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Joshua Shagaya Yahaya

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THÈSE

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Participation, Financement et Investissement dans le Plan de Retraite

Pension Plan Participation, Funding and Investment

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THESIS ABSTRACT

In the chapters of Part I, we introduce the thesis's context, rationale, objectives and structure. We establish a theoretical foundation to guide the research, placing it in an academic context for significant impact.

Part II features three empirical chapters that delve into pension plan participation, funding retirement savings accounts, and pension fund investment analysis. Our focus is primarily on the Defined Contribution (DC) Pension Scheme, with chapters three and four concentrating on the Nigerian pension fund. Chapter five examines the investment performance and uncertainty of the world's leading DC pension fund.

To begin with, the first contribution, contained in the third chapter, titled "Micro Pension Plan for Informal Sector Workers in the Nigerian Informal Economy," delves into the low rate of enrollment and participation levels of Nigerian informal sector workers in the Micro Pension Plan (MPP), which presents an opportunity for long-term savings geared towards post-retirement financial stability. The study found a negative relationship between attitude, subjective norm, and intention to enrol in and participate in the MPP. Households in the informal sector have a negative attitude toward savings and investments, leading to a lack of interest in the MPP. Moreover, the study found that household workers in the informal sector who do not perceive social pressure or norms to enrol in the MPP have lower intentions to participate. However, the study found an affirmative relationship between the consumer financial education of informal workers and their intention to enrol and participate in the MPP.

In the fourth chapter, titled "The Impact of Contribution Remittances on Retirement Savings in Contributory Pension Schemes", we delve into the critical question: What happens to the retirement savings account (RSA) balance of a contributory pension scheme (CPS) when contributions are remitted partially or non-remitted during various accumulation phases? Our analysis focuses on understanding the differences in contribution remittances and their impact on the accumulated RSA balance within a CPS model. We introduce a counterfactual scenario that incorporates partial and non-remittances of contributions through adjustments in contribution rate parameters. Our findings show that non-remittance of pension contributions and partial remittances of pension contributions

provide less retirement income in the RSA than the statutory contributory rate. These findings highlight a significant reduction in retirement income when pension contributions are not remitted on time, underscoring the critical importance of timely remittances in securing retirees' financial futures.

In the fifth chapter, titled "Thrift Savings Plan: Funds Performance and Uncertainty," we analyse the influence of policy uncertainty and inflation risk on the returns of thrift saving funds (TSF). Additionally, we compare these returns to their respective benchmarks to ascertain the fund's performance. Furthermore, we examine the significance of performance measures in evaluating the investment returns of TSF. The findings of this study demonstrate that both policy uncertainty and inflation risk have an impact on the investment returns of TSF. Also, compared to her benchmarks, TSF, as a passive fund, demonstrates commendable performance by closely replicating them. The choice of performance measures does not alter TSF's rankings. Overall, our study underscores the fact that the impact of uncertainty measures on TSF returns varies depending on the prevailing regime, thereby challenging the notion of a uniform impact.

This thesis provides significant insight for policymakers, researchers, and stakeholders in the pension industry. It also offers perspectives for those working to achieve financial security for households in retirement.

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First and foremost, I would like to thank El Shaddai: The All-Sufficient God, God Almighty, The All-Knowing God. He has blessed and given me strength, wisdom, favour and encouragement throughout all the challenging moments of completing this thesis. With His blessings, this thesis is completed. I am truly grateful to God for His mercy, grace, unconditional, endless and matchless love.

In his insightful article, "The Purpose of a Finance Professor," (Edmans 2022) emphasises that professors create and disseminate knowledge. In my experience working with Professor Radu Burlacu, I consistently witnessed his dedication to knowledge creation and willingness to share his vast expertise. I am truly grateful and honoured to have him as my thesis director and to benefit from the knowledge he imparts to me during my time as a master's degree student and throughout my doctoral studies. His unwavering dedication, expertise, and patience have been instrumental in shaping this research. His mentorship and invaluable feedback have been pivotal throughout my academic journey. Prof. Burlacu's continuous support, guidance, encouragement, and unwavering patience during my PhD studies have been immeasurable. He supported me throughout the process and shaped my understanding of research. Most importantly, he allowed me to experience the boundless kindness of humanity and family. I am eternally appreciative of you, Professor Radu Burlacu, on behalf of my family and my entire village, I thank you, Sir.

The adage "*It takes a village to raise a child*" from Africa means that nurturing a child is a collective endeavour of the village. Comparably, I wholeheartedly support the notion that commencing a doctoral expedition requires the support of a community. Consequently, I wish to extend my heartfelt appreciation to individuals in the academic, family and spiritual community who have played crucial roles in facilitating my pursuit of a PhD.

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CONTENTS

| | |
|---|-------------|
| Abstract | i |
| Acknowledgement | ii |
| Table of contents | viii |
| List of figures | ix |
| List of tables | xii |
| List of Abbreviations | xii |
| | |
| I State of the art | 1 |
| | |
| 1 General Introduction | 3 |
| 1.1 Introduction to the topic of the PhD thesis | 3 |
| 1.2 Structure and content of the PhD thesis | 11 |
| | |
| 2 Overarching framework | 13 |
| 2.0.1 Retirement and pension systems | 13 |
| 2.1 The concept of retirement and pension systems | 14 |
| 2.2 Theoretical Framework | 15 |
| 2.2.1 Consumption Loan Model of Interest | 15 |
| 2.2.2 Life cycle hypothesis of savings | 15 |
| 2.2.3 Life cycle theory | 16 |
| 2.2.4 Agency theory | 17 |
| 2.2.5 Stakeholders theory | 18 |
| | |
| II Contribution | 21 |
| | |
| 3 Fund Participation | 23 |
| 3.1 Introduction | 24 |

| | | |
|----------|---|-----------|
| 3.2 | Synopses of the Nigerian MPP | 26 |
| 3.3 | Literature review | 30 |
| 3.3.1 | Conceptual framework | 31 |
| 3.3.2 | Data | 37 |
| 3.4 | Results | 40 |
| 3.4.1 | Measurement model analysis | 40 |
| 3.4.2 | Verification of hypothesis | 42 |
| 3.5 | Discussion and conclusion | 45 |
| 3.5.1 | Predictors of intention to enrol and participate in MPP | 45 |
| 3.5.2 | Limitations of the current study | 48 |
| 3.5.3 | Recommendation | 49 |
| 3.6 | Appendix | 50 |
| 3.6.1 | Measurement model | 50 |
| 3.6.2 | Indicator reliability | 51 |
| 3.6.3 | Internal consistency reliability | 52 |
| 3.6.4 | Convergent Validity | 53 |
| 3.6.5 | Discriminant validity | 53 |
| 3.6.6 | Measures of formative latent variables: Weights | 54 |
| 3.7 | The estimated structural equation model results | 56 |
| 4 | Funding and Contributions | 57 |
| 4.1 | Introduction | 58 |
| 4.2 | The Nigerian Contributory Pension Scheme | 62 |
| 4.3 | Materials and method | 63 |
| 4.3.1 | Method | 65 |
| 4.3.2 | Model results | 70 |
| 4.4 | Empirical strategy | 73 |
| 4.4.1 | Empirical results | 74 |
| 4.4.2 | Discussion and Conclusion | 79 |
| 4.5 | Appendix | 82 |
| 4.5.1 | Descriptive Statistics | 82 |

| | | |
|------------|--|------------|
| 5 | Fund Investment Performance and Uncertainty | 85 |
| 5.1 | Introduction | 86 |
| 5.1.1 | TSP and TSF overview | 89 |
| 5.2 | Data and preliminary analysis | 90 |
| 5.2.1 | Returns | 90 |
| 5.2.2 | Economic state variables | 91 |
| 5.3 | Methods | 97 |
| 5.3.1 | TSFs returns analysis | 97 |
| 5.3.2 | TSFs and performance measurements | 98 |
| 5.3.3 | TSFs risk-adjusted returns analysis | 99 |
| 5.3.4 | The impact of inflation on the returns of TSFs | 102 |
| 5.3.5 | The impact of EPU(GEPU) on the returns of TSF | 104 |
| 5.4 | Empirical analysis and discussion | 106 |
| 5.4.1 | Results of the risks associated with inflation on the returns of TSF | 106 |
| 5.4.2 | Results of the impacts of risk factors on TSF returns. | 107 |
| 5.4.3 | Results of the impact of EPU-GEPU on the returns of TSF across regimes | 111 |
| 5.4.4 | Time-varying probability and expected duration | 113 |
| 5.5 | Summary and conclusion | 119 |
| 5.6 | Appendix | 122 |
| 5.6.1 | Preliminary analysis of data | 122 |
| 5.6.2 | Performance measures variables | 124 |
| III | Conclusion | 127 |
| 6 | General Conclusion | 129 |
| 6.1 | Theoretical Contributions | 129 |
| 6.1.1 | Theoretical contributions to the pension schemes funding through contribution remittance | 131 |
| 6.1.2 | Theoretical contributions to the pension funds performance and uncertainty | 132 |

| | | |
|-------|---|------------|
| 6.2 | Managerial implication | 133 |
| 6.2.1 | Limitations and future research | 134 |
| | Résumé de thèse | 137 |
| | Bibliography | 166 |

LIST OF FIGURES

| | | |
|-----|--|-----|
| 3.1 | Conceptual framework | 33 |
| 3.2 | The estimated structural equation model. | 56 |
| 4.1 | Pension replacement income for strategy A and B | 71 |
| 4.2 | Coefficient plots for strategy A | 79 |
| 4.3 | Coefficient plots for strategy B | 80 |
| 5.1 | Time series plot of TSF returns | 90 |
| 5.2 | Returns and transition probabilities of the 3-regime Markov switching model for F and C Funds | 115 |
| 5.3 | Returns and transition probabilities of the 3-regime Markov switching model for S and I Funds | 116 |

LIST OF TABLES

| | | |
|------|--|----|
| 1.1 | Summary of Research Objectives and Methodologies | 10 |
| 2.1 | Summary of Pension Schemes | 19 |
| 3.1 | Demographics of the respondents | 39 |
| 3.2 | Correlations among latent variables | 40 |
| 3.3 | Structural model evaluation | 43 |
| 3.4 | Statements for measuring the latent variables and collinearity test | 51 |
| 3.5 | Measurement items and their reliability | 52 |
| 3.6 | Discriminant validity: The Heterotrait-Monotrait ratio of correlations (HTMT) | 54 |
| 3.7 | Measures of formative latent variables; Weights | 55 |
| 4.1 | Definition of funding scenarios variables | 65 |
| 4.2 | Front Loaded Expenses | 67 |
| 4.3 | Benchmarks for Replacement Ratio at various income levels | 70 |
| 4.4 | Asset allocation based on lifestyle investment strategy | 70 |
| 4.5 | Summary Statistics for Accumulated Fund in Strategy A | 72 |
| 4.6 | Summary Statistics for Accumulated Fund in Strategy B | 72 |
| 4.7 | Shapiro-Wilk test | 73 |
| 4.8 | Friedman Test | 74 |
| 4.9 | Kendall W Test | 74 |
| 4.10 | Conover post hoc test for Strategy A | 76 |
| 4.11 | Conover post hoc test for Strategy B | 76 |
| 4.12 | Strategy A regression results | 77 |
| 4.13 | Strategy B regression results | 77 |
| 4.15 | Descriptive statistics of responses | 82 |
| 4.14 | Respondents demographics and questionnaires | 83 |
| 5.1 | Definitions of terms and variables | 93 |
| 5.2 | Descriptive Statistics on Monthly Returns and Economic State Variables | 94 |
| 5.3 | Means and Variance measures | 96 |

| | | |
|------|--|-----|
| 5.4 | Ranked correlations based on different performance measures | 100 |
| 5.5 | Results of TSF level analysis | 101 |
| 5.6 | Impact of the risks associated with inflation on fund returns | 108 |
| 5.7 | Estimations of the impact of EPU(GEPU) on the returns of TSF in a Three- state Markov Switching environment (Eqs. (5.7) and (5.8)). | 109 |
| 5.8 | Estimations of the time-varying transition probabilities Eqn. (5.9). | 113 |
| 5.9 | Estimations of the impact of economic policy uncertainty on TSP funds re- turns in a Three-state Markov Switching environment ROBUSTNESS (Eqn. (5.12) and (5.13)). | 117 |
| 5.10 | Estimations of the time-varying transition probabilities Eqn. (5.9). | 118 |
| 5.11 | Results of unit root and multicollinearity test | 122 |
| 5.12 | Panel cointegration test | 123 |
| 6.1 | Summary of Chapter Contributions | 135 |

LIST OF ABBREVIATION

| | |
|---------|--|
| ATT | Attitude |
| AVE | Average Variance Extracted |
| ADF | Augmented Dickey-Fuller |
| CBN | Central Bank of Nigeria |
| CFE | Consumer Financial Education |
| CFI | Comparative Fit Index |
| CPS | Contributory Pension Scheme |
| CONUASS | Consolidated Nigerian Universities Academic Salaries |
| C Fund | Common Stock Index Investment Fund |
| CPI | Consumer Price Index |
| DB | Defined Benefit |
| DC | Defined Contribution |
| DMO | Debt Management Office |
| DJ_TSM | Dow Jones US Completion Total Stock Market Index |
| DS | Default Spread |
| EandP | Enrolment and Participation |
| EAFE | Europe, Australasia, and the Far East |
| EPU | Economic Policy Uncertainty |
| EMV | Equity Market Volatility |
| ExcR | Exchange Rate |
| FGN | Federal Government of Nigeria |
| F Fund | Fixed Income Index Investment Fund |
| FSD | Financial Sector Deepening Organisation |
| FRTIB | Federal Retirement Thrift Investment Board |

| | |
|--------|--|
| GEPU | Global Economic Policy Uncertainty |
| G Fund | Government Securities Investment Fund |
| HTMT | Heterotrait-monotrai |
| ILO | International Labour Organisation |
| IRA | Individual Retirement Account |
| INTENT | Intention |
| I Fund | International Stock Index Fund |
| IntR | Interest Rate |
| IndP | Industrial Production |
| LLC | Levin, Lin, and Chu |
| MPP | Micro Pension Plan |
| MS | Markov regime-switch |
| MATAN | Market Traders Association of Nigeria |
| Max | Maximum |
| Min | Minimum |
| MSCI | Morgan Stanley Capital International |
| NBS | National Bureau of Statistics |
| NGX | Nigerian Pension Index |
| NR_1 | Non-remittance of contribution from the treasury to the end of CONU- ASS 01 level |
| NR_2 | Non-remittance of contribution from the treasury to the end of CONU- ASS 02 level |
| NSE | Nigerian Stock Exchange |
| NURTW | National Union of Road Transport Association |
| OECD | Organisation for Economic Co-operation and Development |
| OLS | Ordinary Least Squares |

| | |
|---------|---|
| OP | Oil Price |
| PBC | Perceived Behavioural Control |
| PENCOM | Nigerian Pension Commission |
| PFA | Pension Fund Administrator |
| PFC | Pension Fund Custodian |
| PLS-SEM | Partial Least Square Structural Equation Model |
| PP | Philips Perron |
| PR_1 | Partial remittance of contribution from the treasury to the end of CONUASS 01 level |
| PR_2 | Partial remittance of contribution from the treasury to the end of CONUASS 02 level |
| PW | Programmed Withdrawal |
| RSA | Retirement Savings Accounts |
| RMSEA | Root Mean Square Error of Approximation |
| SCR | Statutory Contribution Rate |
| S Fund | Small Cap Stock Index Investment Fund |
| S&P 500 | Standard and Poor's 500 |
| SN | Subjective Norm |
| SRMR | Standardised Root Mean Square Residual |
| TPB | Theory of Planned Behaviour |
| TSF | Thrift Saving Fund |
| TSP | Thrift Saving Plan |
| TLI | Tucker Lewis Index |
| TS | Term Spread |
| UDD | Uniform Distribution of Deaths |
| US_AIB | Bloomberg US Aggregate Bond Index |

| | |
|-----|---------------------------|
| VIF | Variance Inflation Factor |
| WHO | World Health Organisation |
| WTI | West Texas Intermediates |

Part I

State of the art

GENERAL INTRODUCTION

"A pension is a promise, and if that promise is broken, it affects real people and their livelihoods."

– Unknown

This chapter provides an overview of the subject matter explored in the thesis and outlines its organisation and structure.

1.1 Introduction to the topic of the PhD thesis

Today's advancements in medical sciences and modern technology have resulted in individuals experiencing a longer life expectancy compared to previous eras (Goss et al. 2016). Consequently, it is imperative to consider the necessity of making preparations for the retirement phase. It is of utmost importance that individuals are encouraged to adequately plan for their financial security during their working years to mitigate the potential risks of longevity associated with retirement (Cruwys et al. 2019).

Regardless of an individual's level of expertise, efficiency, activity, and productivity in the present workplace, the time will come in the future when retirement becomes a reality due to the attainment of the retirement age. However, it is critical to acknowledge that living expenses such as food, medical care, insurance, mortgage payments, and other utility bills do not cease with retirement (Bergstrom 1982; De Nardi, French, and Jones 2016).

Aside from households saving money in banks or investing in financial instruments, one way they can save for the future is through participation in a pension scheme. This scheme involves setting aside a specific amount of money, either by the employer, the employee, or both parties, to guarantee a continuous source of financial support that the employee can depend on during their retirement period. Pension today is a form of social security against risks associated with old age, longevity, poverty, and other uncertainties (Schmähl 2005; Andersen 2008). According to (Davis 2003), pension funds are long-term savings and a form of institutional investment that collect, pool, and invest funds contributed by sponsors and beneficiaries to provide for future pension entitlements. As noted in (Blake 2006), these funds facilitate the ability for individuals to accumulate savings throughout their working years to support their consumption requirements during retirement, either through a one-time payment (lump sum) or the provision of a fixed sum of money regularly (programmed withdrawals or annuity). Moreover, these funds may also serve as a means for corporations, other households (via securitised loans), or governments to make investments, such as through special purpose vehicle funds, which stimulates economic growth (Davis 1998; Clark et al. 2000; Davis and Hu 2004; Davis 2005; Inderst 2009; Corpataux, Crevoisier, and Theurillat 2009; Thomas and Spataro 2016).

