim to restore claimants in current monetary terms to the position they would have been in had they not been dispossessed, but rather the financial loss they incurred at the time of the dispossession. The Land Claims Court was correct to set the loss at the time of the dispossession as the [then current] market value of the property less the amount of compensation the applicants had received at the time of dispossession …

4.3.2 However, it was also held that a history of hardship caused by the dispossession may entitle a claimant to a higher compensation award in order to assuage past disrespect and indignity:

14 *Florence* v *Government of the Republic of South Africa* [2014] Vol6 SA 456 (CC) [@ 124]

> [124] Equitable redress must be sufficient to make up for what was taken away at the time of dispossession. The amount of compensation has to be just and equitable reflecting a fair balance between public interest and the interest of those affected after considering relevant circumstances listed in section 33 of the Restitution Act. For instance, a history of hardship caused by the dispossession may entitle a claimant to a higher compensation award in order to assuage past disrespect and indignity.

4.4 *Jacobs (UAP)*

4.4.1 In *Jacobs (UAP)*,[15] the facts were quite different to *Florence*. The property in *Florence* was an urban erf, dispossessed under the Group Areas Act in the 1960s. In Jacobs, the property was a large rural tract of land, allegedly illegally dispossessed in the 1920s in aggravating circumstances.

4.4.2 The claimant motivated two adjustments to the 'historic market value plus CPI' basis of compensation. Firstly, it was calculated that historic market value adjusted by CPI amounted to only 5% of the current market value of the property. This was said to be inequitable, substantially less than the full current market value which would have in effect been received, had the property been restored. Secondly, claimant adduced evidence of the hardships caused at the time of the dispossession, and in the years thereafter. A methodology for assisting the Court to place a value on these hardships was fashioned, based on the rent that the family would have had to pay to replace their occupation of the dispossessed property. (This methodology is discussed further in Section 5 below.)

4.4.3 In its determination, the Court first followed the *Florence* methodology of determining the historic market value, and then adjusting this by CPI to the present. The Court then adjusted this result upwards:

> [117] …There are two reasons why we do so. The first is the nature of the hardship suffered by [the claimants] …The second is the grossly inequitable outcome of applying the actual financial value of at the time of dispossession [compared to] today's market value in the land.
>
> [119] There is a further claim … payment for the lost [past] use of the land …We do not believe it would be appropriate to consider this claim separately from our assessment of what is just and equitable … For the avoidance of doubt, our decision on the just and equitable compensation for the land equally applies to the loss of the use of the land. The amount we have determined as being just and equitable applies to the value of the land and its use.

4.5 *Jacobs (Erf 38)*

4.5.1 These themes were subsequently traversed by the Court in *Jacobs (Erf 38 Upington)*.[16] The claimants were the same as the *Jacobs (UAP)* matter, and made a similar case. Referring to *Florence*, the Court opined that:

> [14] … where the evidence shows that a conversion of the past loss based on the CPI will result in compensation which is not just and equitable, it will be permissible for the Court, having

15 *Jacobs and Others* v *Department of Land Affairs and Others* (LCC3/98) [2016] ZALCC 14
16 *Jacobs NO* v *Department of Land Affairs*, dated 06/01/2017, per Murphy J (LCC120/99)

> regard to the other factors listed in Section 33 of the Act, to make an adjustment in the quantum of compensation in order to eliminate the prejudice …

4.5.2 Further, that even though the *Chorzow*[17] principles of compensation on a delictual basis did not apply, they:

> [20] … usefully depict and set the parameters of what restitution in kind would amount to in financial compensation. It thus benchmarks the outer limits of compensation which will assist in determining an adjustment in the quantum of the compensation should it be found that conversion of past financial loss based on the CPI will result in compensation that is not just and equitable.

4.6 The *Jacobs* matters at the SCA

Both *Jacobs* matters were appealed to the SCA, which not only upheld the decisions of the Courts *a quo*, but also commented that it would have struck down the judgments of the Court *a quo* had they based the compensation on the current market value of the properties.

5. DATA AND CALCULATIONS

This section traverses the various data and calculations that might be needed in a matter where compensation instead of restitution is requested. These data and calculations are relatively straightforward. But they will be a significant input to the Court's crystallisation of a claim into money, and therefore must be appropriate and correct. Actuaries are ideally suited to serve the public interest by providing this service. Section 6 will look at the ethical and professional issues of an actuary's involvement.

5.1 Historic value

5.1.1 As emphasised in *Florence,* the value of the property at the time of dispossession is a vital element in the compensation calculation. Records of historic market values are usually available in respect of dispossessions under the Group Areas Act. Establishing historic values for older claims often presents a greater challenge.

5.1.2 Establishing a value (or range of values) for land is the job of a qualified property valuer.

5.1.3 Sub-section (3c) of Section 25 of the Constitution refers to market value as one of the relevant circumstances to be considered. There are other valuation methodologies for land, as discussed further in section 5.4 below.

5.2 Compensation received by the claimant at the time of dispossession.

5.2.1 This is a factual item to be supplied by the claimants, and to be deducted from the historic value of the property. In Group Areas dispossessions from the 1960s, there often was such compensation, whereas in many of the earlier dispossessions as a result of unfair racial practices, there may have been no such compensation.

17 *Factory at Chorzow* (Germ. V Poland), 1928. P.C.I.J (Ser.A) No 17 (Sep.13)

5.2.2 The South African Rand was introduced on 14 February 1961. The old South African pounds are converted to Rands at the rate of £1 to R2.

5.3 Changes over time in the value of money

5.3.1 Sub-section (eC) of Section 33 of the LRA is one of the factors for the Court to take into account, and reads as follows:

> In the case of an order for equitable redress in the form of financial compensation, changes over time in the value of money.

5.3.2 The Consumer Price Index has been used by the LCC to measure changes over time in the value of money. This is consistent with other areas of the law, such as the Divorce Act,[18] where changes in the value of money are also calculated with reference to the CPI. Furthermore, awards for general damages are commonly adjusted with the CPI.

5.3.3 Stats SA monthly Publication P0141 is the official CPI data for South Africa. There are 'headline' year-on-year inflation rates covering all categories and areas, as well as breakdowns per product category and province. The monthly rates have been used by Stats SA to create an index going back to 1980. This can be easily be extended backwards.

5.3.4 Recently, the year-on-year rates for each month have been backdated to 1922. The annual average rates go back even further, to 1911. Apparently, these older rates are based on index of retail prices published in 1960 by the Union Government.

5.3.5 It can be debated whether point-to-point index values (eg March 1925 to March 2020) or annual average index values (eg average of all months in 1925 to average of all months in 2020) should be used. Koch (2018) motivates for the use of the latter in loss of income matters on the grounds that they represent the average value for the index over the year and are not skewed by a particular month. However, particularly over the long periods usually involved, and the other uncertainties over data, either method should be acceptable.

5.3.6 As discussed further in section 5.4 below, the current market value of the property may have grown much more than the change in CPI. It is sometimes asked whether a provincial CPI rate, or one related to property rentals only, would be more appropriate. I do not think so, as this part of the calculation is specifically looking at the change in the value of (South African) money. It could be debated whether the change in prices is the best available method for measuring changes in the value of money. Firstly, the constituent elements of the official CPI are changed from time to time. Secondly, economists track changes in a country's Gross Domestic Product per capita as an indication of changes in the standard of living.

5.4 Current value v historic value

5.4.1 The current value of the property does not form part of the 'historic value plus CPI' calculation endorsed in *Florence.* Yet the current value is usually an important factor in the deliberations, and in the minds of the dispossessed claimants. If these claimants had had their land restored to them, they would effectively be receiving the current value

18 Divorce Act [No. 70 of 1979]

thereof. But the Constitutional Court has held that this does not mean that compensation should equal current value.[19]

5.4.2 A simple comparison can be made of the average annual rate of increase in the CPI versus the average annual rate of increase of the property value. Especially in dispossessions from the 1920s, current property values may be far in excess of historic values plus CPI (although they could be less, for a variety of reasons). The Constitution requires compensation to be just and equitable—so the Court has discretion to take this potential inequity into account. In the *Jacobs (UAP)* matter, the Court increased the 'historic value plus CPI' calculation to narrow this gap, saying:

> [117] Compensation should be just and equitable. Market value is a factor. It is not a goal in itself. We intend adjusting the value upwards. There are two reasons why we do so. The first is the nature of the hardship suffered by [the claimants]. The second is the grossly inequitable outcome of applying the actual financial value calculated at the time of dispossession versus today's market valuation in the land.

5.5 Current valuation methods

5.5.1 The profession of property valuers is best suited to provide evidence on the current value of land. The valuation of agricultural land in particular is no easy matter, as evidenced by this quotation from one of the doyens of the profession, Pine Pienaar (2013:50):

> There is a saying among valuers that when you enter the valuer profession, you start off by valuing houses, then advance to commercial property and, with much experience behind you and a well-filled logbook, you qualify to become a candidate valuer in the agricultural sector. This saying is not unfounded and is supported by the diverse nature and complexity of the agricultural sector.
>
> Both macro- and micro-factors play a role in complicating a farm's value, some of which are controllable, but most are not. Farm values are further influenced by aspects such as natural resources and perceptions. All these factors can roughly be categorized into factors that influence the value of agricultural land in general, factors that influence the value of farms in a particular area, and factors that influence the value of a specific farm.
>
> To fully understand the interactions and forward and backward linkages, the ideal valuer should be an agronomist, an economist, a horticulturalist, a soil scientist, an animal husbandry expert and a stock farmer, a hydrologist, a weather man, a construction engineer and a building contractor, to mention only a few fields in which he should be an expert. As if this is not confusing enough, farm valuations can have elements of residential, commercial and industrial valuations woven together and are influenced by whether the natural resources (land and water) have been developed, maintained, exploited and/or utilized in a sustainable manner.
>
> All of this makes farm valuations complex but, although he cannot be all of these things, the well-informed valuer with experience in the agricultural industry who spends a lot of time on research can come up with a professional valuation. A proper understanding of the agricultural industry is, however, not negotiable but a prerequisite.

19 See the extracts from *Florence* at section 4.2 above

5.5.2 Actuaries advising insurers and pension funds will be familiar with the concept of different valuation methods for different purposes. Similarly, in property, there are various methods, as set out for example in Pienaar (2013) and Du Plessis (2015).

5.5.3 The *market value*, or comparable sales, method is easily understood and—at least in urban areas—relatively easy to establish. The *economic value*, or discounted cash flow, method will resonate with actuaries because of our training in valuing future cash flows and contingencies.

5.5.4 When faced with a current *market value* significantly higher than historic value plus CPI, courts may wish to be informed of the *economic value* as a more realistic appraisal of the value of the property. The *economic value* method capitalises future income and is thereby closer to the long-term value of the property to its owner. Of course, this economic value may be higher or lower than market value—for example, Pienaar (2013; 85)

> Normally there is a substantial difference between the market value and productive or economic value of farms. Experience has shown that the productive value of the more extensive types of farming such as cattle, sheep and game tend to be below market value. The productive value of the more intensive types of farming, such as fruit and sugar cane, tend to be above the market value. These differences have much to do with economic viability, farm size and opportunity cost.
>
> This economic value could be the relatively simple present value of future rental income, or a full-blown discounted cash flow analysis of future business plans. This method is obviously complex and needs detailed expert input on future income and expenses, including provisions for recovering capital, refurbishment and rates of discount which take added risk into account.

5.5.5 In the land claim of the Moloto Community,[20] the LCC noted that there could be circumstances in which an economic valuation would be appropriate. However, each case would need to be decided on its own facts, and a standard formula could not be applied. Such calculation will be complex, and the onus of proof lies with the party arguing for its use.

5.5.6 A variation of this method is to apply a *price/earnings ratio* to the current profits of the property. This may be suitable in simple cases, such as rental income, but probably not for a farm with a complex current and future financial structure. In any event, a PE ratio is merely an infinite annuity (1/i), and so still requires the selection of an appropriate risk discount rate. Edwards (2017) reports that the starting point for selecting a discount rate for agricultural properties in the USA is the applicable mortgage rate.

5.5.7 Du Plessis (2015) considers the various methods of valuation in the constitutional era, in order to assist the courts. Although the simplest method,

> the willing buyer willing seller method of determining *market value* has been described as illusory, since the bargaining process is constrained by a compulsory sale, and the seller is more often than not unwilling to sell. As King J stated in *Southern Transvaal Buildings* '… the law enjoins me to transport myself into a world of fiction and to don the mantle of a super

20 *Moloto Community* v *the Minister of Agriculture, Land Reform and Rural Development and others* LCC 204/2010

> valuator, overriding, if necessary, the views expressed by men experienced in the valuation of property and whose views are relied upon almost daily by willing purchasers and sellers. I must at one and the same time be the willing seller and the willing buyer, both well-informed, and I must arrive at a price in a market that did not exist at the time of expropriation. This is so because I must ignore any enhancement or diminution in value flowing from the expropriation or the scheme causing the expropriation. It is an Alice in Wonderland world in which the consideration of principles of valuation and the opinions expressed by experienced property valuators make the task of the super valuator seemingly "curiouser and curiouser".'

5.5.8 Yet market value is usually easily quantifiable, based on comparative sales, and for that reason formed the basis of the [Judge] Gildenhuys Approach arising from the Ex parte Former Highlands Residents matter.[21] This approach is to start with market value, and then adjust up or down for Section 25 factors.

5.5.9 Prof du Plessis concludes that the use of rigid and precise tools is not feasible, and each case must be looked at individually:

> The tool we have is the Constitution, which tells us where to go [just and equitable]. It is up to valuers to get us there!

5.6 Hardship

5.6.1 Sub-section (eB) of Section 33 of the LRA includes the hardship suffered as one of the factors that a court could take into account. However, Mabasa (2022) bemoans the lack of methodology for placing a value on such hardship. "In the majority of cases where claimants opted for financial compensation, the policies that governed the amount of compensation only took into account market compensation and were devoid of losses that were intangible but equally significant, such as the sense of place, livestock, spiritual and cultural heritage, and a general destruction of family units and family life."

5.6.2 Claimants might motivate that compensation for such hardship is a type of 'constitutional damages'. Du Plessis (2015) notes that one method for calculating compensation for expropriation by the State is the benefit the State will gain (as opposed to the loss to the expropriatee).

5.6.3 A somewhat similar 'transferance' methodology was used in the *Life Esidimeni* arbitration.[22] In a paper on the matter, presented to the Actuarial Society, Whittaker (2018) noted the Constitutional Court matter of *Fose*[23] wherein courts were obliged to forge new tools for effective remedies for the breach of constitutional rights, if the common law was inadequate. He also noted the SCA matter of *Kate*[24] where no direct financial loss could be calculated. That Court stated that 'to be held in poverty is a cursed condition', held that to be the true loss, and quantified the loss by 'borrowing' an interest-based approach. The

21 See footnote 8 above

22 Final ruling in the Arbitration between: Families of Mental Health Care Users Affected by the Gauteng Mental Marathon Project and the National Minister of Health and others. Unreported.

23 *Fose* v *Minister of Safety and Security* 1997 (3) SA 786 (CC)

24 *Member of the Executive Council: Welfare* v *Kate* [2006] SCA (46) RSA

claimants in the *Life Esidimeni* matter had not suffered patrimonial loss, since their deceased relatives were all unemployed, and in care, and had not provided any financial support to the claimants. Nevertheless, the plaintiffs argued that the quantification of their constitutional damages could start from a new angle—i.e. the costs saved by the state now that the patients were prematurely deceased.

5.6.4 In a land restitution claim, one hardship usually suffered is the loss of the use and enjoyment of the property, between date of dispossession and date of restoration (or compensation). The courts have repeatedly said that compensation is not a patrimonial loss. Thus, a claim for the lost income from the property is unlikely to find favour. However, using a transference methodology, it may be an acceptable remedy for constitutional damages, to value the hardship caused as the rental income that the dispossessed would have had to expend to secure themselves occupation of a similar property. This argument was made in the *Jacobs (UAP)* and *Jacobs (Erf 38)* matters, and although the Court did not adjust the compensation fully for the amount claimed under this head, both courts stated that their final adjusted award also took into account the value of this lost past use of the land.

> [23] Mr Lowther in his testimony placed two possible values on the loss arising as a result of the affected members of the September family not being able to use the property between 1925 and 2016. In the final analysis, the plaintiff acknowledged, in light of the approach in *Florence*, that there is no entitlement to receive such an amount as compensation. The evidence, however, was intended to assist the court when considering the various factors listed in section 33 of the Act, other than the changes over time in the value of money; including: the desirability of remedying past violations of human rights; the requirements of equity and justice; the amount of compensation or any other consideration received in respect of the dispossession; the history of the dispossession caused, the current use of the land and the history of the acquisition and use of the land.[25]

5.6.5 A calculation of such lost past use could be made by interpolating geometrically between the historic and current land values, and then applying a reasonable rate of rental to produce a lost use value in each past year. Each loss could be adjusted by the CPI to the present to allow for changes in the value of money—but not rolled up with interest.

5.6.6 This approach requires the data item of 'reasonable rental'. In some cases, an actual historical or current rental amount may be available. Otherwise, an estimate could be made, with input from the property valuer. One potential data source for urban properties is to use the reasonable rentals which appear in the old rent control legislation.

5.6.7 In *Jacobs (Erf 38)*, the Court also noted (see 4.5 above) that it was useful to know the full patrimonial loss, as an upper bound for any adjustment. This value could be established by rolling up the result in ¶5.6.4 above with an appropriate rate of interest. In the *Jacobs* matters, this calculation was requested by the claimants, who suggested interpreting the result (using transference) as their 'lost life chances'. The compounding effect of interest was seen as similar to the compounding effect of each generation building their

25 See footnote 16 above

lives, education, employment and standard of living on the previous one—and this chain of development had been broken by the dispossession.

5.6.8 It would be important for the actuary to point out that the results in ¶5.6.6 are a transference calculation, and not a conventional loss of income report as provided in road accident and medical negligence matters. There may be a few cases where an exact loss of income report could be provided, but gathering the data of several generations of descendants of the original disposed family, and crystal-ball gazing as to what might have happened but for the dispossession, will usually be too speculative.

5.6.9 The *Jacobs* awards may be found in the respective judgments, as follows:

ZAR	Historic value plus CPI	Current market value	Value of lost past use	Award
UAP	2 420 000	36 450 000	22 800 000	10 000 000
Erf 38	50 000	2 450 000	910 000	780 000

5.6.10 As an aside, it should be noted that the hardship of lost past use applies equally to claimants whose property is restored to them. However, the legislative framework doesn't allow them financial compensation as well as land restoration.

5.6.11 As a further aside, it should also be noted that in most cases the LCC does not concern itself with the use of the compensation award by the claimants, nor the distribution of the award between the qualifying claimants. In older claims there may be numerous descendants of the original dispossessed family, and in rural claims there may be an entire community. Where land is restored to a community, the CRLR encourages the formation of a Community Property Association to manage the land and ownership issues. Mabasa (2022) regrets that there is no obligation on the CRLR for adequate, meaningful post-settlement support. She quotes an anonymous senior member of the CRLR as follows: "Our role is to return the land to the people. We have now done that. We have no business assisting the community with any post-settlement support, be it business plans or whatever. Our job is done."

6. WHERE ANGELS FEAR TO TREAD—THE ROLE OF THE ACTUARY

6.1 Our Professional Promise

6.1.1 Members of the Actuarial Society of South Africa are required to abide by a Code of Conduct in the form of our Professional Promise. Accordingly, we endeavour to maintain the capability to deliver a quality service that is competent and up-to-date, ethical and subject to professional oversight (ASSA, 2015)

6.1.2 Included in our 'competence' requirement is only to provide services in an area in which we are competent. In more developed fields, such as valuations of life insurance companies, one can work under mentorship until ready to fly solo. In newer and wider fields, such as compensation for land claims, the actuary must be careful to understand the nature of the work—and its effect on the parties and the public.

6.1.3 Where there are no specific professional guidance notes, a general practice standard applies (ASSA, 2019) covering the prudent way in which the actuary should go about their work.

6.1.4 Hopefully, this article and the discussion thereof will be a starting point for an actuary asked to assist in a land compensation matter. It highlights the broad purpose of the land reform process, the balance between public and private interests, and differences from the 'patrimonial loss' concept more familiar to actuaries (as in loss-of-income claims).

6.2 Modelling

6.2.1 A specific competence of the actuary is modelling, and there is a specific part of our education syllabus to develop these skills. In land claims, there may not be many new or complex models to develop—yet even the arithmetic described in Section 5 above is a model—and actuaries are skilled in ensuring that models are appropriate, reliable and transparently documented. It is as vital for the court to understand the meaning of the numbers supplied, as for it to rely on their correctness.

6.2.2 The Actuarial Society (2017) has a relevant guidance note on the management of models. Of particular relevance here is the recommended use of alternative scenarios rather than a single set of assumptions.

6.2.3 In my experience, property valuers appreciate the actuary checking the logic and accuracy of their discounted cash flow spreadsheets and CPI adjustments, given our familiarity with such processes. But the actuary must resist trying to be an expert property valuer, as this is not in our expertise.

6.3 Reporting

6.3.1 A specific part of modelling is documenting and communicating the work. Lowther and Mort (2016) highlights how a poorly thought through report in a claim for maintenance against a deceased estate can lead to the report being incorrectly used—i.e. giving the impression of the actuary 'certifying' the widow's needs, when the report has merely quantified the information supplied.

6.3.2 Thus the actuary will be expected to think carefully about how to position their report, and how to be as transparent as possible. Actuaries have also practised professional communication in their training, but even after years of practice it takes skill, time and a desire to get-it-right to communicate financial matters effectively.

6.4 Public v private interest

6.4.1 The actuary should be aware of Section 25(3) of the Constitution which requires that compensation reflect an equitable balance between the public interest and the interests of those affected. As in other actuarial work, the actuary could highlight whether assumptions are conservative or best estimate, and maybe even do scenarios on different bases.

6.4.2 It is of course the court which has to decide the balance between public and private interest. A somewhat similar situation occurs in medical negligence claims, as expressed by Prof van Boom of Leiden University in the foreword to Whittaker (2021):

> … the quest for alternative compensation systems in the area of medical malpractice birth injuries also raises the key question of whether we want to redistribute the proceeds of the current system over other—and presumably more—beneficiaries. Choosing a system that

compensates all children with birth defects (and their families), irrespective of whether caused by nature or by man, may sound appealing if we have notions like distributive justice, social solidarity and equal opportunities in mind. Such a broad scheme would go a long way in alleviating the burden of the stricken families and providing coverage for an adversity they could not insure against before the event.

This allocation of resources debate resonates with the discussion in Section 3 above as to whether the Restitution strand of the land reform programme should be terminated in favour of Tenure Reform and Redistribution.

6.5 Expert witness or advocate?

6.5.1 The tricky path that angels might fear to tread, alluded to in the title of this paper, arises because this is a new field in which other professions also play—including lawyers and judges and property valuers. Should actuaries 'stick to their knitting' (as a leading lawyer suggested while trying to work through the complexities of the 2001 Pension Funds Amendment Act for which he felt actuaries were responsible)? In other words, just be a super-calculator and produce answers to sums as requested. Or should they use their broader ability to make financial sense of the world in the public interest, especially since the land reform programme is clearly in the public interest?

6.5.2 Perhaps unfortunately in this respect, land compensation has been channelled through a Court system, which can be acrimonious as well as bound by precedent and process. The actuary will be engaged by one of the parties, and there may not be an opportunity for all concerned to sit down and throw possible solutions around. On the other hand, there is some common purpose amongst the parties in that the legislation is intended to bring about restitution, and once a claim is registered, the CRLR pays the claimants approved expenses.

6.5.3 In the area of adjustments to compensation for S33(eB) hardship, the actuary might be able to suggest, or lead a discussion on, possible new methods that could be fashioned. But it is not clear if the actuary would be overstepping the mark as expert witness to the Court and becoming an advocate for the claimant instead.

6.5.4 An assumption may need to reflect a balance between public and private interest—for instance an estimate of rental income as hardship. Presenting alternative scenarios and/or adjustments for contingencies will allow the Court—as opposed to the actuary—to decide where this balance should be.

7. CONCLUSION

If and when the 2012 amendment to the LRA is adequately repaired by Parliament, another 160 000 land claims may fall to be decided. Drawing on the common law that has been developed in the absence of a specific legislated formula, the author has highlighted data and methods that could help fashion the compensation for dispossessed land. It is concluded that actuaries' technical, ethical and professional inputs makes them well suited to assist the Land Claims Court to resolve the potentially large number of claims, and that this will be in the public interest.

