

ESTIMATING THE ACTUARIAL FUNDING TOWARDS THE MICRO PENSION SCHEME IN GHANA, A HYBRID OF THE MULTIPLE DECREMENT MODEL AND THE MARKOV PROCESS MODEL

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ABSTRACT

The issue of the financial sustainability of the micro pension scheme of Ghana based on the adequacy of the contribution rates to meet the benefit obligations is a matter of great concern. This study estimated the actuarial funding requirements of Ghana's Micro Pension Scheme through the use of hybrid Multi-Decrement Model and Multi-state Markov Process approach. A multiple decrement model and Markov process model were used to develop a more integrated approach towards examining the actuarial funding requirements in Ghana's Micro Pension Scheme. By incorporating the various decrement causes such as retirement, disability, withdrawal on volition, death, and the stochastic nature of the transition of the workers, a dynamic analysis of the pension contributions was realized. Using the Entry Age Normal Cost Method actuarial funding requirements were estimated to emphasize on meeting contributions in beneficiaries' working years. The Actuarial Present Value of Benefits, APV (B), from Obeng-Tawiah A et al. (2025) was applied to estimate the Normal Cost Percent, P, and the Actuarial Present Value of Contributions, APV (C). The results revealed that it was cost-effective for contributors to enroll early while those that joined later experienced a higher cost percentage. The findings stress the need to adapt pension models considering economic and demographic variables. This study's results can assist policymakers and pension officers in deriving a sustainable micro pension scheme to enhance retirement benefits of Ghana's formal workers.

Keywords: Micro-Pension Scheme, Actuarial Present Value, Multiple Decrement Model, Normal Cost Percent, Pension Funding.

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INTRODUCTION

Pension systems are the cornerstone of any state, as they provide citizens with a reliable source of income after retirement. However, a significant part of the population is covered by it, thus the pension system of a country is the cornerstone of its social security policy which ensures social stability, prevents poverty in old age and maintains a descent standard of living (Holzmann & Stiglitz, 2001). Pension funds in the context of both developed and developing countries are designed to address the challenges of longevity, accumulation, and risk, as well as to balance contributions, revenues, and expenditures in the long run. Nevertheless, in the context of a developing country, the key issue remains the need for an appropriate pension fund to ensure sustainable funding in the context of a wide range of variables (Barr & Diamond, 2008).

The issue of pension coverage in the informal sector is a peculiar problem in developing countries where most of the labor force is not covered by the existing pension schemes. Over 80% of Ghanaians are currently engaged in the informal economy with limited access to pension schemes (National Pensions Regulatory Authority, 2021). Similarly, in other developing countries like Nigeria, Kenya, and India, over 70% of the working population is in the informal sector (World Bank, 2018). Countries like Nigeria, Kenya, and India have implemented micro-pension schemes to allow more citizens to access some form of pension savings with minimal deductions at entry and withdrawal. India's national pension scheme (NPS-Lite) and Kenya's Mbao Pension plan are examples of micro-pension schemes that have been implemented to cushion some of the citizens against old age (Shankar & Asher, 2017; World Bank, 2020). The micro-pension scheme proposed in Ghana through the National Pensions Act 766 will enable the country to join other developing countries in

attempting to find a long-term solution to the pension fund coverage problem.

Although the discussed approaches can potentially allow for pension schemes with long-term viability, such schemes require accurate actuarial estimation of the contribution and funding levels (Bowers *et al.*, 1997; Boado-Penas & Eisenberg, 2022). The actuarial modeling process is the key to long-term pension scheme sustainability because it allows for determining contribution inflows that are sufficient to fund future pension payments (Boado-Penas & Eisenberg, 2022). However, traditional deterministic approaches to actuarial modeling often assume a constant number of employees, a fixed contribution level and a specific pattern of mortality, which are rarely found in practice. In particular, developing economies are characterized by high risks of disability, withdrawal from the workforce and mortality, which are difficult to account for (Antolin & Whitehouse, 2009). As such, there are now efforts to develop new actuarial models that use stochastic and hybrid modeling approaches.

In recent years, some worldwide studies on actuarial science have begun to apply multiple decrements and Markov process models to assess pension more accurately. MDM offers a systematic approach to evaluating the force of exits, such as retirements, disabilities, withdrawals, deaths, and maintaining consistency with life table processes (Gerber & Shiu, 2003; Haberman & Pitacco, 1999). In turn, MPM introduces uncertainty into the employment force, and contributors move actively, inactively, and re-enter states depending on the time-dependent probability distributions (). The combination of MDM and MPM provides a versatile actuarial framework to capture both static risk structures and dynamic transitions in the workforce, which is suitable for informal labour markets.

In the Ghanaian context, a significant body of literature investigates pension schemes in terms of design, policy, and participation behaviors (NPRA, 2021; Aryeetey & Steel, 2018), with limited investigation into the actuarial aspects of funding and financial adequacy. Empirical analyses on pensions funding in sub-Saharan Africa reveal that underpayments of pensions are routinely connected with the actuarial estimation of liabilities, failing to address the unfunded contributions and benefits obligation in terms of actuarial funding (Mitchell & Turner, 2017, World Bank, 2020). Therefore, the actuarial profession requires models, considering actuarial funding of pensions and social security schemes, focusing on such challenges as high withdrawal rates, economic shocks, and non-adequate incomes to enhance financial sustainability.

Research Objectives and Significance

The main goal of this paper is to estimate the actuarial funding requirements for Ghana's micro-pension scheme using Multiple Decrement Model and Markov Process Model. In particular, the paper seeks to:

- 1) Construct an actuarial model that employs multiple decrements to estimate pension contributions, and use Markov process model to evaluate the probability of transition from the involuntary withdrawal state to active state in Ghana's pension scheme, as a way of coming up with realistic actuarial funding models for the scheme.
- 2) Assess the Normal Cost Percentage (P) with respect to the ages in Ghana's pension scheme, as a way of evaluating the pension affordability and sustainability.
- 3) Evaluate the Actuarial Present Value of Contributions, APV(C) needed to buy pension benefits based on the projected salary progression and demography.

This study fills this gap by developing a hybrid actuarial model for analyzing pension funding requirements, with a focus on Ghana's micro pension scheme. The hybrid model uses the Multiple Decrement Model (MDM) and Markov Process Model (MPM). The model considers five decrements, which include retirement, disability, withdrawal, and deaths. This study used the MDM to evaluate the APV (B) and APV (C) and estimate the Normal Cost Percent (P) for the sustainability of pensions in Ghana. By developing a hybrid MDM-MPM, the study adds value to the understanding of pension funding because it takes a stochastic approach to analyzing employment transitions in pension funding. The approach goes further compared to the traditional deterministic approaches in pension funding analysis. The study contributes to knowledge by providing an alternative actuarial funding model for analyzing pensions in the informal sector, which can be used by other developing countries with similar pension schemes to address pension sustainability problems.