(Davis 2003) went further to assert that, a pension program serves two essential purposes. The first purpose is to smooth out an individual's consumption over their lifetime, meaning that a pension provides income during retirement when the individual is no longer working in exchange for contributions made into the pension scheme while they are working. The second purpose is to provide insurance, particularly against the risk of living longer than expected. (Blake 2006) suggests that public policy may have two additional objectives for a pension scheme. The first objective is to alleviate poverty, whereby a society aims to ensure that its pensioners have a minimum standard of living in retirement. The second aim is to distribute additional resources to specific groups, such as women with children (and/or those who took time off to raise their children) or individuals in certain careers. As pension serves as a means to transfer income from the working years to the retirement years, then the fundamental principle that underlies pension schemes encompasses a harmonious interplay of economic factors (ensuring an adequate source of income for retired individuals), actuarial factors (managing the risks associated with investments

and longevity), and social factors (providing a safety net for older individuals) (Blake 2006; Woodall and Hagemeyer 2009; Blake 2016; Ogg 2021). Pension plans have become a significant tool for helping individuals and households save and invest effectively to support their retirement consumption needs.

Today, there are two main types of pension schemes: Defined benefit (DB) and Defined contribution (DC) pension schemes. A DB scheme can be compared to an employer's fiduciary duty towards an employee, entailing an assured payout of a predetermined retirement benefit. This payout can be a regular periodic (e.g., monthly) payment or a lump sum and is determined based on factors such as the individual's salary history, years of service, and age at retirement (Lemke and Lins 2010). Pension contributions in DB schemes are ascertained via an actuarial valuation, guaranteeing the realisation of the pledged benefits. The responsibility for funding rests with the employer, making it a secure retirement plan.

This thesis concentrates on the DC Pension Scheme, where the employee and employer contribute a fixed percentage or specific amount of the employee's salary towards the pension fund, typically deducted directly from the employee's pay. The funds received are then invested in various financial instruments, including but not limited to stocks, bonds, mutual funds, and other vehicles or investible instruments, all following the regulations established by the scheme. The retirement benefits provided by the DC plan are contingent upon the contributions made by both the employer and employee, plus the investment returns yielded by those contributions. In contrast to DB pension schemes, the pension benefits in DC schemes are not decided beforehand but rather determined by the extent of contributions made by the employer and employee and the investment performance. The scheme is managed by a designated pension provider (e.g. a financial institution), responsible for investment and fund management. A vesting period, varying by scheme, requires employees to work a specific duration to become eligible for pension benefits. Notably, this scheme offers portability, allowing employees to transfer their pension funds when changing jobs, ensuring uninterrupted retirement savings. Upon attaining the statutory retirement age, DC scheme beneficiaries can select various options for pension benefit payments, including lump sum payments, annuities, or regular disbursements (program withdrawals).

The DC scheme presents several advantages (Lindbeck and Persson 2003; Blake 2003;

Holzmann, Koettl, Chernetsky, et al. 2005; Blake 2006). To begin with, it affords individual employees greater control and flexibility with their retirement savings. Employees can exercise discretion over the investment of their contributions. Consequently, this endows employees with the ability to customise their retirement savings plan in alignment with their financial objectives and risk appetite. Secondly, the scheme permits portability, enabling employees to retain their pension benefits when transitioning between jobs. Furthermore, the DC scheme alleviates the financial burden on employers compared to DB schemes, as there is no guarantee of retirement income or payments of backlog liability due to poor investment performance and contribution remittances.

The shift from DB schemes to DC schemes has changed the relationship between workers and financial institutions managing long-term assets like pension funds. While DC schemes offer the aforementioned advantages, they also require employees to manage risks like longevity and investment risk, for which most workers are ill-prepared due to a lack of financial literacy and hence making poor investment decisions, which may lead to inadequate retirement savings (Brown 2016). Also, the retirement income benefit is not guaranteed and depends on the investment performance of the contributions. This exposes individuals to market volatility, uncertainty, and the risk of lower returns.

The introduction of DC schemes by some states has been modest, with recent shifts involving hybrid plans or cash balance plans rather than stand-alone DC schemes. These changes aim to avoid future unfunded liabilities peculiar to DB schemes and reduce investment and mortality risk. However, they also transfer risk to participants, potentially enhancing responsible funding and increasing security (Munnell, Aubry, Cafarelli, et al. 2014; Yao and Lei 2016). Nonetheless, in today's world, saving in a pension scheme has become crucial for individuals to create the necessary income to support their daily expenses during retirement. Governments across the globe perceive an obligation and accountability to strategies and furnish economic stability for individuals in their post-employment phase (Whiteford and Whitehouse 2006).

This thesis concentrates on three critical facets of DC pension schemes: enrolment and participation, funding retirement savings via contributions remittance, and investment performance and uncertainty of pension funds. To answer the questions in the thesis objective,

we divide the thesis into three definite essays for each chapter in the thesis contribution section. The first two chapters of the contribution section in part two of the thesis concern the Nigerian pensions fund. The third chapter in the same part centres on the investment performance and uncertainty of the leading DC pension fund worldwide, owing to the unavailability and inaccessibility of data from Nigeria. In this section, we present an overview of each of these chapters.

To begin with, the World Health Organisation ([WHO](#)) assert that, by 2030, one in six people worldwide will be 60 years or older, rising from 1 billion in 2020 to 1.4 billion. By 2050, this group will double to 2.1 billion, with the number of those 80 or older tripling. Initially seen in high-income countries like Japan, population ageing is now prominent in low- and middle-income nations, with two-thirds of those over 60 years in these regions by 2050. Ageing poses significant challenges for governments globally due to potential increases in healthcare spending and the need to provide pensions and other age-related necessities. The projected increase in the population of those either retired or nearing retirement directly correlates to an expanding demand for pension schemes in low- and middle-income countries, most notably in Nigeria, which boasts a substantial population.

A concerned look at the informal sector, which plays a crucial role in economic development by generating employment opportunities, encouraging entrepreneurial activities, decreasing unemployment rates and poverty levels, and stimulating economic growth ([Losby et al. 2002](#); [Meagher 2013](#); [Estevão, Lopes, and Penela 2022](#)). Shows that Nigerian informal sector workers in the informal economy face challenges to financial exclusion to financial services like pensions and other financial products. With a substantial and expanding informal sector, Nigeria possesses a favourable position for a resilient MPP owing to its robust financial services framework and noteworthy internet and mobile access.

While the contributory pension scheme (CPS), a DC scheme has garnered substantial attention due to its mandatory nature and employer-employee funding structure, characterised by payroll deductions, the MPP stands in stark contrast. The MPP operates within the informal sector, relies on voluntary participation, features irregular and meagre incomes from the sector workers, and has remained underexplored in academic discourse. Existing research ([Ribe, Robalino, and Walker 2012](#); [Peron, John, and Daniel 2013](#); [Dulleman and](#)

Bruijn 2014; Agravat and Kaplelach 2017a; Kibona 2020; Nazarov et al. 2022) has shed light on the influence of socioeconomic and demographic variables on the enrollment and participation in schemes similar to MPP. However, these external factors often lead individual households to repetitively make financial decisions without substantial changes (Jacobs-Lawson and Hershey 2005). Consequently, there is a pressing need for a novel investigation to gain deeper insights into the behavioural determinants shaping the enrollment and participation intentions of informal sector workers in the MPP.

Hence, the first underlying research objective of this thesis is to empirically investigate behavioural determinants of MPP enrolment and participation, which offers a combination of short-term and long-term savings components, with the short-term component allowing participants to access their funds in the near term and the long-term component focusing on long-term returns through investments in longer-term assets. To fulfil the first research objective, we employed a quantitative methodology.

In the past, Nigerian society, much like many other societies, relied on a traditional system where children would provide financial support to their elderly parents as a form of social security during their old age. However, this system has now become dysfunctional. Ageing parents experiencing longer lifespans are confronted with the daunting reality of whether their retirement funds will be sufficient to sustain them (Mitchell and Smith 1991; Orth 2006; Novy-Marx and Rauh 2009; Kitao 2015). The extant literature highlighted several critical issues in pension funding at the household, macroeconomic, and firm levels (Huberman, Iyengar, and Jiang 2007; Valdés-Prieto 2008; Blake, Cairns, and Dowd 2009; Whitehouse 2009; D'Addio and Whitehouse 2010; Van Dalen, Henkens, and Hershey 2010; Nwachukwu and Odigie 2011; Aisen and Veiga 2013; Statman 2013; Thom and Randazzo 2015; Bielawska, Chłoń-Domińczak, and Stańko 2017; Reyers 2018; Han and Meng 2019; Bernal and Olivera 2020; Salonen, Koskinen, and Nummi 2020; James, Price, and Buffel 2020; Alfaro et al. 2020; Glossner et al. 2020; Natali 2020; Babat, Gultekin-Karakas, and Hisarciklilar 2021; Liu, Mikesell, and Moldogaziev 2021; Sharpe 2021; Li and Mutchler 2021; Tomar, Kumar, and Sureka 2021; Ataullah, Le, and Wood 2022; Gallego-Losada et al. 2022; Owusu, Onumah, and Essel-Donkor 2023). These issues range from behavioural disparities among scheme participants' unrelated household plans to retirement savings to the

influence of fiscal crises, global economic performance, and contribution rates on participation. Additionally, employee compensations positively correlate with participation and retirement savings rates, while corruption and political reluctance have impeded the enforcement of statutory contribution rates. The COVID-19 pandemic has exacerbated these challenges by interrupting the remittance of contributions to retirement savings accounts. However, notwithstanding these identified factors that exert influence on the contribution and funding of retirement savings, according to our extensive exploration of existing scholarly works, there appears to be a paucity of empirical evidence regarding the impact of partial or non-remittance of pension contributions on the final balance of retirement savings accounts.

Thus, the second main research objective of this thesis is to investigate, how the partial or non-payment of pension contributions affects the total accumulated balance of retirement savings accounts. In order to accomplish this overarching research objective, a quantitative research approach is employed.

Recent economic and political events have reignited interest in understanding the economic impact of policy uncertainty (Bloom 2009; Baker, Bloom, and Davis 2016). While research has explored the effects of policy uncertainties on returns, including market shifts and global economic policy uncertainty (GEPU) (Arouri et al. 2016; Zhu et al. 2017; Basher, Haug, and Sadorsky 2018; Hoque and Zaidi 2019; Scarciuffolo and Etienne 2021; Liu et al. 2022; Ali et al. 2023), the relationship between policy uncertainty and pension funds remains unexplored. Additionally, given the predominance of stocks and bonds in pension fund portfolios, the impact of inflation on these funds is of growing concern. In this chapter, we seek to address the following questions: Does the presence of policy uncertainty risk have a discernible effect on the returns of thrift savings funds (TSF)? To what degree does the existence of inflation risk influence the returns of TSF? In comparison to its benchmarks, how do the returns of TSF fare? Furthermore, does the choice of performance measures hold significance when assessing TSF returns?

In order to address these questions, the third overarching research aim of this thesis is to empirically examine the relationship between TSF returns, fluctuations in inflation, and their influence on TSF performance. In order to fulfil this initial overarching research objective, we

employed a quantitative research methodology.

In conclusion, the overarching research objectives and research questions of this thesis, along with the methodologies and sample used to address these objectives and questions, are presented in Table 1.1.

Table 1.1: Summary of Research Objectives and Methodologies

| | Chapter 3 | Chapter 4 | Chapter 5 |
|--------------------------------------|---|---|--|
| Overarching re- search objectives | To empirically investigate the behavioural determinants of low enrollment and participation in the MPP among Nigerian informal sector workers | To empirically examine how contribution density impacts the RSA balance in a CPS during different accumulation phases. | To empirically investigate the impact of policy uncertainty and inflation risk on the returns of TSF and their relative performance to benchmarks. |
| Research Question | What are the determinants of low enrollment and participation in the MPP among Nigerian informal sector workers? | What is the impact of partial or non-remittance of contributions on the RSA balance in a CPS during different accumulation phases, and how do variations in contribution remittances affect the accumulated RSA balance within the CPS model? | How do policy uncertainty and inflation risk impact the returns of TSF and their performance relative to benchmarks? |
| Methodology | Quantitative | Quantitative | Quantitative |
| Sample | A nationally representative data set of 14,510 informal sector workers in Nigeria | Public Universities salary data of 2019, NGX Pension index (2013-2021), and macroeconomic data. | TSF Investments in US and MSCI World Index (1989-2023) |

1.2 Structure and content of the PhD thesis

This thesis adopts the form of a monograph based on articles which are not published yet. Herein, a comprehensive outline and a concise summary of the substance of this thesis are delineated as follows:

- Chapter 2 comprises the comprehensive structure of this thesis. Specifically, it delves into the theoretical foundation, identifies the research gaps, and presents the specific research objectives and methodologies that will be examined in the articles that form chapters 3, 4, and 5 of the second part within the contribution section of the thesis.
- Chapter 3 addresses the first overarching research aim and objectives of this thesis. Specifically, the chapter investigates the low enrolment and participation rate of Nigerian informal sector workers in the Micro Pension Plan (MPP), which offers a combination of short-term and long-term savings components, with the short-term component allowing participants to access their funds in the near term and the long-term component focusing on long-term returns through investments in longer-term assets. Given the significant role that the informal economy assumes in Nigeria, the failure of the sector workers to enrol and participate in MPP could potentially result in an escalation of old-age poverty and financial strain on households in the informal sector and the economy. Therefore, it is critical to understand the behavioural factors beyond socioeconomic and demographic variables influencing enrolment and participation in MPP. Therefore, the chapter aims to investigate how these behavioural constructs affect the enrolment and participation of informal sector workers in the MPP. The article that constitutes this chapter is entitled “*Micro Pension Plan for Informal Sector Workers in the Nigerian Informal Economy*”.
- Chapter 4 focuses on the second research objective of this thesis. Specifically, in this chapter, we explore a crucial question concerning the final balance in a retirement savings account (RSA) within a CPS model when contributions are only partially or not remitted as when due during different accumulation phases. Using data from Nigeria and lifestyle investment strategy, the chapter analyses how these variations

in funding scenarios impact the final RSA balance. In the current lifestyle investment strategy, the chapter designates the maximum variable income security with the minimum fixed income securities in the fund structure (I, II and III) as strategy A. Strategy B, the minimum variable income securities with the maximum fixed income security in the fund structure (I, II and III). This Fund structure aims to align RSA participant age and risk profile by dividing the RSA Fund into three active Fund types (I, II and III). Participants can choose Fund I on request. Fund II is the default fund for participants aged 49 and below. Fund III is the default fund for participants aged 50 and above. The article that composes this chapter is entitled “*Impact of Contribution Remittances on Retirement Savings in Contributory Pension Schemes*” and has been developed with Prof. Radu Burlacu. The article is currently under review in the Journal of Asset Management.

- Chapter 5 also addresses the third overarching research objective of this thesis. Specifically, it intends to answer empirically the following questions: Does policy uncertainty risk impact TSF returns? To what extent does inflation risk affect the returns of TSF? In comparison to her benchmarks, how do the returns of TSF fare? Additionally, does the choice of performance measures hold significance when evaluating TSF returns? The article that constitutes this chapter is entitled “*Thrift Savings Plan: Funds Performance and Uncertainty*” and has also been developed in collaboration with Prof. Radu Burlacu. The article is under review in the International Review of Financial Analysis.
- Chapter 6 contains the conclusion of this thesis. Specifically, it provides a comprehensive discussion of the theoretical contributions, managerial implications, limitations, and potential avenues for future research of the articles that form chapters 3, 4, and 5.

At the conclusion of the monograph, we present a comprehensive and distinctive compilation of sources about each chapter comprising this thesis.

OVERARCHING FRAMEWORK

"Evidence is not proof: It may not be universal. Data is not evidence: It may not be conclusive. A fact is not data: It may not be representative. A statement is not fact: It may not be accurate.."

– Alex Edmans

This chapter of the thesis delves into the theoretical underpinnings, highlights the research gaps, and outlines the specific research objectives and methodologies examined in the articles encompassing chapters 3, 4, and 5.

2.0.1 Retirement and pension systems

The evolution of pension and retirement systems has proven to be a continuously evolving and adaptable journey. Over the years, these systems have adapted to societal changes, economic shifts, and demographic transitions (Iparraguirre and Iparraguirre 2020). Thus, understanding their historical context and the development of these systems is essential in understanding their current structure and assessing their sustainability in an ever-changing world. For when we examine the changes in the system, it will enable us to comprehend how societies have addressed the issues of retirement, pension plans, and consequently, the strategies for the economic prosperity, financial well-being and stability of individual households. By examining the historical trajectory of pension systems, we gain insights

into the broader social and economic forces that have shaped retirement policies and practices. Given the absence of a universally applicable pension system that can be seamlessly integrated into all societies, numerous pension systems have been subjected to scrutiny and examination in prior literature. Consequently, recommendations have emerged from this literature concerning the scheme design and ways of improving the pension schemes through reforms in some quotas (Wang et al. 2014).

2.1 The concept of retirement and pension systems

The concept of retirement and pension systems evolved significantly since their inception, with an important milestone in 1889 when German Chancellor Otto von Bismarck introduced voluntary retirement at age 65 (Jackson 2009; Shim et al. 2013).

Retirement, often defined as the phase of an individual's life when the individual ceases active employment, marks the commencement of a significant life transition as contained in the consumption-loan model of interest (Samuelson 1958). Hence, within the context of planning for retirement, retirement systems today are part of the domain of social security—a multifaceted social welfare program. Earlier economies and some today have a social security structure, as an institution, that serves as a safety net that provides a spectrum of benefits to workers and their dependents (Wang et al. 2014). These benefits encompass not only retirement income but also disability income and other forms of financial support for individual households. Thus, the financial underpinning of social security is from the contributions made by individual household workers and their employers through the social security tax. This framework is enshrined in state law to protect these individual households from the possible interruption or loss of their income-earning capacity (Wang et al. 2014). In addition to its fundamental function of income maintenance, social security also serves as a mechanism for social insurance, as pointed out by (Rejda 2011). It is, in essence, a collective effort intended to guarantee that households can sustain their livelihoods after they retire from the workplace and or active employment. As (Asher 1998) astutely noted, the primary objective of a social security system is to furnish a substantial proportion of retirees with an income replacement rate that is not only socially acceptable but also financially sustainable. This replacement rate refers to the portion of their final salary or

a comparable benchmark household can anticipate and receive as benefits payments after retirement.

