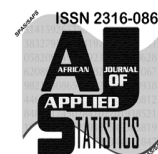


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Projecting Tanzania Pension Fund System

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Abstract. A mandatory Tanzania pension fund with a final salary defined benefit is analyzed. This fund is a contributory pay-as-you-go defined benefit pension system which is much affected by the change in demography. Two kinds of pension benefit, a commuted (at retirement) and a monthly (old age) pension are considered. A decisive factor in the analysis is the increased life expectancy of members of the fund. The projection of the fund's future members and retirees is done using expected mortality rates of working population and expected longevity. The future contributions, benefits, asset values and liabilities are analyzed. The projection shows that the fund will not be fully sustainable on a long term due to the increase in life expectancy of its members. The contributions will not cover the benefit payouts and the asset value will not fully cover liabilities. Evaluation of some possible reforms of the fund shows that they cannot guarantee a long-term sustainability. Higher returns on asset value will improve the funding ratio, but contributions are still insufficient to cover benefit payouts.

Key words: Pension fund; Pay-as-you-go; Defined benefit; Demography.

AMS 2010 Mathematics Subject Classification : 62P05

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Résumé. Un fonds de pension obligatoire en Tanzanie avec un salaire final défini est défini. Ce fonds est un système de retraite à prestations déterminées contributif et payant qui est très affecté par les changements démographiques. Deux types de prestations de retraite, une retraite de rachat (à la retraite) et une pension mensuelle (vieillesse) sont considérés. Un facteur décisif dans l'analyse est l'augmentation de l'espérance de vie des participants au fonds. La projection des futurs membres et des retraités du fonds se fait à l'aide des taux de mortalité attendus de la population active et de la longévité espérée. Les contributions futures, les avantages, la valeur de l'actif et du passif sont analysés. Nos projections montrent que le fonds ne sera pas pleinement durable à long terme, en raison de l'augmentation de l'espérance de vie de membres. Les contributions ne couvriront pas les paiements de prestations et la valeur de l'actif ne couvrira pas entièrement le passif. Une évaluation de certaines réformes possibles du fonds montre qu'ils ne peuvent garantir une viabilité à long terme. Un rendement plus élevé de la valeur de l'actif améliorera le ratio de financement, mais les contributions restent insuffisantes pour couvrir les paiements de prestations.

1. Introduction

A pay-as-you-go (PAYG) pension system refers to a plan in which the pension of the retirees is financed by contributions from current members. Usually, the benefit is calculated according to a formula based on employee's salary and years of the service. This system is adopted by most public pension funds in many countries. However, when the population is ageing and the growth rate of old population is higher than working population growth, the amount of contributions cannot catch up with the promised benefit payouts, which will cause the system to be not sustainable (?).

Sweden, Italy, Canada and Germany have introduced notional defined contribution (NDC) pension systems (Börsch Supan, 2005; Hagemeyer, 2009), whereby pay-as-you-go systems mimic defined contribution plans. This system removes incentives for early retirement and passing on to individual retirees the financial risks of rising longevity. Humberto et al. (2016) studied a sustainability framework for pay-as-you-go pension systems. This study forecasts that, the net present value of expenditure on pensions in the US will exceed the net present value of contributions through the period 2015 – 2089. Moreover Jing et al. (2015) developed a benchmark risk measure for pay-as-you-go pension sponsors by obtaining a total asset requirement for sustaining the pension plan.

Several studies show that the world demography is experiencing that the number of elderly grows with elderly living longer than in past times (Meeks et al., 1999; Batini et al., 2006; Bloom et al., 2007, 2011). As a result, in European countries, the pension system dependency ratios, that is, the number of retirees divided by the number of contributors, are increasing (Hilli et al., 2007; Geyer and Ziemba, 2008). For African countries, e.g. Morocco and South Africa, the life expectancy of pension fund members is also increasing (El Goumi et al., 2016; Van der Berg, 1998). This demographic change will affect the world economy over a long term in many ways. For example, governments pension systems cannot continue with their current rules (Johnson, 2004).

Some studies have been conducted for Tanzania pension funds system. [Macha \(2013\)](#) examines the drivers of investment in the risky asset (equities) for Tanzania pension funds. [Ackson \(2007\)](#) studies the social security law and policy reform in Tanzania with reflection on the South Africa experience. [Mbwile and Chalu \(2013\)](#) attempt to identify determinants of pension funds benefits portability in Tanzania, where they examined the influence of administrative costs, information availability, pension funds, membership and economic factors on members preferences for portable pension schemes. Also, [Bogomolova \(2013\)](#) used PROST to evaluate the impact of reform on National Social Security Fund, by projecting the future state of the fund for a period from 2013 to 2078. Numerical results show that the fund retirees to contributors dependency ratio grows fast as defined benefit plan matures, and longevity increases. As the dependency ratio grows, the annual cash flow turns to negative in 2068 under harmonization rule. Assets are projected to deplete in around 2061 to 2077, and in longer run, there are imbalances between the contributions levels and retirement age benefits.

The pension fund system in Tanzania comprises five public pension funds which are Parastatal Public Pension (PPF), Public Service Pension Fund (PSPF), National Social Security Fund (NSSF), Local Authorities Pension Fund (LAPF) and Government Employees Provident Fund (GEPF). With the exception of the GEPF, all pension funds are operating on pay-as-you-go defined benefit basis. By 2015, the system covered around 2,142,350 members which was about 4% of the total population and 10% of the working population. The social, economic and political changes which took place in early 1980's and the 1990's prompted the formulation of National Social Security policy in 2003. The goal of this policy was to extend the social security services to the majority of the Tanzanians to meet the goals set out in the vision for 2025. This policy resulted in the formulation of Social Security Regulatory Authority (SSRA) in 2008. According to [Policy Note \(2014\)](#), the system in 2014 seemed to be sustainable, although not fully sustainable over a long term. The system dependency ratio was low, about 7% on average. Though this does vary significantly from as little as 1% in National Social Security Fund to over 22% in Parastatal Public Fund, depending on the degree of scheme maturity. This means that the financial burden on each contributor was on average low. But as the system matures this ratio will grow fast. Some of the pension funds like Public Service Pension Fund have already started to experience the effect of increased life expectancy ([Isaka, 2016](#)). Further parametric reforms will be required in future to assure the long-term viability of the system.

The National Social Security Fund is the largest pension fund in Tanzania. It has more members than other funds (about 44% of the total pension funds population in 2015 by SSRA records) and lowest retirees to contributors dependency ratio. The NSSF is a formal institution that provides social security protection in Tanzania and it was established by the Act of Parliament No. 28 of 1997 to replace the defunct National Provident Fund. It is a compulsory scheme that offers social security coverage to employees of private sector and non-pensionable Parastatal organizations, government employees, self-employed or any other employed person not covered by any other fund, and any other category as declared by the Minister of Labour. It is a fully funded scheme running under defined benefit principles. Since the fund is a pay-as-you-go pension plan, it is an inter-generation contract

where current members' contributions are used to pay current retirees' benefits.