Additionally, the study contributes to knowledge by providing recommendations on appropriate contribution levels needed to fund pensions and ensure that pensions are affordable to low-income earners in Ghana. In summary, this study contributes to knowledge by providing an actuarial model for evaluating pension funding requirements in Ghana's micro pension scheme. Using hybrid MDM-MPM approach to pension funding analysis provides a realistic approach to pension funding needed to achieve financial sustainability in Ghana's micro pension scheme, as well as other developing countries' pension schemes.

Related Works

Theoretical Foundations of Pension Funding

The valuation of a pension scheme takes place on the basis of the principle of financial equilibrium between contributions,

investments and benefits payable to the participants over time. The actuarial present value (APV) of any pension benefit scheme is a discounted value of all future expected benefits or contributions payable (Gerber & Shiu, 2003). The APV is the basic concept used in ensuring the financial equivalence principle; the present value of contributions plus earnings on them should equal the present value of benefits and expenses (Bowers *et al.*, 1997). Actuarial concepts are critical in ensuring the solvency of any defined contribution pension and micro pension schemes.

Actuarial models are used to estimate present values on a net present value of future cash flows taking into account the time value of money, salary progression, mortality, withdrawal, and disability rates (Haberman & Pitacco, 1999). The application of the stochastic approach to pension funding valuation has become increasingly popular in recent years since the recognition that deterministic valuation models with constant demographic and financial variables over-estimate the true value of future payments (Pitacco, 2004; Boado Peñas & Eisenberg, 2022). Stochastic process is a probabilistic model with transitions between employment states as key consideration in assessing the future funding requirements of micro pension scheme (Fernández-Villaverde & Krueger, 2019). It is particularly relevant in analysing the informal sector employment where contributions are unstable and unpredictable. Combined with a Multiple Decrement Model (MDM) actuarial analysis helps to evaluate different contingent transition probabilities at any given point in time and simultaneously determine the impact of such events on the funding requirements of the pension scheme (Haberman & Pitacco, 2018). Hybridised MDM and MPM approaches are particularly critical to this study in exploring the stochastic processes of involuntary withdrawal and reinstate and other associated risks. In

addition to the APV concept, the actuarial funding theory involves the concepts of cost allocation methods in determining the funding requirements and schedule of contributions to the schemes.

Cost allocation methods are used to apportion costs on the basis of expected years of service for the members of the scheme. The Entry Age Normal Cost (EAN) method was used to estimate the actuarial funding for this study. The method is commonly applied to micro pension scheme in developing countries since it allows for a smoothing of contributions over the working lifetime of the members of the scheme (Gerber, 1997; Turner, 2006). However, it contrasts sharply with the Accrued Benefit Cost method which is based on estimating the actuarial costs of the benefits accrued up to any age and projected forward to normal retirement age (Blake, 2006). The PUC method although most appropriate for short-term corporate pension schemes creates the greatest funding volatility for informal sector pension schemes. Thus, EAN method was considered appropriate for this study.

Actuarial funding theory suggests dynamic funding as opposed to the traditional static funding of the pension contributions. The current study employed the stochastic process in analysing the informal sector employment patterns to estimate the pension funding requirements. The approach is in tandem with the recommendations for actuarial practice of risk sensitive modelling by the International Labour Organisation (ILO, 2019) and Organisation for Economic Co-Operation and Development (OECD, 2021) to enhance sustainability of pension schemes facing demographic and macroeconomic shocks. In conclusion, therefore, the application of EAN method within a stochastic MDM-MPM framework represents a dynamic actuarial approach to funding micro-pension scheme in Ghana.

Micro-Pension Schemes: Design, Implementation, and Challenges

The design of micro pension schemes was informed by social protection, behavioural economics and actuarial considerations. Although the main purpose is to increase pension coverage among informal employees, their design and effectiveness are determined by the institutional, financial literacy and regulatory environments (Barr & Diamond, 2008). Micro pensions emanate from the need to expand retirement savings schemes to complement the low coverage of pensions by the formal sector among low-income workers and the self-employed (Rutherford, 2008; World Bank, 2018). As a result macro-pension designs focus on affordability, flexibility and accessibility as critical differentiators from traditional occupational pension schemes. Micro pension schemes around the world tend to have a few traits that draw in people who might join. One key point is that contributions are voluntary. This means each person can put in money based on what they can afford. It also allows them to pause or stop payments if they run into cash flow trouble. (Giné, Goldberg, & Yang, 2012). Second, these pension schemes allow contributors to make variable contributions on a regular basis or even seasonally depending on cash flows, typical of informal workers (Giné, Goldberg, & Yang, 2012). Additionally, most micro pension schemes use Defined Contribution (DC) design where contributions are personalised and rolled out as annuities upon retirement (Antolin & Whitehouse, 2009). Fourth, these schemes are pegged to social security nets to provide minimum retirement benefits at the point of need to prevent old-age poverty (ILO, 2019). Finally, most schemes have low administrative costs and utilise digital financial services to facilitate convenient payments and withdrawals an innovation that has enabled their sustainability and scalability in informal sectors (Klapper, Lusardi, & Panos, 2013). From an actuarial perspective micro pensions

have been designed to balance benefit payments against the actuarial present value of contributions (Haberman & Pitacco, 2018).

Comparatively, micro pension schemes present less attractive funding parameters to actuaries due to their small contribution bases that are subject to higher mortality rates, economic risks and withdrawal rates. Actuarial modelling of Markov transition and multiple decrements processes can offer more reliable funding solvency insights compared to traditional deterministic assumptions about labour force participation. Actuarial modelling of micro pension schemes is critical in ensuring their long-term sustainability with benefits portability between different pension systems, especially in the face of economic shocks. The integration of actuarial models in funding micro pensions supports the strategic global agenda of promoting long-term retirement savings and solvency (Boado Peñas & Eisenberg, 2022).

Many countries set up small pension plans using different actuarial assumptions. Still, a few designs help soften the harm that comes from weak funding. India's Atal Pension Yojana, or APY, is one such plan. It is a mix of defined benefit ideas and government support. It aims to give informal workers a minimum pension that they can count on. This structure also helps narrow the funding gap. It does so by spreading the risk linked to investment results and life span between workers and the government (Shankar & Asher, 2017). Kenya's Mbao Pension plan is an innovation that leverages mobile money technology to allow informal workers to pay pension premiums digitally reducing transaction costs while boosting accessibility (ILO, 2019). Chile's solidarity pillar was designed to provide a minimum retirement income to individuals with inadequate pension savings, an actuarial innovation that supports intergenerational equity and social adequacy (Barr, 2013).