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ABBREVIATIONS

ANC	African National Congress
ASSA	Actuarial Society of South Africa
CPI	Consumer Price Index
CRLR	Commission for the Restitution of Land Rights
LCC	Land Claims Court
LRA	Restitution of Land Rights Act , No 22 of 1994
SCA	Supreme Court of Appeal

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The actuary as *amicus curiae*

By GA Whittaker

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ABSTRACT

The role of an *amicus curiae* as a party to litigation is closely linked to promoting constitutional values and protecting the public interest. There is no question that interventions by *amici curiae* have played a critical role in aiding the judiciary in many public interest cases. The Actuarial Society of South Africa is prioritising its focus on advancing issues of public interest and serving a broader spectrum of the populace. However, it has yet to utilise this specific mechanism to manifest this mandate. The Actuarial Society of South Africa can provide a numerical perspective on various rights disputes deriving from the Constitution. In contrast, the courts have asked other professional bodies, such as the South African Institute of Chartered Accountants, to join proceedings. Actuarial bodies, particularly those in the United States of America, are actively involved in public interest matters and occasionally join *amicus curiae* proceedings. Following an exploration of the use of *amici curiae* in South African and African courts, this paper seeks to identify a test case where the Actuarial Society of South Africa may join proceedings as a friend of the court. The mechanism and procedure for joining the court as an *amicus curiae* and the risks and benefits of joining proceedings are examined.

KEYWORDS

Amicus curiae, Actuarial Society of South Africa, actuarial evidence, Constitution, public interest, litigation

CONTACT DETAILS

Gregory Whittaker, University of the Witwatersrand, Algorithm Consultants & Actuaries,
222 Rivonia Road, Morningside, Sandton, 2196
Tel: +27 (0)11 802 0263; Email: gregory@algorithm-ca.com

1. INTRODUCTION

1.1 Background

1.1.1 The Constitutional Court set out the role of an *amicus curiae* (friend of the court) in the matter of *In Re: Certain Amicus Curiae Applications; Minister of Health* v *Treatment Action Campaign*[1] as follows:

> The role of an amicus is to draw the attention of the court to relevant matters of law and fact to which attention would not otherwise be drawn. In return for the privilege of participating in the proceedings without having to qualify as a party, an amicus has a special duty to the court. That duty is to provide cogent and helpful submissions that assist the court. The amicus must not repeat arguments already made but must raise new contentions; and generally these new contentions must be raised on the data already before the court. Ordinarily it is inappropriate for an amicus to try to introduce new contentions based on fresh evidence.

1.1.2 In the ordinary course of litigation, parties engage the court process to resolve a dispute by requesting a type of relief on offer to them by the specific court they choose to approach. Each party has the right to brief any kind of expert to furnish the court with expert evidence to further their arguments on their instruction. The expert is not a party to the proceedings but a tool in the litigation strategy of the individual litigants. Expert witnesses are paid by their instructing party; while they do have a duty to the court, their evidence is used to substantiate the position that the litigant places before the court.

1.1.3 Sometimes, a dispute can raise a need for relief that has a reach beyond the specific parties to the litigation, that will affect the public as a whole. This is commonly referred to as public interest litigation. Once the interest of a wider aspect of the public is brought within the ambit of the case, the need arises for all material relevant to determining the effect of the proposed relief to be brought to the attention of the court, particularly the Constitutional Court, where the majority of these types of cases are finalised. Due to the parties to a dispute each having their own agenda, it is possible for them each to argue their specific cases without necessarily raising all possible contentions out of the evidence before the court.

1.1.4 Any party to a court action must have *locus standi*, that is, a connection of some kind to the case. The vehicle of an *amicus curiae* creates a mechanism by which a range of factual information can be raised, for the benefit of creating a wider parameter within which to understand the effects of the issues to be determined by the court.

1.1.5 Whilst the above passage indicates that an *amicus curiae* does not have the right to raise a new cause of action, leeway is created due to Rule 31 of the Constitutional Court.[2] In particular, Rule 31 permits an *amicus curiae*, where appropriate, to canvass factual material relevant to the determination of the issues before the court. That may include material

1 *In Re: Certain Amicus Curiae Applications*; *Minister of Health and Others* v *Treatment Action Campaign and Others* (CCT8/02) [2002] ZACC 13

2 Rule 31 of the Constitutional Court Rules promulgated in terms of the Constitutional Court Complementary Act 13 of 1995

that does not explicitly appear on the record, provided such facts are official, scientific, technical or statistical and capable of easy verification. The court has further discretion to permit an *amicus curiae* to adduce additional evidence outside the ambit of Rule 31. Actuarial expert evidence would usually fall squarely within what Rule 31 has envisaged as official, scientific, technical or statistical facts.

1.1.6 Invariably, parties acting as an *amicus curiae* present as representative bodies such as non-governmental organisations, community-based groups, or citizens' rights organisations. As such, one would not expect an individual actuary to approach the court as an *amicus curiae* (as they do in their capacity as an expert witness), but rather actuarial perspective in public interest matters could be presented under a professional body such as the Actuarial Society of South Africa (ASSA).

1.1.7 Section 24 of the Code of Conduct[3] of the ASSA encourages members to serve the public interest by engaging with regulators and participating in public debate. Ordinarily this is done through the formal structures of the ASSA such as the Healthcare Committee's input into the National Health Insurance Bill[4] and the Retirement Matters Committee's input into National Treasury's proposed two-pot system.[5]

1.1.8 Section 25 of the Code of Conduct encourages members to consider the public interest when rendering actuarial services. If members meet the requirements of legislation (such as the Pension Funds Act[6]), the Constitution of the ASSA, applicable Standards of Practice and the Code of Conduct, they will be deemed by the ASSA to have met the expectations of the profession with respect to the public interest.

1.1.9 Section 24 considers a broad definition of public interest (the public at large), whereas Section 25 considers a narrow definition of public interest (a smaller community within a broader national community). South African courts have recognised both broad and narrow definitions of the public interest.[7] Actuarial bodies may join proceedings under both the broad definition and narrow definition of the public interest as discussed in Section 5 of this paper.

1.2 Importance of this research

1.2.1 Serving the public interest is a vital part of the vision and mission of the ASSA. To date, the ASSA's participation in public interest matters has included commentary on various bills and participation in parliamentary portfolio committee briefings. Joining a court action as a friend of the court may be a further useful tool at its disposal to further its public interest endeavours.

1.2.2 This paper shows how various public interest organisations in South Africa and Africa have successfully joined court proceedings as a friend of the court. A concrete

3 Actuarial Society of South Africa. Code of Conduct (2015) www.actuarialsociety.org.za
4 National Health Insurance Bill B11 of 2019
5 National Treasury. Encouraging South African households to save more for retirement. Discussion paper, 14 December 2021
6 Pension Funds Act 24 of 1956
7 *Maharaj* v *Chairman Liquor Board* 1997 (1) SA 273 (N)

case is made for impactful litigation in the public health arena in South Africa, that could be considered by the ASSA. The paper also assesses the risk and benefits of such participation to the ASSA.

1.3 Aims

1.3.1 The main aim of this research is to set out a test case in the public health arena where the ASSA can consider acting as an *amicus curiae*.

1.3.2 The following questions are considered:

— How has the role of an *amicus curiae* been used in South African and African courts in order to promote the public interest?
— Are there any examples of international actuarial bodies that have joined court proceedings as an *amicus curiae*?
— What are the mechanisms and procedures for joining proceedings as an *amicus curiae*?
— What are the risks and benefits to a professional body in joining proceedings as a friend of the court?

1.4 Plan of development

1.4.1 The paper unfolds as follows: Section 2 provides a literature review, Section 3 provides an overview of South African case law and Section 4 provides an overview of African case law. Section 5 describes some examples of the *amicus curiae* work of the American Academy of Actuaries. Section 6 discusses the mechanism and procedure for admission as an *amicus curiae* in the various court structures such as the High Court, Supreme Court of Appeal and the Constitutional Court. Section 7 juxtaposes the role of an actuary as an expert witness against that of an *amicus curiae*.

1.4.2 Section 8 provides a test case in the public health arena where the ASSA could join proceedings as an *amicus curiae*. Section 9 sets out the benefits and risks to a professional body of acting as an *amicus curiae*. The paper concludes in Section 10.

2. LITERATURE REVIEW

2.1 In October 1902, actuary Mr Ralph Price Hardy, in proposing a vote of thanks to the then president of the Institute of Actuaries Mr William Hughes, noted that the Institute's reputation had been enhanced by freely imparted technical knowledge in response to the demands of the public (Higham & MacLeod, 1902). In particular he wanted to draw attention to:

> … the very high compliment paid to the Institute, as a chartered and scientific body, in making it *amicus curiae* in respect of the financial position of those several funds administered by the Patriotic Commissioners. It was well known that for some years past considerable friction had ensued between the naval and military services and the Commissioners as a body. This Institute's report will entirely remove that tension.

2.2 Interestingly, the above assistance had close ties to the South African War of 1899–1902. The South African War created nearly 5,000 British working-class war widows and

during the war, the British state for the first time started paying state pensions to widows (Riedi, 2021). Prior to this, the payment of widows' pensions was reliant on charitable donations administered by the Royal Patriotic Fund.

2.3 Whilst Mr Hardy's reference to an *amicus curiae* was the first in any actuarial journal, it was not used in the correct context because he presumably confused *amicus curiae* for *pro amico* (in that the services to which he refers were rendered on an unpaid basis). In this paper, *amicus curiae* will refer to the use within a legal context, which is as a friend of the court. Such work could however in certain instances be undertaken on a *pro bono publico* basis.

2.4 Budlender et al. (2014) point to three forms of *amicus curiae* prior to South Africa's new constitutional dispensation. The first form of an *amicus curiae* is a person who appears at the request of the court to represent an overlooked party or vantage point. The second form is where a court requests counsel to assist it on complex or unusual aspects of the law that arise in a matter. Thirdly, a common type of an *amicus curiae* is the Law Society or Bar Council which assists and advises the court in promoting the interests of the administration of justice by way of the admission of legal practitioners to practise.

2.5 South Africa's new constitutional dispensation introduced a fourth type of an *amicus curiae*, described in *Children's Institute* v *Presiding Officer of the Children's Court, District of Krugersdorp and Others*:[8]

> The role of a friend of the court can, therefore, be characterised as one that assists the courts in effectively promoting and protecting the rights enshrined in our Constitution. Section 39(2) of the Constitution requires that when interpreting any legislation, courts must promote the 'spirit, purport and objects of the Bill of Rights.' Where there are two reasonable interpretations of a provision, section 39(2) mandates a court to prefer the interpretation that better promotes the spirit, purport and objects of the Bill. In public interest matters, like the present case, allowing an amicus to adduce evidence best promotes the spirit, purport and objects of the Bill of Rights.

2.6 Brickhill & Du Plessis (2011) observe that South African courts increasingly recognise that certain cases must necessarily involve the input from organisations that may not have a direct legal interest in the outcome of a matter. These organisations argue their understanding of the public interest.

2.7 Lowther & McMillan (2006) note that the third strand of their proposed professionalism model, namely the professional body, concerns itself with how actuaries create and maintain an association that is tasked with ensuring that skills (the first strand) are delivered in the agreed manner (the second strand). An example of the manifestation of the third strand would be the profession's commitment to the public interest. In 2005, the ASSA set up a task group

8 *Children's Institute* v *Presiding Officer of the Children's Court, District of Krugersdorp and Others* (CCT 69/12) [2012] ZACC 25; 2013 (1) BCLR 1 (CC); 2013 (2) SA 620 (CC)

to define what an obligation to serve the public interest means. The task group recommended that it was up to the members of the Society to reach a consensus on a public interest role that all members would be willing and able to execute (Lowther, et al., 2005).

2.8 Larsen (2014) notes that in the United States, Supreme Court decisions often turn on generalised facts. Whilst the Supreme Court has shown an increased appreciation for empirical factual support for legal arguments, by turning to motivated interest or advocacy groups to fill the need and indeed relying on their *amicus* briefs as evidence on factual claims, the courts risk tainting decisions with unreliable evidence. It is argued that the adversarial system provides weak checks on *amici* fact-finding.

2.9 When called upon to assist in a public interest matter, it is important not to disempower aggrieved communities or social movements. As noted by Moseneke (2016), the role of the public interest lawyer is to support and not to take over grassroots voices. This is an important message for actuaries who become involved in such matters.

2.10 Box-Steffensmeier et al. (2013) caution that organised groups seek to influence outcomes at every level of governance, and the aims of these groups are in no way assured to be aligned with the aims of a majority of citizens. They find that groups that are more connected with other interest groups and participate more regularly in court proceedings have a greater effect on the probability that a court rules in their favour, compared to infrequent participations or groups that participate on their own.

2.11 Subramanien (2013) notes that the participation of an *amicus curiae* in South Africa has historically been in the context of public interest litigation by human rights activists and civil society organisations that sought to fight the inequalities of the apartheid regime. The focus has now moved away from addressing inequalities and towards ensuring that all persons benefit from the rights enshrined in the Constitution. The author cites the matter of *Children's Institute* v *Presiding Officer of the Children's Court District of Krugersdorp* as a classic example of a matter where the *amicus curiae* sought to be admitted in order to adduce statistical evidence, to demonstrate why orphaned children living with family members should receive a foster child grant.

3. SOUTH AFRICAN CASE LAW

3.1 The death penalty

3.1.1 One of the earliest rulings of the Constitutional Court was the matter of *S* v *Makwanyane and Another.*[9] That matter ruled that Section 277 of the Criminal Procedure Act[10] on the death penalty was unconstitutional. The death penalty in South Africa was thus

9 *S* v *Makwanyane and Another* (CCT3/94) [1995] ZACC 3; 1995 (6) BCLR 665; 1995 (3) SA 391; [1996] 2 CHRLD 164; 1995 (2) SACR 1

10 Section 277 of the Criminal Procedure Act (1977)

effectively abolished on 6 June 1995 when the Constitutional Court handed down its decision. Prior to abolishing the death penalty, on 2 February 1990, a moratorium was announced on all executions in South Africa. The last execution occurred on 14 November 1989.

3.1.2 Several *amici curiae* joined the matter, namely Lawyers for Human Rights, the Centre for Applied Legal Studies, The Society for the Abolition of the Death Penalty in South Africa, the Black Advocates Forum, the South African Police and Ian Glauber.

3.1.3 The South African Police provided statistics showing that between 1988 and 1993, approximately 9000 murder cases were brought before the court each year. The Constitutional Court judgment noted that in the more than 40 000 cases that have been heard since the moratorium, only 243 persons were sentenced to death and of these sentences, only 143 were confirmed on appeal. Lawyers for Human Rights, the Centre for Applied Legal Studies and The Society for the Abolition of the Death Penalty in South Africa pointed out that of the 2740 persons executed in South Africa between 1910 and 1975, less than 100 were white.

3.1.4 Notably, no evidence was provided concerning the probability that someone who has been sentenced for murder and is released on parole will commit another murder. As noted in the Constitutional Court judgment, with the abolition of the death penalty, society needs the firm assurance that the murderer will not be released from prison if there is a reasonable possibility that he/she will repeat the crime. The prediction of recidivism is a well-established field that uses actuarial risk models. It may have been instructive for the Constitutional Court to know what the recidivism rate for those serving sentences for murder has been internationally during their deliberations. The use of actuarial risk models could also inform the courts of the appropriate length of sentences.

3.2 The right to water

3.2.1 Section 27(1)(b) of the Bill of Rights,[11] states that everyone has the right to have access to sufficient food and water. The right to sufficient water formed the basis of the Constitutional Court matter of *Mazibuko and Others* v *City of Johannesburg and Others.*[12]

3.2.2 Ngcukaitobi (2021) notes that little attention has been given to water-related reform, yet land and water are inseparable. With one of South Africa's eight metropolitan municipalities currently facing severe water restrictions,[13] the right to sufficient water is likely to be a topic for further litigation in coming years.

3.2.3 The *Mazibuko* matter concerned the reasonableness, fairness and lawfulness of the water policy of the City of Johannesburg, specifically with regard to a pilot project in Phiri, Soweto. Five residents of Phiri challenged the constitutional validity of the introduction of a free basic water allowance of 6 kilolitres per household per month for every household in Johannesburg and the introduction of prepaid water meters.

11 Bill of Rights (1996)

12 *Mazibuko and Others* v *City of Johannesburg and Others* (CCT 39/09) [2009] ZACC 28; 2010 (3) BCLR 239 (CC); 2010 (4) SA 1 (CC)

13 https://www.nelsonmandelabay.gov.za/page/drought-mitigation-plans-and-projects

3.2.4 The Centre on Housing Rights and Evictions (COHRE) joined the matter as an *amicus curiae*. COHRE submitted that the provision of less than 50 litres of water per person per day and the use of pre-payment meters in Phiri constituted unreasonable, retrogressive, unprocedural and discriminatory measures in violation of the City of Johannesburg's constitutional and international obligations.

3.2.5 The Constitutional Court ruled that the City of Johannesburg's free basic water policy was reasonable, but refused to give a quantified content to Section 27 of the Constitution, holding that this would not be appropriate especially where the quantity asked for was not clearly proven on the papers. The introduction of prepaid meters was found to be authorised by law, fair and not discriminatory.

3.2.6 The Constitutional Court judgment was viewed as a win for government and a significant set-back for public interest litigation. Had the applicants engaged actuaries to model the practical and cost implications of the broad relief sought by them (50 litres of water per person per day), a more cost-effective, calculations-based type of relief may have been sought. Consequently the actuarial input may have informed litigation strategies differently.

3.2.7 Future litigation around the right to water will also need to take into account the effects of climate change, an area where actuaries have started formalising their input. As noted by the Institute and Faculty of Actuaries (2019), the expected change to the quantity and quality of water resources caused by climate change may contribute to mass population migrations with inherent consequences of political stability and violent conflict in some regions.

3.3 Self-incrimination

3.3.1 In *Ferreira* v *Levin NO and Others*,[14] the Constitutional Court was asked to determine whether Section 417 of the Companies Act[15] was constitutional. Section 417 concerns the winding-up of a company unable to pay its debts and the summoning of evidence from directors, officers or any other person believed to be capable of giving information concerning the trade, dealings, affairs or property of the company.

3.3.2 In the course of proceedings, the Constitutional Court invited and accepted written memoranda from the Association of Law Societies, the Public Accountants' and Auditors' Board, the South African Institute of Chartered Accountants and the Association of Insolvency Practitioners of Southern Africa. A joint memorandum was provided to the Constitutional Court by the Public Accountants' and Auditors' Board (the Board), and the South African Institute of Chartered Accountants (the Institute) on 22 April 1995.

3.3.3 The memorandum sought to provide the Constitutional Court with the Board's and the Institute's opinion on the following questions:

— whether Section 417(2)(b) of the Companies Act is unconstitutional in that it compels a person summoned to an inquiry to testify and produce documents, even though such a person seeks to invoke the privilege against self-incrimination;

14 *Ferreira* v *Levin NO and Others*; *Vryenhoek and Others* v *Powell NO and Others* (CCT5/95) [1995] ZACC 13; 1996 (1) SA 984 (CC); 1996 (1) BCLR 1

15 Companies Act 61 of 1973

— whether evidence given by any person at an inquiry in terms of Section 417 of the Companies Act falls to be excluded in any subsequent criminal proceedings brought against such person where such evidence may be incriminating and was extracted without recognition of such person's privilege against self-incrimination;
— whether a person appearing at an inquiry in terms of Section 417 of the Companies Act is entitled to have prior access to a copy of the record of the examination of all other persons examined at the inquiry and all documents in the possession of the liquidator or those prosecuting the inquiry relevant to the interrogation of such person;
— whether a person is required to give testimony at an inquiry in terms of Section 417 which testimony may tend or have the effect of supporting a civil claim against such person; and
— whether a person who has given testimony at an inquiry in terms of Section 417 may have such testimony excluded in any subsequent civil proceedings.

3.3.4 The Board's and the Institute's reply noted that:

— an accountant or auditor being examined in terms of Section 417 of the Companies Act ought not to be able to refuse to testify or to produce documents where such testimony or documents may tend to evidence improper professional conduct on his or her part;
— such testimony and documents should be admissible as evidence in any subsequent disciplinary proceedings conducted by the Board or the Institute;
— should the Constitutional Court hold that such evidence may not be used in any subsequent criminal or civil proceedings, then the Board and the Institute would not disclose such evidence to any party for such purpose;
— a person being examined ought not to have prior access to the record of examination of all other persons examined at the inquiry; and
— a person being examined ought not to have prior access to all documents in the possession of the liquidator or those prosecuting the inquiry relevant to the person being examined.

3.3.5 It is instructive that in their response, the Board and the Institute recognised striking a balance between competing interests. On the one hand, the interests of the Board, the Institute, creditors, shareholders and the liquidators justify cheap and speedy procedures for identifying the causes of the winding up of a company, and establishing any misconduct by accountants and auditors. On the other hand, there are the interests of the examinee in not being prejudiced by giving answers which might tend to incriminate him or her and that may subsequently be used in evidence.

3.3.6 In the final analysis the Constitutional Court found that Section 417(2)(b) infringed the rule against self-incrimination and the right of a person to a fair trial in terms of Section 25(3) of the Constitution. The court acknowledged the role of the Board and the Institute:

> We are at the beginning stages of utilising the amicus curiae intervention procedures for which provision is made in Constitutional Court rule 9. We wish to acknowledge the valuable assistance derived by this Court from the argument on behalf of the amici curiae, JSN Fourie and others, as well as from the memoranda filed by the above mentioned professional bodies.

4. AFRICAN CASE LAW

4.1 Kenya

4.1.1 The Constitution of Kenya[16] provides that an organisation or individual with particular expertise may, with the leave of the court, appear as a friend of the court. The Constitution of Kenya (Protection of Rights and Fundamental Freedoms) Practice and Procedure Rules[17] defines a friend of the court as a person or entity that is expert in an issue that is the subject matter of proceedings, but is not a party to the case and serves to benefit the court with its expertise.

4.1.2 In *Trusted Society of Human Rights Alliance* v *Mumo Matemo & 5 others*,[18] the Supreme Court of Kenya developed rules to determine the admission of an *amicus curiae* to a case. In particular, it was held that admission of a friend of the court should be governed by principles of neutrality and fidelity to the law. This is in contrast to other common law countries including South Africa, where an *amicus curiae* may adopt a specific position on a matter.

4.1.3 The matter of *Baby 'A' and Another* v *Attorney General and Others*[19] saw intervention from the Kenya Human Rights Commission as an *amicus curiae*. In that matter, Baby A was born intersex, with both male and female genitalia. The hospital had marked Baby A's gender with a question mark on the legal paperwork, with the result that no birth certificate had been issued as the Registrar of Births and Deaths only provided for two options for gender, being male or female. The court's finding was aligned to the *amicus curiae* in the matter, noting that while there was no evidence of Baby A having undergone discrimination, there was a need to register intersex children to prevent future discrimination. The court acknowledged that there was a need to create laws and guidelines that protected intersex persons, but left this to the legislature. In 2019, Kenya became the first African country to collect statistics on intersex people in its national population census.

4.2 Nigeria

4.2.1 One of the obstacles for the admission of an *amicus curiae* in Nigerian courts is the lack of civil procedure rules or any other rules of court. Two broad ways in which they have been able to participate in court proceedings historically is by invitation from the court, or by invitation from parties to proceedings. The latter however must be done with leave of the court.

4.2.2 Anozie & Windgate (2020) discuss the landmark Supreme Court case of *Centre for Oil Pollution Watch* v *NNPC*.[20] They note that non-governmental organisations have been at the forefront of securing environmental justice for the people of the Niger Delta

16 Constitution of Kenya, 2010 art 22(3)(e)
17 Mutunga Rules, 2013 rule 2
18 *Trusted Society of Human Rights Alliance* v *Mumo Matemo & 5 Others* (Petition 12 of 2013) [2015] eKLR 41
19 *Baby 'A' (suing through the Mother E.A.) & another* v *Attorney General & 6 others* [2014] eKLR, petition no. 266 of 2013
20 *Centre for Oil Pollution Watch* v *NNPC* (2018) LPERL-50830 (SC)

who suffer from the effects of oil pollution, but in the past have lacked the necessary legal standing to pursue such cases in their own capacity.

4.2.3 In the Supreme Court ruling, it was found that environmental non-governmental organisations that were previously unable to institute action under existing public interest procedures may now institute action in their own right so as to prevent or remedy environmental pollution. The decision was aided by five teams of senior advocates who made up the *amicus curiae* in the matter. The import of the case is that Nigerian courts now recognise claims by non-governmental organisations for damages arising from oil pollution in the category of public interest litigation.

