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A history and forecast of the South African life tables No. E1 to No. E9

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ABSTRACT
During the 20th century, government statistical departments in South Africa produced nine complete life tables for the white population group, seven complete life tables for the coloured population group, six complete life tables for the Asian population group and no complete life tables for the African population group. As of 2020, the South African Life Tables 1979/1981 for the white population group are still used in capitalising pensions in terms of the Compensation for Occupational Injuries and Diseases Act No. 130 of 1993. Similarly, the South African Life Tables 1984/1986 for the white population group are still used extensively in damages calculations by South African actuaries. This paper provides a historical record of the nine complete life tables for the white population group and provides a forecast of those tables to 2020. The aim of the forecast is to provide an estimate for current white population mortality rates which could then serve as a non-racial mortality basis for damages claims. It also aims to complement the work of demographers in their development of new population tables based on more sophisticated demographic techniques.

KEYWORDS
South African Life Tables; damages; mortality forecasting; Lee–Carter method; limited data

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1. INTRODUCTION

1.1 Historically there have been substantial differences in mortality between population groups in South Africa. This has been due to numerous factors the most important of which is the restriction of economic development under apartheid, poor living conditions in rural areas and urban squatter camps and insufficient health services for large segments of the population (Mostert et al., 1998).

1.2 Determining mortality rates is requisite in personal injury litigation for the purposes of calculating the lump sum damages of a claimant. Actuaries are utilised as expert witnesses for both the claimant and the defending party (which in a South African context is usually the State in the form of the Road Accident Fund or the Department of Health) to provide impartial expert evidence as to the present value of the future loss most likely to be incurred by the claimant. The starting point for calculating the present value is the application of a mortality table.

1.3 There is a conundrum faced by actuaries in having no alternative but to effectively apply race-based life tables to claimants in a post-democratic non-racial context. In post-democracy litigation the trend is for judges to approve the application of the South African Life Tables 1984/1986 for the white population group to all claimants (that is, including those previously classified as non-white) so as to remove racial bias. The following recorded decisions reflect the evolution of this principle.

1.4 In 2010, the Supreme Court of Appeal approved the application of the South African Life Table 1984/1986 for the white population group to an Indian claimant in *Singh and Another* v *Ebrahim*:[1]

> As with most things in this matter, the appropriate life tables to be applied to the assessment of Nico's life expectancy were also in issue. The high court applied the SA white male tables. The appellant contends for the application of the Koch life tables which adds between 2 to 4 years to the various scenarios calculated by Strauss. Koch's attempt to remove race from the SA life tables is obviously attractive, but the evidence of the assumptions made to compile his life tables does not, in this case, succeed to illustrate their reliability. Although the 1984/1986 SA life tables are out of date, they are still the best available. In the circumstances it seems eminently reasonable to have used the white male tables to exclude any racial component from the calculation. Consequently the dispute about whether the appellant agreed to the application of the SA life tables only to the actuarial calculation or also to the assessment of life expectancy is irrelevant.

1.5 The actuary called to give oral evidence by the appellant had published a series of life tables that represented an attempt to classify claimants on the basis of income instead of race. He had, since the 1990s, produced a series of six life tables representing various combinations

1 *Singh and Another* v *Ebrahim* (413/09) [2010] ZASCA 145

of the South African Life Tables 1984/1986 for the white population group and coloured population group.[2] Whilst the principle of moving to income-based tables is applauded, there was a lack of evidence before the Court as to the various income classifications on which his assumptions were based.

1.6 Later, in the 2016 decision of *AD and Another* v *MEC for Health and Social Development, Western Cape Provincial Government*[3] the Western Cape High Court referred to the above passage from Singh:

> This passage embodies a decision of legal policy by which I am bound in the absence of new data. The conclusion, based on this policy, would be that although IDT is a coloured child I should, to exclude any racial component, use the 1985 life table for white males (i.e. K2, not K3–K6). Apart from the reason given by Snyders JA, this may be justified on the basis that at least the legal impediments to equality which existed in 1985 were removed with our transition to a democratic country, more than 15 years before IDT was born.

1.7 Following that, in 2017, a full bench held in *PM (obo TM)* v *MEC for Health, Gauteng*[4] that:

> The unanimous decision of the Supreme Court of Appeal in Singh (supra), paras 65 and 199, was that the South African 1984/1986 life tables, although out of date, were still the best available and they were thus applied to the assessment of the life expectancy of the child in that case. Therefore I propose to apply the 1984/1986 life tables to the assessment of TM's life expectancy, which results in a further downward adjustment of Prof Strauss' estimation, and to follow Rogers J in Du Toit (supra), paras 176–197, in making a further downward qualitative adjustment based on the more recent information and data that became available after the 2010 census and Statistics South Africa (SSA) in 2015, producing male and female life expectancies at birth for persons not at risk of HIV/AIDS.

1.8 In both the *AD and Another*, and *PM (obo TM)* matters above, reference is made to new data. An attempt was made to bring the available South African Life Tables into a more current context by overlaying the life expectancy at birth produced by Statistics South Africa for the not at risk of HIV/AIDS population. A criticism of this route is that the Statistics South

2 Life Table 1 represented 80% of the SALT1984/1986 mortality rates for the white population group, Life Table 2 represented 100% of the SALT1984/1986 mortality rates for the white population group, Life Table 3 represented two-thirds of the SALT1984/1986 mortality rates for the white population group plus one-third of the SALT1984/1986 coloured population group, Life Table 4 represented one-third of the SALT1984/1986 mortality rates for the white population group plus two-thirds of the SALT1984/1986 coloured population group, Life Table 5 represented 100% of the SALT1984/1986 mortality rates for the coloured population group and Life Table 6 represented 120% of the SALT1984/1986 mortality rates for the coloured population group.

3 *AD and Another* v *MEC for Health and Social Development, Western Cape Provincial Government* (27428/10) [2016] ZAWCHC 116

4 *PM obo TM v MEC for Health, Gauteng Provincial Government* (A5093/2014) [2017] ZAGPJHC 346

Africa estimate is not based on a mortality study and is designed as an input that conforms to the demographic mortality profile of the country. It is erroneous to make a comparison between a complete population life table and a demographic estimate of life expectancy at birth which is not based on census data. The new data to which the judiciary refers is a call for revised mortality rates.

1.9 The paper unfolds as follows: first, Section 2 provides a literature review and Section 3 provides an overview of the data. Section 4 provides a brief overview of forecasting methods. Section 5 describes the Lee–Carter method for populations with limited data. Section 6 provides results after applying that method to the South African Life Tables and an interim life table projected to 2020. The paper concludes in Section 7.

2. LITERATURE REVIEW

2.1 Lowther (2011) notes that discrimination by race and gender has been integral to actuarial calculations in the past. In the absence of availability of life tables which do not bear the weight of a historic backlog, compensation awards become tainted by the competing principles of a fair settlement value and historical unfair discrimination. With respect to the selection of an appropriate mortality table in the legal context, the actuary needs to consider whether or not past injustices should influence current rates and more contemporaneously, whether or not the rates should include or exclude the impact of HIV/AIDS.

2.2 It is significant to note that the South African Life Tables 1984/1986 pre-date the HIV/AIDS pandemic in South Africa. In addition, there are starkly contrasting rates of HIV/AIDS across the economic divide and the effect on life expectancy similarly varies depending on economically driven factors such as access to health care.

2.3 In the ordinary course of a damages claim, there is no specific requirement for the HIV/AIDS status of the claimant to be disclosed. The HIV status of a claimant may be brought into evidence by way of medico-legal reports placed before the court. In such instances, presiding officers have been found to consider the HIV status with strict regard to the specific facts applicable to the individual claimant. This personalised approach has created various possibilities in dealing with HIV-positive claimants.

2.4 In *Njoko* v *Minister of Safety and Security and Another*[5] the Court did not make explicit provision for a reduction in life expectancy of an HIV-positive claimant, but instead opted for an increased deduction for general contingencies to take into account the possibility of a reduced life expectancy:

> I accept the evidence of Professor Venter that the effect of his HIV-positive status would not have a negative effect on the plaintiff's life expectancy and future loss of earnings.

5 *Njoko* v *Minister of Safety and Security and Another* (2011 (5) SA 512 (KZP)) [2011] ZAKZPHC 25

> Based on the normal contingencies applied by Koch, and taking into account the possibility of a reduced life expectancy, I set the contingencies which should be applied to the plaintiff's future loss of earnings at 23%.

2.5 By contrast, in *Seme* v *Road Accident Fund*[6] the Court allowed for an explicit reduction in the plaintiff's life expectancy:

> It is safe to say that the plaintiff was diagnosed with HIV in 1995. Thirteen years later he is still in a generally healthy state without the use of retrovirals. I therefore find that life expectancy of a person diagnosed with HIV is halfway between 11 years and normal. I would add the *caveat,* however, that every case is *sui generis* and must be judged on its own particular circumstances.

2.6 Koning & Van der Merwe (unpublished) constructed population mortality tables for the South African population as a whole based on 2011 census data and vital registration data on all causes of deaths including HIV/AIDS. The purpose of the study was to provide an up-to-date tool for quantum of damages assessments. Technical criticisms raised about the paper included the lack of adjustment for the under-registration of deaths and concerns around the lack of smoothness of the graduated rates.

2.7 The landscape of the effect of HIV/AIDS on the South African population and, in particular, on life expectancy has altered since 2010. There have been significant developments with respect to the roll-out and use of antiretroviral medication. In 2010 the National Department of Health expanded treatment to all children under one year, all pregnant women regardless of CD4 count and all TB-HIV co-infected patients with a CD4 count of <350 cells/μl. Further, in 2012 a decision was made to increase the initiation threshold to 350 cells/μl for all adults and to expand access thresholds for children (Simelela & Venter 2014). On the latter ground alone, the population mortality estimates of Koning & Van der Merwe centred at 2011 would be inappropriate for current use given that a significantly greater proportion of the HIV-positive population is not only receiving antiretroviral medication, but is receiving it earlier on in the progression of the virus than was the case in 2011. In particular, Strydom et al. (2016) find that life expectancy at birth has improved meaningfully with the help of the aggressive roll-out of antiretrovirals.

2.8 For HIV-negative claimants, Schneider & Kelly (unpublished) present an actuarial approach to assessing the impact of HIV/AIDS on the calculation of damages claims. The proposed model includes risk loadings that differ by age, gender, calendar year, province, urban/rural and recent HIV test results. These techniques could be applied to an HIV-negative claimant who is perceived to be at risk of becoming HIV-positive. Similarly, this approach was developed 20 years ago and as such does not take into account the subsequent impact of antiretroviral medication.

6 *Seme* v *Road Accident Fund* (13917/04) [2008] ZAKZHC 47

2.9 It is important to bear in mind that in the exercise of applying a mortality table to a litigant, the actuary does not have the array of personal information that is ordinarily available to an underwriter. More often than not, the usual factors which would load mortality rates in an insurance setting such as the HIV status of an insured are not before the court as evidence. Should a defendant argue for a reduction in life expectancy on the basis of a suspicion of HIV positivity on the part of the claimant, the onus is on the defendant to adduce evidence of this. Such evidence can be simply rebutted by the disclosure of the claimant's status as negative. Should the claimant indeed be positive, then the approach as discussed in the case law above would apply. As such there is little basis for loading mortality rates to generally take into account HIV/AIDS in order to account for the general infection rates in the population. In highly specific circumstances the actuary may encounter a situation where the defendant raises a higher probability of the claimant contracting HIV/AIDS post settlement of the damages claim. Such a scenario could evolve where the claimant engages in high risk activity such as a sex worker. This probability can be catered for by the application of a higher general contingency deduction, as one would do for any other loading factor that is present in the claimant.

2.10 Koch (2020) notes that the South African Life Tables 1984/1986 remain the best available tables for persons who do not test positive for HIV/AIDS. The author notes that in South Africa, damages claims are assessed on the assumption that the claimant is not HIV positive.

2.11 Dorrington & Richman (unpublished) note that when valuing cash flows outside of the insurance and retirement context, actuaries may need to rely upon population mortality rates. This is in alignment with the approach of Martin et al. (unpublished) who advocate for the use of the English Life Tables for damages assessments in the United Kingdom on the basis that it is thought to provide a fair reflection of the population group for plaintiffs.

2.12 Cooper-Williams et al. (unpublished) analysed mortality improvement using the various South African Life Tables for the white population group. The authors note that by so doing, the impact of HIV/AIDS is minimised to a large extent and the use of these tables may act as a rough proxy for individuals currently purchasing insurance and annuity products.

3. DATA

3.1 The South African Life Tables No. 1 (1920–1922) were obtained from the National Library of South Africa. The published tables contained values of q_x from age 0 to age 105 inclusive for males, and values of q_x from age 0 to age 107 inclusive for females (Population Census, 1921).

3.2 The South African Life Tables No. 2 (1925–1927) were obtained from the Institute and Faculty of Actuaries Library and checked against the tables contained in the Human Mortality Database that were provided by Dr V Kannisto. The published tables contained

values of q_x from age 0 to age 109 inclusive for males, and from age 0 to age 109 inclusive for females (Fourth Census of the Population of the Union of South Africa, enumerated 4 May 1926).

3.3 The South African Life Tables No. 3 (1935–1937) were obtained from the National Library of South Africa. The published tables contained values of q_x from age 0 to age 103 inclusive for males, and values of q_x from age 0 to age 105 inclusive for females (Sixth Census of the Population of the Union of South Africa, enumerated 5 May 1936).

3.4 The South African Life Tables No. 4 (1945–1947) were obtained from the National Library of South Africa and checked against the tables contained in the Human Mortality Database that were provided by Dr V Kannisto. The published tables contained values of q_x from age 0 to age 104 inclusive for males, and values of q_x from age 0 to age 106 inclusive for females (Eighth Census of the Population of the Union of South Africa, 7 May 1946).

3.5 The South African Life Tables No. 5 (1950–1952) were obtained from the National Library of South Africa. The published tables contained values of q_x from age 0 to age 104 inclusive for males, and values of q_x from age 0 to age 107 inclusive for females (Population Census, 8 May 1951).

3.6 The South African Life Tables No. 6 (1959–1961) were obtained from the National Library of South Africa after a legal application in terms of the Promotion for Access to Information Act. The published tables contained values of q_x from age 0 to age 89 inclusive for males, and values of q_x from age 0 to age 89 inclusive for females (Population Census, 6 September 1960).

3.7 The South African Life Tables No. 7 (1969–1971) were obtained from the National Library of South Africa. The published tables contained values of q_x from age 0 to age 89 inclusive for males, and values of q_x from age 0 to age 89 inclusive for females (South African Life Tables 1969–71). The tables were extended from age 90 to age 100 by the then Secretary for Statistics. Correspondence dating back to 1977 was obtained from Actuary Mr GW van der Linde in this regard.

3.8 The South African Life Tables No. 8 (1979–1981) were obtained from the National Library of South Africa. The published tables contained values of q_x from age 0 to age 80 inclusive for males, and values of q_x from age 0 to age 80 inclusive for females (South African Life Tables 1979–81). These tables are still in use by the Department of Labour in calculating the capitalised value of pensions in terms of the Compensation for Occupational Injuries and Diseases Act, 1993. The factors derived from the white population group are used to calculate the capitalised value of pensions for all population groups. Up to the early 1990s, the method used was discriminatory in that the capitalised value of pensions for other than the white population group were calculated by using an age rating of five years. Values

of q_x from age 81 to age 100 were obtained from the late Actuary Mr CA Scott, who was involved in the development of the capitalisation factors for the Department of Labour.

3.9 The South African Life Tables No. 9 (1984–1986) were obtained from the University of Stellenbosch Library. The published tables contained values of q_x from age 0 to age 89 inclusive for males, and values of q_x from age 0 to age 89 inclusive for females (South African Life Tables 1984–86).

3.10 A historical record of the South African Life Tables for males and females is provided in Appendix A and Appendix B.

4. MORTALITY FORECASTING METHODS

4.1 Booth & Tickle (2008) provide a comprehensive review of mortality forecasting methods. Three broad methods are discussed namely parametrisation functions, Lee–Carter variants and extensions, and generalised linear modelling.

4.2 Forecasting with parametrisation functions such as the Heligman–Pollard model involves repeated fitting to annual data, thereby obtaining a time series of each model parameter. Annual data is not available in the South African context. The parameters of the Heligman–Pollard model are difficult to interpret and the forecasting results are sensitive to the past period that is chosen to start the extrapolation (Keyfitz, 1991). Given that only nine complete life tables were available over the period from 1921 to 1985, the parametrisation method was considered inappropriate. In addition, various mortality curves were fitted to the data using the R package Mortality Laws (Pascariu, 2020) and the best fitting mortality curve varies over time.

4.3 Lee–Carter variants and extensions represent a principal components approach to mortality forecasting. The principal components approach estimates the age pattern of mortality from the data. Advantages of the Lee–Carter model include simplicity, parameters can be easily interpreted and the method involves minimal subjective judgment. A further advantage in the South African context is the extension of the model to forecast mortality for populations with limited data as discussed in detail in Section 4. Some shortcomings of the Lee–Carter model are that forecast rates lack across-age smoothness and become increasingly jagged over time. In Bengtsson & Keilman (2019), Tuljapurkar shows that we can expect a reasonable performance from Lee–Carter forecasts for as far as 40 years into the future.

4.4 Generalised linear models were not considered as researchers have found that two- or higher degree polynomials in time are required to obtain a satisfactory fit, but lead to implausible forecasts (Booth & Tickle, 2008).

5. Lee–Carter METHOD FOR POPULATIONS WITH LIMITED DATA

5.1 The Lee–Carter method (Lee & Carter, 1992) was originally developed using data at single year intervals. In particular, the method forecast mortality using United States data at single year intervals from 1933 to 1987 inclusive.

5.2 The Lee–Carter Method first applies the singular-value decomposition (SVD) on $\left\{\log\left[m(x,t)\right]-a(x)\right\}$, where $m(x,t)$ is the death rate for age x at time t, to obtain:

$$\log\left[m(x,t)\right]=a(x)+b(x)k(t)+\varepsilon(x,t) \tag{1}$$

5.3 The $k(t)$ are modelled using standard time series methods. In most applications, it has been found that a random walk with drift provides a good fit. The model for $k(t)$ is expressed as follows:

$$k(t)=k(t-1)+c+e(t)\sigma,\ e(t)\sim N(0,1),\ E\left(e(s)e(t)\right)=0 \tag{2}$$

5.4 The Lee–Carter Method was extended to forecast mortality for populations with limited data by Li et al. (2002).

5.5 In particular, let mortality data be collected at times $u(0),u(1),\ldots,u(T)$. In the case of South Africa, $u(0)=1921$, $u(1)=1926$, $u(2)=1936$, $u(3)=1946$, $u(4)=1951$, $u(5)=1960$, $u(6)=1970$, $u(7)=1980$, and $u(8)=1985$.

5.6 Parameters $a(x)$ are calculated as:

$$a(x)=\sum_{t=0}^{T}\frac{\log\left[m\left(x,u(t)\right)\right]}{T} \tag{3}$$

5.7 Applying SVD on $\left\{\log\left[m\left(x,u(t)\right)\right]-a(x)\right\}$, $b(x)$ and $k\left(u(0)\right),k\left(u(1)\right),\ldots,k\left(u(T)\right)$ are obtained. SVD was performed using SVD macros in excel (Lipkovich & Smith, 2002).

5.8 For $k\left(u(t)\right)$, however, (2) becomes

$$k\left(u(t)\right)-k\left(u(t-1)\right)=c\left[u(t)-u(t-1)\right]+\sigma\left[e\left(u(t-1)+1\right)+\ldots+e\left(u(t)\right)\right] \tag{4}$$

5.9 For different t, $\left[k\left(u(t)\right)-k\left(u(t-1)\right)\right]$ are no longer identically distributed.

5.10 An unbiased estimate of c is obtained by:

$$c=\frac{\sum_{t=1}^{T}\left[k\left(u(t)\right)-k\left(u(t-1)\right)\right]}{\sum_{t=1}^{T}\left[u(t)-u(t-1)\right]}=\frac{k\left(u(T)\right)-k\left(u(0)\right)}{u(T)-u(0)} \tag{5}$$

5.11 The derivation of the standard error of $e\left(u\left(t\right)\right)$, *see*, is somewhat complicated, and is derived as:

$$see^2 = \frac{\sum_{t=1}^{T}\left[\left[k\left(u\left(t\right)\right)-k\left(u\left(t-1\right)\right)\right]-c\left[u\left(t\right)-u\left(t-1\right)\right]\right]^2}{u\left(T\right)-u\left(0\right)-\frac{\sum_{t=1}^{T}\left[u\left(t\right)-u\left(t-1\right)\right]^2}{u\left(T\right)-u\left(0\right)}} \tag{6}$$

5.12 The standard error in estimating *c*, *sec*, is estimated as follows:

$$sec^2 = \frac{var\left\{\sum_{t=1}^{T}\left[e\left(u\left(t-1\right)+1\right)+\ldots+e\left(u\left(t\right)\right)\right]\right\}}{\left[u\left(T\right)-u\left(0\right)\right]^2} = \frac{\sigma^2}{u\left(T\right)-u\left(0\right)} \approx \frac{see^2}{u\left(T\right)-u\left(0\right)} \tag{7}$$

5.13 Once the values of *c* and *see* have been determined, forecasting is carried out by:

$$k\left(t\right) = k\left(T\right)+\left[c+sec.e\left(T\right)\right]\left(t-T\right)+see\sum_{s=T+1}^{t}e\left(s\right) \tag{8}$$

5.14 Finally:

$$\log\left[m\left(x,t\right)\right] = \log\left[m\left(x,T\right)\right]+b\left(x\right)\left[k\left(t\right)-k\left(T\right)\right] \tag{9}$$

6. RESULTS

6.1 Fitted values of $a\left(x\right)$ and $b\left(x\right)$ are shown in Appendix C.

6.2 Values of $k\left(t\right)$ from 1921 to 1985 are shown in Table 1 below.

TABLE 1. Fitted values of *k*(*t*)

$u\left(t\right)$	$k\left(u\left(t\right)\right)$ male	$k\left(u\left(t\right)\right)$ female
1921	30.636671	53.814598
1926	25.886915	44.409418
1936	20.527914	37.605683
1946	2.130471	9.116399
1951	–4.481167	–5.510732
1960	–10.888190	–22.965064
1970	–16.479784	–30.934813
1980	–20.486869	–37.525275
1985	–26.845960	–48.010214

6.3 The forecasted value for *k*(2020) is obtained by performing 1000 stochastically simulated trajectories. The mean forecasted value of *k*(2020) is –58.28 for males (95% confidence interval –35.45 to –81.49). The mean forecasted value of *k*(2020) is –104.27 for females (95% confidence interval –65.06 to –145.34).

6.4 A sample of the trajectory of $k(2020)$ for males is shown in Figure 1.

6.5 Fitted values of $q(x)$ for 2020 are shown in Appendix D.

6.6 Fitted values of $q(x)$ for 2020 for females compared to prior years are shown in Figure 2 (overleaf).

6.7 The forecasted life expectancy for females has been compared to the South African Annuitant Standard Mortality Tables (Dorrington & Tootla, 2007) and to pensioner mortality rates for female pensioners in receipt of pensions in excess of R30,000 a year for 2005–2010 (Actuarial Society of South Africa Continuous Statistical Investigation Committee, 2017) in Table 2.

TABLE 2. Life expectancy for females at selected ages

Age	SALT 1984/1986	SALT 1984/1986 forecast to 2020	SAIFL98	CSI pensioners 2005–2010
40	37.80	40.30	41.81	–
50	28.74	30.93	32.48	31.44
60	20.48	22.32	23.68	23.82
70	13.37	14.78	15.77	16.27

6.8 As noted by Martin et al. (unpublished), annuitant and assurance tables cover a subset of the population and in general, mortality rates in these groups are lower than for the

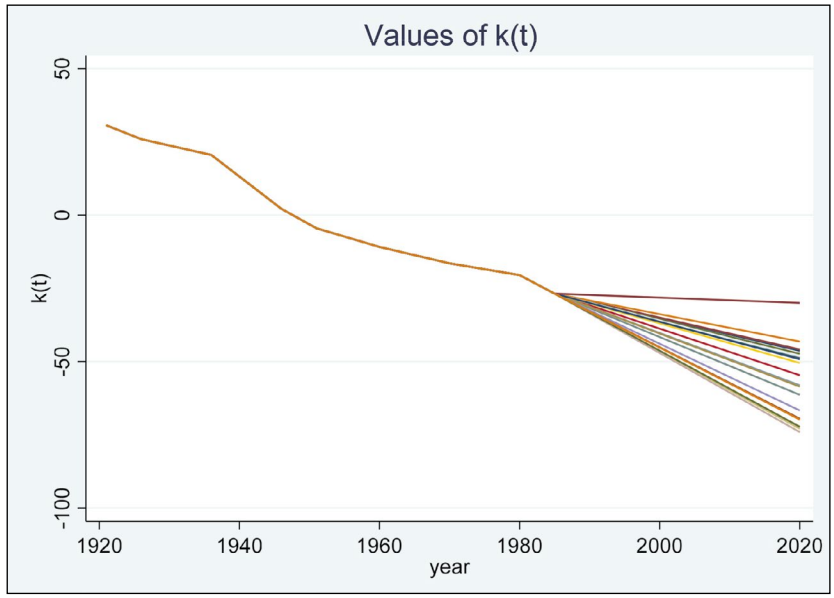

FIGURE 1. Sample trajectory of $k(2020)$ for males

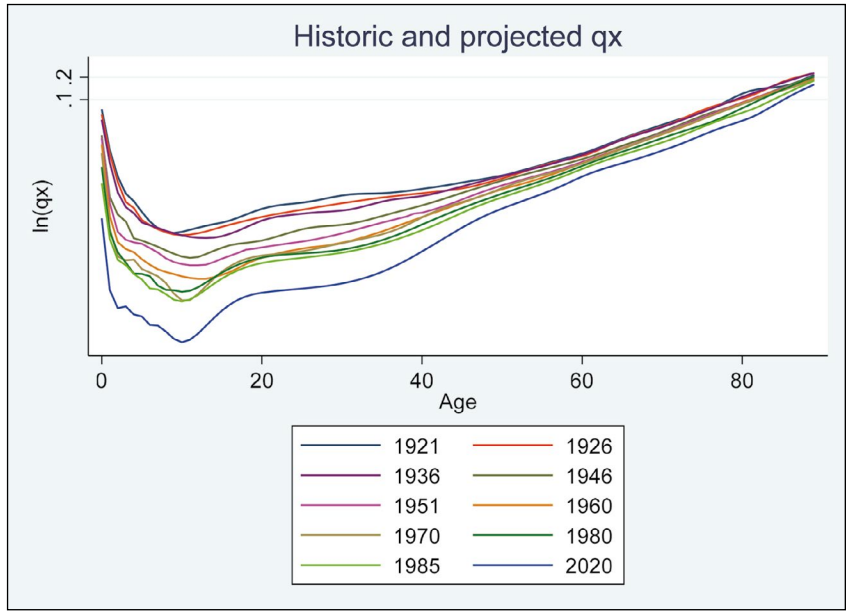

FIGURE 2. Historic and fitted mortality rates for females

population as whole. This is borne out by the forecasted rates and comparison of life expectancies in Table 2.

7. CONCLUSION

7.1 A historical record of the nine complete life tables for the white population group is provided in Appendices A and B to this paper. No such record exists at either the National Library of South Africa, Statistics South Africa or with the Actuarial Society of South Africa.

7.2 Despite government statistical departments not having produced official complete South African Life Tables in the last 35 years, the method applied in this paper produces useful forecasts for 2020.

7.3 Life expectancy at birth for white males in 2020 is estimated at 70.52 years (95% confidence interval 69.08 years to 71.55 years). The life expectancy at birth according to the South African Life Tables 1984/1986 for white males was 68.37 years. An improvement of 2.15 years is therefore estimated over the past 35 years.

7.4 Life expectancy at birth for white females in 2020 is estimated at 79.56 years (95% confidence interval 77.12 years to 81.61 years). The life expectancy at birth according to the South African Life Tables 1984/1986 for white females was 75.84 years. An improvement of 3.72 years is therefore estimated over the past 35 years.

7.5 It is recommended that the Actuarial Society of South Africa commission research into an appropriate set of population mortality tables for damages work subject to specifications such as removing racial bias and the impact of HIV/AIDS. The attempt by Koch to develop population mortality tables that are more aligned to an economic context could be advanced to establish a free, fair and equal basis on which mortality rates may be measured. The ultimate goal would be to afford claimants a balance of their right to a fair settlement and the foundational principles of the Bill of Rights. The forecasts in this paper can then be compared to the new population tables based on more sophisticated demographic techniques.

REFERENCES

Actuarial Society of South Africa Continuous Statistical Investigation Committee (2017). Report on pensioner mortality 2005–2010. Online: www.actuarialsociety.org.za

Cooper-Williams, J, Albertyn, L-M & Lewis, P (unpublished). Mortality improvements in South Africa. Convention, Actuarial Society of South Africa, 2012

Bengtsson, T & Keilman, N (2019). *Old and New Perspectives on Mortality Forecasting*. Springer. https://doi.org/10.1007/978–3–030–05075–7

Booth, H & Tickle, L (2008). Mortality modelling and forecasting: A review of methods. *Annals of Actuarial Science*, **3**(1–2), 3–43

Dorrington, RE & Tootla, S (2007). South African Annuitant Standard Mortality Tables 1996–2000 (SAIML98 and SAIFL98). *South African Actuarial Journal* **7**, 161–84

Dorrington, R & Richman, R (unpublished). Mortality rates and improvement over time at advanced ages in South Africa – insights from the national-level data. Convention, Actuarial Society of South Africa, 2016

Eighth Census of the Population of the Union of South Africa, 7 May 1946; Volume III, South African Life Tables (Whites and Coloureds)

Fourth Census of the Population of the Union of South Africa, enumerated 4 May 1926; South African Life Table No. 2 (Whites)

Human Mortality Database. University of California, Berkeley (USA), and Max Planck Institute for Demographic Research (Germany). Available at www.mortality.org

Keyfitz, N (1991). Experiments in the projection of mortality. *Canadian Institute of Population Studies* **18**(2), 1–17

Koch, RJ (2020). *The Quantum Yearbook*. Van Zyl, Rudd & Associates, Port Elizabeth

Koning, F & Van der Merwe, C (unpublished). 2011 Population mortality tables for quantum of damages calculations. Convention, Actuarial Society of South Africa, 2016

Lee, R & Carter, LR (1992). Modeling and forecasting U.S. mortality. *Journal of the American Statistical Association* 87, 659–71

Li, N, Lee, R & Tuljapurkar, S (2002). Using the Lee–Carter method to forecast mortality for populations with limited data. *International Statistical Review* 72, 19–36

Lipkovich, I & Smith, E (2002). Biplot and singular value decomposition macros for Excel©. *Journal of Statistical Software*. Online: https://www.jstatsoft.org/article/view/v007i05

Lowther, MW (2011). Promoting quality in the actuarial assessment of quantum of damages in South Africa. *South African Actuarial Journal* 11, 85–110

Martin, AC, Beardmore, JW, Gallop, AP, Kennedy, PG, McKenzie, JL, Owen, R, Patel, CC, Pettengell, CT & Wright, PW (unpublished). Damages: Personal injury awards – A discussion paper by an Actuarial Working Group, 1997

Mostert, WP, Hofmeyr, BE, Oosthuizen, JS & Van Zyl, JA (1998). *Demography Textbook for the South African Student*. Pretoria: Human Sciences Research Council

Pascariu, MD (2020). Mortality Laws. R package version 1.8.4. https://cran.r-project.org/web/packages/MortalityLaws/

Population Census 1921; Final Report (Whites)

Population Census 8 May 1951; Volume VIII, South African Life Tables (Whites, Coloureds and Asians)

Population Census 6 September 1960; Statistical News Release P11, South African Life Tables (Whites, Coloureds and Asians)

Schneider, DH & Kelly, NJ (unpublished). Impact of HIV/AIDS on damages claims. Convention, Actuarial Society of South Africa, 2001

Simelela, NP & Venter, WDF (2014). A brief history of South Africa's response to AIDS: history of HIV in SA-Progress towards the Millennium Development Goals. *South African Medical Journal*, 104(3), 249–51

Sixth Census of the Population of the Union of South Africa, enumerated 5 May 1936; Volume XI, South African Life Tables (Whites and Coloureds)

South African Life Tables 1969–1971; Report No. 02–06–02

South African Life Tables 1979–1981; Report No. 02–06–03

South African Life Tables 1984–1986; Report No. 02–06–04

Strydom ML, Corubolo D & Nel C (2016). Changes in mortality of people living with HIV in South Africa and their potential implications for life assurers. *SAAJ* **16**, 1–33. DOI: http://dx.doi.org/10.4314/saaj.v16i1.1

APPENDIX A
South African Life Tables for White Males $q(x)$

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
0	0.087844	0.074438	0.066410	0.041280	0.037890	0.032420	0.024668	0.015923	0.010598
1	0.021636	0.018703	0.014640	0.005990	0.004610	0.003140	0.001969	0.001737	0.001583
2	0.008912	0.007360	0.006200	0.002800	0.002280	0.001490	0.001202	0.001244	0.000921
3	0.005734	0.004705	0.004360	0.002090	0.001880	0.001050	0.000960	0.000854	0.000830
4	0.003438	0.003463	0.002840	0.001650	0.001420	0.000940	0.000887	0.000746	0.000714
5	0.002943	0.002920	0.002380	0.001570	0.001300	0.000820	0.000812	0.000727	0.000494
6	0.002575	0.002510	0.002130	0.001460	0.001170	0.000720	0.000665	0.000633	0.000436
7	0.002314	0.002210	0.001920	0.001310	0.001030	0.000630	0.000528	0.000612	0.000368
8	0.002140	0.002000	0.001750	0.001160	0.000810	0.000570	0.000397	0.000458	0.000301
9	0.002038	0.001864	0.001620	0.001030	0.000700	0.000530	0.000278	0.000250	0.000221
10	0.001997	0.001786	0.001540	0.000930	0.000620	0.000510	0.000200	0.000173	0.000192
11	0.002005	0.001758	0.001500	0.000880	0.000570	0.000510	0.000248	0.000214	0.000231
12	0.002056	0.001773	0.001510	0.000920	0.000580	0.000510	0.000397	0.000352	0.000331
13	0.002147	0.001827	0.001570	0.001010	0.000670	0.000540	0.000623	0.000564	0.000480
14	0.002277	0.001920	0.001680	0.001130	0.000860	0.000630	0.000901	0.000829	0.000669
15	0.002446	0.002055	0.001850	0.001280	0.001110	0.000820	0.001207	0.001126	0.000888
16	0.002661	0.002240	0.002070	0.001420	0.001390	0.001100	0.001519	0.001435	0.001126
17	0.002928	0.002483	0.002350	0.001560	0.001650	0.001470	0.001816	0.001736	0.001373
18	0.003264	0.002800	0.002720	0.001720	0.001860	0.001850	0.002080	0.002012	0.001615
19	0.003619	0.003138	0.003110	0.001880	0.001970	0.002200	0.002297	0.002250	0.001842
20	0.003942	0.003445	0.003460	0.002020	0.002010	0.002440	0.002458	0.002439	0.002040
21	0.004183	0.003668	0.003680	0.002100	0.002020	0.002540	0.002559	0.002572	0.002199
22	0.004317	0.003781	0.003750	0.002150	0.002030	0.002530	0.002603	0.002649	0.002310
23	0.004375	0.003819	0.003700	0.002150	0.002030	0.002470	0.002596	0.002674	0.002370
24	0.004396	0.003819	0.003600	0.002130	0.002050	0.002400	0.002552	0.002656	0.002384
25	0.004421	0.003820	0.003500	0.002110	0.002080	0.002350	0.002487	0.002607	0.002360
26	0.004487	0.003859	0.003450	0.002110	0.002120	0.002350	0.002415	0.002539	0.002313
27	0.004587	0.003916	0.003440	0.002140	0.002180	0.002380	0.002350	0.002465	0.002257
28	0.004693	0.003967	0.003440	0.002210	0.002260	0.002430	0.002282	0.002378	0.002179
29	0.004820	0.004040	0.003460	0.002300	0.002380	0.002500	0.002277	0.002332	0.002153
30	0.004981	0.004164	0.003520	0.002410	0.002480	0.002570	0.002316	0.002313	0.002158
31	0.005188	0.004370	0.003660	0.002530	0.002600	0.002660	0.002398	0.002322	0.002189
32	0.005456	0.004700	0.003840	0.002670	0.002720	0.002770	0.002522	0.002358	0.002243