The examples illustrate that successful micro pension schemes worldwide require actuarial modelling, policy support and digital innovations to enhance their sustainability. Despite the successes demonstrated by micro pensions worldwide, several challenges hinder the design and effective implementation of similar schemes in other regions. Limited public awareness, weak enforcement mechanisms, low financial literacy and institutional capacity constraints hinder the success of most micro pension schemes in developing countries (Klapper *et al.*, 2013; World Bank, 2020).

The absence of robust actuarial modelling in developing countries undermines the validity of funding forecasts and appropriate benefit design needed for long-term sustainability. The hybrid modelling framework (MDM & MPM) developed in this study can be applied in various jurisdictions to overcome the limitations of using a single model in micro pension design. The combined approach was instrumental in capturing the most critical actuarial assumptions and uncertainties that affect the funding and benefits of micro pensions. The model provides a comprehensive perspective of actuarial valuation practice worldwide and guides the selection of Normal Cost Percent for most micro pension schemes globally. Overall the discussion on social-protection micro-pension schemes worldwide highlights the need for Ghana to consider several actuarial and policy factors in developing its micro pension scheme. The country's scheme design should incorporate voluntary contributions to boost accessibility, utilise dynamic actuarial modelling approaches to guide the benefit design. Encourage government co-payments to supplement individual retirement savings and promote intergenerational equity.

Actuarial Models for Pension Contribution Estimation

The sustainability and solvency of pension systems rely on actuarial models that estimate the expected value of the benefits, the required contributions, and the funding ratios subject to uncertainties. In the case of micro-pension schemes for informal workers, these factors have to consider stochastic elements like income, interruptions and diverse withdrawals typical of the informal employment (Mitchell & Turner, 2017; Bravo & Holzmann, 2021). Consequently, the actuarial models are used as decision-support tools to estimate the funding and benefit adequacy and inform decision-makers on matters concerning pensions. This study uses a combination of a Multiple Decrement Model (MDM) and a Markov Process Model (MPM) to estimate the contribution requirements and sustainability of the micro pension scheme in Ghana. Using a hybrid model guarantees a comprehensive assessment of the APV(C) and APV(B) and the actuarial funding of the scheme by considering both deterministic decrements and stochastic transitions in employment status.

The Multiple Decrement Model (MDM) in Pension Estimation

The Multiple Decrement Model (MDM) is a classic actuarial model used to study the decrements that result in workforce termination due to various causes. The MDM considers different causes of separation from an organization, including retirement, disability, voluntary resignation, involuntary resignation. Death, with each having a certain probability of occurring (Gerber & Shiu, 2003; Boado-Peñas & Eisenberg, 2022). Each of these decrements has an equal probability of occurring at a given point in time, and therefore an actuary can estimate the probability of survival to a particular age or the probability of dying at a certain age.

Using the MDM, it becomes possible to apportion pension obligations and contributions by decrement causes and examine them closely to assess the scheme's solvency. Additionally, the model is appropriate for analyzing micro-pension schemes since it considers a wide range of decrement causes, which are prevalent in the informal sector. Participants' exits, which are frequent. As a result, the MDM allows actuaries to determine the exact probability of participants' exits and contribute to determining the Actuarial Present Value of Contributions (APV(C)) needed to meet the present value of benefits (Bowers *et al.*, 1997).

In actuarial science, the MDM is essential because it allows actuaries to consider multiple decrement exposures when projecting pension schemes' solvency while using a single life table. As a result, the model helps actuaries determine Normal Cost Percent (P) more accurately and reduce the likelihood of underfunding (Bravo & Holzmann, 2021). In the MDM, the probability of an exit due to any of the decrements is estimated as a cause-specific hazard. Consequently, the model is critical in actuarial analysis since it considers multiple decrement causes, allowing actuaries to make more accurate Normal Cost Percent (P) projections, thus reducing the likelihood of underfunding. The MDM would be appropriate for modeling the informal labor market in Ghana because it would be able to capture the complexity of workforce dynamics due to the fluctuating incomes and employment patterns of informal workers.

The Markov Process Model (MPM) in Pension Estimation

The MDM is sophisticated enough to handle a few decrement types in a more elegant way. However, it has a critical limitation: the transition chances are held constant over time. In the context of the informal labor market, this property is not always desirable.

Individuals may voluntarily or forcibly leave the program and re-enter later. In case they can find a source of stable income, the worker will return to the plan.

The MPM introduces an element of randomness in transitions between employment states. The transition intensities define the probability of going from one employment category to another during a specific period. (Fernández-Villaverde & Krueger, 2019; OECD, 2022). In a Markov chain, an individual's employment status is a state that is associated with a set of possible states with transition probabilities. In this set, the states can be Active, Involuntary Withdrawal, Retirement, Disability, Death, among others. Using transition probabilities, the Markov process determines the subsequent employment state.

The simplest Markov process is characterized by one property that significantly simplifies the calculations: the probability of going to a particular state depends solely on the current state. This allows actuaries to construct a stochastic forecast with relative ease while still taking into account various factors for different groups. (Haberman & Pitacco, 2018).

Thanks to their state-based nature, MPMs allow actuarial models to update forecasts of pension funds' future cash flows as new information becomes available. Any change in employment status observed in the sample will affect the subsequent estimates. In the case of annuities, MPMs address the two closely related problems of projecting future cash flow streams and funding. Stochastic processes can adapt funding projections to reflect changes in funding risks while taking into account changes in disruption patterns. They allow actuaries to take into account re-entry and mortality factors and, therefore, are especially relevant for micro-pension programs in informal employment.

With their help, it becomes possible to take into account the fact that contributions to the fund may be volatile and to estimate the probabilistic weighted value of future benefits with greater precision.

Hybridization of MDM and MPM: A Comprehensive Actuarial Approach

The hybridization of the Multiple Decreasing Model (MDM) and Markov Process Model (MPM) constitutes the theoretical and methodological foundation of the study's actuarial framework.

While the MDM provides an actuarial decomposition of decrements, the MPM facilitates stochastic transition probabilities that enable the model to adjust dynamically (Fernández-Villaverde & Krueger, 2019).

The hybrid approach thus combines the actuarial rigor of the deterministic approach with the flexibility of the stochastic process.

In particular, the hybrid approach employs MDM to estimate the likelihoods of final decrements, such as retirement, disability, and voluntary withdrawals, plus transitions among transient conditions, for instance, Involuntary Withdrawal and Active Status (for death, the MPM informs transitions). Thus, the method captures the subtleties of the formal and informal workforce: the former is associated with fixed decrements, whereas the latter entails transition probabilities as a function of time spent in employment.