The aim of our study is a long-term projection of the demographic and financial development of the Tanzania pension system, with the purpose of analyzing its long-term sustainability. As an application, we consider National Social Security Fund. The projection is made for a horizon of 50 years from 2015 to 2065. The projection is founded on available data, established projections of future life expectancy, and assumptions that are plausible with respect to the anticipated development of social and health services of the country.

The remainder of the paper is organized as follows. In Section 2 we give the projection of members and retirees while in Section 3 we give the projection of contributions, benefits, cash flows, liabilities and asset values. The Section 4 evaluates the effect of some possible system reforms and the Section 5 evaluates the effects of changes in assets values. Section 6 gives conclusion and future research.

2. Projecting members and retirees

We consider a fund with a number of initial members. Every year new members are recruited, also some members retire, and others die. The exiting fund members are not included in this paper since in a Tanzania mandatory defined benefit pension fund, there is no withdraw benefit. Although this is a subject to a debate among trade unions and politicians, there is still no legal amendment of this regulation. The member population process is illustrated in Figure 1.

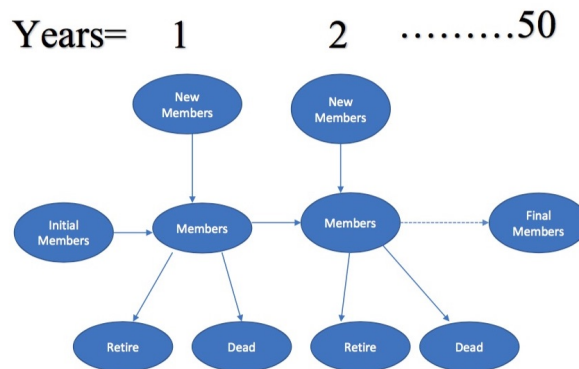


Fig. 1: Pension fund population process

According to SSRA records, the NSSF has 673,959 members in 2015, which define the initial number of members in our projection. By Tanzania pension regulation, a member who attains the age of 55 years may at any time thereafter opt to retire. Otherwise, he may continue to be a member until he attains the compulsory retirement age of 60 years (SSRA,

2014).

We assume that the entry age is from 20 to 29 years and the retirement age is 60 years. An estimate of the initial distribution of members by ages from 20 years to 59 years is made according to the 2012 Tanzania National Census (NBS, 2013).

According to the 2012 National Census, the population growth rate is 3%. The SSRA aims the number of members of pension funds to reach 20% of the working population by 2020. To achieve this growth in members, we assume a rapid growth rate of 15% in members per year for the first 10 years, followed by the rate of 12% for next 5 years, to reach around 20% of the working population. After that, the number of members will grow slowly with 3% per year for 10 years and finally drop to a growth rate of 2% for the remaining horizon. We assume that the growth rate is decreasing since the world population growth rate is projected to decrease in future (Lutz et al., 2001). Table 1 summarizes this information.

Table 1: Population growth rates

Years	1-10	11-15	16-25	25-50
Percentage	15%	12%	3%	2%

Mortality rates in developing countries have declined dramatically raising the average life expectancy (Kalasa, 2001). According to the 2012 National Census, the mortality rate for Tanzania working population is 0.6%. We assume that the mortality rate will be decreasing in future due to the improvement of social awareness and health services. Starting with a mortality rate of 0.5%, it is assumed to decrease by 0.1% after every 10 years. The final mortality rate after 40 years is then of the same order as that in developed countries. Table 2 gives the summary of the assumption.

Table 2: Mortality rates

Years	1-10	11-20	21-30	31-40	41-50
Mortality rate	0.5%	0.4%	0.3%	0.2%	0.1%

The future members are projected as discussed in Mettler (2005). A pension fund population is described as a vector of states P_t and updated by a transition matrix Π_t . The transition matrix changes with time t . There are $n = 43$ states in total (40 ages, retirement, old age and dead) and an element π_{ijt} of the matrix Π_t is the portion of the population in state i

that transitions to a state j . Hence

$$\begin{aligned} \pi_{ijt} &\geq 0 \quad \forall i, j \in \{1, \dots, n\} \\ \sum_{j=1}^n \pi_{ijt} &= 1 \quad \forall i \in \{1, \dots, n\}. \end{aligned}$$

The state vector P_t is given by

$$P_t = \Pi_t^T P_{t-1} + k_t P_{t-1}, \tag{1}$$

where k_t is a matrix which captures the growth rate in year t according to Table 1. The new members are distributed equally each year from age 20 to age 29. The Figure 2 describes the projected distribution of members by age states after every 10 years. Here, eight aggregate age states are formed, named states 1 to 8, with respect to age classes 20 – 24, 25 – 29, 30 – 34, 35 – 39, 40 – 44, 45 – 49, 50 – 54 and 55 – 59, respectively.

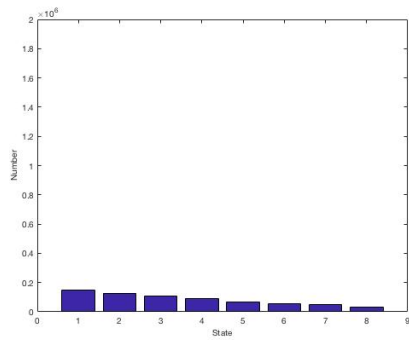
Figure 2a shows initial aggregate ages states whose number of members is very low. It is followed by the fast growth in aggregate age state 1, which is the age class 20 – 24, 2 which is age class 25 – 29 and 3, which is 30 – 34, after 10 years as shown in the Figure 2b. Then at the end of time horizon as shown in the Figure 2f, the aggregate age state 8 which is age class 55 – 59 seems higher compared to the preceding aggregate age states. The age state 1 decreases after 10 years as shown in the Figures 2c and 2d, and then grows after 40 years as shown in the Figure 2e and Figure 2f. The reason is that, despite the low growth rate, the mortality rate has declined to allow more people to reach higher ages.

The life expectancy of members of pension funds is expected to increase in future. The future expected lifetime in Tanzania according to Isaka (2016), is shown in the Table 3. In our projection, men’s life expectancy at age 60 is used since according to ILO (2016) the rate of men employed is higher compared to women in Sub-Sahara countries. In future, the employment rate for women can be expected to rise. Since women’s life expectancy is higher, our analysis based on men’s expected lifetime is slightly optimistic with respect to the fund’s sustainability.