4.2.4 Reddy & Thomson (2015) note that environmental damage can be wrought in the short term, but it may take many years to reverse the damage done by one year of activity. Actuaries would be well placed to join non-governmental organisations in developing countries in order to model such effects and hence strengthen legal arguments. The provision of technical information and modelling in environmental litigation can aid the decision making of courts.

4.3 Malawi

4.3.1 The Malawi High Court Civil Procedure Rules[21] provide for any person interested in any matter in a proceeding before the court, with the permission of the court, to be admitted as an *amicus curiae* upon such terms and conditions as the court may determine.

4.3.2 In *Gwanda* v *The State*,[22] four *amici curiae* joined the matter, namely the Legal Aid Bureau; the Centre for Human Rights Education, Advice and Assistance; the Paralegal Advisory Services Institute, and the Malawi Law Society.

4.3.3 In the matter, Mr Gwanda, a street vendor by trade, was arrested in terms of Section 184 of the Malawian Penal Code[23] that was adopted on 1 April 1930. He was charged with being a rogue and a vagabond, concepts that found their way into Malawian law due to their colonial ties. The wording of the Malawian Penal Code can be traced back to the Vagrancy Act[24] in the United Kingdom, that consolidated all other laws relating to vagrants in the early 1800s.

4.3.4 The extent of colonialisation is illustrated in the African Court on Human and Peoples' Rights advisory opinion,[25] where it was noted that at least 18 African countries still have laws containing vagrancy offences. A vagrant is defined as any person who does not have a fixed abode nor means of subsistence, and who does not practise a trade or profession. As noted by Mr Gwanda following the conclusion of the trial:

> I believe poverty is no crime.

21 Malawi High Court Civil Procedure Rules (2017) Order 19
22 *Gwanda* v *The State* [2017] MWHC 23
23 Malawi Penal Code (Chapter 7:01) [as amended to Act No. 8 of 1999]
24 Vagrancy Act of 1824.
25 Request for Advisory Opinion by The Pan African Lawyers Union on the Compatibility of Vagrancy Laws with The African Charter on Human and Peoples' Rights and Other Human Rights Instruments Applicable in Africa No. 001/2018 Advisory Opinion 4 December 2020

4.3.5 Some African countries still have antiquated and oppressive vagrancy laws. In order to fast track change, statistical and demographic research into questions such as how migration is changing, how policies affect migration and what the social and economic implications of migration are on various African countries, will serve the judiciary well.

5. ACTUARIAL BODIES AS AN *AMICUS CURIAE*

5.1 Obamacare

5.1.1 On 23 March 2010, the United States Congress enacted the Patient Protection and Affordable Care Act, commonly referred to as the Affordable Care Act (ACA) or Obamacare. The purpose of the ACA was to increase the number of Americans covered by health insurance and decrease the cost of healthcare. One of the key provisions of the ACA is the individual mandate that requires most Americans to maintain minimum essential health insurance coverage. Individuals who are not exempt and who do not receive health insurance through an employer or government programme, are required to purchase insurance from a private company. With effect from the beginning of 2014, non-compliant individuals would be required to make a shared responsibility payment and that penalty would be paid to the Internal Revenue Service along with an individual's taxes. The ACA has been referred to as President Barack Obama's signature legislative achievement.[26]

5.1.2 Gluck et al. (2019) note that the ACA is the most challenged statute in American history. The ACA has faced seven United States Supreme Court challenges since its enactment. The first such challenge was the matter of *National Federation of Independent Business* v. *Sebelius*.[27]

5.1.3 Prior to reaching the Supreme Court (the highest court in the United States), the matter had initially been heard by the United States District Court for the Northern District of Florida. In a ruling on 31 January 2011, the District Court ruled that the individual mandate provision was unconstitutional and since it could not be severed from the body of the act, this caused the entire act to be invalid.

5.1.4 The United States federal government appealed the ruling of the District Court and the matter was then heard by the Eleventh Circuit Federal Court of Appeals. On 12 August 2011, the Federal Court of Appeal upheld the District Court's finding that the individual mandate was unconstitutional in a split 2–1 decision, but upheld the constitutionality of the remainder of the ACA.

5.1.5 On 28 September 2011, the Obama Administration petitioned the Supreme Court for a review of the decision. On 14 November 2011, the Supreme Court granted a review in the case. Oral arguments were then heard by the Supreme Court from 25 March 2012 to 27 March 2012.

5.1.6 The American Academy of Actuaries (AAA) is a non-profit professional association for actuaries of all specialties practising in the United States. That body is the

26 *NFIB* v *Sebelius and the Individualization of the State Action Doctrine*. (2014). *Harvard Law Review*, **127**(4), 1174–1195

27 *National Federation of Independent Business* v. *Sebelius* 567 U.S. 519 (2012)

public voice for the actuarial profession in the United States and provides independent and objective actuarial information, analysis and education for the formulation of public policy. Importantly, the Academy identifies and addresses issues of public interest to which actuarial science can provide a unique understanding.

5.1.7 With respect to the hearing in the Supreme Court, the AAA filed an *amicus curiae* brief on 27 January 2012 in an effort to assist the Supreme Court in understanding the actuarial consequences of a decision to invalidate the individual mandate.

5.1.8 In court papers, the AAA noted that:

> The Academy takes no position on the constitutionality of the individual-mandate provision, or on any of the other issues besides severability that are before the Court in the litigation concerning the Act. The Academy files this brief for the sole purpose of informing the Court of its judgment that, from an actuarial perspective, a decision invalidating only the individual-mandate provision would impose an unsound regulatory regime on the American health-insurance market—a regime that Congress would not have intended.
>
> However the Court rules on the constitutionality of the individual-mandate provision, therefore, the guaranteed-issue and community-rating provisions should stand or fall together with it.

5.1.9 The AAA provided detailed argument, noting that through the guaranteed-issue and community-rating provisions, the ACA eliminates the ability of insurers to deny coverage based on pre-existing conditions, eliminates the ability of insurers to base premiums on health status, and substantially limits the ability of insurers to vary premiums based on other characteristics associated with healthcare costs. In light of the guaranteed-issue and community-rating provisions, it was argued that the individual-mandate provision of the ACA is a vital mechanism for keeping insurance pools fully stocked with lower-risk individuals.

5.1.10 On 28 June 2012, the Supreme Court overturned the judgment of the Eleventh Circuit Federal Court of Appeals in a split 5–4 decision. The Supreme Court upheld the individual mandate as constitutional. By implication, this coincided with the AAA's opinion that the constitutionality of the individual mandate should stand with the guaranteed-issue and community-rating provisions.

5.1.11 The above matter is indicative of an actuarial body acting as an *amicus curiae* in the broad definition of public interest.

5.2 Actuarial Standards of Practice

5.2.1 In a further matter, the AAA filed an *amicus* brief in the matter of *Willens* v. *Northwestern Mutual Life Insurance Co.* [28] on 29 March 2004. That matter was enrolled in the Superior Court of the State of California (County of Los Angeles). The purpose of the brief was to clarify when Actuarial Standards of Practice (ASOPs) apply to individual assignments performed by actuaries and the process of developing and adopting ASOPs.

28 *Willens* v. *Northwestern Mutual Life Insurance Co.* Case No. BC 221648

5.2.2 Similar to the ASSA Advisory Practice Note 901,[29] Precept 3 of the AAA's Code of Professional Conduct,[30] provides that where a question arises with regard to the applicability of a standard of practice, or where no applicable standard exists, an actuary shall use professional judgement, taking into account generally accepted actuarial principles and practices.

5.2.3 In this particular matter, Northwestern Mutual Life Insurance Co. (Northwestern Mutual) actuaries examined ASOP 15,[31] for guidance in allocating divisible surplus among different groups of disability insurance policyholders. The applicable ASOP 15 at the time applied to dividends illustrated or distributed under the provisions of participating policies issued for delivery in the United States by mutual and stock life insurance companies and by fraternal societies and associations.

5.2.4 It was represented that in the absence of an ASOP dealing with dividend determination for disability insurance policies, the actuaries of Northwestern Mutual looked to ASOP 15 for guidance in how to allocate divisible surplus among different groups of policyholders. The plaintiffs in the law suit in question questioned the appropriateness of the decision of Northwestern Mutual's actuaries to do so.

5.2.5 The *amicus* brief of the AAA explained that if the disability policies at issue in the *Willens* case fell within the defined scope of ASOP 15, the code requires Northwestern Mutual's actuaries to comply with it. However, in the absence of a standard that deals expressly with the allocation of divisible surplus for disability insurance, the code requires the actuary to exercise professional judgement in dividing the surplus, taking into account the guidance set out in ASOP 15 and acting consistently with generally accepted principles and practices.

5.2.6 A second question raised by the plaintiffs in the matter was the participation of a Northwestern Mutual actuary in the drafting of ASOP 15. It was alleged that this unduly influenced the language of the standard that was adopted by the Actuarial Standards Board (ASB).

5.2.7 The AAA explained that the ASB uses a separate operating committee to develop each standard and that every standard is carefully reviewed, edited, and approved by the entire ASB. It was recorded that every new or amended standard is exposed to the actuarial profession and other interested parties through a broad period of notice and comment. All comments that are received are considered and answered in writing by the operating committee under the active oversight of the ASB. It was emphasised that the ASB process appropriately maintains the integrity of the standards. In addition, it would be highly unlikely that a single individual would unduly influence the drafting process involving the active participation of many professionals.

29 Actuarial Society of South Africa. APN901: General Actuarial Practice (2021)
30 American Academy of Actuaries. Code of Professional Conduct (2001)
31 Actuarial Standards Board. Dividend determination for participating individual life insurance policies and annuity contracts (1990)

5.2.8 Subsequent to the matter, the scope of ASOP 15 was extended to Dividends for Individual Participating Life Insurance, Annuities, and Disability Insurance with effect from March 2006.

5.2.9 The above matter is indicative of an actuarial body acting an *amicus curiae* within the narrow definition of public interest.

6. MECHANISM AND PROCEDURE FOR ADMISSION AS AN *AMICUS CURIAE*

6.1 It is important to examine the principles governing the admission of *amicus curiae* as compliance with these principles will ensure proper assessment of such applications. Consent is not merely granted just because an organisation asks to join proceedings as a friend of the court. Admission of *amici* in the Constitutional Court is governed by Rule 10 of the Constitutional Court Rules. Different rules govern admission of *amici* in the High Court and the Supreme Court of Appeal, but essentially the same principles apply.

6.2 Subrule 10(1) provides for an organisation to be admitted as an *amicus curiae* provided that it receives the written consent of all parties. Even in matters where written consent has been obtained from all parties, the court is not bound to automatically admit that organisation as a friend of the court. The court still needs to satisfy itself whether regard has been had to the principles that govern the admission of an *amicus curiae.* These principles are whether the submissions sought to be advanced are relevant to the issues before the court, will be useful to the court and are different from those of the other parties. Subrule 10(7) states that the submission should raise new contentions and should not repeat the arguments set out by other parties.

6.3 In matters where written consent has not been obtained from all parties, the *amicus curiae* can approach the Chief Justice in terms of subrule 10(4). The Chief Justice may grant such an application upon such terms and conditions and with such rights and privileges as he or she may determine.

6.4 Irrespective of the mechanism for admission, it was ruled in *Institute for Security Studies: In re S* v *Basson*[32] that no person may be admitted without the consent contemplated in subrule 10(4). That is, after obtaining written consent in terms of subrule 10(1), an applicant must still make an application to the Chief Justice for admission.

6.5 Subrule 10(6)(c) requires an application for admission as an *amicus curiae* to set out the submissions to be advanced, their relevance to the proceedings, the reasons for believing that the submissions would be useful to the court and different from those of the other parties to the proceedings. For a proper assessment to be made, the application for admission as an

32 *Institute for Security Studies: In Re S* v *Basson* (CCT30/03B) [2005] ZACC 4; 2006 (6) SA 195 (CC)

amicus curiae must ordinarily be accompanied by a summary of the written submissions sought to be advanced. This will enable the Court to assess the application properly.

6.6 There are no formal limits on the length of heads of argument of an *amicus curiae* in the Constitutional Court. However, heads of argument filed by the parties are limited (by directions of the Court) to fifty pages. When *amici* are admitted, the directions frequently limit the length of heads of argument. The heads of argument are based on the evidence presented by the *amici* and the applicable legal principles.

6.7 A plain reading of subrule 10(8) indicates that *amici curiae* are not permitted to present oral argument. Budlender (2006) notes however that whilst that may be the default position, it is not the usual practice. The Constitutional Court has discretion to permit the *amicus curiae* to offer oral argument and that appears to be derived from subrule 32(2). In the Supreme Court of Appeal, Rule 16(8) of the rules regulating the conduct of proceedings in that court limits the *amicus curiae* to the record on appeal, unless directed otherwise by the court.

7. EXPERT WITNESS VERSUS *AMICUS CURIAE*

7.1 A distinction must be drawn between individual actuaries acting as expert witnesses for litigants, and the ASSA or another appropriate actuarial body acting as an *amicus curiae*.

7.2 An actuary acting as an expert witness for an individual party does so on the instruction of that party and the contentions contained in the expert report are usually limited to the information and bases provided by the client. This is not always the case. An actuarial expert may testify on the basis of his or her own research and expertise, wholly independent of the client. In contrast, the role of the ASSA acting an as *amicus curiae* is envisaged to consider the public interest component of the case in its entirety and provide an actuarial perspective that is holistic. The briefing parameter is essentially twofold: first to promote the spirit, purport and objectives of the Bill of Rights, and secondly to manifest Section 24 of the ASSA Code of Conduct to serve the public interest. As long as the contentions raised canvass factual material based on scientific, technical or statistical fact, the ASSA may bring them to the court's attention.

7.3 An expert witness is paid for by the individual parties engaging in their services. The ASSA would be required to self-fund any participation as an *amicus curiae*, including the costs of legal counsel to draft papers and, where appropriate, present legal argument.

7.4 An expert witness almost always provides a written expert report containing his or her opinion. The client has the prerogative of whether or not to disclose this report to the court or merely utilise same for their own litigation strategy. If the expert report is served on all parties and incorporated as part of the court record, it becomes public. If the matter proceeds to trial, the expert will give oral evidence which would include being cross-examined by

all other parties. The scope of the oral evidence is generally limited to that contained in the expert report. Acting as an *amicus curiae* provides the ASSA with the opportunity to record their input in written heads of argument which is submitted to the court. An *amicus curiae* would not be required to give oral evidence or be subject to cross examination.

7.5 A litigating party decides whether or not to appoint an expert actuary. This is usually based on previous involvement of actuaries in the particular area of law under dispute and whether or not the client has sufficient funds. As is evident from Section 3 and Section 4 above, the ASSA is better placed to give creative consideration to instances where actuaries can add critical value to the courts in determining a far wider range of rights-based litigation than has been seen in practice to date.

7.6 By using a strategic impact litigation strategy, the ASSA would raise the profile of the actuarial profession as leaders in societal risk management. This culminates in the transition of the actuarial profession from service providers targeting the healthy and the wealthy, to drivers of well-considered social reform. This complements the ASSA's realisation of active citizenry.

8. A TEST CASE

> I can get no remedy against this consumption of the purse: borrowing only lingers and lingers it out, but the disease is incurable.[33]
>
> William Shakespeare: *Henry IV*, Part 2

8.1 Introduction

8.1.1 The South African Law Reform Commission (SALRC) has documented the medical negligence claims crisis facing the various provincial departments of health[34] and notes that:

> It must be emphasized again that the more money is taken from the public health sector to benefit a handful of successful claimants, the less money is available to improve services for the benefit of all users of public health services. It is the members of the poorest communities who have no option but to use public health services that are most affected by deteriorating health services standards due to depleted budgets. The solution to addressing the problems in the public health sector does not reside in making huge lump sum payments to a lucky few claimants. The same principles apply to any patient suffering a permanent injury and requiring long-term care, rehabilitation and treatment.

8.1.2 The above passage highlights the contentious issue of large lump sum payments. In the ensuing four sections, the once-and-for-all rule, the various defences

33 As quoted by Judge Eksteen in *MEC for Finance, Eastern Cape* v *LPC* [2022] 2091–2011 (ECM)
34 South African Law Reform Commission (2021). Discussion Paper 154 Project 141 Medico-Legal Claims

that have been raised—such as the public healthcare defence, periodic payments and the undertaking to pay defence—and the State Liability Amendment Bill are discussed.

8.1.3 The remaining sections provide additional information for the benefit of the court, and explain what additional information must be obtained so that the court can make a more informed decision concerning the appropriate payment mechanism.

8.2 The once-and-for-all rule

8.2.1 The once-and-for-all rule is a common law convention which requires that all damages flowing from a cause of action must be claimed in one court action. This is to prevent a plaintiff from making multiple claims against the same defendant arising from the same event. This rule means that damages for past harm and for future loss must be claimed within the same court action.

8.2.2 In the matter of *Member of the Executive Council for Health and Social Development, Gauteng* v *DZ obo WZ*,[35] the Constitutional Court held that damages due in law are to be awarded in money. In addition, damages may not be paid in periodic payments as an alternative to being paid in a lump sum. Finally, it was ruled that a defendant may not compensate a plaintiff by providing future medical services in the place of damages.

8.2.3 In order to allow damages to be paid in any of these ways rather than as a lump sum, the court would have to develop the common law. There are two possible justifications for developing the common law set out in the Constitution—firstly if it conflicts with the Bill of Rights or, secondly, if it is in the interests of justice for the common law to be developed.

8.2.4 The court chose not to develop the common law in this case, because it found that the Member of the Executive Council (MEC) for Health and Social Development, Gauteng had not put forward a sufficiently strong factual foundation for why the law should be changed. However, it did not rule out developments of the common law as a future possibility.

8.3 The public healthcare defence

8.3.1 This is an argument that was made by the MEC for Gauteng and was also raised by the MEC of the Eastern Cape as an *amicus curiae*. The argument was that instead of paying for future medical services rendered to the plaintiff in the private healthcare sector, the defendant should be allowed to provide these services directly to the plaintiff at a public hospital.

8.3.2 The court rejected this proposition. The court did not feel it was appropriate for it to develop the common law in this new direction, although it did recognise some of the benefits of doing so. For example, it recognised that in principle, providing medical services in the place of paying out damages would serve the purpose of compensation in a delictual claim (placing the plaintiff in the position they would have been in if the wrong had not occurred). The court left the door open for this to happen in future cases.

35 *Member of the Executive Council for Health and Social Development, Gauteng* v *DZ obo WZ* (CCT20/17) [2017] ZACC 37; 2017 (12) BCLR 1528 (CC); 2018 (1) SA 335 (CC)

8.3.3 Whilst the court did not accept the public healthcare defence, it accepted that the plaintiff would need to show that the damages claimed for private healthcare were reasonable. This would include demonstrating why it was reasonable to claim the costs of private healthcare, rather than public healthcare if the defendant had produced evidence that equivalent services of equal quality were available at a lesser cost. This is known as the mitigation of health costs defence. The court found that this defence was possible within the current ambit of the common law because it falls within the current law that a plaintiff must prove that the damages they are claiming are reasonable.

8.4 Periodic payments

8.4.1 The MEC for Gauteng argued that instead of damages being paid in a lump sum, they could be made by way of instalments. Froneman J found that whilst there are isolated examples of courts ordering damages in periodic payments, this is not a concept which is recognised within the common law. Froneman J referred to sources in English law which declined to amend the common law in order to allow periodic payments, stating it was a matter better left for the legislature to decide upon.

8.4.2 The court recognised some of the potential benefits of periodic payments, such as the difficulty of making an accurate calculation when awarding a lump sum. At the heart of this is the difficulty in predicting, with accuracy, the life expectancy of a child with cerebral palsy. The court acknowledged that periodic payments could be less speculative than a lump sum, especially where there are top-up provisions (allowing the plaintiff to apply for more money should further need occur) and claw back provisions (allowing the defendant to regain the remainder of the funds in the event of the early death of the child).

8.4.3 At the same time, it acknowledged that periodic payments posed potential difficulties with regard to inflation, taxation, etc. Froneman J opined that the common law would need to be developed in order to allow periodic payments and declined to develop the law to allow periodic payments in this case; however he suggested that in a future case where a fully pleaded argument for periodic payments had been made, the common law might be developed in this direction.

8.4.4 In a minority judgment, Jafta J, disagreed that periodic payments depart from the common law of South Africa. He argued that the fact that other common law jurisdictions demand a lump sum payment does not necessarily mean that the same should apply in South Africa. Jafta J cited examples such as judgment debts being paid in instalments in relation to execution on a person's home. He argued that the High Court has the inherent power to order periodic payments. However, he agreed with Froneman J that the MEC for Gauteng had not provided a persuasive factual basis for why the court should order periodic payments rather than a lump sum in this case.

8.4.5 Consequently, the court did not allow the defendant to pay damages as periodic payments; however this case laid the groundwork for the common law to change when a case with the right set of facts comes along.

8.5 The undertaking to pay defence

8.5.1 This was another argument put forward by the MEC for Gauteng, which was also raised by the MEC for the Eastern Cape. She argued that a claim for future medical expenses could be satisfied by an undertaking by the MEC to pay for medical expenses as and when they arose in the future. The MEC would undertake to pay invoices raised within 30 days. The payment would be made directly to the service provider. Froneman J felt that like periodic payments, this fell outside of the current possibilities of the common law. Jafta J disagreed, finding that this was simply an administratively different mechanism for payment of damages, rather than a different type of damages.

8.5.2 However, both judges agreed that it would not be appropriate to allow damages to be paid in this way on the facts of this case, because the defendant had not provided sufficient evidence to support their case. Therefore, like the other alternatives to a lump sum, this proposition was rejected by the court.

8.6 The State Liability Amendment Bill

8.6.1 The State Liability Amendment Bill[36] (the Bill) was introduced in the National Assembly on 30 May 2018. The Bill seeks to amend the State Liability Act, 1957, so as to provide for structured settlements for the satisfaction of claims against the State as a result of wrongful medical treatment of persons by servants of the State; and to provide for matters connected therewith. The memorandum on the objects of the Bill states that the Bill is promoted in the interim pending the outcome of the larger investigation into medico-legal claims by the SALRC.

8.6.2 Public hearings with respect to the Bill were held on 31 October 2018. According to National Assembly Rule 333(2), the Bill automatically lapsed when Parliament was dissolved on 7 May 2019, but was revived by the National Assembly on 29 October 2019.

8.6.3 The Portfolio Committee for Justice and Correctional Services (the Committee), who preside over the Bill, convened a meeting on 26 January 2021[37] in which the Bill was discussed. The Committee noted that it did not understand why the Bill is being brought before it when the matter is still being holistically investigated by the SALRC. It was stated that the Committee cannot consider a Bill which has not been fully processed without all the available information before the decision makers.

8.7 The missing link

8.7.1 Of crucial importance surrounding the debate of a lump sum as opposed to a structured settlement (consisting of a smaller lump sum, a payment in kind plus a periodic payment), is the historical experience of lump sum payments.

36 State Liability Amendment Bill B16 of 2018

37 South Africa. Parliament. Committee on Justice and Constitutional Development (2021). State Liability Amendment Bill: Briefing

8.7.2 Valuable insights would include whether or not plaintiffs actually benefit from lump sum awards, whether or not the numerous recommendations made in expert reports are actually implemented after litigation, what remains of the lump sum after a few years, the mortality experience of the children involved, and a comparison of the amount of the award paid out by the Department of Health compared to the amount that actually gets placed in trust for the plaintiff.

8.7.3 Research into the expenditure of lump sums is minimal.[38] A reason for this is the sensitive nature of the information that is required to properly account for the expenditure of a lump sum payment.

8.8 Claims paid data

8.8.1 Over the period from 1 April 2014 until 21 March 2021, total claims payments by the nine provincial health departments totalled approximately R9.76 billion.[39]

8.8.2 Claims payments are made out of provincial health department annual budgets. As noted by Wessels (2019):

> … the most worrying consequence of the excessive medical malpractice litigation against the state is that it may potentially undermine the department of health's ability to provide public healthcare in future … In other words, the problem is that an already overwhelmed and underfinanced public healthcare sector is exposed to the ever increasing amount of malpractice claims.

8.8.3 Data was obtained for an anonymised province containing claims paid from 1 April 2014 until 31 March 2021 as shown in Table 1.