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
33	0.005778	0.005135	0.004100	0.002820	0.002850	0.002890	0.002685	0.002419	0.002315
34	0.006131	0.005613	0.004410	0.002990	0.002980	0.003050	0.002889	0.002507	0.002401
35	0.006495	0.006071	0.004720	0.003180	0.003110	0.003250	0.003133	0.002624	0.002504
36	0.006849	0.006444	0.005010	0.003390	0.003260	0.003450	0.003422	0.002777	0.002628
37	0.007173	0.006688	0.005260	0.003630	0.003440	0.003690	0.003758	0.002972	0.002776
38	0.007481	0.006845	0.005470	0.003900	0.003660	0.003970	0.004144	0.003213	0.002951
39	0.007802	0.006980	0.005700	0.004200	0.003930	0.004280	0.004584	0.003505	0.003156
40	0.008166	0.007159	0.006000	0.004560	0.004270	0.004620	0.005067	0.003848	0.003395
41	0.008601	0.007448	0.006430	0.004960	0.004660	0.005000	0.005584	0.004241	0.003669
42	0.009141	0.007871	0.007010	0.005420	0.005120	0.005410	0.006124	0.004684	0.003981
43	0.009768	0.008387	0.007710	0.005940	0.005640	0.005860	0.006678	0.005176	0.004334
44	0.010434	0.008959	0.008490	0.006530	0.006230	0.006350	0.007244	0.005718	0.004730
45	0.011090	0.009552	0.009300	0.007190	0.006880	0.006900	0.007834	0.006315	0.005176
46	0.011688	0.010130	0.010090	0.007910	0.007590	0.007510	0.008470	0.006977	0.005679
47	0.012172	0.010652	0.010820	0.008720	0.008360	0.008180	0.009175	0.007710	0.006247
48	0.012573	0.011144	0.011540	0.009590	0.009160	0.008920	0.009966	0.008524	0.006887
49	0.012973	0.011662	0.012270	0.010530	0.010010	0.009740	0.010869	0.009423	0.007606
50	0.013454	0.012266	0.013080	0.011520	0.010920	0.010640	0.011868	0.010403	0.008411
51	0.014100	0.013016	0.013990	0.012560	0.011900	0.011650	0.012959	0.011458	0.009310
52	0.014914	0.013929	0.015020	0.013640	0.012980	0.012770	0.014130	0.012581	0.010309
53	0.015841	0.014967	0.016160	0.014780	0.014170	0.014030	0.015368	0.013766	0.011414
54	0.016887	0.016114	0.017370	0.015990	0.015480	0.015460	0.016682	0.015011	0.012632
55	0.018055	0.017351	0.018640	0.017280	0.016920	0.017070	0.018062	0.016340	0.013965
56	0.019350	0.018660	0.019960	0.018670	0.018490	0.018880	0.019604	0.017784	0.015417
57	0.020797	0.020034	0.021270	0.020170	0.020170	0.020840	0.021277	0.019372	0.016990
58	0.022401	0.021490	0.022590	0.021790	0.021970	0.022900	0.023126	0.021132	0.018684
59	0.024134	0.023044	0.023990	0.023530	0.023890	0.025010	0.025191	0.023083	0.020505
60	0.025965	0.024710	0.025560	0.025410	0.025890	0.027110	0.027445	0.025193	0.022459
61	0.027860	0.026507	0.027390	0.027420	0.027950	0.029170	0.029878	0.027418	0.024554
62	0.029703	0.028386	0.029520	0.029570	0.030050	0.031260	0.032474	0.029714	0.026798
63	0.031515	0.030341	0.031890	0.031860	0.032160	0.033480	0.035206	0.032037	0.029198
64	0.033478	0.032457	0.034490	0.034260	0.034260	0.035930	0.038098	0.034367	0.031762
65	0.035788	0.034824	0.037290	0.036770	0.036430	0.038690	0.041162	0.036782	0.034489
66	0.038653	0.037537	0.040280	0.039380	0.038720	0.041840	0.044460	0.039385	0.037376
67	0.042276	0.040566	0.043340	0.042090	0.041230	0.045330	0.048044	0.042279	0.040422
68	0.046578	0.043868	0.046510	0.044990	0.044020	0.049100	0.051953	0.045566	0.043625
69	0.051343	0.047542	0.049950	0.048170	0.047150	0.053060	0.056256	0.049314	0.046999

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
70	0.056328	0.051694	0.053870	0.051740	0.050630	0.057160	0.060860	0.053459	0.050625
71	0.061254	0.056446	0.058450	0.055810	0.054450	0.061330	0.065699	0.057899	0.054603
72	0.065934	0.062061	0.063970	0.060440	0.058600	0.065610	0.070696	0.062537	0.059031
73	0.070542	0.068558	0.070400	0.065590	0.063060	0.070030	0.075756	0.067272	0.064006
74	0.075336	0.075677	0.077470	0.071200	0.067850	0.074640	0.080899	0.072057	0.069565
75	0.080607	0.083100	0.084880	0.077190	0.073120	0.079480	0.086210	0.077052	0.075486
76	0.086680	0.090491	0.092260	0.083480	0.079040	0.084610	0.091892	0.082469	0.081489
77	0.093779	0.097454	0.099190	0.090070	0.085760	0.090190	0.098126	0.088521	0.087289
78	0.101793	0.104203	0.105870	0.097200	0.093470	0.096390	0.105072	0.095418	0.092603
79	0.110565	0.111236	0.112990	0.105170	0.102250	0.103390	0.112924	0.103327	0.097338
80	0.119900	0.119125	0.120950	0.114300	0.111900	0.111340	0.121460	0.112217	0.102145
81	0.129567	0.128527	0.130840	0.124870	0.122120	0.120400	0.130498	0.122091	0.107868
82	0.139641	0.140290	0.143170	0.137050	0.132650	0.130520	0.139828	0.132952	0.115351
83	0.150336	0.154302	0.157740	0.150390	0.143190	0.141650	0.148692	0.144802	0.127648
84	0.161586	0.169733	0.174230	0.164280	0.153610	0.153710	0.158150	0.157643	0.140499
85	0.173309	0.185526	0.192200	0.178110	0.164360	0.166640	0.167798	0.171478	0.155581
86	0.185404	0.200358	0.211070	0.191300	0.176030	0.180390	0.177725	0.186309	0.172552
87	0.197188	0.214000	0.231070	0.207280	0.189240	0.194950	0.188085	0.202140	0.190823
88	0.208664	0.227147	0.252820	0.224290	0.204570	0.210340	0.199081	0.218972	0.209632
89	0.220872	0.239675	0.276130	0.242340	0.222510	0.226580	0.210933	0.236809	0.228143

APPENDIX B
South African Life Tables for White Females $q(x)$

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
0	0.073884	0.062761	0.053480	0.032910	0.030050	0.024930	0.018855	0.012352	0.007434
1	0.020757	0.018381	0.014020	0.004830	0.003970	0.002640	0.001779	0.001631	0.001311
2	0.009150	0.007700	0.005550	0.002810	0.001640	0.001190	0.000761	0.000867	0.000686
3	0.005347	0.004139	0.003520	0.002250	0.001280	0.000960	0.000679	0.000629	0.000579
4	0.004251	0.003435	0.002920	0.001340	0.001180	0.000870	0.000690	0.000447	0.000442
5	0.003035	0.002368	0.002190	0.001250	0.001130	0.000700	0.000514	0.000443	0.000372
6	0.002262	0.002026	0.002010	0.001140	0.000990	0.000590	0.000462	0.000411	0.000283
7	0.001823	0.001776	0.001850	0.001030	0.000860	0.000510	0.000410	0.000307	0.000273
8	0.001623	0.001609	0.001690	0.000920	0.000720	0.000470	0.000334	0.000271	0.000236
9	0.001583	0.001514	0.001570	0.000830	0.000640	0.000440	0.000241	0.000266	0.000199
10	0.001640	0.001481	0.001470	0.000760	0.000600	0.000410	0.000195	0.000254	0.000188
11	0.001743	0.001501	0.001400	0.000730	0.000580	0.000390	0.000197	0.000262	0.000200
12	0.001860	0.001564	0.001360	0.000750	0.000580	0.000380	0.000236	0.000292	0.000230
13	0.001973	0.001660	0.001350	0.000820	0.000590	0.000380	0.000302	0.000338	0.000273
14	0.002077	0.001778	0.001370	0.000910	0.000640	0.000400	0.000385	0.000396	0.000326
15	0.002186	0.001911	0.001430	0.001000	0.000710	0.000430	0.000475	0.000460	0.000383
16	0.002326	0.002046	0.001540	0.001080	0.000780	0.000470	0.000562	0.000525	0.000440
17	0.002540	0.002176	0.001690	0.001130	0.000850	0.000530	0.000641	0.000589	0.000495
18	0.002801	0.002314	0.001890	0.001160	0.000940	0.000600	0.000705	0.000646	0.000544
19	0.003078	0.002456	0.002110	0.001200	0.000970	0.000670	0.000753	0.000696	0.000586
20	0.003341	0.002599	0.002330	0.001250	0.001010	0.000730	0.000787	0.000737	0.000621
21	0.003561	0.002737	0.002500	0.001330	0.001050	0.000790	0.000809	0.000769	0.000649
22	0.003722	0.002868	0.002630	0.001430	0.001090	0.000840	0.000826	0.000793	0.000672
23	0.003842	0.002996	0.002720	0.001540	0.001130	0.000890	0.000843	0.000811	0.000692
24	0.003946	0.003123	0.002800	0.001660	0.001170	0.000930	0.000866	0.000825	0.000711
25	0.004058	0.003253	0.002870	0.001770	0.001210	0.000970	0.000897	0.000838	0.000730
26	0.004200	0.003388	0.002950	0.001860	0.001260	0.001010	0.000937	0.000851	0.000751
27	0.004391	0.003531	0.003010	0.001920	0.001320	0.001040	0.000983	0.000866	0.000774
28	0.004616	0.003679	0.003050	0.001960	0.001390	0.001070	0.001039	0.000885	0.000800
29	0.004847	0.003829	0.003100	0.001990	0.001470	0.001110	0.001095	0.000909	0.000828
30	0.005058	0.003981	0.003170	0.002040	0.001560	0.001170	0.001153	0.000941	0.000859
31	0.005221	0.004133	0.003280	0.002110	0.001670	0.001230	0.001215	0.000982	0.000896
32	0.005315	0.004286	0.003460	0.002210	0.001790	0.001320	0.001280	0.001033	0.000939

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
33	0.005358	0.004441	0.003680	0.002340	0.001910	0.001420	0.001349	0.001095	0.000992
34	0.005382	0.004596	0.003930	0.002500	0.002040	0.001530	0.001427	0.001172	0.001054
35	0.005420	0.004748	0.004180	0.002680	0.002180	0.001660	0.001520	0.001265	0.001128
36	0.005506	0.004897	0.004400	0.002860	0.002320	0.001810	0.001640	0.001376	0.001215
37	0.005641	0.005034	0.004560	0.003060	0.002470	0.001980	0.001797	0.001508	0.001316
38	0.005803	0.005161	0.004690	0.003260	0.002620	0.002170	0.002002	0.001664	0.001433
39	0.005990	0.005289	0.004820	0.003480	0.002890	0.002370	0.002263	0.001846	0.001567
40	0.006201	0.005427	0.004980	0.003730	0.002970	0.002590	0.002564	0.002053	0.001723
41	0.006431	0.005585	0.005210	0.004000	0.003170	0.002830	0.002889	0.002284	0.001904
42	0.006682	0.005744	0.005520	0.004320	0.003420	0.003090	0.003219	0.002538	0.002116
43	0.006955	0.005895	0.005880	0.004670	0.003720	0.003370	0.003537	0.002814	0.002363
44	0.007251	0.006071	0.006280	0.005060	0.004070	0.003690	0.003834	0.003110	0.002647
45	0.007571	0.006301	0.006710	0.005480	0.004480	0.004030	0.004126	0.003428	0.002962
46	0.007914	0.006617	0.007170	0.005930	0.004920	0.004410	0.004439	0.003766	0.003303
47	0.008261	0.007019	0.007640	0.006420	0.005400	0.004820	0.004800	0.004127	0.003660
48	0.008611	0.007489	0.008140	0.006940	0.005900	0.005250	0.005232	0.004510	0.004027
49	0.008995	0.008026	0.008680	0.007480	0.006410	0.005690	0.005757	0.004916	0.004399
50	0.009449	0.008630	0.009240	0.008050	0.006930	0.006130	0.006351	0.005347	0.004783
51	0.010005	0.009303	0.009840	0.008640	0.007460	0.006580	0.006989	0.005809	0.005189
52	0.010670	0.010065	0.010450	0.009260	0.008010	0.007040	0.007643	0.006303	0.005626
53	0.011423	0.010920	0.011070	0.009900	0.008580	0.007550	0.008284	0.006834	0.006105
54	0.012260	0.011837	0.011730	0.010570	0.009170	0.008120	0.008900	0.007406	0.006637
55	0.013174	0.012787	0.012490	0.011270	0.009800	0.008780	0.009510	0.008037	0.007232
56	0.014160	0.013738	0.013370	0.012010	0.010500	0.009550	0.010152	0.008746	0.007904
57	0.015165	0.014584	0.014360	0.012790	0.011290	0.010440	0.010861	0.009551	0.008666
58	0.016195	0.015344	0.015420	0.013640	0.012190	0.011440	0.011669	0.010471	0.009531
59	0.017333	0.016177	0.016610	0.014590	0.013220	0.012560	0.012616	0.011520	0.010505
60	0.018664	0.017250	0.017980	0.015680	0.014380	0.013790	0.013704	0.012685	0.011578
61	0.020281	0.018735	0.019580	0.016920	0.015670	0.015160	0.014940	0.013952	0.012732
62	0.022232	0.020757	0.021470	0.018360	0.017080	0.016650	0.016333	0.015301	0.013951
63	0.024476	0.023229	0.023630	0.019980	0.018620	0.018260	0.017881	0.016717	0.015218
64	0.026966	0.026003	0.026000	0.021770	0.020280	0.020000	0.019608	0.018192	0.016522
65	0.029653	0.028921	0.028520	0.023720	0.022120	0.021880	0.021513	0.019754	0.017880
66	0.032485	0.031808	0.031130	0.025820	0.024150	0.023890	0.023616	0.021440	0.019313
67	0.035458	0.034480	0.033730	0.028080	0.026440	0.026070	0.025932	0.023287	0.020843
68	0.038623	0.037048	0.036370	0.030570	0.029020	0.028440	0.028469	0.025332	0.022493
69	0.042006	0.039782	0.039200	0.033390	0.031920	0.031030	0.031269	0.027603	0.024296

Age	1920–1922	1925–1927	1935–1937	1945–1947	1950–1952	1959–1961	1969–1971	1979–1981	1984–1986
70	0.045639	0.042973	0.042410	0.036630	0.035180	0.033880	0.034328	0.030083	0.026323
71	0.049554	0.046941	0.046180	0.040390	0.038790	0.037030	0.037679	0.032745	0.028659
72	0.053516	0.052020	0.050600	0.044740	0.042780	0.040540	0.041345	0.035563	0.031388
73	0.057512	0.058108	0.055570	0.049560	0.047150	0.044520	0.045336	0.038509	0.034590
74	0.061936	0.064864	0.061120	0.054730	0.051920	0.049040	0.049721	0.041607	0.038317
75	0.067230	0.071889	0.067250	0.060110	0.057140	0.054190	0.054515	0.045070	0.042479
76	0.073899	0.078710	0.073950	0.065560	0.062850	0.060040	0.059791	0.049164	0.046954
77	0.082968	0.084798	0.081370	0.071030	0.069100	0.066540	0.065609	0.054154	0.051618
78	0.094460	0.090404	0.089610	0.076770	0.075920	0.073640	0.072008	0.060303	0.056348
79	0.107274	0.096236	0.098600	0.083080	0.083360	0.081270	0.079091	0.067772	0.061122
80	0.119987	0.103093	0.108290	0.090280	0.091420	0.089380	0.086765	0.076305	0.066309
81	0.130816	0.111894	0.118570	0.098710	0.100080	0.097940	0.094991	0.085921	0.072383
82	0.138029	0.123765	0.129550	0.108570	0.109330	0.106980	0.103724	0.096640	0.079814
83	0.142420	0.138554	0.141390	0.119690	0.119170	0.116590	0.112571	0.108479	0.090151
84	0.145961	0.155205	0.154080	0.131770	0.129600	0.126840	0.122252	0.121460	0.101378
85	0.150788	0.172325	0.167580	0.144530	0.140690	0.137810	0.132580	0.135600	0.114367
86	0.159223	0.188116	0.181850	0.157700	0.152530	0.149550	0.143678	0.150920	0.129009
87	0.173835	0.201892	0.197000	0.172400	0.165200	0.162140	0.155707	0.167438	0.145073
88	0.193920	0.214544	0.213160	0.188230	0.178800	0.175610	0.168848	0.185174	0.162243
89	0.216674	0.226419	0.230310	0.205290	0.193400	0.190010	0.183293	0.204146	0.180166

APPENDIX C
Fitted values of $a(x)$ and $b(x)$ for 1921–1985

Age	$a(x)$ male	$b(x)$ male	$a(x)$ female	$b(x)$ female
0	–3.313330	0.032923	–3.557514	0.019523
1	–5.254911	0.048935	–5.365562	0.028311
2	–5.952547	0.040515	–6.141921	0.026680
3	–6.262072	0.036563	–6.465115	0.022728
4	–6.511167	0.030313	–6.675890	0.022343
5	–6.651362	0.030549	–6.876618	0.020346
6	–6.781020	0.030803	–7.030478	0.020086
7	–6.907900	0.031397	–7.171393	0.020005
8	–7.075720	0.034489	–7.299502	0.020501
9	–7.276038	0.040849	–7.406559	0.021661
10	–7.411044	0.044959	–7.472180	0.022575
11	–7.362789	0.041217	–7.471551	0.022450
12	–7.204017	0.033843	–7.415038	0.021472
13	–7.014943	0.026802	–7.328003	0.020164
14	–6.817240	0.020948	–7.222523	0.018769
15	–6.621371	0.016345	–7.116249	0.017591
16	–6.441872	0.012997	–7.015516	0.016765
17	–6.280785	0.010855	–6.920424	0.016264
18	–6.139748	0.010012	–6.830878	0.016094
19	–6.027024	0.009860	–6.758064	0.016186
20	–5.945654	0.010044	–6.695439	0.016409
21	–5.897092	0.010201	–6.642032	0.016612
22	–5.874755	0.010201	–6.597659	0.016780
23	–5.872732	0.010150	–6.558800	0.016882
24	–5.880367	0.010180	–6.522964	0.016976
25	–5.890704	0.010409	–6.488441	0.017039
26	–5.895848	0.010940	–6.452838	0.017103
27	–5.895011	0.011629	–6.418410	0.017167
28	–5.892367	0.012437	–6.383425	0.017180
29	–5.877115	0.012915	–6.347018	0.017156
30	–5.854026	0.013356	–6.306581	0.017062
31	–5.819363	0.013853	–6.263042	0.016909
32	–5.774770	0.014438	–6.213687	0.016671

Age	$a(x)$ male	$b(x)$ male	$a(x)$ female	$b(x)$ female
33	–5.721920	0.015118	–6.161734	0.016354
34	–5.663658	0.015691	–6.106666	0.015974
35	–5.603449	0.015983	–6.048159	0.015499
36	–5.543733	0.015916	–5.987419	0.014923
37	–5.483866	0.015400	–5.923896	0.014230
38	–5.422838	0.014542	–5.858577	0.013429
39	–5.358445	0.013540	–5.786195	0.012556
40	–5.288251	0.012578	–5.718931	0.011715
41	–5.212137	0.011820	–5.645498	0.010913
42	–5.129944	0.011327	–5.569356	0.010168
43	–5.044737	0.010986	–5.493042	0.009466
44	–4.958759	0.010670	–5.416009	0.008816
45	–4.873710	0.010257	–5.338799	0.008241
46	–4.790988	0.009650	–5.260971	0.007737
47	–4.711154	0.008784	–5.183101	0.007281
48	–4.633511	0.007749	–5.105997	0.006864
49	–4.555958	0.006656	–5.029578	0.006501
50	–4.477354	0.005647	–4.954164	0.006203
51	–4.396595	0.004811	–4.879404	0.005980
52	–4.314076	0.004151	–4.805415	0.005826
53	–4.230917	0.003593	–4.732230	0.005710
54	–4.147604	0.003094	–4.659696	0.005614
55	–4.064511	0.002634	–4.586609	0.005515
56	–3.981243	0.002168	–4.512068	0.005383
57	–3.898856	0.001704	–4.436986	0.005155
58	–3.817216	0.001248	–4.361072	0.004835
59	–3.736291	0.000807	–4.281911	0.004504
60	–3.656594	0.000420	–4.198714	0.004248
61	–3.578383	0.000106	–4.110892	0.004127
62	–3.502201	–0.000180	–4.018871	0.004171
63	–3.428168	–0.000448	–3.925343	0.004319
64	–3.355161	–0.000645	–3.832529	0.004504
65	–3.281736	–0.000742	–3.741435	0.004666
66	–3.206629	–0.000721	–3.652906	0.004762
67	–3.129836	–0.000606	–3.566980	0.004760
68	–3.051722	–0.000449	–3.482226	0.004695
69	–2.972348	–0.000280	–3.396680	0.004609

Age	$a(x)$ male	$b(x)$ male	$a(x)$ female	$b(x)$ female
70	–2.892141	–0.000099	–3.308913	0.004543
71	–2.811588	0.000092	–3.217933	0.004526
72	–2.730447	0.000319	–3.123924	0.004545
73	–2.649253	0.000592	–3.028542	0.004560
74	–2.568888	0.000873	–2.932344	0.004565
75	–2.489859	0.001141	–2.835740	0.004561
76	–2.412309	0.001373	–2.738944	0.004545
77	–2.336391	0.001536	–2.641425	0.004555
78	–2.260954	0.001655	–2.543098	0.004589
79	–2.184279	0.001781	–2.444760	0.004606
80	–2.105427	0.001917	–2.347224	0.004578
81	–2.022847	0.002083	–2.250502	0.004460
82	–1.935791	0.002297	–2.154397	0.004229
83	–1.844004	0.002374	–2.057525	0.003858
84	–1.753378	0.002508	–1.962312	0.003480
85	–1.664216	0.002537	–1.867709	0.003098
86	–1.578021	0.002419	–1.773470	0.002756
87	–1.492782	0.002178	–1.677445	0.002531
88	–1.408846	0.001892	–1.580593	0.002405
89	–1.325803	0.001626	–1.485034	0.002294

APPENDIX D
Fitted values of $q(x)$ for males and females in 2020

x	$q(x)$ male	$q(x)$ female
0	0.003778	0.002485
1	0.000340	0.000267
2	0.000258	0.000153
3	0.000263	0.000161
4	0.000275	0.000126
5	0.000189	0.000118
6	0.000166	0.000091
7	0.000137	0.000089
8	0.000102	0.000074
9	0.000061	0.000059
10	0.000047	0.000053
11	0.000063	0.000057
12	0.000114	0.000069
13	0.000207	0.000088
14	0.000346	0.000113
15	0.000531	0.000142
16	0.000748	0.000171
17	0.000976	0.000198
18	0.001179	0.000220
19	0.001351	0.000236
20	0.001488	0.000247
21	0.001596	0.000255
22	0.001677	0.000262
23	0.001723	0.000268
24	0.001732	0.000274
25	0.001702	0.000280
26	0.001640	0.000287
27	0.001566	0.000295
28	0.001474	0.000304
29	0.001435	0.000315
30	0.001419	0.000329
31	0.001417	0.000346
32	0.001425	0.000368

x	$q(x)$ male	$q(x)$ female
33	0.001440	0.000395
34	0.001467	0.000429
35	0.001516	0.000472
36	0.001594	0.000525
37	0.001712	0.000591
38	0.001869	0.000673
39	0.002063	0.000774
40	0.002287	0.000892
41	0.002532	0.001031
42	0.002790	0.001195
43	0.003070	0.001388
44	0.003384	0.001613
45	0.003752	0.001864
46	0.004196	0.002139
47	0.004743	0.002431
48	0.005402	0.002739
49	0.006174	0.003054
50	0.007048	0.003376
51	0.008008	0.003709
52	0.009054	0.004057
53	0.010201	0.004432
54	0.011468	0.004844
55	0.012862	0.005308
56	0.014408	0.005845
57	0.016111	0.006492
58	0.017972	0.007269
59	0.019996	0.008163
60	0.022168	0.009128
61	0.024473	0.010107
62	0.026948	0.011049
63	0.029606	0.011955
64	0.032402	0.012848
65	0.035288	0.013781

x	$q(x)$ male	$q(x)$ female
66	0.038217	0.014808
67	0.041183	0.015986
68	0.044231	0.017318
69	0.047405	0.018800
70	0.050778	0.020447
71	0.054451	0.022289
72	0.058460	0.024393
73	0.062863	0.026869
74	0.067746	0.029769
75	0.072926	0.033026
76	0.078184	0.036556
77	0.083350	0.040189
78	0.088120	0.043812
79	0.092291	0.047506
80	0.096470	0.051649
81	0.101391	0.056788
82	0.107766	0.063466
83	0.119037	0.073223
84	0.130577	0.084134
85	0.144563	0.096996
86	0.160996	0.111559
87	0.179406	0.127100
88	0.198821	0.143264
89	0.218115	0.160209

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The impact of giving and receiving remittances on life insurance purchases

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ABSTRACT
Remittance arrangements, or inter-household transfers in cash or kind, have been identified as an influential factor in funeral insurance purchase decisions of South African households. On the one hand, remittances can alter income and higher levels of income are associated with more insurance purchases. On the other hand, remittances can act as an informal insurance arrangement reducing formal insurance purchases. It was found using data from the fifth wave of the National Income Dynamics Study that remittances did not have a strong effect on life insurance purchases generally although for young, low-income, unbanked African and other households, receiving remittances may have discouraged life insurance purchases.

KEYWORDS
Remittances given; remittances received; life insurance purchase behaviour

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1. INTRODUCTION

1.1 The insurance and remittance landscape in South Africa

1.1.1 Insurance mitigates the financial consequences of risks that could lead to financial ruin (Kirby & Kaneda, 2010). Life insurance is particularly important as it provides people with protection against personal risks in their lives (Mahdzan & Victorian, 2013). A pertinent South African example of this is that a household may not have enough money to meet high funeral costs, which are 15 times the monthly income for an average household (Roth, 2001). In 2017, more than 40% of South Africans did not have a formal life insurance policy.[1]

1.1.2 Another common aspect of South African financial life is that of remittances (Mangoma & Wilson-Prangley, 2019). Remittance behaviour in South Africa emanated from colonialism and apartheid and involves mainly domestic transfers (Posel, unpublished). This study, as well as others focused on insurance demand, define remittances as inter-household transfers in cash or kind (Van Doorn, 2002). However, remittances can be more broadly defined to include inter-household transfers of social (Zhou & Li, 2018; Kshetri et al., 2015), cultural (Zhou & Li, 2018), technological (Kshetri et al., 2015) and political (Zhou & Li, 2018; Kshetri et al., 2015) knowledge.

1.1.3 The literature suggests that remittances can affect insurance purchase behaviours in complex ways. Remittances received increase income in the receiving household and decrease income in the donating household (Crayen et al., 2013), which may increase and decrease the demand for formal insurance respectively. In addition, remittances can be viewed as a migrant-based risk-reducing strategy by households (Lucas & Stark, 1985) which may thus affect decisions about other risk mitigation techniques like purchasing formal insurance (Lucas & Stark, 1988).

1.2 Aims

1.2.1 The aim of this research is to establish how the giving and receiving of remittances impact life insurance purchase behaviour in South Africa.

1.2.2 In order to explore the impact of remittances on insurance purchase behaviour, this paper aims to address the following research questions:

— What factors, apart from remittances, affect insurance purchase behaviour?
— How could remittances influence life insurance purchase behaviour?
— Based on the National Income Dynamic Study (NIDS) data, how does giving and receiving remittances affect life insurance purchase behaviour?

1.3 Plan of development

Section 2 sets out the literature on the influence of remittances and other factors on insurance purchases. Section 3 sets out the methodology and data. Section 4 sets out the results and discussion and section 5 concludes.

1 Life Insurance Facts. Available: http://www.hippo.co.za/blog/insurance/Life-Insurance-Facts/, 05/08/2021

2. LITERATURE REVIEW

2.1 Factors that influence the demand and purchase of life insurance

The literature identifies the following key factors, other than remittances, that influence the demand and purchase of life insurance:

— stage of life, age and family structure;
— income level;
— formal insurance deterrents and use of alternatives to formal insurance and lending;
— sex and precautionary motives;
— level of education; and
— race and religion.

These factors are expanded upon below. It should be noted that the definition of life insurance can differ over time and geography and the precise definitions used in the literature were not always clear. This may have led to significant factors not being identified.

2.1.1 Stage of life, age and family structure

2.1.1.1 Modigliani (1986) described the life-cycle hypothesis as the spending and consumption habits of people over the course of their lifetime. Assuming that people plan their spending by considering their future income, individuals will level out their consumption and save for future events and expenses that could occur at different stages of their life (Modigliani, 1986).

2.1.1.2 Age is often a proxy for stages of the life-cycle in literature, but Neurgarten (1979) and Settersten & Mayer (1997) argued that timing of life events is becoming more irregular and age is losing its traditional association with life-stage at an individual level.

2.1.1.3 Life insurance has been seen as a priority purchase for young, married couples (Anderson & Nevin, 1975). Previous studies have shown that a larger number of dependants corresponds to an increase in future consumption, thereby increasing the demand for life insurance (Browne & Kim, 1993; Li et al., 2007). More recent findings show that single individuals had the greatest demand for life insurance as opposed to married or divorced individuals because of fewer financial commitments and hence greater disposable income (Mahdzan & Victorian, 2013).

2.1.1.4 Showers & Shotick (1994) indicated that single income-earner households felt less financially secure than households with more than one income-earner. Hence, it was more likely that single income-earner households purchase insurance than households with more than one income-earner (Showers & Shotick, 1994).

2.1.2 Income level

Higher incomes can increase the demand for life insurance (Hwang & Gao, 2003). This is primarily because individuals with higher incomes can afford insurance and feel the need to safeguard their potential income for dependants in the case of premature death (Dragos, 2014). Kirigia et al. (2005) confirmed that it is more likely that individuals employed in white-collar occupations with a regular higher income own insurance.

2.1.3 Formal insurance deterrents and use of alternatives to formal insurance and lending

2.1.3.1 Low-income households often have poor access to formal insurance (Ardington et al., unpublished). This can be due to lack of supply of appropriate formal insurance products (Ardington et al., unpublished), access barriers or usage barriers (Hougaard et al., unpublished).

2.1.3.2 According to Crayen et al. (2013), South African insurers have shifted focus from high-income to low-income households which should ease the supply side constraints.

2.1.3.3 Access barriers are defined as external factors that prevent individuals from using insurance, even if they had a desire to use it (Hougaard et al., unpublished). The FinScope Tanzanian survey respondents identified the main barriers as physical access, affordability and availability (Hougaard et al., unpublished). In addition, lack of access to a bank account can decrease demand for formal insurance products, particularly funeral cover (Crayen et al., 2013). Where lack of access is due to physical access, Hwang & Gao (2003) have found that urbanisation has positively influenced life insurance purchases. Urbanisation leads to lower distribution costs for insurers (Beck & Webb, 2003). This consequently decreases the cost of insurance and thus increases the supply and demand of insurance products (Beck & Webb, 2003).

2.1.3.4 Usage barriers, or internal barriers that discourage individuals from using insurance, include lack of knowledge about insurance, poor perceptions about insurance and negative word of mouth (Hougaard et al., unpublished).

2.1.3.5 Consequently, poorer households manage risk through informal family and community mechanisms including loans and remittances (Ardington et al., unpublished; Thomson & Posel, 2002) as well as informal insurance like burial societies and self-insurance (Ardington et al., unpublished).

2.1.3.6 Thomson & Posel (2002) found that many households prefer informal schemes over formal insurance due to the additional non-financial support. In the case of burial societies, this can be emotional support as well as assistance with funeral arrangements (Thomson & Posel, 2002). In comparison, formal insurance only provides financial aid (Thomson & Posel, 2002).

2.1.3.7 Formal loans are often sold with credit life assurance (Shand & Angove, unpublished). The use of informal personal loans would logically be associated with lower take-up of credit life assurance.

2.1.3.8 Hence the availability of informal financial services may discourage the use of formal products. There is debate over whether social security may also act as a substitute good. Beck & Webb (2003) explained that life insurance ownership was higher in countries that spent more on social security benefits and have a greater degree of income equality. In contrast, Li et al. (2007) and Browne & Kim (1993) highlighted that increased social security spending served as mandatory life insurance and thus reduced the need for private life insurance.

2.1.4 Sex And precautionary motives

Based on an Italian population, women are less likely to own annuities, endowment products and term assurances than men (Luciano et al., 2016). Luciano et al. (2016) suggested this may be due to household earning patterns. This contradicts Jianakoplos & Bernasek (unpublished) who found that women are more concerned about the impact of risks than men. Mahdzan & Victorian (2013) affirmed that precautionary motives impact life insurance demand as people want to be protected against personal risks such as disability and ill health. However, Inkmann & Michaelides (2012) argued that precautionary saving may often crowd out life insurance purchases.

2.1.5 Level of education

Hwang & Gao (2003) and Mahdzan & Victorian (2013) identified that education level was positively associated with life insurance ownership as education promoted a greater understanding of the need for life insurance. Mahdzan & Victorian (2013) further suggested that more educated individuals may have better access to financial services than those with lower levels of education, while Ćurak (2013) suggested that education level and risk aversion are positively correlated.

2.1.6 Race and religion

Gutter & Hatcher (2008) suggested that there is no difference in the number of black and white people who own life insurance, however, there may be a significant difference in the monetary value of life insurance purchased by the different racial groups. Of course, race may be acting as a proxy for a number of other factors that may influence insurance purchase behaviour such as occupation (Hiltz, 1971), family structure (Hiltz, 1971), values (Hiltz, 1971; Beck & Webb, 2003) and religion (Beck & Webb, 2003). For example, it was also found that life insurance ownership was lower in Islamic countries compared to non-Islamic countries due to religious opposition towards life insurance (Beck & Webb, 2003).

2.2 The impact of remittances on formal insurance demand

2.2.1 Remittances as informal insurance

As discussed in section 2.1.3, informal insurance arrangements can act as a substitute for formal insurance. Lu & Treiman (2011) and Crayen et al. (2013) suggested that the remittances received are used to enable the family to cope with risk, including risk from natural disasters (Mohapatra & Ratha, 2011). Stark & Levhari (1982), Rosenzweig (1988), Maphosa (2007) and Carling (2008) explained that remittances protect the remitter and the receiving household against external shocks due to potential reciprocity and hence also act as informal insurance. Lucas & Stark (1988) explained that the migration of a family member acts as a replacement for formal insurance by diversifying income generation. It thus follows that remittances would reduce demand for formal insurance via the substitution effect.

2.2.2 REMITTANCES AND HOUSEHOLD INCOME AND CONSUMPTION

2.2.2.1 Remittances received increase the household income of the recipient (World Bank, unpublished a). The higher the remitter's income, excluding remittances received, the higher the remittances sent (Miller & Paulson, unpublished; Biyase & Tregenna, unpublished). Miller & Paulson (unpublished) suggested that older, urban remitters tend to send larger remittances, which obviously reduces their household income.