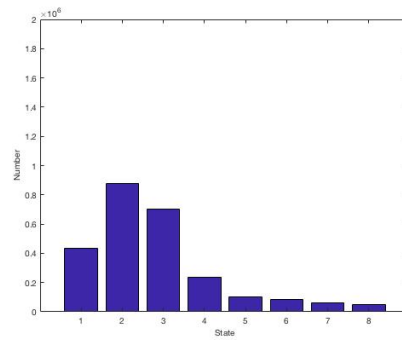
Table 3: Life expectancy of members at different time, by age and sex

Year	Men			Women		
	At 20	at 40	At 60	At 20	At 40	At 60
2013	54.6	37.5	20.8	55.7	39.1	22.2
2038	57.1	39.2	21.8	58.1	40.4	22.9
2063	59.7	41.0	22.9	61.2	42.5	24.2
2088	61.8	42.6	23.9	63.6	44.2	25.4

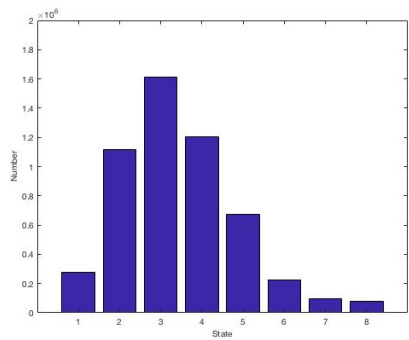
The total number of members T_t , is equal to the sum of members in all ages in the year t . The projected number of members in future 50 years is shown in Figure 3. The projection shows a fast growth in first 15 years, which is 2030, to reach a membership of around 20% of



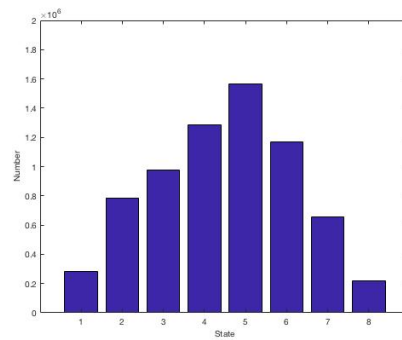
(a) Initial aggregate age states



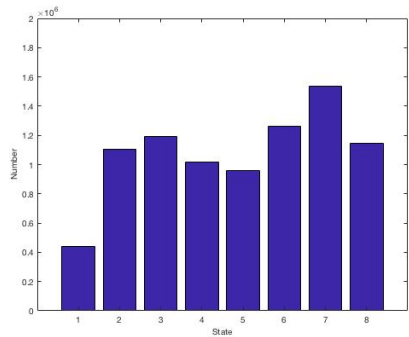
(b) Aggregate age states after 10 years



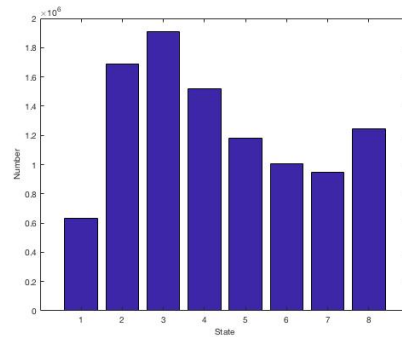
(c) Aggregate age states after 20 years



(d) Aggregate age states after 30 years



(e) Aggregate age states after 40 years



(f) Aggregate age states after 50 years

Fig. 2: Members by ages distributions in steps of 10 years

the working population, due to the assumed high initial growth rate, and then the number of members grows more slowly for the remaining horizon.

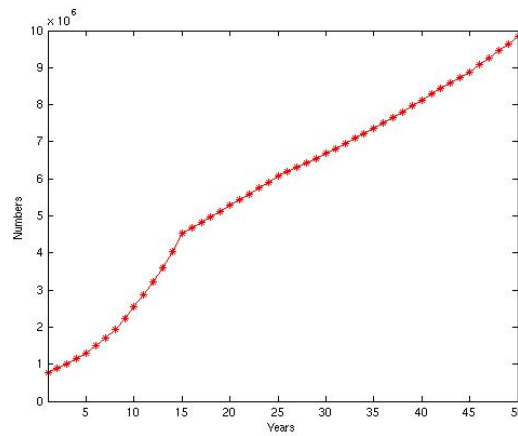


Fig. 3: Members growth

As shown in Figure 4, the number of retirees grows slowly in the beginning and then grows fast after 35 years, which is 2050. This implies that after 35 years the fund will experience a fast increase of benefit payments.

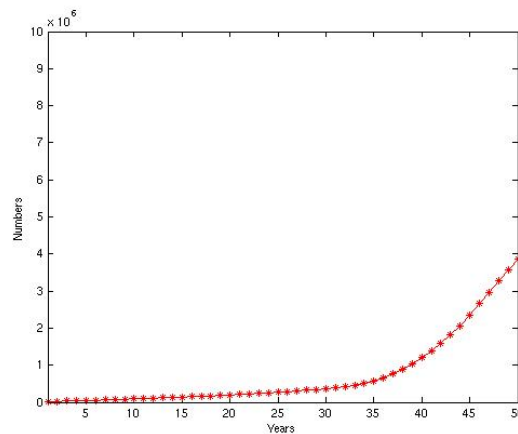


Fig. 4: Retirees growth

The retirees to members dependency ratio is shown in the Figure 5. By letting the number of retirees in the year t be denoted by R_t , the ratio is given by

$$dr_t = \frac{R_t}{T_t}.$$

The Figure 5 shows how dr_t increases along the horizon. The dependency ratio starts in the beginning years at around 2% and increases to around 39% at the end of the horizon, which

is very high. This is an adverse situation since the contributions from a 100 members is not sufficient to pay benefit payouts for 39 retirees.

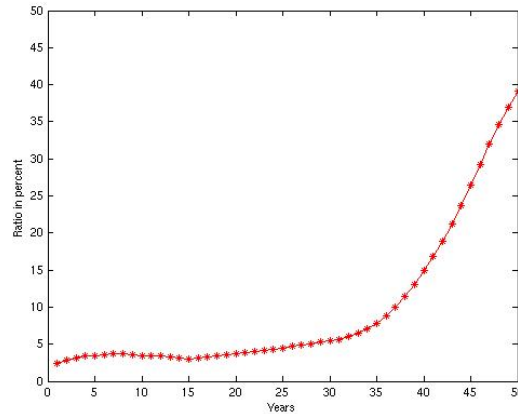


Fig. 5: Retirees to members dependency ratio

3. Projected contributions, benefits, cash flows, liabilities and asset values

In this section, we project the future contributions, benefits, cash flows, liabilities and asset values. Contributions, benefits and liabilities depend on salary. Cash flow depends on contributions and benefits payouts. Furthermore, asset value depends on cash flow. All values are in Tanzanian shillings. We consider a pension fund which starts with an initial asset value (wealth). Then the fund receives contributions from active members and employers. Contributions are used to pay current benefits. The cash flow and previous year asset values are invested with a given return rate of 4%. The following year, the contributions are collected and benefits are paid, and again the accumulated asset value plus cash flow are invested. The process continues until the end of the horizon. The Figure 6 illustrates the process.