TABLE 1. Claims paid from 01/03/2014 to 31/03/2021

Payment made on file in the financial year ending	Number of unique claim payments in financial year	Total claims payments in financial year	Average claim size
31/03/2015	33	R72,100,000	R2,200,000
31/03/2016	58	R245,300,000	R4,300,000
31/03/2017	40	R205,100,000	R5,200,000
31/03/2018	48	R378,400,000	R7,900,000
31/03/2019	66	R784,800,000	R11,900,000
31/03/2020	71	R793,900,000	R11,200,000
31/03/2021	97	R1,007,300,000	R10,400,000
Total	413	R3,486,600,000	R8,500,000

38 Road Accident Fund Commission Report (2002). Volume 3
39 Ibid., 37

8.8.4 The distribution of claim sizes, unadjusted for inflation, is shown in Table 2.

TABLE 2. Distribution of claims paid from 01/03/2014 to 31/03/2021

Claim size (million)	Number of claims	Total claims payments	Cumulative
< R1	150	R39,600,000	1.1%
R1–R2	16	R21,500,000	1.8%
R2–R5	30	R100,900,000	4.6%
R5–R10	44	R330,200,000	14.1%
R10–R15	49	R607,600,000	31.5%
R15–R20	83	R1,397,200,000	71.6%
> R20	41	R989,900,000	100.0%

8.8.5 Two firms of attorneys (or their associated firms) accounted for approximately 39% of all claim payments in the province, and approximately 14% of all claim payments in the country over the period from 1 March 2014 until 31 March 2021. Firm A settled 39 claims and received total payments of approximately R744.0 million with an average claim size of approximately R19.1 million. Firm B settled 40 claims and received total payments of approximately R612.2 million with an average claim size of approximately R15.3 million. It is possible that some claims were only partially settled and that additional amounts may be payable in respect of a file, but this was not immediately apparent from the data.

8.9 Trusts

8.9.1 Once a matter is settled and made an order of court, court orders invariably require that the monies be paid to the attorney's trust account and that thereafter a trust is to be established in respect of the child. In practice, either trusts are formed or in some matters a trust is not even established despite the court order.[40]

8.9.2 There is a clear lack of oversight in relation to trusts. Despite the fact that most court orders require that annual financial statements of the trust be lodged with the Master's Office, this is a meaningless provision. This is due to the fact that the Master's Office is oblivious to how much the actual award was and only has a record of the amount that is actually transferred into the trust account from the attorney's trust account. In addition, it is unclear if party-and-party costs recovered from the defendant are in fact paid into the trust.

8.9.3 With respect to Firm A, using the publicly available online Master's Office portal,[41] letters of authority were obtained that corresponded to 33 settlement values

40 *The South African Legal Practice Council and Another* v *Nonxuba and Others* (10313/2021) [2022] ZAWCHC 105

41 www.icmsweb.justice.gov.za

amounting to approximately R694.6 million. In all instances, the attorney representing the plaintiff also became a trustee of the trust set up for the child. With respect to curators, the courts have ruled on a conflict of interest in the matter of *Martin* v *Road Accident Fund*.[42] In that matter the court ruled that it is advisable that no member of the firm that represented the plaintiff should be appointed as the *curator bonis*, so that there is no conflict of interest when fees and disbursements have to be quantified and recovered. The conflict of interest described above has major financial implications for plaintiffs and should equally apply to trusts.

8.9.4 In all instances, three trustees were appointed: a chartered accountant, the attorney from the firm representing the plaintiff in the original court action, and a parent or guardian of the child. The same chartered accountant appeared as a trustee in 31 out of 33 trusts. Each trustee commands a trustee's fee and aside from the attorney and chartered accountant, each parent or guardian also receives a trustee's fee. Consideration should be given to establishing an umbrella trust so as to circumvent the additional fees generated by the arrangement described above.

8.9.5 Instances have been identified where the attorney acting for the claimant becomes a trustee of the trust set up for the birth-injured child and then also becomes the executor of the child's estate on death.

8.10 Triangulation of data

8.10.1 It is compulsory for trusts to be registered for tax purposes.[43] Trusts are required to submit an income tax return annually and it is compulsory for trusts to file a return on time. An entity such as the SALRC could consider using their powers in terms of the Commission Act.[44] For the purposes of investigating a matter of public concern, the Commission Act would permit the SALRC to summons any information it deems relevant to their investigation. It is imperative that information concerning whether trusts are complying with the Income Tax Act and the amounts left in various identified trusts be established from the South African Revenue Service (SARS).

8.10.2 The Legal Practice Council (LPC) is a national statutory body established in terms of the Legal Practice Act.[45] The LPC and its provincial councils regulate the affairs of and exercise jurisdiction over all legal practitioners (attorneys and advocates) and candidate legal practitioners. An important mandate of the LPC is to regulate the professional conduct of legal practitioners to ensure accountability. The LPC has the power to inspect attorneys' trust accounts and accounting records. The SALRC could request the LPC to investigate certain identified trusts with the view of determining how much of the original award was set up in trust for a successful claimant.

8.10.3 The identity numbers of the parents or guardians of various trusts are publicly available on the Master's Office Portal. The South African Social Security Agency

42 *Martin* v *Road Accident Fund* [1999] JOL 5350 (W)
43 Section 1 of the Income Tax Act 58 of 1962
44 Commission Act 8 of 1947
45 Section 4 of the Legal Practice Act 28 of 2014

(SASSA) can provide information on all social grant recipients linked to a particular parent or guardian. This will serve two purposes. Firstly, it will permit a more complete check of the vital status of various birth-injured children. Secondly, it will permit the court to know how many birth-injured children are receiving additional state-sponsored assistance, despite large lump sum awards having been concluded.

8.10.4 It is clear that the very nature of this data requires the aforementioned triangulation from SARS, the LPC and SASSA. As such, an independent, objective third party acting as an *amicus curiae* would be well placed as a vehicle to deliver this critical, as yet under-investigated, perspective to the courts.

9. BENEFITS AND RISKS OF *AMICI* BRIEFS

9.1 The risk of adverse cost orders

9.1.1 Humby (2009) explains that two principles have governed cost orders in South Africa since the early 1900s. Firstly, the court has judicial discretion to award costs and secondly, costs follow the event in that the successful party to litigation is normally awarded costs. Hence, the ASSA would want to avoid an adverse costs order in the event that the position adopted on a particular matter was rejected by the court.

9.1.2 The matter of *Trustees for the time being of the Biowatch Trust* v *Registrar Genetic Resources and Others*[46] provides protection however. The Constitutional Court ruled that:

> I conclude, then, that the general point of departure in a matter where the state is shown to have failed to fulfill its constitutional and statutory obligations, and where different private parties are affected, should be as follows: the state should bear the costs of litigants who have been successful against it, and ordinarily there should be no costs orders against any private litigants who have become involved. This approach locates the risk for costs at the correct door—at the end of the day, it was the state that had control over its conduct.

9.1.3 In litigation between the state and a private party seeking to assert a constitutional right, the so-called Biowatch principle provides protection for unsuccessful litigants from the obligation of paying costs to the state. This is different from ordinary civil litigation where an unsuccessful litigant is liable for the costs of the successful party. In the event that the ASSA adopted a position opposite to that of the state in a Constitutional Court matter, they would be limited to their own costs.

9.1.4 The matter of *Hoffmann* v *South African Airways*[47] stated further that with respect to an *amicus curiae*:

> It joins in the proceedings to assist the court because of its expertise on or interest in the matter before the court. It chooses the side it wishes to join, unless requested by the court to urge a

46 *Biowatch Trust* v *Registrar Genetic Resources and Others* (CCT 80/08) [2009] ZACC 14; 2009 (6) SA 232 (CC) at para 56

47 *Hoffmann* v *South African Airways* (CCT17/00) [2000] ZACC 17; 2001 (1) SA 1; 2000 (11) BCLR 1211; [2000] 12 BLLR 1365 (CC)

particular position. An amicus, regardless of the side it joins, is neither a loser nor a winner and is generally not entitled to be awarded costs.

9.2 The benefit of incremental change

9.2.1 Rosenberg (1991) notes that courts are political institutions and questions whether as political institutions they can be consequential in effecting significant social reform. Courts have traditionally been viewed as passive problem solvers and piece-meal adjudicators of private disputes. The result of this mixture of interesting but unconnected judgments is that it tells us little about whether or not courts produce social change. A natural concern of the ASSA membership (aside from the costs of litigation), would be whether or not involvement in a litigation matter would bring about any meaningful change.

9.2.2 Budlender, et al. (2014) emphasise that optimal societal impact is normally achieved through a series of cases and not a single case. There needs to be a coherent long-term strategy as it is unlikely that one case on its own will bring about the desired social change. A research report produced by actuaries may highly inform this long-term strategy, given the actuarial control cycle and the importance of feedback loops. To ensure that the long-term strategy has considered practical, statistical and economic knowledge, the reliance on credible actuarial research can be critical.

9.2.3 For an *amicus curiae*, there is an additional value of publicising the consequences of the decision a court is asked to make. The most crucial factor is ensuring that a public interest litigation victory translates into practical benefits for many people at grassroots level. Part of achieving such a goal is to create awareness, educate and empower communities as to the real impact of a ruling.

9.3 Other considerations

9.3.1 Litigation can be prohibitively expensive. As the SALRC notes, a worrying new trend is developing where persons or organisations who are not attorneys engage in litigation funding. Khoza (2018) notes that in South Africa there is no regulation of third party litigation funding agreements. Litigation funders are not subject to the Contingency Fees Act[48] and as a result litigants may be prejudiced where the funder receives a disproportionate percentage of the capital. In a matter that determines the future of medical malpractice litigation and litigation funding in this arena, plaintiffs are likely to have access to extensive legal resources, expertise and funding resources. A voluntary association wishing to participate as a friend of the court in such proceedings would require significant litigation funding. To this end the ASSA could conceivably create a mechanism, separate from itself (similar to the Actuarial Society Educational Trust), with the main objectives of the promotion or advocacy of human rights and democracy. This entity could then qualify as a public benefit organisation that is authorised to issue certificates in terms of Section 18A of the Income Tax Act.

48 Contingency Fees Act 66 of 1997

9.3.2 Easterly (2019) notes that friend of the court briefs can reduce litigant power disparities in federal appellate cases. There are clear power disparities at play in medical malpractice litigation, with a well-organised and well-funded plaintiff facing an inexperienced and disorganised defence. This is illustrated in *MEC for Finance, Eastern Cape* v *LPC*:

> They attribute their current embarrassment to numerous factors, including: the "excessive" litigation against the ECDOH; unscrupulous and dishonest attorneys; the incompetent and under resourced state attorney, particularly in the Mthatha office, who is unable to provide effective legal advice or representation …

10. CONCLUSION

10.1 The 1885 matter of *Clair* v *Port Elizabeth Harbour Board*[49] is the earliest account of an actuary being of assistance to South African courts in calculating damages. Numerous actuaries throughout the last 137 years have since contributed to South African common law, mostly in the personal injury arena. The ASSA has not acted as an *amicus curiae* in a public interest matter as yet.

10.2 Numerous *amici curiae* have assisted the courts in South Africa and Africa. The sample of matters discussed in this report range from the death penalty, the right to water, aspects of commercial law, issues around gender identity, environmental protection and vagrancy laws. In some of these matters, actuarial evidence could have presented factual material relevant to the issues to be determined before the court to aid their decisions. Internationally, actuarial bodies have become involved as *amici* in matters such as public health and the interpretation of professional standards of practice.

10.3 It is well known that South Africa is facing a medico-legal claims crisis that led to the publication of an issue paper by the SALRC in 2017, the introduction of the Bill in 2018 and a discussion paper by the SALRC in 2021.

10.4 The SALRC has emphasised that the more money is taken from the public health sector to benefit a handful of successful claimants, the less money is available to improve services for the benefit of all users of public health services. It is members of the poorest communities who cannot afford private health services that are most affected by depleted budgets. The SALRC states that the solution to addressing the problems in the public health sector does not reside in making huge lump sum payments to a few successful claimants. This is an assertion that will be challenged and any legislation to this effect is likely to be met with legal challenges.

10.5 In anticipation of the likely course of future litigation, this paper seeks to provide an additional view for the court to consider when assessing the payment methodology to

49 *Clair* v *Port Elizabeth Harbour Board* (1885–1887) 5 EDC 311

be employed in settling medical malpractice claims. The ASSA is well placed to present statistical, technical and factual material in a way that is neutral and faithful to the court.

10.6 The ASSA is well placed to promote constitutional values, social justice, equality, accountability and the rule of law by providing a much needed numerical perspective on issues facing the courts. It is hoped that this paper will provide the impetus for the ASSA to further their public interest endeavours by joining litigation proceedings as a friend of the court. With respect to the Constitution, Cameron (2014) notes that it requires:

> … me, you and all of us to give it life.

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An economic scenario generator for embedded derivatives in South Africa

By Alexis Levendis and Eben Maré

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ABSTRACT
It is well known that interest rate risk is a dominating factor when pricing long-dated contingent claims. The Heston stochastic volatility model fails to capture this risk as the model assumes a constant interest rate throughout the life of the claim. To overcome this, the risk-free interest rate can be modelled by a Hull-White short rate process and can be combined with the Heston stochastic volatility model to form the so-called Heston-Hull-White model. The Heston-Hull-White model allows for correlation between the equity and interest rate processes, a component that is important when pricing long-dated contingent claims. In this paper, we apply the Heston-Hull-White model to price Guaranteed Minimum Maturity Benefits (GMMBs) and Guaranteed Minimum Death Benefits (GMDBs) offered in the life insurance industry in South Africa. We propose a further extension by including stochastic mortality rates based on either a continuous-time Cox-Ingersoll-Ross short rate process or a discrete-time AR(1)-ARCH(1) model. Our findings suggest that stochastic interest rates are the dominating factor when reserving for GMMB and GMDB products. Furthermore, a delta-hedging strategy can help reduce the variability of embedded derivative liabilities.

KEYWORDS
Heston-Hull-White, stochastic volatility, stochastic interest rates, stochastic mortality, GMMB, GMDB, pricing, hedging

CONTACT DETAILS
Alexis Levendis, Department of Actuarial Science, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa; Momentum Metropolitan Holdings Limited; Email: alexilevendis@gmail.com
Eben Maré, Department of Mathematics and Applied Mathematics, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa; Email: eben.mare@up.ac.za

1. INTRODUCTION

1.1 Life insurers often sell policies with embedded guarantees. Pricing these guarantees is challenging due to the financial and insurance risks involved. Two popular products sold by life insurers include the Guaranteed Minimum Maturity Benefit (GMMB) and the Guaranteed Minimum Death Benefit (GMDB). The former provides the policyholder with the greater of the guaranteed amount at maturity or the fund value in which the initial premium was invested, whereas the latter provides the policyholder with the greater of the guaranteed amount or the fund value at the time of death, should death occur before the maturity of the contract. To price these products, a model is required that can capture financial risks, including equity and interest rate volatility, and insurance risks such as mortality.

1.2 The Black-Scholes (1973) model is unsuitable for modelling long-dated guarantees as it does not account for stochastic interest rates or stochastic volatility. Furthermore, it has been shown that the model is inconsistent with the stylised facts of financial returns (see Cont, 2001). Fortunately, the Black-Scholes (1973) model has been extended to incorporate stochastic volatility.

1.3 The Heston (1993) model incorporates stochastic volatility, and, hence, can capture the equity skew observed in financial markets. However, as shown by Kammeyer & Kienitz (2012), stochastic interest rates are a bigger risk driver for long-dated contingent claims than stochastic volatility. Consequently, a model is required that can incorporate stochastic volatility as well as stochastic interest rates.

1.4 The Hull-White (1990) model is a stochastic process that describes the short-term instantaneous interest rate and is popular among practitioners. The model has the benefit in that it can fit the initial term structure of interest rates and has an analytical solution for zero-coupon bonds. Given the model's analytical tractability, researchers in the field of quantitative finance started to investigate its use with the Heston (1993) stochastic volatility model, leading to what is now known as the Heston-Hull-White model.

1.5 A particular challenge faced when pricing GMMB and GMDB products is their long-dated nature. As discussed by Maze (2014), the further a call or put option is from maturity, the more time a stochastic interest rate has to reach its long-run mean and affect the option price. Therefore, it is important for practitioners to include stochastic interest rates when reserving for embedded derivatives. The Heston-Hull-White model will allow for this. Apart from financial risks, insurance risks such as mortality must also be incorporated.

1.6 Traditional actuarial modelling assumes deterministic mortality rates based on actuarial life tables. In reality, mortality rates are stochastic and it may be necessary to price contingent claims based on this assumption. In this paper, we extend the Heston-Hull-White model to include stochastic mortality rates based on either a continuous-time Cox-Ingersoll-Ross

(1985) process or discrete-time AR(1)-ARCH(1)[1] model when pricing products contingent on either survival or death. We call this extension the Heston-Hull-White-Mortality model.

1.7 The remainder of this paper is structured as follows: Section 2 reviews relevant literature on guaranteed maturity benefits, the Heston-Hull-White model, and stochastic mortality; Section 3 introduces the mathematical theory of the Heston-Hull-White model; Section 4 reviews the continuous-time Cox-Ingersoll-Ross (1985) short rate process and its extension proposed by Brigo & Mercurio (2001), and the discrete time AR(1)-ARCH(1) model that will be used for mortality rates; Section 5 shows the formulas that will be used to price the GMMB and GMDB products; Section 6 introduces the data that will be used to calibrate the Heston-Hull-White-Mortality model and price the GMMB and GMDB products; Section 7 shows our pricing and hedging results, and Section 8 concludes the findings.

2. LITERATURE REVIEW

2.1 In 2007, ING, a large Dutch banking group, presented a problem from the financial industry where the goal was to derive a closed-form or semi-closed form solution for a call option under the hybrid Heston-Hull-White model. To understand the complexity of this challenge, Oosterlee (2007) writes:

> Quite a few mathematicians took up this ING challenge, and during the week three subgroups were formed, each approaching the problem from a different side. A particular challenge here was that some Dutch professors in financial mathematics in earlier attempts were not able to come up with a closed form option pricing solution for this particular model.

From this challenge, three interesting approaches were suggested to solve the model, see Muskulus (2007), in 't Hout et al. (2007), and Fang & Janssens (2007).

2.2 The Heston-Hull-White model has become popular since the so-called ING challenge. Kammeyer & Kienitz (2009) considered an interest rate process that is independent of the equity and volatility processes, and showed the resulting characteristic function and calibration of the model based on the Carr & Madan (1999) fast Fourier transform (FFT) method. Still, the challenge remained to incorporate a non-zero correlation structure between the equity, volatility and interest rate processes.

2.3 Grzelak & Oosterlee (2011) made a breakthrough by deriving approximations for specific terms in the Heston-Hull-White model that allow for a non-zero correlation structure between the equity, volatility, and interest rate processes. The authors conclude that the approximations yield accurate prices for European options. This was a big contribution to the field of quantitative finance and the model has since been applied to price long-dated contingent claims.

1 First-order autoregressive and autoregressive conditional heteroskedastic model

2.4 Maze (2014) applied the Heston-Hull-White model to price long-dated European call options and compared the results to the standard Black-Scholes (1973) model. The author showed that call option prices under the Heston-Hull-White model increase when compared to the Black-Scholes (1973) model as the time to maturity increases. This is an important finding, especially considering the long-dated nature of embedded derivatives such as GMMB and GMDB products.

2.5 Patel (2019) implemented the Heston-Hull-White model to price long-dated European call options and compared the deterministic and stochastic approximations for the Heston-Hull-White model proposed by Grzelak & Oosterlee (2011). The author concludes that the deterministic approximation is a feasible way to calibrate the Heston-Hull-White model, whereas the stochastic approximation is inefficient.

2.6 As mentioned earlier, traditional actuarial modelling assumes deterministic mortality rates. In reality, mortality rates tend to behave randomly. Cairns et al. (2008) discuss various stochastic mortality models including the discrete-time Lee-Carter (1992) model and continuous-time short rate models. Mortality modelling is similar to interest rate modelling, hence, it is relatively simple to extend the theory of interest rates to mortality.

2.7 A weakness of many short rate models is that they cannot fit the initial term structure of interest rates. Examples include the Vasicek (1977) and Cox-Ingersoll-Ross (1985) models. The Hull-White (1990) model overcomes this issue, but, due to its Gaussian distribution, can produce negative values. Brigo & Mercurio (2001) extended the Cox-Ingersoll-Ross (1985) model to include a deterministic shift that allows the model to fit the initial term structure of interest rates whilst maintaining its analytical tractability for zero-coupon bonds. The model is termed the CIR++ model.

2.8 Truter (2012) applied the CIR++ model to price defaultable zero-coupon bonds. The author showed that the hazard rate, or instantaneous probability of default, can be modelled as a CIR++ process. From there, an analytical solution exists to calculate survival probabilities (the probability that a counterpart does not default). Simply replacing the hazard rate with the force of mortality (instantaneous rate of mortality), the CIR++ model can be used to calculate survival probabilities in a life insurance context.

2.9 Literature on the use of hybrid models to price embedded derivatives or variable annuities is limited. Wang (2011) applied the Heston-Hull-White model to price the Guaranteed Minimum Withdrawal Benefit (GMWB) product and discussed two semi-analytical techniques that can be used to calibrate the model to market data. The author considered the FFT technique of Carr & Madan (1999) and the Fourier-Cosine (COS) technique introduced by Fang & Oosterlee (2008). The author concludes that the Heston-Hull-White model is an appropriate model to use when pricing long-dated claims.

2.10 Ignatieva et al. (2016) presented a framework for pricing guaranteed maturity benefits with a regime-switching and stochastic mortality model. The authors considered a continuous-time two-factor affine mortality model and assume that the unsystematic mortality risk can be diversified away, hence, the instantaneous mortality intensity is the same under the physical and risk-neutral measures.

2.11 Ballotta et al. (2020) proposed a Lévy-based hybrid model that allows for dependence between interest rates and equity prices. Furthermore, the authors divide insurance risk into two components: mortality risk and surrender risk. The authors conclude that surrender risk is particularly important in the valuation of variable annuities due to the large number of policyholders who terminate their contracts prematurely.

2.12 Veilleux (2016) tested the impact of stochastic volatility, stochastic interest rates, and stochastic mortality on the hedge efficiency of the Guaranteed Lifetime Withdrawal Benefit (GLWB). The author considered various models including a regime-switching lognormal model to capture stochastic volatility, the Hull-White (1990) model for stochastic interest rates, and the Lee-Carter (1992) model for stochastic mortality. The author concludes that stochastic interest rates and stochastic mortality have a significant impact on the hedge efficiency of GLWB benefits.

2.13 In South Africa, the Actuarial Society of South Africa's advisory practice note, APN 110: Allowance for Embedded Investment Derivatives,[2] gives guidance to actuaries on how to reserve for embedded derivatives including GMMB and GMDB products. The advisory practice note is rather open-ended and leaves the actuary with many modelling choices. An extract from APN 110 reads:

> No specific investment return projection model is prescribed. The actuary may use any market-consistent stochastic investment return projection model that he/she deems appropriate for purposes of quantifying reserves required to meet the potential cost of embedded investment derivatives.

The only minimum prescription set by APN 110 is that the model must be "market-consistent", meaning that it must match the prices of tradable assets as closely as possible.

2.14 Limited research has been conducted in South Africa comparing different modelling approaches for embedded derivatives. Ngugi et al. (2015) applied a Variance-Gamma model to price GMMB and GMDB products written on the FTSE/JSE All Share Index (ALSI) and compared this to a regime-switching model (see Hardy (2003) for details). The authors conclude that the Variance-Gamma model is more aligned with the stylised facts of financial returns (see Cont, 2001). Furthermore, the authors suggest further research on the topic by

2 https://www.actuarialsociety.org.za/download/apn-110-allowance-for-embedded-investment-derivatives/

including stochastic interest rates and stochastic mortality. This suggestion is what motivated our research paper.

2.15 We are not aware of literature pertaining to the Heston-Hull-White model used to price embedded derivatives in the presence of stochastic mortality. Therefore, our contribution to the literature is by pricing GMMB and GMDB products with an extension of the Heston-Hull-White model that we term the Heston-Hull-White-Mortality model. We will apply the model to price and hedge GMMB and GMDB products written on the FTSE/JSE TOP40 index in South Africa.