2.2 Theoretical Framework

2.2.1 Consumption Loan Model of Interest

The consumption-loan model of interest, as established by (Samuelson 1958), is a widely recognised economic theory encompassing the concepts of borrowing and savings, which holds a direct correlation to pension plans (Settergren and Mikula 2005). The model focuses on the interplay between borrowing and saving decisions over a person's lifetime. It explains how individuals make decisions about borrowing and saving throughout their lives (Samuelson 1958). Because individuals have a two-period life. In the first period, they work, earn a wage and save. In the second period, they retire and consume their savings (Samuelson 1958). Also, individuals borrow when they are young to fund projects like their education, purchase a home, or cover other major expenses, and they save when they are working to repay those loans and accumulate wealth for their retirement. This approach is based on the idea that individuals want to smooth their consumption over their lifetime to ensure they have enough resources to maintain their standard of living before and during retirement. Thus, the model has had a significant impact and is the foundation for a wide range of research in public finance and macroeconomics, including pension and social security studies, national debt analysis, taxation and capital accumulation, the Phillips curve, the business cycle, and the fundamentals of monetary theory (Geanakoplos 1989; Asch 1995).

2.2.2 Life cycle hypothesis of savings

The life cycle hypothesis of savings and theory plays a significant role in understanding pension plan participation, funding and investments. They have played a pivotal role in understanding the behaviour of individuals, households and the overall economy in saving. Since individual life encompasses a period of active employment followed by retirement. This, in turn, requires households to redistribute their consumption from their working

years, when they earn income, to their retirement years, when resources might be limited (Modigliani 1986; Blake, Wright, and Zhang 2013).

To this end, we begin by looking at the life cycle hypothesis of savings. This implies that individual households save during their active employment period to ensure they have a consistent level of consumption to secure their financial well-being in retirement (Modigliani and Brumberg 1954; Ando and Modigliani 1963; Modigliani 1986). The central idea is that households aim to smooth their consumption levels across their lifetime by saving during their working years to support consumption during retirement. The life cycle hypothesis focuses on how individuals allocate their resources over time and is often used to explain the saving and investment patterns of individual households or the aggregate society. To this end, empirical evidence (Evans 1984) has demonstrated that the life cycle hypothesis and demographic factors can elucidate a substantial proportion of the disparity in savings rates across the Organization for Economic Cooperation and Development (OECD) countries.

2.2.3 Life cycle theory

The life cycle theory provides a theoretical foundation for understanding how individuals, households, and the larger economies allocate resources, make financial decisions, and plan for their financial security and well-being over their lifetimes. The theory encompasses not only the notions associated with consumption and savings but also broader aspects of financial planning, such as investment choices, risk management, and retirement planning. The theory posits that individual households adjust their savings and investment behaviours over their lifetime to ensure financial security in retirement (Modigliani 1986). In the early stage of their careers, individuals tend to participate in pension plans by contributing a portion of their income. As individuals advance in their professional careers, they incrementally augment their pension contributions, thus capitalising on the compounding returns to establish a considerable retirement fund in their RSA. During the subsequent phase of life, when retirement looms near, it is typical to witness a shift towards more conservative investments as a means to safeguard the accumulated funds. To effectively align participation, funding, and investment options with long-term retirement objectives, a comprehen-

sive understanding of the life cycle theory is imperative for individuals and pension plan providers.

2.2.4 Agency theory

When there is a conflict between the objectives of the principal and the agent, it poses a challenge for the principal to ascertain the actions taken by the agent, thereby giving rise to the agency problem (Baker 2019). Thus, the agency theory elucidates the relationship between the principal and the agent by directing attention towards the contractual relationship and the potential conflicts of interest and information asymmetry that may arise between them (Eisenhardt 1989; Panda and Leepsa 2017). Under the agency theory, the principal possesses the economic resource, whereas the agent is accountable for utilising and managing said resources (Jing et al. 2018; Moloi et al. 2020). Hence, in the context of pension, as in this thesis, agency theory examines the relationship between the principal (the pension plan participants) and the agent (the financial institutions managing and administering the pension funds on behalf of the plan participants). This theory recognises a potential conflict of interest between these two parties, as the agents may not always act in the best interests of the principals (Baker 2019).

Also, within pension plans, agency theory implies that those responsible for managing the investments and administration of the plan (the agents) should act in a fiduciary capacity, prioritising the long-term financial well-being of the plan participants. It emphasises the importance of transparency, accountability, and proper governance to ensure the agents' interests align with the plan participants. Pension plan participants can apply agency theory by carefully monitoring the performance and decisions of the agents, holding them accountable, and advocating for their best interests. Understanding agency theory can help participants make informed choices regarding their pension fund investment strategies, contributions remittances and fund administrators, as well as ensure that the plan and their funds are managed in a manner that is consistent with their long-term financial goals. By applying agency theory principles, participants can work to minimise conflicts of interest and promote better governance in their pension plans.

2.2.5 Stakeholders theory

Stakeholder theory places significant emphasis on the interconnectedness between organisations and their stakeholders and the imperative to consider the interests and apprehensions of all pertinent stakeholders during decision-making procedures (Hill and Jones 1992; Donaldson and Preston 1995; Laplume, Sonpar, and Litz 2008; Freeman 2010; Mainardes, Alves, and Raposo 2011; Freeman 2020). Stakeholder theory is also significant in studying pension plan participation, funding, and investments. Based on this theory, pension plans do not exist in isolation and have multiple stakeholders beyond the employees who are the plan participants. These stakeholders encompass a range of individuals and entities, such as employers, administrators of pension funds, custodians of pension funds, regulatory bodies, and the society as a whole. Thus, recognising the interests of all stakeholders is essential for the long-term success and sustainability of the schemes. Hence, pension schemes should aim to balance the needs and expectations of various stakeholders. For example, employers should ensure that their employees have access to suitable pension plans, regulatory bodies (e.g. The National Pension Commission of Nigeria PENCOR) should establish and enforce rules that protect plan participants, like remitting pension contributions when due, and funds administrators should make responsible investment decisions that consider the interests of both participants and the broader community. By considering stakeholder theory, scheme participants can advocate for transparency, ethical and social investing, and responsible management of funds assets. They can also make fund managers and employers accountable for their obligations to all stakeholders. This approach helps ensure that the funds are not only financially secure but also align with the values and expectations of all those involved, ultimately contributing to the welfare of the scheme participants.

The particular role of contexts in DC research

As pension systems differ by scheme and country, and we summarise the DC scheme used in this thesis and characterise them in Table 2.1.

Table 2.1: Summary of Pension Schemes

| Scheme | Definition & Features |
|---------------------------|--|
| Defined Benefit (DB) | The pension benefit paid out under this scheme depends on salary, years of service, and other factors. This benefit is fixed at retirement and does not change with salary. DB has advantages like being less risky and predictable for the employer. However, it can be expensive and lead to higher retirement age (Watson 2008). |
| Defined Contributory (DC) | The pension benefits of this scheme depend on the contributions and investment returns. Pension benefits can vary based on the fund's investment performance. DC schemes offer flexibility and cost-effectiveness for employers, but members bear the investment risk (Blake 2006; Watson 2008). |
| Micro Pension Plan (MPP) | The MPP is a voluntary pension plan for informal sector workers in Nigeria with flexible contributions. Like in a typical DC plan, the pension benefits depend on the contribution made, the fund's investment performance and survival factors. The member's contributions are split into a retirement benefits fund (60%) and a contingency fund (40%) (PENCOM). |
| Thrift Savings Plan (TSP) | This is a retirement plan for US government employees and service members. It operates as a DC plan, where members' retirement benefits are dependent on contributions during one's career and the accumulated earnings over time plus the fund performance (TSP). |

Part II

Contribution

FUND PARTICIPATION

“A good financial plan is a road map that shows us exactly how the choices we make today will affect our future.”

– Alexa Von Tobel

We investigate the low enrolment and participation rate of Nigerian informal sector workers in the Micro Pension Plan (MPP), which offers long-term savings for retirement income. Given the significant role that the informal economy assumes in Nigeria, the failure of the sector workers to enrol and participate in MPP could potentially result in an escalation of old-age poverty. Therefore, it is critical to understand the factors influencing enrollment and participation in MPP. The study utilises a nationally representative data set and an extended version of the theory of planned behaviour (TPB), which incorporates consumer financial education. The influence of the TPB construct on workers’ intentions to enrol in and participate in the MPP is studied using the Partial Least Squares Structural Equation Model (PLS-SEM). As attitudes towards long-term savings and investments decrease, so do the informal sector workers’ intentions to participate in the MPP. The study also found a strong positive relationship between the sector worker’s financial education and their willingness to enrol and participate in the MPP. Behavioural intention is a strong predictor of MPP enrollment and participation. In addition to scientific implications, our findings have practical applications for the implementation design of MPP.

Keywords: Micro pension plan, Informal sector, Informal economy, consumer financial

education, PLS-SEM and Theory of Planned Behaviour

JEL Classification: J26, J32, O17, G22

3.1 Introduction

Micro pension plan (MPP), a third pillar pension system, is designed to provide old-age retirement income for households in the informal economy that do not have access to the contributory pension schemes (CPS) available to public and formal private sectors. It aims to meet the economic needs of informal sector workers, who may not retire in the same way as those in the formal sector, but still face the possibility of a loss of earning capacity as they age.

MPP offers a combination of short-term and long-term savings components, with the short-term component allowing participants to access their funds in the near term and the long-term component focusing on long-term returns through investments in longer-term assets.

MPPs are gaining worldwide popularity as a means of promoting financial inclusion and retirement security for workers in the informal sector (Karmakar, Banerjee, and Mohapatra 2011; Kwena and Turner 2013). However, enrollment and participation rates in Nigeria are low. Failure of informal sector workers to enrol and participate in the MPP could lead to a rise in old-age poverty and financial strain on households in the informal sector and the economy. This is compelling because the informal economy in Africa, particularly Nigeria, plays a significant role in promoting entrepreneurialism, job creation, and stimulating economic growth. However, workers in the informal sector often lack employment benefits such as pensions and are usually faced with economic shocks, poor health, and unemployment in their later years (ILO 2018; World Development Report 2018; OECD and ILO 2019). As a result, they may struggle to maintain their standard of living and continue to work past retirement age or rely on family support for elderly care (Njuguna 2012; Bloom and Eggleston 2014; Hayden, McNally, and Kinsella 2021). Therefore, understanding the factors that influence enrollment and participation in MPP designed to support these workers is essential in addressing poverty problems and improving the financial well-being of informal

sector workers.

We employed the Partial Least Squares Structural Equation Model (PLS-SEM) to examine the intention to enrol and participate in MPP using a representative Nigerian national data set. The model consists of two linear equation sets (Henseler, Hubona, and Ray 2016), the measurement model (also known as the outer model) and the structural model (also known as the inner model), which define the paths. The measurement model specifies the relationship between constructs and their observed indicators, while the structural model specifies the relationships between constructs. To ensure the validity and reliability of the measurement model, we evaluated item loading on the defined constructs by performing some test analysis. Next, we verified our hypothesis by testing the model fit. Our study utilised an extended version of the theory of planned behaviour, henceforth (TPB) (Ajzen 1991), incorporating consumer financial education into the theory's traditional constructs.

Our findings show a negative, albeit statistically significant, relationship between attitude, subjective norm, and behavioural intention to enrol in and participate in the MPP. Specifically, as one has a negative attitude towards long-term savings and investments, so does one have a negative behavioural intention to enrol in and participate in the MPP. Additionally, the negative relationship between subjective norm and behavioural intention suggests that as informal sector workers do not perceive social pressure or norms to enrol and participate in MPP, their actual intention to enrol or participate in MPP decreases. Within the informal economy, informal workers often hold diverse viewpoints on the prospect of enrolling and participating in a formal scheme like MPP. This diversity arises from their varying degrees of perceived control over financial matters and investments, resulting in a statistically insignificant relationship between perceived behavioural control and the inclination to enrol and participate. Moreover, the findings demonstrate a remarkably positive relationship between informal sector workers' consumer financial education and their behavioural intention to enrol in and participate in the MPP. Thus, this suggests that as workers' knowledge of consumer financial education increases, so does their willingness to participate in the MPP. Additionally, the study indicates a statistically significant positive relationship between workers' intentions to enrol in and participate in the MPP and their actual participation in the scheme.

This study contributes to the existing literature in two ways. To begin with, we investigate the relationship between the constructs of TPB (attitude, subjective norm and perceived behavioural control) and the behavioural intention of informal sector workers to enrol in and participate in the Nigerian MPP. Furthermore, adding more factors to the TPB may influence behavioural intention, according to (Ajzen and Fishbein 1977). Hence, we did this with the aim to improve the TPB's applicability in determining MPP enrolment and participation by incorporating consumer financial education. Secondly, we contribute to the existing literature by addressing a notable gap in prior studies. We extend the literature by examining the underexplored context of developing economies, particularly Nigeria's MPP for informal sector workers, which has received little attention. By doing so, we provide valuable insights that contribute to a better understanding of retirement planning dynamics globally, ultimately aiding in the development of targeted strategies for this population.

This article is organised as follows. The synopsis of the Nigerian MPP is provided in Section 2. Section 3 reviews the literature and presents our research data. Section 5 concludes with a discussion after Section 4 presents the study methodology and empirical findings.

3.2 Synopses of the Nigerian MPP

In low-income countries, labour markets differ significantly from those in advanced economies (Poschke 2019). As a result, workers in the informal sector in the informal economy of low-income countries are classified into two types of workers (Dell'Anno 2021). The "self-employed" category comprises informal business employers, own-account workers, and contributing family workers. The "wage-employed" category includes casual workers, paid domestic workers, industrial out-workers, and home workers (Güven 2019). The creation of MPP promoted savings and financial inclusion for workers in the informal sector, whether wage-employed or self-employed. In other contexts (Landerretche and Martínez 2013), households use voluntary pension schemes to supplement their retirement savings. In this context, as in most low-income countries, workers in the informal sector have no access to social security or pension funds, so MPP is their only option for retirement savings.

The MPP is a voluntary third-pillar pension plan that allows households to contribute

small amounts to retirement savings. There is no fixed statutory actuarial contribution rate in the MPP. Contributions are invested to generate returns for MPP participants. The Pension Fund Administrator (PFA) manages and invests the MPP funds of the contributors, while the Pension Fund Custodian (PFC) keeps the funds safe. The MPP is managed and regulated by the Nigerian Pension Commission (PENCOM).

The amount paid in the individual retirement savings account of the MPP, the accumulation, and survival factors affect the benefits to be paid out just as in other CPS funds. The funds split the MPP contributions into two accounts: one for contingencies and the other for retirement benefits. 60% of the money contributed goes to the MPP retirement benefits fund, and the contingent fund receives 40%. Participants in the MPP scheme may use a portion of their 60% retirement benefit balance as an equity contribution toward obtaining a residential mortgage. Hence, it facilitates the informal sector workers' ability to own a residential home during their working lives, thus closing the housing gap and raising the living standards of those employed in the informal sector.

Following (Haberman and Vigna 2002; Otibine and Jahonga 2020), and heuristic judgments, lifestyle investment strategy used by asset and private wealth managers, portfolio managers to evaluate and forecast financial risk tolerance (Roszkowski, Snelbecker, and Leimberg 1993), we assume that a 60% retirement benefit portion of the MPP fund's X_A and $1 - X_A$ are invested in a variable income instrument (e.g., an equity fund) and a fixed income security asset (e.g., a bond). The net return on the assets of the portfolio is then determined by the annual yield of the fixed income instruments Y_b and the yield of the variable income instruments Y_{st} , as follows:

$$C_T = [X_A(e^{\lambda t})(Y_{st} - F_s) + (1 - X_A)(e^{\mu t})(Y_b - F_b)] \quad (3.1)$$

where F_b and F_s are the annual fees of the fund. The level of contribution at time T is indicated by C_T . The real forces of interest for the variable and fixed income security in year $[t, T]$ are λ_t and μ_t , respectively. The sequences λ_t and μ_t are assumed to be independent and identically distributed with a normal distribution, whereas the annual forces of interest λ_t and μ_t are correlated with the correlation factor ρ , which is assumed to be constant for any t . Thus, the accumulated fund at time T will be:

$$A_T = \sum_{t=0}^{T-1} (C_T) [E(1 + i_t)(P_r\{T(x) > t\})] \quad (3.2)$$

where $E(1 + i_t)$ is the accumulation factor with a log-normal distribution and parameters μ and σ as in $(1 + i_t) \log N((\mu, \sigma^2))$. Also, $E(1 + i_t) = \exp(\mu + \frac{1}{2}\sigma^2)$ and $\text{var}(1 + i_t) = \exp[2(\mu + \sigma^2)] - \exp(2\mu + \sigma^2)$. Then $P_r\{T(x) > t\}$ is the $P_r\{(\alpha) \text{ survives to age } x + t \mid (\alpha) \text{ survives to age } x\}$ that is equal to;

$$\frac{P_r\{T(\alpha) > x - \alpha + t\}}{P_r\{T(\alpha) > x - \alpha\}} = P_r\{T(x) > t\} = {}_tP_x$$

where ${}_tP_x$ is the probability that a person of age x will live another t years to the exact age $x + t$. Therefore, ${}_tP_x = \frac{\ell_{x+t}}{\ell_x}$, with ℓ_{x+t} being the number of people alive in the scheme at age x who live for t years to exactly age $(x + t)$, and ℓ_x is the number of people alive at age x . Consequently, it is possible to calculate the value of a retirement benefit using a multiple-decrement model. The rate of decrement is not equal to the probability of decrement in a multiple-decrement environment, where more than one decrement is operational (Winklevoss 1993), such as in this informal sector and economy. Consider linear interpolation, also known as UDD (uniform distribution of deaths between integral ages). According to the UDD assumption, the age at death of those who will die at curtate age x is uniformly distributed between ages x and $x + 1$. The UDD assumption is common when converting a rate into a probability in a multiple-decrement environment because it assumes that all decrements occur uniformly throughout the year. Our MPP decrement environment as in (Winklevoss 1993), $q^{(k)}$ represents the rate of decrement for cause k and $q^{(k)}$ represent the probability of decrement, which is the transformation of a rate into a probability in a decrement environment ($k = 1, 2, 3, 4$, which is; $q^{(m)}$ = mortality rate, $q^{(d)}$ = disability rate, $q^{(t)}$ = termination rate, $q^{(r)}$ = normal-age retirement rate), based on approximation of the UDD assumption, the decrement will be;

$$\begin{aligned}
 q^{(1)} &\approx q^{(1)} \left[1 - \frac{1}{2}q^{(2)} \right] \left[1 - \frac{1}{2}q^{(3)} \right] \left[1 - \frac{1}{2}q^{(4)} \right] \\
 &\approx q^{(1)} \left[1 - \frac{1}{2} (q^{(2)} + q^{(3)} + q^{(4)}) \right. \\
 &\quad \left. + \frac{1}{4} (q^{(2)}q^{(3)} + q^{(2)}q^{(4)} + q^{(3)}q^{(4)}) \right. \\
 &\quad \left. - \frac{1}{8} (q^{(2)}q^{(3)}q^{(4)}) \right]
 \end{aligned}$$

(3.4)

Low-income households are more likely to withdraw funds from their retirement accounts because their source of income may be temporary or suffer during economic downturns (Argento, Bryant, and Sabelhaus 2015; Kos and Lensink 2023). So, three months after the first payment, a participant in the MPP can withdraw from the contingent fund. The buffer stocks theory (Carroll, Hall, and Zeldes 1992) underpins this withdrawal option where households use their savings to buffer against economic shocks and maintain a minimum consumption. Following Eqn. 3.4, In the event of death, disability, or inability to buy a pension program withdrawals (due to low accumulated savings), the fund makes a lump sum payment of the retirement benefit part of the fund to the beneficiary after accounting for the MPP 40% contingent fund. If an MPP member retires at the standard retirement age and has enough money in the retirement savings account to buy a pension or an annuity, the participant will receive a lump sum payment and a program withdrawal or annuity monthly.