3.1. Salary growth

We here start by studying the salary growth. We first assume that the salary grows in line with the growth of GDP per capita of working age population. This gives a growth on an annual basis adjusted for inflation and expressed in percentage. Members contribute through their monthly salary. For computational simplicity, we use an average annual salary of a participant in year t , which is denoted S_t and given by

$$S_t = (1 + d)S_{t-1},$$

where d is the annual salary growth rate. From World Bank statistics the average growth in GDP per capita for working population is approximate to 3.7%. Practically this rate

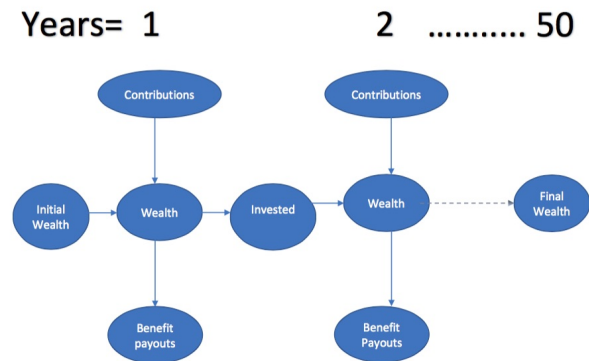


Fig. 6: Pension fund financial process

should be varying in line with time, but any change will proportionally cause changes in contributions, benefits, cash flow, asset value, and liabilities. Because of this, and to simplify our analysis, it is kept constant.

3.2. Contributions

Contributions depend on contribution rate and members' salaries. The contribution rate is the percentage of salary which is contributed to the fund. In Tanzania, currently, the contribution rate is 20%. The employee pays 5% and the employer pays 15% while in other funds, employee and employer each pays 10%. For computational simplicity, we assume these contributions are paid annually. Total annual contribution to the fund in year t , denoted C_t is given by

$$C_t = cr \times S_t \times T_t,$$

where cr is the contribution rate and S_t is the average annual salary. In our baseline analysis, the current contribution rate of 20% is used. In Section 4, changes in contribution rates are considered. Figure 7 represents the contributions growth. As the projection of the members behaves, also contributions grow fast in the first 15 years, and then grow slower in the succeeding years.

3.3. Benefits

Tanzania pension funds pay different kinds of pension benefit. These include maternity, gratuity, education, death gratuity, commuted pension and monthly pensions. In our analysis, only commuted and monthly pension are considered, other benefits are ignored. This assumption is due to the fact that other benefits are significantly smaller and it is optimistic with respect to the fund's sustainability. Commuted pension is a part of benefit paid as a lump sum at retirement. The monthly pension is a part of benefit paid in terms

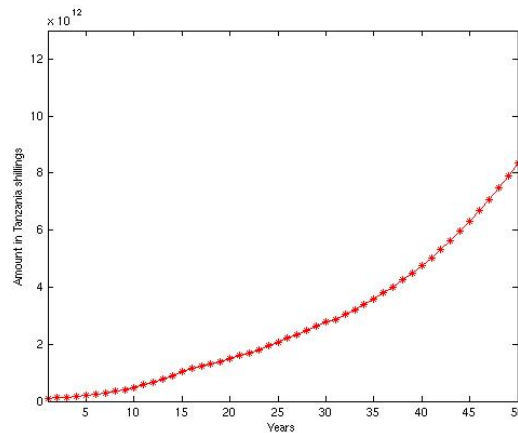


Fig. 7: Contributions growth

of regular payments every month from retirement until the death of the retiree. These two benefits depend on the number of months that a member has been contributing to the fund and on a retiree’s average annual earnings in the best three of the last 10 years preceding retirement. We assume as above that the entry age of new members of the fund is from 20 to 29 years.

To receive pension benefit a member should contribute for at least 180 months and reach an age of retirement. In 2014 SSRA issued the harmonization rule formula for commuted and monthly benefits (SSRA, 2014). The commuted benefit denoted CB , is given by

$$CB = \frac{1}{580} \times m \times S_{fin} \times 12.5 \times 25\%, \quad (2)$$

where m is the number of months a participant has been contributing to the fund, S_{fin} is the average final salary, $\frac{1}{580}$ is the annual accrual factor, 12.5 is commutation factor at retirement, and 25% is the commutation rate of the annual full amount of the pension.

A monthly pension denoted MB is given by

$$MB = \frac{1}{580} \times m \times S_{fin} \times 75\% \times \frac{1}{12}, \quad (3)$$

where 75% is the commutation rate of the annual full amount of the pension. The minimum monthly retirement pension payable to a member shall however not be below 40% of the prescribed lowest sectorial minimum wage. In our calculations, after retirement, the monthly salary is regularly revised to follow the growth in average salary for the working population. Also, MB is converted to annual benefit instead of monthly.

Since the NSSF was established in 1997, a member who retires 2015 has contributed at most 216 months. With reference to equations (2) and (3), the total benefit payouts at year t is

$$pa_t = nr_t \times CB + no_t \times MB, \quad (4)$$

where nr_t and no_t are total number of retirees and old age pensioners at year t respectively. Figure 8 displays the projected benefit payouts. The graph shows a slow growth before year 35, which is year 2050. Then the amount increases fast towards the end of the horizon.

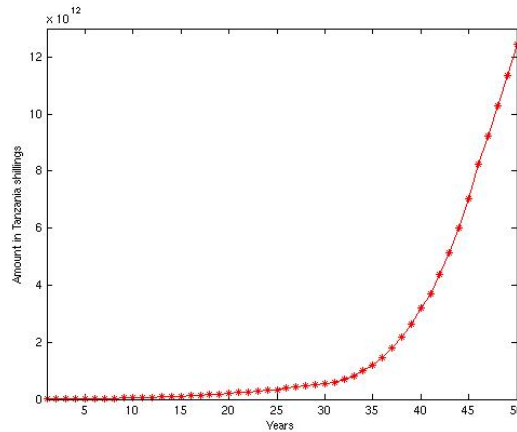


Fig. 8: Benefit payouts

3.4. Cash flow

Cash flow is the net amount of cash moving into and out of a fund. Positive cash flow indicates that a fund’s asset value is increasing and the fund can then invest the cash flow for future use. Negative cash flow indicates that a fund’s asset value might decrease. The cash flow in year t is given by

$$N_t = C_t - pa_t.$$

Figure 9 shows that the cash flow is initially positive and grows up to year 34 (which is year 2049), and thereafter starts to decrease due to an increase in the number of retirees. After year 43 (which is year 2058) the situation becomes worse since the cash flow is negative, showing that contributions will not cover the benefits. The fund must then use asset value to pay benefits, instead of investing to provide a buffer against future financial challenges.