2.16 In the next section, we introduce the mathematical theory of the Heston-Hull-White model.

3. THE HESTON-HULL-WHITE MODEL

3.1 Let $\mathbb{Q}$ denote the risk-neutral measure. Under the $\mathbb{Q}$-measure, the Heston-Hull-White model is given by the following system of stochastic differential equations (SDEs):

$$\begin{cases} dS_t &= r_t S_t dt + \sqrt{v_t} S_t dW_t^s, & S_0 > 0, \\ dv_t &= \kappa\left(\overline{v} - v_t\right) dt + \sigma\sqrt{v_t} dW_t^v, & v_0 > 0, \\ dr_t &= \lambda\left(\theta_t - r_t\right) dt + \eta dW_t^r, & r_0 \in \mathbb{R}, \end{cases}$$

where S_t is the underlying asset price a time t, v_t is the instantaneous variance of the underlying asset at time t driven by a Cox-Ingersoll-Ross (1985) process, and r_t is the instantaneous short term interest rate at time t driven by a Hull-White (1990) process.

3.2 The parameters of the variance process are defined as follows: κ denotes the mean reversion speed of the variance, $\overline{v}$ is the long-run mean of the variance, and σ is the volatility of the variance.

3.3 The parameters of the short-term interest rate process are defined as follows: θ_t denotes the time-dependent mean reversion level of the interest rate, λ denotes the mean reversion speed of the interest rate, and η is the volatility of interest rate.

3.4 In the system of SDEs, the Brownian motions, dW_t^s, dW_t^v, and dW_t^r are correlated by $\rho_{s,v}$, $\rho_{s,r}$, and $\rho_{v,r}$ respectively.

3.5 Taking $x_t = \log S_t$, Grzelak & Oosterlee (2011) consider the log-dynamics for the Heston-Hull-White model as it is often easier to work with this form. Applying Itô's lemma, the log-dynamics for the Heston-Hull-White model are given by the following system of SDEs under the $\mathbb{Q}$-measure:

$$\begin{cases} dx_t &= \left(r_t - \frac{1}{2}v_t\right)dt + \sqrt{v_t}\,dW_t^s, \quad x_0 = \log S_0 > 0, \\ dv_t &= \kappa\left(\overline{v} - v_t\right)dt + \sigma\sqrt{v_t}\,dW_t^v, \quad v_0 > 0, \\ dr_t &= \lambda\left(\theta_t - r_t\right)dt + \eta dW_t^r, \qquad r_0 \in \mathbb{R}. \end{cases}$$

3.6 Patel (2019) summarises the work of Grzelak & Oosterlee (2011) and shows that the Heston-Hull-White log-dynamics can be expressed in terms of independent Brownian motions. If $\boldsymbol{B}_t$ is a standard three-dimensional Brownian motion, then

$$d\boldsymbol{X}_t = \mu\left(\boldsymbol{X}_t\right)dt + \sigma\left(\boldsymbol{X}_t\right)d\boldsymbol{B}_t, \tag{1}$$

where

$$\boldsymbol{X}_t = \begin{bmatrix} x_t \\ v_t \\ r_t \end{bmatrix},$$

$$\mu\left(\boldsymbol{X}_t\right) = \begin{bmatrix} r_t - \frac{1}{2}v_t \\ \kappa\left(\overline{v} - v_t\right) \\ \lambda\left(\theta_t - r_t\right) \end{bmatrix},$$

and

$$\sigma\left(\boldsymbol{X}_t\right) = \begin{bmatrix} \sqrt{v_t} & 0 & 0 \\ \rho_{s,v}\sigma\sqrt{v_t} & \sqrt{1-\rho_{s,v}^2}\,\sigma\sqrt{v_t} & 0 \\ \rho_{s,r}\eta & \dfrac{\rho_{v,r} - \rho_{s,r}\rho_{s,v}}{\sqrt{1-\rho_{s,v}^2}}\eta & \sqrt{1-\rho_{s,r}^2 - \left(\dfrac{\rho_{v,r} - \rho_{s,r}\rho_{s,v}}{\sqrt{1-\rho_{s,v}^2}}\right)}\eta \end{bmatrix}.$$

See Patel (2019) for the proof.

3.7 The covariance matrix, $\Sigma\left(\boldsymbol{X}_t\right) = \sigma\left(\boldsymbol{X}_t\right)\sigma(\boldsymbol{X}_t)^\top$, for the Heston-Hull-White model is given by:

$$\Sigma\left(\boldsymbol{X}_t\right) = \begin{bmatrix} v_t & \rho_{s,v}\sigma v_t & \rho_{s,r}\eta\sqrt{v_t} \\ * & \sigma^2 v_t & \rho_{v,r}\eta\sqrt{v_t} \\ * & * & \eta^2 \end{bmatrix}. \tag{2}$$

When the underlying asset and variance processes are correlated to the interest rate process, the Heston-Hull-White model cannot be written in an affine form. The reader is referred to Duffie et al. (2000), Grzelak & Oosterlee (2011), and Patel (2019) for more information on affine models. In short, a model is said to be affine if each element of its drift and covariance can be written as a linear function of the state variables.

3.8 From equation (2), it is clear that the covariance matrix contains elements that are nonlinear functions of the state variables, more specifically $\sqrt{v_t}$. In this paper, we are only interested in the case where the interest rate process is correlated to the spot process, hence, we set $\rho_{v,r} = 0$. To make the model affine, Grzelak & Oosterlee (2011) propose a deterministic approximation by replacing $\sqrt{v_t}$ with $\mathbb{E}\left[\sqrt{v_t}\right]$. The covariance matrix then becomes:

$$\Sigma\left(\boldsymbol{X}_t\right) = \begin{bmatrix} v_t & \rho_{s,v}\sigma v_t & \rho_{s,r}\eta\mathbb{E}\left[\sqrt{v_t}\right] \\ * & \sigma^2 v_t & 0 \\ * & * & \eta^2 \end{bmatrix}. \tag{3}$$

Grzelak & Oosterlee (2011) approximate $\mathbb{E}\left[\sqrt{v_t}\right]$ with the following function:

$$\Lambda_t = \sqrt{c_t\left(\lambda_t - 1\right) + c_t d + \frac{c_t d}{2\left(d + \lambda_t\right)}}, \tag{4}$$

where

$$c_t = \frac{1}{4\kappa}\sigma^2\left(1 - e^{-\kappa t}\right), \quad d = \frac{4\kappa\overline{v}}{\sigma^2}, \quad \lambda_t = \frac{4\kappa v_0 e^{-\kappa t}}{\sigma^2\left(1 - e^{-\kappa t}\right)}.$$

See Grzelak & Oosterlee (2011), and Patel (2019) for the proof.

3.9 Grzelak & Oosterlee (2011) mention that the approximation in equation (4) is still non-trivial and propose a further approximation for $\mathbb{E}\left[\sqrt{v_t}\right]$ with the following function:

$$\mathbb{E}\left[\sqrt{v_t}\right] \approx a + be^{-ct} := \tilde{\Lambda}_t, \tag{5}$$

where

$$a = \sqrt{\overline{v} - \frac{\sigma^2}{8\kappa}},\ b - \sqrt{v_0} - a,\ c = -\log\left(b^{-1}\left(\Lambda\left(1\right) - a\right)\right).$$

As we will show in the next section, the approximation in equation (5) plays an important role in the Heston-Hull-White characteristic function.

3.10 The Heston-Hull-White characteristic function

3.10.1 Grzelak & Oosterlee (2011) assume a constant term structure of interest rates, $\theta_t = \theta$, in their derivation of Heston-Hull-White characteristic function. This assumption simplifies the mathematics and we will maintain this assumption throughout the rest of this paper. From Grzelak & Oosterlee (2011), the characteristic function is given by:

$$\phi_{HHW}\left(u,\mathbf{X}_t,\tau\right)=\exp\left(\tilde{A}\left(u,\tau\right)+B\left(u,\tau\right)x_t+C\left(u,\tau\right)r_t+D\left(u,\tau\right)v_t\right), \tag{6}$$

where

$$B\left(u,\tau\right)=iu,$$

$$C\left(u,\tau\right)=\frac{1}{\lambda}\left(iu-1\right)\left(1-e^{-\lambda\tau}\right),$$

$$D\left(u,\tau\right)=\frac{1-e^{-D_1\tau}}{\sigma^2\left(1-ge^{-D_1\tau}\right)}\left(\kappa-\sigma\rho_{s,v}iu-D_1\right),$$

$$A\left(u,\tau\right)=\lambda\theta I_1\left(u,\tau\right)+\kappa\bar{v}I_2\left(u,\tau\right)+\frac{1}{2}\eta^2 I_3\left(u,\tau\right),$$

$$\tilde{A}\left(u,\tau\right)=A\left(u,\tau\right)+\rho_{s,r}\eta I_4\left(u,\tau\right),$$

with

$$D_1=\sqrt{\left(\sigma\rho_{s,v}iu-\kappa\right)^2-\sigma^2 iu\left(iu-1\right)},$$

$$g=\frac{\kappa-\sigma\rho_{s,v}iu-D_1}{\kappa-\sigma\rho_{s,v}iu+D_1},$$

$$I_1\left(u,\tau\right)=\frac{1}{\lambda}\left(iu-1\right)\left(\tau+\frac{1}{\lambda}\left(e^{-\lambda\tau}-1\right)\right),$$

$$I_2\left(u,\tau\right)=\frac{\tau}{\sigma^2}\left(\kappa-\sigma\rho_{s,v}iu-D_1\right)-\frac{2}{\sigma^2}\log\left(\frac{1-ge^{-D_1\tau}}{1-g}\right),$$

$$I_3\left(u,\tau\right)=\frac{1}{2\lambda^3}\left(i+u\right)^2\left(3+e^{-2\lambda\tau}-4e^{-\lambda\tau}-2\lambda\tau\right),$$

$$I_4\left(u,\tau\right)\approx-\frac{1}{\lambda}\left(iu+u^2\right)\left[\frac{b}{c}\left(e^{-ct}-e^{-cT}+a\tau+\frac{a}{\lambda}\left(e^{-\lambda\tau}-1\right)\right.\right.$$

$$\left.\left.+\frac{b}{c-\lambda}e^{-cT}\left(1-e^{\tau(\lambda-c)}\right)\right)\right].$$

3.10.2 The deterministic approximation proposed by Grzelak & Oosterlee (2011) in equation (5) feeds into the valuation of I_4 above, hence the approximation sign. Since the characteristic function for the Heston-Hull-White model is known, Fourier methods can be used to solve the price of a European call option as we show in the next section.

3.11 Heston-Hull-White calibration

3.11.1 Carr & Madan (1999) showed that European call options can be priced via Fourier transform methods if the characteristic function of the model is known analytically. The authors initially considered constant interest rates in their paper. In the case of stochastic interest rates, the Fourier method must be adapted slightly.

3.11.2 Patel (2019) derived the price of a European call option with strike K and maturity T using the Fourier method under stochastic interest rates as:

$$V_{HHW}(k) = \frac{e^{-\alpha k}}{\pi} \int_0^{\infty} Re\left\{e^{-ivk}\psi(v)\right\} dv, \tag{7}$$

where $k = \log(K)$, $\alpha > 0$, $i = \sqrt{-1}$, $Re\{\cdot\}$ denotes the real part of the complex number, and

$$\psi(v) = \frac{\phi_{HHW}\left(v-(\alpha+1)i\right)}{(\alpha+1+iv)(\alpha+iv)}.$$

3.11.3 The symbol α refers to the dampening coefficient and a suitable value must be chosen in order to compute the option price in equation (7). As mentioned by Patel (2019), choosing α is subjective. The author set $\alpha = 0.75$ and tested the sensitivity of European call option prices to various values of α around 0.75. From the author's testing, it was concluded that $\alpha = 0.75$ is sufficient. We therefore set $\alpha = 0.75$ going forward.

3.11.4 As mentioned, we are not aware of any literature that combines the Heston-Hull-White model with a stochastic mortality model. GMMB and GMDB products are contingent on survival or death; this implies that mortality is an important risk driver when pricing these products. Therefore, we propose an extension of the Heston-Hull-White model by including stochastic mortality rates based on either a continuous-time Cox-Ingersoll-Ross (1985) process or discrete-time AR(1)-ARCH(1) model.

4. STOCHASTIC MORTALITY

This section is divided into two parts. In the first subsection, we introduce the continuous-time Cox-Ingersoll-Ross (1985) model for mortality rates. In the second subsection, we present the discrete-time AR(1)-ARCH(1) model of Syuhada & Hakim (2021). The reason for considering both a continuous-time model and a discrete-time model is to allow for calibration depending on the type of mortality data that is available. A continuous-time model is generally calibrated to a survival probability curve derived from historical data or longevity swaps, whereas a discrete-time model is calibrated to a historical time series of mortality rates.

4.1 Cox-Ingersoll-Ross model

4.1.1 Let $\mu_{x+t,t}$ denote the force of mortality at time t and age $x+t$. The force of mortality represents the instantaneous probability of death at time t for a life aged $x+t$. Cairns et al. (2008) show that the probability of survival up to time t under $\mathbb{Q}$ is given by:

$$ {}_tp_x = S_x(0,t) = \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^t \mu_{x+s,s} ds} \right]. \tag{8} $$

4.1.2 In order to calculate the expectation in equation (8), a suitable stochastic process must be chosen to describe the dynamics of $\mu_{x+t,t}$. Cairns et al. (2008) list certain criteria for mortality rates, including the following:

— mortality rates should be positive;
— long-term dynamics of the model should be reasonable; and
— the model should be simple to implement using analytical methods or numerical methods.

4.1.3 Based on the criteria listed above, we propose the Cox-Ingersoll-Ross (1985) process as a plausible model to describe mortality rates. The reason for choosing this process is the following: the model produces positive values (although care must be taken to ensure the Feller condition[3] is met), the model is mean reverting which means that long-term rates will not explode, and the model has an analytical solution for survival probabilities.

4.1.4 For a fixed age x at inception, the original Cox-Ingersoll-Ross (1985) model is given by the SDE:

$$ d\mu_{x+t,t} = \gamma(\omega - \mu_{x+t,t})dt + \xi\sqrt{\mu_{x+t,t}}dW_t^{\mu}, \qquad \mu_{x,0} > 0, \tag{9} $$

where γ denotes the mean reversion speed of mortality, ω is the long-run mean of mortality rates, and ξ is the volatility of mortality rates.

4.1.5 A shortcoming of this model is that it cannot fit the term structure of mortality. When the force of mortality is plotted against age, it shows an increasing trend. The original Cox-Ingersoll-Ross (1985) model does not capture this effect. Fortunately, the model has been extended to incorporate a term structure.

4.1.6 Brigo & Mercurio (2001) extended the Cox-Ingersoll-Ross (1985) model to incorporate a term structure and created the so-called CIR++ model. The model takes the following form where $\varphi_{x,t}^{CIR}$ is a deterministic function of time:

$$ \mu_{x+t,t} = \varphi_{x,t}^{CIR} + X_{x+t,t}, \tag{10} $$

where

$$ dX_{x+t,t} = \gamma(\omega - X_{x+t,t})dt + \xi\sqrt{X_{x+t,t}}dW_t^{\mu}, \qquad X_{x,0} > 0, $$

3 The Feller condition is met if $2\gamma\omega > \xi^2$, where γ is the mean reversion speed of mortality, ω is the long-run mean of mortality, and ξ is the volatility of mortality.

$$\varphi_{x,t}^{CIR} = f_x^M(0,t) - f_x^{CIR}(0,t).$$

4.1.7 Furthermore, $f_x^M(0,t)$ denotes the market forward mortality curve observed from the initial term structure of mortality (survival curve), and

$$f_x^{CIR}(0,t) = 2\gamma\omega\frac{e^{th}-1}{2h+(\gamma+h)(e^{th}-1)} + X_{x,0}\frac{4h^2e^{th}}{\left[2h+(\gamma+h)(e^{th}-1)\right]^2},$$

with $h = \sqrt{\gamma^2+2\xi^2}$.

4.1.8 The survival probability from time t up to time T is then given by:

$$S_x(t,T) = \frac{S_x^M(0,T)L_x(0,t)e^{-M_x(0,t)X_{x,0}}}{S_x^M(0,t)L_x(0,T)e^{-M_x(0,T)X_{x,0}}}L_x(t,T)e^{-M_x(t,T)\left[\mu_{x+t,t}-\varphi_{x,t}^{CIR}\right]}, \tag{11}$$

where

$$L_x(t,T) = \left[\frac{2he^{(\gamma+h)(T-t)/2}}{2h+(\gamma+h)(e^{(T-t)h}-1)}\right]^{2\gamma\omega/\xi^2},$$

$$M_x(t,T) = \frac{2(e^{(T-t)h}-1)}{2h+(\gamma+h)(e^{(T-t)}h-1)},$$

and $S_x^M(0,\cdot)$ denotes the market observed survival probability curve at $t=0$ for a life aged x at inception.

4.1.9 A major advantage of term structure models, and specifically the CIR++ model, is that they fit the input survival probability curve at $t=0$, i.e, $S_x(0,.)$.

4.1.10 Throughout the rest of this paper, we make the same assumption as Ignatieva et al. (2016) in that the life insurer has an adequately large number of policyholders so that unsystematic mortality risk can be diversified away. This implies that the force of mortality under the physical probability measure $\mathbb{P}$ and risk-neutral probability measure $\mathbb{Q}$ are equal:

$$\mu_{x+t,t}^{\mathbb{P}} = \mu_{x+t,t}^{\mathbb{Q}}.$$

4.1.11 Life insurers in South Africa typically use life tables published by the Actuarial Society of South Africa to calculate survival probabilities. Our assumption that the instantaneous force of mortality is the same under the $\mathbb{P}$ and $\mathbb{Q}$ measures allows us to calibrate the CIR++ model directly to a survival probability curve derived from the life tables.

4.1.12 In the next subsection, we present the discrete-time mortality model of Syuhada & Hakim (2021).

4.2 AR(1)-ARCH(1) model

4.2.1 Syuhada & Hakim (2021) adopted the AR(1)-ARCH(1) model of Giacometti et al. (2012) and Lin et al. (2015) and applied the model to yearly changes in the log mortality rate. Syuhada & Hakim (2021) explain that the conditional mean of the change in log mortality rate is modelled by a first-order autoregressive AR(1) model, and the conditional variance is modelled by a first-order autoregressive conditional heteroscedastic ARCH(1) stochastic volatility model to capture volatility clustering and the time-varying nature of volatility.

4.2.2 Let $\mu_{x,t}$ denote the force of mortality at age x in year t calculated as:

$$\mu_{x,t} = \frac{D_{x,t}}{E_{x,t}}, \tag{12}$$

where $D_{x,t}$ denotes the number of individuals aged x in year t who die before year $t+1$ or age $x+1$, and $E_{x,t}$ denotes the number of individuals exposed to death risk at age x in year t.

4.2.3 Let $Y_{x,t}$ denote the change in the log mortality rate for each fixed age $x \in \{x_0, x_0+1, x_0+2, ..., X_{max}\}$, that is:

$$Y_{x,t} = \log \mu_{x,t} - \log \mu_{x,t-1} = \log \frac{\mu_{x,t}}{\mu_{x,t-1}}. \tag{13}$$

where $t \in \{t_0+1, t_0+2, ..., T_{max}\}$, with X_{max} and T_{max} denoting the maximum age and year in the historical data respectively.

4.2.3 Syuhada & Hakim (2021) model $Y_{x,t}$ according to an AR(1)-ARCH(1) model:

$$Y_{x,t} = a_x + b_x Y_{x,t-1} + \varepsilon_{x,t}, \tag{14}$$

where

$$\varepsilon_{x,t} = \sqrt{h_{x,t}}\, z_{x,t},$$

$$h_{x,t} = \omega_x + \gamma_x \varepsilon_{x,t-1}^2,$$

with $h_{x,t}$ denoting the conditional variance, $a_x \in \mathbb{R}$, $b_x \in (-1,1)$, $\omega_x \in (0,\infty)$, $\gamma_x \in [0,1)$, and $\varepsilon_{x,t}$ is an innovation parameter with $z_{x,t} \sim N(0,1)$.

4.2.4 For each fixed age x, the model can be calibrated to a time series of historical mortality rates via maximum likelihood estimation.

4.2.5 This concludes the section on stochastic mortality models. In the next section, we introduce the mathematics of the GMMB and GMDB products.

5. GUARANTEED MINIMUM MATURITY AND DEATH BENEFITS

5.1 From now on, we will refer to the Heston-Hull-White-Mortality model when combining the Heston-Hull-White model with either the Cox-Ingersoll-Ross (1985) or AR(1)-ARCH(1) models for mortality. We assume that the force of mortality in the Heston-Hull-White-Mortality model evolves independently from the processes driving S_t, v_t, and

r_t. This implies that the Heston-Hull-White model and CIR++/AR(1)-ARCH(1) stochastic mortality model can be calibrated independently. Furthermore, an independent mortality process will simplify the calculations for the GMMB and GMDB products going forward.

5.2 We make extensive use of the following relationship when deriving pricing formulae for the GMMB and GMDB products: given two independent random variables Y and Z, the expected value of their product is equal to the product of their expected values:

$$\mathbb{E}[YZ] = \mathbb{E}[Y]\mathbb{E}[Z]. \tag{15}$$

5.3 We use the same notation as in the textbook by Feng (2018) when presenting the pricing formulae for the GMMB and GMDB products, adjusting the formulae to account for stochastic interest rates and stochastic mortality.

5.4 The price of a GMMB at $t=0$ from a life insurer's perspective is given by the formula:

$$\begin{aligned}
V_{GMMB,0} &= \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s ds}(G-F_T)^+ e^{-\int_0^T \mu_{x+s,s} ds}\right] \\
&\quad -\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du} m_e F_s e^{-\int_0^s \mu_{x+u,u}\,du}\right] ds \\
&= \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s ds}(G-F_T)^+\right]\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T \mu_{x+s,s} ds}\right] \\
&\quad -m_e\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du} F_s\right]\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s \mu_{x+u,u} du}\right] ds \\
&= \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s ds}\left(G-F_T\right)^+\right]{}_T p_x - m_e\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du} F_s\right]{}_s p_x ds,
\end{aligned} \tag{16}$$

where

— G is the minimum guaranteed amount defined at inception of the contract;
— F_t is the value of the fund account at time t in which the initial premium was invested; and
— m_e is the annualised fee for the GMMB deducted by the insurer from the fund account expressed as a percentage.

5.5 Furthermore, $F_t = F_0 \dfrac{S_t}{S_0} e^{-mt}$, where S_t denotes the value of the underlying equity index at time t, and m denotes the annualised charge payable by the insurer, expressed as a percentage. We assume that $m_e < m$.

5.6 Note from equation (16) that the terms $\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s\,ds}(G-F_T)^+\right]$ and the term $\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T \mu_{x+s,s}ds}\right]$ were split using the relation in equation (15) since the force of mortality is independent from all other risk drivers. Furthermore, if the bank account is used as numeraire, the discount factor cannot be removed from the expectation since the interest rate process is stochastic and correlated to the stochastic process driving the fund value. Therefore, the terms $\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s\,ds}(G-F_T)^+\right]$ and $m_e\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du}F_s\right]{}_sp_x$ can be solved using the brute force Monte Carlo method. Ignatieva et al. (2016) proposed a Fourier space time-stepping (FST) algorithm to reduce the computational cost of pricing embedded derivatives. See Ignatieva et al. (2016) for details.

5.7 The price of a GMDB at $t=0$ from a life insurer's perspective is given by the formula:

$$
\begin{aligned}
V_{GMDB,0} &= \int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du}\mu_{x+s,s}e^{-\int_0^s \mu_{x+u,u}\,du}(G_s-F_s)^+\right]ds \\
&\quad -\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du}m_d e^{-\int_0^s \mu_{x+u,u}\,du}F_s\right]ds \\
&= \int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du}(G_s-F_s)^+\right]\mathbb{E}_{\mathbb{Q}}\left[\mu_{x+s,s}e^{-\int_0^s \mu_{x+u,u}\,du}\right]ds \\
&\quad -m_d\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^T r_s ds}F_s\right]\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s \mu_{x+u,u}\,du}\right]ds \\
&= \int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_u\,du}(G_s-F_s)^+\right]\mathbb{E}_{\mathbb{Q}}\left[\mu_{x+s,s}e^{-\int_0^s \mu_{x+u,u}\,du}\right]ds \\
&\quad -m_d\int_0^T \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^s r_s\,ds}F_s\right]{}_sp_x\,ds,
\end{aligned}
\tag{17}
$$

where m_d denotes the annualised fee for the GMDB deducted by the insurer from the fund account. We assume that $m_d < m$.

5.8 Recall the probability of survival formula for a life aged x at inception:

$$
{}_tp_x = S_x(0,t) = \mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^t \mu_{x+s,s}\,ds}\right].
$$

5.9 The instantaneous probability of dying at time t and age $x+t$, given survival up to time t, is given by the term $\mathbb{E}_{\mathbb{Q}}\left[\mu_{x+t,t}e^{-\int_0^t \mu_{x+s,s}\,ds}\right]$. This term is used extensively in the GMDB pricing formula and can be solved numerically by the "brute force" Monte Carlo method.