2.2.2.2 Cash remittances give households flexibility as to how the remittance is used (Torero & Viceisza, 2015) but can result in the remittance being used for a different purpose than what was intended (World Bank, unpublished b). Uses of remittances change with time as priorities of households alter with financial ability and capacity (Zewdu, 2019). Poorer households often use remittances to cover basic expenses such as healthcare (International Fund for Agricultural Development & World Bank, unpublished) and food (Babatunde & Martinetti, unpublished; Thow et al., 2016; International Fund for Agricultural Development & World Bank, unpublished). In less vulnerable households, remittances can be used as an investment resource to invest in education, capital and financial assets (International Fund for Agricultural Development & World Bank, unpublished). Hence one would only expect a remittance received to be used to purchase insurance in a wealthier household and this can be termed the income effect.

2.2.3 EMPIRICAL EVIDENCE

2.2.3.1 Crayen et al. (2013) found a negative correlation between formal funeral insurance and remittances received. This substitution effect is more pronounced in rural households which have access barriers to formal insurance products (World Bank, unpublished a), as explored in ¶2.1.3.3.

2.2.3.2 Hwang & Gao (2003) found that in Chinese culture, adult children are expected to provide economic support to their parents in old age, through remittances. However, as a result of China's one-child policy, the number of children per couple decreased and couples could no longer solely rely on family remittance support (Hwang & Gao, 2003). This increases the need for financial protection through insurance purchases (Hwang & Gao, 2003). This again illustrates the substitution effect.

2.2.3.3 Kirigia et al. (2005) found that the proportion of people who have insurance, particularly health insurance, increases significantly when their household income increases. Impact Insurance noted that larger amounts of remittance received was linked to purchasing microinsurance because remittances acted as additional resources to cover premium costs,[2] providing further evidence for the income effect. One reason why the income effect may not be strong is that research suggests that sending money home for the purpose of insurance was one of the least popular reasons why remitters sent money home (Smit et al., unpublished).

2 Enhancing access to microinsurance among remittance recipients—Seguros Futuro. Available: http://www.impactinsurance.org/projects/lessons/enhancing-access-microinsurance-among-remittance-recipients, 05/08/2021

3. METHODOLOGY

3.1 Data

3.1.1 NIDS data were used to test the effect of remittances on insurance purchases empirically. This is a study by the Southern Africa Labour and Development Research Unit at the School of Economics based at the University of Cape Town.[3] The data are publicly accessible on the DataFirst website.

3.1.2 The NIDS is a longitudinal survey that is conducted for individuals and households. There are five waves of data. The study began in 2008 and is repeated approximately every two years. Wave 5, the most recent wave at time of writing, which consists of data collected from February to December 2017, was used (Brophy et al., unpublished).

3.1.3 The NIDS data cover fields relevant to social, economic and demographic changes in the surveyed population.[4] The NIDS data consist of four questionnaires but only the individual questionnaire, filled out by every household member, aged 15 years and older, was used. For the purposes of this research, this is termed the adult questionnaire.

3.1.4 The adult questionnaires include variables relating to contributions of remittances given and received and life insurance ownership. Variables relating to the value of remittances given or received are often limited in literature (Carling, 2008), however the NIDS data records the frequency and amounts of remittances given or received.

3.2 Data variables

3.2.1 Table 1 displays the high-level summary of the variables included in the CHAID analysis as well as their justification in the literature.

TABLE 1. Summary of variables

Variable details	Description from questionnaire	Number of variables	Justification in literature
Dependent variable			
life_insurance	Does the respondent personally have life insurance?	1	Section 2.2
Independent variables			
Age	Age of the respondent based on date of birth	1	¶2.1.1.2
Dependant-type variables	Questions regarding number of biological children residing with the respondent or away	3	¶2.1.1.3
Income variables	Details of income received in the household	8	¶2.1.2
Access variables	Information about use of bank accounts and stokvels	2	¶2.1.3.3
Loan variables	Whether the respondent has formal or informal loans	5	¶2.1.3.7
Grant variables	Details of grant amounts received for the Child Support Grant and Old Age Grant	4	¶2.1.3.8

3 What is NIDS? Available: http://www.nids.uct.ac.za/about/what-is-nids, 05/08/2021

4 NIDS Wave 5 Overview (2008–2019). Available: http://www.nids.uct.ac.za/images/documents/201901-NIDS-W5Overview-V1.0.pdf, 05/08/2021

Variable details	Description from questionnaire	Number of variables	Justification in literature
Sex	Self-reported sex of the respondent	1	¶2.1.4
Education	Self-reported tertiary education	1	¶2.1.5
Race	Self-reported race of the respondent	1	¶2.1.6
Religion	Self-reported religion of the respondent	1	¶2.1.6
Remittance variables	Details of remittances received or given	10	Section 2.2

Table A.1 in Appendix A displays a summary of variables taken directly from the questionnaire and full variable definitions. The table provides the variable codes used, the description of the variables as per the questionnaire and their possible values.

3.2.2 It is important to note that only these variables were considered for analysis. This was because these variables were identified as having an influence on the demand for life insurance in the literature review. The results of the analysis may thus be influenced by factors that influence life insurance purchase behaviour that were not identified in the literature review. Identification of such other factors was beyond the scope of this research and the ethics clearance obtained.

3.3 Data limitations

3.3.1 Although the adult questionnaire provided useful data, it also had its limitations, which are outlined below.

3.3.2 'Life insurance' was not defined in the NIDS questionnaire. This means the definition may have been inconsistent between households, possibly differing by income or financial sophistication. It is unclear whether it includes or excludes funeral cover. No data were collected on the type of insurance owned. Approximately 11% of the South African population holds insurance other than funeral cover[5] and 9% of the total cleaned sample indicated that they have life insurance. It is possible that households interpreted the question to include funeral cover but no firm conclusions can be drawn. 'Personally have' is also a vague term that could be interpreted to mean being a policyholder or being an insured life.

3.3.3 The NIDS data recorded if insurance was purchased but the amount and percentage of household income spent on life insurance purchases is not available in the data. The NIDS data can thus be used to ascertain if giving and receiving remittances would change the likelihood of purchasing insurance, but it cannot be used to determine the effect of remittances on the amount of insurance purchased.

3.3.4 Certain variables could not be observed from the data:

— Household income split within the household, as discussed in ¶2.1.1.4 and ¶2.1.4;
— Physical access to insurance, as discussed in ¶2.1.3.3;

5 Own calculations based on: Statistics South Africa's midyear population estimate for 2020. Available: http://www.statssa.gov.za and insurance coverage information from https://mayaonmoney.co.za/2020/01/the-real-cost-of-death/#:~:text=Insurance%20companies%20have%20found%20a,insurance%20other%20than%20funeral%20cover.

— Usage barriers, as discussed in ¶2.1.3.4; and
— Precautionary motives, as discussed in ¶2.1.4.

3.3.5 Dependant-type variables were only gathered for female respondents. Furthermore, these dependants were limited to biological children residing with or away from the female; however, their ages were not provided in the questionnaire in order to determine if they were legally dependants. The effect of other dependants such as elderly parents and other family members could not be examined as these data were not available. It would have also been ideal to consider the effect of dependants on male respondents.

3.3.6 Annual figures were not available for each component of the income variables. However, since there were monthly figures for each component, income was analysed on a monthly basis. Annual income variables could have allowed for a greater amount of net remittances to be received and, thus, might have been a better indicator of the relationship between remittances and insurance purchase behaviour.

3.3.7 The data were thoroughly inspected and observations that were encoded 'Missing', 'Not Applicable', 'Refused' and 'Don't know' were excluded from the dataset. Impossible values, e.g. nonsensical birth years, were also excluded. Further data checks were done based on follow-up questions, e.g. 'Do you earn a regular income?' and if the respondent replied 'Yes', the observation was verified by checking that an amount was indeed provided. After cleaning, of the 30 110 respondents in the NIDS data, only 7 711 remained for whom the data were clean and dependant-type information were available. If dependant-type variables were ignored, there were 17 689 observations.

3.3.8 Of the 17 689 observations, illustrated in Figure 1, 94.9% stated that they neither gave nor received remittances. It is possible that the respondents might not know or necessarily consider differences between remittances, stokvels, and informal loans from

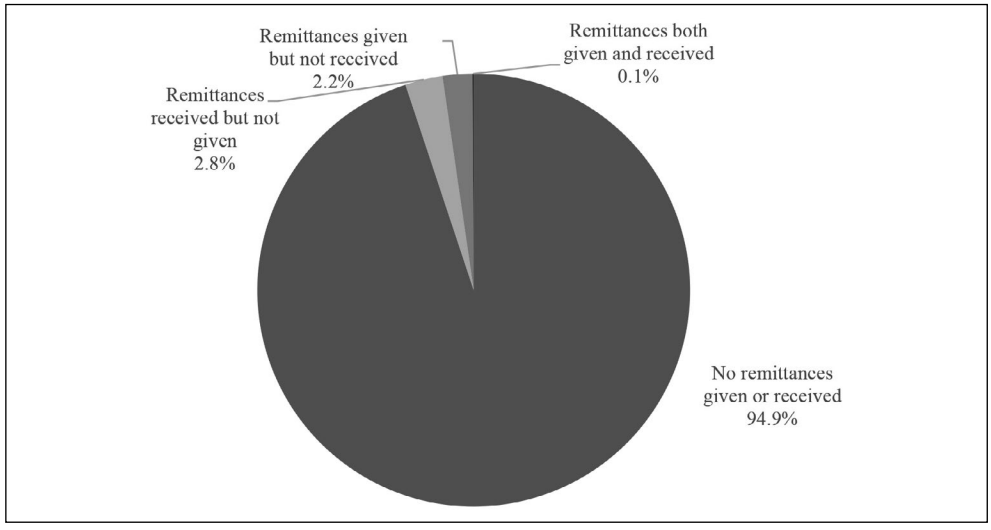

FIGURE 1. Analysis of remittance behaviour by respondent

family or friends, which may have influenced this statistic. This left just 903 people who gave or received remittances.

3.3.9 Respectively, 89.8% and 85.4% of remittance givers and receivers were African. Data on remittance behaviour for other race groups were scanty. This is supported by Phangaphanga (unpublished) who states that remittance behaviour is more popular among Africans in comparison with other racial groups.

3.4 Statistical methodology

3.4.1 STATISTICAL THEORY APPLIED IN PAST STUDIES

3.4.1.1 Two statistical techniques were used in the literature on insurance purchase behaviour: logit models and chi-squared tests of independence.

3.4.1.2 Crayen et al. (2013) and Kirigia et al. (2005) used the logit model. Logit regression models are used to model binary dependent variables.[6] The following assumptions are required to use a logit regression model:[7]

— The dependent variable must be binary.
— There should not be high levels of correlation between variables to prevent multicollinearity.
— A large sample is required.

3.4.1.3 Managing multicollinearity in a logit regression can be assisted by using chi-square tests of independence to narrow down the choice of independent variables. This is a non-parametric statistical technique that identifies significant relationships between categorical variables(McHugh, 2013). The following assumptions are required (McHugh, 2013):

— The categories are mutually exclusive.
— No cell count should have an expected value of less than one.

3.4.1.4 Crayen et al. (2013) analysed whether individuals were less likely to own formal funeral cover if they received remittances and used household income per capita, banking status, risk management and risk awareness, and remittances as independent variables in a logit model (Crayen et al., 2013).

3.4.1.5 When Kirigia et al. (2005) considered factors likely to influence health insurance purchase behaviour, the authors first performed multiple chi-square tests of independence followed by a logit regression model. Independent variables included health rating, environment rating, residence, income, education, age, age-squared, race, household size, occupation, employment, smoking, alcohol use, contraceptive use and marital status (Kirigia et al., 2005). It should be noted that remittances were not considered in this model.

6 What is logistic regression? Available: http://www.statisticssolutions.com/what-is-logistic-regression/, 05/08/2021

7 Assumptions of logistic regression. Available: http://www.statisticssolutions.com/assumptions-of-logistic-regression/, 05/08/2021

3.4.2 THEORY BEHIND CHI-SQUARE AUTOMATIC INTERACTION DETECTION (CHAID)

3.4.2.1 CHAID analysis is a useful non-parametric technique to partition data into more homogeneous groups (Kass, 1980). The CHAID algorithm requires that the dependent variable be categorical (Kass, 1980). The data are divided into mutually exclusive and exhaustive subclasses that most appropriately explain the dependent variable (Kass,1980).

3.4.2.2 The CHAID algorithm is described by Hill & Lewicki (2006):

— The dependent variable, either continuous or categorical is identified. If the dependent variable is continuous, it would need to be converted to a categorical variable. This may reduce the statistical power of the result.
— For each independent variable, pairs of categories within each independent variable are compared with a chi-square test. Non-statistically significant pairs are merged. Bonferroni adjusted p-values are calculated for statistically significant differences. The Bonferroni adjustment alters the significance level to account for the number of significance tests conducted.
— Observations are then divided into statistically significant categories using the most significant independent variables identified.
— The process is iterative and continues until no more significant differences are identified.

This is a statistically robust equivalent to the repeated chi-square tests performed by Kirigia et al. (2005).

3.4.2.3 The CHAID algorithm is often represented by a dendrogram (Huang et al., 1993). In this research, the entire population is termed the root node and divisions thereof are termed sub-nodes. Terminal or leaf nodes are the final nodes that can no longer be split.

3.4.3 IMPLEMENTATION OF CHAID

The CHAID analysis was conducted using IBM SPSS Statistics and used a 5% level of significance for the splitting and merging of nodes. Each parent node had a minimum sample size of 100 and each child node had a minimum size of 20.

4. RESULTS AND DISCUSSION

4.1 Preliminary analysis

4.1.1 The purpose of this research paper is to consider whether remittance behaviour affects life insurance purchases. However, due to the fact that dependant-type information was missing for most of the cleaned data sample, a CHAID analysis was performed on the sample for whom dependant-type information was available. The rationale was that if the dependant-type information were missing at random and it did not affect the propensity to purchase insurance where it was available then the dependant-type variables were not required to test whether remittances affected insurance-purchase behaviour.

4.1.2 When this analysis was performed, it was found that children did not affect the propensity to purchase life insurance at the 5% level of significance. Hence the full CHAID analysis was performed on the full clean data sample and dependant-type variables were ignored.

4.1.3 This could contradict the findings of Browne & Kim (1993) and Li et al. (2007) who suggested that dependants increase the demand for life insurance, in ¶2.3.2.2. However, since dependants were limited to children, this result may not be a true reflection of the effect of dependants on remittances and life insurance.

4.2 Remittance analysis

4.2.1 The CHAID analysis was performed to ascertain factors that influenced life insurance purchases. The appearance of total income including remittances (total_income) or any of the ten remittance variables in the CHAID trees will indicate that there is a significant relationship between life insurance purchases and remittances.

4.2.2 Overall, 9% of the sample indicated that they owned life insurance. The dendrogram identified total income excluding remittances (total_income_excl.R) as the most significant variable in explaining life insurance purchase behaviour with an adjusted p-value of less than 0.05%. This method categorised the rand amount of the income variable into five suitable income bands to analyse the data further. The result is shown in Table 2.

TABLE 2. Monthly income excluding remittances split into five income bands

Node	Income band (rands)	Life insurance			
		Yes	%	No	%
1	≤ 350	421	4.8	8 306	95.2
2	(350, 750]	51	2.8	1 791	97.2
3	(750, 2 499]	158	4.5	3 384	95.5
4	(2499, 4 870]	177	9.8	1 632	90.2
5	> 4 870	782	44.2	987	55.8

The results in Table 2 show that a greater proportion of higher income-earning individuals owned life insurance which corresponds with the literature by Hwang & Gao (2003) in ¶2.1.2 This is further supported by Thomson & Posel (2002) and Ardington et al. (unpublished), in ¶¶2.1.3.5-6, that poorer households are more likely to use informal insurance.

4.2.3 A remittance variable, namely remittances received, only appeared once in the entire CHAID analysis. It appeared significant at the terminal node for the lowest-income, African and Other (population group), youngest and unbanked individuals and this branch of the dendrogam is shown in Figure 2. There were only 92 observations in this node, representing 0.52% of the entire sample. The fact that remittances were only found to be significant in the African population group may be due to the majority of the remittances given and received in the sample involving Africans.

4.2.4 Table 3 shows that there was only one individual who received a remittance that had life insurance. This might be a result of low-income earning individuals spending their remittances on more immediate and essential needs as indicated in ¶2.2.2 by Babatunde & Martinetti (unpublished). Given that this group has poor access to financial services, they may use remittances as a substitute good as discussed in ¶2.2.1.

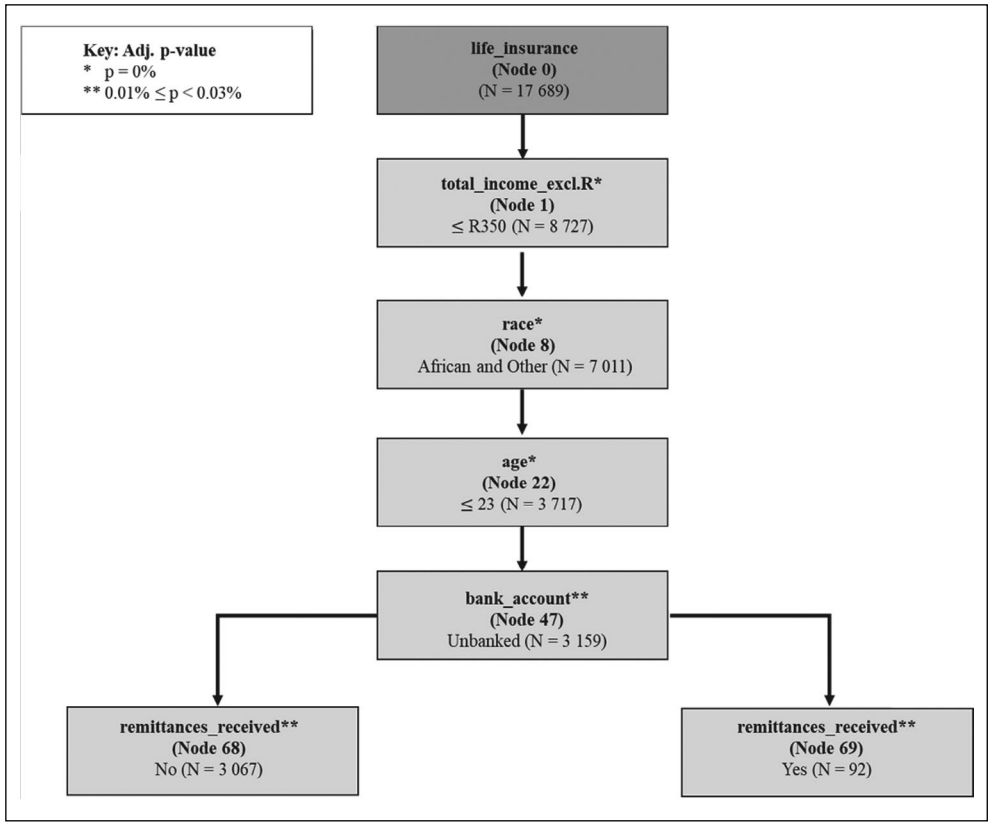

FIGURE 2. Branch where remittances were significant

TABLE 3. Distribution of life insurance for individuals with total income excluding remittances less than or equal to R350 p.m., African or Other, 23 years old or younger

Node	Characteristics	Life insurance			
		Yes	%	No	%
68	No remittances received	4	0.1	3 063	99.9
69	Received remittances	1	1.1	91	98.9

4.2.5 It is important to recognise that this result could be spurious in that only one person who received a remittance held life insurance. In addition, the remittances received variable could represent a cash or in-kind transfer and the latter would not give an individual the ability to purchase life insurance.

4.2.6 Giving remittances was not associated with a significant difference in life insurance ownership. A possible explanation might be that there was a very small number of remitters in higher income bands and therefore it did not appear significant. Alternatively, it is possible that giving remittances may be associated with purchasing more life insurance as life

insurance is purchased for a broader group than for someone who does not give remittances. It was not possible to test this hypothesis from the data.

4.2.7 While Crayen et al. (2013), in ¶2.2.3.1, found a negative correlation between remittances and funeral cover, this was only true in relation to life insurance for a very small sub-sample in this study.

5. CONCLUSION AND AREAS FOR FURTHER RESEARCH

5.1 Conclusion

5.1.1 The aim of this research was to establish how the giving and receiving of remittances impact life insurance purchase behaviour in South Africa. To achieve this aim, research surrounding remittances, life insurance and models exploring insurance behaviour was analysed.

5.1.2 The literature indicated that the following factors were expected to influence insurance purchase behaviour:

— Remittances
— Stage of life, age and family structure;
— Income level;
— Formal insurance deterrents and use of alternatives to formal insurance and lending;
— Sex and precautionary motives;
— Level of education; and
— Race and religion.

Remittances given or received could decrease the purchase of formal insurance via the substitution effect, as discussed in ¶2.2.1. Alternatively, the changes in income for the giving and receiving households could decrease and increase insurance purchases respectively via the income effect as discussed in ¶2.2.2.

5.1.3 A CHAID analysis was used to test the effect of giving and receiving remittances on the decision to purchase life insurance or not. Remittances received (cash or in kind) by individuals categorised as the lowest income, African or Other, youngest and unbanked decreased the propensity to purchase life insurance. For all other groups, giving or receiving remittances did not significantly affect the purchase of life assurance.

5.1.4 It is difficult to draw firm implications for life insurers due to the limitations of the data. However, it is possible that the opportunities for life insurers lie in increasing the number of lives covered on policies owned by people who already own insurance. This would require further research on whether remittance behaviour changes the amount of insurance purchased and whether the insurance covers the policyholders own life or the lives of dependants.

5.1.5 Alternatively, there could be opportunities to make it easier and cheaper for remittance givers to purchase insurance for family members who they support. One such opportunity could be to offer life insurance packaged with money-transfer facilities, for example, via bancassurance or mobile money transfers.

5.2 Areas for further research

5.2.1 A data sample with higher rates of giving or receiving remittances may be helpful. This is particularly important outside of the African population group where only 3.2% and 5.5% of the sample gave or received remittances respectively. Similarly, there may be a credibility issue due to low life insurance penetration in certain groups.

5.2.2 The data could incorporate NIDS data from other waves for the purpose of comparing how the relationship between remittances and life insurance ownership has evolved. Also, using data from multiple waves may resolve some of the credibility issues discussed in ¶5.2.1 as well as smoothing out economic factors that could distort the result. Using longitudinal data will highlight possible trends over time as well as allowing for additional variables to be created. For example, income from savings products may indicate growing financial literacy.

5.2.3 Future work should address the data limitations discussed in section 3.3. In addition, the unclear definition of life insurance used in the literature may have resulted in significant factors affecting life insurance behaviour not being identified and this would need to be addressed.

5.2.4 An additional limitation is that the education measure used was fairly crude and the split between those with tertiary education and those without was fairly arbitrary. An alternative definition for education may have yielded different results.

5.2.5 As discussed in section 2.1.3, it is possible that life insurance is not purchased because of alternative ways of meeting needs such as the use of accumulated savings, government grants, borrowing and informal insurance arrangements. The use of these alternatives merits further investigation and the results would be of interest to the life insurance industry.

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REFERENCES

Anderson, D & Nevin, J (1975). Determinants of young marrieds' life insurance purchasing behaviour: An empirical investigation. *The Journal of Risk and Insurance* **42**(3), 375–87

Ardington, C, Lam, D, Leibbrandt, M & Levinsohn, J (unpublished). Savings, insurance and debt over the post-apartheid period: A review of recent research. CSSR Working Paper No. 65, University of Cape Town, 2004, http://opensaldru.uct.ac.za/bitstream/handle/ 11090/640/csssr-saldru-wp65.pdf?sequence=1, 17/04/2020

Babatunde, RO & Martinetti, EC (unpublished). Impact of remittances on food security and nutrition in rural Nigeria. Center for International Cooperation and Development, University of Pavia, Italy, 2010

Beck, T & Webb, I (2003). Economic, demographic, and institutional determinants of life insurance consumption across countries. *The World Bank Economic Review* **17**(1), 51–88

Biyase, M & Tregenna, F (unpublished). Determinants of remittances in South Africa. SALDRU Working Paper Number 176, NIDS Discussion Paper 2016/3, Cape Town: SALDRU, University of Cape Town, 2016, http://opensaldru.uct.ac.za/bitstream/ handle/11090/831/2016_176_Saldruwp.pdf?sequence=1, 16/03/2020

Browne, M & Kim, K (1993). An international analysis of life insurance demand. *The Journal of Risk and Insurance Association* **60**(4), 616–34

Brophy, T, Branson, N, Daniels, R, Leibbrandt, M, Mlatsheni, C & Woolard, I (unpublished). National Income Dynamics Study Panel User Manual, Version 1. SALDRU and UCT, 2018. Available:http://www.nids.uct.ac.za/images/documents/20180831-NIDS-W5PanelUserManual-V1.0.pdf, 05/08/2021

Carling, J (2008). The determinants of migrant remittances. *Oxford Review of Economic Policy* **24**(3), 581–98

Crayen, D, Hainz, C & Martinez, C (2013). Remittances, banking status and the usage of insurance schemes. *The Journal of Development* **46**(6), 861–75

Ćurak, M (2013). The effect of social and demographic factors on life insurance demand in Croatia. *International Journal of Business and Social Science* **4**(9), 65–72

Dragos, SL (2014). Life and non-life insurance demand: The different effects of influence factors in emerging countries from Europe and Asia, *Economic Research—Ekonomska Istraživanja*, **27**(1), 169–80

Gutter, MS & Hatcher, CB (2008). Racial differences in the demand for life insurance. *American Risk and Insurance Association*, **75**(3), 677–89

Hill, T & Lewicki, P (2006). *Statistics: Methods and Applications*, 1st edn., StatSoft, Tulsa

Hiltz, SR (1971). Why black families own less life insurance. *The Journal of Risk and Insurance* **38**(2), 225–35

Hougaard, C, De Vos, M, Bowman, N, Mahori, N & Bester, H (unpublished). Tanzania access to insurance diagnostic document 8: Understanding consumer needs and segmenting the target market. Report, 2012, http://www.finmark.org.za/wp-content/uploads/2016/01/A2i_Diagnostic_Consumer_needs_Doc8.pdf, 10/03/2020

Huang, HC, Lin, TK & Ngui, PW (1993). Analysing a mental health survey by Chi-square automatic interaction detector. *Annals of the Academy of Medicine Singapore* **22**(3), 332–7

Hwang, T & Gao, S (2003). The determinants of the demand for life insurance in an emerging economy – the case of China. *Managerial Finance* **29**(5), 82–96

Inkmann, J & Michaelides, A (2012). Can the life insurance market provide evidence for a bequest motive? *The Journal of Risk and Insurance* **79**(3), 671–95

International Fund for Agricultural Development & World Bank (unpublished). The use of remittances and financial inclusion. Report, 2015, https://www.ifad.org/documents/38714170/40187309/gpfi.pdf/58ce7a06-7ec0-42e8-82dc-c069227edb79, 29/05/2020

Jianakoplos, N & Bernasek, A (unpublished). Are women more risk averse? Colorado State University Working Paper, 1996, https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1465-7295.1998.tb01740.x?casa_token=2548f8hJXroAAAAA:CAC8HPiBcMtJgFH51-J_Bs4T4C7Jl8f3RgOylRQ6cajWsdxygv2N1RssGwXHlbdByXkWZ5qh5p-sCQ,01/06/2020

Kass, GV (1980). An exploratory technique for investigating large quantities of categorical data. *Journal of Royal Statistical Society (Applied Statistics)* **29**(2), 119–27

Kirby, JB & Kaneda, T (2010). Unhealthy and uninsured: Exploring racial differences in health and health insurance coverage using a life table approach. *Demography* **47**(4), 1035–51

Kirigia, J, Sambo, L, Nganda, B, Mwabu, G, Chatora, R & Mwase, T (2005). Determinants of health insurance ownership among South African women. *BMC Health Services Research* **5**(1), https://doi.org/10.1186/1472-6963-5-17, 17/03/2020

Kshetri, N, Rojas-Torres, D & Acevedo, MC (2015). Diaspora networks, non-economic remittances and entrepreneurship development: Evidence from some economies in Latin America. *Journal of Developmental Entrepreneurship* **20**(1), 1550005

Li, D, Moshirian, F, Nguyen, P & Wee, T (2007). The demand for life insurance in OECD countries. *The Journal of Risk and Insurance* **74**(3), 637–52

Lu, Y & Treiman, DJ (2011). Migration, remittances and educational stratification among blacks in apartheid and post-apartheid South Africa. *Social Forces* **89**(4), 1119–43

Lucas, RE & Stark, O (1985). Motivations to remit: Evidence from Botswana. *Journal of Political Economy* **93**(5), 901–18

Lucas, RE & Stark, O (1988). Migration, remittances and the family. *Economic development and cultural change* **36**(3), 465–81

Luciano, E, Outreville, JF & Rossi, M (2016). Life insurance ownership by Italian households: A gender-based differences analysis. *The Geneva Papers on Risk and Insurance Issues and Practice* **41**(3), 468–90

Mahdzan, N & Victorian, S (2013). The determinants of life insurance demand: A focus on saving motives and financial literacy. *Asian Social Science* **9**(5), 274–84

Mangoma, A & Wilson-Prangley, A (2019). Black Tax: Understanding the financial transfers of the emerging black middle class. *Development Southern Africa* **36**(4), 443–60

Maphosa, F (2007). Remittances and development: The impact of migration to South Africa on rural livelihoods in southern Zimbabwe. *Development Southern Africa* **24**(1), 123–36

McHugh, M (2013). The chi-square test of independence. *BioChem Med(Zagreb)* **23**(2), 143–9

Miller, D & Paulson AL (unpublished). Informal insurance and moral hazard: Gambling and remittances in Thailand. Princeton University, Northwestern University, 1999, https:// core.ac.uk/download/pdf/7354294.pdf, 22/05/2020

Modigliani, F (1986). Life cycle, individual thrift, and the wealth of nations. *The American Economic Review* **76**(3), 297–313

Mohapatra, S & Ratha, D (2011). *Remittance Markets in Africa*. The World Bank, Washington, DC

Neurgarten, BL (1979). Time, age, and the life cycle. *The American Journal of Psychiatry* **136**(7), 887–94

Phangaphanga, M (unpublished). Internal migration, remittances and household welfare: Evidence from South Africa. School of Economics, Faculty of Commerce, University of Cape Town, 2013, https://open.uct.ac.za/bitstream/handle/11427/12866/thesis_com_2013_phangaphanga_m.pdf; sequence=1, 19/05/2020

Posel, D (unpublished). Inter-household transfers in South Africa: Prevalence, patterns and poverty. SALDRU Working Paper 180, 2016, http://opensaldru.uct.ac.za/bitstream/handle/11090/851/2016_07_NIDSW4.pdf?sequence=1, 19/03/2020

Rosenzweig, M (1988). Risk, implicit contracts and the family in rural areas of low- income countries. *The Economic Journal* **98**(393), 1148–70

Roth, J (2001). Informal microinsurance schemes-the case of funeral insurance in South Africa. *Enterprise development & microfinance* **12**(1), 39–50

Settersten, RA (Jr) & Mayer, KU (1997). The measurement of age, age structuring, and the life course. *Annual Review of Sociology*, **23**(1), 233–61

Shand, N & Angove, J (unpublished). Credit life insurance in South Africa: The customer's perspective. Published report, 2013, http://www.treasury.gov.za/public%20comments/CCI/Annexure%20C.pdf, 22/04/2020

Showers, V & Shotick J (1994). The effect of household characteristics on the demand for insurance: A Tobit analysis. *The Journal of Risk and Insurance* **61**(3), 492–502

Smit, K, Haux, C, Esser, A, Pérez, L & Thom M (unpublished). Digital remittance senders in the UK: Is there a case for for-purpose remittances? Published report, 2020, https://cenfri.org/wp-content/uploads/2020-01-13_For-purpose-remittances-report_final.pdf, 22/05/2020

Stark, O & Levhari, D (1982). On migration and risk in LDCs. *Economic Development and Cultural Change* **31**(1), 191–6

Thomson, RJ & Posel, DB (2002). The management of risk by burial societies in South Africa. *South African Actuarial Journal* **2**(1), 83–128

Thow, AM, Fanzo, J & Negin, J (2016). A systematic review of the effect of remittances on diet and nutrition. *Food and Nutrition Bulletin* **37**(1), 42–64

Torero, M & Viceisza, A (2015). To remit, or not to remit: that is the question. A remittance field experiment. *Journal of Economic Behavior and Organization* **112**(2015), 221–36

Van Doorn, J (2002). Migration, remittances and development. *Labour Education* **4**(129), 48– 53

World Bank (unpublished a). Global economic prospects. Published report, 2006, http://documents.worldbank.org/curated/en/507301468142196936/841401968_200510327112047/additional/343200GEP02006.pdf, 28/05/2020

World Bank (unpublished b). Migrants' remittances from France: Findings of a survey on migrants' financial needs and remittance behavior in Montreuil. Published report, 2015, http://documents.worldbank.org/curated/en/931361467993181398/pdf/97081WPPUBLICBox391470B-Migrants-Remittances-France-PUBLIC.pdf, 17/05/2020

Zewdu, GA (2019). Remittance flows, remitting behavior and utilization patterns: The case of Ethiopia, *Social & Cultural Geography*, **22**(8), 1143–63, 2021. https://doi.org/10.1080/14649365.2019.1685677

Zhou, M & Li, X (2018). Remittances for collective consumption and social status compensation: Variations on transnational practices among Chinese international migrants. *International Migration Review* **52**(1), 4–42

APPENDIX A
Data

Table A.1 displays a summary of variables used in the CHAID analysis.

Table A.1. Variables used in the CHAID analysis

Variable coding	Description from questionnaire[8]	Possible values
Dependent variable		
life_insurance	'Do you personally have life insurance?'	yes; no
Independent variables		
Grant variables		
state_oldage_grant	'Did you receive income or assistance from a state old age grant in the last month?'	yes; no
state_oldage_grant_value	'How much did you receive last month from the state old age grant in rands?'	rand amount
child_support_grant	'Did you receive income or assistance from a child support grant in the last month?'	yes; no
child_support_grant_value	'How much did you receive last month from the child support grant in rands?'	rand amount
Remittance variables		
remittances_received	'In the past 12 months, did you receive money, food, or any other kind of contribution from people who do not usually sleep under the roof for four nights a week? If you receive maintenance for you or your child, please include it here.'	yes; no
no._cash_remittances_received	'In the past 12 months, how many times did the main remitter send you money?'	integer value
cash_remittances_received	'In the past 30 days, how much money in total did the main remitter send to you?'	rand amount
no._kind_remittances_received	'In the past 12 months, how many times did the main remitter make a contribution in kind to you?'	integer value
kind_remittances_received	'In the past 30 days, what was the total monetary value of in-kind contributions to you by the main remitter?'	rand amount
remittances_given	'In the past 12 months, did you send money, food, or any other kind of contribution to people who do not usually sleep under the roof for four nights a week? If you send maintenance or child support payments, please include it here.'	yes; no
no._cash_remittances_given	'In the past 12 months, how many times did you send money to the main receiver?'	integer value
cash_remittances_given	'In the past 30 days, how much money in total did you send to the main receiver?'	rand amount
no._kind_remittances_given	'In the past 12 months, how many times did you make a contribution in-kind to the main receiver?'	integer value
kind_remittances_given	'In the past 30 days, what was the total monetary value of your in-kind contributions to the main receiver'	rand amount

8 NIDS Adult (15+) Questionnaire Wave 5 2017

Income variables		
regular_income	'Are you currently being paid a wage or salary to work on a regular basis for an employer whether full time or part time?'	yes; no
regular_income_value	'How much was your take-home pay last month?'	rand amount
interest_income	'Did you receive income or assistance from interest earnings including dividends, interest from savings, loans in the last month?'	yes; no
interest_income_value	'How much did you receive last month from interest income in rands?'	rand amount
other_income	'Did you receive income or assistance from other [sources] in the last month?'	yes; no
other_income_value	'How much did you receive last month from other [sources] in rands?'	rand amount
total_income	regular_income_value + interest_income_value + other_income_value + cash_remittances_received – cash_remittances_given + state_oldage_grant_value + child_support_grant_value	rand amount
total_income_excl.R	regular_income_value + interest_income_value + other_income_value + state_oldage_grant_value + child_support_grant_value	rand amount
Loan variables		
bank_loan	'Do you personally have a personal loan from a bank?'	yes; no
micro_loan	'Do you personally have a personal loan from a micro-lender?'	yes; no
family_loan	'Do you personally have loan from a family member?'	yes; no
friend_loan	'Do you personally have loan from friends?'	yes; no
mashonisa_loan	'Do you personally have loan with a Mashonisa/ informal money lender?'	yes; no
General variables		
age	'What is your date of birth? (year)'	integer value
gender	'What is your gender?'	male; female
religion	'What religion are you?'	not religious; Christian; Jewish; Muslim; Hindu; African Traditional Spiritual Beliefs
race	'What population group do you belong to?'	African; Coloured; Asian/Indian; White; Other
tertiary_education	'Have you successfully completed any diplomas, certificates or degrees outside of school?'	yes; no
stokvel	'Do you belong to a stokvel or savings club?'	yes; no
bank_account	'Do you personally have a bank account?'	yes; no
Dependant-type variables		
children_reside	'Do you have any biological children to whom you have given birth who are currently living with you?'	yes; no
children_away	'Do you have any biological children who are still alive, but are not living with you?'	yes; no
dependants	children_reside + children_away	integer value

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Updated remarriage contingency deductions for widowed South Africans

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ABSTRACT

Where a widowed person has a legal claim for support following the death of their spouse, their compensation may be reduced to allow for the possibility of remarriage. This reduction, known as a remarriage contingency, accounts for both the probability of remarriage and the change in financial status on remarriage. The only South African tables available are viewed as outdated and focus only on widows. This research uses data from the National Income Dynamics Survey to find updated remarriage contingencies for South African widows and widowers. The data indicate that age and race may influence the remarriage probabilities although this result may have been influenced by poor income and child data. The remarriage contingencies calculated were lower than the old tables for widowed whites and younger coloureds but higher for widowed Africans, Asians and older coloureds. The remarriage contingencies calculated were high relative to the general post-settlement contingency of 15% suggesting that there may still be scope for an explicit remarriage contingency.