Thus, the informal sector households preferred a more flexible long-term savings product over a less flexible one, for a flexible product creates a better balance between current and future consumption needs (Kos and Lensink 2023). As a result, the MPP is an ideal program for households working in the informal sector. Households in the informal sector traditionally save for retirement through participating in thrift, credit, and cooperative societies in their homes or marketplaces (Rutherford 2009). These societies, such as Adashe, Ajo, Esusu, Susu, and Tontine, are prevalent in West Africa. Additionally, some households

in the informal sector purchase land in instalments to generate long-term cash flow (Alcala and Koshy 2007; Shankar and Asher 2011; Dullemen and Bruijn 2015). As a result, they exhibit familiarity bias by saving in ways they have previously or currently used. However, the low enrollment rate in MPS may also be ascribed to low levels of education, financial illiteracy, changing demographics, limited access to financial services and government policies (Manohar 2009; Agravat and Kaplelach 2017b; Kibona 2020; Oyewole 2021).

3.3 Literature review

The CPS, a mandatory scheme funded by the employer and the employee through payment deductions made from payrolls, with automatic enrollment and other provisions encouraging retirement savings, has received more attention. MPP, on the other hand, is unique because employment is informal, participation is voluntary, income is low and irregular, and it has received little attention in the academic literature. Hence, (Ribe, Robalino, and Walker 2012; Peron, John, and Daniel 2013; Dullemen and Bruijn 2014; Agravat and Kaplelach 2017a; Kibona 2020; Nazarov et al. 2022) have shown how socioeconomic and demographic variables affect the enrollment and participation in schemes like MPP. However, these external factors cause people to consider their financial situation and make decisions in a particular way, so they often make the same savings decisions over and over (Jacobs-Lawson and Hershey 2005). This necessitates a new study to promote a better understanding of the factors leading to informal sector workers' enrollment and participation intention in MPP.

In recent times, retirement planning has gained increasing importance due to incorporating psychological insights into economics and finance to help explain decision-making, such as in long-term savings for retirement (Tomar et al. 2021). As a result, researchers are paying more attention to the psychological factors that affect the likelihood that households will plan, enrol, and participate in retirement plans. The literature suggests that these factors can influence retirement planning decisions (Jacobs-Lawson and Hershey 2005; Tomar et al. 2021; Peter and Ambilikumar 2021; Horák, Kukučková, and Dobeš 2022). For example, prior studies of (Alcala and Koshy 2007; Rutherford 2009; Dullemen and Bruijn 2015) examine familiarity bias, which occurs when households save in ways that they have previously or currently used (some of these are customary age-long contributory saving systems, such

as Adashe, Ajo, and Esusu in Nigeria).

However, this particular study on the MPP for individual households employed within the informal sector of the informal economy, in which we aim to examine why the low enrolment and participation, encompasses various unexplored aspects that have recently garnered attention from scholars (Griffin, Loe, and Hesketh 2012; Kimiyagahlam, Safari, and Mansori 2019; Magwegwea and Lim 2020). The behavioural constructs from TPB (Ajzen 1991) incorporating consumer financial education will aid our understanding of MPP enrolment and participation and thus require our investigation. By addressing the gaps in behavioural factors, we aim to offer new insight into the low enrolment and participation of the informal sector workers in the MPP in this study. Furthermore, a population gap is evident after reviewing earlier research (Griffin, Loe, and Hesketh 2012; Kimiyagahlam, Safari, and Mansori 2019; Magwegwea and Lim 2020). A gap exists in developing economies like Nigeria and MPP as a scheme that has received little attention. The distinct socio-economic context of the study population, a developing economy, necessitates the need for this study. The informal sector in Nigeria faces unique economic challenges, limited access to financial services, and inadequate social safety nets. This study provides insights into addressing specific needs and limitations of informal sector workers in developing economies, thus improving our understanding of retirement planning dynamics in various global contexts.

3.3.1 Conceptual framework

According to the TPB, behaviours are the result of intention, and intention is defined as "indicators of how hard an individual is willing to try to perform the behaviour." Thus, the individual's intention to engage in a specific behaviour is influenced by the individual attitudes toward the behaviour, perceived control over the behaviour, and the associated subjective norms. This individual's intention then affects the actual behaviour. The TPB assumes that behaviour is voluntary and can be measured using the theory's lens. Thus, TPB suggests that people are more likely to engage in a particular behaviour if they have a positive attitude towards it, feel social pressure to do it, and believe they have control over it.

The TPB is supported by empirical evidence in financial decision-making, where it has been used to measure investment intentions (Alleyne 2011), and mutual funds investors' behaviour in decision-making situations (Pellinen et al. 2015). This theory is also mobilised to understand the individuals' intention to invest in socially responsible investments like wind energy (Gamel et al. 2022), to predict customer intentions to apply for financial products and invest in the capital market (Cucinelli, Gandolfi, Soana, et al. 2017; Raut, Das, and Kumar 2018), to explain capital market investment interest (Setyorini and Indriasari 2020), and in the behavioural intention to adopt online financial trading (Sharif and Naghavi 2021).

(Griffin, Loe, and Hesketh 2012) highlight the significance of the TPB as a predictor of retirement planning; as a result, the use of the TPB in the literature on retirement planning is gradually increasing. Hence, (Van Dam, Vorst, and Heijden 2009) posits that employees' intentions to retire early are affected by their perceived work conditions and planned behaviour. The TPB describes the effect of subjective norms and financial advisor engagement on retirement planning (Kimiyaahlam, Safari, and Mansori 2019). The TPB has been used to explain the influences on the behavioural intention to purchase longevity annuities (Nosi et al. 2017) and to own an individual retirement account (IRA/Keogh)(Magwegwea and Lim 2020).¹

So, in the context of MPP, we mobilise the TPB, which suggests that attitudes, subjective norms, perceived behavioural control, and consumer financial education shape informal sector workers' intentions to enrol in and participate in MPP. Figure 2.1 illustrates the conceptual framework model.

¹IRA / Keogh is a tax-deferred retirement plan in the United States for self-employed individuals and employees of unincorporated businesses

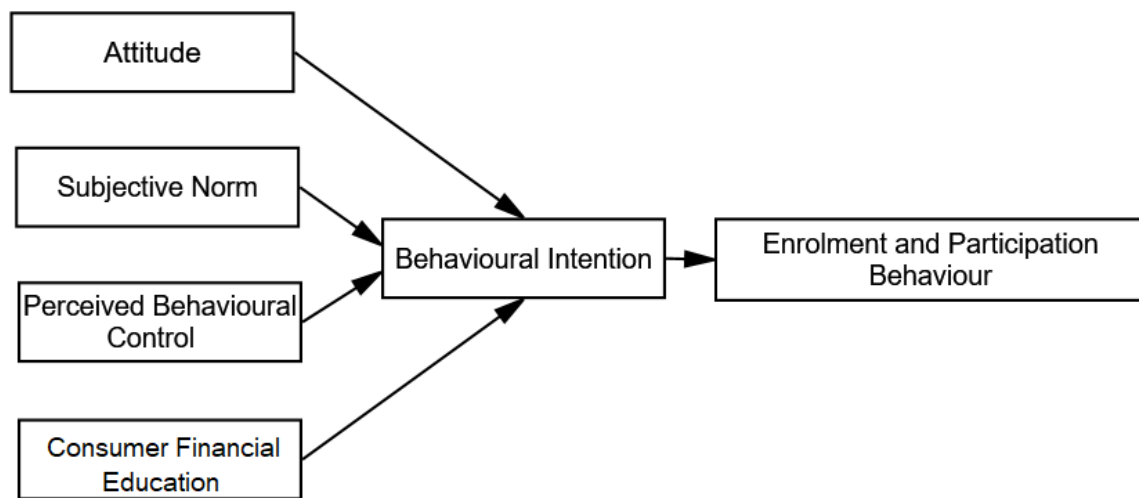


Figure 3.1: Conceptual framework

Attitude

According to the TPB, one's attitude is one's assessment of one's behaviour with its outcomes. This assessment begins with planning. (DeVaney, Anong, and Yang 2007) asserts that planning influences individual retirement decisions, which include plans to save and participate in a scheme like MPP. Hence, individual households' attitude towards long-term financial planning and investments can influence their decision to enrol in and participate in a scheme like MPP (Fisher and Montalto 2010). Those who value long-term financial security and are willing to commit to saving and investing for their future are more likely to see the benefits of enrolling in and participating in MPP. For such individuals, households understand the importance of planning for their future and are willing to make long-term financial commitments to achieve their goals financially. (Collins-Sowah, Kuwornu, and Tsegai 2013) use these as determinant factors and are thought to indicate a person's perspective on enrolling in and participating in pension plans like MPP. Therefore, those who decide to enrol in and participate in a plan like MPP are demonstrating either a positive or negative attitude towards long-term savings and investments to reach their future objectives. As a result, we hypothesise that;

H1. Attitude toward long-term savings and investment influences informal sector workers' intention to enrol in and participate in MPP.

Subjective Norm

Subjective norm, as defined in TPB, is the influence of the individual's perception of what others think they should do. It is a social pressure to perform or not perform the behaviour. It's both injunctive and descriptive. The injunctive norm is peer approval, while the descriptive norm is perceived peer behaviour.

Precedent research has established that peer effects (Duflo and Saez 2003; Zhao and Qu 2021), social norms (Beshears et al. 2015), and subjective norms (Magwegwea and Lim 2020) affect employees' savings plan participation decisions and decisions about how much to contribute to a retirement plan. Also, (Robertson-Rose 2020) find that parents can encourage their adult children to save for retirement and that family financial socialisation continues into adulthood. Hence, our second hypothesis, which is based on the descriptive norm and peer effect, is;

H2. Subjective norms influence an informal sector worker's intention to enrol in and participate in MPP.

Perceived behavioral Control

According to TPB, perceived behavioural control is the individuals' perception of their ability to perform the behaviour. Studies have shown that financial knowledge affects long-term savings (Jacobs-Lawson and Hershey 2005), is a deciding factor in the choice between a default life-cycle retirement plan and active management fund (Kristjanpoller and Olson 2015) and influences participation in retirement plans (Henager and Cude 2016). To that end, (Magwegwea and Lim 2020) assessed an individual's perceived behavioural control based on subjective financial knowledge and subjective financial management ability.

As a result, we incorporate the subjective financial management ability indicators into the latent variable of our perceived behavioural control. In light of these arguments, we propose a third hypothesis as follows,

H3. Perceived behavioural control influences an informal sector worker's intention to enrol in and participate in MPP.

Consumer Financial Education

In this context, many states continue to operate a defined benefit pension scheme, characterised by too frequent verification exercises, delayed or non-payment of pension entitlement, and misappropriation of pension funds, resulting in a low standard of living or high poverty incidence for most retirees. These retirees live, interact, and socialise with informal sector workers who know about their struggles and experiences. As a result of this experience, the pension system has a poor reputation. (Rudiawarni, Narsa, and Tjahjadi 2020) show that people tend to weigh negative information more heavily than positive information.

As such, we believe the retiree's experience will shape informal sector MPP enrollment and participation intention, leading to a potential bias and a vicarious-based trust. Past experiences and interactions with a financial services firm, as well as long-term priorities, influence financial decisions that affect the welfare of households in the short and long term (Petersen, Kushwaha, and Kumar 2015), hence the need for consumer financial education.

We refer to consumer financial education as the process of imparting knowledge to informal sector workers on financial products and services and their rights and responsibilities as consumers. When they have a good understanding of financial products and services, they will make informed decisions about their finances and be aware of their rights as consumers. They will also understand the terms of contracts, know how to handle dissatisfaction and know where to direct complaints. Additionally, the ability to compare different products and services and understand the benefits and drawbacks of each will show a high level of consumer financial education. Financial education training intervention has a statistically and economically significant effect on subjective and objective assessments of financial knowledge (Brugiavini et al. 2020). As a result, (El Mekkaoui and Legendre 2022) shows that understanding financial products such as pensions can help increase retirement savings.

Financial education has been shown to influence households' retirement planning and financial literacy (Clark et al. 2006; Barua, Koh, and Mitchell 2018), which leads us to propose the following fourth hypothesis:

H4.Consumer financial education influences an informal sector worker's intention to enrol in and participate in MPP.

Behavioral Intention

The TPB's theoretical framework combines attitude towards behaviour, subjective norms, and perceived behavioural control to forecast behavioural intention. This behavioural intention subsequently acts as a mediator in the relationship between attitudes, subjective norms, PBC, and actual behaviour. Based on the TPB, we define behavioural intention as the informal sector worker's plan or decision to perform a behaviour. It is the strongest predictor of actual behaviour in TPB. The behaviour itself is a direct result of the intention.

Prior studies (Mayer, Zick, and Marsden 2011; Zhu and Chou 2018; Magwegwea and Lim 2020) conducted in other contexts show that the decision to calculate retirement savings influences an individual's intent to enrol in retirement savings schemes. In this context, where illiteracy among informal sector workers is prevalent and financial literacy is low, calculating retirement needs is a complex task. As a result, a subjective method is considered to measure behavioural intention, which is a foundational step in the retirement planning process.

Using an informal sector worker decision regarding their future orientation, we assess their intent to enrol in and participate in MPP. The informal sector worker's response to the future orientation question measures their behavioural intention to enrol in and participate in MPP. Future orientation describes how households focus on the future compared to the present or past (Jacobs-Lawson and Hershey 2005).

The fundamental tenet of the concept of future orientation is about subjective perceptions of the future rather than foretelling it (Lens and Seginer 2015). The ability of informal sector workers to make sound financial decisions is affected by their outlook for the future and their concern for their future well-being.

According to previous research (Jacobs-Lawson and Hershey 2005; Kadoya and Khan 2020), household saving behaviours are likely to be influenced by future orientation. As a result, we believe that future orientation is an essential step in the retirement planning process. Hence, our fifth hypothesis is formulated as follows:

H5. The behavioural intention will mediate the relationship between attitudes, subjective norms, perceived behavioural control, and consumer financial education.

3.3.2 Data

We use survey data collected in 2021 by Enhancing Financial Innovation and Access (EFInA), a Financial Sector Deepening organisation in Nigeria (FSD) that promotes inclusive finance. They conducted 27,938 interviews (99% of the target sample of 28,380), which document the use of financial products in both the formal and informal sectors in urban and rural areas. Ipsos in Nigeria, a market research and consulting firm, carried out the household surveys and data collection from November 2020 to February 2021, with supervision from the Nigerian National Bureau of Statistics (NBS). The English questionnaire was translated and administered in Nigeria's four primary regional languages: Hausa, Yoruba, Igbo, and Pidgin English.

To achieve the study objectives, we subject the dataset to the domain analysis (by checking the column's data values for "invalid" values) of the informal sector, with particular attention to variables that influence MPP enrollment and participation. The datasets exclude minors as defined by the Nigerian constitution (anyone under the age of 18). We extracted data for households aged 18 and older (not more than 60 years old) who live in rented or owned housing, have a source of income (wage and self-employed), work in the informal sector, and are not dependent. We exclude observations with missing values. After excluding those who work in the formal sector, the 14,510 respondents in the sample form our datasets. Table 3.1 shows the descriptive statistics for the variables used in the study. The respondents' ages ranged from 18 to 60, with a mean of 39.28.

Of a total sample of 14,510 respondents, the study sample includes 4,937 (34%) women and 9,573 (66%) men. A total of 1,243 respondents (8.6%) knew what MPP meant. A total of

14,171 households (97.7%) do not participate in an MPP. The mean number of respondents who enrolled and participated in the MPP was 2%, indicating a low level of enrollment and participation.

The classification of the Nigerian educational system is 6-3-3-4 (primary - junior secondary school - senior secondary school - tertiary institution). According to ([Statista](#)), Nigerian adult literacy rate between 2018 and 2020, is 62.02 per cent. On average, respondents had more than three years of education, indicating they had just about primary school education. Low levels of education are thus a defining characteristic of the informal sector, and 75.6% of our respondents are currently in a union.

Table 3.1: Demographics of the respondents

| Variable | Observations | Percentage | Mean | Std.Dev |
|--|--------------|------------|-------|---------|
| Age (Years) | 14,510 | | 39.28 | 9.90 |
| 18 - 25 | 1,549 | 10.7 | | |
| 26 - 35 | 4,701 | 32.4 | | |
| 36 - 45 | 3,926 | 27.1 | | |
| 46 - 55 | 2,277 | 15.7 | | |
| 56+ | 2,057 | 14.2 | | |
| Level of schooling (LOS) | 14,510 | | 3.24 | 1.86 |
| Never attended school | 2,128 | 14.7 | | |
| Primary school | 2,652 | 18.3 | | |
| Junior Secondary School | 1,318 | 9.1 | | |
| Senior Secondary school | 5,372 | 37.0 | | |
| Tertiary Institution of Learning | 3,040 | 21.0 | | |
| Marital status (MS) | 14,510 | | | |
| Currently in a union | 10,972 | 75.6 | | |
| Formerly in a union | 1,507 | 10.4 | | |
| Single | 2,031 | 14.0 | | |
| Respondent gender (RG) | 14,510 | | | |
| Female | 4,937 | 34.0 | | |
| Male | 9,573 | 66.0 | | |
| Home ownership (HO) | 14,510 | | | |
| Own the House | 10,010 | 69.0 | | |
| Rent the House | 4,500 | 31.0 | | |
| Source of employment income (SOEI) | 14,510 | | | |
| Dependent | 1,214 | 8.1 | | |
| Formal source (Wage-employed) | 1,592 | 11.0 | | |
| Own Business (Self-employed) | 7,410 | 451.1 | | |
| Informal source (Wage-employed) | 1,285 | 8.9 | | |
| Farming (Self-employed) | 4,223 | 29.9 | | |
| Knowledge of MPP (KOMPP) | 14,510 | | 1.91 | 0.28 |
| Yes | 1,243 | 8.6 | | |
| No | 13,267 | 91.4 | | |
| enrolled and Participate in MPP (EPinMPP) | 14,510 | | 0.02 | 0.15 |
| Yes | 339 | 2.3 | | |
| No | 14,171 | 97.7 | | |

Authors' computation.