5.10 The pricing formula for the GMDB is more complex than the pricing formula for the GMMB. This is because the payoff of the GMDB product can occur at any time in the interval $[0,T]$ depending on when the policyholder dies, whereas the GMMB only pays an amount of $\max(G,F_T)$ if the policyholder survives to time T.

5.11 In the next section, we introduce the data used in this study.

6. DATA

6.1 Daily FTSE/JSE TOP40 closing prices from September 2005 to November 2020 were downloaded from za.investing.com.[4] The historical closing prices are shown in Figure 1.

6.2 For the Hull-White (1990) component of the Heston-Hull-White model, we require a starting value for r_0. We use the South African 3-month T-Bill rate as a proxy for the short term interest rate. Historical 3-month T-Bill rates were downloaded from the South African Reserve Bank website[5] for the period September 2005 to November 2020 and are shown in Figure 2.

6.3 South African mortality rates were sourced from the Actuarial Society of South Africa's investigation: Report on pensioner mortality 2005–2010,[6] published in February 2017. The investigation was conducted by the Continuous Statistical Investigations (CSI) Committee of the Actuarial Society of South Africa. In the study, the CSI used pensioner data from the start of 2005 to the end of 2010 to construct the force of mortality for each age from 50 to 110, split by male and female.

6.4 Figure 3 shows the survival probability, p_{50}, $t \in \{1,2,...,60\}$, for a 50-year old South African male and female pensioner.

6.5 From Figure 3, the survival probability for a South African 50-year old male and female pensioner decreases the further we look into the future. Furthermore, the survival probability for a 50-year old male is considerably lower than a 50-year old female. The CIR++ model is calibrated to the survival probability curves in Figure 3.

4 https://za.investing.com/indices/ftse-jse-top-40-historical-data
5 https://www.resbank.co.za/en/home/what-we-do/statistics/key-statistics/selected-historical-rates
6 http://legacy.actuarialsociety.org.za/Societyactivities/CommitteeActivities/ContinuousStatisticalInvestigation(CSI).aspx

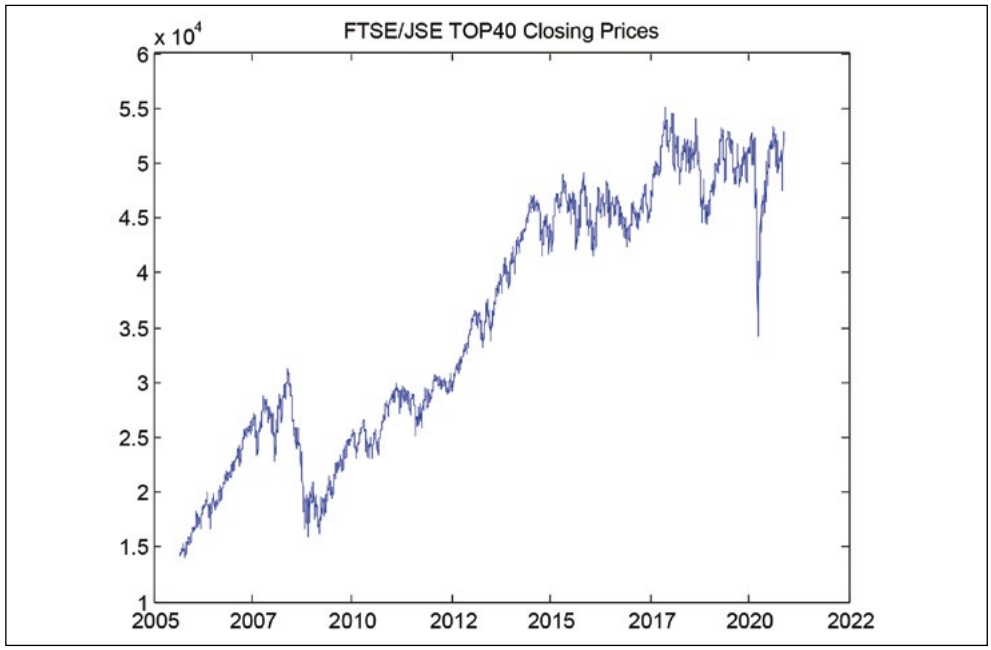

FIGURE 1. Historical FTSE/JSE TOP40 closing prices

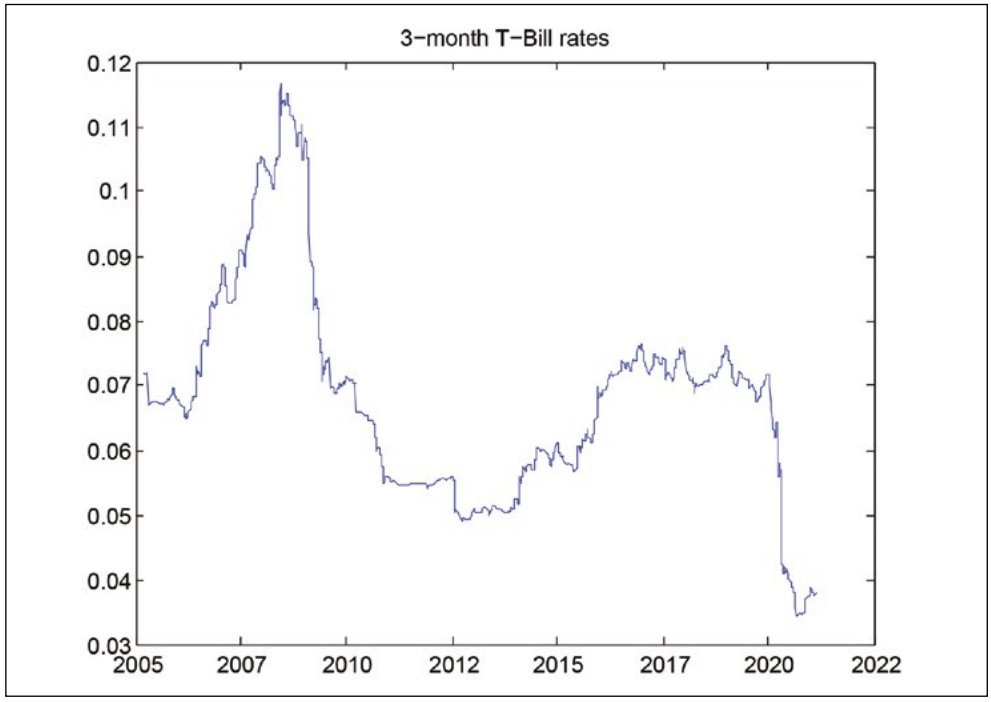

FIGURE 2. Historical 3-month T-bill rates in South Africa

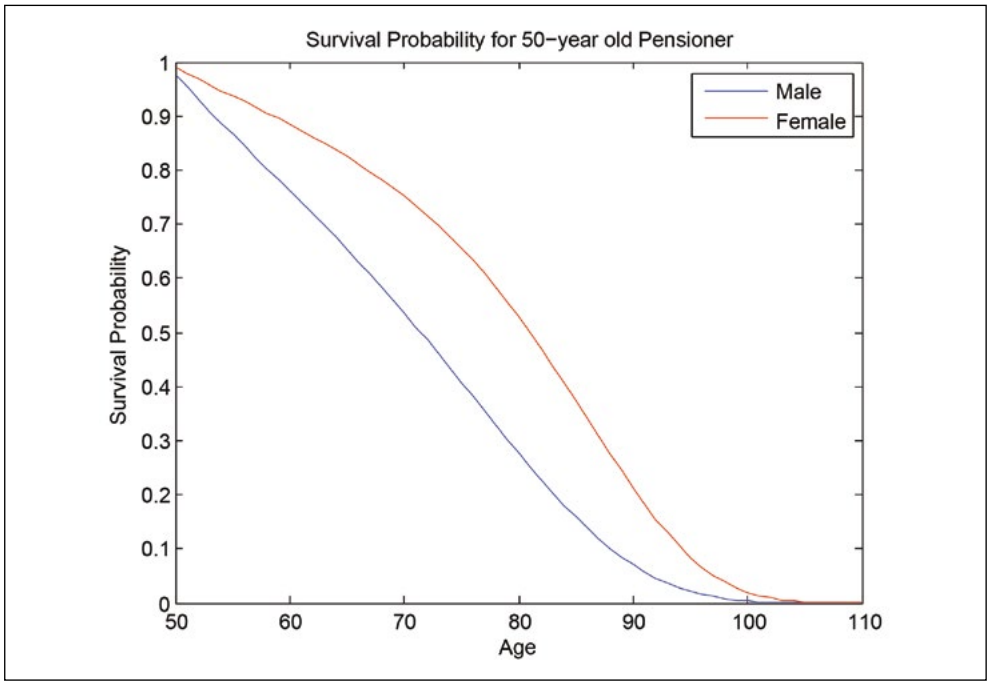

FIGURE 3. Survival probability for 50-year old male and female pensioner

6.6 For the purpose of the AR(1)-ARCH(1) model, we were unable to source historical mortality rates, $\mu_{x,t}$, for South African males and females. However, our goal is not to focus on the quality or availability of historical mortality data, but rather to show how to calibrate and apply the AR(1)-ARCH(1) model. Therefore, we use historical mortality rates for the United Kingdom (UK) from 1922 to 2020 sourced from the Human Mortality Database[7] (HMD), the world's leading source of mortality data for developed countries. The historical mortality rates for the UK are split by age and sex.

6.7 It is important to note that mortality in the UK is not representative of mortality in South Africa due to various social and economic factors such as income, education, employment, and community safety. However, using UK mortality data does not diminish the point we are trying to make. The only reason for using UK mortality data is that it is comprehensive and freely available from HMD. Any life insurer in South Africa with access to South African mortality data can easily adjust the input data to calibrate the AR(1)-ARCH(1) model.

6.6 Figures 4 and 5 show the log mortality rates for UK males and females from 1922 to 2020 for ages 0 to 100.

7 https://www.mortality.org/

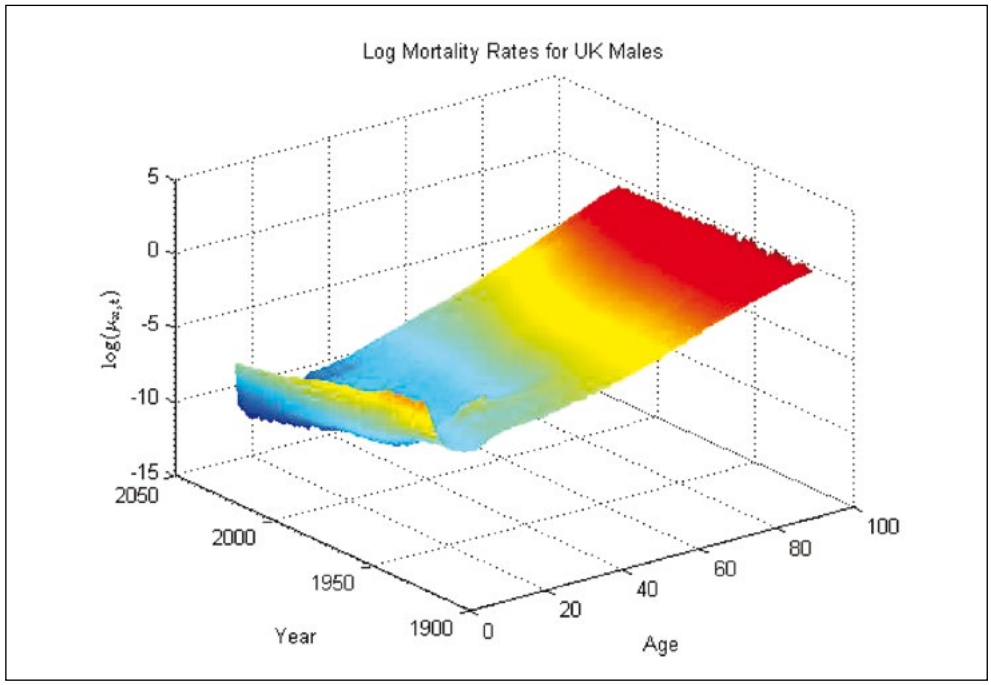

FIGURE 4. Log mortality rates for UK males

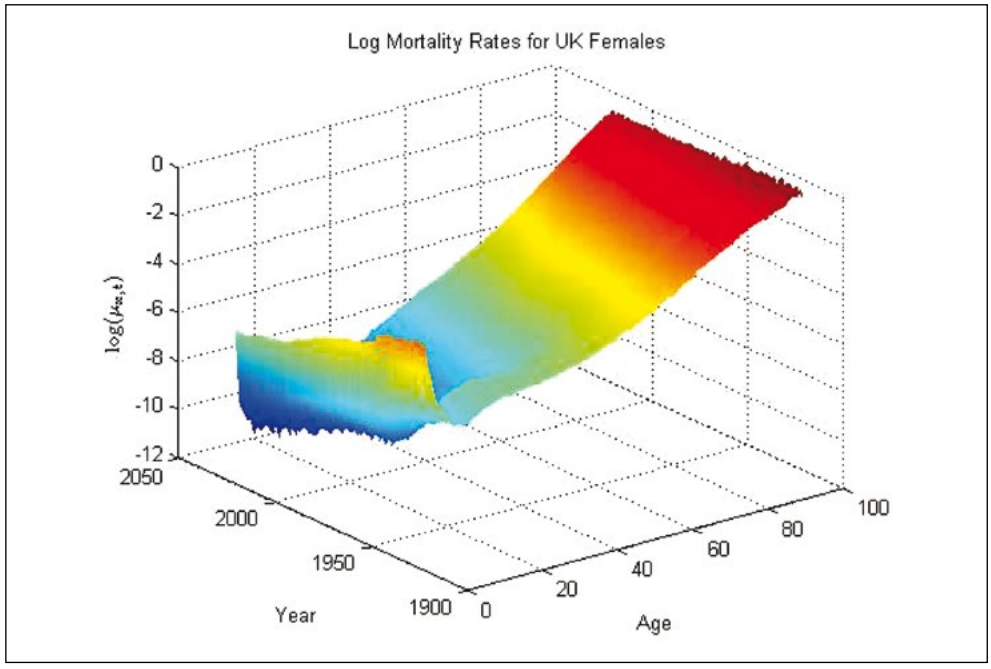

FIGURE 5. Log mortality rates for UK females

6.7 Figures 6 and 7 show the yearly changes in log mortality rates for UK males and females.

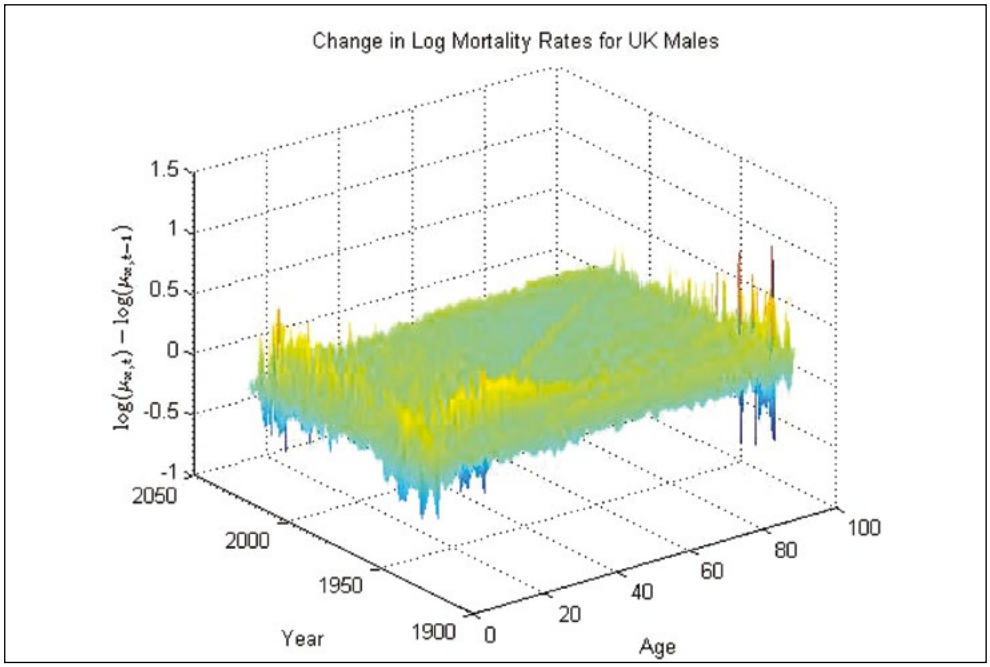

FIGURE 6. Change in log mortality rates for UK males

6.8 The AR(1)-ARCH(1) model of Syuhada & Hakim (2021) can now be applied to the stationary time series of the changes in log mortality rates for each age.

6.9 Weekly FTSE/JSE TOP40 volatility surfaces from September 2005 to November 2020 were provided by Peresec.[8] Each volatility surface covers a forward moneyness range of 75% to 125% and maturities from 1 to 15 months. For more details on the methodology used to construct the volatility surfaces, see Flint & Maré (2017).

6.10 The South African equity options market is illiquid compared to developed markets like Europe and the United States. As mentioned by Flint & Maré (2017), it is uncommon for options to trade beyond an expiry of 15 months in South Africa. This poses a further challenge when pricing GMMB and GMDB products with maturities typically extending far beyond 15 months.

6.11 Due to the illiquid equity options market in South Africa, there is no benchmark volatility that can be used for calibration beyond the 15-month mark. This implies that the

8 https://www.peresec.com/

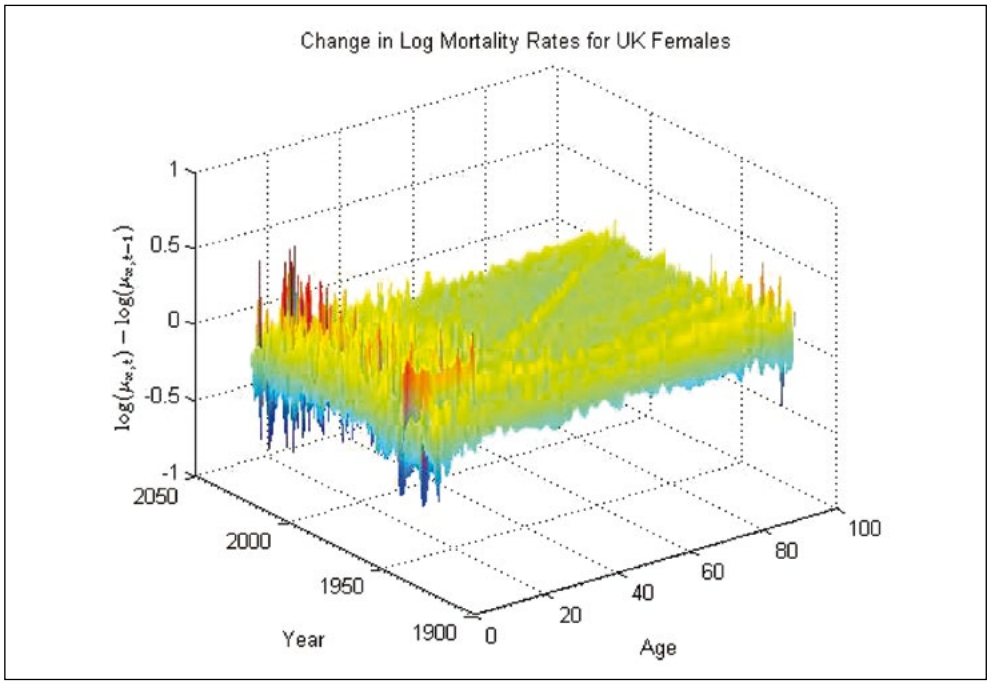

FIGURE 7. Change in log mortality rates for UK females

volatility term structure produced by the model can yield nonsensical values for long-dated maturities. Flint et al. (2014) tested several models that can produce long-term volatility estimates and showed that different models yield substantial differences for the volatility term structure.

6.12 In this paper, we allow the Heston-Hull-White-Mortality model to generate the volatility term structure beyond the 15-month mark. We will test the model by plotting the term structure of volatility to ensure that the model leads to plausible estimates for long-term volatility. For more detail on long-term volatility estimation, see Flint et al. (2014).

6.13 Figure 8 shows the implied volatility surface constructed from FTSE/JSE TOP40 index options as at 16 November 2020.

6.14 Note from Figure 8 the volatility skew observed across forward moneyness levels and the non-constant volatility across term to maturity. APN 110 requires that the investment return projection model reproduce this surface as closely as possible.

6.15 In the next section, we implement the Heston-Hull-White-Mortality model to price GMMB and GMDB products written on the FTSE/JSE TOP40 index, and backtest a delta-hedging strategy for the GMMB.

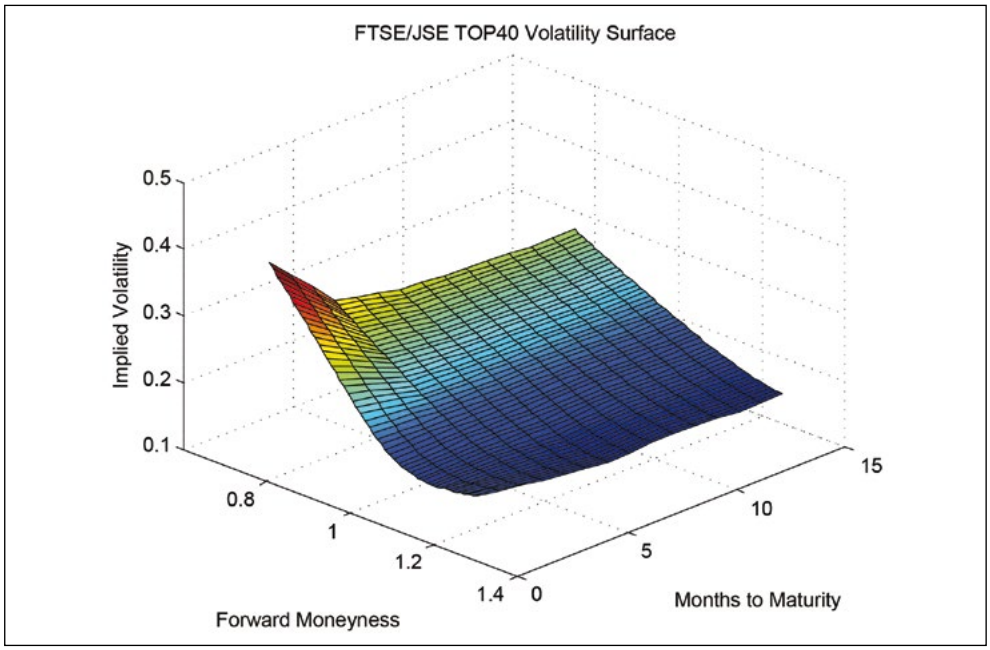

FIGURE 8. FTSE/JSE TOP40 volatility surface as at 16 November 2020

7. NUMERICAL RESULTS

This section has two subsections. The first subsection shows the pricing results obtained from the Heston-Hull-White-Mortality model for the GMMB and GMDB products, and the sensitivity of the prices to various model parameters. In the second subsection, we perform a backtesting experiment over weekly periods from September 2005 to November 2020 to test the hedging performance of the Heston-Hull-White-Mortality for the GMMB liability.

7.1 Pricing

7.1.1 The first step in pricing the GMMB and GMDB liabilities is to calibrate the Heston-Hull-White parameters to market data. We optimise the set of parameters on the following search space:

$$\begin{aligned}\Omega^{Search} &= D_{\kappa} \times D_{v_0} \times D_{\bar{v}} \times D_{\sigma} \times D_{\rho_{s,v}} \times D_{\lambda} \times D_{\eta} \times D_{\rho_{s,r}} \\ &= [1,1] \times [0,1] \times [0,1] \times [0,3] \times [-1,1] \times [0,10] \times [0,1] \times [-1,1],\end{aligned}$$

where D denotes the search domain for each parameter.

7.1.2 Grzelak & Oosterlee (2011) suggest that the Heston-Hull-White model be calibrated in two stages. First, the parameters for the Hull-White (1990) short rate process should be estimated independently from the equity (Heston, 1993) component. Then, keeping the parameters fixed for the short-term interest rate process, the remaining parameters are estimated.

7.1.3 The Hull-White (1990) mean reversion parameter, λ, is generally estimated from historical data in practice. Once λ has been estimated, the volatility parameter, η, is calibrated to a set of at-the-money swaptions.