KEY WORDS

Remarriage; contingency deductions; remarriage rates; widowers; widows

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1. INTRODUCTION

1.1 Background

1.1.1 A widow may have the legal right to claim for support from the deceased spouse (Thomson, 1988). Such legal claims include claims made against the Road Accident Fund (RAF) and claims made in respect of the Maintenance of Surviving Spouses Act.[1] Once the quantum of the loss is established, a deduction may be applied to the amount she will receive due to the possibility that she might remarry (Van der Nest & Nienaber, 2001; Steynberg, 2011). This is because a woman should not be receiving support from two spouses, as any legal claim should be for compensation instead of the enhancement of the widow's financial prospects (Van der Nest & Nienaber, 2001).

1.1.2 Although men may also make legal claims based on loss of support from their spouses, the widower's prospect for remarriage is very rarely considered when calculating his net claim (Van der Nest & Nienaber, 2001).

1.2 Importance of the research

1.2.1 The only published South African table of remarriage contingency deductions was published by Thomson (1988) and were for white, coloured and Asian/Indian widows as data for African widows were not available at the time. A more detailed set of tables is set out in Thomson (unpublished) although Thomson (1988) forms the basis of the remarriage contingency deduction used in actuarial practice.

1.2.2 In 2014 in the case of *LD* v *RAF*,[2] the learned judge made the following remarks:

> Proper statistics relating to remarriage may well be useful in assessing an appropriate contingency, but statistics are only assistive if they are derived from a sufficiently large and representative sample. Furthermore, the statistics should at least be derived from data collected within a reasonable frame of time relative to when the contingency is to be applied so as to provide some validity to the specific social and other circumstances which would influence marriage and remarriage trends prevailing at the time.

In the judgment, the data underlying the Thomson (1988) tables, which were collected between 1970 and 1980, were deemed outdated and unrepresentative. Ultimately, in this case, the remarriage contingency was assumed to be reflected in the general contingencies applied to the claim due to the absence of such 'proper statistics'.

1.2.3 While this judgement is not binding on other jurisdictions, it does cast doubt on the continued use of the Thomson (1988) tables or the blanket general contingency of 15% which according to anecdotal evidence are used in the absence of any other statistics.

1.2.4 Much has changed in South Africa's marriage framework since 1988. Both the Customary Marriages Act[3] which provided formal recognition to customary unions and

1 Act 27 of 1990, as amended. Republic of South Africa.
2 *LD* v *Road Accident Fund* (14606/2016) [2018] ZAGPPHC 181, at paragraph 32
3 Act 120 of 1998 as amended, Republic of South Africa

the Civil Union Act[4] which allowed for same-sex marriage have been introduced. Hence the definition of marriage used currently is different to that used prior to the publication of the Thomson (1988) tables. Remarriage rates that are more relevant to the current time and definitions of marriage are required for use in finding the remarriage contingency deductions in the case of the claim for loss of support for the widowed.

1.2.5 These newer tables would need to address gender inequality by considering contingencies for widowers (Van der Nest & Nienaber, 2001). They also need to consider the issue of race. Commentators like Van der Nest & Nienaber (2001) and the courts[5] are concerned that race-based tables may be discriminatory.

1.3 Aims

1.3.1 The main aim of this research is to update the probability of remarriage. It is intended that the updated probabilities will be used to determine fairer and more relevant remarriage contingency deductions.

1.3.2 The following questions are considered:

— What are the factors that affect the probability of remarriage and change in financial circumstances on remarriage?
— What are the updated contingency deductions for South Africa?

1.4 Terminology

1.4.1 The term 'widowed' is used to describe both widows and widowers throughout this research.

1.4.2 The term 'black' is used to describe a race group in the context of international literature. The exact definition of this term may differ from country to country. For the purposes of describing the racial characteristics of South Africans, the authors have used the official race groups: African, white, coloured and Asian/Indian. For brevity, the white, coloured and Asian/Indian populations, which collectively make up less than 20% of the population,[6] are referred to as non-African.

1.5 Plan of development

1.5.1 As Steynberg (2007) noted, the contingency deduction incorporates two probabilities among others: firstly, the probability of remarriage and secondly, the probability of financial benefit if such a marriage takes place. The other probabilities relate to survival. Section 2 contains a discussion of the literature on factors known to affect the probability of remarriage and change in financial status on remarriage. This is important as, in developing the new tables, data will need to be divided according to factors that are statistically significant in influencing these probabilities.

4 Act 17 of 2006 as amended, Republic of South Africa
5 For example, *LD* v *Road Accident Fund* (14606/2016) [2018] ZAGPPHC 181
6 STATSSA, Mid-Year Population Estimate, July 2020

1.5.2 Section 3 describes the dataset and variables. Section 4 gives a broad overview of the three-stage process used to calculate the remarriage contingencies. The methodology that can be used to identify factors that are statistically significant in terms of determining the contingencies is set out in section 5 and the results of this analysis are given in section 6. Section 7 outlines the methodology to calculate the probability of remarriage and the results and discussion are given in section 8. Section 9 outlines the methodology to calculate the contingency deduction and the discussion thereon is set out in section 10. Section 11 summarises and concludes.

2. OBJECTIVELY OBSERVABLE FACTORS AFFECTING THE REMARRIAGE CONTINGENCY

Before tabulated remarriage contingency rates were available, the courts used arbitrary or stereotypical criteria like attractiveness in determining the remarriage contingency (Van der Nest & Nienaber, 2001). The authors submit that contingency deduction tables based on objective and observable characteristics are more defensible even though some unobservable and subjective factors like the level of emotional support received (Carr, 2004) and health status (Smith et al., 1991; Coleman et al., 2000) affect remarriage rates. Health and emotional support are not considered further. The objective criteria that are discussed are sex, age, duration of widowhood, children, education, income and race.

2.1 Factors that affect the probability of remarriage

2.1.1 Sex

Men have a higher probability of remarriage than women (Wu et al., 2015). Carr (2004) hypothesised that this was due to men getting more health and lifestyle benefits from remarriage than women. Gentry & Shulman (1988) found similarly with regard to health benefits. In addition, the income of women falls sharply following widowhood whereas the income of men remains relatively level following widowhood (Ozawa & Yoon, 2002). This relative financial dependence of widows may account for some of the difference in remarriage rates between men and women.

2.1.2 Age at widowhood and current age

2.1.2.1 Wu et al. (2015) analysed Canadian data on cohabitation and remarriage and demonstrated that the age at widowhood has a negative relationship to the remarriage rates of both males and females but to a larger extent for females.

2.1.2.2 Davidson (2002) found that getting older decreases the remarriage probability for both males and females, although this decrease happens much sooner for females. Some reasons for the decline in remarriage probability with age are:

— fewer available partners (Bumpass et al., 1990) particularly healthy ones (Vespa, 2013);
— fewer economic incentives (Wu et al., 2015);
— fewer social benefits (Wu et al., 2015) particularly given the psychological profile of the older widow (Gentry & Shulman, 1988; Vespa, 2013); and
— more practical constraints (Vespa, 2013).

2.1.2.3 Possible reasons why this effect is less pronounced in men include:

— Men tend to marry younger women than themselves (Moorman et al., 2006).
— At these higher ages, the ratio of women to men will increase, this means that at higher ages men would have more chances to date other women and potentially remarry if they want to (Carr, 2004).
— There is a higher likelihood of males to marry someone from a lower age group (Wu et al., 2015).
— Gender roles can create differences in the desire to remarry at older ages (Wu et al., 2015). Remarriage may be undesirable for older women who do not want the burden of traditional gender roles and the responsibility of being a caregiver. Carr (2004) noted that women may prefer dating to remarriage as they would receive the companionship that they value without the obligations and responsibilities that come with remarriage.

2.1.3 Duration of widowhood

The remarriage rates for widows increase after allowing a certain period of mourning (Smith et al., 1991). Men spend less time in widowhood compared to women (Ahn, 2005) but it is unclear whether there is a difference in this mourning period. After this initial increase in remarriage rates, they decline again due to advancing age as discussed in section 2.1.2.

2.1.4 Number and age of children

2.1.4.1 Having children is considered to be an obstacle to remarriage for women (Bumpass et al., 1990). Empirical evidence by Ivanova et al. (2013) showed that across Europe, widows with children are less likely to remarry than widows without. This may be due to several reasons which are outlined below:

— The dependent children are usually considered to be an extra financial cost to the new family that will be formed (Bumpass et al., 1990).
— The extra children may add complexity to the new family relationships (Gentry & Shulman 1988; Bumpass et al., 1990; Smith et al., 1991; Ivanova et al., 2013).
— Having a younger child who is in need of more attentive care will reduce the time that the widow spends on social activities and at work and thus reduce the opportunity for the widow to meet someone new and consequently remarry (Ivanova et al., 2013).

2.1.4.2 An alternative argument presented by Bumpass et al. (1990) suggested that more children may mean that the widow is likely more pressured financially, which can encourage the widow to more actively search for a new partner and consequently remarry. Ivanova et al. (2013) suggested that this would especially be the case with young children living at home, which would limit work opportunities.

2.1.4.3 However, these factors affect men and women differently. Bishop & Cain (2003) and Ivanova et al. (2013) find no evidence that the number and age of children has a significant effect on a man's propensity to remarry.

2.1.5 EDUCATION

2.1.5.1 Bumpass et al. (1990) noted that there were only very weak data to support the theory that more education results in lower remarriage rates for women. Smith et al. (1991) however did establish this relationship with a p-value of 10%.

2.1.5.2 Smith et al. (1991) also found that for widowers over the age of 60 there is a significant positive relationship between the level of education and the probability of remarriage. There is no such relationship for widowers under the age of 60 (Smith et al., 1991).

2.1.6 INCOME

2.1.6.1 The economic-needs theory suggests that the lower the income of the widowed spouse, the more likely they are to seek remarriage (Pasteels & Mortelmans, 2017). However, as their financial dependence may reduce their remarriage probability, Pasteels & Mortelmans (2017) suggest that income has no net effect on remarriage probability.

2.1.6.2 Pasteels & Mortelmans (2017) did note that the characteristics that make men and women attractive for remarriage have become more similar over time. The labour market prospects of a woman as well as her income earning ability are becoming more important and this is especially the case in societies where dual-income families have become a norm (Pasteels & Mortelmans, 2017). This could explain why some older studies such as Talbott (1998), Dewilde & Uunk (2008) and Vespa (2013) found an inverse relationship between income and a woman's propensity to remarry.

2.1.6.3 However, Wu et al. (2015) found that higher incomes are associated with higher remarriage rates for men. This effect of income may weaken as the age of the widowed increases, since the couples would be less directly dependent on the income of the husband as they age (Carr, 2004).

2.1.7 RACE

2.1.7.1 Older research suggested that white widows remarry more than black widows (Cleveland & Gianturco, 1976; Bumpass et al., 1990; Bramlett & Mosher, 2002). Research done by Bramlett & Mosher (2002) showed that the remarriage rates were diverging by race at that time. It is acknowledged that this older research may no longer be relevant in the South African context.

2.1.7.2 In contrast, research by Laloo (unpublished) showed that for widows aged under 55, race is not a significant factor, and further found that for older widows, African widows have the highest remarriage rate, which differs from international experience.

2.1.7.3 There is a lack of research as to whether race influences remarriage rates for widowers.

2.2 Factors that affect the financial circumstances on widowhood and remarriage

Traditionally, just the income level has been considered when investigating the financial circumstances before and after remarriage, for example in Aslaksen et al. (2005) and Dewilde & Uunk (2008). Ozawa & Yoon (2002) suggested that the change in income status of the remarried widowed should be measured using the income-to-needs ratio to account for

different family sizes. The income-to-needs ratio is the ratio of the income of a family to the poverty line of the country for a family of a particular size (Ozawa & Yoon, 2002).

2.2.1 Financial circumstances on widowhood

For both men and women, income status declines on widowhood but this depends on household earning patterns and sex (Ozawa & Yoon, 2002; Ahn, 2005). Where the widowed was heavily financially dependent on their deceased spouse, this effect is greater (Ahn, 2005). The income of women falls sharply following widowhood whereas the income of men remains relatively level following widowhood (Ozawa & Yoon, 2002). This could be as a result of men having a stronger attachment to the labour market (Dewilde & Uunk, 2008) or women being more financially dependent (Ahn, 2005).

2.2.2 Financial circumstances on remarriage

Upon remarriage, the financial status can improve or decline relative to the widowed state (Ozawa & Yoon, 2002). This is strongly influenced by sex and income.

2.2.2.1 Sex

Sex influences the income pattern on remarriage strongly. Ozawa & Yoon (2002) found that the income-to-needs ratios for men and women rose by 20.5% and 91.9% respectively on remarriage irrespective of whether the person was previously widowed or divorced. The general pattern is that the financial status improves although men are more likely than women to have a negative change in financial position on remarriage (Ozawa & Yoon, 2002). However, when women do have a negative change in their financial circumstances due to remarriage it is usually to a far greater extent than a man undergoing such a change (Ozawa & Yoon, 2002).

2.2.2.2 Income

Ozawa & Yoon (2002) also found that widowed spouses with higher income experience a much higher boost in the income-to-needs ratio than lower-income individuals. This result holds for both males and females. Dewilde & Uunk (2008) found a similar effect for the income levels of divorced women.

2.2.3 Net pattern

Where financial status improves on remarriage relative to widowhood, this may be a result of higher-income individuals marrying each other (Aslaksen et al., 2005; Dewilde & Uunk, 2008). Aslaksen et al. (2005) noted that this effect becomes more apparent as the level of access to education, labour supply and income for women increases. This supports the assumption in Steynberg (2007) that generally the widowed spouse would marry someone in a similar social group so the financial position of the widowed spouse would be similar before widowhood and after remarriage. However, this general result may not hold for extremely high and low incomes for the deceased spouse (Steynberg, 2007) or for women with low levels of education, low income or who are not in the labour market (Aslaksen et al., 2005).

3. DATA

3.1 Description

3.1.1 The National Income Dynamics Study (NIDS) dataset was used for this research. This South African study was conducted by the Southern Africa Labour and Development Research Unit at the University of Cape Town School of Economics.[7]

3.1.2 The NIDS study has followed the same group of 28 000 people and their cohabitants since 2008. This sample was selected to be representative of the South African population. Fieldworkers attempt to interview the same people every two years to see if their circumstances have changed since the last interview. Everyone included in the data can be tracked through the different waves through the unique identifier assigned to them. Households are also assigned a unique identifier and so the data are anonymised. Five waves of NIDS were available as of March 2020. Waves one to five of NIDS were based on data collected in 2008, 2010 to 2011, 2012, 2014 to 2015 and 2017 respectively.[8]

3.1.3 This dataset was selected as it is both recent and representative. Given that a focus of the NIDS is to see how households react to shocks including death in the family, it included many of the required data fields, which were outlined in Section 2.

3.1.4 To obtain the data, a request which includes information regarding the name, institution of the researchers, as well the purpose and method of the research was submitted to the NIDS website (nids.uct.ac.za).

3.2 Data cleaning

3.2.1 Data with entries that were not possible were eliminated. For example, when someone selected 'Widow/Widower' in marital status in the first wave but selected 'Never married' in the second wave.

3.2.2 Entries with empty cells in any of the variables in consideration were eliminated to ensure consistency. Any entry with categories where the applicant answered 'Refused' or 'Don't know' was also excluded.

3.2.3 Any newly widowed survey participants arising from wave 1 to wave 4 were also considered. Those identifying as widowed for the first time in wave 5 were not considered as they had no opportunity to remarry.

3.3 Variable definitions

3.3.1 The variable of interest was remarriage on widowhood. A widowed person was only considered remarried if there was a transition from the state of being a 'Widow/Widower' to being 'Married' during the course of the NIDS data periods.

3.3.2 The following variables were directly observable from the data and were of reasonable quality:

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7 Brophy, T, Branson, N, Daniels, R, Leibbrandt, M, Mlatsheni C & Woolard, I, National Income Dynamics Study Panel User Manual (2018), Version 1. Available: http://www.nids.uct.ac.za/images/documents/20180831-NIDS-W5PanelUserManual-V1.0.pdf, 22/09/2020

8 Ibid.

— Sex (discussed in sections 2.1.1 and 2.2);
— Current age (discussed in section 2.1.2);
— Duration since widowhood (discussed in section 2.1.3), measured in years; and
— Race (discussed in section 2.1.7).

3.3.3 It is acknowledged that when race appears as a variable in research, it may be a proxy for other variables. Recent research has shown that there are still distinct racial differences in South Africa in terms of earnings, transfers and access to assets (UNU-WIDER & Oosthuizen, unpublished). Hence, despite the sensitivity of the topic, the authors believe that analysis by race still adds value. An ethics waiver letter with number HRECNMW20/11/01 was also obtained. Only the main categories for race as specified in the questionnaire for NIDS have been considered. They were African, Coloured, Asian/Indian and White. Applicants who may have been in other race groups have not been considered.

3.3.4 The impact of education level on the remarriage contingency was discussed in sections 2.1.5 and 2.2.3. Education levels used the following variable definitions:
— Limited to no schooling: highest school year obtained smaller than or equal to grade 7; and
— Secondary or higher: any academic qualification equal to grade 8 or higher.

3.4 Data limitations

3.4.1 Waves 4 and 5 of the NIDs data had many incomplete entries regarding the participants' marital status compared with the first three waves. In wave 1, 15 570 data points were available on the marital status of the participants; whereas there were 1 013 and 1 174 in waves 4 and 5 respectively. This means that most of the data that were observed regarding transition from widowhood to remarriage came from the first three waves of data. The effect that this has on the results must be considered when analysing the results

3.4.2 The data would also not have captured remarriage information about someone who was married in one wave and then was widowed and remarried before the next wave. The data would reflect that this person was married the whole time. This may not be a serious limitation in terms of calculating the remarriage contingencies for legal applications as, if a person remarries within two to three years of the spouse's death, the information about the new spouse would be known at the time the matter is considered by the courts. However, it does mean that the remarriage contingencies may understate the probability of remarriage for the very recently widowed.

3.4.3 The relevance of income was discussed in sections 2.1.6, 2.2.2.2 and 2.2.3. There were very limited data on the income of the widowed. In wave 1, only 138 of the widowed provided their income amount. A chi-squared test indicated that this variable did not significantly affect remarriage rates for this dataset when available and hence it was not used in further analysis.

3.4.4 Only women were asked about their children in the NIDS data. This meant that the factors that would affect both women and men could not be evaluated consistently if children were considered. In addition, the information about the children of widows was often inconsistent. For example, the number of children for whom dates of birth were provided did

not match up to the number of children declared. Consequently, information about children could not be used.

3.4.5 As discussed in section 2.2, the change in income from married to widowed to remarried is of great interest when modelling the remarriage contingency. However, there was only one observation for which this data was recorded and so the data could not be used to analyse this.

4. METHODOLOGY OVERVIEW

4.1 The methodology used in this paper unfolds in three distinct stages.

4.2 In the first stage, factors that are statistically significant in affecting the contingency deduction are identified. As discussed in ¶3.4.5, the data were inadequate to consider the extent of financial benefit on remarriage. Hence the only factors that would affect the remarriage contingency deduction would be those that influenced the probability of remarriage. The methodology used for this process is described in section 5. The purpose of this stage was to determine how to divide the data into homogeneous groups while avoiding splitting for factors that are not statistically significant. This provides more credibility in the later stages. The results of the first stage of the analysis are presented in section 6.

4.3 Once these groups had been determined, the second stage of analysis took place which involved calculating the remarriage rates for each homogeneous group, or more accurately, their force of remarriage. This process is discussed in section 7 and depended on the analysis in section 6. The resultant forces of remarriage are presented and discussed in section 8.

4.4 The final step involved using these forces of remarriage to calculate tables of remarriage contingency deductions. The development of the equations used is discussed in section 9 and section 10 contains a discussion of the results.

5. METHODOLOGY TO IDENTIFY STATISTICALLY SIGNIFICANT FACTORS

5.1 Chi-squared automatic interaction detection (CHAID) is a non-parametric method of dividing data into mutually exclusive and exhaustive sets (Kass, 1980). The method, as pioneered in Kass (1980), is described by Ritschard (2013) as follows. A predictor is chosen and the data are divided according to the categories of this predictor. All possible groupings of the predictor with sufficient data to be credible are considered and statistical significance is determined using a chi-square test to get a Bonferroni adjusted p-value. The most statistically significant grouping of the predictor categories is noted. The process is then repeated on another predictor variable until all predictor variables have been considered. The data are then divided by the most statistically significant variable grouping provided the p-value is lower than the cut-off value. If the number of variables in each resultant node are large enough to be credible, the process is then repeated until there are no further statistically significant divisions.

5.2 This was the method used by Laloo (unpublished) in determining the probability of remarriage.

5.3 CHAID is a convenient methodology for this sort of analysis as it can be used even if the variables are correlated with each other (Ritschard, 2013). In this dataset, age and education level are likely to be correlated with each other, for example.

5.4 In conducting the CHAID exercise, the minimum split size was set at 20 to ensure the reliability of the groupings. The minimum number of observations in terminal nodes was set at 20. A 10% level of statistical significance was used.

6. DATA GROUPINGS FOR THE CALCULATION OF REMARRIAGE RATES

6.1 The response variable used was whether the widowed individual had remarried or not. The predictor variables applied, as outlined in section 3.3 were education, race, duration of widowhood, sex and age.

6.2 The exercise was performed for all the widowed as well as on widows and widowers separately and a consistent tree structure was found each time. This tree structure, using the data from all the widowed individuals, is shown in Figure 1.

6.3 This analysis suggests that two tables of probabilities for remarriage are required. The first table is for widowed Africans with no distinction by age. The second table is for

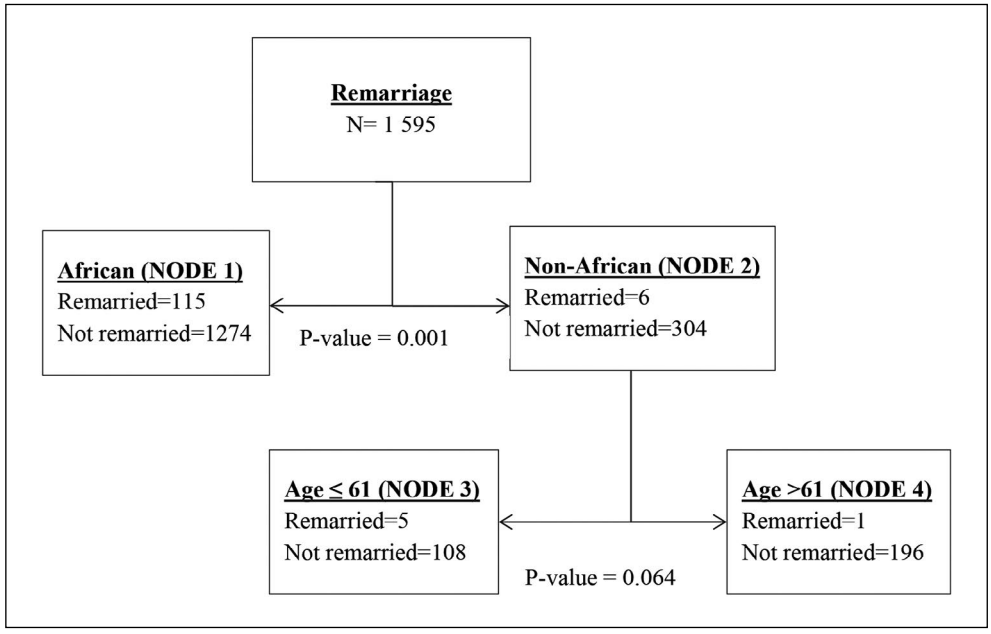

FIGURE 1. Tree diagram showing the results of the CHAID analysis

non-Africans where the probability of remarriage is calculated separately for those 61 and younger from those 62 and older.

6.4 Although the sample size of 1 595 widowed individuals may seem small, it is important to remember that this sample size is taken into account in the determination of the p-values. The sample size also compares favourably to the samples used in other studies to investigate the effect of factors on remarriage. For example, Davidson (2002) used a sample of 51 and Moorman et al. (2006) used a sample of 308.

6.5 The tree diagram shows that sex had no statistically significant effect on the propensity to remarry, even at a 10% significance level. This is somewhat surprising given that the literature in ¶2.1.1 suggested that widowers were expected to have higher remarriage rates than widows. This might be a result of the fact that widowers made up only 20.1% of the sample or may suggest that there is actually no sex effect.

6.6 Widowed Africans had significantly different remarriage rates to widowed non-Africans. The p-value of 0.1% indicates a high degree of statistical significance. It is important to note that CHAID cannot be used to prove causation. In other words, these results do not tell us that *all other things being equal*, an African widow or widower has different remarriage prospects to a non-African widow or widower. What the results do suggest is *that in the absence of other information*, the remarriage rates differ by race. This might be a result of underlying factors, including factors such as income, children, emotional support and health or might be a true race effect. In other words, race may be acting as a proxy variable.

6.7 It is interesting to note that the crude remarriage rates for Africans was approximately 8.3% as opposed to 1.9% for non-Africans. The literature discussed in ¶2.1.7 suggested that widowed Africans would have lower remarriage rates, not significantly higher rates. However, the most recent study in the literature was dated 2002 and hence the literature may be outdated. It is also noteworthy that Bumpass et al. (1990), Cleveland & Gianturco (1976) and Bramlett & Mosher (2002) did not study widowed South Africans.

6.8 There were no statistically significant differences by race in remarriage rates within the non-African group according to the CHAID analysis. This could reflect reality or could be a result of the small sample size, low remarriage rate within this group or age group simply being more significant.

6.9 Duration since widowhood was expected to be significant but was not found to be. This may be because at long durations, remarriage rates decrease with duration. However, remarriage rates also decrease with age and age was found to be significant for non-Africans. Hence the duration effect may no longer be significant once the age variable is taken into account.

6.10 The relationship between age and remarriage rate for non-African widows is not statistically strong. The Bonferroni adjusted p-value was 0.064. If only the first three waves of NIDS data are considered, widowed individuals under the age of 55 of all races were found to have significantly different remarriage rates than their older counterparts with a p-value of 0.005 (Laloo, unpublished). This decrease in the importance of current age to remarriage prospects should be tracked over future waves.

6.11 Education level was not found to be statistically significant. The literature discussed in 2.1.5 only found weak evidence for this relationship and hence this result is not overly surprising.

6.12 It is noteworthy that many of the findings of this analysis contrasted with previous literature. Notwithstanding the arguments presented above, one possible explanation might be that the literature is not directly applicable to widowed South Africans.

6.13 This could be a result of the literature being drawn from other countries and regions, for example:
— United States of America: Gentry & Shulman (1988), Carr (2004), Moorman et al. (2006), and Bramlett & Mosher (2002);
— Canada: Wu et al. (2015);
— United Kingdom: Davidson (2002); or
— Europe: Ahn (2005).

6.14 Alternatively, it may be because the data contained younger individuals than those included in some studies, for example Davidson (2002), Carr (2004) and Ahn (2005).

6.15 Most literature on remarriage considered remarriage in general and not only remarriage after widowhood, for example Bumpass et al. (1990). Dewilde & Uunk (2008) considered only divorced women instead of widows. James & Shafer (2012) found that divorced individuals remarry more quickly than widows in general but this differs by demographic factors and hence data for the divorced may or may not be helpful.

7. METHODOLOGY TO DETERMINE REMARRIAGE PROBABILITY

7.1 Willekens et al., (1982) and Smith et al. (1991) used a multiple-decrement model with Kolmogorov forward equations and a hazard rate model respectively to estimate the probability of remarriage. Neither of these methods were suitable for the NIDS data.

7.2 Thomson (1988) assumed that duration in widowhood was significant due to the literature available at the time and the existence of this relationship in UK data. This necessitated the creation of a select remarriage rate table where the select period was duration since widowhood. However, the results discussed in section 6 show that such a select table is not required.

7.3 The Kaplan-Meier estimator was used to find the probability of a widow remaining unmarried after a number of years.

7.4 The population was divided into the three terminal nodes from Figure 1. Within each group the number of years for which the widow has been widowed until the year of investigation or date of remarriage was identified. The exposed to risk for each year after widowhood was determined by finding the number of widows who have been widowed for at least that specific number of years at the date of investigation.

7.5 The widowed population not remarried after a particular duration was divided by the starting population to give the probability of remaining in the widowed state after a particular duration.

7.6 The force of remarriage was then estimated assuming that it was constant over all durations in each terminal node. This means that the instantaneous probability of remarriage does not differ by duration.

8. THE PROBABILITY OF REMARRIAGE: RESULTS AND DISCUSSION

8.1 The resultant forces and probability of remarriage are shown in Table 1.

TABLE 1. Forces of remarriage per group

Category	Force of remarriage	Annual probability of remarriage	Probability of remarriage before age 65
African	0.01440	1.4297%	8.3%
Non-African ≤ 61	0.00754	0.7512%	0.5%
Non-African > 61	0.00085	0.0850%	0.044%

8.2 The remarriage rates for both racial groupings are lower than those calculated by Laloo (unpublished) using only the first three waves of the NIDS data. These differences are particularly marked for younger widows. Mathematically, this is a result of very few remarriages recorded in waves 4 and 5 and an increased time period in which marriages could take place.

9. METHODOLOGY FOR CALCULATING THE CONTINGENCY DEDUCTION

9.1 Thomson's (1988) methodology for calculating the contingency deduction

9.1.1 Thomson (1988) suggests that the deduction can be expressed as a combination of the widow's future pecuniary gain from potential remarriage during the time that her late husband would have been alive and the value of the widow's future pecuniary loss from the loss of her late husband.

9.1.2 Thomson (1988) suggests that the value of the widow's future pecuniary loss from the loss of her late husband can be expressed as:

$$V_w = I_1 \int_s^{n_1} \left(\frac{Lm(x_1+t)}{Lm(x_1)} \right) \left(\frac{Lf(y+t)}{Lf(y+s)} \right) \exp\left(-\delta_i (t-s)\right) dt.$$

The terms used in the equation are defined as:

— s denotes the period that has elapsed between the date of delict and the date of settlement.
— y denotes the age of the widow at the date of delict.
— x_1 denotes the age of the late husband at the date of delict.
— I_1 denotes the widow's share of the net annual income of the late husband.
— $L_m(x_1)$ denotes the number of males in the model population in the age interval (x_1, x_1+dx) subject to the mortality of the specific population according to the life table for that population.
— $L_f(x)$ denotes the number of females in the model population in the age interval $(x, x+dx)$ subject to the mortality of the specific population according to the life table for that population.
— x_1+n_1 denotes the age at which the late husband would have ceased to earn an income but for his death.
— δ_i denotes the excess of the force of interest (net of tax) over the force of growth in the widow's share of net annual incomes.

9.1.3 Thomson (1988) expresses the widow's future pecuniary gain from potential remarriage during the time that her late husband would have been alive as:

$$V_r = I_2 \int_s^{n_1} \left(\frac{Lm(x_1+t)}{Lm(x_1)} \right) \exp\left(-\delta_i (t-s)\right) \int_s^{t} \left(\frac{Lf(y+t)}{Lf(y+u)} \right) \left(\frac{Lm(x_2+t)}{Lm(x_2+u)} \right) \left(\frac{Lr(y+u)}{Lr(y+s)} \right) F_r(y,u)\, du\, dt.$$

The terms in the above equation are defined as:

— x_2 denotes the presumed age of a future husband at the date of delict.
— I_2 denotes the widow's share of the presumed net annual income of a future husband.
— $L_r(y+s)$ denotes the number of women who were widowed at age y and remained widows for at least s years.
— $F_r(y,u)$ denotes the force of remarriage of widows exactly u years after widowhood at exact age y in the model population.
— x_2+n_2 denotes the assumed age at which a future husband will cease to earn an income if he survives.

9.1.4 The remarriage contingency deduction per unit of the damages as calculated in a particular case is then:

$$V = \frac{V_r}{V_w}.$$

9.2 Assumptions and parameterisation

9.2.1 Thomson's (1988) methodology required the use of mortality data and based on the remarriage rates described in section 8, sex affects the remarriage contingency only through the mortality rates applied. The mortality data were obtained from the Thembisa Model v 4.2. Since the NIDS data were initially collected in 2008 the mortality for this period was used in the calculation of the contingency deduction. It was assumed that all marriages were between heterosexual couples for ease of comparability to previous work.

9.2.2 Thomson (1988) found the remarriage contingency deduction as a proportion of the pecuniary loss of the widow assuming that the income of the new spouse is the same as the income of the late spouse, i.e. when $I_1 = I_2$. This corresponds with Steynberg (2007) but as discussed in ¶2.3.3, this assumption may not be appropriate in all circumstances. When $I_1 \neq I_2$ then we calculate V as if $I_1 = I_2$ and then determine it as:

$$V = \frac{I_2 V_r}{I_1 V_w}.$$

Also, if there are other deviations from the assumptions used for the calculation of V in this paper, so that the actual pecuniary loss before deduction for remarriage is V'_w, then, assuming proportionality, we may approximate the deduction using the formula:

$$V^* = \frac{V'_w}{V_w} V.$$

9.2.3 For the purposes of deriving the tables, it was assumed that all retirements happened at age 65. Hence $x_1 + n_1 = 65$ and $x_2 + n_2 = 65$.

9.2.4 A real discount rate of 2.5% was used to calculate the contingency deduction as this was in line with then current practice in RAF claims.

9.2.5 Thomson (unpublished) calculated remarriage contingency deductions for $s = 0$, $s = 1$, $s = 2$, $s = 3$ and $s = 4$. However, this is the select period that arises if the remarriage rate is contingent on duration since widowhood. No such select period was found in section 6 and hence $s = 0$ has been used to produce the contingency tables.

9.2.6 It is important to note that these formulae assume that the only way that the second marriage will end is through death. The formulae may over-estimate the contingency as the courts have noted that the remarriage may not last.[9]

10. CONTINGENCY DEDUCTIONS: RESULTS AND DISCUSSION

The contingency deductions calculated can be found in Appendices A and B. The tables show the deduction applicable to widowed individuals of different ages with the assumption of the new spouse aged 5 years younger (–5), the same age (0), 5 years older (5) or 10 years older (10) than the widowed. Appendix A contains the deductions applicable from the widow's point of view and Appendix B contains the deductions applicable from the

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widower's point of view. It is of interest to compare the contingency deductions to those in Thomson (unpublished) for $s = 0$. This is shown graphically in Figure 2.