By capturing the subtleties of informal contributions, the hybrid approach bolsters actuarial control and forecasting abilities, a vital step toward optimizing the Normal Cost Percent (P) and ensuring the scheme's solvency in the long term (World Bank, 2021).

Notably, the hybridization of MDM with MPM supports the actuarial standards of contemporary pension modeling, as advocated by the International Actuarial Association (IAA,

2020) and Organization for Economic Co-operation and Development (OECD, 2022). The proposed model thus contributes to the state of the art in the actuarial sciences by advancing a viable approach to funding in emerging markets.

Policy and Regulatory Framework for Micro Pension Schemes

The rapid rise of micro-pension schemes in developing economies is an indication of a rising policy issue: the provision of retirement income security for informal sector workers who are currently excluded from existing pension schemes. In contrast to occupational or public pension schemes that are designed for wage-earners, micro-pension schemes cater to individuals with irregular sources of income and limited capacity for saving. Therefore, the need for specific regulatory frameworks to promote sustainability, affordability, and transparency while ensuring the actuarial viability of pensions is critical (OECD, 2021; World Bank, 2020). The establishment of legal parameters for fund management, contribution structure, investment allocation, and benefit distribution necessitates effective policy and regulatory oversight for the success of micro-pensions. Robust regulatory frameworks help to protect a participant's contributions, the accountability of pension fund managers, and the equitable delivery of benefit entitlements (ILO, 2019). In addition, through regular evaluation, risk-based supervision, prudent investment strategies that conform to international pension standards, the regulatory procedures promote the actuarial sustainability of these pension products (Boado-Peñas & Eisenberg, 2022). Three main institutional and legal types of micropension regulations have been identified around the world:

State-Sponsored Regulation in which the government is centrally involved in oversight and fiscal support (e.g., India's Atal Pension Yojana under the Pension Fund Regulatory and Development Authority);

Public-Private Partnership Regulation in which the state partners pension administrators who are appropriately licensed (e.g., Kenya's Mbao Pension Scheme under the Retirement Benefits Authority); and

Market-Based Regulation in which micro pension funds operate within a decentralised financial system under standardised risk and disclosure requirements (OECD, 2022).

Each of the above models described in this study ensures access and financial discipline by balancing between market flexibility and regulatory protection.

There is a guaranteed minimum pension threshold for low-income earners under India's Atal Pension Yojana (APY). APY is a hybrid defined-contribution program with guarantees from the state (Shankar & Asher, 2017). Kenya's Mbao Pension plan uses mobile money technologies to provide reliable and transparent tracking of contributions (ILO, 2021). In Latin America, several nations offer multi-tier systems as an alternative to fully privatized and fully socialized pensions. For example, Chile has laws that allow hybrid arrangements and public subsidies to private schemes (Barr, 2013).

The Ghanaian system relies on the National Pensions Act, 2008 The National Pensions Act, 2008 (Act 766) which sets a three-tier system of contributions (mandatory and voluntary). The National Pensions Regulatory Authority (NPRA) is responsible for the regulation of the fiduciary management, actuarial, and funding issues related to the law. Even though the National Pensions Act, 2008 provides a good legal framework for private and occupational pensions, it does not apply to the majority of Ghanaians that work in the informal sector.

It is necessary to discuss potential legislative changes that can create a basis for micro-pensions with a set of characteristics that will make them easier to adopt. The OECD's Core Principles of Private Pension Regulation suggest a prudent allocation of pension funds in low- and mid-risk assets to balance the benefits of fixed deposits and stocks. To prevent underfunding, the micro-pension program in Ghana should introduce risk-based supervision and mandatory actuarial certification. Attracting more low-income workers into the system requires consideration of fiscal incentives in the form of tax breaks, matching grants, and subsidies.

Accelerated withdrawal penalties undermine the accumulations' performance and threaten the scheme's sustainability. By introducing differentiated withdrawal benefits, policy-makers can address the liquidity needs of participants while ensuring the long-term solvency of micro-pensions.

In conclusion, developing a regulatory regime for micro-pensions requires the inclusion of actuarial elements and financial inclusion. The author suggests that Ghana should adopt the international experience and implement regulations that ensure transparent and honest control of the functioning of micro-pension and contribute to the development of incentives for informal sector employees to participate in the program.

MATERIALS AND METHODS (METHODOLOGY)

Research Design

The study is primarily an analytical type of research design that uses actuarial and probabilistic methods to predict future pensions contributions. It was quantitative since the mathematical calculation was applied to predict the outcome rather than subject to analysis.

Data on the income of drivers by age was collected across various lorry stations in Accra, Sunyani and Kumasi in order to estimate their projected annual salary. The total number of drivers who died, stopped driving voluntarily and due to circumstances beyond their control, retired, disabled through accidents within a given period in addition to their life expectancies was also used in this research. Hence, a primary data collection method was adopted using structured questionnaires and record based surveys administered across selected lorry stations in Accra, Sunyani, and Kumasi to obtain income and decrement data on commercial drivers. The study is also classified as a model-based research design because it constructs a hybrid actuarial framework using the Multiple Decrement Model (MDM) and Markov Process Model (MPM) to determine pension funding requirements. In general, the pension cost of a plan is the sum of the Actuarial Present Value of the benefits corresponding to all the individuals of various ages at time t . This pension cost is paid for by the participants through contributions, as a proportion of their annual salaries while in active service. The percentage of the Annual Salary is determined by dividing the Actuarial Present Value of Benefits by the Actuarial Present Value of Contributions. The cost is spread over the working lives of the participants by using the Entry Age Normal Cost Method, which is a recognized actuarial method used to spread the cost of a pension benefit evenly among the employees.

However, the main aim of the current study is to estimate the actuarially fair contribution rate, which is assumed to be between 5% and 15%, and sufficient to ensure the financial sustainability of the Ghanaian micro-pension scheme. The estimates of benefits have been taken from the literature review. In actuarial science, the Multiple Decrement Model (MDM) is an actuarial model used to evaluate pensions with members departing

the pension plan for various independent reasons. The following factors are considered decrements: retirement, disability, voluntary resignation, involuntary resignation, and death. Pension funding estimates are impacted by the decreased probability of each of these occurrences. Because it enables a methodical assessment of contribution levels based on actuarial assumptions, the model is especially helpful for pension plans with different exit scenarios.

The stochastic aspect of state transitions is not taken into consideration by the MDM, despite the fact that it offers an organised method for examining various departure causes. This restriction is overcome by the Markov Process Model (MPM), which incorporates probabilistic state shifts across time. A participant may continue to be active, retire, become incapacitated, withdraw freely or involuntarily, or die at any time; each of these events is controlled by predetermined probability functions. This work improves the accuracy of pension contribution estimates by including MPM into the actuarial modelling process and taking participant status uncertainty into account over time.