Table 3.2: Correlations among latent variables

| Latent variables | Mean | SD | Range | ATT | SN | PBC | CFE | INTENT | EandP |
|------------------|------|------|-------|-----------|-----------|-----------|----------|----------|-------|
| ATT | 2.09 | 0.58 | 2 | 1 | | | | | |
| SN | 3.27 | 0.97 | 4 | -0.060*** | 1 | | | | |
| PBC | 1.50 | 0.46 | 1 | 0.233*** | 0.051*** | 1 | | | |
| CFE | 3.47 | 0.91 | 4 | -0.208*** | 0.028*** | -0.138*** | 1 | | |
| INTENT | 0.03 | 0.15 | 1 | -0.049*** | -0.049*** | -0.035*** | 0.104*** | 1 | |
| EandP | 0.09 | 0.29 | 1 | -0.107*** | -0.022*** | -0.070*** | 0.170*** | 0.498*** | 1 |

This table shows the Pearson correlations between the latent variables. Composite scores were calculated and subsequently analysed for correlation statistics. We compared the respondent's mean score to the range of the latent variables. Attitude (ATT) mean score suggests respondents lean more towards "disagree" than "agree" with savings and long-term investments. The score indicates some degree of uncertainty. The results highlight a significant negative correlation between ATT, INTENT and EandP. Thus, an increase in ATT results in a decrease in both intention (INTENT) and actual enrolment and participation behaviour (EandP). Respondents tend to agree or mostly agree with the subjective norm (SN) statements on average based on the response scale range of 1 to 5 and the mean score of 3.27. An increase in the SN levels leads to a decrease in INTENT and EandP, as evidenced by a statistically significant negative correlation. The respondents generally agree with Perceived Behavioral Control (PBC) statements based on a mean score of 1.50. The composite score shows that most respondents lean towards the "yes" response, indicating their belief in their ability to control and manage their finances. The negative correlation suggests that as PBC increases, INTENT and EandP decrease. The scale ranges from 1 to 5, and a mean score of 3.47 indicates that respondents leaned towards Agree to Neutral for consumer financial education. There is a positive correlation between CFE and intention (INTENT). This correlation is statistically significant, meaning that as CFE increases, INTENT and EandP also increase. Legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

3.4 Results

3.4.1 Measurement model analysis

We perform the analysis with the Partial Least Squares Structural Equation Model (PLS-SEM)². We train and test our dataset to ensure that our model can learn from the data and find patterns to make accurate predictions on new data. Hence, by splitting the dataset into training (70%) and testing (30%) sets, we test the model's generalisation and ensure it is not just memorising the training data. The aforementioned is crucial for creating a model that can accurately predict behavioural intention and behaviour to enrol in and participate in MPP.

The measurement model is a requisite for structural equation modelling (SEM), which

²We used SEMinR and the lavaan package in R studio to perform the PLS-SEM analysis

connects measurement items to latent variables. The goal is to evaluate item loading on the defined construct (Ab Hamid, Sami, and Sidek 2017). Hereafter in the appendixes, we detail the statistical analysis used to ensure the measurement model's validity and reliability.

Measures

Scales based on prior literature (Ringle, Sarstedt, and Straub 2012; Sarstedt et al. 2014; Nosi et al. 2017; Magwegwea and Lim 2020; Gamel et al. 2022) and TPB (Ajzen 1991) applications were used to measure the latent variables. Bipolar and unipolar rating scales were used in this study to measure the latent variables of attitude, subjective norm, perceived behavioural control, and consumer financial education. To operationalize these variables, we used three-point Likert scales from 1 (agree) to 3 (disagree), 1 (always) to 3 (do not save/no) and five-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). Table 2.4 in the appendixes shows the measurement statements for the latent variables.

We employ a unipolar scale to show whether a respondent believes an attitude trait is present or absent. Here, we want to assess informal sector workers' attitudes towards long-term savings and investments' influence on intention to enrol in and participate in MPP and the behaviour as the outcome. Hence, we take an objective approach to assess long-term savings and investment considerations. Furthermore, the subjective norm item uses a bipolar Likert scale that allows us to measure both agreement and disagreement with the injunctive norm and the descriptive norm.

To assess perceived behavioural control, we use the two items of subjective financial knowledge and subjective financial management ability. The degree of agreement with the above constructs was measured using a unipolar Likert scale. Lastly, we use a bipolar Likert scale to measure the impact of consumer financial education on the behavioural intention to enrol in and participate in MPP.

Model fit

For the structural equation model fit, we assessed the Comparative-Fit-Index (CFI), Tucker-Lewis-Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized

Root Mean Square Residual (SRMR). The results are shown in Table 3.3. The CFI and the TLI are above the recommended level of 0.90, and the RMSEA and SRMR are below the cut-off value of 0.08 (Hair Jr et al. [2021a](#)).

3.4.2 Verification of hypothesis

Traditional parametric tests rely on distributional assumptions, which may not be appropriate in SEM; thus, bootstrapping that does not rely on these assumptions was used as an alternative. We test our hypotheses using bootstrapping without making distributional assumptions. A bootstrapping method with a significance level of 0.05 and a one-tailed test is used in the PLS-SEM (Benitez et al. [2020](#)). The results are presented in Table 3.3 hereafter and Fig.3.2 in the appendix, respectively.

Table 3.3: Structural model evaluation

| Relationships | Original Est. | Bootstrap Mean | Bootstrap SD | T Stat. | 2.5% CI | 97.5% CI |
|---------------------------------|----------------------|----------------------|--------------|---------|---------|----------|
| H1: ATT → intention | -0.041 | -0.041 | 0.011 | -3.853 | -0.062 | -0.021 |
| H2: SN → intention | -0.062 | -0.063 | 0.010 | -5.990 | -0.084 | -0.043 |
| H3: PBC → intention | -0.015 | -0.016 | 0.010 | -1.564 | -0.035 | 0.003 |
| H4: CFE → intention | 0.095 | 0.095 | 0.007 | 13.100 | 0.081 | 0.109 |
| H5: intention → behavior | 0.509 | 0.509 | 0.014 | 37.480 | 0.483 | 0.535 |
| ATT → intention | -0.041 | -0.041 | 0.011 | -3.853 | -0.062 | -0.021 |
| ATT → behavior | -0.021 | -0.021 | 0.005 | -3.793 | -0.032 | -0.010 |
| SN → intention | -0.062 | -0.063 | 0.010 | -5.990 | -0.084 | -0.043 |
| SN → behavior | -0.032 | -0.032 | 0.006 | -5.782 | -0.043 | -0.022 |
| PBC → intention | -0.015 | -0.016 | 0.010 | -1.564 | -0.035 | 0.003 |
| PBC → behavior | -0.008 | -0.008 | 0.005 | -1.558 | -0.018 | 0.002 |
| CFE → intention | 0.095 | 0.095 | 0.007 | 13.100 | 0.081 | 0.109 |
| CFE → behavior | 0.048 | 0.048 | 0.004 | 11.305 | 0.040 | 0.057 |
| intention → behavior | 0.509 | 0.509 | 0.014 | 37.480 | 0.483 | 0.535 |
| Endogenous variable | R² | Q² | | | | |
| Intention | 0.017 | 0.007 | | | | |
| enrollment and Participation | 0.259 | 0.009 | | | | |
| Overall fit of the model | Value | | | | | |
| SRMR | 0.024 | | | | | |
| CFI | 0.982 | | | | | |
| TLI | 0.968 | | | | | |
| RMSEA | 0.039 [0.036, 0.043] | | | | | |
| Cohen's effect size | f² | | | | | |
| ATT → Intention (H1) | 0.002 | | | | | |
| SN → Intention (H2) | 0.004 | | | | | |
| PBC → Intention (H3) | 0.000 | | | | | |
| CFE → Intention (H4) | 0.009 | | | | | |
| Intention → behavior (H5) | 0.350 | | | | | |

The table reports the path coefficient of attitude (ATT), subjective norm (SN), perceived behavioural control (PBC) and consumer financial education (CFE) to intention.

The estimated path coefficient of attitude towards long-term savings and investments to intention to enrol and participate in MPP is (-0.041), with a bootstrap mean of (-0.041) and a bootstrap standard deviation of 0.011. The t-statistic for this path is (-3.853), indicating a significant negative relationship between this attitude and intention. The limit of

the confidence intervals are (-0.062) and (-0.021) at 2.5% and 97.5%, respectively. Cohen's effect size f^2 for the relationship between attitude and intention is 0.002, indicating a small effect size. Hence, our results did not support the hypothesis that "Attitude towards long-term savings and investment influences informal sector workers' intention to enrol in and participate in MPP".

According to the findings of the relationship between subjective norm and intention to enrol and participate in MPP, there is a significant negative relationship, with an original estimate of $-0.062(t = -5.990, p < 0.05)$, indicating that as subjective norm decreases, the intention to enrol in and participate in MPP decreases. The bootstrap means of the path coefficient is (-0.063) , with a standard deviation of (0.010) . The 95% confidence interval for the path coefficient is between $(-0.084$ and $-0.043)$. Cohen's effect size f^2 for the model is (0.004) , demonstrating that subjective norm accounts for a small proportion of the variance in the behavioural intention to enrol in and participate in MPP. Our findings did not support the hypothesis that "Subjective norms influence informal sector workers' intentions to enrol in and participate in MPP".

The estimate for the path coefficient of the perceived behavioural control and the behavioural intention to enrol in and participate in MPP is -0.015 , indicating a negative association. The mean and standard deviation of the path coefficient is -0.016 ($SD = 0.010$). The t-statistic for the path coefficient is -1.564 , which is not significant at the $p < 0.05$ level. The 95% confidence interval for the path coefficient ranges from -0.035 to 0.003 , indicating that the path coefficient is not significantly different from zero. The Cohen's effect size f^2 value for the relationship is 0.000 , indicating that perceived behavioural control accounts for a very small proportion of the variance in behavioural intention to enrol in and participate in MPP. Based on our findings, "Perceived behavioural control does not influence an informal sector worker's intention to enrol in and participate in MPP".

The original estimate of the path coefficient between the consumer financial education and behavioural intention to enrol in and participate in MPP is 0.095 , with a bootstrap mean of 0.095 and a bootstrap standard deviation of 0.007 . The t-statistic is 13.100 , indicating a positive significant relationship between the financial education of the informal sector worker consumer and the behavioural intention to enrol in and participate in MPP. The 95%

confidence interval for the path coefficient ranges from 0.081 to 0.109. The Cohen's effect size f^2 value is 0.009, indicating that consumer financial education explains 0.9% of the variance in the behavioural intention to enrol in and participate in MPP. Our findings have shown that consumer financial education influences an informal sector worker's intent to enrol in and participate in MPP.

The estimate for the relationship path between intention and behaviour toward enrollment and participation is 0.509. The bootstrap analysis yields a mean estimate of 0.509 with a standard deviation of 0.014. The t-statistic is 37.480, indicating a positive significant relationship between the behavioural intention and actual behaviour to enrol in and participate in MPP ($p < 0.001$). The 95% confidence interval ranges from 0.483 to 0.535. The effect size is large, with a Cohen's effect size f^2 of 0.350. Our results have shown that intention is positively associated with the behaviour of enrollment in and participation in MPP.

3.5 Discussion and conclusion

MPP is a platform for informal sector households to save for retirement and improve their financial security in old age. MPP aligns with the United Nations' sustainable development goal of eradicating poverty and improving the standard of living everywhere and for everyone. Given the importance of MPP in promoting financial inclusion and stability for informal sector workers in an informal economy, it is necessary to understand the factors influencing an individual's intentions to enrol in and actively participate in MPP. Previous studies did not consider the relationship between individual behavioural differences or consumer financial education and its influence on enrollment and participation in schemes like MPP. This study aimed to fill this gap by testing a model based on the theory of planned behaviour (Ajzen 1991), including consumer financial education.

3.5.1 Predictors of intention to enrol and participate in MPP

The study's results show a negative, but statistically significant relationship between attitude, subjective norm, and the intention to enrol in and participate in MPP. The results indicate that households in the informal sector in this informal economy are less likely to

enrol in or participate in MPP because they have a negative attitude towards long-term savings and investments. Thus, indicating limited interest or awareness in the informal sector regarding the benefits or importance of MPP. Our results support the findings of (Collins-Sowah, Kuwornu, and Tsegai 2013), which show that savings and investment decisions have a negative impact on willingness to participate in a micro pension scheme. Thus, it is a long-held belief among many informal sector workers in this informal economy that they should invest in buying property, equipment, or livestock or save towards the realisation of the previously mentioned assets. This leads to familiarity bias toward the behaviour to enrol in and participate in MPP, which aims to provide more benefits or complement these traditionally held beliefs, which is unfortunately not embraced by the informal sector workers.

While (Zhao and Qu 2021) demonstrates that low-income households' pension scheme participation decisions and contribution levels are significantly influenced by the choices and characteristics of their peers, their study shows no evidence of significant peer effects on participation intention. The subjective norm from our study, which is based on the descriptive norm and the peer effect, decreases the intentions of informal sector workers to enrol in and participate in MPP in this informal economy. This shows that the opinions, influence, or impacts of others, such as friends, family, or colleagues, do not contribute positively to the intention to enrol and participate in MPP. Consequently, the results suggest that societal expectations may not align with deliberate financial choices made for retirement planning among the informal sector workers.

Furthermore, our study did not provide evidence for a significant relationship between the perceived behavioural control of the informal sector workers and the behavioural intention to enrol in and participate in MPP in this informal economy. In contrast to prior findings (Magwegwea and Lim 2020), our results show that using subjective financial management skills as a proxy for perceived behavioural control does not affect the behavioural intention of informal sector workers to enrol in and participate in MPP.

To our conceptual model, we added consumer financial education to the TPB's constructs to assess informal sector workers' intentions to enrol in and participate in the MPP. This is essential because it supports the idea that consumer financial education should fo-

cus on improving financial knowledge and confidence (Fernandes, Lynch Jr, and Netemeyer 2014). Our findings strongly support the inclusion of this predictor. The analysis revealed a significant positive relationship between the consumer financial education of the informal sector worker and behavioural intention to enrol in and participate in MPP, indicating that as consumer financial education increased, behavioural intention also increased. Furthermore, the study results demonstrate a statistically significant positive relationship between workers' intentions to enrol in and participate in the MPP and their behaviour to enrol in and participate in the MPP.

Our results are consistent with those of earlier studies on other aspects of financial behaviours, even though no prior investigations have specifically examined the impact of consumer financial education on behavioural intention to enrol in and participate in a retirement scheme like MPP. For instance, according to (Magwegwea and Lim 2020), employed households have more financial responsibilities, such as the need to save for retirement, which has increased their interest in financial education and financial behaviours. This has caused them to sign up for schemes like IRA/Keogh. Subjective financial knowledge affects financial behaviours, such as determining retirement savings needs and IRA/Keogh ownership (Mayer, Zick, and Marsden 2011; Magwegwea and Lim 2020). Increased long-term savings and better investment behaviour are linked to financial education (Atkinson et al. 2015).

Lastly, intention exerts a significant amount of influence over the actualization of behaviour (Ajzen 1991). Our results, in conformity to TPB, imply that behavioural intention is a strong predictor of behaviour to enrol in and participate in MPP and that any behavioural intention changes are likely to significantly impact the behaviour to enrol in and participate in MPP.

These findings enable us to make two conclusions. First, the perceived social behaviour commonly practised in the informal economy is to invest by purchasing (property, equipment, or livestock) or save to acquire these instruments, thus reflecting the broad consensus among workers in the informal sector about what is appropriate in this economy. Because they have the same financial situation, they work and earn their living the same way as everyone else in their social group; the peer effect from this group drives social compar-

ison, conformity, and social learning. As a result, these factors influence their attitudes, behaviours, and financial decisions. This effect can be positive or negative, which means that if everyone believes in long-term savings with commitment and investment to buy property, equipment, and livestock, it will be difficult for an individual worker to do otherwise. Also, social pressure to conform, as seen in herding behaviour (Baddeley 2010), makes an individual informal sector worker want to be accepted, which means acting the same way as others (i.e. buying property, equipment, and/or livestock).

Second, since our research shows that attitude (towards long-term savings and investment) and subjective norms (descriptive norm and the peer effect) have a significant and negative influence on the intention to enrol in and participate in MPP, consumer financial education can help workers in the informal sector understand the advantages of long-term savings in MPP and investing for retirement through MPP. Consumer financial education can deepen the informal sector workers' understanding of MPP and the significance of beginning to save and invest early in life, as well as the advantages of regular contributions and the power of compound interest. This knowledge can motivate informal sector workers to take action by enrolling in and participating in MPP by making regular contributions based on their source of income.

3.5.2 Limitations of the current study

Further research into MPP enrollment and participation would be beneficial to increase the enrollment rate. The following are some limitations of this study. To begin with, our latent variables were operationalised with fewer than five items, unlike in (Ajzen 2006), which recommends using five to six items for each theory construct. However, previous studies (Nosi et al. 2017; Magwegwea and Lim 2020; Gamel et al. 2022) have shown that TPB constructs can be operationalised with fewer items. Future research can increase the construct items to determine the model's predictive power and the constructs' significance.

In addition, future orientation is a psychological trait that evolves in households. Our dataset only contains one item on a respondent's outlook toward future uncertainty, which we used to determine if a person's future orientation is a factor for the behavioural intention

to enrol in and participate in the MPP; future research may add to this constraint.