7.1.4 The purpose of this paper is not to focus on the calibration of the Hull-White (1990) model, since this in itself can become rather complex, see, for example, Gurrieri et al. (2009). Rather, we aim to show the sensitivity of the GMMB and GMDB prices to various short-term interest rate parameters.

7.1.5 Once the parameters for the Hull-White (1990) component of the Heston-Hull-White model have been estimated, the next step is to calibrate the volatility parameters for the Heston (1993) component of the Heston-Hull-White model. We implemented the Fourier method of Carr & Madan (1999) discussed in Section 3.11.

7.1.6 The Heston-Hull-White characteristic function in Section 3.10 was implemented in Matlab. The next step involved solving the infinite integral in the Fourier transform pricing formula, $\int_0^\infty Re\left\{e^{-ivk}\psi(v)\right\}dv$, via numerical integration.

7.1.7 Choosing a suitable upper bound, $v_{\max}$, for the integral, and discretising the integration grid uniformly, the integral was evaluated using the trapezoidal rule of integration. We set $v_{\max} = 50$ and $dv = 0.01$ and used the trapz[9] function in Matlab.

7.1.8 For the characteristic function, we fixed the parameters $\{\kappa, \lambda, \eta, \rho_{s,r}\}$, and left the parameters $\{v_0, \overline{v}, \sigma, \rho_{s,v}\}$ free to estimate, bounded by the constraints in Ω^{Search}. We used the least squares optimisation algorithm lsqnonlin[10] in Matlab to minimise the sum of squared differences between the model and European call option prices. We fixed $\kappa = 1$ since the calibration results became unstable when we left this parameter free to estimate. Similar findings were reported by van Dijk et al. (2018).

7.1.9 The details of the calibration for the Heston-Hull-White model to the FTSE/JSE TOP40 volatility surface as at 16 November 2020 are shown in Table 1.

TABLE 1. Calibration details as at 16 November 2020

Number of strikes included	21
Number of maturities included	3
Number of options included	63
θ	0.07
λ	0.05
η	0.02
$\rho_{s,r}$	0.3
κ	1
v_0	Free to estimate
$\overline{v}$	Free to estimate
σ	Free to estimate
$\rho_{s,v}$	Free to estimate

9 https://www.mathworks.com/help/matlab/ref/trapz.html
10 https://www.mathworks.com/help/optim/ug/lsqnonlin.html

Using the information in Table 1 to calibrate the Heston-Hull-White model to the implied volatility surface in Figure 8, we estimated the parameters $v_0 = 0.0433$, $\overline{v} = 0.05$, $\sigma = 0.3817$, and $\rho_{s,v} = -0.9208$. Figure 9 shows the calibration results compared to the market data.

7.1.10 Figure 9 shows that the Heston-Hull-White model reproduces the European call option prices well. The model is therefore aligned with the guidelines set by APN 110 in terms of being market-consistent.

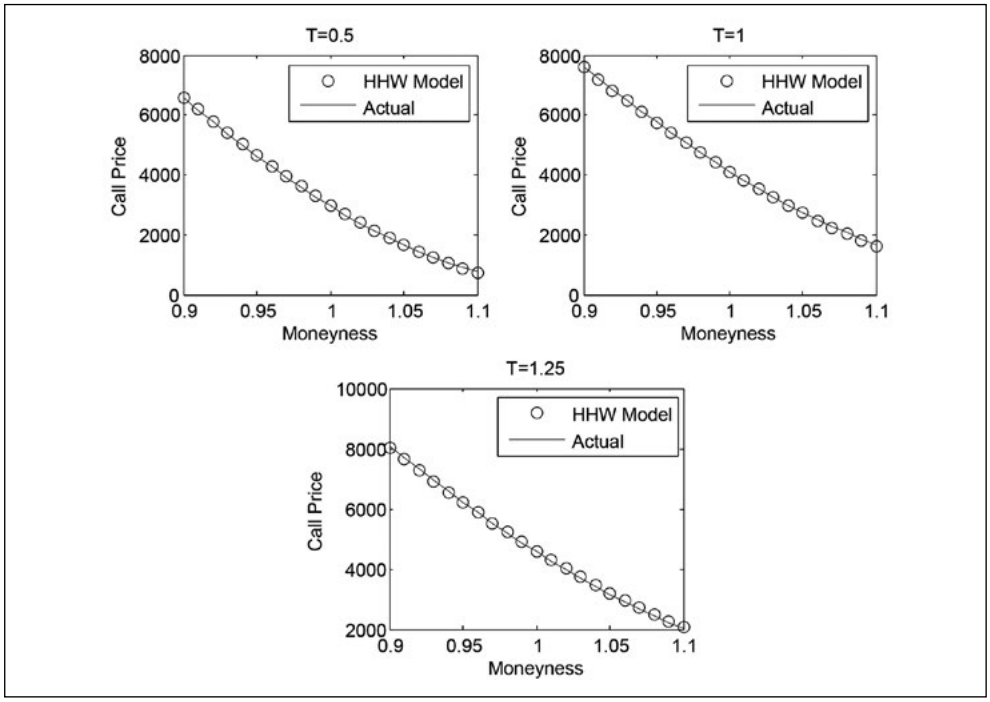

FIGURE 9. Heston-Hull-White model fit to market data on 16 November 2020

7.1.11 As mentioned earlier, the South African equity options market is short-dated. From Figure 8, the longest maturity observable is 15 months. Since the GMMB and GMDB liabilities have maturities that extend far beyond this point, we must test whether the calibrated Heston-Hull-White model produces a plausible volatility term structure for maturities beyond 15 months. Figure 10 shows the volatility term structure for at-the-money options as at 16 November 2020.

7.1.12 From Figure 10, the 30-year annualised volatility produced by the Heston-Hull-White model as at 16 November 2020 is approximately 30%. This is a reasonable estimate and falls within the range of values reported by Flint et al. (2014) in their testing of various models. However, more advanced methods for long-term volatility estimation are available and the reader is referred to Flint et al. (2014) for further detail.

7.1.13 In order to price the GMMB and GMDB liabilities, we use a brute force Monte Carlo simulation to generate sample paths for each state variable. We use an Euler

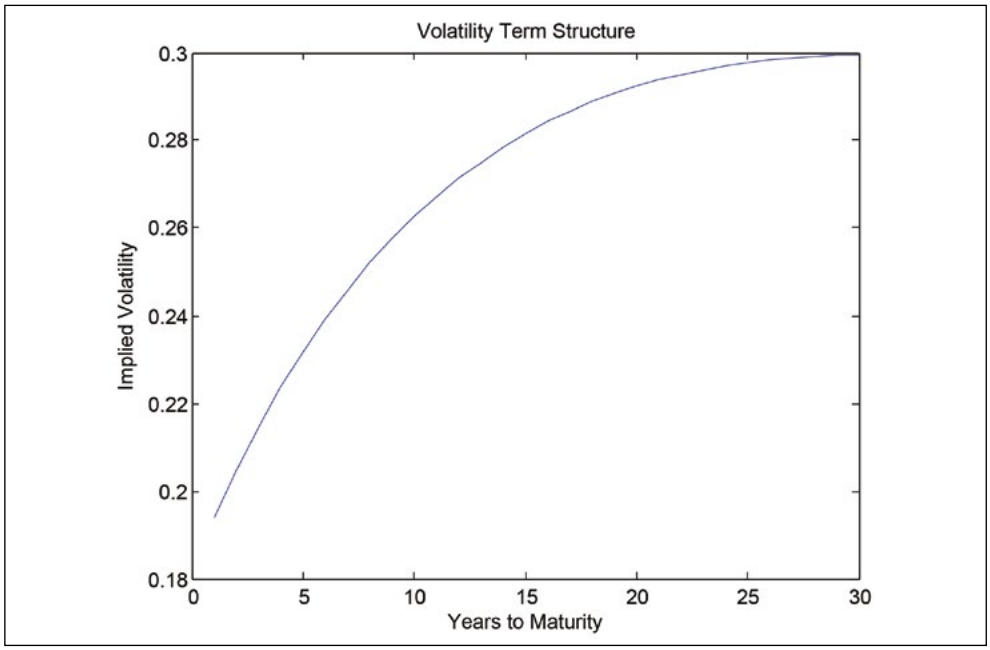

FIGURE 10. Heston-Hull-White volatility term structure as at 16 November 2020

discretisation scheme to discretise the time grid. The discretised Heston-Hull-White model is given by:

$$\begin{cases} S_{t+1} &= S_t + r_t S_t \delta_t + \sqrt{v_t} S_t \left(W_{t+1}^s - W_t^s \right), & S_0 > 0, \\ v_{t+1} &= v_t + \kappa\left(\overline{v} - v_t\right)\delta_t + \sigma\sqrt{v_t}\left(W_{t+1}^v - W_t^v \right), & v_0 > 0, \\ r_{t+1} &= r_t + \lambda\left(\theta - r_t\right)\delta_t + \eta\left(W_{t+1}^r - W_t^r \right), & r_0 \in \mathbb{R}, \end{cases}$$

where δ_t denotes the spacing of the time grid, and $W_{t+1} - W_t \sim N\left(0, \delta_t\right)$. To generate correlated Brownian motion increments for the state variables, we use Cholesky factorisation.[11]

7.1.14 Using a time spacing of $\delta_t = 1/252$, Figure 11 shows a single simulation from the Heston-Hull-White model for each state variable.

7.1.15 In Figure 11, the left y-axis refers to the share price, and the right y-axis refers to the volatility and interest rate. Note the inverse relationship between the volatility and share price. From our calibration, we estimated $\rho_{s,v} = -0.9208$, hence, the inverse relationship between the two state variables. This relationship is generally observed in equity markets and Black (1976) refers to this as the leverage effect. Recall that $\rho_{v,r} = 0$ so that the volatility and interest rate processes move independently. In our pricing experiment, we test the sensitivity of the GMMB and GMDB prices to various Heston-Hull-White model parameters.

11 https://www.mathworks.com/help/matlab/ref/chol.html

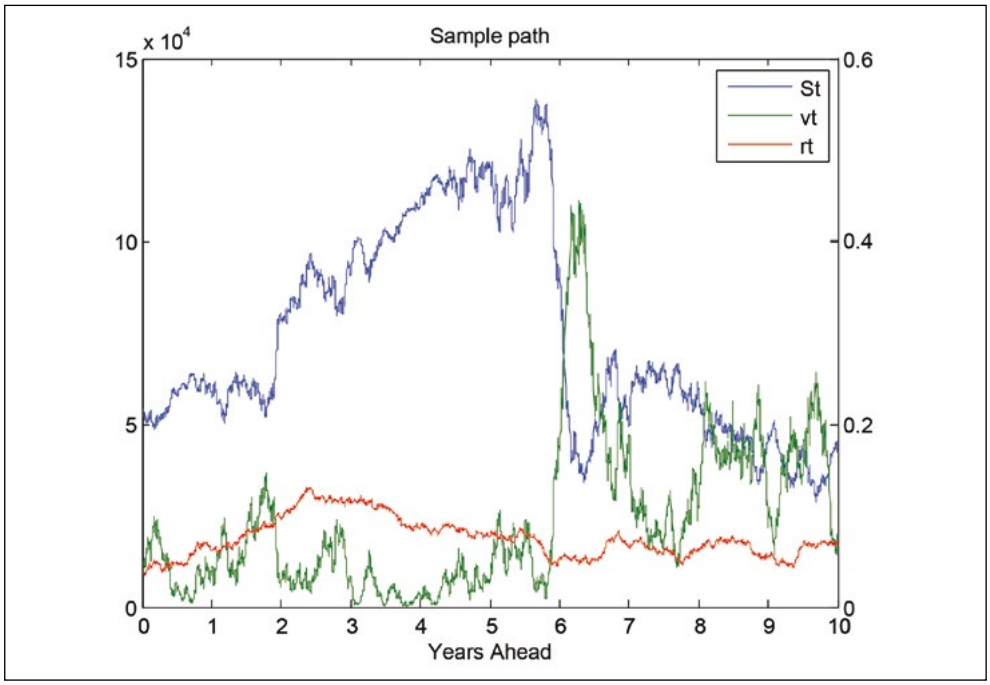

FIGURE 11. Single sample path for each state variable

7.1.16 As mentioned, the CIR++ model is a term structure model that can fit the input survival probability curve. To illustrate the mechanics of the CIR++ model, we consider a 50-year old South African male and female pensioner with parameters shown in Table 2.

TABLE 2. CIR++ parameters for 50-year old male and female pensioners

Parameter	Male	Female
γ	0.90	1.00
ω	0.05	0.03
η	0.03	0.01

7.1.17 Figure 12 shows the simulation for the force of mortality, $\mu_{50+t,t}$, for a 50-year old South African male and female pensioner from the CIR++ model. Note that the force of mortality increases with age. Furthermore, the distribution for $\mu_{50+t,t}$ is wider for males than females. This is driven by the volatility of mortality, set to $\eta = 0.03$ for males and $\eta = 0.01$ for females.

7.1.18 Figure 13 shows the stochastic survival probability curves calculated from the formula $e^{-\int_0^t \mu_{50+s,s} ds}$.

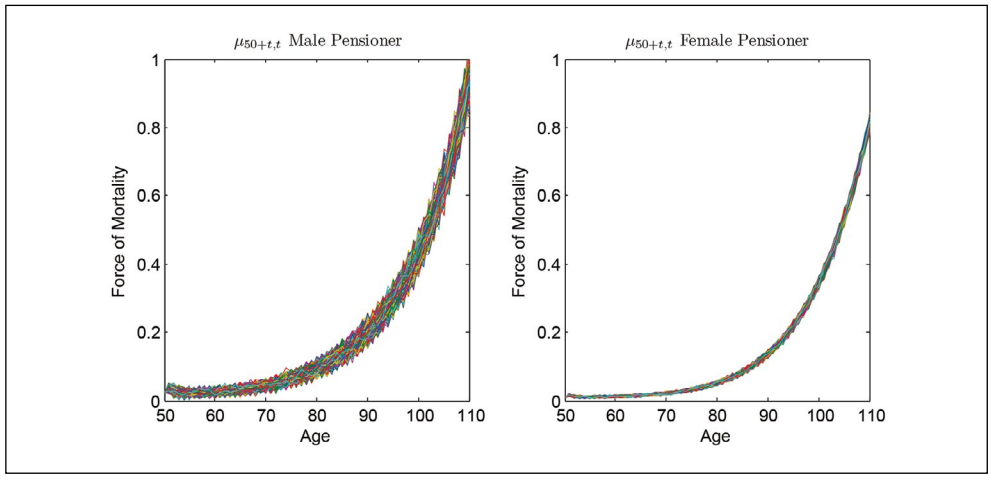

FIGURE 12. CIR++ simulation for force of mortality

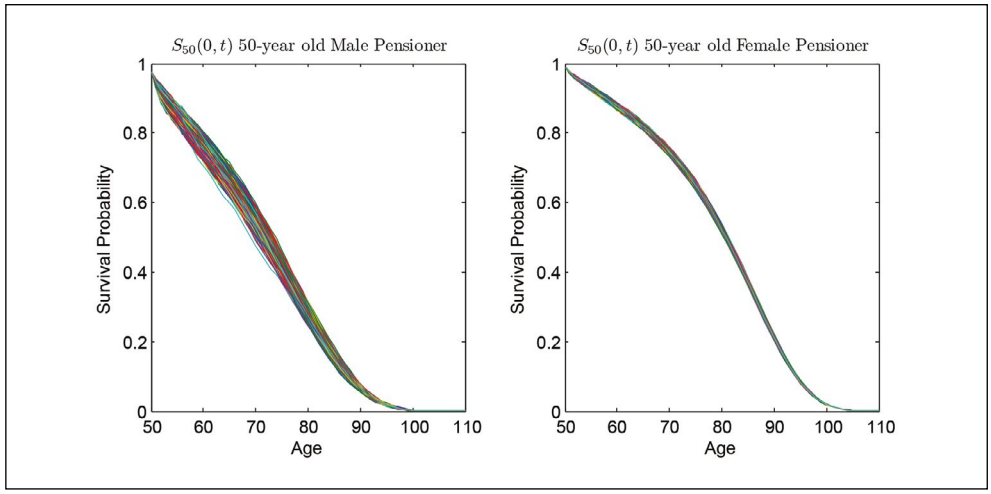

FIGURE 13. Stochastic survival probability curves

7.1.19 Figure 14 shows the mean survival probability curve, $\mathbb{E}_{\mathbb{Q}}\left[e^{-\int_0^t \mu_{50+s,s}ds}\right]$, compared to the input survival probability curve for a 50-year old South African male and female pensioner. Figure 14 shows that the CIR++ model reproduces the input survival probability curves. Although the CIR++ model has the attractive feature of matching the supplied survival probability curve and incorporating volatility for mortality, we recommend that further research be done to test the impact of non-mean reverting models on mortality.

7.1.20 To illustrate the performance of the AR(1)-ARCH(1) model, we calibrated the model to yearly changes in the log mortality rate for the UK female population in Figure 7.

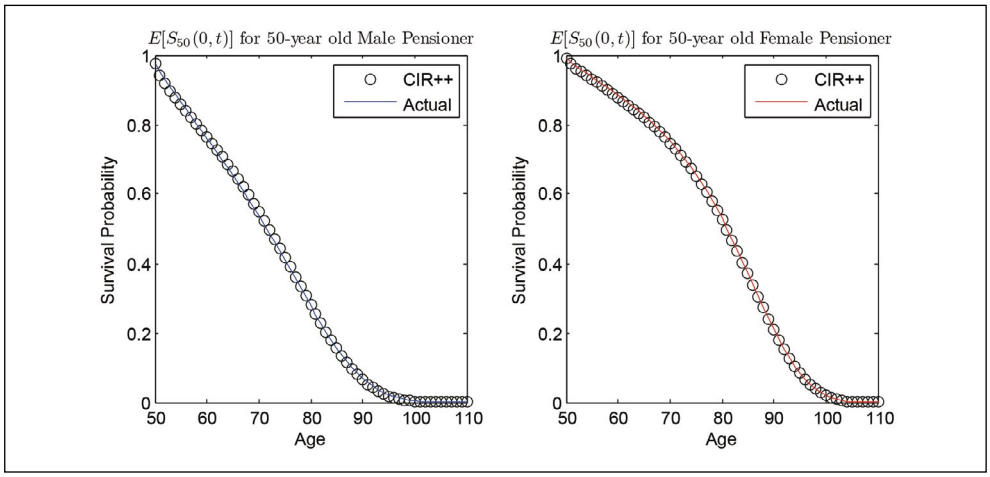

FIGURE 14. Mean survival probability curve versus input survival probability curve

For each fixed age, we estimated the parameters over the period 1922 to 2020 using the ar[12] and garch[13] packages in Matlab. The calibrated parameters are shown in Figure 15.

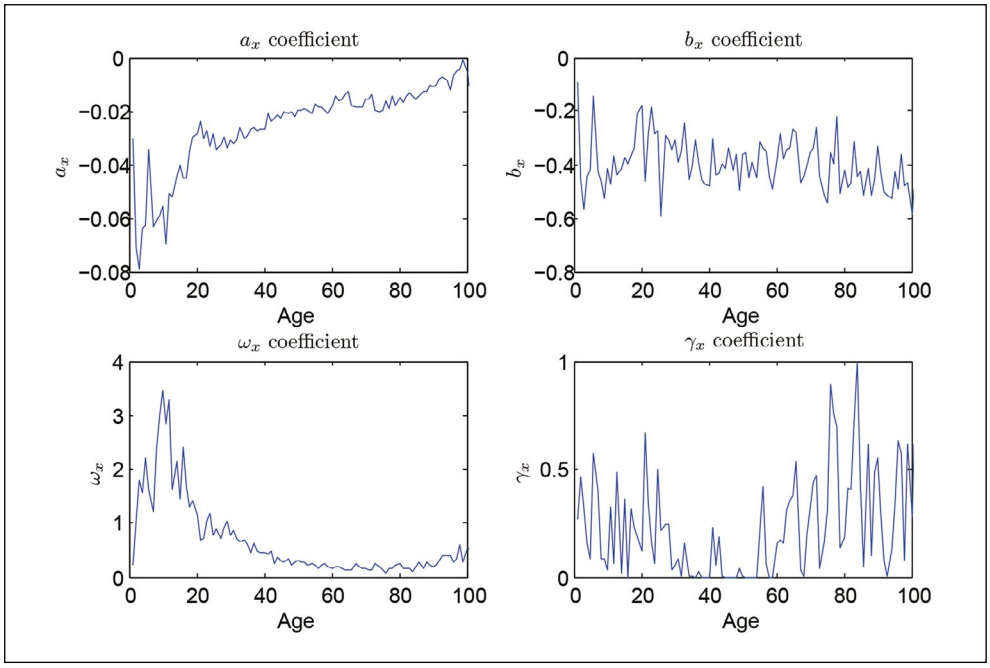

FIGURE 15. Calibrated AR(1)-ARCH(1) parameters for UK females

12 https://www.mathworks.com/help/ident/ref/ar.html
13 https://www.mathworks.com/help/econ/garch.html

7.1.21 Figure 16 shows the predicted force of mortality for each year from 1922 to 2020 for an 85-year old UK female. Visually, the AR(1)-ARCH(1) model predicts the force of mortality well. Furthermore, the actual mortality rates generally lie within the 95% confidence interval.

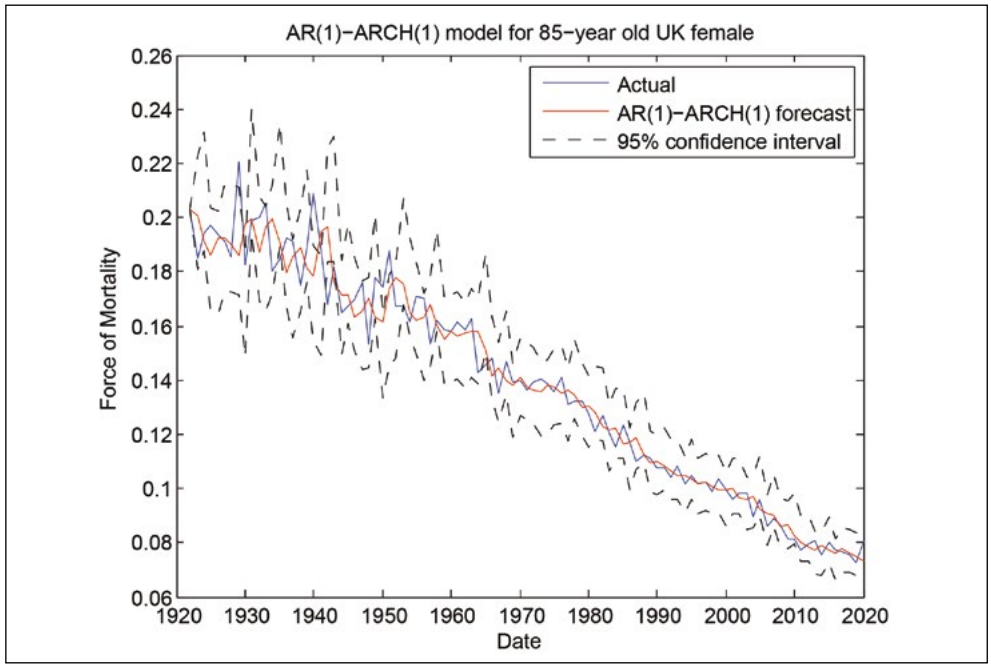

FIGURE 16. AR(1)-ARCH(1) forecast for 85-year old UK female

7.1.22 To test the goodness-of-fit, the standardised residuals (assuming normal innovations for the AR(1)-ARCH(1) model) are compared to the standard normal density function in Figure 17.

7.1.23 The Jarque-Bera test can be used to test the normality of the data—the null hypothesis is that the standardised residuals are normally distributed. We calculated the p-value for the Jarque-Bera test as 0.08, hence, we do not reject the null hypothesis at a 5% level of significance. We conclude that the AR(1)-ARCH(1) model with normally distributed innovations captures the mean and variance for 85-year old UK females well.

7.1.24 To construct a survival probability curve, the AR(1)-ARCH(1) model is fit to a time series of mortality rates for each fixed age using the age specific parameters in Figure 15.

7.1.25 As mentioned, we are not aware of historical mortality data that is publicly available in South Africa. Therefore, we showed how to calibrate the AR(1)-ARCH(1) model to mortality data sourced from the UK. The purpose was to show the mechanics of the AR(1)-ARCH(1) model, and the reader should note that the model can easily be applied to historical South African mortality rates by just changing the input data.