Model Development

General Formula for the Actuarial Present Value of Contributions

The estimated Annual Contribution, also referred to as the Normal Cost is then obtained as a proportion P (Normal Cost Percent) of the estimated Annual Salary for all ages.

We can now go ahead and deduce a general formula for estimating the Actuarial Present Value of Contributions. The Actuarial Present Value of Contributions (APV (C)) is given by:

$$APV(C) = P(AS)_x \left[{}_k p_x^{(\tau)} q_{x+k}^{(j)} v^k \frac{w_{x+k-1}}{w_x} \right] \quad (1)$$

Where P is the Annual Contribution Proportion/Normal Cost Percent, $(AS)_x$ is the Annual Salary at age x , ${}_k p_x^{(\tau)}$ is the probability of remaining in active service, k is the active service period from age x , $q_{x+k}^{(j)}$ is the probability of decrement due to cause j , v^k is the present value factor/discount factor ($v^k = \frac{1}{(1+d)^k}$) using a discount rate d of 0.2 and w_x is salary scale.

Since the Projected Annual Salary $((ES)_x)$ is given by:

$$(ES)_x = \frac{w_{x+k-1}}{w_x}$$

we can express the Actuarial Present Value of Contributions (APV (C)) in terms of the Projected Annual Salary as

$$APV(C) = P(ES)_x \left[{}_k p_x^{(\tau)} q_{x+k}^{(j)} v^k \right] \quad (2)$$

In the calculation of the Actuarial Present Value of Contributions, the probability of

$$C_2 = P(ES)_x \left[{}_k p_x^{(\tau)} \left(q_{x+k}^{(i)} + q_{x+k}^{(w2)} + q_{x+k}^{(d)} \right) v^k \right] \quad (4)$$

Where $q_{x+k}^{(i)}$ is the probability of decrement due to disability, $q_{x+k}^{(w2)}$ is the probability of decrement due to voluntary withdrawal and $q_{x+k}^{(d)}$ is the probability of decrement due to death.

Contribution due to Involuntary Withdrawal

Finally, we denote the Actuarial Present Value of Contributions due to Involuntary Withdrawal as C_3 , given by

$$C_3 = P(ES)_x \left[{}_k p_x^{(\tau)} q_{x+k}^{(w1)} \bar{a}_{x:\overline{k}|} \right] \quad (5)$$

remaining in active service is introduced because contributions are paid only when the participant is in active service. Based on the above formula, we can deduce expressions for the Actuarial Present Value of Contributions due to each cause.

Actuarial Present Value of Contribution due to Retirement

Let the Actuarial Present Value of Contribution due to retirement be C_1 . So,

$$C_1 = P(ES)_x \left[{}_k p_x^{(\tau)} q_{x+k}^{(r)} v^k \right] \quad (3)$$

Where $q_{x+k}^{(r)}$ is the probability of decrement due to retirement.

Contribution due to Disability, Voluntary Withdrawal and Death

Also, let the Actuarial Present Value of Contributions due to Disability (i), Voluntary Withdrawal (w2) and death (d) be C_2 . Hence,

Where $q_{x+k}^{(w1)}$ is the probability of decrement due to involuntary withdrawal and $\bar{a}_{x:\overline{k}|}$ is the Actuarial present value of continuous life annuity-due, given by

$$\bar{a}_{x:\overline{k}|} = \int_0^k e^{-\delta t} {}_t p_x^{(\tau)} dt \quad (6)$$

δ is the force of interest given by

$$\delta = \log(1+i)$$

Final Contribution Estimation

Merging all gives the Actuarial Present Value of Contributions,

$$APV(C) = C_1 + C_2 + C_3 \quad (7)$$

$$APV(C) = P(ES)_x \left\{ \left[{}_k p_x^{(\tau)} q_{x+k}^{(r)} v^k \right] + \left[{}_k p_x^{(\tau)} \left(q_{x+k}^{(i)} + q_{x+k}^{(w2)} + q_{x+k}^{(d)} \right) v^k \right] + \left[{}_k p_x^{(\tau)} q_{x+k}^{(w1)} \bar{a}_{x:\overline{k}|} \right] \right\} \quad (8)$$

Based on the research results from (Obeng-Tawiah A. et.al., 2025) on the Actuarial Present Value of Benefits (APV (B)), the Normal Cost Percent P is then estimated using the equivalence principle;

$$APV(B) = APV(C) \quad (9)$$

So,

$$P = \frac{APV(B)}{\left\{ \left[{}_k p_x^{(\tau)} q_{x+k}^{(r)} v^k \right] + \left[{}_k p_x^{(\tau)} \left(q_{x+k}^{(i)} + q_{x+k}^{(w2)} + q_{x+k}^{(d)} \right) v^k \right] + \left[{}_k p_x^{(\tau)} q_{x+k}^{(w1)} \bar{a}_{x:\overline{k}|} \right] \right\}} \quad (10)$$

Hence the Projected Annual Contribution = $P(ES)_x$

The Normal Cost Percent P is multiplied by the Projected Annual Salary $(ES)_x$ to obtain the Projected Annual Contribution for the Micro Pension Scheme.

FINDINGS AND DISCUSSIONS

This study aimed to estimate the Actuarial Present Value of Contributions (APV(C)) necessary to sustain Ghana's micro-pension scheme, employing a hybrid actuarial approach that integrates the Multiple Decrement Model (MDM) and the Markov Process Model (MPM). The results obtained are helpful in establishing relationships between the age, projected salaries, actuarial present value of benefits (APV (B)), normal cost percentage (P), and

projected annual contributions with a focus on the actuarial present value of benefits and projected annual contributions.

The results indicate that as one ages, the projected annual contributions gradually increase as a result of the combined impact of the projected increase in salaries and the actuarial cost of providing retirement benefits.

The results also indicate that the normal cost percentage (P) can vary significantly from one age to another and hence, people joining at an older age face a significantly higher contribution burden. Hence, it is important to encourage early participation, responsive contribution designs, and government intervention for the sustenance of the long-run financial viability.