Furthermore, the findings of this study indicate the necessity of additional investigation to examine the reasons behind the negative relationship between attitude, subjective norm, and behavioural intention to enrol and participate in MPP and its potential variation among diverse demographic or psychographic groups. Conducting qualitative research or follow-up surveys might reveal the underlying factors contributing to this negative relationship.

Our findings, which we hope will contribute to a better understanding of the constructs of attitude, subjective norm, and consumer financial education, as well as their impact on enrolment and participation in MPP by informal sector workers, should not be significantly impacted by these limitations. By contributing to a deeper understanding of these constructs, our research holds the potential to inform and shape future studies in this field. Like other cross-sectional studies, causality was not concluded, so further research should consider using instrumental variables for causality tests.

3.5.3 Recommendation

Highlighting the importance of MPP through education and marketing is underscored by our findings. Raising awareness and sharing information about the advantages of MPP should be a top concern for PENCOM, PFA, and policymakers, as it can potentially positively impact attitudes and intentions.

According to (Tajfel 1979), groups provide individuals with a sense of social identity (belonging to the social world) and a source of pride and self-esteem (as cited in McLeod 2008). As a result, workers in the informal sector are members of organizations such as the National Union of Road Transport Workers - NURTW or the Market Traders' Association of Nigeria - MATAN. They adopt the identity of the group to which they have assigned themselves. Their identification with such a group will have emotional significance, and their self-esteem will become inextricably linked with group membership.

Because MPP is a new concept, there may be some scepticism. Hence, we recommend that PFA use the agency model (Manohar 2009), in which the PFA agent uses its normal agency office and sells MPP directly to informal sector workers, or the micro agent model,

in which PFAs appoint an agent who is a member of a small reference group (e.g., Ìyál'ò jà)³. She will be responsible for persuading the members of her group to participate in the scheme. In exchange for her efforts, she will receive a commission based on how many new members she can sign up for the program.

3.6 Appendix

The amounts are in Nigerian currency, Naira (₦). At the time of the survey, the average exchange rate was 1 USD to ₦385.72. Seniors' population share will double from 10% to 20% by 2050. And 80% of the world's elderly (1.3 billion) will live in low-income countries ([WorldBank](#)). However, less than one-third of people in these countries have a guaranteed retirement income.

MPPs are easily accessible in Nigeria, but many in the informal sector do not know. Nigerians can readily find reliable information about these programs and their potential benefits from PFAs. The government, through PENCOM, has invested in awareness campaigns to ensure that informal sector workers are informed. The enrolling process in MPPs may seem complicated to many workers, with difficulties in accessing local service points and navigating bureaucratic hurdles and paperwork. This is crucial, as many workers in the informal sector may not have prior experience in dealing with formal institutions.

3.6.1 Measurement model

Collinearity

When two or more indicators in a formative measurement model are highly correlated, this is referred to as collinearity (Hair Jr et al. [2021b](#)). To evaluate collinearity, we examine the tolerance and the Variance Inflation Factor (VIF), two collinearity diagnostic parameters that can aid in detecting collinearity. Table 3.4 reveals that the VIF values for the composite model indicators vary from 1.304 to 2.268 and are less than 5 (Daoud [2017](#)), indicating that collinearity will not be an issue in the structural equation model. The tolerance values are

³"pronounced e-yah-lo-ja"- a Yoruba word that means "mother of the market" - a women's leader in south-western Nigeria

all greater than 0.2, thus showing low collinearity (Weisburd and Britt 2014).

Table 3.4: Statements for measuring the latent variables and collinearity test

| Designation | Statement | Tolerance | VIF |
|-------------|---|-----------|-------|
| ATT1 | Do you save or keep the money for different reasons? | 0.735 | 1.361 |
| ATT2 | Do you invest money in assets (buying properties, equipment, livestock or stock market instruments, etc. to generate future cash flow or profit)? | 0.768 | 1.301 |
| SN1 | Most of your family, friends, and neighbours are in a similar financial situation as you are | 0.637 | 1.570 |
| SN2 | Most of your family, friends, and neighbours work/earn their livelihood in the same way you do | 0.634 | 1.578 |
| PBC1 | Do you know how much money you spent personally in the last 7 days? | 0.507 | 1.973 |
| PBC2 | Do you keep track of the money you get and spend? | 0.505 | 1.982 |
| CFE1 | When you buy financial products or services you compare different options and then choose the best one that suits your needs: | 0.538 | 1.857 |
| CFE2 | You know what to do for recourse when not satisfied with a financial service or product | 0.457 | 2.186 |
| CFE3 | You are confident enough to make a complaint against a bank or financial institution if you are not satisfied with the service or product offered | 0.578 | 1.731 |

¹ Acronym: ATT: Attitude, SN: Subjective norm, PBC: Perceived behavioural control and CFE: Consumer financial education.

² VIF: Variance Inflation Factor.

3.6.2 Indicator reliability

We examine how much variance each indicator's construct (ATT, SN, PBC, and CFE) explains, which measures indicator reliability (Hair Jr et al. 2021b). Our results are presented in Table 3.5 for the indicator loading as well as the indicator reliability. The indicator loading of the reflectively measured constructs is significantly higher than the threshold value of 0.708 (Hair, Sarstedt, and Ringle 2019; Hair Jr et al. 2021b; Hair Jr et al. 2021a), indicating

significant levels of indicator reliability. With a value of $0.559(0.748^2)$, the indicator ATT2 with loading (0.748) has the smallest indicator-explained variance. While the indicator SN2 with loading (0.940) has the highest explained variance, with a value of $0.883(= 0.940^2)$ - both values are well above the threshold value of 0.5 (Hair, Sarstedt, and Ringle 2019; Hair Jr et al. 2021b). As a result, the constructs are all reliable.

Table 3.5: Measurement items and their reliability

| Indicator | Cronbach's alpha | ρ_A | ρ_C | AVE | indicator loading | indicator reliability |
|------------------------------|------------------|----------|----------|-------|-------------------|-----------------------|
| Attitude | 0.629 | 0.792 | 0.832 | 0.715 | | |
| ATT1 | | | | | 0.933 | 0.871 |
| ATT2 | | | | | 0.748 | 0.559 |
| Subjective norm | 0.748 | 0.868 | 0.883 | 0.791 | | |
| SN1 | | | | | 0.835 | 0.698 |
| SN2 | | | | | 0.940 | 0.883 |
| Perceived behavioral control | 0.825 | 0.834 | 0.919 | 0.851 | | |
| PBC1 | | | | | 0.912 | 0.833 |
| PBC2 | | | | | 0.932 | 0.869 |
| Consumer financial education | 0.819 | 0.827 | 0.892 | 0.733 | | |
| CFE1 | | | | | 0.826 | 0.683 |
| CFE2 | | | | | 0.885 | 0.784 |
| CFE3 | | | | | 0.856 | 0.733 |

Notes: ρ_A and ρ_C are the composite reliability A and C respectively, and AVE is the average variance extracted.

3.6.3 Internal consistency reliability

The degree to which indicators measuring the same construct are related to one another is known as internal consistency reliability (Hair Jr et al. 2021b). One of the primary measures used in PLS-SEM is Jöreskog's composite reliability (ρ_C) (Hair Jr et al. 2021b). All construct measures are reliable, according to the composite reliability (ρ_C) (0.832 for ATT, 0.883 for SN, 0.919 for PBC, and 0.892 for CFE), which is above the 0.70 cutoffs (Hair 2009; Hair Jr et al. 2021b). The results are presented in Table 3.5.

Cronbach's alpha, an acceptable lower-bound approximation of true internal consistency reliability, is the second measure of internal consistency reliability (Trizano-Hermosilla and Alvarado 2016; Hair Jr et al. 2021b). The results for Cronbach's alpha show that ATT

has an acceptable level of reliability of 0.629, SN has a good level of reliability of 0.748, and PBC and CFE have excellent reliability of 0.825 and 0.819, respectively (Ursachi, Horodnic, and Zait 2015). Cronbach's alpha assumes that all indicator loadings in the population are the same (also known as tau-equivalence), which is a significant limitation as highlighted in (Hair Jr et al. 2021b). According to (Hair Jr et al. 2021b), Cronbach's alpha is conservative, composite reliability (ρ_C) may be too liberal, and the construct's true reliability falls between these two extreme values. Therefore, an acceptable middle ground between the conservative Cronbach's alpha and the liberal composite reliability is the reliability coefficient (ρ_A) (Dijkstra 2009; Dijkstra 2014; Dijkstra and Henseler 2015; Hair Jr et al. 2021b). While ATT has a good level of internal consistency, all other reflectively measured constructs have high levels of internal consistency reliability, with (ρ_A) values of 0.792 for ATT, 0.868 for SN, 0.834 for PBC, and 0.827 for CFE.

3.6.4 Convergent Validity

Convergent validity is a measure of how well a concept can explain the differences between its indicators (Hair Jr et al. 2021b). It is equal to the commonality of a construct and is the average variance extracted (AVE) for all indicators on each construct. (Ab Hamid, Sami, and Sidek 2017; Hair Jr et al. 2021a) assert that an AVE of 0.50 or higher means that the construct explains at least 50% of the difference between the indicators that make up the construct. Table 3.5. shows that all average variance extracted (AVE) values are significantly higher than the required minimum level of 0.50, indicating a high level of convergence validity.

3.6.5 Discriminant validity

To test discriminant validity, we use the Heterotrait-monotrait (HTMT) ratio of correlation to measure the extent to which the constructs differ from one another empirically. Thus, discriminant validity assesses the degree to which the overlapping constructs differ (Ab Hamid, Sami, and Sidek 2017; Hair Jr et al. 2021a). Using the alpha argument, we set the significance level to 0.10 and the bootstrap sub-samples to 10,000. We obtain two-sided bootstrap confidence intervals for the HTMT values.

Table 3.6. summarises our findings. The upper boundaries of the confidence intervals are all less than the HTMT < 0.90 threshold value (Henseler, Ringle, and Sarstedt 2015; Ab Hamid, Sami, and Sidek 2017; Hair Jr et al. 2021a). As a result, discriminant validity between the constructs based on the HTMT has been established.

Table 3.6: Discriminant validity: The Heterotrait-Monotrait ratio of correlations (HTMT)

| Relationship | Original Est. | Bootstrap Mean | Bootstrap SD | T Stat. | 5% CI | 95% CI |
|------------------------|---------------|----------------|--------------|---------|-------|--------|
| ATT – > SN | 0.106 | 0.108 | 0.012 | 8.662 | 0.090 | 0.130 |
| ATT – > PBC | 0.315 | 0.315 | 0.013 | 24.328 | 0.294 | 0.336 |
| ATT – > CFE | 0.288 | 0.287 | 0.013 | 21.663 | 0.266 | 0.309 |
| ATT – > intention | 0.073 | 0.073 | 0.013 | 5.593 | 0.051 | 0.095 |
| ATT – > behavior | 0.134 | 0.134 | 0.012 | 11.288 | 0.115 | 0.154 |
| SN – > PBC | 0.075 | 0.075 | 0.012 | 6.028 | 0.055 | 0.095 |
| SN – > CFE | 0.041 | 0.043 | 0.009 | 4.786 | 0.030 | 0.058 |
| SN – > intention | 0.064 | 0.064 | 0.013 | 4.950 | 0.042 | 0.085 |
| SN – > behavior | 0.032 | 0.033 | 0.011 | 3.063 | 0.018 | 0.052 |
| PBC – > CFE | 0.162 | 0.162 | 0.012 | 13.708 | 0.142 | 0.182 |
| PBC – > intention | 0.037 | 0.037 | 0.011 | 3.427 | 0.019 | 0.055 |
| PBC – > behavior | 0.069 | 0.069 | 0.011 | 6.355 | 0.051 | 0.086 |
| CFE – > intention | 0.115 | 0.115 | 0.008 | 14.712 | 0.102 | 0.127 |
| CFE – > behavior | 0.188 | 0.188 | 0.008 | 23.186 | 0.175 | 0.202 |
| intention – > behavior | 0.509 | 0.509 | 0.014 | 36.921 | 0.486 | 0.532 |

HTMT < 0.90

3.6.6 Measures of formative latent variables: Weights

This section focuses on the statistical significance and importance of indicator weights in formative measured constructs. Indicator weights result from regressing each formatively measured construct on its associated indicators (Hair Jr et al. 2021b). We present the results in Table 3.7, which includes confidence intervals used for significance testing. The findings demonstrate a significant effect because none of the confidence intervals for the estimated coefficients includes zero. Additionally, the t-values of these indicators are greater than 1.960, further supporting their statistical significance.

Table 3.7: Measures of formative latent variables; Weights

| Relationship | Original Est. | Bootstrap Mean | Bootstrap SD | T Stat. | 2.5% CI | 97.5% CI |
|-----------------------|---------------|----------------|--------------|---------|---------|----------|
| ATT1 – > ATT | 0.748 | 0.751 | 0.063 | 11.808 | 0.634 | 0.885 |
| ATT2 – > ATT | 0.404 | 0.396 | 0.082 | 4.930 | 0.211 | 0.535 |
| SN1 – > SN | 0.426 | 0.419 | 0.068 | 6.255 | 0.265 | 0.532 |
| SN2 – > SN | 0.686 | 0.690 | 0.059 | 11.601 | 0.586 | 0.820 |
| PBC2 – > PBC | 0.508 | 0.503 | 0.082 | 6.180 | 0.329 | 0.644 |
| PBC3 – > PBC | 0.575 | 0.578 | 0.081 | 7.133 | 0.437 | 0.742 |
| FCE1 – > CFE | 0.345 | 0.344 | 0.018 | 18.883 | 0.307 | 0.379 |
| FCE2 – > CFE | 0.394 | 0.394 | 0.017 | 23.552 | 0.360 | 0.427 |
| FCE3 – > CFE | 0.427 | 0.428 | 0.021 | 20.521 | 0.388 | 0.469 |
| INTENT1 – > intention | 1.000 | 1.000 | 0.000 | - | 1.000 | 1.000 |
| EandP1 – > behavior | 1.000 | 1.000 | 0.000 | - | 1.000 | 1.000 |

3.7 The estimated structural equation model results

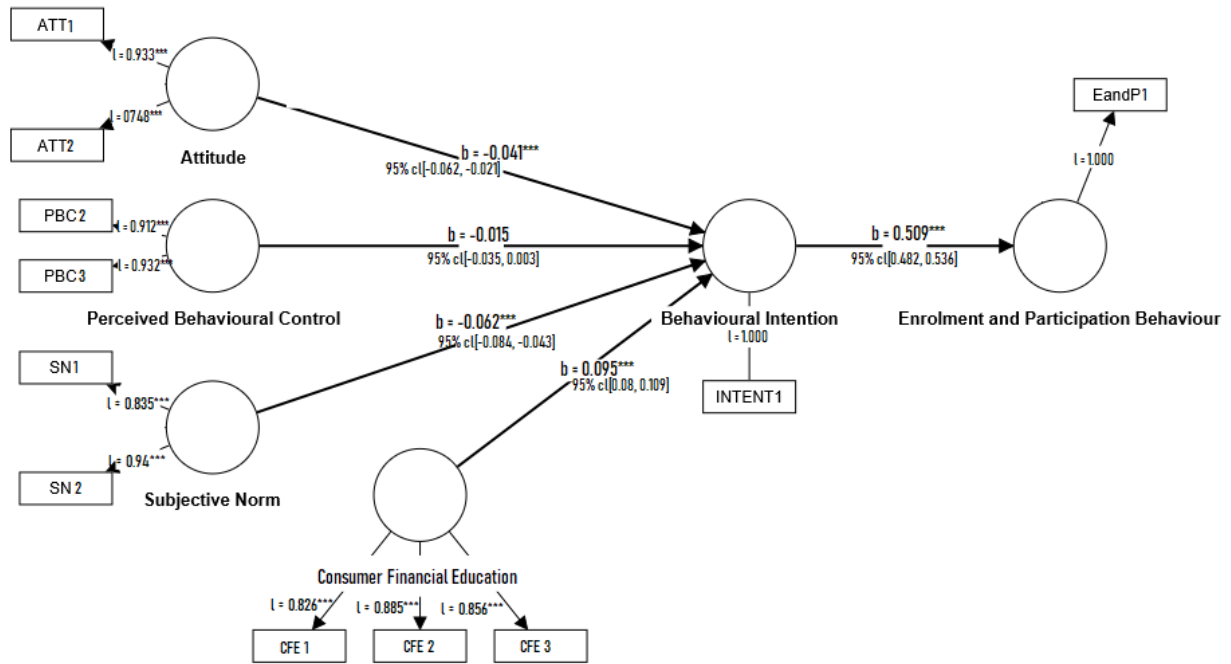


Figure 3.2: The estimated structural equation model.

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. SEM - fit:

$$\chi^2(45) = 22258.001, CFI = 0.982, TLI = 0.968, RMSEA = 0.039, SRMR = 0.024.$$

FUNDING AND CONTRIBUTIONS

"Without much effort, a tree may still grow and mature; however, with a little more attention and care, that same tree may blossom into something magnificent". The aforementioned statement remains accurate in regard to accumulating funds for the purpose of future financial security.

– I.B.Petosa

In this section, we delve into the critical question: What happens to the retirement savings account (RSA) balance of a contributory pension scheme (CPS) when contributions are remitted partially or non-remitted during various accumulation phases? Our analysis focuses on understanding the differences in contribution remittances and their impact on the accumulated RSA balance within a CPS model. We introduce a counterfactual scenario that incorporates partial and non-remittances of contributions through adjustments in contribution rate parameters. Utilising Nigerian data, we analyse how these variations in funding scenarios affect the final RSA balance. Our findings show that non-remittance of contributions and partial contribution remittances provide less retirement income in the RSA than the statutory contributory rate. These findings highlight a significant reduction in retirement income when pension contributions are not remitted on time, underscoring the critical importance of timely remittances in securing retirees' financial futures.

Keywords: Pension funding, contribution rates, retirement savings account, accumulation, underfunding, lifestyle investment.

JEL Classification: C14, G22, G23, H55, J26, J32

4.1 Introduction

Pension benefits represent the only source of income for many retired households. Ex-ante financing in a defined contributory pension scheme (*hereafter* CPS) requires workers to accumulate pension fund savings in a retirement savings account (*hereafter* RSA) using a statutory contribution rate (*hereafter* SCR). To maintain a healthy fund situation, as the benefits are not guaranteed, the fund must receive appropriate contributions from scheme participants. Thus, the fund's adequacy depends on consistent efforts to remit contributions over time plus capital growth in real terms.