3.5. Total liabilities

Liabilities depend on expected future benefits. When a member makes a contribution, an expected benefit to be paid in future is created. According to Tanzania pension regulation, commuted and monthly benefits depend on the number of months a member has been contributing to the fund and a final average salary.

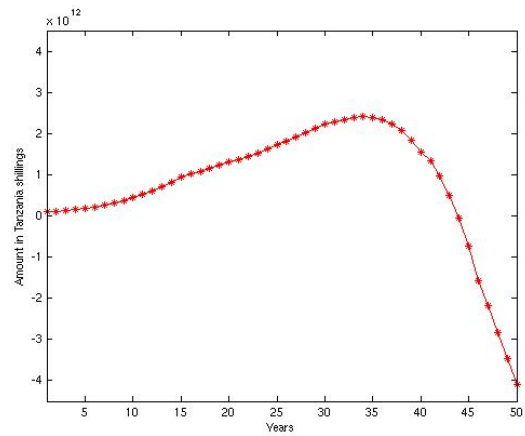


Fig. 9: Cash flow

In our calculations, a final average salary of a member aged k years in year t is obtained from

$$S_{fin_k} = S_t \times (1 + d)^{60-k}. \tag{5}$$

Here, d is the annual salary growth rate introduced in Subsection 3.1, S_t is the annual average salary in year t and k is the age of the member at time t . The total expected created commuted benefit in year t for members of age k is

$$CB_{tk} = P_k^{60-k} \times n_k \times \frac{1}{580} \times m_k \times S_{fin_k} \times 12.5 \times 25\% \tag{6}$$

where P_k^{60-k} is the probability of a member aged k years in year t to live $60 - k$ years more, that is, until retirement, n_k is the number of members aged k years in year t and m_k is the average number of months that members of age k have contributed.

Total expected yearly benefit in year t for members of age k is

$$MB_{tk} = P_k^{60-k} \times n_k \times \frac{1}{580} \times m_k \times S_{fin_k} \times 75\% \times Ep_{60_t} \tag{7}$$

where Ep_{60_t} is the remaining life expectancy of a member which is of age k in year t when he reaches the age of 60, as shown in Table 3.

The total expected benefit B_{tk} in year t for members of age k is

$$B_{tk} = CB_{tk} + MB_{tk}.$$

Liability is the discounted present value of expected total benefit. The total liability in year t is given by

$$L_t = \sum_{k=20}^{59} \frac{B_{tk}}{(1+r)^{60-k}}, \quad (8)$$

where $r = 5\%$ is a discount factor. This discount factor is in line with other assumptions and modelling used by World Bank economists (Policy Note, 2014). With assumption that initial members had been creating liabilities before the horizon, which is year 2015, and by using equation (8) the projected total liability can be calculated and it is shown in the Figure 10.

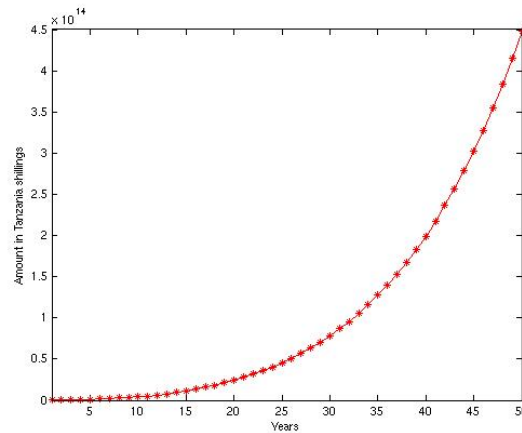


Fig. 10: Liabilities growth

3.6. Individual member liability

We consider an individual member to see the effect of increased life expectancy at age 60 on the created liability. Take a member who contributed for 12 months. Using equation (8) for a single member, Figure 11 shows that, the liability created grows linearly with the increase in life expectancy. A life expectancy of 9 years corresponds to created liability equal to 20% of the annual salary. But for a life expectancy of 20 years, the created liability corresponds to 37% of the annual salary. So for a life expectancy greater than 9 years, the contribution made will not cover the liability.

In another view, we consider the same equation (8) for a member who has contributed 20% of the salary for 40 years. Then contributions made are equal to 8 years of full salary. Figure 12 shows that for a life expectancy of 9 years the liability created is approximately equal to 8 years of full salaries. For a life expectancy of 20 years, the liability created is then equal to 15 years of full salaries. This implies that contributions of 20% of salary are insufficient to cover this individual’s pension benefit.

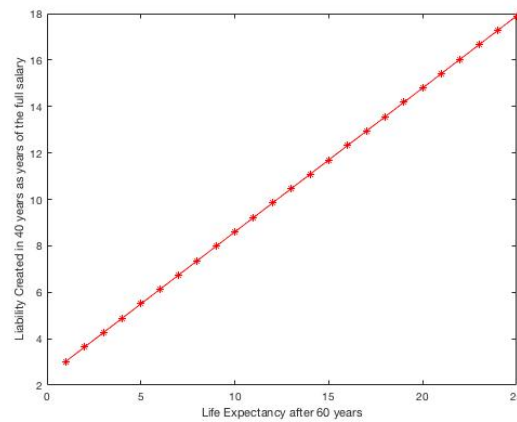


Fig. 11: Individual liability reference to life expectancy

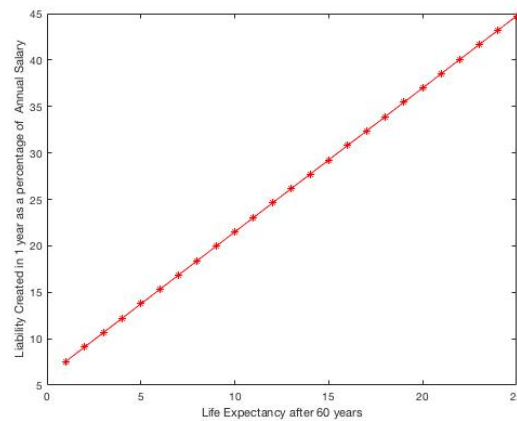


Fig. 12: Individual liability reference to life expectancy

3.7. Asset value

Asset value growth depends on the cash flow and return rate. When a fund receives contributions, current benefits are paid, and remaining cash flows are invested if being positive. We assume the fund starts with an initial asset value (wealth). This initial wealth of the NSSF is estimated to be equal to 3.3 trillion Tanzanian shillings and it is assumed that the investment gives a return of 4% per year. The return rate lies in line with the assumption that the return is approximately equal to the growth in salary. The following year the net cash flow N_t , combined with return on asset A_{t-1} gives the new asset value. Therefore, the asset value in year t is given by

$$A_t = N_t + (1 + b) \times A_{t-1}, \tag{9}$$

where b is the return rate. Figure 13 displays the projected future asset value. The projection shows that asset value growth is lower than liabilities growth as shown in the Figure 10. This means that the asset values are not enough to cover liabilities.