Table 1: Projected Annual Salary with Total APV (B)

Age (I)	Projected Salary (GH¢)	Total APV(B) (GH¢)
18	24,000.00	23,796.86
19	24,480.00	28,484.04
20	24,960.00	24,748.66
21	25,440.00	32,115.48
22	25,920.00	25,909.89
23	26,400.00	30,750.08
24	26,880.00	30,349.39
25	27,360.00	37,351.02
26	27,840.00	39,259.31
27	28,320.00	35,115.55
28	28,800.00	32,505.41
29	29,280.00	36,667.61
30	29,760.00	42,556.61
31	30,240.00	42,838.59
32	30,720.00	37,233.80
33	31,200.00	46,792.48
34	31,680.00	45,171.51
35	32,160.00	45,930.83
36	32,640.00	57,905.05

Table 1 Cont. Projected Annual Salary with Total Apv (B)

Age (I)	Projected Salary (GH¢)	Total APV(B) (GH¢)
37	33,120.00	50,460.38
38	33,600.00	66,061.71
39	34,080.00	53,154.98
40	34,560.00	71,287.21
41	35,040.00	64,644.83
42	35,520.00	66,848.22
43	36,000.00	65,517.87
44	36,480.00	76,681.48
45	36,960.00	82,132.17
46	37,440.00	82,889.62
47	37,920.00	76,932.52

48	38,400.00	73,155.04
49	38,880.00	78,633.66
50	39,360.00	77,833.54
51	39,840.00	112,265.12
52	40,320.00	100,031.57
53	40,800.00	101,545.23
54	41,280.00	88,173.19
55	41,760.00	92,904.26
56	42,240.00	102,620.28
57	42,720.00	114,469.07
58	43,200.00	116,469.98
59	43,680.00	128,213.63
60	44,160.00	114,937.29
61	44,640.00	126,379.36
62	45,120.00	129,677.74
63	45,600.00	151,262.30
64	46,080.00	141,609.16

Table 2: Projected Annual Salary with Normal Cost Percent

Age (I)	Projected Salary (GH¢)	Normal Cost Percent (P)
18	24,000.00	0.0686052
19	24,480.00	0.0524905
20	24,960.00	0.0498791
21	25,440.00	0.0369168
22	25,920.00	0.031664
23	26,400.00	0.0303038
24	26,880.00	0.0290101
25	27,360.00	0.0404161
26	27,840.00	0.0331919
27	28,320.00	0.0630274
28	28,800.00	0.0515662
29	29,280.00	0.0712379
30	29,760.00	0.0567546
31	30,240.00	0.0536231
32	30,720.00	0.0540467
33	31,200.00	0.0401913
34	31,680.00	0.0597382
35	32,160.00	0.0670556

36	32,640.00	0.0641043
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Table 2 Cont. : Projected Annual Salary with Normal Cost Percent

Age (I)	Projected Salary (GH¢)	Normal Cost Percent (P)
37	33,120.00	0.0910724
38	33,600.00	0.0599955
39	34,080.00	0.1095162
40	34,560.00	0.0581137
41	35,040.00	0.062345
42	35,520.00	0.1182035
43	36,000.00	0.1619109
44	36,480.00	0.0744523
45	36,960.00	0.0881296
46	37,440.00	0.0886581
47	37,920.00	0.0808037
48	38,400.00	0.1723731
49	38,880.00	0.1260824
50	39,360.00	0.1766726
51	39,840.00	0.1172029
52	40,320.00	0.1288765
53	40,800.00	0.1798592
54	41,280.00	0.2342751
55	41,760.00	0.1747327
56	42,240.00	0.1931813
57	42,720.00	0.1473676
58	43,200.00	0.1651773
59	43,680.00	0.1520316
60	44,160.00	0.198328
61	44,640.00	0.3490731
62	45,120.00	0.1867798
63	45,600.00	0.214105
64	46,080.00	0.2432907

Table 3: Projected Annual Salary with Projected Annual Contribution

Age ()	Projected Salary (GH¢)	Average Normal Cost Percent (P)	Projected Annual Contribution (GH¢)
18	24,000.00	0.1086475	2,607.54
19	24,480.00	0.1086475	2,659.69
20	24,960.00	0.1086475	2,711.84
21	25,440.00	0.1086475	2,763.99
22	25,920.00	0.1086475	2,816.14
23	26,400.00	0.1086475	2,868.29
24	26,880.00	0.1086475	2,920.44
25	27,360.00	0.1086475	2,972.60
26	27,840.00	0.1086475	3,024.75
27	28,320.00	0.1086475	3,076.90
28	28,800.00	0.1086475	3,129.05
29	29,280.00	0.1086475	3,181.20
30	29,760.00	0.1086475	3,233.35
31	30,240.00	0.1086475	3,285.50
32	30,720.00	0.1086475	3,337.65
33	31,200.00	0.1086475	3,389.80
34	31,680.00	0.1086475	3,441.95
35	32,160.00	0.1086475	3,494.10
36	32,640.00	0.1086475	3,546.25

Table 3 Cont.: Projected Annual Salary with Projected Annual Contribution

Age ()	Projected Salary (GH¢)	Average Normal Cost Percent (P)	Projected Annual Contribution (GH¢)
37	33,120.00	0.1086475	3,598.41
38	33,600.00	0.1086475	3,650.56
39	34,080.00	0.1086475	3,702.71
40	34,560.00	0.1086475	3,754.86
41	35,040.00	0.1086475	3,807.01
42	35,520.00	0.1086475	3,859.16
43	36,000.00	0.1086475	3,911.31
44	36,480.00	0.1086475	3,963.46
45	36,960.00	0.1086475	4,015.61

46	37,440.00	0.1086475	4,067.76
47	37,920.00	0.1086475	4,119.91
48	38,400.00	0.1086475	4,172.06
49	38,880.00	0.1086475	4,224.22
50	39,360.00	0.1086475	4,276.37
51	39,840.00	0.1086475	4,328.52
52	40,320.00	0.1086475	4,380.67
53	40,800.00	0.1086475	4,432.82
54	41,280.00	0.1086475	4,484.97
55	41,760.00	0.1086475	4,537.12
56	42,240.00	0.1086475	4,589.27
57	42,720.00	0.1086475	4,641.42
58	43,200.00	0.1086475	4,693.57
59	43,680.00	0.1086475	4,745.72
60	44,160.00	0.1086475	4,797.87
61	44,640.00	0.1086475	4,850.02
62	45,120.00	0.1086475	4,902.18
63	45,600.00	0.1086475	4,954.33
64	46,080.00	0.1086475	5,006.48