Extant literature (e.g. Bernal and Olivera 2020; Salonen, Koskinen, and Nummi 2020; Babat, Gultekin-Karakas, and Hisarciklilar 2021) on pension funding at the household level identified some behavioural differences in saving ability and risk preferences among participants, which they associated with reluctance to make pension contributions. Also, many household plans are unrelated to retirement savings decisions (Blake, Cairns, and Dowd 2009, James, Price, and Buffel 2020), further exacerbating the issue. Young potential scheme participants' disinterest in retirement planning and the absence of clear retirement goals within some schemes can also undermine RSA contributions and pension funding (Blake, Cairns, and Dowd 2009, Babat, Gultekin-Karakas, and Hisarciklilar 2021).

On the macroeconomy level, fiscal and financial crises and the performance of both local and global economies have been identified as critical elements affecting contribution density and funding gaps (Whitehouse 2009, D'Addio and Whitehouse 2010 Nwachukwu and Odigie 2011, Aisen and Veiga 2013, Bielawska, Chłoń-Domińczak, and Stańko 2017). At the firm level, the amount of contributions has a notable impact on the participation of employers. Higher rates place a more substantial responsibility on businesses, while lower rates promote participation (Han and Meng 2019). Additionally, participation, contribution, and retirement savings rates are positively associated with compensation (Huberman,

Iyengar, and Jiang 2007, Han and Meng 2019), suggesting that higher incomes lead to increased remittances and RSA funding frequency. Other studies (e.g. Valdés-Prieto 2008, Thom and Randazzo 2015, Liu, Mikesell, and Moldogaziev 2021) have underscored the role of corruption and political reluctance in enforcing SCR across various industries and sectors. Lastly, a recent line of studies (e.g. Alfaro et al. 2020, Glossner et al. 2020, Li and Mutchler 2021, Natali 2020, Ataullah, Le, and Wood 2022) has investigated the impact of the COVID-19 pandemic on RSA funding. These studies have all demonstrated that the pandemic resulted in a global economic shutdown, leading to business closures, cyclical unemployment, and interrupted contributions to scheme participants' RSAs. Lockdown measures forced businesses to furlough employees or reduce working hours, resulting in wage losses and non-remittance of pension fund contributions.

Although these posited factors are responsible for the contribution density and funding gaps, there is little empirical evidence to evaluate the impact of these funding scenarios on RSA's final balance. Hence, this study seeks to fill the gap by examining the unexplored aspects concerning the impacts of partial or non-remittance of pension contributions into the RSA, which has recently gained research attention (Van Dalen, Henkens, and Hershey 2010; Statman 2013; Reyers 2018; Sharpe 2021; Tomar, Kumar, and Sureka 2021; Gallego-Losada et al. 2022; Owusu, Onumah, and Essel-Donkor 2023). We aim to examine the impact on the balance standing in an RSA if contribution rates were partially or not remitted during the accumulation phase in the mandatory CPS in Nigeria, a lower-middle-income economy.

To achieve our objective, we propose the implementation of a counterfactual scenario. This approach takes into account both partial remittance and non-remittance through the utilisation of contribution rate parameters. Our methodology employs the 2019 consolidated Nigerian universities' academic staff salaries (CONUASS) and real rates of return derived from historical security data variables to determine the accumulated balance in the RSA. With this goal in mind, this study examines the impact of this funding scenario using a lifestyle investment strategy from the scheme participant's position. In the current lifestyle investment strategy, we designate the maximum variable income security with the minimum fixed income securities in the fund structure (I, II and III) as strategy A. Conversely, the minimum variable income securities with the maximum fixed income security in the

fund structure (I, II and III) as strategy B. This Fund structure which aims to align RSA holders' age and risk profile by dividing the RSA Fund into three active Fund types (I, II and III). Participants can choose Fund I by writing a formal request to the PFA. Fund II is the default fund for participants aged 49 and below. Fund III is the default fund for participants aged 50 and above. By considering the differences in funding scenarios and their impact on the final accumulated balance in RSA from this lifestyle investment strategy, we are able to offer a unique perspective on this issue.

Our study presents two noteworthy empirical observations. Firstly, our investigation shows that for strategy A, the partial remittance of participant contributions from the treasury to the end of CONUASS 01 level into the RSA has a notable positive impact on the accumulated balance standing in the CPS RSA at the 25th, 50th, 75th, and 99th percentile levels. Also, partial remittance of treasury contributions to the CONUASS 02 level into RSA positively impacts the CPS RSA balance at the 25th percentile. The non-remittance of contributions from the treasury to the end of CONUASS 02 level into the RSA negatively impacts the accumulated balance standing in the CPS RSA at the 25th, 50th, 75th, and 99th percentile levels.

Secondly, our analysis implementing strategy B shows that when there is partial remittance of participant contributions from the treasury to the end of the CONUASS 01 level into the RSA. This action positively impacts the accumulated balance standing in the CPS RSA at the 25th, 50th, 75th, and 99th percentile levels. Additionally, partial remittance of treasury contributions to the CONUASS 02 level into RSA positively impacts the CPS RSA balance at the 25th and 50th percentile levels. On the other hand, the non-remittance of treasury contributions to the CONUASS 01 level into RSA has a negative impact on the CPS RSA balance at the 25th percentile level. Similarly, the non-remittance of contributions from the treasury to the end of CONUASS 02 level into the RSA negatively impacts the accumulated balance standing in the CPS RSA at the 25th, 50th, 75th, and 99th percentile levels. This signifies that partial remittance of pension contributions in an RSA increases the RSA balance more than in an account with non-remittance of pension contributions. The RSA balance of the partial remittance remains lower than the RSA with SCR-funded, whereas non-remittance decreases the RSA balance, falling behind both partial and SCR-

funded RSAs.

Prior studies of pension savings adequacy and contribution density align with our analysis. Our analysis of partial and non-remittance of pension contributions shows that any pension contribution remittance other than the SCR remittance results in lower RSA balances for CPS participants. (Sogunro, Adeleke, and Ayorinde 2019) suggests that achieving retirement saving adequacy in the RSA necessitates a 50% to 80% replacement rate for both high and low-income earners. To align this with the SCR, a contribution rate increase of around 10.01% from the minimum of 8% is required. Also, (Antolin 2010) emphasises the need for higher contributions between 5% and 15% of wages to ensure adequate retirement funds benefits of about 70% of the final salary for scheme participants. (Cheung 2007) analysis shows that variable contribution rates play a crucial role in optimising the lifecycle of a pension program. In the case of a pension program with fixed contributions, a constant proportion allocation may prove to be equally efficient.

The study emphasises that lifecycle investment advice is incomplete without additional guidance on planning variable contributions. (Rudys 2023) show that scheme participants with low net replacement rates and or retirement income uncertainty accumulate more private savings and reduce risky portfolio shares at an earlier age to hedge against the risks of retirement savings inadequacy. These empirical results imply a relationship between the rate of pension contribution and the sufficiency of retirement savings. Our results suggest that only an SCR contributions remittance can generate sufficient retirement savings for CPS participants.

Our study has made noteworthy contributions to the existing body of literature. Firstly, we have augmented the nascent literature on contribution density and retirement savings adequacy studies. Previous research has investigated the determinants of contribution density and RSA funding to ensure the sufficiency of retirement savings (Banks et al. 2002; Cheung 2007; Antolin 2010; Van Dalen, Henkens, and Hershey 2010; Reyers 2018; Sogunro, Adeleke, and Ayorinde 2019; Rudys 2023). In this study, we extend this research by examining various funding scenarios through the lens of a lifestyle investment strategy as perceived by scheme participants. As a result, this study differs from prior pension funding studies, which have predominantly focused on fund benefits and adequacy. Our study con-

tributes to further understanding the impact of non-remittance of pension contributions to CPS's RSA.

Secondly, our study endeavours to not only enhance our understanding regarding the impact of partial or non-remittance of pension contributions but also provide pragmatic perspectives that have the potential to guide scheme participants, scheme sponsors, and policymakers. By addressing this problem through rigorous investigation and analysis, we contribute valuable insights to the existing body of knowledge in pension funding RSA and offer a foundation for informed decision-making in funding CPS. Thirdly, the pay-as-you-go-defined benefit scheme dominates the global pension system, but some states have a CPS for only public sector employees. In some quarters, the public sector scheme differs from the private sector scheme, while others, especially upper-middle-income countries, have social pension programs designed as universal or means-tested (Abels and Guven 2016, Guven 2019). Due to each economy's peculiarities, no single pension system model will work for every country (Banks et al. 2002). In contrast to previous studies (e.g. Khorasaneh 1995, Teksoz and Sayan 2002, Burtless 2003, Cannon and Tonks 2012) concentration on developed economies, with regular contributions throughout working life and social security like state benefit and basic state pension, we focused on Nigeria's CPS, a developing economy in an African developing market context, as an appropriate setting. Because the need for pensions to support ageing populations is a significant issue in both advanced, emerging and developing economies (Mitra and Medova 2010).

The following is the outline for this paper. In section II we introduce the Nigerian contributory pension scheme. The materials and procedures are presented in Section III. In Section IV, the study's empirical strategy and findings are presented, and in Section V, we conclude the research with a discussion of our findings.

4.2 The Nigerian Contributory Pension Scheme

Due to demographic changes and ageing, the defined benefit pension scheme operational in Nigeria had been plagued by underfunding and accrued pension liabilities, rendering it unappealing and unsustainable (Casey and Dostal 2008). In 2004, Nigeria transitioned from

a defined benefit, a pay-as-you-go pension scheme, to a fully funded (money purchase) CPS. The CPS depends on contributions made by the employer and employee at a statutorily defined rate to build a retirement fund in an individual worker's RSA, with the accumulated pension fund at retirement dependent on these contributions. While future benefits are uncertain in this scheme, they are contingent on the scheme participants' contributions and the interest earned on their investments. Thus, the computation of the retirement benefit is contingent upon several factors, namely the quantum of contribution payment made by the employer-employee duo, the rate of accumulation, and the survival rate.

The CPS allows employers to deduct pension contributions at source and remit them to the employees' pension fund administrator (PFA), which then credits each contributor's RSA with the amount owed. As a result, the CPS aims to ensure that Nigerian workers have a dependable source of income after they retire. The implementation of the CPS, a DC plan, established a three-tiered system involving three essential players to guarantee separation and distinction among the entities responsible for regulation (National Pension Commission-PENCOM), administration (PFA), and safeguarding of pension fund assets (Pension Fund Custodian-PFC). This measure was taken to mitigate and potentially eliminate the risk of fraud and malpractice, which had been widespread before the transition.

The Nigerian scheme is similar to the private mandatory CPS in Chile, where individual workers select their preferred PFA. The Nigerian CPS, like in Chile and Switzerland, has a maximum asset allocation to investible instruments in a lifestyle investment strategy concerning asset allocations for different types of assets. Contributions are tax-free in Nigeria and Argentina, but accumulated benefits are taxed in Chile and Switzerland.

4.3 Materials and method

We analyse the frequencies of pension contributions from the scheme participants' point of view to examine the state of non-remittance and partial remittance of pension contributions, shown in Tables 4.14 and 4.15 in the appendix. To establish the eligibility of the CPS participants and ensure that the information provided pertains to current experience, our sample was limited to individuals who have spent a minimum of three years in the

workplace. Within our study population, 9.58% occupy the position of assistant lecturer, while 54.79% hold the rank of lecturer II. Finally, 34.25% are categorised as lecturer I. The findings reveal that all respondents acknowledge pension deductions from their payslips. Specifically, 31.50% respondents reported complete remittance of pensions, while 68.49% claimed non-remittance or partial remittance of pension contributions in their RSA statement of accounts. Also, 28.76% respondents noted either the employer or the employee remitted pensions in their RSA statement at the CONUASS 01 level, while 42.46% reported similar issues up to the CONUASS 02 level. Also, 21.91% respondents stated no remittance of pensions from either the employer or the employee in their RSA statement of accounts at the CONUASS 01 level, and 30.13% respondents reported the same issue at the CONUASS 02 level. These findings are consistent with the study by (Adeyele and Maiturare 2012) and emphasise the varying degrees of non-remittance and partial remittance of pension contributions within the surveyed population. We do not include additional positions beyond Lecturer I due to the possibility of individuals receiving backlog payments after filing complaints or the employer releasing funds for disbursement in the individual's RSA. For this partial and non-remittance is purely an administrative problem and very prevalent in the study setting. Therefore, this raises an important question: Does the compensation received through backlog payments offset the potential investment gains that may have otherwise accrued during the period of partial and non-remittance of pension contributions? Thus, it is imperative to analyse the effects of different levels of non-remittance and partial remittance of pension contributions on the RSA balance.

Pension savings adequacy depends on various pension parameters, for example, Uncertainty in investment returns, inflation, discount rates, and life expectancy. Also, the choices made by individual scheme participants, their employers, and policymakers affect savings adequacy. These choices include contributions, accumulation periods, investment strategy, payout structure, and additional contributions (Antolin 2008; Antolin 2010). In our analysis, we use the acronyms in Table 4.1 to define the remittance scenarios as follows.

Table 4.1: Definition of funding scenarios variables

| Variables | Description |
|-----------|--|
| SCR | Statutory contribution rate remittance |
| NR_1 | Non-remittance of contribution from the treasury to the end of CONUASS 01 level |
| PR_1 | Partial remittance contribution from the treasury to the end of CONUASS 01 level |
| NR_2 | Non-remittance of contribution from the treasury to the end of CONUASS 02 level |
| PR_2 | Partial remittance of contribution from the treasury to the end of CONUASS 02 level. |

4.3.1 Method

To begin, we consider a graduate assistant with grade level one - step one (CONUASS 01/01) as the entry-level participant, with an age of 25 at time $t = 1$, no asset transfer into the fund ($A_0 = 0$), and a contribution of $C_t = (k \times S_t) - A_f$ at the end of time t in naira (₦ the currency of Nigeria), with k being the proportion rate of contribution and S_t being salary at time t . Under this scheme, employees contribute 8% of their monthly compensation, which is the sum of their basic salary, transportation allowance, and housing allowance. The employer contributes 10% of the employee's monthly compensation to their retirement benefits. As a result, we assign a value of 18% to k , with participants contributing 8% and sponsors contributing 10%. The administrative fee, A_f , is a one-time, front-loaded expense paid to the pension fund administrator (PFA) upon receipt of a contribution. At the end of period t , C_t is invested, which follows a discrete flow of funds into the RSA.

The accumulation of flows $C_1, C_2, C_3, \dots, C_T$ dues at times $t = 1, 2, 3, \dots, T$, taking into account wage increases due to upgrades and promotions as a result of new skills and experience gained with no break in service (Teksoz and Sayan 2002; Ibiwoye 2008; Bravo and Hecce 2020). The salary at time t is a function of the specific grade, level, and steps on the scale, and is a non-fixed variable S_t . Over T service periods, this will result in an oscillation of C_t with varying interest rates of $i_1, i_2, i_3, \dots, i_T$. C_t is compounded with an f frequency at the conclusion of the t interest period on the balance from the beginning of the t interest period.

This varying interest rate represents the participant's preference for time, the loss of money's value, and the unpredictability of future occurrences. This results in a nominal

interest rate of $(1 + i)$, which reflects a real interest rate of r with a π^e inflation expectation and a risk premium of \varnothing . Thus, $(1 + i) = (1 + r)(1 + \pi^e)(1 + \varnothing)$.

Considering the existing literature (Cannon and Tonks 2012; Jarvis 2014; Petters and Dong 2016), we assume that yield values are independent in every t year and, in addition, they are independent of all yields from previous years. Therefore, at the end of the first period ($t = 1$) of contributing C_1 into the individual RSA, the fund will accumulate

$$A_t = C_t + A_{t-1} \left(1 + \frac{i_t}{f}\right) \quad (4.1)$$

Since we assumed $A_0 = 0$, it follows $A_1 = C_1$. A_1 is reinvested to yield $A_2 = C_2 + A_1 \left(1 + \frac{i_2}{f}\right) = C_2 + C_1 \left(1 + \frac{i_2}{f}\right)$, the accumulation for the second period, which is reinvested to further yield an accumulation A_3 and so on. The process continues until the participant attains the retirement age T with a contribution of C_T and a preceding contributions of C_{T-1} with $\frac{i_T}{f} A_{T-1}$ the interest earned into the accumulated fund for the total period, which will be;

$$\begin{aligned} A_T = & C_T + C_{T-1} \left(1 + \frac{i_T}{f}\right) + C_{T-2} \left(1 + \frac{i_T}{f}\right) \left(1 + \frac{i_{T-1}}{f}\right) + \dots \\ & + C_1 \left(1 + \frac{i_T}{f}\right) \left(1 + \frac{i_{T-1}}{f}\right) \dots \left(1 + \frac{i_2}{f}\right) \end{aligned} \quad (4.2)$$

Assume that a proportion X_A from the fund is invested in a variable income instrument (e.g. an equity fund) following (Vittas and Alier 1999, Haberman and Vigna 2002, Cheung 2007, Rudys 2023). Then, the net return on the portfolio's assets depends upon the annual yield of fixed income instruments (Y_b) and the yield of variable income instruments (Y_{st}), respectively, as follows:

$$C_T = (C_t) [X_A(e^{\lambda t})(Y_{st} - C_s) + (1 - X_A)(e^{\mu t})(Y_b - C_b)] \quad (4.3)$$

where C_b and C_s are the fund's annual management fees and are presented in Table 4.2. to cover expenses such as portfolio management, advisory services, and administrative costs. Different investment firms charge varying fees based on factors such as management style and investment size. Investment firms that manage their investments passively charge lower fees than those that manage their investments actively. C_t is the contribution level

at time t , X_A and $(1 - X_A)$ are the proportion of funds invested in the variable and fixed income security asset respectively. λ_t and μ_t are the real force of interest for the variable and fixed income security in year $[t, T]$ respectively, which are all assumed to be constant over the year $[t, T]$. The sequences μ_t and λ_t are assumed to be independent and identically distributed with normal distribution, whereas the annual forces of interest μ_t and λ_t are correlated with correlation factor ρ , which is assumed to be constant for any t .