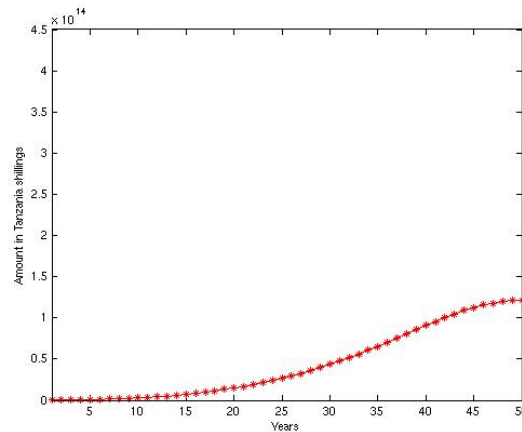


Fig. 13: Asset values growth

3.8. Funding ratio

Funding ratio is the ratio of asset value to liabilities, and it is used to measure the solvency of the fund. If the funding ratio is 100%, it implies that asset value matches exactly liabilities. If the funding ratio is less than 100%, it is called underfunding and means that asset value can not cover all liabilities. In this situation, a sponsor of the fund should make extra contribution to cover the deficit. If the funding ratio is greater than 100%, it is called over-funding. In this case, the fund has a surplus and this is favorable. The funding ratio in year t is calculated from

$$Fr_t = \frac{A_t}{L_t}, \quad (10)$$

where A_t is asset value in respect to equation (9) and L_t is liability in respect to equation (8). As shown in Figure 14, the fund starts with the funding ratio of 91% and it then decreases along the horizon. At the end of the horizon, the funding ratio is 27% which means the asset value will only cover 27% of the liabilities.

3.9. Cash flow to asset value ratio

When the contributions fail to cover the current benefit payments, a fund must use asset value to pay current benefits instead of investing for the future. As have been shown earlier, the cash flows decrease to negative values after year 43 due to the increase of retirees. We

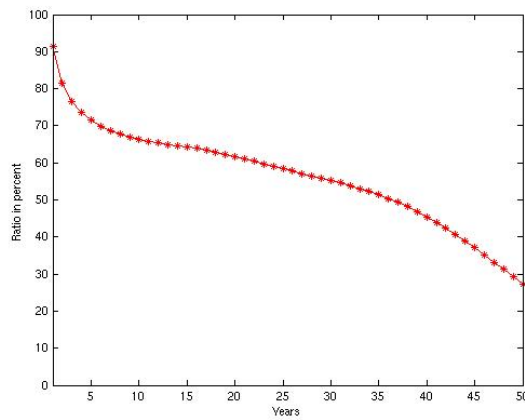


Fig. 14: Funding ratio

find the cash flow to asset value ratio Cr_t using the relation

$$Cr_t = \frac{N_t}{A_t}. \tag{11}$$

Figure 15 shows the cash flow to asset value ratio. The ratio is positive up to the year 43, which is 2048, and thereafter the ratio is negative. At the end of the horizon, the ratio is around -3.4% . This means that 3.4% of the asset value will be used to pay benefits, which implies that at a return rate of 4% , the remaining will be only 0.6% . Further, beyond the horizon, the assets will be consumed at even higher rates, and cause the assets to eventually deplete.

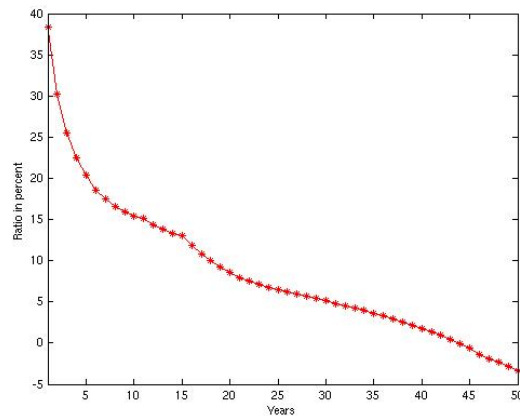


Fig. 15: Cash flow to asset value ratio

4. Pension fund reforms

The analysis in Section 3 shows, due to increased life expectancy, the fund will not be sustainable in a long future. The contributions will not cover the benefit payouts, which will cause the fund to use asset values to pay benefits and depletion of the fund's assets. To secure financial sustainability of pension funds in ageing societies, many countries introduced reforms which adapt future benefit levels to changes in demography (OECD, 2011; Hagemeyer, 2009). This is achieved by implementing parametric reform to the existing pension fund rules, or moving towards a notional defined contribution rules (Clavijo, 1998). The later is not a part of our study.

We present the evaluation of three parametric reforms for existing pension fund system in Tanzania. One option is to increase the contribution rate; one of the countries to take this reform is Colombia (Clavijo, 1998). Another one is the most visible and politically contested measures which is raising the retirement age. This reform involves a decline in retirees to members ratio. Many transition economies countries have already moved in this direction, for example, Hungary (Lasagabaster et al., 2004). Lastly, a combination of both reforms, increasing contribution rate and retirement age is considered.

We here consider and analyze possible reforms after 20 years to see how they will improve the sustainability of the fund. The same formulas as in Sections 2 and 3 are used, except after 20 years, the parameters are changed accordingly.

4.1. Increase of contribution rate

We consider raising the contribution rate to be 25% after 20 years. This increase will affect the contributions, asset values, cash flow, funding ratio, and cash flow to asset value ratio.

The increase in contribution rate causes an increase in asset value which in turn causes changes in the funding ratio. Figure 16 shows that with this reform, at the end of the horizon, the funding ratio will improve to around 38%, which is higher compared to when the contribution rate is 20%.

Cash flows will improve and go below zero after a period of 46 years, which is 2061, as shown by Figure 17. This period is longer than when the contribution rate is 20%.

The ratio of cash flow to asset value has improved compared to when the contribution rate is 20% as shown by Figure 18. At the end of the horizon, the ratio is around -1% which means that 1% of asset value will be used to pay the benefit at the end of the horizon. The remaining return rate is 3% which is higher compared to when the contribution rate is 20%.