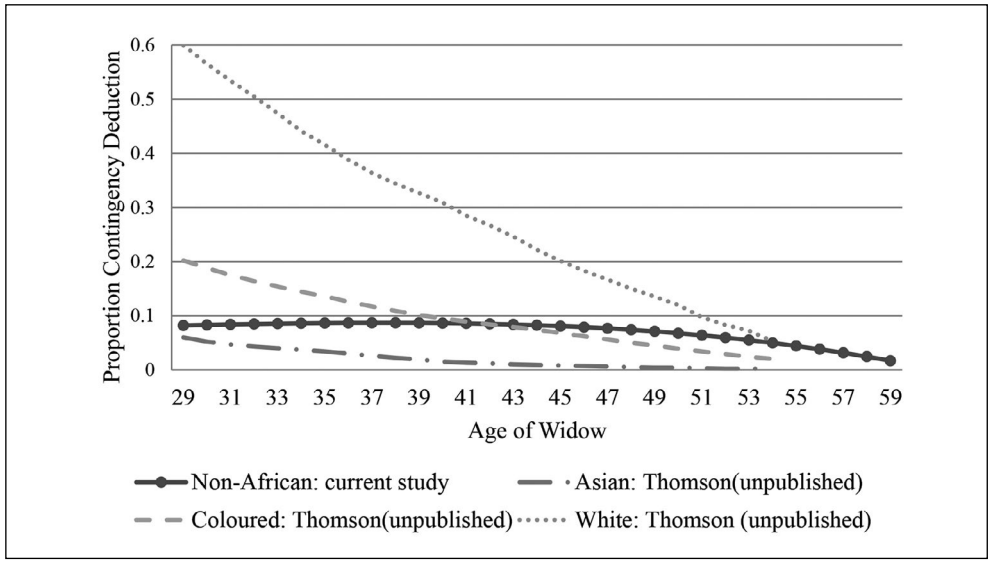

FIGURE 2. Contingency deductions from current and previous studies

10.1 Level relative to Thomson (1988)

10.1.1 It is clear that the contingency deduction for widowed whites is much higher in Thomson (1988) than what was calculated for non-Africans in this study even though the majority of widowed non-Africans are white. This study also suggests a reduced contingency deduction for widowed coloureds under 40 but a higher deduction for widowed coloureds over 40. This study suggests that widowed Asians/Indians would have higher contingency deductions at all ages than those calculated in Thomson (1988).

10.1.2 Koch (2011) suggests a contingency deduction for widowed Africans of 50% of the rates tabulated in Thomson (1988). However, these data suggest that the remarriage rate for widowed Africans is higher, not lower than for other groups. It is possible that this marked change is as a result of the recognition of customary marriages under South African law since 1998.[10]

10.1.3 A change in the level of remarriage rates, relative to 1988, is also unsurprising given that marriage is now only one of the ways that people can live together in mutual dependency (Steynberg, 2007). It is possible that some of the observed declines in remarriage are reflecting an increasing tendency to cohabit without marrying. In addition, changing income patterns within families now mean that a wife may have her own income. As discussed in section 2.1.6 and ¶2.2.2.2 this would affect the remarriage contingency.

10 Customary Marriages Act, Act 120 of 1998 as amended, Republic of South Africa

10.2 Level relative to the general contingency deduction

In *LD* v *RAF*,[11] the court found that the remarriage contingency could be catered for in the general contingency. The contingencies for the general hazards of life post-settlement date was 15%. The remarriage contingency deduction reaches 17.75% for widowed Africans and 9.20% for widowed non-Africans. These remarriage contingency deductions are thus high relative to the general contingency. This is unsurprising as the general contingency was not intended to cover remarriage.

10.3 Shape

10.3.1 The general trend in the deduction presented in Appendix B is cap-shaped. For Thomson's (1988) results, all three races showed a decreasing trend with Asians having the lowest contingency deductions at all ages and whites having the highest contingency deduction.

10.3.2 This change in shape may be a reflection of changing marriage age patterns. The median age at marriage and remarriage has been increasing over time and can be observed over as short a time span as five years (Statistics South Africa, 2021)

11. CONCLUSION

11.1 This represents the first attempt since Thomson (1988) to create remarriage contingency deductions for the South African population. These updated statistics may be useful for the courts. However, it is noteworthy that while the remarriage rates calculated allow for same-sex marriages, the remarriage contingencies presented in the appendices do not. The remarriage rates calculated are also more narrowly defined and hence lower than a more general repartnering contingency. The extension of the results for these circumstances is left to future research.

11.2 International literature suggests that race, sex, current age, duration since widowhood, income, children and education may all influence the probability of remarriage and financial circumstances on remarriage.

11.3 The NIDS data were unfortunately not useful for ascertaining the change in financial circumstances on remarriage. This is an important area of future research.

11.4 The data regarding income and children also meant that the impact of these factors on remarriage could not be thoroughly tested. Where income data were available it did not have a statistically significant effect, but data may not have been missing at random and being able to include these variables in future studies may lead to different results.

11.5 The data indicated that sex, education and duration since widowhood are not statistically significant determinants of the propensity to remarry, but race and current

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age are. This suggests that in the absence of information regarding income and children, applying different remarriage contingency deductions based on age is appropriate and there are statistical grounds for having different remarriage contingencies for Africans and non-Africans. However, when interpreting these racial differences, it is important to remember that race may be acting as a proxy variable for economic factors.

11.6 The resultant remarriage contingencies indicate that the current contingency deductions are too high for white and younger coloured widows and too low for older coloured and Asian widows. Some preliminary suggestions as to the reasons for these differences are provided in the discussion, however an in-depth analysis is left for future research.

11.7 For all widowed South Africans, the remarriage contingency deductions for widows and widowers in their late 40s are fairly high relative to the standard post-settlement general contingency deduction of 15%. This suggests that, while an adjustment to this general contingency deduction may be one way to account for the remarriage contingency, as was done in *LD* v *RAF*,[12] this may result in the widowed party's loss being overstated.

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REFERENCES

Ahn, N (unpublished). Financial consequences of widowhood in Europe. Working paper no. 32, European network of economic policy research institutes, 2005

Aslaksen, I, Wennemo, T & Aaberge, R (2005). 'Birds of a feather flock together': The impact of choice of spouse on family labor income inequality. *LABOUR* **19**(3), 491–515

Bishop, SL & Cain, AC (2003). Widowed young parents: Changing perspectives on remarriage and cohabitation rates and their determinants. *OMEGA* **47**(4), 299–312

Bramlett, MD & Mosher, WD (2002). Cohabitation, marriage, divorce, and remarriage in the United States. *Vital and health statistics* **23**(22), 1 – 93

Bumpass, L, Sweet, J & Martin, TC (1990). Changing patterns of remarriage. *Journal of Marriage and the Family* **52**(3), 747–56

Carr, D (2004). The desire to date and remarry among older widows and widowers. *Journal of Marriage and Family* **66**(4), 1051–68

Cleveland, WP & Gianturco, DT (1976). Remarriage probability after widowhood: A retrospective method. *Journal of Gerontology* **31**(1), 99–103

Coleman, M, Ganong, L & Fine, M (2000). Reinvestigating remarriage: Another decade of progress. *Journal of Marriage and Family* **62**(4), 1288–307

Davidson, K (2002). Gender differences in new partnership choices and constraints for older widows and widowers. *Ageing International* **27**(4), 43–60

Dewilde, C & Uunk, W (2008). Remarriage as a way to overcome the financial consequences of divorce—a test of the economic need hypothesis for European women. *European Sociological Review* **24**(3), 393–407

Gentry, M & Shulman, AD (1988). Repartnering as a coping response for widowhood. *Psychology and Aging* **3**(2), 191–96

Ivanova, K, Kalmijn, M & Uunk, W (2013). The effect of children on men's and women's chances of re-partnering in a European context. *European Journal of Population* **29**(4), 417–44

James, SL & Shafer, K (2012). Temporal differences in remarriage timing: Comparing divorce and widowhood. *Journal of Divorce & Remarriage* **53**(7), 543–58

Kass, GV (1980). An exploratory technique for investigating large quantities of categorical data. *Applied Statistics* **29**(2), 119–27

Koch, RJ (2011). Damages for personal injury and death: Legal aspects relevant to actuarial assessments. *SAAJ* **11**(1), 111–33

Laloo, M (unpublished). Factors affecting rates and models of remarriage after widowhood. Unpublished honours research report, University of the Witwatersrand, Johannesburg, 2014

McArdle, JJ & Ritschard, G (eds.) (2014). *Contemporary Issues in Exploratory Data Mining in the Behavioural Sciences*. Routledge, London

Moorman, SM, Booth, A & Fingerman, KL, (2006). Women's romantic relationships after widowhood. *Journal of Family Issues* **27**(9), 1281–304

Ozawa, MN & Yoon, H (2002). The economic benefit of remarriage. *Journal of Divorce & Remarriage* **36**(3–4), 21–39

Pasteels, I & Mortelmans, D (2017). The socioeconomic determinants of repartnering after divorce or separation in Belgium. *Demographic Research* **36(**58), 1785–812

Ritschard, G (2013). CHAID and Earlier Supervised Tree Methods. In McArdle & Ritschard (2014: 48–74)

Smith, KR, Zick, CD & Duncan, GJ (1991). Remarriage patterns among recent widows and widowers. *Demography* **28**(3), 361–74

Statistics South Africa (2021). Marriages and divorces, 2019. Statistical release P0307, Pretoria

Steynberg, L (2007). Re-partnering as a contingency deduction in claims for loss of support–comparing South African and Australian law. *Potchefstroom Electronic Law Journal* **10**(3), 2–25

Steynberg, L (2011). 'Fair' mathematics in assessing delictual damages. *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad* **14**(2), 1–35

Talbott, MM (1998). Older widows' attitudes towards men and remarriage. *Journal of Aging Studie*s **12**(4), 429–49

Thomson, RJ (unpublished). The determination of the deduction for remarriage from the pecuniary loss of a widow. Proceedings of the 10th Conference of the International Association of Consulting Actuaries, 1986

Thomson, RJ (1988). The determination of the deduction for remarriage from the pecuniary loss of a widow. *De Rebus* **67**, 8–24

Van der Nest, D & Nienaber, AG (2001). The good, the bad and the ugly: Contingency deductions for remarriage in the light of *Ongevallekommissaris* v *Santam*. *Journal for Juridical Science* **26**(2), 23–40

Vespa, J (2013). Relationship transitions among older cohabitors: The role of health, wealth, and family ties. *Journal of Marriage and Family* **75**(4), 933–49

UNU-WIDER & Oosthuizen, M (unpublished) Racial inequality and demographic change in South Africa: Impacts on economic development. UNU-WIDER Research Brief 2019/5, Helsinki, 2019.

Willekens, FJ, Shah, I, Shah, JM & Ramachandran, P (1982). Multi-state analysis of marital status life tables: Theory and application. *Population Studies* **36**(1), 129–44

Wu, Z, Schimmele, CM & Ouellet, N (2015). Repartnering after widowhood. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* **70**(3), 496–507

APPENDIX A
CONTINGENCY DEDUCTIONS FROM THE WIDOW'S POINT OF VIEW

TABLE A1. Contingency deductions for African females of different ages whose new spouse can be 5 years younger, the same age, 5 year older or 10 years older

Age of female	Age difference			
	–5	0	5	10
29	NA	0.150228	0.149456	0.143269
30	NA	0.152988	0.151457	0.144208
31	NA	0.155693	0.153347	0.144915
32	NA	0.158285	0.155086	0.145347
33	NA	0.16076	0.156647	0.145475
34	0.142921	0.163158	0.158011	0.1453
35	0.145642	0.165459	0.159151	0.144801
36	0.148325	0.16765	0.160044	0.143933
37	0.15093	0.16971	0.160661	0.142662
38	0.153452	0.171606	0.16097	0.140965
39	0.155911	0.173296	0.16095	0.138807
40	0.158286	0.174748	0.160576	0.136165
41	0.160561	0.175932	0.159791	0.133001
42	0.162714	0.176814	0.158556	0.129269
43	0.164707	0.177349	0.156835	0.124923
44	0.16651	0.177527	0.154597	0.119921
45	0.168101	0.177328	0.151824	0.114232
46	0.169443	0.176678	0.148466	0.107812
47	0.170502	0.175533	0.144466	0.100626
48	0.171245	0.173859	0.139776	0.092661
49	0.171652	0.171615	0.134344	0.083902
50	0.171701	0.168774	0.128126	0.074352
51	0.171333	0.165289	0.121081	0.064
52	0.170504	0.161099	0.113168	0.052827
53	0.169179	0.156147	0.104368	0.040821
54	0.16731	0.150362	0.094659	0.028011
55	0.16486	0.143683	0.08403	NA
56	0.161769	0.136048	0.072459	NA
57	0.157968	0.127397	0.059912	NA
58	0.153398	0.117703	0.046372	NA
59	0.147992	0.106936	0.031868	NA
60	0.141693	0.095088	NA	NA
61	0.134446	0.082135	NA	NA
62	0.126185	0.068037	NA	NA
63	0.11687	0.052763	NA	NA
64	0.106454	0.036336	NA	NA

TABLE A2. Contingency deductions for non-African females of different ages whose new spouse can be 5 years younger, the same age, 5 year older or 10 years older

Age of female	Age difference			
	–5	0	5	10
29	NA	0.082019	0.082008	0.077794
30	NA	0.083272	0.082932	0.078156
31	NA	0.084484	0.083793	0.078392
32	NA	0.08562	0.084569	0.078481
33	NA	0.086678	0.085248	0.078402
34	0.073832	0.087677	0.085824	0.078155
35	0.074771	0.088605	0.08628	0.077729
36	0.075651	0.089458	0.086602	0.077102
37	0.076447	0.090221	0.086776	0.076268
38	0.077152	0.090878	0.086779	0.075213
39	0.077771	0.091408	0.086598	0.073922
40	0.078288	0.091789	0.086221	0.072382
41	0.078691	0.092002	0.085618	0.070578
42	0.078913	0.09199	0.084784	0.068488
43	0.078975	0.091761	0.083697	0.066086
44	0.078858	0.091302	0.082345	0.063352
45	0.07854	0.090602	0.080719	0.060268
46	0.077991	0.089622	0.078795	0.056809
47	0.077182	0.088335	0.076548	0.052962
48	0.076077	0.086713	0.073951	0.048728
49	0.074648	0.084729	0.070977	0.044098
50	0.072864	0.082351	0.067602	0.03906
51	0.070677	0.079545	0.063804	0.033591
52	0.068039	0.07626	0.059565	0.027711
53	0.064849	0.072396	0.054886	0.021409
54	0.061081	0.067917	0.049753	0.014686
55	0.056658	0.062736	0.044145	NA
56	0.051482	0.056742	0.038031	NA
57	0.045333	0.049702	0.031427	NA
58	0.03814	0.041493	0.024321	NA
59	0.029704	0.031776	0.016708	NA
60	0.019767	0.019956	NA	NA
61	0.007968	0.004848	NA	NA
62	0.007469	0.004013	NA	NA
63	0.006912	0.003112	NA	NA
64	0.006292	0.002142	NA	NA

APPENDIX B
CONTINGENCY DEDUCTIONS FROM THE WIDOWERS POINT OF VIEW

TABLE B1. Contingency deductions for African males of different ages whose new spouse can be 5 years younger, the same age, 5 year older or 10 years older

Age of male	Age difference			
	–10	–5	0	5
29	NA	NA	0.150228	0.142921
30	NA	NA	0.152988	0.145642
31	NA	NA	0.155693	0.148325
32	NA	NA	0.158285	0.15093
33	NA	NA	0.16076	0.153452
34	NA	0.149456	0.163158	0.155911
35	NA	0.151457	0.165459	0.158286
36	NA	0.153347	0.16765	0.160561
37	NA	0.155086	0.16971	0.162714
38	NA	0.156647	0.171606	0.164707
39	0.143269	0.158011	0.173296	0.16651
40	0.144208	0.159151	0.174748	0.168101
41	0.144915	0.160044	0.175932	0.169443
42	0.145347	0.160661	0.176814	0.170502
43	0.145475	0.16097	0.177349	0.171245
44	0.1453	0.16095	0.177527	0.171652
45	0.144801	0.160576	0.177328	0.171701
46	0.143933	0.159791	0.176678	0.171333
47	0.142662	0.158556	0.175533	0.170504
48	0.140965	0.156835	0.173859	0.169179
49	0.138807	0.154597	0.171615	0.16731
50	0.136165	0.151824	0.168774	0.16486
51	0.133001	0.148466	0.165289	0.161769
52	0.129269	0.144466	0.161099	0.157968
53	0.124923	0.139776	0.156147	0.153398
54	0.119921	0.134344	0.150362	0.147992
55	0.114232	0.128126	0.143683	0.141693
56	0.107812	0.121081	0.136048	0.134446
57	0.100626	0.113168	0.127397	0.126185
58	0.092661	0.104368	0.117703	0.11687
59	0.083902	0.094659	0.106936	0.106454
60	0.074352	0.08403	0.095088	NA
61	0.064	0.072459	0.082135	NA
62	0.052827	0.059912	0.068037	NA
63	0.040821	0.046372	0.052763	NA
64	0.028011	0.031868	0.036336	NA

TABLE B2. Contingency deductions for non-African males of different ages whose new spouse can be 5 years younger, the same age, 5 year older or 10 years older

Age of male	Age difference			
	–10	–5	0	5
29	NA	NA	0.082019	0.073832
30	NA	NA	0.083272	0.074771
31	NA	NA	0.084484	0.075651
32	NA	NA	0.08562	0.076447
33	NA	NA	0.086678	0.077152
34	NA	0.082008	0.087677	0.077771
35	NA	0.082932	0.088605	0.078288
36	NA	0.083793	0.089458	0.078691
37	NA	0.084569	0.090221	0.078913
38	NA	0.085248	0.090878	0.078975
39	0.077794	0.085824	0.091408	0.078858
40	0.078156	0.08628	0.091789	0.07854
41	0.078392	0.086602	0.092002	0.077991
42	0.078481	0.086776	0.09199	0.077182
43	0.078402	0.086779	0.091761	0.076077
44	0.078155	0.086598	0.091302	0.074648
45	0.077729	0.086221	0.090602	0.072864
46	0.077102	0.085618	0.089622	0.070677
47	0.076268	0.084784	0.088335	0.068039
48	0.075213	0.083697	0.086713	0.064849
49	0.073922	0.082345	0.084729	0.061081
50	0.072382	0.080719	0.082351	0.056658
51	0.070578	0.078795	0.079545	0.051482
52	0.068488	0.076548	0.07626	0.045333
53	0.066086	0.073951	0.072396	0.03814
54	0.063352	0.070977	0.067917	0.029704
55	0.060268	0.067602	0.062736	0.019767
56	0.056809	0.063804	0.056742	0.007968
57	0.052962	0.059565	0.049702	0.007469
58	0.048728	0.054886	0.041493	0.006912
59	0.044098	0.049753	0.031776	0.006292
60	0.03906	0.044145	0.019956	NA
61	0.033591	0.038031	0.004848	NA
62	0.027711	0.031427	0.004013	NA
63	0.021409	0.024321	0.003112	NA
64	0.014686	0.016708	0.002142	NA

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Quantitative guidelines for retiring (more safely) in South Africa

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ABSTRACT

In this paper we present guidelines for safe withdrawal rates from a living annuity (income drawdown accounts), periodically, to cover living expenses. In essence, a retiree is faced with the risk management problem of outliving their retirement fund (withdrawing too much) versus living below their means (withdrawing too little). The empirical evidence in the literature advocates for a 'safe' 4% annual withdrawal (or spending) rate. Therefore, the object of this paper is to examine withdrawal rates for retirees in the South African economy. Furthermore, we carry out a simulation study using historical data while incorporating longevity and fund management fees. Our analysis emphasises the risks associated with different withdrawal rates and asset allocations. We then give an example of how derivative instruments can increase the success rate of a retirement portfolio.

KEYWORDS

Retirement planning; safe spending rates; income drawdown accounts

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1. INTRODUCTION

1.1 Retirement planning is an important topic for actuaries and financial advisors as it plays a vital role in society, especially in an era of increasing longevity. The demographer, James Vaupel, is reported to have said that "half of the children born in Sweden in 2012 will live to be 104".[1] Moreover, reports of increased longevity abound; see for example, Innovation Hub (Purdy, 2015) reports, "the first person to live to 150 has already been born." In Table 1, we illustrate how life expectancy (and conditional life expectancy) has increased globally over time.[2]

TABLE 1. Life expectancy at birth, at age 60, for global and South African citizens of all sexes

Year	Region	Life expectancy at birth			Life expectancy at age 60		
		Male	Female	Both sexes	Male	Female	Both sexes
2000	Global	64.4	68.7	66.5	17.2	20.2	18.2
	RSA	56.1	62.0	59.0	13.4	17.8	15.7
2005	Global	66.1	70.3	68.2	17.8	20.7	19.3
	RSA	52.6	56.2	54.4	13.4	17.8	15.7
2010	Global	68.0	72.3	70.1	18.4	21.3	19.9
	RSA	55.6	60.4	58.0	1.6	18.1	16.0
2016	Global	69.8	74.2	72.0	19.0	21.9	20.5
	RSA	60.2	67.0	63.6	14.0	18.8	16.6

1.2 Increased longevity does, however, pose challenges. In a recent study, Allianz (2010)[3] surveyed US adults aged between 44 and 75; of the people surveyed, 61% reported being more afraid of outliving their financial assets than dying! Similar findings were reported in a recent survey in the UK,[4] where the majority of the people surveyed believed they were not currently saving enough for retirement.

1.3 To illustrate some of the concerns faced by retirees, we need to look at life expectancy post-retirement. Richman (2017) studied the mortality of those aged 75 and above in the South African population, where he found mortality improvement rates of 0.7% and 0.1% per annum over the period 1985–2011 for males and females respectively. However, mortality rates for the population can be quite different to that of insured (or pensioner) lives. The most recent report focusing on mortality rates of insured (or pensioner) lives in a South African context can be found in CSI (2017) covering the period 2005–2010. Furthermore, Richman &

1 Ennart, H (2012). *Åldrandets gåta* [*The Mystery of Aging*]. Stockholm, Ordfront
2 World Health Organization (2020). Global health observatory data repository. Retrieved from https://apps.who.int/gho/data/view.main.SDG2016LEXv?lang=en
3 Allianz (2010). Outliving your money feared more than death. Online.
4 Institute and Faculty of Actuaries (2019). Savings goals for retirement: Policy briefing. Retrieved from https://www.actuaries.org.uk/system/les/eld/document/Saving.

Velcich (2020) studied insured (or pensioner) lives mortality improvements in South Africa, where they found that from their sample, that mortality improvements are slowing down at all ages.

1.4 It is evident from most recent reports on pensioner mortality in South Africa (CSI, 2017; Richman, 2017; Richman & Velcich, 2020) that pensioners who reach their retirement years could face 20 more years of life with substantial probability. The retiree, therefore, needs to understand the balance between periodic inflation adjusted payments to sustain living expenses and avoid running out of capital—all given an inherently volatile investment environment (e.g., Scott et al., 2009).

1.5 In studies carried out by Butler & Van Zyl (2012a; 2012b), it was found that consumption rates after retirement do not tend to decrease, as popularly believed, and may suggest the need of an upward adjustment of retirement adequacy goals. Furthermore, they conclude that based on their analysis, retirement before the age of 67 is unlikely to be affordable for most households. Cooley et al. (1998) note:

> Most investors who plan for retirement eventually confront the question of how much money they should plan to withdraw from their investment portfolio. The dilemma is that if they withdraw too much, they prematurely exhaust the portfolio, but if they withdraw too little, they unnecessarily lower their standard of living.

1.6 Their conclusions, the so-called '4% safe withdrawal rate', derived for the US-market are often used as a rule-of-thumb by advisors to guide to 'safe' inflation-adjusted spending by retirees (see also Bengen, 1994).

1.7 In South Africa, retirees typically choose between so-called single life guaranteed annuities and living annuities[5] with their retirement proceeds. A single life guaranteed annuity is an insurance contract that covers the insured pensioner for life and yields a defined income. So-called living annuities allow the pensioner freedom to invest in a wide spectrum of investment vehicles while drawing a monthly amount for pension—currently limited by South African law to between 2.5% and 17.5% per annum. A guaranteed annuity will typically leave no benefit to the pensioner's estate, whereas a living annuity could bequeath a substantial amount to their estate.

1.8 The 4% safe withdrawal rate studies by Cooley et al. (1998; 1999) were performed for retirees in the United States. In Table 2, we demonstrate differences between asset class returns in the United States and South Africa (over the period 1900 to 2015) using reference returns from Dimson et al. (2016). Real asset-class returns are similar in both countries, however, we note that South African inflation is typically significantly higher (and more volatile) than inflation in the United States.

5 Typically referred to as income drawdown accounts in international markets.

TABLE 2. AM/GM arithmetic/geometric mean returns % p.a.

		Asset class returns					
		US			RSA		
	Asset class	AM	GM	Std Dev	AM	GM	Std Dev
Nominal	Equities	11.4%	9.4%	19.9%	14.7%	12.6%	22.9%
	Bonds	5.3%	4.9%	9.0%	7.2%	6.8%	9.6%
	Cash	3.8%	3.8%	2.9%	6.1%	6.0%	5.5%
	Inflation	3.0%	2.9%	4.8%	5.2%	4.9%	7.3%
Real	Equities	8.3%	6.4%	20.1%	9.4%	7.3%	22.1%
	Bonds	2.5%	2.0%	10.4%	2.3%	1.8%	10.5%
	Cash	1.0%	0.8%	4.6%	1.2%	1.0%	6.1%

1.9 Given the importance of retirement planning, a number of research papers can be found in the literature (see, for example, Milevsky & Huang, 2011; Butler & van Zyl, 2012b; Waring & Siegel, 2015; Maré, 2016; Rusconi, 2020; Klein & Sapra, 2020). Moreover, Maré (2016) considers safe withdrawal rates in the South African context using different asset allocations between stocks and bonds, and Rusconi (2020) considers regulatory and government policies in the South African context.

1.10 Although there have been numerous studies on safe withdrawal rates for different asset allocations, fewer studies incorporate transactional fees (costs) and longevity into the analysis. Therefore, the aim of our research is to:

— extend the research done by Maré (2016) by examining withdrawal rates (read synonymously with spending rates) in living annuities for South African retirees using an extended dataset of historical asset class returns from 1900 to 2020 for equity, bonds, cash, and inflation. A basic requirement for any statistical analysis is that some of the statistical properties of the data under study remains stable over time, which corresponds to the stationarity hypothesis (see Cont, 2001). In the analysis, we also considered reducing the historical dataset to more recent historical returns, where we found no difference in the results.
— incorporate transactional fees (costs) and longevity into the analysis. Longevity is a key component in measuring the success of a portfolio, as a portfolio needs to outlast the individual's life expectancy and not a predestined time of, for example, 30 years. Therefore, a typical question would be to ask whether a 5% annual spending rate remains sustainable for South African retirees. Since life expectancy is a vital part of retirement portfolio success, we incorporate the conditional probability of surviving into our simulation.
— consider the impact of hedging some of the downside of the equity market on the portfolio safety.

1.11 Furthermore, we concur with Rusconi (2020) that research of this nature is highly relevant given the well-established markets in South Africa. The data and asset classes used for this study are primarily based on South African assets.

1.12 An outline of the rest of the paper is as follows. In Section 2 we provide detail of our general simulation methodology, which is based on randomly sampling (with replacement) returns in a Monte Carlo simulation based on historical returns. We provide results in Section 3 with details on probabilities of depleting capital for various periods of investment. We provide relevant conclusions and areas for further investigation in Section 4.

2. METHODOLOGY

Cooley et al. (1998; 1999) and Bengen (1994) use a methodology of overlapping periods (also referred to as rolling periods) to calculate end-of-period portfolio values from equities and bond returns. Cooley et al. (2003) also consider a Monte Carlo-based simulation based on the distributional characteristics of the asset classes. In our study we calculate end-of-period portfolio values from equities, bonds, and cash based on a bootstrap simulation analysis of the historical asset returns.

2.1 Portfolio make-up

2.1.1 The retirement portfolio process is typically structured as follows: an asset allocation is decided based on advice from the retiree's financial advisor, with the portfolio weights updated annually (typically at the start of each year). In the cash account, we place a forecasted amount to be withdrawn from the portfolio for the year based on the particular withdrawal rate at retirement and the December inflation rate. Thus, the monthly retirement spending is withdrawn from the cash account. The remaining portfolio value is rebalanced between equity, bonds, and cash according to the specified weighting structure.

2.1.2 In practice, institutions often demand a fee, such as advisor fees, for managing a retirement portfolio. These costs could have a significant impact on the success of a retirement portfolio and should be taken into account in retirement planning. Often there are three costs associated in the managing of a retirement portfolio, namely fund management fees, platform fees, and advisor fees. The fund management fees are typically structured as follows:

— Cash: 0.25% p.a.
— Bonds: 0.5% p.a.
— Equity: 0.75% p.a.

where the platform and advisor fees are 0.5% and 1%, respectively, of the total portfolio value per annum.

2.2 The data

2.2.1 In this study, we will be making use of historical asset class returns as a guide to future returns. The data used comprises historical equity, bonds, cash, and inflation total return performances in South Africa for the period 1900 to 2020.[6] This data consisted of monthly and yearly rates (see Table 3). When only yearly rates were available, we

6 Sourced from Firer & McLeod (1999), Firer & Staunton (2002), and I-Net.

approximated the monthly rates by using the 12th root function of the yearly return rate and adjusting this rate with a monthly seasonal adjustment factor based on average corresponding returns so that the monthly returns match the yearly return.

TABLE 3. Data summary

	Yearly data	Monthly data
Equity	1900–1959	1925–2020
Bonds	1900–1945	1946–2020
Cash	1900–1928	1929–2020
Inflation	1900–1938	1939–2020

2.2.2 The stylised facts present in the data are generally not easy to exhibit by using stochastic processes,[7] hence the preferred use of historical returns in this simulation study. Although, historical returns do not necessary reflect future returns, the underlying statistical properties, to some extent, remain stable over time. Figure 1a through Figure 1c show the historical monthly returns over the period 1900 to 2020 for a portfolio consisting of equity, bonds and cash in South Africa. While the individual asset-class returns are summarised in Table 2, portfolios typically consist of a range of asset classes. Therefore, in Figure 1, we show the historical returns for a typical balanced portfolio asset allocation. The sample correlation matrix, based on total returns, is shown in Table 4.

TABLE 4. Correlation matrix

	Equity	Bonds	Cash	Inflation
Equity	1.0000	0.2434	0.0455	0.0342
Bonds	0.2434	1.0000	0.2144	0.0332
Cash	0.0455	0.2144	1.0000	0.4391
Inflation	0.0342	0.0332	0.4391	1.0000

2.2.3 It is worthwhile to note that the South African equity market has witnessed a period of low growth over the last decade, in line with emerging markets, whereas the USA has had a tremendous equity bull market over the same period. Withdrawals from a retirement fund under a bear market are far more costly than withdrawals under a bull market and could drastically reduce the success of the fund. This is known as sequence risk.[8]

2.2.4 It is important to note that our analysis is based on index returns; this decision is based on data limitations—the longest representative dataset available is limited to equity, bond and cash returns. Furthermore, growth assets here are represented by equities, while we would typically add some property exposure in practice as well. In the fixed income

7 See, for example, Cont (2001).
8 See, for example, Blanchett et al. (2013).

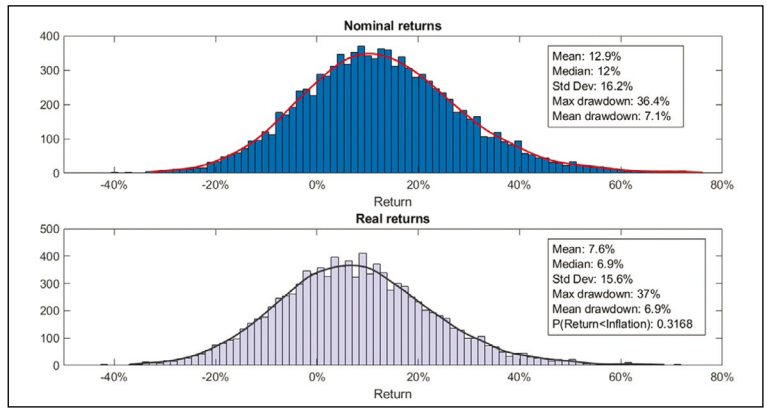


FIGURE 1A. Portfolio (90% equity and 10% cash) return

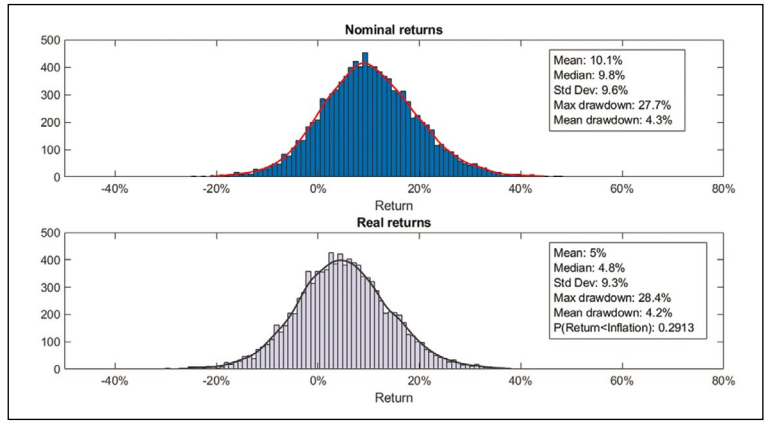


FIGURE 1B. Portfolio (50% equity, 40% bonds and 10% cash) return

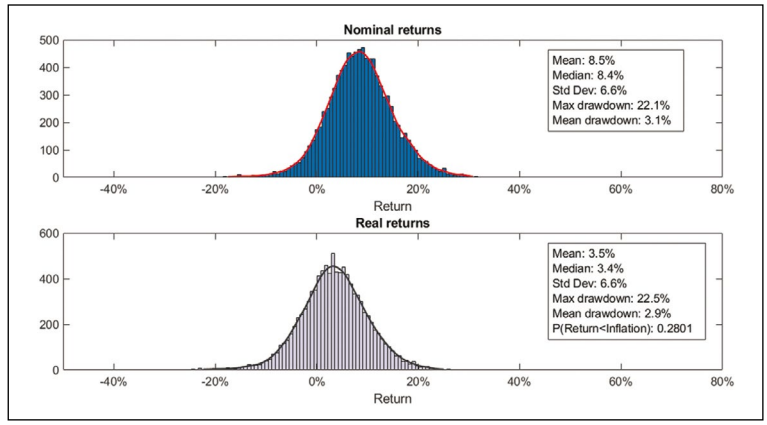


FIGURE 1C. Portfolio (25% equity, 65% bonds and 10% cash) return

FIGURE 1: Yearly returns for three scenarios of asset class allocations from 1900 to 2020

investment space one would typically choose between a variety of bonds, which could alter risk/return ratios relative to the index-based returns contained in the data.

2.3 Simulation by random sampling

2.3.1 Our methodology is based on a Monte Carlo simulation using the historical return data for our asset classes (see Figure 1). Our data consist of monthly South African total returns for each asset class, i, namely cash, bonds and equity (i.e., we assume full reinvestment of interest, dividend proceeds and incidental accruals) over the period January 1900 to April 2020, i.e., $X_1^{(i)}, X_2^{(i)}, \ldots, X_{1444}^{(i)}$. From these historical returns we assume each X_j has equal probability of being selected. Furthermore, the j^{th} sampled return is then used across all asset classes to keep the correlation structure intact. Therefore, each path constitutes a random scenario based on the monthly bootstrapped returns.

2.3.2 We consider an investment portfolio with a yearly rebalanced fixed asset allocation between equities, bonds and cash, and draw an income from the cash account on a monthly basis (income is adjusted monthly for inflation, i.e., we look at real spending rates). Firstly, we consider the Monte Carlo simulation over fixed investment periods of 15, 20, 25 and 30 years, assuming no mortality, indicating the intended holding period of the portfolio for the retiree. It is important to consider success rates for a fixed investment period, as it gives a retiree a better understanding for retirement planning as the retiree's longevity is unknown. Secondly, we consider the simulation incorporating longevity using the South African pensioner mortality tables (CSI, 2017) covering mortality in the years 2005–2010, and thirdly, we incorporate portfolio costs into the simulation. The monthly portfolio value is, therefore, a function of the simulated investment returns less the inflation-adjusted amounts withdrawn (inclusive of levied costs) by the retiree.