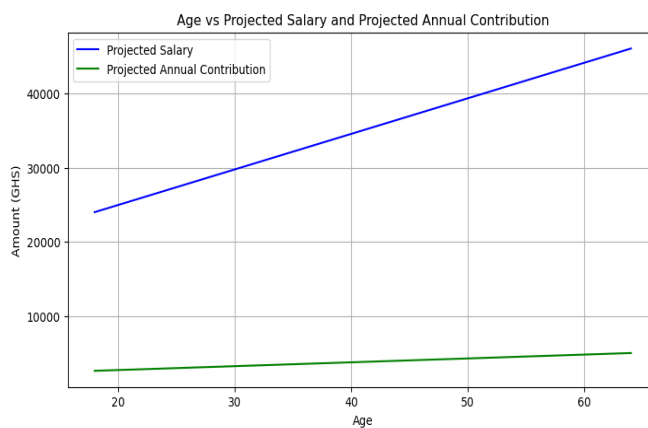


Figure 1: Age vs Projected Salary and Projected Annual Contribution

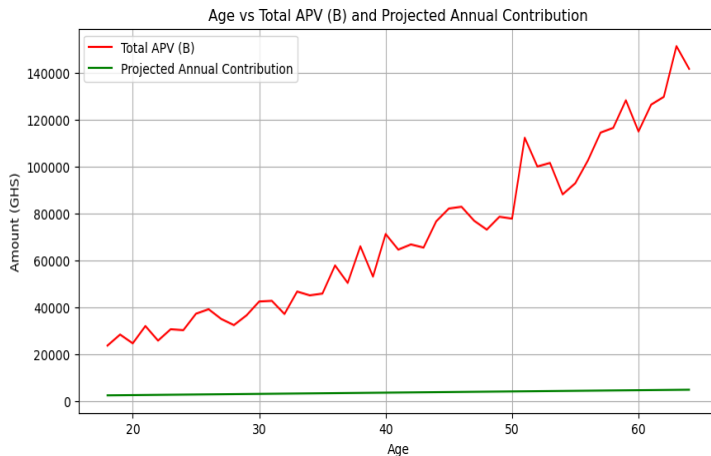


Figure 2: Age vs Total APV (B) and Projected Annual Contribution.

The Projected Annual Contributions and Salary Growth Trends

The analysis indicated that the anticipated contributions were increasing with age. The results presented in Table 3 proved that the expected wages and matching pension contributions had improved as people progressed overtime in their working time. For example, the projected salary at age 18 was GHC 24,000.00 with an annual contribution of GHC 2,607.54. The anticipated wage had improved to GHC 46,080.00 by age 64 and the contribution had risen to GHC 5, 006.48. These two interdependent actuarial factors were the dominant contributors to the rise in trend.

Initially, the required contributions were significantly dictated by salary growth projections. Any increase in the predicted income led to an increase in the annual payments since their ratios were articulated as percentage of earnings (Bowers *et al.*, 1997; Haberman & Pitacco, 2018). Secondly, actuarial accumulation principle ensured contribution levels are rising overtime to cover future benefits requirements, which depicted the continuous accumulation of pension reserves throughout a contributor's career.

The Entry Age Normal (EAN) actuarial financing approach, which spreads the contributions uniformly throughout an employee's working life incorporating pay progression was theoretically vindicated by these findings (Gerber & Shiu, 2003).

Empirical studies such as Bravo and Holzmann (2021) and Boado-Peñas and Eisenberg (2022), which argued that contribution escalation overtime was critical in maintaining scheme solvency and intergenerational equity showed similar results. The findings illustrated the importance of enrolment in micropension plans at a young age from a policy perspective. Since benefits accrued from the compounding effect of a longer accumulation period, those who joined the program at a younger age benefited from lower initial contribution rates. On the contrary, late joiners had to make substantial contributions in a short time frame to attain similar benefit levels.

This finding substantiated the claims of Shankar and Asher (2017) and World Bank (2020) who advocated the need to provide incentives for early involvement through financial incentives and awareness campaigns.

Again, the results indicate that with respect to Ghana micro pension scheme design, contribution schedules need to be crafted along a progressive pro-early entry tax credit or a matching contributions scheme.

This would help improve the sustainability of the scheme while at the same time providing an incentive for continuous work and regular contributions from the informal sector workers who make irregular contributions to the scheme.

Fluctuations in the Normal Cost Percentage (P) and Its Implications

The study revealed significant Normal Cost Percentage (P) variations across the various age groups, which represented the various contributions to salaries that the participants had to contribute in order to maintain actuarial soundness. The percentage of the yearly income that had to be contributed to fund the expected pension liabilities along the span of time was represented by the Normal Cost Percentage. The study unearthed a typical age dependency financing pattern where P was the lowest for the young contributors and escalated steeply with age.

For instance, the Normal Cost Percentage was calculated at 3.17% ($P = 0.0317$) at age 22 whereas it escalated significantly to 34.9% ($P = 0.3491$) at age 61. A short pre-retirement contribution horizon, which entailed higher contributions to meet the benefit equivalency was the key factor that accounted for the observed steeper increase in P amongst the older members (Gerber & Shiu, 2003; Haberman & Pitacco, 2018). Similar trends have been identified in the actuarial literature, where a critical feature of the Entry Age Normal (EAN) funding technique, by which the deferred benefits accumulation was executed, is known to entail an increase in the contribution rates as age increases (Bowers *et al.*, 1997; Boado-Peñas & Eisenberg, 2022).

The results had several important actuarial and policy implications. First, the age-adjusted contribution strategies where the contribution rates are supposed to gradually rise during an individual's working life instead of staying level were necessitated by the observed fluctuation in PPP. Such a strategy would be in line with Bravo and Holzmann's (2021) contention that progressive contribution schedules have kept the scheme solvency while enhancing affordability for younger participants.

Second, the results highlighted the financial vulnerability of the late entrants. According to Shankar and Asher (2017) and the World Bank (2020), those who joined the plan late in life faced significantly higher contribution demands because of their shorter accumulation period. Specific policy interventions like government-matching contributions or tax incentives are needed to alleviate their financial burden and enhance retention since they are more likely to be subjected to contribution fatigue or withdrawal.

Third, the variations in P suggested that dynamic actuarial adjustments could be used to optimize contributions. As noted by the OECD (2022), pension managers might recast P on a regular basis considering pay progression, demographic shifts, and investment performance rather than set contribution rates.

The micro-pension scheme would be shielded from demographic uncertainties and economic fluctuations by such a flexible funding strategy.

In general, the variability of the Normal Cost percentage underlined the need to use actuarial finance models that would balance the tripartite goals of sustainability, affordability. Social equity.

To maintain the financial integrity of the scheme and at the same time ensure that all contributors, irrespective of the age of entry and income level, would receive adequate retirement benefits, a flexible, data-informed contribution planning approach was needed.

The Relationship Between Actuarial Present Value of Benefits (APV (B)) and Contributions

The study established the progressive nature of pension liabilities as people approached retirement by illustrating the increase in Actuarial Present Value of Benefits (APV (B)) in accordance with advancing age. It was observed that APV (B) increased from GH¢ 23,796 at 18 years to GH¢ 151,262 at 63 years suggesting the cumulative effect of reduced discounting, accumulation of contributions, and income growth. Fundamental actuarial concepts concerning the valuation and funding adequacy of pensions were consistent with the progressive trend (Gerber & Shiu, 2003; Haberman & Pitacco, 2018).