4.2. Increase of retirement age

The increase in pensionable age is a possible policy response to the fact that people are living longer (OECD, 2011). We here assume that the retirement age changes to 65 after

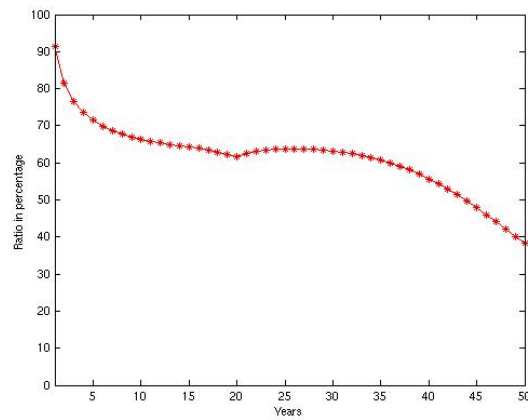


Fig. 16: Funding ratio

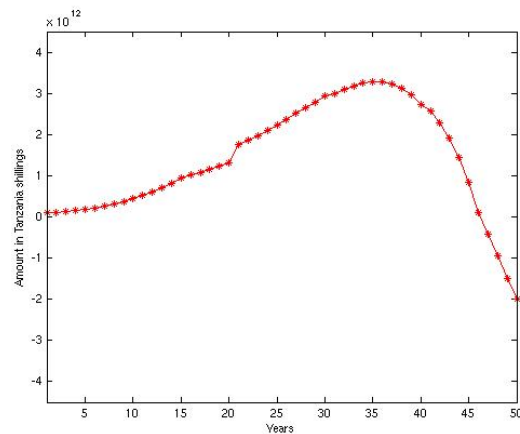


Fig. 17: Cash flows

20 years and study the change in the fund's sustainability. The increase in retirement age decreases the number of retirees which directly causes a decline in the dependency ratio. As shown by the Figure 19, the increase stabilizes between year 20 to 25 because there is no new retirees. The fast increase starts after 40 years, which is 2055, which is later than when the retirement age is 60.

Figure 20 shows that the dependency ratio is around 20% at the end of the horizon compared to 39% when the retirement age is 60 years. This ratio is better and enables the contributions to cover all benefit payouts through the horizon.

Also by changing the retirement age, obviously the amount of contributions change as well as asset values and liabilities. The funding ratio is displayed by the Figure 21. The result shows

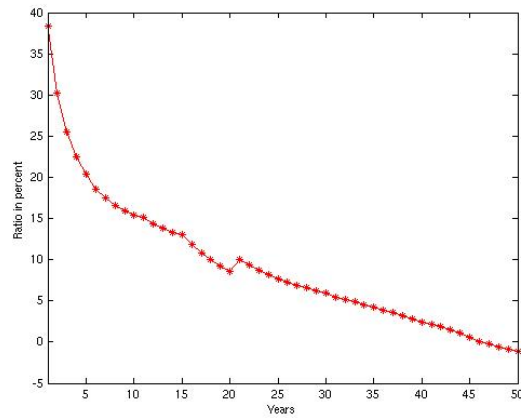


Fig. 18: Cash flow to asset value ratio

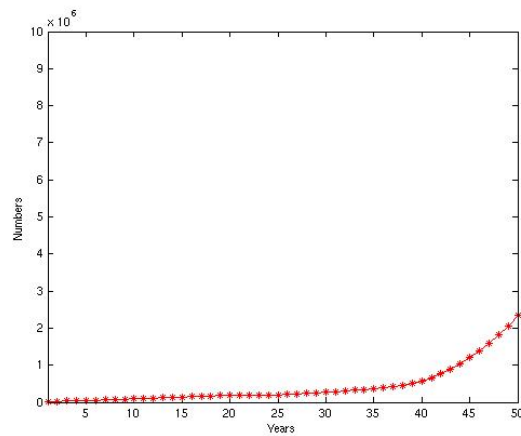


Fig. 19: Retirees growth

that the ratio improves to 42% at the end of the horizon. This ratio is higher compared to when the retirement age is 60 and even higher than when the contribution rate is raised to 25%.

The cash flow has improved and is well above zero up to the end of the horizon, as shown in the Figure 22. The cash flow is higher compared to when the retirement age is 60 or when the contribution rate is raised to 25%. Up to the end of the horizon, the cash flow is still positive showing that, contributions cover all benefits and make a surplus to be invested.

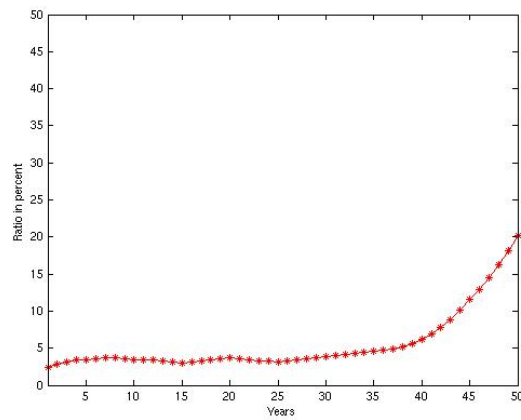


Fig. 20: Dependency ratio

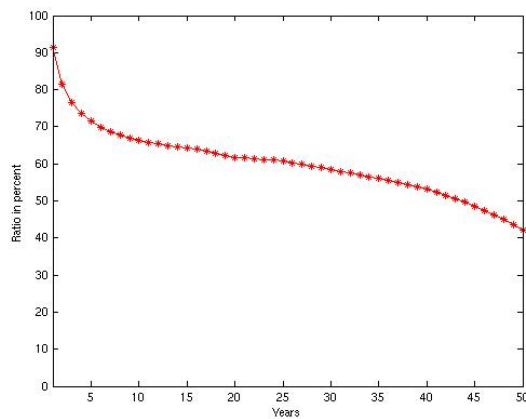


Fig. 21: Funding ratio

4.3. Increase of both retirement age and contribution rate

We here assume that both retirement age and contribution rate are increased after 20 years, setting the retirement age to be 65 and the contribution rate to 25%. We study the sustainability of the fund. The retirees to members dependency ratio will clearly be the same as in Figure 20. An increase in both contribution rate and retirement age directly changes the asset values and liabilities. As shown in Figure 23, the funding ratio has increased to 53% at the end of the horizon. This value is higher than if only contribution rate or the retirement age is increased.