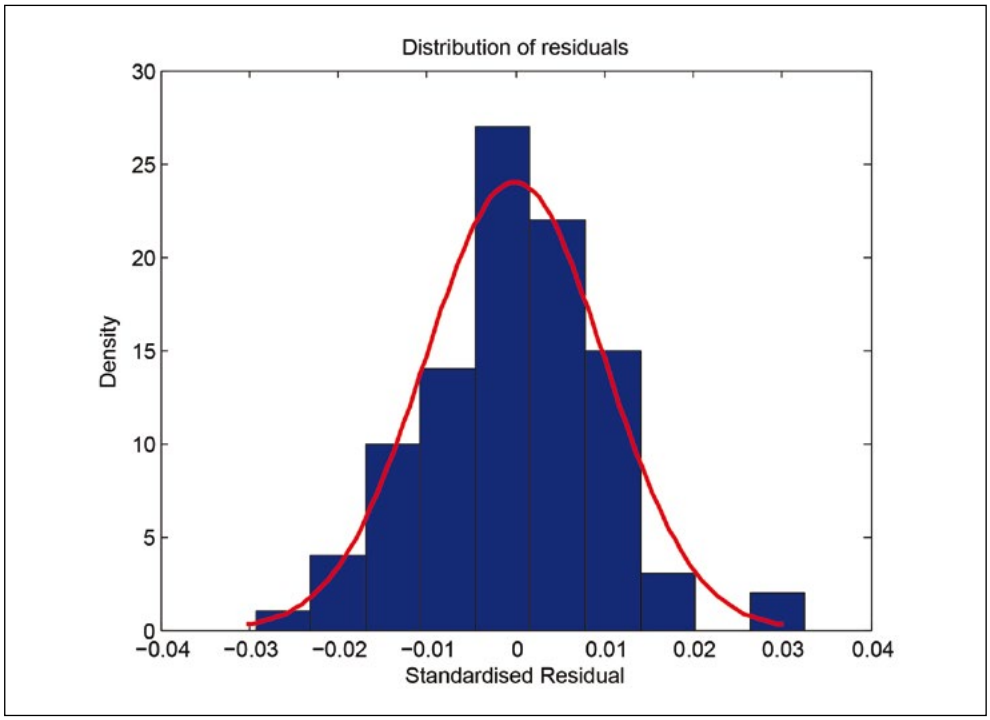

FIGURE 17. Standardised residuals versus standard normal density

7.1.26 The focus of this paper is specifically on the South African market, hence, we apply the CIR++ model going forward since survival probability curves for South African male and female pensioners are readily available from the CSI Committee's "Report on pensioner mortality 2005–2010".

7.1.27 Before we present the sensitivity of the GMMB and GMDB prices to various Heston-Hull-White-Mortality model parameters, we first create a base set of parameters. We use the parameters from Tables 1 and 2 as our base. Table 3 shows the base parameters for a 50-year old male and female pensioner in South Africa.

7.1.28 In the results below, we run 10,000 simulations and consider a single premium of R100,000 invested in the GMMB and GMDB respectively. It is simple to extend the analysis to take into account recurring premiums, see Feng (2018). We report our results as a ratio of the GMMB and GMDB price to the initial premium invested at $t = 0$:

$$R_{GMMB} = \frac{V_{GMMB,0}}{Initial \quad Premium},$$

$$R_{GMDB} = \frac{V_{GMDB,0}}{Initial \quad Premium}.$$

TABLE 3. Base parameters as at 16 November 2020

Hull-White component	θ	0.07
	r_0	0.04
	λ	0.05
	η	0.02
	$\rho_{s,r}$	0.3
Heston component	κ	1.00
	v_0	0.04
	$\overline{v}$	0.05
	σ	0.38
	$\rho_{s,v}$	–0.92
CIR++ component	$\mu_{50,0,Male}$	0.02
	$\mu_{50,0,Female}$	0.01
	γ_{Male}	0.90
	γ_{Female}	1.00
	ω_{Male}	0.05
	ω_{Female}	0.03
	ξ_{Male}	0.03
	ξ_{Female}	0.01

7.1.29 First, we consider three scenarios for the GMMB price from a life insurer's perspective: 1) deterministic interest rates by setting $\eta = 0$; 2) an independent interest rate process by setting $\rho_{s,r} = 0$; and 3) constant equity volatility by setting $\sigma = 0$. We keep all other parameters in Table 3 fixed. Figure 18 shows R_{GMMB} for all three scenarios with a guaranteed rate of $g = 6\%$ per annum, where $G = G_0(1+g)^T$, with $G_0 = 100,000$.

7.1.30 From Figure 18, we observe the following:

— From a life insurer's perspective, a 6% guarantee per annum relates to a life contingent put option that is written in-the-money, hence, there may be a significant liability;
— The GMMB price for a 50-year old female is higher than the price for a 50-year old male. This is driven solely by the fact that the survival probability for South African females is higher than males;
— Deterministic interest rates, $\eta = 0$, yield GMMB prices that are significantly lower than the base model. The difference is amplified as the term to maturity increases;
— Independent equity and interest rates, $\rho_{s,r} = 0$, yield GMMB prices that are lower than base model, but higher than the deterministic interest rate model; and
— Constant equity volatility, $\sigma = 0$, yields GMMB prices that are very close to the base model.

Our findings suggest that interest rate risk is the dominating factor when pricing GMMB products. Assuming deterministic rates may lead to GMMB prices that are significantly understated and, hence, pose a large risk to the life insurer. Assuming independent interest rate

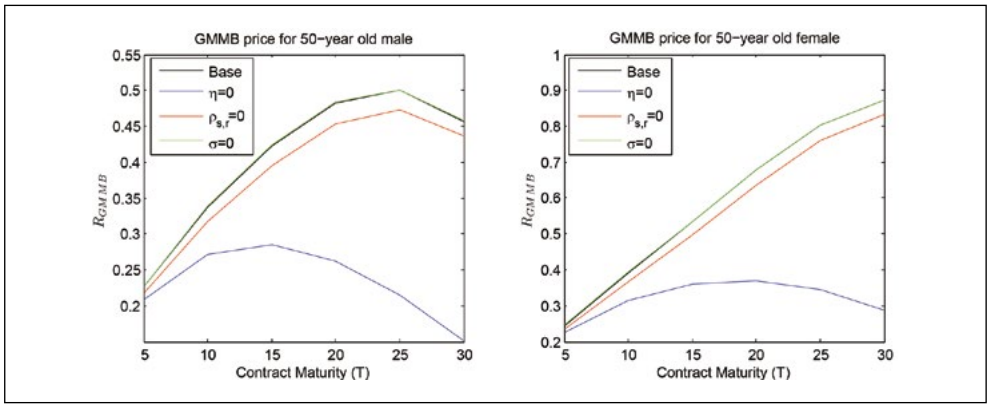

FIGURE 18. GMMB price for a 50-year old South African pensioner

and equity processes may also not be sufficient. An interesting observation is that stochastic volatility makes nearly no impact on the price of the GMMB.

7.1.31 Next, we present three scenarios for the GMDB price from a life insurer's perspective: 1) deterministic interest rates by setting $\eta = 0$; 2) an independent interest rate process by setting $\rho_{s,r} = 0$; and 3) constant equity volatility by setting $\sigma = 0$. As with the GMMB product, we keep all other parameters in Table 3 fixed. Figure 19 shows R_{GMDB} for all three scenarios with a guaranteed roll-up rate of $g = 6\%$ per annum, where $G_t = G_0 e^{gt}$, with $G_0 = 100,000$.

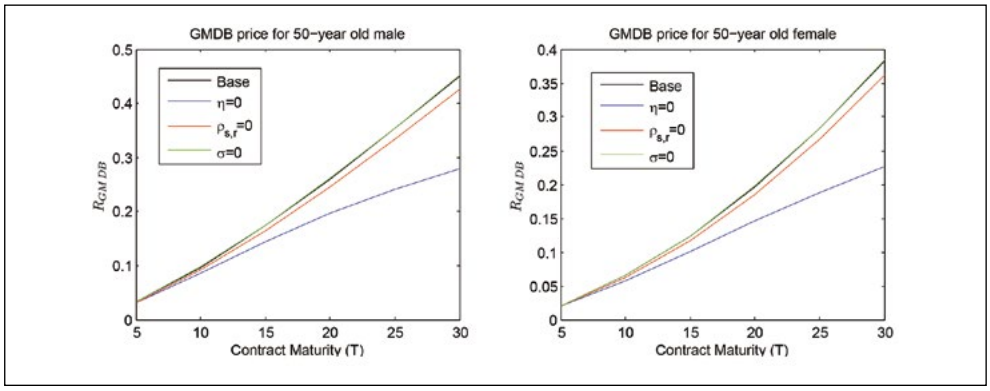

FIGURE 19. GMDB price for a 50-year old South African pensioner

7.1.32 From Figure 19, we observe the following:

— The GMDB price increases as the term to maturity increases, whereas the GMMB price starts to decrease as the contract maturity becomes larger;
— The GMDB price for a 50-year old male is higher than the price for a 50-year old female. This is because the force of mortality for South African males is higher than females;

— Deterministic interest rates, $\eta = 0$, yield GMDB prices that are considerably lower than the base model. The difference is amplified as the term to maturity increases;
— Independent equity and interest rates, $\rho_{s,r} = 0$, yield lower prices than the base model, but higher prices than the deterministic interest rate model; and
— Constant volatility, $\sigma = 0$, yields GMDB prices that are very close to the base model.

Once again, our findings suggest that interest rates are the dominating factor when pricing GMDB products.

7.1.33 Stochastic mortality has application in risk management problems and can be applied to Value-at-Risk (VAR) (see Syuhada & Hakim, 2021) and longevity stress testing (see Browne et al., 2009), for example.

7.1.34 In the next section, we apply the Heston-Hull-White-Mortality model to hedge the GMMB.

7.2 Hedging

7.2.1 Standard Black-Scholes (1973) theory suggests that a contingent claim can be replicated with a combination of shares and cash. This is referred to as delta-hedging. Since the GMMB and GMDB payoffs resemble the payoff of a put option (although life contingent), Black-Scholes (1973) theory can be applied to hedge these products.

7.2.2 Let Δ_t denote the number of shares that an insurer must hold in a hedging portfolio to hedge against movements in the underlying equity index. Furthermore, let B_t denote the money market account from which money can be borrowed or invested. No upfront premium is payable for the GMMB. Therefore, the value of the money market account at $t = 0$ is given by:

$$B_0 = -\Delta_0 S_0, \tag{18}$$

where $\Delta_0 \in [-1, 0]$ in the case of a put option.

7.2.3 For $t > 0$, the money market account grows at the risk-free rate, r. We assume that the risk-free rate is the 3-month T-Bill rate in South Africa. The change in the money market account over a discrete time interval is given by:

$$B_t = B_{t-1} e^{r\delta t} - (\Delta_t - \Delta_{t-1}) S_t, \quad B_0 = -\Delta_0 S_0. \tag{19}$$

Note that we consider a discrete hedging portfolio since it is impractical to hedge continuously in practice. At every time step, the hedging portfolio must be rebalanced to reflect the sensitivity of the derivative to the underlying asset price as new information becomes available.

7.2.4 The hedging portfolio at time t consists of a combination of shares and cash and is given by:

$$\Pi_t = \Delta_t S_t + B_t. \tag{20}$$

7.2.5 In order to calculate Δ_t in the Heston-Hull-White-Mortality model, we approximate Δ_t with a forward finite difference scheme as follows:

$$\Delta_t \approx \frac{V_{GMMB}\left(t, S_t + 0.01, v_t, r_t, \mu_t\right) - V_{GMMB}\left(t, S_t, v_t, r_t, \mu_t\right)}{0.01}. \tag{21}$$

7.2.6 Before we proceed with our backtesting experiment, we calibrate the Heston-Hull-White-Mortality model to weekly FTSE/JSE TOP40 implied volatility surfaces from September 2005 to November 2020. The calibrated parameters are shown in Figure 20. Note the clear spikes in volatility during the global financial crisis of 2007/2008 and the COVID-19 pandemic. In the calibration, we set $\kappa = 1$ since an unrestricted κ produced unstable results.

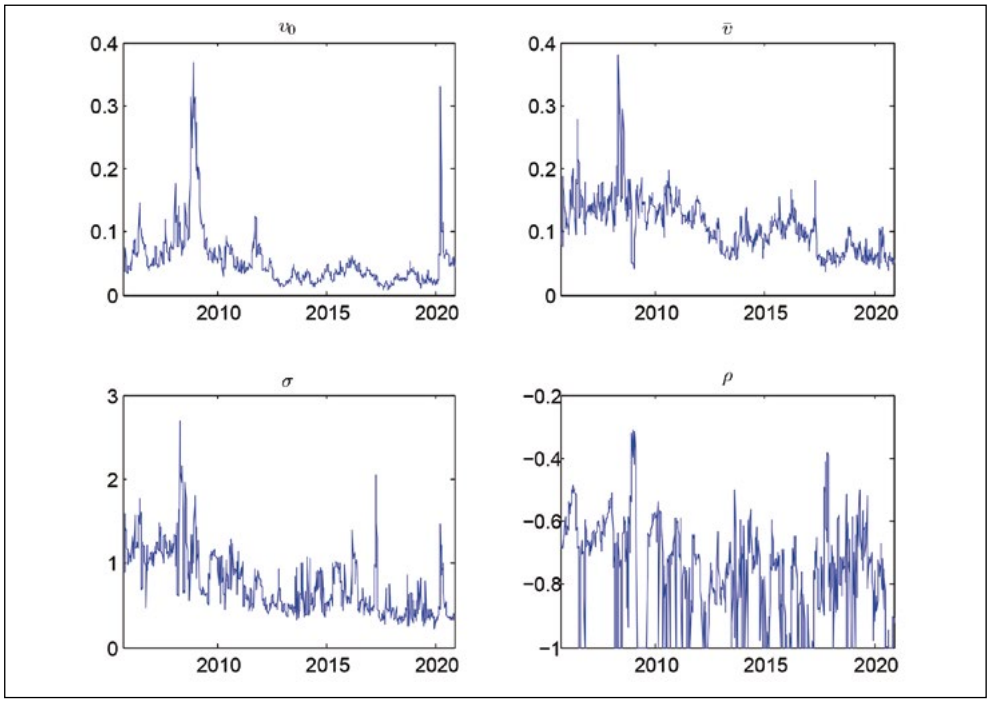

FIGURE 20. Calibrated parameters over time

7.2.7 For this experiment, we rebalance the hedging portfolio once every week. We consider a 6% per annum GMMB product sold to a 50-year old male pensioner in September 2005, expiring in November 2020. We further assume that the investor is alive at each valuation date for this backtesting experiment.

7.2.8 Figure 21 shows the value of the GMMB liability over time calculated from the Heston-Hull-White-Mortality model. Note the extreme volatility in the GMMB price over time. The volatility is driven by movements in the underlying FTSE/JSE TOP40 index, interest rates, and mortality. Furthermore, the GMMB liability displays significant jumps in the 2007/2008 global financial crisis and COVID-19 periods. Hedging is a key tool that can be used by life insurers to manage the risk of selling embedded derivatives.

7.2.9 Figure 22 shows the value for Δ over time calculated from equation (21). In periods of stress and poor equity performance, Δ approaches –1. This means that equity

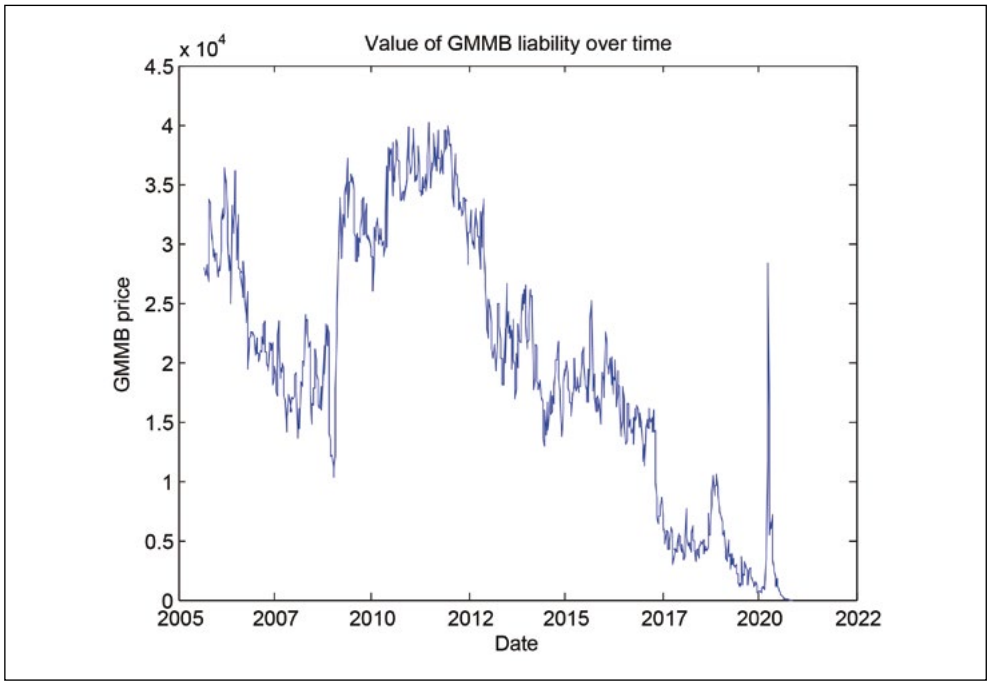

FIGURE 21. GMMB liability over time

exposure in the hedging portfolio increases. Note that Δ is close to –1 in the time of the global financial crisis and the COVID-19 pandemic. Alternatively, when equity performs well, Δ approaches 0 (equity exposure decreases). Hedging the GMMB requires active management by consistently updating the allocation in a short equity position and cash.

7.2.10 From Feng (2018), we define $V^*_{GMMB,t}$ as:

$$V^*_{GMMB,t} := V_{GMMB,t} - V_{GMMB,0}e^{rt}. \tag{22}$$

$V^*_{GMMB,t}$ represents the deviation from the risk-neutral expectation of the GMMB calculated at inception of the contract. Figure 23 shows the performance of the delta-hedging strategy in equation (20) compared to equation (22).

7.2.11 Delta-hedging captures the general trend of the movements in the GMMB liability, but fails to capture the volatility and jumps. This makes sense since the market is incomplete under the Heston-Hull-White-Mortality model. Volatility, interest rates, and mortality are all factors that are not directly tradable in the South African market. To capture the effect of volatility, interest rates, and mortality on the GMMB liability, more products that derive their value from these risk factors need to be added to the hedging portfolio.

7.2.12 Although not perfect, delta-hedging does seem to provide some benefit for the GMMB liability. The hedging strategy reduces the variability of GMMB liability since it captures the downward trend through time.

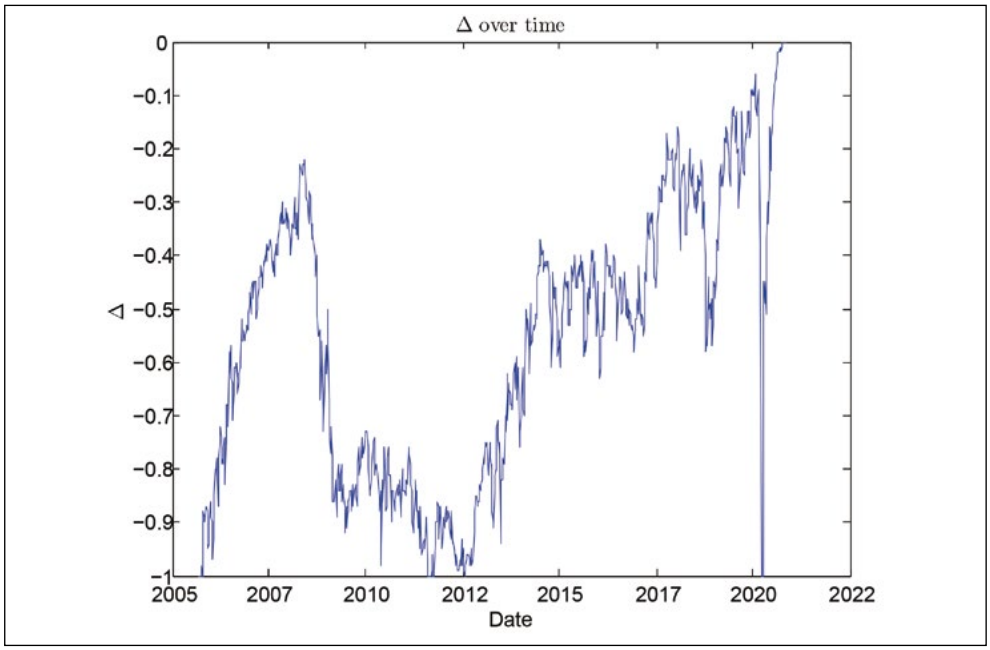

FIGURE 22. GMMB Δ over time

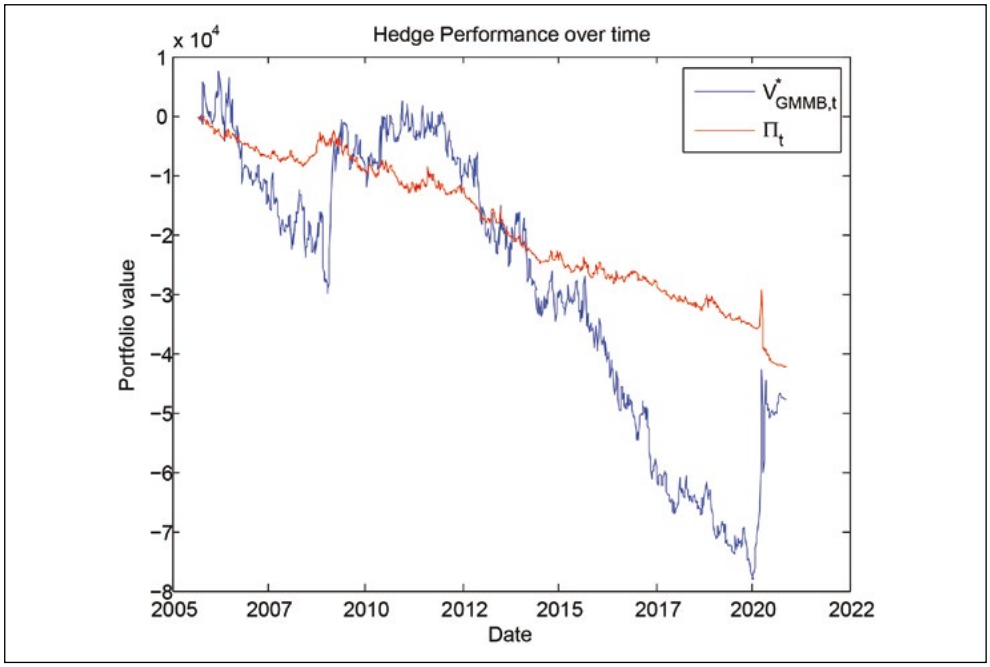

FIGURE 23. Hedge performance over time

7.2.13 Hedging is a complex problem and highly relevant in the life insurance industry. Therefore, further research in the field of embedded derivative hedging is of significant importance.

8. CONCLUSION

8.1 In this paper, we showed the importance of incorporating stochastic interest rates when reserving for GMMB and GMDB products since interest rate risk is the dominating factor when pricing these claims. Ignoring interest rate risk can lead to prices that are significantly understated from a life insurer's perspective. Stochastic volatility had no significant impact on the GMMB and GMDB liabilities.

8.2 Furthermore, we proposed the continuous-time CIR++ and discrete-time AR(1)-ARCH(1) models for mortality. The stochastic mortality models performed very well. The CIR++ model is able to reproduce the input survival probability curve, whereas the AR(1)-ARCH(1) model provides a good fit to historical data. Both models can be applied to risk management problems such as VAR and longevity stress testing, and we suggest further research on this topic.

8.3 Insurance liabilities change through time as the underlying risk factors change. To hedge these risks, we implemented a simple delta-hedging strategy based on the Heston-Hull-White-Mortality model and showed that a delta-hedging strategy captures the general trend of the movements in the liability value. However, under the Heston-Hull-White-Mortality model, the market is incomplete. Further research should be conducted to test whether a volatility (delta-vega) or interest rate (delta-rho) hedging strategy can produce better hedging results than a simple delta-hedging strategy. This is a significant challenge faced in the life insurance industry and finding a good hedge may lead to less volatility in the profit and loss (P&L) in the insurer's income statement.

8.4 The proposed Heston-Hull-White-Mortality model aligns with the requirements set by APN 110 and is a good starting point for life insurers when deciding on a model for embedded derivatives.

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