2.3.3 We consider a portfolio to be successful if it has capital left at the end of the specific investment period considered. We report the portfolio success rates, i.e., the percentage of portfolio values that are non-negative at the end of an investment period based on the simulations described above (see Bengen, 1994; Cooley et al., 1998, 1999). It is important to note that our analysis does not account for taxes; although, in principle, these can easily be taken into account.

3. RESULTS

3.1.1 Practically, safe withdrawal rates are heavily dependent on the retiree's longevity. In Table 5, we demonstrate portfolio success rates as a function of spending rates versus varying asset allocations over a period of 15, 20, 25, and 30 years, ignoring longevity. Specifically, the full year's withdrawal amount is placed into a cash account at the beginning of each year, and the remaining portfolio value is allocated between equity and bonds.

3.1.2 It is evident from the table that higher spending levels result in portfolios that will fail the retiree within the total investment period, independent of the chosen asset allocation. It is, however, interesting to note from the results that portfolios with more growth assets, such as equities, have a higher propensity for success than portfolios that are more fixed-income oriented.

3.1.3 To measure the extent of ruin, it is also instructive to consider the conditional expected time to failure of the portfolio—we call this the fugit.[9] More specifically, in this context, the fugit is defined to be the expected life of the portfolio given that the portfolio was unsuccessful before the intended holding period, e.g., 30 years. The fugit is expressed in monthly periods; 200 months would, for example, mean the average failed portfolio lasts 200 months out of the full intended investment period of 360 months. In Table 6, we demonstrate the portfolio fugit along with the standard deviation in the time to ruin as a function of spending rates versus varying asset allocations over a period of 30 years.

TABLE 5. Portfolio success rate given withdrawal rate vs asset allocation (equity, bonds & cash) over 30-year period

Payout period	4%	5%	6%	7%	8%	9%	10%
100% equity							
15 years	100%	99%	96%	88%	80%	67%	54%
20 years	98%	94%	87%	75%	62%	47%	33%
25 years	96%	89%	78%	64%	49%	36%	24%
30 years	94%	84%	70%	56%	42%	29%	19%
75% equity / 25% bonds							
15 years	100%	99%	97%	91%	79%	63%	43%
20 years	99%	96%	86%	71%	53%	36%	21%
25 years	97%	89%	75%	56%	38%	22%	12%
30 years	94%	83%	66%	46%	28%	16%	8%
50% equity / 50% bonds							
15 years	100%	100%	98%	92%	75%	51%	29%
20 years	100%	97%	85%	64%	38%	19%	7%
25 years	98%	88%	66%	40%	19%	7%	2%
30 years	95%	78%	51%	26%	10%	4%	1%
25% equity / 75% bonds							
15 years	100%	100%	99%	90%	63%	30%	9%
20 years	100%	97%	77%	42%	13%	3%	0%
25 years	98%	81%	43%	13%	2%	0%	0%
30 years	91%	59%	22%	4%	1%	0%	0%
100% bonds							
15 years	100%	100%	97%	74%	34%	8%	1%
20 years	99%	89%	48%	12%	2%	0%	0%
25 years	90%	48%	10%	1%	0%	0%	0%
30 years	66%	20%	2%	0%	0%	0%	0%

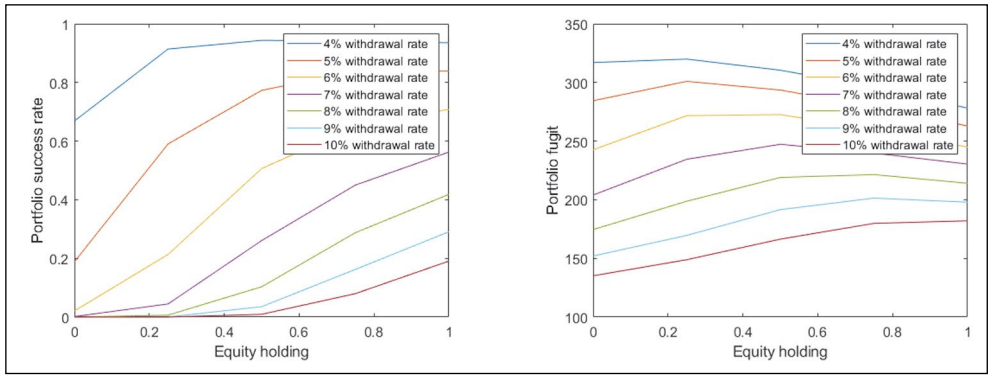
9 The term 'fugit' was first introduced by Garman (1989) and was used to represent the optimal date to exercise an American option.

3.1.4 A key conclusion from Table 6 pertains to the spending rate—to sustain higher spending rates a retiree needs to be willing to allocate more to risk-bearing assets. This can be seen by the shaded values in Table 6 which represents the largest expected time to ruin for each withdrawal rate. However, this strategy comes with an increase in the variation in the time to ruin. This needs to be clearly understood and forms a key consideration in the financial advisor discussion process. Asset allocation appears to be of lesser concern when spending is low.

TABLE 6. Fugit given withdrawal rate and asset allocation (equity, bonds & cash) over 30-year period

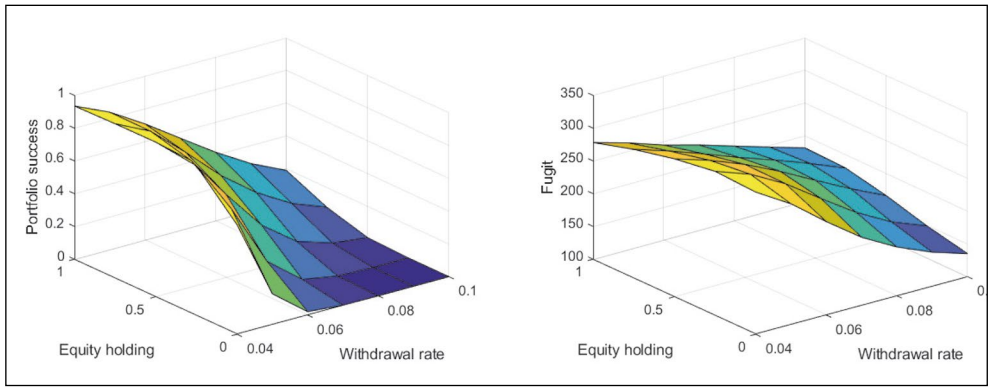
	Withdrawal rate						
Asset allocation	4%	5%	6%	7%	8%	9%	10%
100% stocks							
Mean	272.8	262.4	247.1	230.4	212.7	198.1	181.2
Standard deviation	53.6	56.9	61.1	63.6	64.6	64.5	63.2
75% stocks/25% bonds							
Mean	291.7	275.0	259.2	241.8	219.7	200.1	178.8
Standard deviation	45.7	50.8	55.7	59.1	59.9	59.7	56.2
50% stocks/50% bonds							
Mean	306.4	293.3	272.0	245.5	218.4	191.2	165.8
Standard deviation	37.1	44.9	50.1	53.4	53.2	50.0	42.4
25% stocks/75% bonds							
Mean	318.7	299.5	269.4	232.7	197.2	168.8	147.7
Standard deviation	30.8	39.2	45.2	44.9	38.0	29.0	23.4
100% bonds							
Mean	315.7	283.9	241.9	203.0	173.3	151.5	134.2
Standard deviation	30.3	39.4	39.6	31.9	25.2	20.0	16.2

3.1.5 In Figure 2 and Figure 3, we show the portfolio success rates across different withdrawal rates and equity holdings, thus confirming that portfolios with higher success and longevity have larger equity allocation. In Figure 4, we show some descriptive measures calculated from the 10 000 Monte Carlo simulations with a 75% equity ratio and a 5% initial portfolio withdrawal. Although we expect the portfolio to have a positive balance at $T=30$ years, it is also evident from Figure 4a that there is a 5% chance that the portfolio will run out of money within 245 months (i.e., approximately 20 years). This is obviously not a desirable outcome for retirees, even with low probability. In Figure 4b, we show the conditional probability of portfolio success at time, t, given success at time, $t-1$, where $t \in [0,360]$ months. We note that the conditional probability of success drastically increases from around 200 months, indicating the importance of effective early portfolio management.



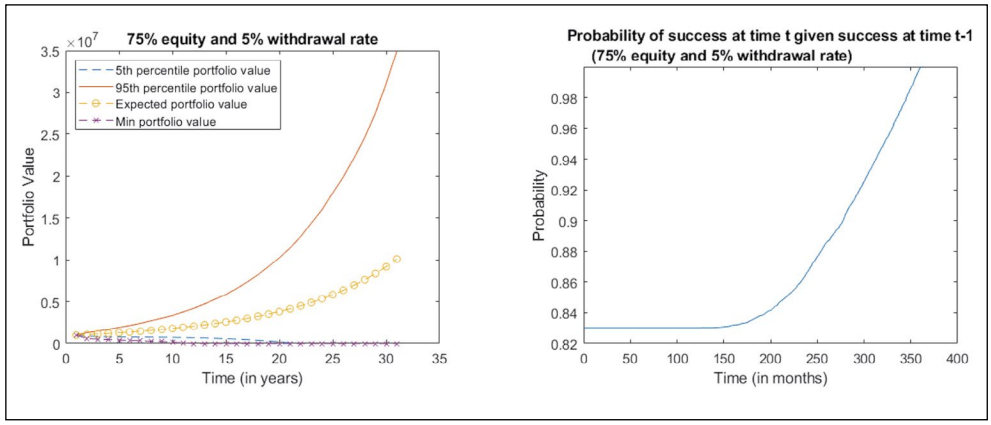
(a) Portfolio success (b) Portfolio fugit

FIGURE 2. Portfolio success and fugit over a 30-year period



(a) Portfolio success (b) Portfolio fugit

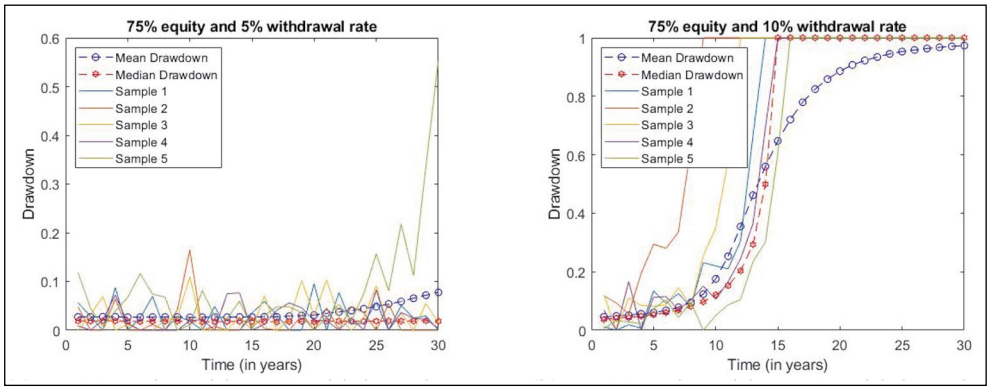
FIGURE 3. Portfolio success and fugit over a 30-year period



(a) Portfolio value over time (b) Portfolio success probability over time

FIGURE 4. Portfolio descriptive measures over time

3.1.6 Figure 5 shows the mean and median drawdown per year (measured as a proportion of the portfolio value) for the 10 000 simulated scenarios. Due to the inflation adjusted withdrawals, the drawdown increases exponentially over time. Furthermore, we also show the drawdown for the first five simulations.



(a) 75% equity with a 5% withdrawal rate (b) 75% equity with a 10% withdrawal rate

FIGURE 5. Drawdown as a portion of the portfolio capital; the figures also include five sample paths of the 10 000 simulated paths)

3.1.7 Furthermore, the relationship between the mean yearly drawdown (as a proportion of the portfolio value), and fugit is shown in Figure 6. The inverse relationship between the mean yearly drawdown and fugit is clearly evident in Figure 6, where an average yearly drawdown in excess of 10% is unlikely to last for a 30-year period.

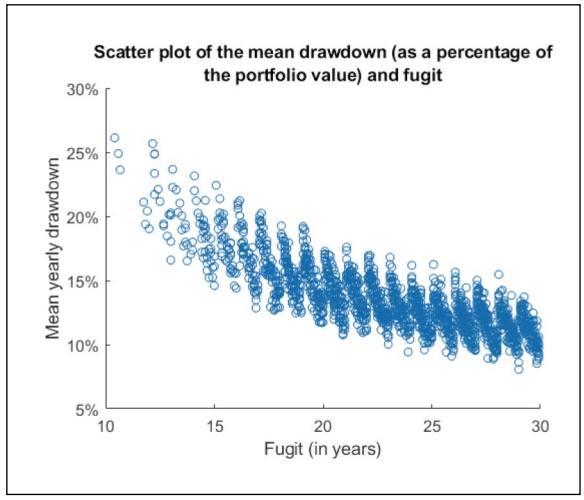


FIGURE 6. Relationship between the mean yearly drawdown (as a portion of the portfolio value) and fugit

3.1.8 In Table 7, we incorporate longevity into our simulation. Here we are simulating the portfolio given the conditional probability of surviving[10] between x and $x+t$. Factoring longevity into the simulation improved the expected success rates of the portfolio. Furthermore, in Table 8, we factor fund management costs into the simulation. In our analysis, costs reduced the portfolio success by up to 4%. This is obviously not a desirable outcome on an already strained problem.

TABLE 7. Success rates with longevity

	Withdrawal rate as percentage of initial investment value						
Asset allocation	4%	5%	6%	7%	8%	9%	10%
100% equity/0% bonds	99%	96%	92%	87%	79%	72%	63%
75% equity/25% bonds	99%	97%	92%	85%	75%	66%	58%
50% equity/50% bonds	99%	97%	90%	80%	70%	60%	51%
25% equity/75% bonds	99%	94%	84%	72%	61%	52%	45%
0% equity/100% bonds	97%	87%	74%	63%	53%	46%	40%

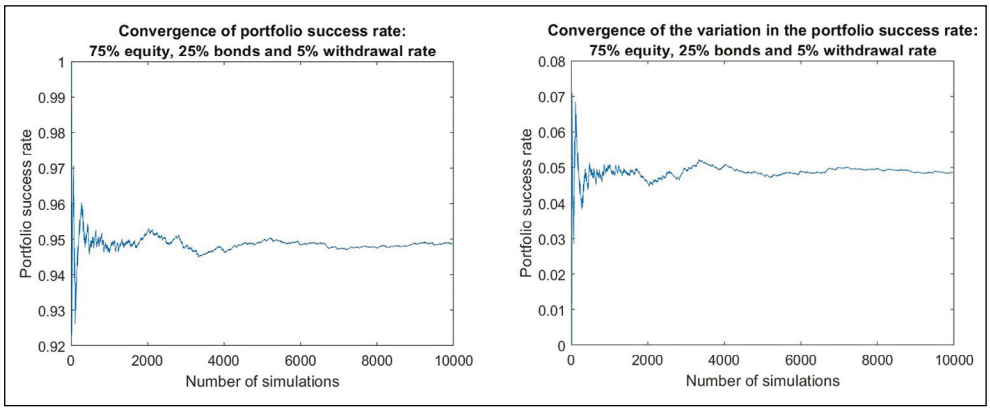
TABLE 8. Success rates with fund costs and longevity

	Withdrawal rate as percentage of Initial investment value						
Asset allocation	4%	5%	6%	7%	8%	9%	10%
100% equity/0% bonds	98%	95%	89%	82%	75%	67%	58%
75% equity/25% bonds	99%	95%	89%	80%	71%	61%	54%
50% equity/50% bonds	99%	94%	86%	76%	64%	55%	47%
25% equity/75% bonds	98%	91%	79%	66%	56%	48%	42%
0% equity/100% bonds	94%	82%	69%	59%	50%	44%	39%

3.1.9 The convergence of the sample mean and variance of portfolio success rates is shown in Figure 7. Qualitatively, we see that the convergence graphs reach a flat region, indicating convergence of the sample moments.

3.1.10 Retirees are often advised to carry portfolios with lower risk at retirement. That is, they are advised to hold portfolios that have a larger asset allocation in fixed income and cash-based securities. In Table 9, we show that this could drastically reduce the success rates of a portfolio.

10 The conditional survival probabilities for the simulation were obtained from CSI (2017).



(a) Convergence of the mean portfolio success rates

(b) Convergence of the variation in the portfolio success rates

FIGURE 7. Convergence of the sample mean and variance of portfolio success rates as functions of the number of Monte Carlo simulations

TABLE 9. Portfolio with larger cash allocation

	Withdrawal rate as percentage of initial investment value						
Asset allocation	4%	5%	6%	7%	8%	9%	10%
85% equity/0% bonds/15% cash	55%	48%	42%	37%	33%	30%	27%
75% equity/10% bonds/15% cash	53%	46%	41%	36%	32%	29%	27%
50% equity/35% bonds/15% cash	50%	44%	38%	35%	31%	28%	26%
25% equity/60% bonds/15% cash	47%	41%	37%	33%	30%	27%	25%
0% equity/85% bonds/15% cash	44%	39%	35%	31%	28%	26%	24%

3.1.11 The results above indicate that we need to be very conscious of our spending habits. We also need to ensure that we hold sufficient growth assets, although these could introduce more uncertainty to our portfolios. We can, however, mitigate some of the downside risks associated with growth assets. In Table 10, we detail results where we protect equity holdings against downside moves. To pay for the protection we sacrifice some upside returns, in this case 50% of the return above 4%. This is done as follows,

Protection:

$$floor = -0.03,\ cap = 0.04,\ participation = 0.5,\ \text{cost} = 0.001,\ X = one-month\ equity\ return$$

$$payoff = X + \max\left(0, floor - X\right) - participation \times \max\left(0, X - cap\right) - \text{cost}$$

TABLE 10. Protecting equity returns for 5% and 10% spending rates

		5%		10%	
Asset allocation	Protected equity	Success	Fugit	Success	Fugit
75% equities / 25% bonds	No	83%	279.8	8%	179.7
75% equities / 25% bonds	Yes	95%	312.6	3%	187.0
50% equities / 50% bonds	No	78%	293.6	1%	166.5
50% equities / 50% bonds	Yes	88%	315.5	0%	165.5
25% equities / 75% bonds	No	59%	300.7	0%	148.7
25% equities / 75% bonds	Yes	61%	310.8	0%	147.8

3.1.12 The results in Table 10 are encouraging, with improvements in both the fugit and success rates in lower withdrawal rates. Moreover, these results further illustrate the main challenge encountered by retirees is that large withdrawals are not sustainable for the success of a retirement portfolio. The derivative protection strategy illustrated above can easily be implemented by buying put options and selling call options on the index on a rolling one-month basis. Our analysis here is based on long-term average costs.

4. DISCUSSION OF RESULTS AND CONCLUSION

4.1 We have presented a simulation-based approach to analyse withdrawal rates for retirement-based portfolios in a South African setting. In our approach we consider the distribution of terminal account balances and also calculate the probability of the investor's capital being depleted. This corresponds to the notion of a safe withdrawal rate. Our results show clearly that portfolio success rate is a rapidly decaying function of retirement spending (measured on an annual inflation-adjusted percentage basis). The notion of the portfolio fugit provides insight into the expected failure time (or extent of ruin) of a portfolio and provides insight into establishing the effects of path-dependence on portfolio success.

4.2 We observe, for low withdrawal rates, that asset allocation does not have a large influence on the success of the portfolio. When we consider larger withdrawal rates, however, a higher percentage of growth assets (such as equity) is needed, and even then the portfolio is not necessarily sustainable.

4.3 We also detail that there are options to increase investment results, which entail growth asset protection by use of derivative instruments; in this paper, we provided a proof of concept towards this, however, more work needs to be performed in this area.

4.4 Scott et al. (2009) and Waring & Siegel (2015) criticised the notion of withdrawing a fixed real amount from an inherently volatile portfolio. We concur, the results obtained here indicate moderation and a cautious approach. The risk associated with the investment

environment is significant, while we expect the risky nature to be maintained in future years, there can be no guarantee that historical returns would be maintained.

4.5 Cooley et al. (2003) note that "a portfolio is only successful if it lasts as long as required by the retiree"—this motivates our use of incorporating longevity into the simulation of the portfolio success rate. It should be noted that other measures could be used and investigated as well.

4.6 In conclusion our results showed that withdrawal rates depend critically on the investor's portfolio makeup and life expectancy. Withdrawal rates in excess of 5% is not sustainable over a 30-year period, regardless of the portfolio makeup. Furthermore, our simulation showed that the portfolio fugit is often shorter than the retiree's life expectancy for larger withdrawal rates. This indicates that retirees need to buy some life annuities in addition to living annuities. The 'optimal' incorporation of life annuities into one's retirement portfolio could safeguard against a complete loss of income—this reflects an area of future research.

4.7 Further research could be carried out in recalculating safe withdrawal rates each year based on the portfolio value, economic climate, and expected lifetime in order to decrease the likelihood of running out of money before end of life. To achieve this, forward looking return information would be vitally important.

REFERENCES

Bengen, W (1994). Determining withdrawal rates using historical data. *Journal of Financial Planning*, **7**(1),171–80

Blanchett, DM, Finke, M & Pfau, WD (2013). Low bond yields and safe portfolio withdrawal rates. *The Journal of Wealth Management*, **16**(2), 55–62

Butler, M & Van Zyl, C (2012a). Consumption changes on retirement for South African households. *South African Actuarial Journal* **12**, 31–64

Butler, M & Van Zyl, C (2012b). Retirement adequacy goals for South African households. *South African Actuarial Journal* **12**, 1–29

CSI (2017). Report on Pensioner Mortality 2005–2010 (Tech. Rep.). Cape Town: Continuous Statistical Investigation Committee, Actuarial Society of South Africa

Cont, R (2001). Empirical properties of asset returns: stylized facts and statistical issues. *Quantitative Finance* **1**(2), 223–36

Cooley, P, Hubbard, C & Walz, D (1998). Retirement Savings: Choosing a withdrawal rate that is sustainable. *Journal of the American Association of Individual Investors* **10**(1), 40–50

Cooley, P, Hubbard, C & Walz, D (1999). Sustainable withdrawal rates from your retirement portfolio. *Financial Counselling and Planning* **20**(2), 16–21

Cooley, P, Hubbard, C & Walz, D (2003). A comparative analysis of retirement portfolio success rates:

Simulation versus overlapping periods. *Financial Services Review* 12, 115–28

Dimson, E, Marsh, P & Staunton, M (2016). Credit Suisse Global Investment Returns Sourcebook 2016. Zurich: Credit Suisse Research Institute

Firer, C & McLeod, H (1999). Equities, bonds, cash and inflation: Historical performance in South Africa 1925 to 1998. *Investment Analysts Journal* **28**(50), 7–28

Firer, C & Staunton, M (2002). 102 years of South African financial market history. *Investment Analysts Journal* **31**(56), 57–65

Garman, M (1989). Semper tempus fugit. *Risk* **2**(5), 34–5

Klein, S & Sapra, S (2020). Optimal asset allocation, asset location and drawdown in retirement. *Quantitative Research and Analytics* 1–15

Maré, E (2016). Safe spending rates for South African retirees. *South African Journal of Science* **112**(1/2), 1–4

Milevsky, MA & Huang, H (2011). Spending retirement on planet Vulcan, the impact of longevity risk aversion on optimal withdrawal rates. *Financial Analysts Journal* **67**(2), 45–58

Purdy, M (2015). The first person to live to 150 has already been born. Technical report, Innovation Hub

Richman, R (2017). Old age mortality in South Africa. Cape Town, 1985–2011. MPhil thesis. University of Cape Town

Richman, R, & Velcich G (2020). Mortality improvements in South Africa, insights from pensioner mortality. Presented at the Actuarial Society of South Africa's 2020 Virtual Convention

Rusconi, R (2020). Regulating South Africa's retirement funds: the case for clearer objectives. Presented at the Actuarial Society of South Africa's 2020 Virtual Convention

Scott, J, Sharpe, W & Watson, J (2009). The 4% rule—at what price? *Journal of Investment Management* **7**(3), 31–48

Waring, MB & Siegel, LB (2015). The only spending rule article you will ever need. *Financial Analysts Journal* **71**(1), 91–107

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Anti-selection in voluntary health insurance markets: A focus on medical schemes in South Africa

by R Harris and S Besesar

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ABSTRACT

This paper discusses the role of voluntary health insurance (VHI) in relation to public healthcare systems and universal health coverage (UHC). The paper explores why VHI markets are particularly susceptible to anti-selection. As the largest VHI market globally, the South African medical scheme market is then examined in detail. An overview of the history of the South African healthcare system provides insight into the development of the medical scheme market. Thereafter, an analysis on the impact of anti-selection on medical schemes is conducted using the experience from the largest open medical scheme in the market. The results demonstrate how existing risk mitigation measures are ineffective at protecting medical schemes from the effects of anti-selection, and the subsequent negative impacts of this phenomenon on the industry and the healthcare system as a whole. The paper discusses alternative mechanisms for addressing anti-selection risks and concludes that mandatory membership in some form has the potential to improve the sustainability of medical schemes in South Africa, which will in turn support the country's transition towards UHC.

KEY WORDS

Anti-selection; private voluntary health insurance; medical schemes; South Africa

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1. INTRODUCTION

1.1 Universal health coverage

1.1.1 The World Health Organisation (WHO) states that universal health coverage (UHC) entails timely access to essential healthcare services for all, without financial hardship (WHO a, n.d.). The core tenets of UHC include, protecting the poorest and most vulnerable, reducing out-of-pocket (OOP) expenditure and strengthening the healthcare system. In 2012, the United Nations endorsed the movement towards UHC. Since then, the WHO and the World Bank Group have recognised the significance of UHC for sustainable development at a national and global level (WHO, 2014).

1.1.2 Countries across the world have now prioritised the transition towards UHC as a key policy objective. There is no one-size approach towards UHC, and each country is developing its own pathway based on current health infrastructure and available resources. The WHO and the World Bank Group have developed a framework that allows each country to measure its UHC progress. These metrics include the degree of financial protection and coverage of health services provided by the healthcare system (WHO, 2014). As per this indicator, South Africa scored 69 (out of 100) in 2017 (WHO, 2019).

1.2 The role of voluntary health insurance and universal health coverage

1.2.1 As acknowledged by the WHO, "[a]ll countries, rich and poor, struggle to raise the funds required to pay for the health services their populations need or demand. No country, no matter how rich, is able to provide its entire population with every technology or intervention that may improve health or prolong life" (WHO, 2010).

1.2.2 International evidence shows that characteristics of the public system, particularly the extent of public coverage, shapes the market for voluntary health insurance (VHI). Consequently, gaps in public coverage are a key determinant of VHI market development (Thomson, 2010). In the United Kingdom for example, VHI is purchased to avoid potential waiting lists for treatment provided by the National Health Service (Foubister & Richardson, 2016).

1.2.3 In mature healthcare systems, the principal means of healthcare finance is a statutory insurance scheme covering all citizens. This is typical in higher income countries where the statutory package is relatively comprehensive, ensuring all citizens have access to essential healthcare services (sometimes with a modest co-payment). VHI, purchased by those willing and able to pay, often supplements this scheme (Smith, 2007).

1.2.4 In lower income countries, financial resources for statutory health insurance depends on a lean fiscus and (sometimes) donor funds. Public healthcare services in these resource-constrained regions are focused on cost-effective interventions targeted at the sick and poor. These systems rely heavily on personal financing of healthcare usually in the form of user fees. Private insurance in non-rich countries is usually confined to the upper classes (Smith, 2007).

1.2.5 The emergence of VHI may therefore not only be a desirable alternative or addition to public provision but also an unavoidable one (Preker et al., 2010). While VHI has traditionally been associated with the notions of unequal access, unaffordability and elite care

for the rich, private voluntary health insurance has evolved into a valuable instrument when public insurance is too costly to be efficient (He, 2017).

1.2.6 Governments often rely on VHI as a means of addressing shortcomings of the health system. Policymakers may use private health insurance as a vehicle to generate additional funding or increase health system capacity. The competition and innovation that characterises private health insurance can enhance efficiencies of the health system and quality of care delivered, while providing consumers with a degree of choice. Consumers may perceive private health insurance to be more responsive and sensitive to their demands in comparison to public health systems plagued by bureaucratic slowness and rigidities (Colombo & Tapay, 2004).

1.2.7 Critics however argue that private health insurance drives inefficiency by spurring demand. In addition, multiple competing insurers increase administrative costs taking resources away from healthcare services. Private health insurance may also increase costs for the public purse by steering healthier lives and healthcare resources into the private sector. Further, a dual healthcare system, where one provides better access than the other, may create inequities in coverage and access to healthcare (Colombo & Tapay, 2004).

1.2.8 Policymakers rely on regulation to address the shortcomings of private health insurance. Generally, the degree of dominance of the private health insurance market dictates the extent of regulatory intervention (Colombo & Tapay, 2004).

1.2.9 However, regulation is no panacea for market failures in the private health insurance landscape. Regulation comes with its own associated costs that must be assessed relative to its benefits. When defining regulation, policymakers must therefore balance the conflicting goals of consumer protection and choice against equity and cost containment to identify optimal interventions (Sekhri et al., 2005).

1.3 The healthcare policy landscape in South Africa

1.3.1 After democracy in 1994, healthcare policymakers believed that the most feasible trajectory towards attaining UHC was via a two-tier system that enabled the public and private sectors to operate in parallel (Van den Heever, 2016).

1.3.2 Healthcare reform from 1994 was thus focused on developing the private medical schemes framework into a social health insurance (SHI) system for those that could afford to cover their own healthcare expenses. The tax-funded public sector was to serve as a safety net for the rest of the population, providing free services to those in need. This system was believed to be the optimal path to UHC; it would allow the State to focus its limited resources on those most vulnerable, while creating a social solidarity framework for those that chose to opt out of public provision (Van den Heever, 2016).

1.3.3 Policymakers implemented a number of reforms via the Medical Schemes Act of 1998 to create the SHI framework. This included provisions for a prescribed minimum benefit (PMB) package applicable across benefit options which cover almost 300 conditions, as well as the enforcement of community rating and open enrolment across the industry (McLeod & Ramjee, 2007).

1.3.4 To encourage those who can afford medical cover to provide for themselves,

tax relief was introduced on medical scheme contributions. This has evolved from a tax deduction to a system of tax credits, intended to be more beneficial to low income earners (National Treasury of South Africa, 2011; Nhamo & Mudimu, 2020).

1.3.5 Mandatory membership (for those earning above a defined income bracket) and a risk equalisation fund (to enhance risk and income cross-subsidies across the industry) were proposed to be implemented in 2008 to ensure the fiscal sustainability of the system; however the shadow period and implementation plans were suspended in 2011 (Van den Heever, 2016).

1.3.6 Policymakers expressed commitment to this route to UHC by establishing GEMS (the Government Employees Medical Scheme) in January 2005. GEMS is a medical scheme with eligibility restricted to government employees. Although membership is not mandatory, government incentivises membership to GEMS with employee contribution subsidies (Government Employees Medical Scheme, 2007).

1.3.7 A change in the political landscape in 2007 brought about a divergence in the policy trajectory towards UHC. Policymakers abruptly abandoned the SHI framework. The proposal to implement mandatory membership and the risk equalisation fund across the medical schemes were withdrawn and the policy of implementing a National Health Insurance (NHI) was adopted (Van den Heever, 2016).

1.3.8 The motivation for this policy change was based on growing concerns regarding the inequalities of the two-tier system. While the dual healthcare system provides excellent financial protection, (measured in terms of OOP expenditure as a percentage of current healthcare expenditure (WHO b, n.d.)), the healthcare system is largely divided along socio-economic lines (National Department of Health South Africa, 2015).

1.3.9 Despite attempts since 1994 to increase access to healthcare and integrate the health system through public-private partnerships, inequalities persisted between the public and private sectors (National Department of Health South Africa, 2015). For example in 2020, the average expenditure per medical scheme beneficiary was R2,053 per month (Council for Medical Schemes a, 2021). In comparison, expenditure per capita in the public sector was estimated at R412 per capita per month in 2020, excluding OOP (National Treasury of South Africa, 2021). However, it should be noted that the difference is funded by private expenditure since the value of the tax credit for medical scheme beneficiaries has been at a discount to average per-capita expenditure in the public sector since 2007/8 (Health Market Inquiry, 2018).

1.3.10 The disproportionate spend between the public and private sectors reflects the differences in costs (and quality) of services provided between public and private health providers (Armstrong et al., 2010). Competition for resources from medical schemes is perceived to have a negative impact on the quality of care in the public sector (Ramjee & Vieyra, 2014). Further, this has also led to concerns about perpetuating a two-tier framework, given the large disparities in the quality of healthcare accessed in the public and private sector (National Department of Health South Africa, 2015).

1.3.11 The 2007 proposal was to establish a single fund NHI system to enable centralised pooling. This is based on the belief that an NHI would allow for a more efficient

allocation of resources at a national level to reduce inequities and expedite progress towards UHC (Van den Heever, 2016).

1.3.12 With the policy departure from SHI, it is currently unclear as to what role medical schemes will play under the NHI framework. The NHI Bill of 2019 states that after the implementation of the NHI, medical schemes will only be allowed to provide complementary cover for services outside the NHI benefit package (Minister of Health South Africa, 2019).

1.3.13 There is a risk that with the policy shift towards NHI, the medical scheme industry will become a 'regulatory orphan'. The partial implementation of social health reforms has hampered the ability of medical schemes to contribute effectively to social solidarity and UHC (Ramjee & Vieyra, 2014).

2. BACKGROUND TO THE SOUTH AFRICAN MEDICAL SCHEMES MARKET

2.1 In 2018, total healthcare expenditure in South Africa amounted to 8.3% of GDP (WHO c, n.d.). Public sector financing amounted to R248.8 bn in 2020 (National Treasury of South Africa, 2021). Over the same period, medical schemes' total gross contribution income equalled R219 bn and the industry covered 8.9 million lives (Council for Medical Schemes a, 2021).

2.2 With almost 44% of current health expenditure (CHE) channelled through VHI (medical schemes), South Africa is an outlier to the rest of the world in the role VHI plays in healthcare financing (see Figure 1). This is largely due to the historical context of South Africa's history and health policy, as well as structural features of the healthcare system.

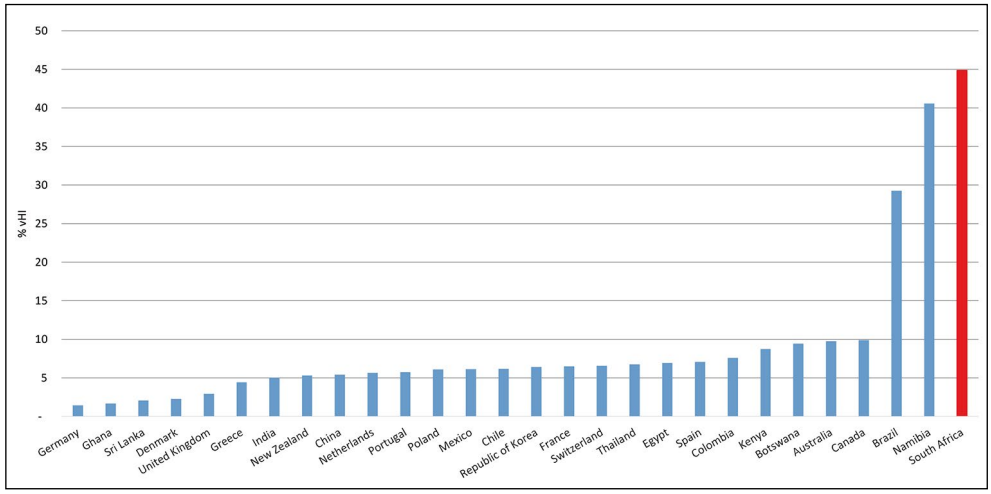

FIGURE 1. VHI as a percentage of CHE for selected countries (2018)
Source: World Health Organisation Global Health Observatory and authors' calculations

2.3 Overall, however, per capita health expenditure in South Africa is not comparable with high income countries. As shown in Figure 2, South Africa's public health expenditure, is similar to other low and middle-income countries such as Thailand, Sri Lanka and Egypt when measured in monetary terms (purchasing power parity (PPP) adjusted). Further, Figure 2 shows that when comparing the medical scheme expenditure per medical scheme beneficiary (PPP adjusted), it is evident that even medical scheme expenditure per capita is lower in comparison to CHE per capita of higher income countries including the United Kingdom, France and Germany.