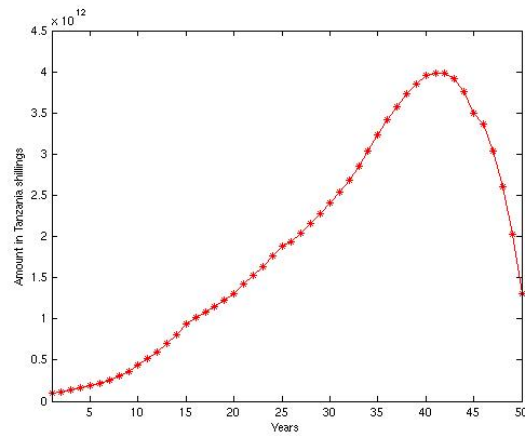


Fig. 22: Cash flows

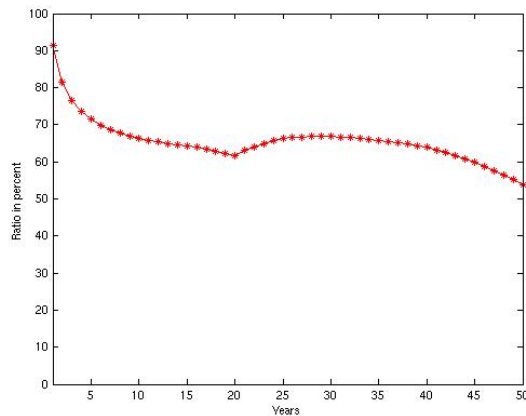


Fig. 23: Funding ratio

Figure 24 shows that this reform will raise the cash flow significantly. Its value is still high at the end of the horizon and higher than if only the contribution rate or the retirement age is increased.

5. Effect of return on assets

None of the reforms of the system analyzed above appears to guarantee a long-term sustainability of the fund. We next consider that the asset investment return rate changes. We here again consider the baseline situation studied in Section 3 and note that a change in return rate will not change the cash flow but only the asset value. We first assume that the fund invests the assets with a return rate of 3% and study the funding ratio. Figure 25 gives the trend of the funding ratio, which is around 21% at the end of the horizon. This is, of course,

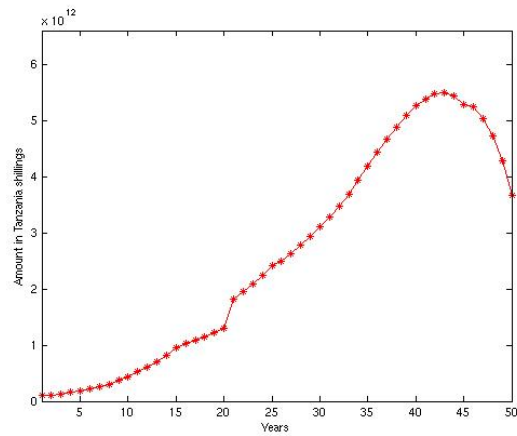


Fig. 24: Cash flows

lower compared to the case with a return rate of 4%. As Figure 26 shows, by increasing

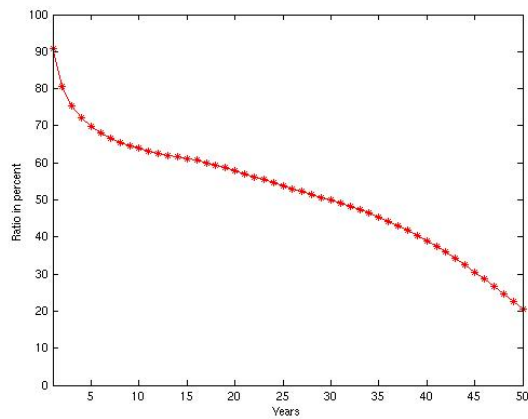


Fig. 25: Funding ratio with 3% return rate

the return rate to 5%, the funding ratio has raised higher and at the end of the horizon is approaching 36%.

Also, when increasing the return rate to 6%, the funding ratio has raised even higher and at the end of the horizon is around 47%, as shown in the Figure 27.

Worth noting, however, is that even with this relatively high return rate, the funding ratio is still decreasing on the long term. This means that it is not financially sound to use return on the asset to make benefit payments.

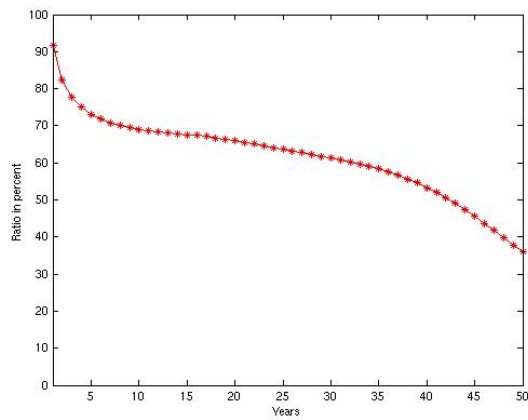


Fig. 26: Funding ratio with 5% return rate

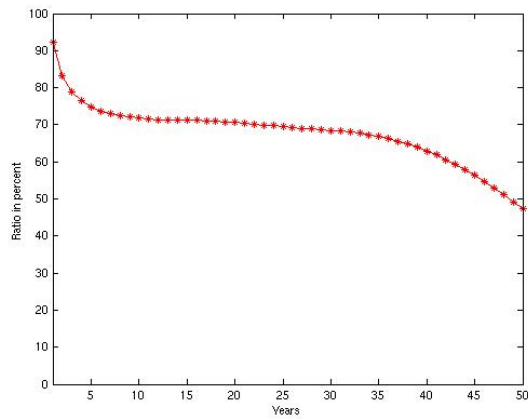


Fig. 27: Funding ratio with 6% return rate

6. Conclusion

This paper is a study of Tanzania pension fund system. This system is a mandatory pay-as-you-go which gives a final salary benefit. For the largest pension fund in Tanzania, a long-term projection shows that it will not be fully sustainable in a long future. Despite several reforms taken by the government to improve the sector, still, the analysis shows that the current system will not be sustainable since the cash flow will eventually turn negative and begin to deplete the accumulated asset value. Even when evaluating some possible reforms, it has been observed that they do not indicate a long-term sustainability, although a combination of increased contribution rate and retirement age will significantly enhance the long-term prospects.

On the other hand, by considering asset investment with other return rates, the study shows that higher return rates will improve the funding ratio, but still, it will not help on covering benefit payouts.

Our analysis suggests that in order to improve the long-term sustainability of the Tanzania pension fund system, it is necessary to make reforms concerning contribution rate and retirement age, and also to apply investment policies to improve return on assets.

In future research, reforms of the system will be studied. The shifting of the system from pay-as-you-go defined benefit to pay-as-you-go defined contribution will be analyzed with reference to other countries which have reformed their systems. We will focus on pension adequacy and their key task of avoiding poverty in old age. Also, we will develop a stochastic programming model for Tanzania pension funds using the existing regulations and policies. This stochastic model chooses the assets with the best return to raise the asset value closer to the liability level.

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