This relationship was explained by two actuarial mechanisms. Firstly, the present value of benefits across ages was highly affected by discounting. Given their longer time horizon to retirement, younger participants were subjected to higher discounting thus decreasing the present value of the benefits payable. Thus the discounting effect reduced across advancing age contributing to higher APV (B) since the time to payouts was near. (Bowers *et al.*, 1997). Secondly, contribution sufficiency was dictated by the length of the accumulation period. An extended period where payments were allowed to compound gradually and uniformly was beneficial to the early participants in the scheme. Conversely, late entrants had more stringent-funding requirements since the shorter-horizon required higher payments to meet the accumulated liabilities (Boado-Peñas & Eisenberg, 2022).

Actuarially, the findings illustrated the actuarial equivalency principle where under equilibrium, the present value of expected contributions should be equal to the present value of expected benefits. Equivalency was the basis on which pensions' long-term viability was determined (Haberman & Pitacco, 1999).

The study's results illustrated that despite the gradual increase in contributions with age, the rate of increase in APV (B) was more conspicuous, implying possible financial imbalances in the absence of other sources of income. This phenomenon was consistent with international pension studies which also demonstrated a disparity between contribution streams and benefit liabilities in matured pension schemes (Bravo and Holzmann, 2021; World Bank, 2020). The study recommended diversifying funding sources to include investment income, government-matching contributions, or adjusting the contribution rate progressively to overcome the imbalance. These mechanisms were pertinent to Ghana's mini pension scheme due to the unstable income source of informal sector workers and their inability to pay large lump sum subscriptions

Usually, the results revealed that balancing contributions and benefits were the key to the existence of the program. To avoid the occurrence of financing deficits and a substantial reduction of payments to retirees at the time of their retirement, it was crucial to apply the above-mentioned actuarial procedures, including government fiscal contributions, considering investment proceeds, and continuous discount rate revaluations. The growing disparity between APV (B) and contributions required continuous actuarial surveillance and policy interventions to enhance the long-term viability of Ghana's micro pension scheme.

Policy and Practical Implications

The results of the study contained a lot of valuable recommendations to Ghana to ensure the sustainability of their micro-pension scheme. According to the research, APV (B) for contributors increased consistently with the aging process – meaning that the older a person is, the higher their future pension payments from the scheme will be.

Thus, it was recommended to take measures to ensure solvency and balance within the scheme. Additionally, the researchers suggested introducing significant tax benefits and matching contributions to encourage individuals not to enroll later in life.

The micro-pension scheme proposed by Kenya, called Mbao Pension Plan, and the Atal Pension Yojana in India, both similar to Ghana's future pensions, proved to be successful by offering tax benefits and matching contributions (Shankar & Asher, 2017; ILO, 2021). Introducing similar incentives to taxpayers in Ghana can ensure a longer lifespan of contributions and higher payments in the future. First and foremost, tax benefits will allow the majority of contributors not to worry about their disposable income after making payments to the scheme. Since many people tend to face economic hardships on a regular basis, they often have to avoid additional expenses when possible. Secondly, the researchers recommended allocating some shares to a pension reserve fund to prevent losses due to inflation, market risks, and economic volatility. Even in times of macroeconomic instability, the micro-pension plan would be able to sustain liquidity and benefit payment stability thanks to such a reserve (Boado-Peñas & Eisenberg, 2022). From an actuarial perspective, this would enhance the scheme's funding ratio and promote intergenerational equity by guaranteeing that future commitments were sufficiently covered by accumulating asset. In order to reduce the early depletion of pension funds, withdrawal regulations also needed to be strengthened. Unrestricted withdrawals have often threatened the long-term viability of pension funds as witnessed in similar schemes in emerging nations (ILO, 2019; OECD, 2022). A tiered withdrawal system can be instituted in Ghana's micro-pension to ensure that retirement funds are preserved for their intended purpose while allowing some level of withdrawal in times of distress. Lastly, the results suggested that the participants ought

to be more informed and educated about finances. There was a lack of financial literacy about pensions among informal sector workers, and this resulted in some participants saving inconsistently and withdrawing their savings prematurely before retirement. Therefore, it was recommended that a comprehensive financial literacy program be developed and deployed through unions and digital media to educate Ghanaians on the virtues of pension funds and motivate them to save more consistently throughout their working life (Klapper, Lusardi & Panos, 2013). It was crucial to adopt a multi-level policy by blending actuarial, fiscal, regulatory, and educational aspects to render the micro-pension scheme sustainable in Ghana. This would be achieved by providing subsidies, enforcing regulations, and educating the informal sector on the importance of pension funds. In addition, the recommendations provided will enable the informal sector to save more efficiently and ensure that they have some financial stability in retirement.

CONCLUSION AND RECOMMENDATIONS

Using a hybrid approach of Multiple Decrement Model (MDM) and Markov process model (MPM), this study examined the actuarial funding implications of the Ghana micro pension scheme. Having computed the Normal Cost percent (P) and the Actuarial present value of the contributions (APV(C)) using the Entry Age Normal Cost method, this study provides insight into the actuarial funding, contribution schemes and pensions sustainability of the Ghana Micro Pension Scheme.

The results of this study indicate that although the burden of late entries is disproportionately high, it is paramount that participants are enrolled early enough to enable reasonable contributions. In addition, this study highlights the need for government intervention and

financial planning measures to ensure the sustainability of the pension scheme. Overall, the findings of this study provide significant insights on the actuarial aspects of the Ghanaian pension scheme to the policymakers, pension managers and participants.

The recommended proposals to improve the efficiency and sustainability of the micro pension plan consist of encouraging early enrollment, reviewing economic assumptions, strengthening investment strategy, improving workforce volatility. Regulatory oversight and awareness.

Encouraging Early Enrollment: It is advised that the policymakers encourage early enrollment through the diminishment of initial contributions or implementation of matching contributions by employers. This will motivate most people to save more for their retirement.

Periodic Review of Economic Assumptions: There is a need to perform a periodic review of the actuarial assumptions for the pension scheme. The actuarial assumptions consist of the discount rate, wage growth, and mortality. There is a need to evaluate the actuarial present value of the pension obligation.

Strengthen Investment Strategy: To strengthen the investment strategy, the plan sponsors must diversify their investments to lower the risks associated with retirement savings.

Improving Workforce Volatility Management: To improve the projected contributions, the actuaries should update the pension model to include the actuarial assessment of the withdrawal rates and employment changes. The informality of employment has to be considered in calculations to avoid shortfalls.

Regulatory Oversight and Public Awareness: Improving the regulatory processes to oversee and control the fund managers' behavior to guarantee proper contributions management is also essential. The lack of awareness cannot be underrated. Most informal workers do

not realize the significance of making regular contributions to their pensions.

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