2.4 Medical schemes are largely voluntary health insurance vehicles (Armstrong et al., 2010) and are regulated by the Council for Medical Schemes (CMS) (Ramjee & Vieyra, 2014). Contributions to medical schemes are privately funded, although members still receive a tax subsidy, equivalent to about 17.0% of gross contributions in 2020 (Council for Medical Schemes a, 2021; South African Revenue Service, n.d.). Coverage is concentrated amongst the higher income earners (Ramjee & Vieyra, 2014) relative to the total population, however it should be noted that 31.6% of medical scheme members earn less than R13,000 per month.[1]

2.5 Medical schemes are owned by their members, and are tax-exempt not-for-profit trusts. As mentioned above, the industry is governed by strict social solidarity principles, including community rating which prohibits differentiation of contribution rates by age or health status. Medical schemes typically purchase care from private providers (Ramjee & Vieyra, 2014).

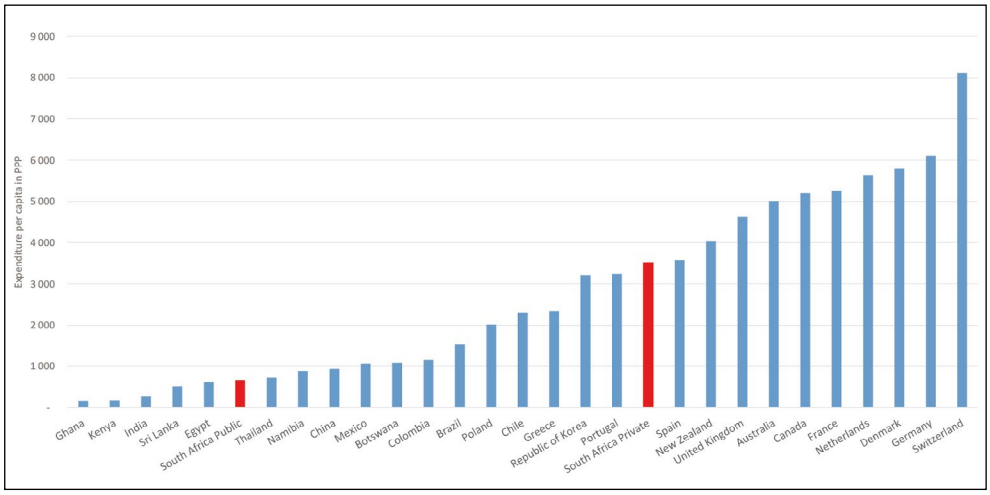

FIGURE 2. Healthcare expenditure per capita in PPP (2018) for selected countries
Source: World Health Organisation Global Health Observatory and authors' calculations

1 Calculated from the Finscope 2018 database

2.6 There are two types of medical schemes, open and restricted. Open schemes must accept anyone willing to join, while restricted schemes may limit membership to a particular employer, profession or industry (Armstrong et al., 2010). The Discovery Health Medical Scheme (DHMS) is an open scheme and is the largest funder in the market covering 2.8 million lives. The restricted scheme GEMS is the second largest scheme, covering more than 1.9 million lives (Council for Medical Schemes a, 2021).

2.7 Additionally, all medical schemes are required to cover Prescribed Minimum Benefits (PMBs) as set out in the regulations to the Medical Schemes Act. These benefits cover a comprehensive range of in-hospital benefits, treatment of a defined list of chronic conditions and some out-of-hospital cover (McLeod & Ramjee, 2007). The cost of PMBs effectively sets a minimum cost of cover and the CMS reports the cost of PMBs in 2020 at R883 per average beneficiary per month (Council for Medical Schemes a, 2021).

2.8 While medical schemes provide duplicative benefits, medical scheme members effectively purchase private cover as substitutive coverage to all services provided by the public sector. This is not unique to South Africa, but a characteristic of countries with similar wealth where higher income earners voluntarily choose to opt out of free public provision, in order to gain better access to healthcare in terms of waiting times and freedom of choice of provider. This is due to the perception that there is either an insufficient supply of providers in the public sector, or that private providers provide better quality of care (Armstrong et al., 2010).

3. ANTI-SELECTION IN VOLUNTARY HEALTH INSURANCE MARKETS

3.1 The Organisation for Economic Co-operation and Development (OECD) defines VHI markets as those insurance markets where participation or purchase of products is on a voluntary basis rather than being compelled by regulation. This includes instances where employers themselves choose to offer health insurance cover to their employees or by effecting group policy agreements with compulsory participation as part of conditions of employment. Though participation may be encouraged, for example with tax breaks or other fiscal incentives, it remains entirely voluntary. Even if group policy agreements require coverage as a condition of employment, the employer has voluntarily opted to effect such an agreement (Organisation for Economic Co-Operation and Development, 2004).

3.2 Due to the voluntary nature of these markets, VHI is prone to anti-selection. Anti-selection (or adverse-selection) is a concept where the insurance attracts patients who are likely to use services at a higher than the average rate. This is because potential beneficiaries are better informed than their insurer about their health status and their expected demand for healthcare services—a phenomenon known as asymmetry of information (Folland et al., 2013).

3.3 Anti-selection is the central cause that distorts smooth and efficient functioning of competitive health insurance markets (Geruso & Layton, 2017). Anti-selection often reduces the number of policies sold in the insurance market, can prevent the existence of a stable market, and might (though rarely) cause the market to disappear entirely (Pauly, 2007). The challenges posed by anti-selection represent the primary concerns for policymakers when regulating health insurance markets (Geruso & Layton, 2017). In South Africa, the incomplete regulatory framework, coupled with the voluntary nature of membership undermines the achievement of social solidarity as it not only permits, but also incentivises, anti-selection (Ramjee & Vieyra, 2014).

3.4 Anti-selection can also manifest itself in the manner in which beneficiaries choose a health plan within a health insurer, where higher risk individuals choose more comprehensive plans than those in better health (Belli, 2001). This is evident in South Africa, where consumers may switch annually between benefit packages according to their need and affordability constraints. While this provides consumers with a great degree of flexibility and freedom of choice, and allows medical schemes to be more responsive to consumer's needs, it can also lead to significant anti-selection, as better-informed consumers can choose the most suitable package for their expected upcoming expenditure (Ramjee & Vieyra, 2014).

3.5 Further, anti-selection effects can be exacerbated in markets where insurers are not permitted (by law or custom) to set premiums that reflect risk, even if better information is known (Pauly, 2007). Pricing restrictions typically exacerbate anti-selection, because community rating imposes an information asymmetry between the consumer and health insurer (Geruso & Layton, 2017). This suggests that the community rating structure in South Africa also contributes to anti-selection effects in the medical scheme industry.

3.6 Anti-selection may not only affect the prices of contracts, but may also impact the design of the products themselves. This is known as risk selection, where private insurers use benefit design to 'cream skim' healthier members, by tailoring each contract to attract or deter certain risk groups from coverage (Geruso & Layton, 2017). In South Africa, medical schemes have a strong incentive to use benefit design to cream skim healthier lives into their risk pools. While this may reduce anti-selection effects, it also goes against social solidarity principles, and is a particular concern in the absence of an industry risk-equalisation scheme (Ramjee & Vieyra, 2014).

4. ANTI-SELECTION ACROSS MEDICAL SCHEMES IN SOUTH AFRICA

4.1 In practice, identifying and quantifying anti-selection is not always straightforward. Comparisons of the chronic profile between those that elect comprehensive plans compared to those on less-generous plans may be a starting point. However, anti-selection may manifest itself in complex ways that go beyond the issue of who purchases cover and their subsequent choice of plan (Geruso & Layton, 2017).

4.2 Given the lack of a systemic framework to quantify anti-selection, the analysis below attempts to assess the extent of anti-selection in the South African private medical scheme industry by exploring trends in the available data.

4.3 An analysis of the demographics of medical schemes from the Council for Medical Schemes annual reports show that medical schemes are significantly older than the general South African population (Council for Medical Schemes, 2019). For example, for 2017 it is estimated that while only 26.8% of the South African population was over age 40, 39.2% of the medical scheme population is above this age.

4.4 Figure 3 illustrates the extent of anti-selection faced by the industry by showing the medical scheme population as a percentage of the total South African (RSA) population by age and gender for 2017.

4.5 From Figure 3 it is apparent that the medical scheme population is significantly older than the general South African population, with medical schemes carrying an increasing percentage of the South African population by age. For example, Figure 3 illustrates that 34.9% of South African males over 80 belong to medical schemes, while only 7.8% of males between ages 20–24 are covered.

4.6 Figure 3 also highlights the extent of anti-selection by females in their childbearing ages, with the percentage of females covered by medical schemes being about 30% higher than that of males during the ages of 25–39. The Prescribed Minimum Benefit package includes almost all maternity care, and thus, it has become a common phenomenon for women to join

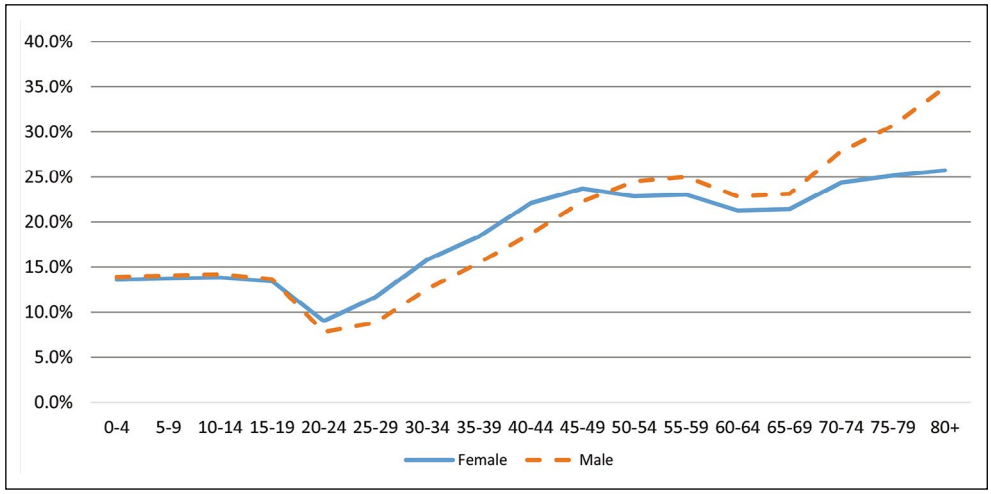

FIGURE 3. Medical scheme population as a percentage of total population by age and gender (2017)
Source: Authors' calculations using data from Statistics South Africa and Council for Medical Schemes' annual reports

a medical scheme to have their children and to leave if the children are healthy (McLeod, 2012).

4.7 Figure 4 highlights how the medical scheme population has aged in comparison to the general South African population between 2006 and 2017. Over the past 11 years, the medical scheme population has lost younger, healthier lives (those below 40) and are now carrying a significantly higher proportion of older and sicker South Africans. For example, Figure 4 shows that in 2006 medical schemes covered 18.9% of South Africans over age 80, but by 2017 medical schemes were carrying almost 30% of this population. As shown in the Council for Medical Schemes Annual Report 2018/19, there is strong correlation between age and healthcare costs. This higher uptake of medical scheme membership at the older ages relative to younger ages can therefore place significant cost pressures on medical schemes.

4.8 Figures 5 and 6 compare the age distribution for medical schemes members between 2006 and 2017 for restricted and open schemes respectively. From these figures the 'twin-peaks' phenomenon is apparent. This is due to the anti-selective effects mentioned above, exacerbated by the lower propensity by parents to cover older children (as well as children who no longer qualify to be dependants on their parents' medical scheme not taking up membership of their own). This is likely to be due to affordability and the fact that they can enter up to the age of 35 without penalty. This is as per the definition of late joiner penalties set out in the regulations to the Medical Schemes Act (National Department of Health South Africa, 1999).

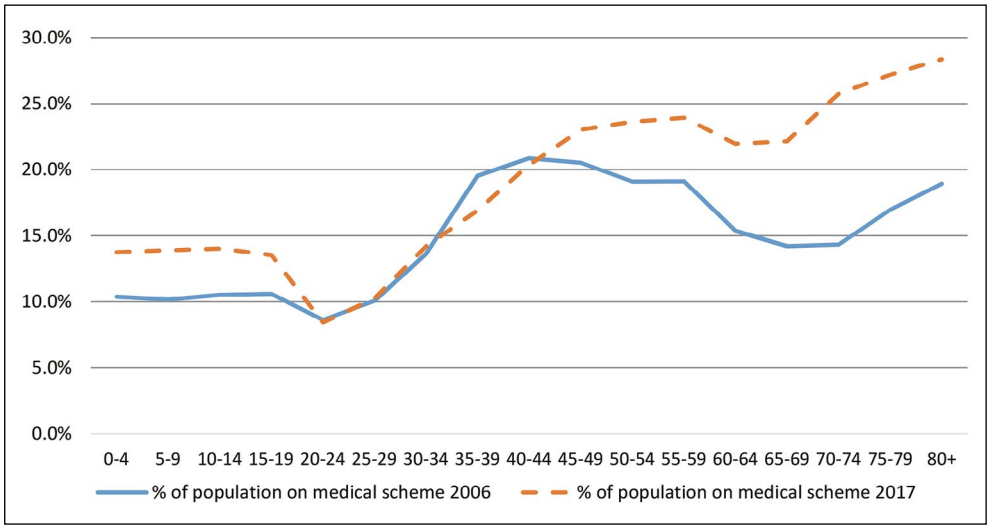

FIGURE 4. Medical scheme population as a percentage of total population by age 2006 vs 2017
Source: Authors' calculations using data from Statistics South Africa and Council for Medical Schemes' annual reports

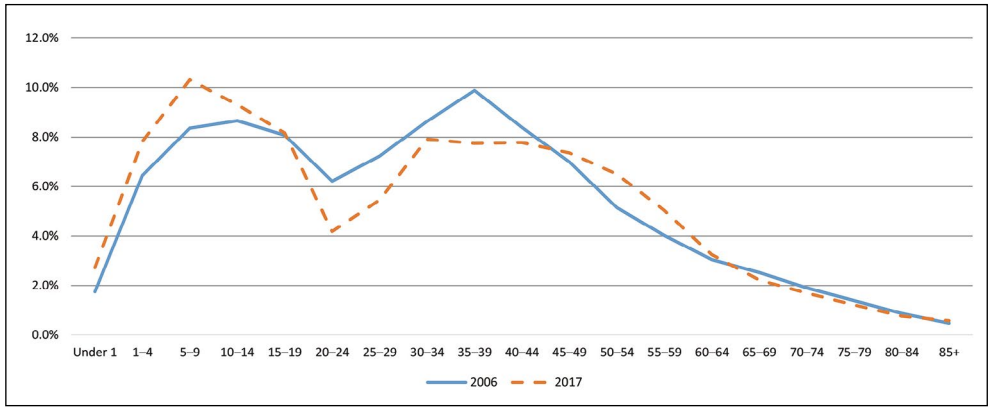

FIGURE 5. Distribution of restricted scheme population by age 2006 vs 2017
Source: Authors' calculations using data from Statistics South Africa and Council for Medical Schemes' annual reports

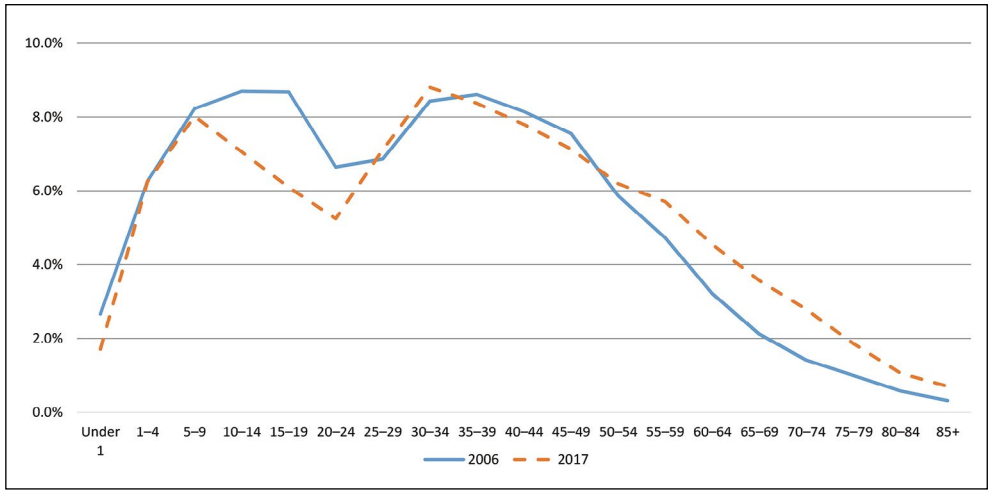

FIGURE 6. Distribution of open scheme population by age 2006 vs 2017
Source: Authors' calculations using data from Statistics South Africa and Council for Medical Schemes' annual reports

4.9 What is most concerning from the figures, though, is the extent of ageing that the open medical schemes have experienced in comparison to the restricted schemes. While the restricted schemes have gained younger and healthier lives between 2006 and 2017, the reverse is true for open schemes, which are highly exposed to risks of anti-selection. For example, in 2006, 17.1% of restricted scheme members were below age 35. By 2017, this figure had increased to 24.6%. In comparison, the percentage of open scheme lives below age 35 had decreased from 39.0% in 2006 to 28.1% in 2017 (Council for Medical Schemes, 2019).

4.10 These profile shifts have manifested in increasing healthcare expenditure, which have been borne by open medical scheme members in the form of higher contribution rates. This financial effect can be quantified by using cost estimates from the Risk Equalisation Tables (REF)[2] of 2010, which show the average industry cost of providing the PMBs by age. Ignoring the effect of changes in chronic disease prevalence and referring to the REF2010 table published by the CMS, the financial effect of the above shift on the cost of cover is an increase of 15.6% between 2006 and 2017 for open schemes before allowing for any inflation. In comparison, the effect on restricted schemes was only 1.1% for the same period, with the average for the entire industry at 9.4%.

4.11 The differences in experience between the open and restricted schemes is substantiated when analysing claims of DHMS between lives that join individually and those that join as part of an employer group.[3] The analysis shows individual members have an older age profile and higher chronic prevalence than group members do. This is manifested in the claims experience with individual members' claims 36.6% higher than group members for 2016, after adjusting for age, gender and chronic status.

4.12 As industry data on chronicity by age is not available, data was obtained from DHMS to quantify the impact of the change in the chronic prevalence and age on claims costs. Figure 7 shows the proportion of DHMS lives registered for a chronic condition by age, for selected years between 2005 and 2017.

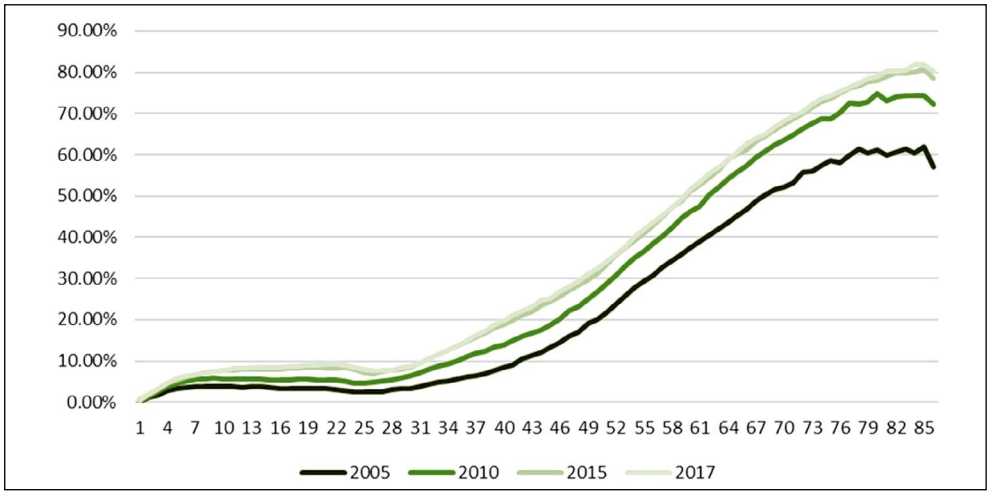

FIGURE 7. Change in DHMS chronic profile ratio by age and year
Source: Authors' calculations using data from Discovery Health

2 The Risk Equalisation Fund was run on a shadow basis from 2006 to 2011 and the tables are available at https://www.medicalschemes.com/Publications.aspx

3 Coverage under employer groups is more representative of mandatory cover, unlike individual coverage where membership is completely voluntary.

4.13 Combining the change in the age profile and the increase in chronic prevalence across ages increases the escalation in costs calculated with reference to the REF2010 table to 32.5% for DHMS over the period 2006 to 2017 (as compared to the 9.4% on age only noted above).

4.14 This shows the significant effect of the change in the age profile and the prevalence of chronic conditions which is influenced by anti-selection. This quantification does not include the effect of medical scheme members being able to buy up to more comprehensive cover without restriction on an annual basis.

5. TOOLS AVAILABLE TO MEDICAL SCHEMES TO MANAGE ANTI-SELECTION

5.1 The Medical Schemes Act permits the following tools to manage anti-selection:

— Late joiner penalties that can be applied from the age of 35.
— Condition-specific waiting period (12 months) that can be applied in respect of conditions for which the applicant received treatment or advice in the 12 months prior to application.
— General waiting periods of 3 months that can be applied to members who have no prior coverage (the waiting period also applies to PMBs) or who change schemes voluntarily (but in this case the waiting period does not apply to PMBs which must be covered in full).

5.2 Table 1 shows the percentage of members where such restrictions have been applied as at 31 December 2017 for DHMS.

TABLE 1. Percentage of DHMS members with underwriting restrictions

Restriction	Proportion of new entrants in 2017	Proportion of all beneficiaries at 31 December 2017
3-month general waiting period	13.6%	0.4%
12-month pre-existing condition exclusion	7.6%	0.9%
Later joiner penalty	4.7%	4.5%

Source: Authors' calculations using data from Discovery Health

5.3 From Table 1 it is evident that only a small percentage of new members receive a waiting period. As underwriting is discretionary, competitive pressures compelling schemes to waive waiting periods may contribute to these low levels.

5.4 This table highlights that current underwriting tools are clearly ineffective as risk mitigation tools to protect schemes from anti-selection. The large majority of members are able to enter the scheme without waiting periods or late joiner penalties, despite the levels of anti-selection observed in the industry.

5.5 Late joiner penalties (LJPS)

5.5.1 The later in life that members join a medical scheme, on average the higher the claims costs and contributions will be. A late joiner penalty (LJP) should theoretically be set at least at a level so that the higher claims costs are recovered by the scheme through the higher contribution. When doing this calculation, allowance should be made for expected mortality rates, future claims inflation and investment returns.

5.5.2 Figure 8 shows the quantum of the South African (medical scheme) LJP in comparison to that applied in the Australian private health sector. It is evident that the quantum of the medical scheme LJPs are on average very similar to the Australian system except for the older ages. It is also noted that, in addition, from April 2019, the Australian government introduced discounts to those aged 18–29 to incentivise younger people to join private health insurance (Australian Government Private Health Ombudsman, n.d.)

5.5.3 The United States Medicare system also applies premium penalties for those who choose to delay joining Medicare. In this case a penalty of 1% of the national premium multiplied by the number of uncovered months without creditable coverage is applied. This penalty remains the same for as long as someone belongs to Medicare ("Part D late enrollment penalty | Medicare," n.d.).

5.5.4 Figure 9 shows that the LJPs as prescribed by the Medical Schemes Act are more or less in line with the theoretical requirements, except at the old ages (greater than 65) where the LJPs are significantly too low. This was calculated using claims costs from DHMS by age to construct a theoretical LJP structure. The LJPs were calculated by age band using the present value of expected future claims divided by the present value of expected future contributions. Expected values were based on risk adjusted DHMS claims curves and allowing for mortality and discounting.[4]

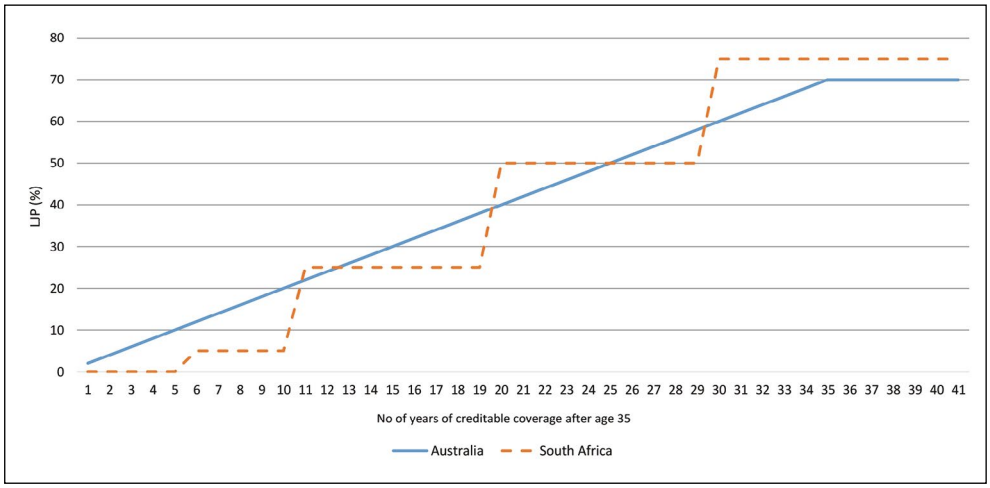

FIGURE 8. Comparison of South African and Australian LJPs
Source: Authors' calculations

4 Discount rate of 7%

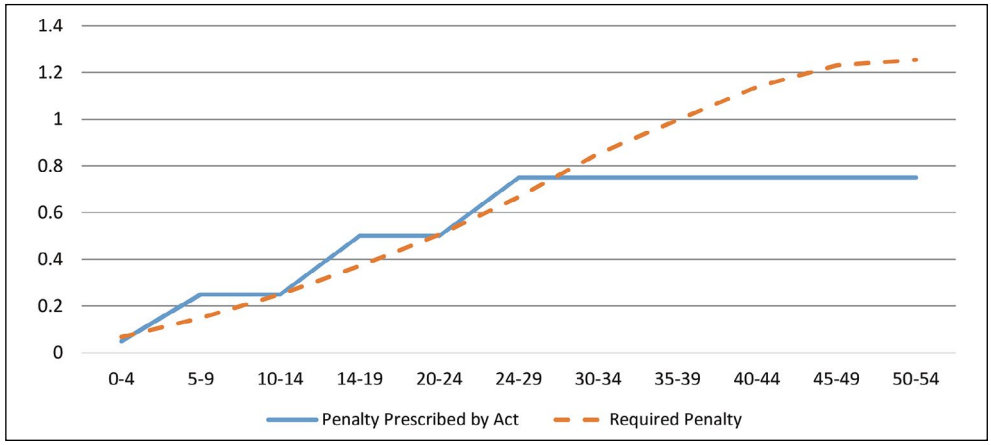

FIGURE 9. The theoretical LJP for someone joining per year after age 34 compared to the LJP prescribed by the Act

Source: Authors' calculation based on Discovery Health data

5.5.5 The above assumes that there is no anti-selection by members who only join later in life and are subject to an LJP. One would expect there to be some form of anti-selection from members who are given an LJP when joining a scheme as only members who really need the medical care would be willing to pay the LJP (Wayburne & Bradley, 2013).

5.5.6 An analysis of this was done using 2017 DHMS claims, comparing the risk-adjusted claims of joiners that received an LJP to the risk-adjusted claims of those that did not receive an LJP. As shown in Table 2, it was found that the members who did receive an LJP claimed between 16% and 23% more after adjusting for age than those that did not receive an LJP. This difference also increases as the LJP increases. In order to compensate schemes for taking on this anti-selection risk, the theoretical LJP calculated above should thus be increased in the order of 16%–23%.

TABLE 2. The difference in risk-adjusted claiming patterns between joiners with and without LJPs after adjusting for age

LJP	% difference in PLPM claims
5%	17%
25%	16%
50%	22%
75%	23%

Source: Authors' calculations based on Discovery Health data

5.6 Condition-specific waiting periods

5.6.1 Many serious and high-cost conditions require treatment over several years, or even the lifetime of the member. These thus have significant long-term financial

consequences for schemes, and the current 12-month condition-specific waiting period (CSWP) is not sufficient to counter the effect of anti-selection for these high cost long-term conditions. Some examples include rheumatoid arthritis (RA), ulcerative colitis (UC), haemophilia, Crohn's disease and multiple sclerosis (MS). Current treatment with biologics for RA typically cost DHMS approximately R71,000 per claimant per year, treatment with biologics for MS costs R106,000 per claimant per year, and haemophilia up to R220,000 per claimant per year.

5.6.2 Similarly, medical schemes face significant cost when obliged to fund certain expensive orphan drugs required by rare disease patients. For example, enzyme replacement therapies (ERTs) are orphan drugs that treat rare diseases such as Fabry's disease or Gaucher's disease. In 2018, the average treatment cost for an ERT patient was R2.2 million per year. This is equivalent to almost 105 times the average 2018 contribution per beneficiary per annum.

5.6.3 Since 2010, DHMS has funded ERT for selected conditions, on the perception that this was the prevailing level of care in the State, and therefore a PMB obligation. As the only open scheme funding ERT as a PMB, DHMS was exposed to significant anti-selection, and a number of new members joined the Scheme with the exclusive purpose of accessing coverage for ERT. For example, it was found that in 2014, DHMS was funding almost half of the country's patients on ERT with Gaucher's disease (23 out of 53 at the time).

5.6.4 As evident in Table 3, the number of unique ERT claimants across the Scheme increased from 40 in 2015 to 56 in 2018, an average annualised increase of 11.9%. The average ERT cost per claimant increased from R1.5 million in 2015 to R2.2 million in 2018, an average annualised increase of 13.8%. The cumulative effect of these impacts was an increase in the total ERT costs for the Scheme from R59 million in 2015 to R122 million in 2018, an average annualised increase of 27.3% over the four-year period.

TABLE 3. Number of ERT claimants on DHMS and their claims costs for ERT (2015–2018)

	2015	2016	2017	2018	Average annual increase
Unique ERT claimants	40	41	52	56	11.9%
Ave ERT cost per claimant	R1,483 mil	R1,883 mil	R1,947 mil	R2,185 mil	13.8%
Total ERT cost	R59 mil	R77 mil	R101 mil	R122 mil	27.3%

Source: Authors' calculations based on Discovery Health data

5.6.5 The CMS submission to the Health Market Inquiry (HMI) in January 2018[5] presents case studies on anti-selection relating to chronic renal failure and pregnancy as well as the way in which members make option selections on Polmed. This report found that studies indicated that anti-selection (in terms of age, chronic conditions and pregnancy) is a factor contributing to the escalation in health costs for medical schemes.

5 http://www.compcom.co.za/cms/

5.6.6 Considering high cost chronic conditions, DHMS has experienced a significant increase in the oncology prevalence rates of the Scheme for both male and female lives. In 2017, approximately 8 000 DHMS members were diagnosed with some form of cancer. It is estimated that the number of lives with cancer increased by 2.42 times and 2.75 times for females and males respectively between the period 2008 to 2017. Figure 10 and Figure 11 illustrate the increase in oncology prevalence rates by the most prevalent types of cancer for females and males respectively.

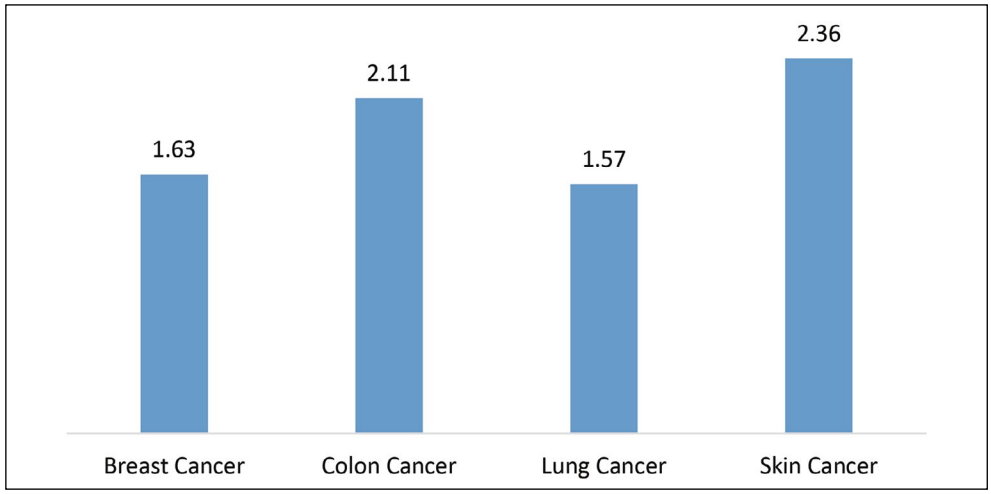

FIGURE 10. Increase in female cancer rates across DHMS between 2008 and 2017
Source: Authors' calculations based on Discovery Health data

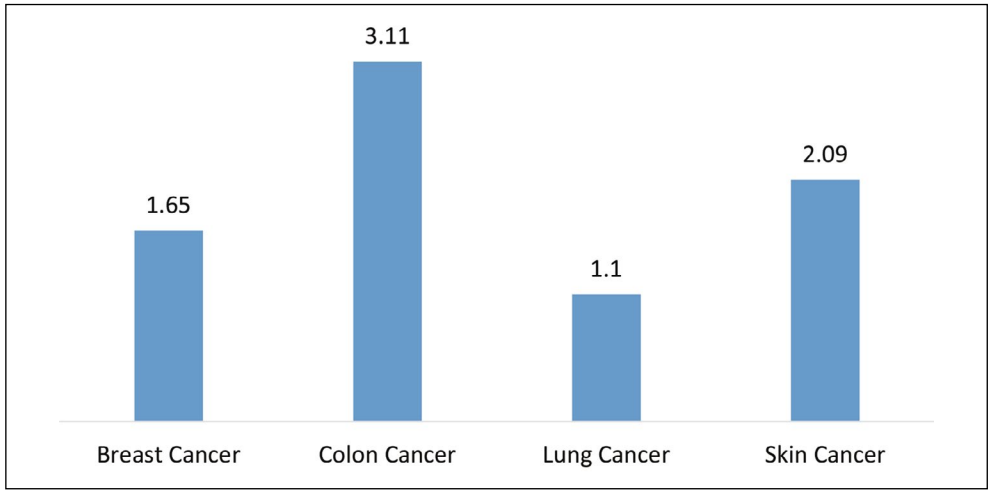

FIGURE 11. Increase in male cancer rates across DHMS between 2008 to 2017
Source: Authors' calculations based on Discovery Health data

5.6.7 The increase in oncology prevalence rates, together with the extensive oncology cover provided by DHMS, has led to significant expenditure for the Scheme. It is estimated that between 2011 and 2017, DHMS paid a total of R15 billion in cancer claims.

5.6.8 DHMS has reported that this degree of anti-selection is not limited to oncology alone, but is observed across all chronic conditions with the prevalence rates increasing at levels that cannot be explained by natural ageing of a Scheme. For example, hypertension prevalence rates increased 106% between 2008 and 2017, with 12.3% of members now being treated for this disease. Similarly, diabetes prevalence rates increased 159% across the Scheme between 2008 and 2017. DHMS has also observed an increase of 78% in members with mental illness between 2008 and 2017, with a concomitant increase of 58% in the number of depression-related hospital admissions over the same period.

5.6.9 To demonstrate the impact of the inadequacy of the CSWP as a tool for medical schemes to protect against adverse claims experience, the gross loss ratio (calculated as claims/contributions) was compared between new lives joining DHMS in 2017 with and without the 12-month condition-specific waiting period, in their first three years of membership. The results are illustrated in Figure 12 and have been age-adjusted.

5.6.10 From Figure 12 it is evident that lives entering the Scheme with a CSWP have a significantly lower loss ratio in Year 1 (due to the 12-month duration of the waiting period), than subsequent years once the CSWP has expired. The loss ratios for these members in Year 2 and Year 3 are also significantly higher when compared to new members without the CSWP. In fact, the loss ratios in Year 2 and Year 3 for members with a CSWP are well in excess of 100%, indicating that these members are claiming around 60% more than they are contributing.

5.6.11 In this context, a 12-month waiting period is thus not sufficient protection for the scheme and its members, as a person diagnosed with one of these conditions can wait

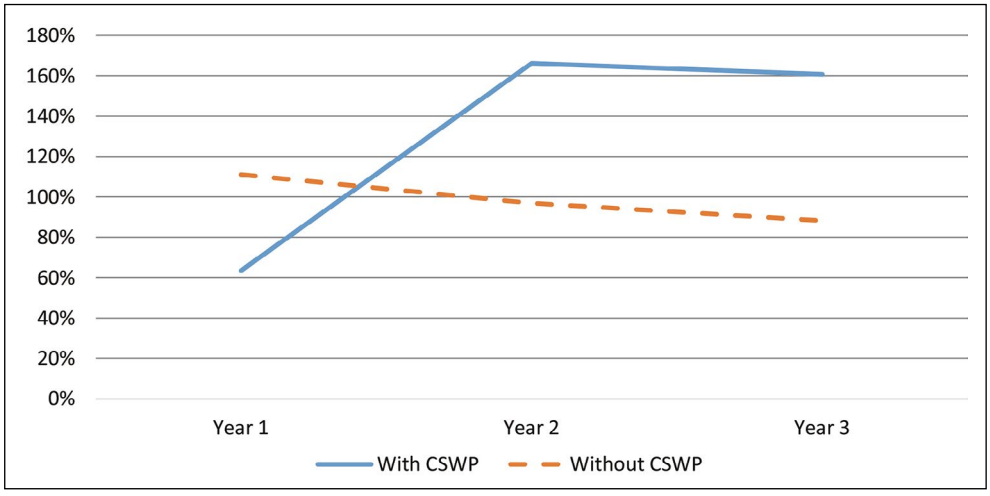

FIGURE 12. Loss ratios of new lives with and without CSWPs entering the Scheme in 2014
Source: Authors' calculations based on Discovery Health data

out the period and then claim substantially more than they pay in contributions for the rest of their life.

5.7 General waiting periods

5.7.1 Comparing the claims experience of those DHMS lives with and without the general waiting highlights similar inadequacies of the general waiting period. An analysis was done comparing the claims experience of those with and without general waiting periods at the time of enrolment for 2013–2016.

5.7.2 The average annual claims experience[6] of those with a general waiting period was 20.8% higher (on a risk-adjusted basis accounting for age, gender and benefit option) for those with a general waiting period compared to those without a waiting period.

5.7.3 The higher average annual claims for lives with the general waiting period is evidence that the majority of those joining schemes for the first time and those switching schemes largely do so on an anti-selective basis.

5.8 The impact of anti-selection on medical schemes

5.8.1 As mentioned above, the impacts of anti-selection manifest in a deteriorating risk profile for medical schemes, leading to higher claims, which must be funded by increasing contributions. As evident from Figure 13, medical scheme contribution inflation has been outstripping the consumer price index (CPI)[7] across the industry. This

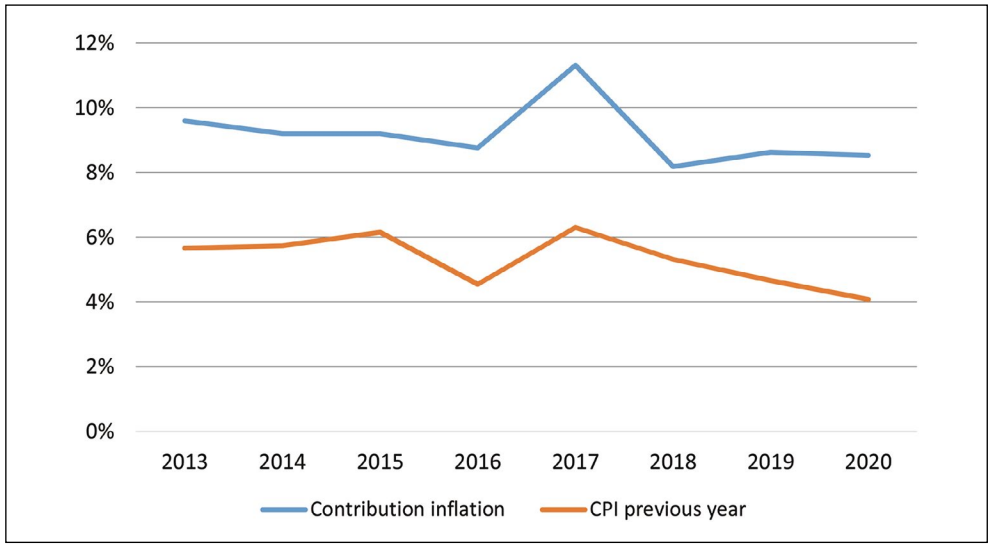

FIGURE 13. Medical scheme contribution increases vs CPI of the previous year (2013 to 2020)
Source: Council for Medical Schemes Circular 60 of 2021 and Statistics South Africa

6 Excluding claims incurred in the three months waiting period for both cohorts
7 Contribution inflation is benchmarked to CPI as a measure of affordability, given that salary inflation is often linked to CPI.

effect is greater for open schemes than for restricted schemes (Council for Medical Schemes b, 2021), and is a result of the trends discussed above.

5.8.2 This unsustainable inflation undermines solidarity in two key ways: it prevents new members from purchasing cover and it encourages medical scheme members to buy down to less extensive benefit options or withdraw from coverage altogether. This is most likely to affect younger and healthier beneficiaries, or lower income earners who are most price sensitive (McLeod & Ramjee, 2007).

6. DISCUSSION: HOW TO COMBAT ANTI-SELECTION IN SOUTH AFRICA

Regulations aimed at mitigating anti-selection in private health insurance markets include risk-rating contributions, risk equalisation funds, premium subsidies and penalties, waiting periods, exclusions and mandatory membership. The public sector can also subsidise insurance coverage for higher risk individuals to encourage their uptake of private cover (Geruso & Layton, 2017; Sekhri et al., 2005). The merits of these policy interventions are discussed below.

6.1 Risk rating of contributions

Risk rating contributions is the most obvious tool available to counter anti-selection across medical schemes. This will not only ensure that the level of contributions reflect the underlying risk profile of each applicant, but it will also encourage younger and healthier lives to purchase coverage earlier. However, risk rating is unpopular in healthcare insurance markets of higher income countries including the United States, as consumers and policymakers perceive it to be unfair practice. Moreover, risk-averse consumers are likely to prefer flat premiums that do not change with health status, given that health status is most likely to deteriorate with age (Geruso & Layton, 2017). Most importantly though, risk rating goes against social solidarity and UHC principles, which aim to protect those most vulnerable.

6.2 Risk equalisation

6.2.1 Where community rating is an inherent characteristic of the health insurance market, a risk equalisation fund (REF) is necessary to equalise risk amongst insurers. While the REF may not mitigate anti-selection at an industry level, an REF allows for an equitable distribution of the demographic profile across insurers to mitigate anti-selection at an individual insurer level. An REF will also hamper the incentive for insurers to compete on risk selection (cream skimming) (Geruso & Layton, 2017).

6.2.2 Further, risk equalisation can promote social solidarity at an industry level, by ensuring the healthy subsidise the sick irrespective of their choice of scheme or benefit option (Geruso & Layton, 2017). This is particularly relevant to the South African medical schemes industry, where current regulatory provisions require each of 254 benefit options to be self-sustaining, severely limiting the potential of cross-subsidisation (Council for Medical Schemes a, 2021; Ramjee & Vieyra, 2014). The implementation of an REF is in line with the recommendations made by the South African Competition Commission's Health Market Inquiry (HMI) in their final report (Health Market Inquiry, 2019).

6.3 Contribution subsidies and penalties

6.3.1 Contribution subsidies or penalties for not purchasing cover is another tool that policymakers may implement to combat selection problems, including the asymmetry of information created by community rating. However, in practice it may be difficult to quantify the optimum level of the subsidy that would maximise take-up while limiting the cost on the public purse. For this reason, contribution penalties may be more a more efficient tool. However, penalties may be politically unpopular, difficult to enforce, and may conflict with the goals of social solidarity particularly if the low-income or high-risk groups are disproportionately affected. A combination of penalties and subsidies may therefore be most effective and efficient to mitigate anti-selection (Geruso & Layton, 2017).

6.3.2 In this light, the HMI has recommended that the current medical scheme tax credit should be reformed to ensure that lower income households earning below the tax threshold also benefit from these subsidies (Health Market Inquiry, 2019). For example, instead of a tax credit for personal income taxpayers, all individuals purchasing medical scheme coverage could receive a partial subsidy from government. Including income as a factor in the REF can further promote income cross-subsidies and enhance social solidarity (Ramjee & Vieyra, 2014).

6.3.3 In addition, late joiner penalties should be bolstered to better reflect the claims experience of lives who defer coverage similar to the Australian system. This will have the dual effect of promoting early entry into medical schemes and improving the demographic profile of the industry, while enabling medical schemes to better meet the claims expenses of late joiners without penalising the rest of the risk pool. In their final recommendations, the HMI concurred that tighter late joiner penalties are required to curb anti-selection in the voluntary environment (Health Market Inquiry, 2019).

6.3.4 The HMI also suggested that contribution discounts be offered to those below age 35. However, it is critical to note that there is a real risk that the costs of this will not be fully funded by the number of new young joiners. This will then mean that the costs of the contribution discount will have to be borne by older members. This will erode risk-cross subsidies from the young to the old inherent in the social solidarity framework of medical schemes. Further, current late joiner penalties are already acting as a form of premium discount to those below age 35, yet they have proved to be unsuccessful in attracting young lives into the medical scheme environment. Any contribution discount to attract new young joiners should thus be very carefully designed, together with schemes and administrators, to ensure that the benefits outweigh the costs to schemes and their members.

6.3.5 Similarly, waiting periods discourage anti-selection and keep premiums affordable (Sekhri et al., 2005). However, as shown above, the current structure of waiting periods in South Africa is ineffective and needs to be lengthened, particularly for pre-existing conditions. This was also a key recommendation of the HMI, who recognised that longer waiting periods are necessary in order to deter anti-selection across the industry (Health Market Inquiry, 2019).

6.4 Exclusions

While exclusion relating to pre-existing conditions is another tool used by global insurers to combat anti-selection, these are unlikely to be effective in South Africa due to PMB regulations. Further, consumers may perceive exclusion of high-cost conditions such as cancer or AIDS, as unfair, as these are often the very conditions for which insurance is most needed (Sekhri et al., 2005). Such exclusions also work against social solidarity and UHC principles, as the vulnerable are left exposed. Policies across most developed countries permit exclusions for certain primary care services, but limit exclusions for higher cost services (Sekhri et al., 2005).

6.5 Mandatory membership

6.5.1 Nonetheless, the authors' view is that the best mechanism to address anti-selection is to mandate membership for a defined set of common benefits across all schemes for all those in formal employment earning above a defined income threshold. Further, given the maturity and magnitude of medical schemes in South Africa, completing the partial reforms to develop an SHI system is the most feasible pathway towards UHC.

6.5.2 This reasoning is in line with the literature. Mandatory membership may be justified in healthcare insurance markets on the basis that this promotes social solidarity by enabling an equitable distribution of payments for health services. Further, a mandatory private insurance sector may be used as a foundation to build a national health insurance system. This may be done by extending the mandate for coverage from the private sector to the public sector as the public sector evolves (Geruso & Layton, 2017).

6.5.3 It has been estimated that prices in a voluntary environment are some 17%–23% more expensive than they would be under mandatory cover (McLeod & Grobler, 2009). Similarly, it is estimated that open scheme contributions could be lower by 23% in an environment without anti-selection (Childs, 2012).

6.5.4 The influx of healthier and younger lives will not only have the direct once-off impact of significantly reducing medical scheme contributions, but will improve the demographic risk profile of schemes. This will strengthen schemes' resilience to claims volatility and improve the long-term financial sustainability of the industry.

7. CONCLUSIONS

7.1 The intentional nature of the purchasing decision of VHI makes it susceptible to anti-selection as those who are aware of their higher morbidity risk are more inclined to purchase cover. This paper has described how this is a global challenge in markets where VHI plays a role in the health system. The significance of the role played by VHI tends to be driven by the extent of coverage by the public health system as well as the accessibility and quality of care provided.

7.2 In South Africa, the susceptibility of VHI to anti-selection is exacerbated by the social solidarity framework under which VHI is regulated. This includes open enrolment PMBs,

and community rating but does not include risk equalisation or mandatory membership which results in medical scheme risk pools being even more exposed to anti-selection. The analysis of the deteriorating profile of medical scheme membership, particularly for open medical schemes demonstrates the effect of anti-selection on the cost of cover and the sustainability of risk pools.

7.3 Measures that can be considered for mitigating anti-selection risk include strengthened underwriting measures, however these can affect accessibility, particularly where lives are not aware of their health risk status until they require treatment. Mandatory membership of some form, related to income level or employment status is an alternative approach to addressing anti-selection as well as ensuring public resources are focused on vulnerable groups. VHI plays an important role in supporting access to healthcare, particularly in low- and middle-income countries, and so managing the sustainability of risk pools is a vital consideration for promoting UHC.

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DECLARATION

The authors confirm that they are employed by Discovery Health (Pty) Ltd which is an administrator of medical schemes and that this is their original work.

REFERENCES

Armstrong, J, Paolucci, F, McLeod, H & van de Ven, WPMM (2010). Risk equalisation in voluntary health insurance markets: A three country comparison. *Health Policy* 98. pp 39–49. Available at: https://doi.org/10.1016/j.healthpol.2010.06.009

Australian Government Private Health Ombudsman (n.d.). Age-based Discount. Available at: https://www.privatehealth.gov.au/health_insurance/surcharges_incentives/discount_age.htm (accessed 5 November 2021)

Belli, P (2001). How anti-selection affects the health insurance market. Policy Research working papers series. No 2574. World Bank. Washington DC. Available at: https://openknowledge.worldbank.org/handle/10986/19694

Childs, B (2012). Presentation: The impact of mandatory membership on affordability. Presented at the Board of Healthcare Funders Annual Conference 2012

Colombo, F & Tapay, N (2004). Private health insurance in OECD countries: The benefits and costs for individuals and health systems. Working Paper 15. Organisation for Economic Co-operation and Development. Available at: https://www.oecd.org/els/health-systems/33698043.pdf

Council for Medical Schemes a (2021). Annual Report 2020/21. Available at www.medicalschemes.com

Council for Medical Schemes b (2021). Circular 60 of 2021. Available at www.medicalschemes.com

Council for Medical Schemes (2019). CMS Annual Report 2018/19. Available at www.medicalschemes.com

Folland, S, Goodman, AC & Stano, M (2013). *The Economics of Health and Healthcare*, 7th edition. Upper Saddle River. New Jersey: Prentice Hall.

Foubister, T & Richardson, E (2016). 'Chapter 15: United Kingdom', in: Sagan, A & Thomson, S (eds) in: *Voluntary Health Insurance in Europe: Country Experience*. World Health Organisation. United Kingdom. pp. 157–161. Available at: https://www.euro.who.int/__data/assets/pdf_file/0011/310799/Voluntary-health-insurance-Europe-country-experience.pdf

Geruso, M & Layton, T (2017). Selection in health insurance markets and its policy remedies. *Journal of Economic Perspectives*. **31**(4), 23–50. Available at: https://www.aeaweb.org/articles?id=10.1257/jep.31.4.23

Government Employees Medical Scheme (2007). GEMS update to the Portfolio Committee on Public Service and Administration. Available at: https://www.slideserve.com/kevinc/portfolio-committee-on-public-service-and-administration-gems-update-2o-june-2007-powerpoint-ppt-presentation

He, AJ (2017). Introducing voluntary private health insurance in a mixed medical economy: are Hong Kong citizens willing to subscribe? *BioMed Central Health Services Research*. Available at: https://pubmed.ncbi.nlm.nih.gov/28841880/

Health Market Inquiry (2019). Final findings and recommendations report. Available at: https://www.compcom.co.za/wp-content/uploads/2020/01/Final-Findings-and-recommendations-report-Health-Market-Inquiry.pdf

Health Market Inquiry (2018). Provisional findings and recommendations report. Available at: https://www.compcom.co.za/wp-content/uploads/2020/02/Health-Market-Inquiry.pdf

McLeod, H & Grobler, P (2009). The role of risk equalization in moving from health voluntary private insurance to mandatory coverage: the experience in South Africa, in: *Advances in Health Economics and Health Services Research*. 21. pp 159–96. 10.1108/S0731-2199(2009)0000021010.

McLeod, H & Ramjee, S (2007). Medical Schemes, in: *South African Health Review 2007*. Health Systems Trust. Available at: https://www.hst.org.za/publications/South%20African%20Health%20Reviews/SAHR2007.pdf

Minister of Health South Africa (2019). National Health Insurance Bill. Number 11. National Assembly. Available at: https://www.gov.za/sites/default/files/gcis_document/201908/national-health-insurance-bill-b-11-2019.pdf

National Department of Health South Africa (2015). White Paper: National Health Insurance in South Africa. Version 40. Available at: https://www.gov.za/documents/national-health-insurance-10-dec-2015-0000

National Department of Health South Africa (1999). Medical Schemes Act number 131 of 1998 Regulations.

National Treasury of South Africa (2021). Budget Review 2021. Available at: http://www.treasury.gov.za/documents/National%20Budget/2021/review/FullBR.pdf

National Treasury of South Africa (2011). Conversion of medical deductions to medical tax credits – tax policy discussion document for public comment. Available at: http://www.treasury.gov.za/public%20comments/2011061701.pdf

Nhamo, S & Mudimu, E (2020). Shifting from deductions to credits: Unpacking the distributional effects of medical expenditure considerations in South Africa, Wider Working Paper 2020/30. United Nations University. Available at: https://ideas.repec.org/p/unu/wpaper/wp-2020-30.html

Organisation for Economic Co-Operation and Development (2004). Proposal for a taxonomy of health insurance. study on private health insurance. Available at: https://www.oecd.org/els/health-systems/31916207.pdf

Part D late enrollment penalty | Medicare (n.d.). Available at: https://www.medicare.gov/drug-coverage-part-d/costs-for-medicare-drug-coverage/part-d-late-enrollment-penalty (accessed 3 November 2021)

Pauly, MV (2007). Insight on demand for private voluntary health insurance in less developed countries in: Preker, AS, Sheffler, RM & Bassett, MC (eds) in: *Private Voluntary Health Insurance in Development: Friend or Foe*. World Bank Group. Washington DC. pp 25–53. Available at: https://openknowledge.worldbank.org/handle/10986/6641

Preker, AS, Schellekens, OP & Lindner, M (2010). Introduction: Strength in numbers, in: Preker, AS, Zweifel, P & Schellekens, OP (eds) in: *Global Marketplace for Private Health Insurance – Strength in Numbers*. World Bank. Washington DC. pp 1–26. Available at: https://openknowledge.worldbank.org/handle/10986/13085

Ramjee, S & Vieyra, T (2014). Neither here nor there: the South African medical scheme industry in limbo. Presented at the Actuarial Society of South Africa's 2014 Convention. Available at: https://www.actuarialsociety.org.za/convention/convention2014/assets/pdf/papers/2014%20ASSA%20Ramjee%20Vieyra.pdf

Sekhri, N, Savedoff, W & Thripathi, S (2005). Regulation private health insurance to serve the public interest policy issues for developing countries. World Health Organisation. Available at: https://apps.who.int/iris/handle/10665/69033

Smith, PC (2007). Provision of a public benefit package alongside private voluntary health insurance, in: Preker, AS, Sheffler, RM & Bassett, MC (eds) in: *Private Voluntary Health Insurance in Development: Friend or Foe*. World Bank. Washington DC. pp 147–67. Available at: https://openknowledge.worldbank.org/handle/10986/6641

South African Revenue Service (n.d.). Medical Credits – South African Revenue Service. Med. Credits. Available at: https://www.sars.gov.za/types-of-tax/personal-income-tax/medical-credits/ (accessed 20 October 2021)

Thomson, S (2010). What role for voluntary health insurance, in: Kutzin, J, Cashin, C & Jakab, M (eds) in: *Implementing Health Financing Reform: Lessons from Countries in Transitions*. World Health Organisation. United Kingdom. pp 299–325. Available at: https://www.euro.who.int/__data/assets/pdf_file/0014/120164/E94240.pdf

Van den Heever, AM (2016). South Africa's universal health coverage reforms in the post-apartheid period. Health Policy 120. pp 1420–28. Available at: https://doi.org/10.1016/j.healthpol.2016.05.012

Wayburne, L & Bradley, E (2013). Maintaining a balance: The impacts of ageing on the age cross-subsidy in medical scheme contributions. Presented at the Actuarial Society of South Africa's 2013 Convention. Available at: https://www.actuarialsociety.org.za/convention/convention2013registration/papers/12-821cd3c7ba1745dca4a75f334159954c.pdf

WHO (2019). Primary health care on the road to universal health coverage. 2019 Global Monitoring Report. Available at: https://www.who.int/healthinfo/universal_health_coverage/report/uhc_report_2019.pdf

WHO (2014). The global push for universal health coverage. Available at: https://www.who.int/health_financing/GlobalPushforUHC_final_11Jul14-1.pdf

WHO (2010). The World Health Report. Available at: https://www.who.int/publications/i/item/9789241564021

WHO a (n.d.). Universal Health Coverage. Available at: https://www.who.int/westernpacific/health-topics/universal-health-coverage (accessed 14 October 2021)

WHO b (n.d.). Global Health Observatory Data Repository. Out of pocket expenditure as a percentage of total health expenditure. Available at: https://apps.who.int/nha/database/ViewData/Indicators/en (accessed 20 October 2021)

WHO c (n.d.). Global Health Observatory Data Repository. Current health expenditure as a % of gross domestic product. Available at: https://apps.who.int/nha/database/ViewData/Indicators/en (accessed 18 October 2021)

Cumulative index

Carswell MBJ, Ng D, Eydatoula Z, Murray SH & Curtis M (2019). The effectiveness of South African defined-contribution occupational fund benefit statements to inform and persuade: framework and initial applications. *SAAJ* **19**, 1–25. DOI: http://dx.doi.org/10.4314/saaj.v19i1.1

Channa A, Yuan J & Carswell MBJ (2021). Updated remarriage contingency deductions for widowed South Africans. *SAAJ* **21**, 49–73. DOI: https://dx.doi.org/10.4314/saaj.v21i1.3

Clover RJ (2008). Taxation of life insurance in South Africa revisited. *SAAJ* **8**, 1–34

Clur JC, Dorrington RE, Schriek KA & Lewis PL (2013). Modelling the mortality of members of group schemes in South Africa. *SAAJ* **13**, 143–83. DOI: http://dx.doi.org/10.4314/saaj.v13i1.5

Dardis A (2002). Risk-position reporting in the South African life-insurance industry. *SAAJ* **2**, 1–28

Da Silva R, Milner K, Kolbe-Alexander TL, Greyling M & Patel D (2014). The prevalence of chronic conditions associated with modifiable health risk factors in corporate employees in South Africa. *SAAJ* **14**, 101–36. DOI: http://dx.doi.org/10.4314/saaj.v14i1.4

Da Silva R & Wayburne L (2008). The effects of HIV/AIDS on medical schemes in South Africa. *SAAJ* **8**, 35–91

Davies N & Kijko A (2003). Seismic risk assessment: with an application to the South African insurance industry. *SAAJ* **3**, 1–28

Davis RWD & Kendal S (2012). Surplus? What surplus? Did the Pension Funds Second Amendment Act achieve its aims? *SAAJ* **12**, 97–128. DOI: http://dx.doi.org/10.4314/saaj.v12i1.4

Dorrington RE & Tootla S (2007). South African annuitant standard mortality tables 1996–2000 (SAIML98 and SAIFL98). *SAAJ* **7**, 161–84

Emslie S & Mataramvura S (2020). Comparison of numerical methods to price zero coupon bonds in a two-factor CIR model. *SAAJ* **20**, 109–47. DOI: http://dx.doi.org/10.4314/saaj.v20i1.5

Farmar GJ (2002). Deficiencies in the theory of free-knot and variable-knot spline graduation methods with specific reference to the ELT 14 males graduation. *SAAJ* **2**, 69–82

Flint E & Maré E (2017). Estimating option-implied distributions in illiquid markets and implementing the Ross recovery theorem. *SAAJ* **17**, 1–28. DOI: http://dx.doi.org/10.4314/saaj.v17i1.1

Flint E & Maré E (2019). Regime-based tactical allocation for equity factors and balanced portfolios. *SAAJ* **19**, 27–52. DOI: http://dx.doi.org/10.4314/saaj.v19i1.2

Flint EJ, Ochse ER & Polakow DA (2014). Estimating long-term volatility parameters for market-consistent models. *SAAJ* **14**, 19–72. DOI: http://dx.doi.org/10.4314/saaj.v14i1.2

Flint E, Seymour A & Chikurunhe F (2020). Defining and measuring portfolio diversification. *SAAJ* **20**, 17–48. DOI: http://dx.doi.org/10.4314/saaj.v20i1.2

Foroughi K, Jones IA & Dardis A (2003). Investment guarantees in the South African life insurance industry. *SAAJ* **3**, 29–75

Ganz MD (2012). The effect of SAM on the South African medical-scheme environment: a quantitative analysis. *SAAJ* **12**, 65–96. DOI: http://dx.doi.org/10.4314/saaj.v12i1.3

Georgiopoulos N (2017). A closed-form approximation for deriving expected losses in excess loss life reinsurance. *SAAJ* **17**, 29–42. DOI: http://dx.doi.org/10.4314/saaj.v17i1.2

Govender P, Kambaran N, Patchett N, Ruddle A, Torr G & Van Zyl, N (2007). Poverty and inequality in South Africa and the world. *SAAJ* **7**, 117–60

Harris R & Besesar S (2021). Anti-selection in voluntary health insurance markets: A focus on medical schemes in South Africa.*SAAJ* **21**, 93–118. DOI: https://dx.doi.org/10.4314/saaj.v21i1.5

Hong L & Zou H (2015). Jump tests for semimartingales. *SAAJ* **15**, 93–108. DOI: http://dx.doi.org/10.4314/saaj.v15i1.4

Jeaven H, Wapnick R & Carswell MBJ (2021). The impact of giving and receiving remittances on life insurance purchases. *SAAJ* **21**, 27–47. DOI: https://dx.doi.org/10.4314/saaj.v21i1.2

Johnson LF & Dorrington RE (2007). The potential effect of an HIV/AIDS vaccine in South Africa. *SAAJ* **7**, 49–72

Kijko A, Smit A & Van de Coolwijk N (2015). A scenario approach to estimate the maximum foreseeable loss for buildings due to an earthquake in Cape Town. *SAAJ* **15**, 1–30. DOI: http://dx.doi.org/10.4314/saaj.v15i1.1

Kilian CG (2020). An investigation of an overlap in penalty calculations: profit commission in reinsurance treaties versus profit commission in binder agreements for underwriting managers. *SAAJ* **20**, 1–16. DOI: http://dx.doi.org/10.4314/saaj.v20i1.1

Koch RJ (2011). Damages for personal injury and death: legal aspects relevant to actuarial assessments. *SAAJ* **11**, 111–33. DOI: http://dx.doi.org/10.4314/saaj.v11i1.4

Lowther MW (2004). Exercising actuarial discretion in the pricing of transfer values. *SAAJ* **4**, 63–95

Lowther MW (2011). Promoting quality in the actuarial assessment of quantum of damages in South Africa. *SAAJ* **11**, 85–110. DOI: http://dx.doi.org/10.4314/saaj.v11i1.3

Lowther MW & McMillan W (2006). Planning lifelong professionalisation learning for actuaries. *SAAJ* **6**, 1–17

Lowther MW & McMillan WJ (2014). Authentic professional development: key to quality service delivery. *SAAJ* **14**, 1–18. DOI: http://dx.doi.org/10.4314/saaj.v14i1.1

Lowther MW, McMillan WJ & Venter F (2009). Education for actuarial quality must develop more than technical competence. *SAAJ* **9**, 53–75

Lowther MW & Mort JWT (2002). Managing actuaries' professional risk. *SAAJ* **2**, 29–52

Lowther MW & Mort JWT (2016). Towards best practice in the actuarial assessment of claims for maintenance against deceased estates. *SAAJ* **16**, 127–41. DOI: http://dx.doi.org/10.4314/saaj.v16i1.5

Maitland AJ (2001). An empirical approach to immunization in South Africa. *SAAJ* **1**, 119–38

Maitland AJ (2002). Interpolating the South African yield curve using principal-components analysis: a descriptive approach. *SAAJ* **2**, 129–45

Maitland AJ (2010). A multiple Markov switching model for actuarial use in South Africa. *SAAJ* **10**, 71–108

Martin M & Hayes M (2013). Operational risk management: practical implications for the South African insurance industry. *SAAJ* **13**, 39–95. DOI: http://dx.doi.org/10.4314/saaj.v13i1.3

McLeod HD (2005). Mutuality and solidarity in healthcare in South Africa. *SAAJ* **5**, 135–67

McLeod HD, Achmat Z & Stein AM (2003). Minimum benefits for HIV/AIDS in South African medical schemes. *SAAJ* **3**, 77–112

McLeod HD, Slattery PG & Van den Heever AM (2001). The use and abuse of reinsurance in medical schemes. *SAAJ* **1**, 95–117

Molloy L & Ronnie L (2020). Sustaining the life insurance industry in the Fourth Industrial Revolution. *SAAJ* **20**, 81–107. DOI: http://dx.doi.org/10.4314/saaj.v20i1.4

Mourik T (2018). Mortality risks, reinsurance and risk-based supervision. *SAAJ* **18**, 1–15. DOI: http://dx.doi.org/10.4314/saaj.v18i1.1

Ngugi A, Maré E & Kufukunesu R (2015). Pricing variable annuity guarantees in South Africa under a Variance-Gamma model. *SAAJ* **15**, 131–70. DOI: http://dx.doi.org/10.4314/saaj.v15i1.6

O'Malley BR, Dorrington RE, Jurisich SC, Valentini JA, Cohen TM & Ross BJ (2005). An investigation of the mortality of South African assured lives, 1995–1998. *SAAJ* **5**, 27–59

Plaks S & Butler MBJ (2012). Access to public healthcare in South Africa. *SAAJ* **12**, 129–64. DOI: http://dx.doi.org/10.4314/saaj.v12i1.5

Plantinga AA, Corubolo D & Clover R (2015). Catastrophe modelling: deriving the 1-in-200-year mortality shock for a South African insurer's capital requirements under Solvency Assessment and Management. *SAAJ* **15**, 51–92 [print]. Online version with full appendices at DOI: http://dx.doi.org/10.4314/saaj.v15i1.3

Polakow DA, Dunne TT & Whitworth JAG (2001). Parameterisation of expected residual lifetime after seroconversion in a Ugandan sample population. *SAAJ* **1**, 35–61

Ramjee S, Kooverjee A & Dreyer KA (2013). The construction of a price index for contributions to South African open medical schemes. *SAAJ* **13**, 1–19. DOI: http://dx.doi.org/10.4314/saaj.v13i1.1

Ramjee S, Sibiya FG & Dreyer KA (2013). The gender profile of the South African actuarial profession. *SAAJ* **13**, 21–37. DOI: http://dx.doi.org/10.4314/saaj.v13i1.2

Ranchod S, Abraham M & Bloch J (2015). An actuarial perspective on healthcare expenditure in the last year of life. *SAAJ* **15**, 31–49. DOI: http://dx.doi.org/10.4314/saaj.v15i1.2

Ranchod S, Childs B, Abraham M & Taylor R (2016). International benchmarking of hospital utilisation: how does the South African private sector compare? *SAAJ* **16**, 69–90. DOI: http://dx.doi.org/10.4314/saaj.v16i1.3

Raubenheimer H & Kruger MF (2010). Generating interest-rate scenarios for fixed-income portfolio optimisation. *SAAJ* **10**, 1–42

Raubenheimer H & Kruger MF (2010). A stochastic-programming approach to integrated asset and liability management of insurance products with guarantees. *SAAJ* **10**, 43–70

Reddy TL & Thomson RJ (2011). The capital-asset pricing model: the case of South Africa. *SAAJ* **11**, 43–84. DOI: http://dx.doi.org/10.4314/saaj.v11i1.2

Rusconi RD (2005). Saving for retirement in South Africa: charges to the consumer. *SAAJ* **5**, 61–133

Rusconi R (2020). The contribution of South Africa's insurers to systemic risk: thoughts for policy-makers. *SAAJ* **20**, 149–210. DOI: http://dx.doi.org/10.4314/saaj.v20i1.6

Şahin Ş & Levitan S (2020). A stochastic investment model for actuarial use in South Africa. *SAAJ* **20**, 49–79. DOI: http://dx.doi.org/10.4314/saaj.v20i1.3

Schriek KA, Lewis PL, Clur JC & Dorrington RE (2013). The mortality of members of group schemes in South Africa. *SAAJ* **13**, 97–142. DOI: http://dx.doi.org/10.4314/saaj.v13i1.4

Slattery PG & Kemp HJ (2007). Options for the development of the education and professional qualification of South African actuaries. *SAAJ* **7**, 1–48

Smith ML, Beyers FJC & De Villiers JP (2016). A method of parameterising a feed forward multi-layered perceptron artificial neural network, with reference to South African financial markets. *SAAJ* **16**, 35–67. DOI: http://dx.doi.org/10.4314/saaj.v16i1.2

Strugnell D & Ranchod S (2017). Throughput in the UCT Actuarial Science programme: a microcosm of the profession's transformation challenge. *SAAJ* **17**, 43–72. DOI: http://dx.doi.org/10.4314/saaj.v17i1.3

Strydom ML, Corubolo D & Nel C (2016). Changes in mortality of people living with HIV in South Africa and their potential implications for life assurers. *SAAJ* **16**, 1–33. DOI: http://dx.doi.org/10.4314/saaj.v16i1.1

Taljaard BH & Maré E (2019). Considering the use of an equal-weighted index as a benchmark for South African equity investors. *SAAJ* **19**, 53–70. DOI: http://dx.doi.org/10.4314/saaj.v19i1.3

Terblanche W (2009). Demand for actuarial resources in South Africa. *SAAJ* **9**, 1–52

Thomson RJ (2006). A typology of models used in actuarial science. *SAAJ* **6**, 19–36

Thomson RJ (2010). Modelling the market in a risk-averse world: the case of South Africa. *SAAJ* **10**, 109–36

Thomson RJ (2011).The arbitrage-free equilibrium pricing of liabilities in an incomplete market: application to a South African retirement fund. *SAAJ* **11**, 1–41. DOI: http://dx.doi.org/10.4314/saaj.v11i1.1

Thomson RJ & Posel DB (2002). The management of risk by burial societies in South Africa. *SAAJ* **2**, 83–128

Thomson RJ & Reddy TL (2013). The capital-asset pricing model reconsidered: tests in real terms on a South African market portfolio comprising equities and bonds. *SAAJ* **13**, 221–63. DOI: http://dx.doi.org/10.4314/saaj.v13i1.7

Van Appel V, Maré E and Van Niekerk A (2021). Quantitative guidelines for retiring (more safely) in South Africa. *SAAJ* **21**, 75–91. DOI: https://dx.doi.org/10.4314/saaj.v21i1.4

Van Zyl N & Van Zyl DJJ (2016). The impact of behavioural economics and finance on retirement provision. *SAAJ* **16**, 91–125. DOI: http://dx.doi.org/10.4314/saaj.v16i1.4

Walters NM, Beyers FJC, Van Zyl AJ & Van den Heever RJ (2018). A framework for simulating systemic risk and its application to the South African banking sector. *SAAJ* **18**, 99–133. DOI: http://dx.doi.org/10.4314/saaj.v18i1.5

Whittaker GA (2018). The Life Esidimeni arbitration and the actuarial quantification of constitutional damages. *SAAJ* **18**, 71–97. DOI: http://dx.doi.org/10.4314/saaj.v18i1.4

Whittaker GA (2021). A history and forecast of the South African life tables No. E1 to No. E9. *SAAJ* **21**, 1–25. DOI: https://dx.doi.org/10.4314/saaj.v21i1.1

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