Table 4.2: Front Loaded Expenses

| Commission | Proportion (%) |
|--------------------------------------|----------------|
| Pension Fund Administration (PFA) | 1.290 |
| Pension Fund Custodian (PFC) | 0.270 |
| National Pension Commission (PENCOM) | 0.200 |

We use the Nigerian Pension Index (NGX) from the Nigerian Stock Exchange (NSE) for variable income securities because all PFAs are working with the scheme’s main goal of asset safety and maintaining a fair (real) return on investment. This index tracks stocks that have been specially screened in accordance with pension investment guidelines and are weighted by adjusted market capitalization.

$$NGXPension\ Index = \frac{\text{Total free float market capitalisation}}{\text{Base market capitalization}} \times \text{Base index value}$$

The value of Total free-float market capitalisation = Total number of free float shares \times Market price of each share \times free float factor in (%). As of December 31, 2021, using historical data from January 2, 2013 index inception year, the index had returned 4.32% year to date, with an annualised standard deviation of 3.46%.

Nigeria has a high level of country risk, which includes political risk, exchange rate risk, economic risk, sovereign risk, and transfer risk, according to the OECD the country risk rating is 6%. The historical federal government of Nigeria risk risk-free T-bill 364-day data is 10.381% from January 2008 to December 2021. Deducting Nigeria’s country risk of 6% from the 364-day T-bill rate of 10.381% yields a net return of 4.381% which is our risk-free rate with a standard deviation of 2.813%, and our choice of T-bill as a better proxy for the risk-free is motivated by (Blake, Cairns, and Dowd 2001; Mukherji 2011; Oosthuizen and Rooyen 2013; Heerden 2016). Using macroeconomic data from the Central Bank of Nigeria

(CBN), we used an annual inflation rate of 12.314 per cent from January 2003 to February 2022. We use the Federal Government of Nigeria (FGN) Bonds, which are debt securities, for fixed-income securities. These bonds are liabilities of the FGN and are issued by the Debt Management Office (DMO) on behalf of the government.

The scheme participants' fund assets under management follow a lifestyle investment strategy that includes fixed and variable income instruments. In this strategy, the younger scheme participants through their PFA try to maximise investment returns by including an appropriate proportion of stocks in their assets. Those nearing retirement take a conservative defensive approach, investing primarily in bonds. This is in accordance with previous works of (Cheung 2007; Rudys 2023).

For expositional convenience, we consider $i_{T+1} = 0$, which allows writing the accumulated fund A_T at the end of T service years of the individual RSA to be

$$A_T = \sum_{t=0}^{T-1} C_{T-t} + C_T \left\{ \prod_{j=0}^t \left(1 + \frac{i_{T+1-j}}{f} \right) \right\} \quad (4.4)$$

When a scheme participant retires at age x time T , they are given a lump sum payment as their initial payment in full. It is A_T 's remaining balance after monthly and/or quarterly pension payments have been made. This lump sum at retirement is based on the factors of age at retirement, scheme participant gender, A_T balance, and final salary of the participant (which comprises; basic, housing, and transportation allowance). The balance is used to purchase a program withdrawal with a PFA or a life annuity with a life insurance company. If the participant chooses the program withdrawal option (PW), the annual indexed pension PW at retirement is;

$$PW = \frac{A_T - LSE - (charges \times LSE)}{\ddot{a}_x \times 12} \quad (4.5)$$

Where the lump sum to which the scheme participant is entitled is $LSE = \%(A_T)$. The amount of lumpsum a participant takes depends on their financial, economic and health needs, risk appetite, lifestyle planning or being a retiree with dependents, which in this context refers to any person(s) to whom the retiree will provide a level of ongoing finan-

cial support at retirement, such as children, parents, and or relatives. For instance, some participants might decide to take the minimum lump sum, which is equal to 25% of the A_T , which would result in a higher monthly PW draw-down, or a higher lump sum, which is equal to 60% of the A_T , which would result in a lower monthly PW draw-down. Typically, the PFA suggests that the scheme participant receive 50% of the A_T , and on rare occasions, some scheme participants may choose not to accept any lump sum.

The \ddot{a}_x is the actuarial present value of a whole life annuity due for a life age (x) that pays a benefit of a unit $\text{N}1$ at the beginning of each year that the annuitant (x) survives. The current payment technique for evaluating the life annuity is;

$$\ddot{a}_x = \sum_{k=0}^{\infty} V^k {}_kP_x = \sum_{k=0}^{\infty} V^k \left(\frac{\ell_{x+k}}{\ell_x} \right) = \frac{N_x}{D_x}$$

where ${}_kP_x = \frac{\ell_{x+k}}{\ell_x}$ is the probability that a scheme participant of age x will live for k years and is calculated actuarially using adopted mortality table, V^k is the present value discount factor. $D_x = V^x \ell_x$ is the discounted lives and N_x is the sum of discounted lives represented as;

$$N_x = \sum_{j=0}^{\infty} D_{x+j} = \sum_{j=0}^{\infty} V^x \ell_{x+j}$$

$$\therefore \ddot{a}_x = \frac{\sum_{j=0}^{\infty} V^x \ell_{x+j}}{V^x \ell_x}$$

In order to analyse the PW amount from the various lifestyle investment strategies under partial and non-remittance of contributions made to the RSA, we made a few key assumptions; The CONUASS retirement age at T is 70 years and male, full-time CPS participation is required throughout, \ddot{a}_x has an interest rate range of 4 per cent, the frequency withdrawal amount is 12, management fees are 5 per cent and regulatory fees are 0.30 per cent, and the value of the commutation was calculated using the formulae and table for examination of the Faculties of Actuaries and Institute of Actuaries (IFoA).

4.3.2 Model results

We establish a replacement rate and its equivalent income based on (Antler and Kahane 1987, Haberman and Vigna 2002, Cannon and Tonks 2012, Chybalski and Marcinkiewicz 2015) and scheme participant final salary, using the minimum wage of ₦30,000 as in Table 4.3. Figures 4.1a and 4.1b for strategies A and B, respectively, show the outcome of Eqn.4.5 in ₦0,000s

Table 4.3: Benchmarks for Replacement Ratio at various income levels

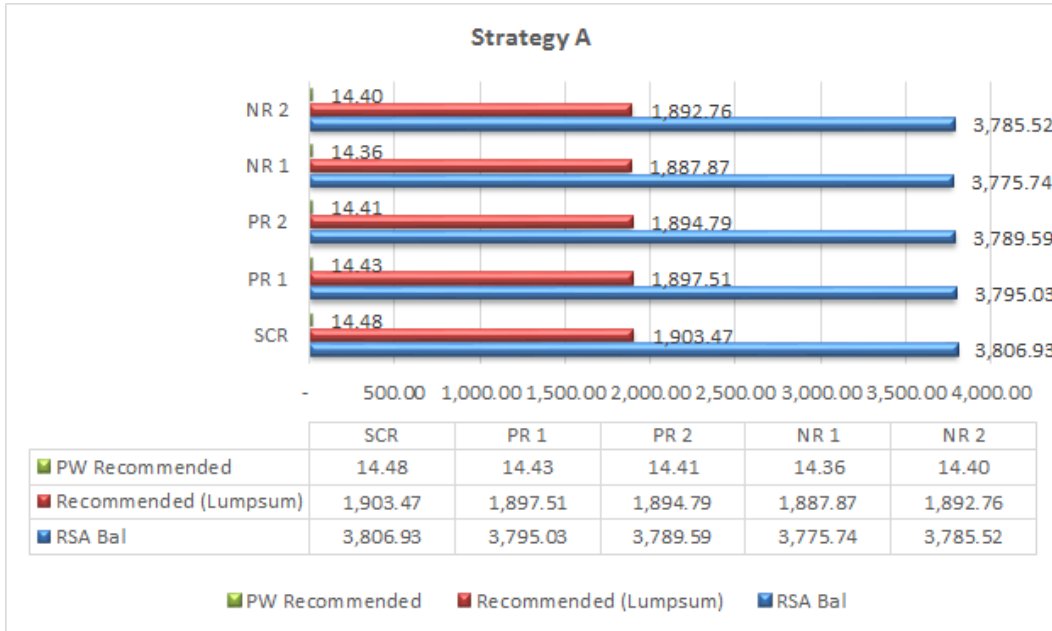
| Monthly salary | Target replacement rate | Target replacement income |
|----------------|-------------------------|---------------------------|
| 30,000 | 80% | 24,000 |
| 30,001-50,000 | 70% | 21,00.70 - 35,000 |
| 50,001-70,001 | 67% | 33,500.67 - 46,900 |
| 70,001-100,000 | 60% | 42,000.60 - 60,0000 |
| >100,001 | 50% | 50,000.50 |

Using Table 4.4, assets are allocated into 5 group scenarios based on Table 4.1 and 4.2 features. We assign maximum variable income security with minimum fixed income securities in fund structure (I, II and III) in Table 4.4 as strategy A, and minimum variable income securities with maximum fixed income security in fund structure (I, II and III) as strategy B. There are seven grade levels (i.e., CONUASS 1 through CONUASS 7), and we used fund at time t (the beginning of the grade level) and fund at time T (the end of the grade level). Thus, bringing the total observed fund accumulation period to 14.

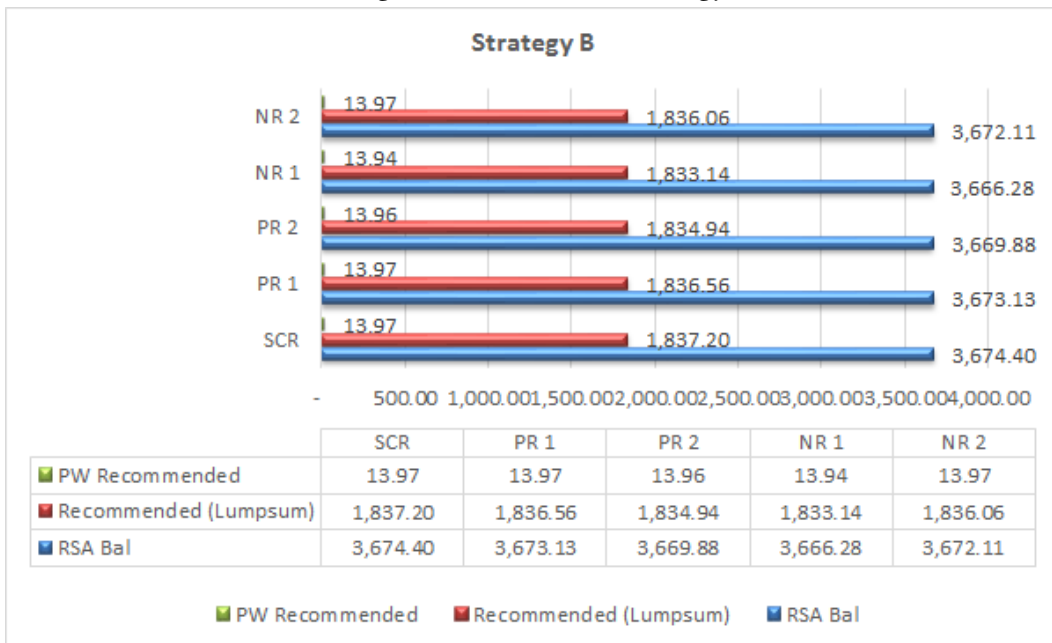
Table 4.4: Asset allocation based on lifestyle investment strategy

| Fund structure | Participant age | Asset allocation |
|----------------|-----------------|--|
| I | < 39(25 – 39) | Max(variable income:75%, fixed income:25%) Min(variable income:20%, fixed income:80%) |
| II | < 49(40 – 49) | Max(variable income:55%, fixed income:45%) Min(variable income:10%, fixed income:90%) |
| III | ≥ 50(50 – 70) | Max(variable income:20%, fixed income:80%) Min(variable income:5%, fixed income:95%) |

In Eq.4.4, the accumulations in (₦^{*t*} million) are summarised and presented in Tables 4.5 and 4.6. Table 4.5 shows accumulations using strategy A, with SCR having the highest accumulation of (38.069) with NR_1 (37.757) being the lowest accumulated fund at A_T



(a) Program withdrawal for strategy A..



(b) Program withdrawal for strategy B..

Figure 4.1: Pension replacement income for strategy A and B

shown in column *Max*. While in strategy B Table 4.6, SCR has the highest accumulation of (36.744) and the lowest accumulation is in the NR_1 (36.663) funding at A_T in column *Max*. This shows that accumulations at time T in strategy A yielded a higher growth bias than strategy B evidenced by the accumulated fund values.

Table 4.5: Summary Statistics for Accumulated Fund in Strategy A

| Statistic | N | Mean | St. Dev. | Min | Max |
|-----------|----|-------|----------|-------|--------|
| SCR | 14 | 9.276 | 10.233 | 0.264 | 38.069 |
| NR_1 | 14 | 8.764 | 10.426 | 0.000 | 37.757 |
| PR_1 | 14 | 9.138 | 10.258 | 0.117 | 37.950 |
| NR_2 | 14 | 9.028 | 10.279 | 0.000 | 37.855 |
| PR_2 | 14 | 8.992 | 10.337 | 0.117 | 37.896 |

Table 4.6: Summary Statistics for Accumulated Fund in Strategy B

| Statistic | N | Mean | St. Dev. | Min | Max |
|-----------|----|-------|----------|-------|--------|
| SCR | 14 | 8.880 | 9.906 | 0.132 | 36.744 |
| NR_1 | 14 | 8.552 | 10.124 | 0.000 | 36.663 |
| PR_1 | 14 | 8.831 | 9.940 | 0.059 | 36.731 |
| NR_2 | 14 | 8.792 | 9.967 | 0.000 | 36.721 |
| PR_2 | 14 | 8.697 | 10.024 | 0.059 | 36.699 |

Normality Test

Because we had a small sample size (fund accumulations over 14 periods), determining the distribution of accumulated funds at time T was critical for selecting an appropriate statistical method. As a result, a Shapiro-Wilk test was performed with the hypothesis;

H_0 : Funds accumulated at time T are from a normal distribution.

H_1 : Funds accumulated at time T are not from a normal distribution.

The P-values and corresponding statistic as shown in Table 4.7 from the Shapiro-Wilk test revealed that neither of the funding scenarios in both strategies A and B were normally distributed at the $\alpha = 5\%$ significance level, so we reject the hypothesis that accumulated funds at time T in an RSA follow a normal distribution. Based on this result, a non-parametric test was used for further empirical analysis.

Table 4.7: Shapiro-Wilk test

| | Variables | Statistic (w) | P-values |
|------------|-----------|---------------|----------|
| Strategy A | SCR | 0.80189 | 0.005267 |
| | NR_1 | 0.80739 | 0.006169 |
| | NR_2 | 0.80799 | 0.006277 |
| | PR_1 | 0.80537 | 0.005820 |
| | PR_2 | 0.80543 | 0.005829 |
| Strategy B | SCR | 0.80261 | 0.005376 |
| | NR_1 | 0.80931 | 0.006521 |
| | NR_2 | 0.80941 | 0.006540 |
| | PR_1 | 0.80649 | 0.006011 |
| | PR_2 | 0.80686 | 0.006075 |

4.4 Empirical strategy

Quantile regression's robustness makes it an appealing alternative for modelling the heavy-tailed behaviour of portfolio returns and other financial data that does not assume normality, as they frequently exhibit skewness and heavy tails (Xiao, Guo, and Lam 2014, Rodriguez and Yao 2017).

The regression model Eq.4.7 for quantile level τ was developed to assess the effect of counterfactual conditionals on the accumulation of funds in the RSA. We assume that the 25th, 50th, 75th, and 99th quantiles correspond to the low, median, upper quartile, and high percentiles of pension fund contribution remittance. This model can predict the impact of non-remittance and or partial remittance of contributions on total accumulations in the RSA, along with the 99th percentile of the RSA balance standing. To test the counterfactual hypothesis, we want to estimate the following regression model:

H0: If an RSA receives consistent contributions, the RSA will have an adequate fund balance.

H1: If RSA had experienced inconsistent contribution remittance, the RSA balance would be insufficient.

$$SCR = \beta_0 + \beta_1(PR_1) + \beta_2(PR_2) + \beta_3(NR_1) + \beta_4(NR_2) + \epsilon \quad (4.6)$$

$$Q_{SCR}(\tau/x) = \beta_0(\tau) + \beta_1(\tau)PR_1 + \beta_2(\tau)PR_2 + \beta_3(\tau)NR_1 + \beta_4(\tau)NR_2 \quad (4.7)$$

4.4.1 Empirical results

We proceed to test the hypothesis based on the results of the normality test, that;

Strategy A; H_{01} : Each funding scenario in strategy A has the same expected accumulated fund.

Strategy B; H_{01} : Each funding scenario in strategy B has the same expected accumulated fund.

In both strategies; H_{a1} : At least one funding scenario's anticipated accumulated fund differs from the others.

| | Strategy A | Strategy B |
|-------------|---------------|---------------|
| N | 14 | 14 |
| χ^2 | 53.7 | 52.5 |
| df | 4 | 4 |
| $p - value$ | $6.14e^{-11}$ | $1.07e^{-10}$ |

Table 4.8: Friedman Test

| | Strategy A | Strategy B |
|-----------|------------|------------|
| N | 14 | 14 |
| effsize | 0.959 | 0.938 |
| magnitude | large | large |

Table 4.9: Kendall W Test

The Friedman test for strategy A revealed differences between the various expected accumulated funds in the RSA in the funding scenarios of (SCR, NR_1, PR_1, NR_2, and

PR_2). The test demonstrates a statistically significant difference in projected accumulated funds across the different funding scenarios in strategy A ($\chi^2(4) = 53.7, P = 6.14e^{-11}$) given in Table 4.8 at $\alpha = 5\%$ level of significance. A follow-up Kendall W test value of 0.959 as shown in Table 4.9, indicates a large effect (degree of difference) in the various funding scenarios, according to Cohen's interpretation guidelines (0.1: small effect, 0.3: moderate effect, and > 0.5 : large effect in (Valentine and Cooper 2003)).

In strategy B (see Table 4.8), the Friedman test revealed differences between the various funding scenarios of (SCR, NR_1, PR_1, NR_2, and PR_2) and the RSA anticipated cumulative funds. At the $\alpha = 5\%$ level of significance, the test shows a statistically significant difference in predicted accumulated funds across the different financing scenarios in the RSA ($\chi^2(4) = 52.5, P = 1.07e^{-10}$). A Kendall W test result of 0.938 (see Table 4.9) suggests a significant effect (degree of difference) in the various funding scenarios based on Cohen's interpretation guidelines (0.1: small effect; 0.3: moderate effect; and > 0.5 : large effect, in (Valentine and Cooper 2003)).

The Friedman test p-values for both strategies are statistically significant, resulting in the rejection of H_0 . We then conduct a Conover post hoc test (Coakley and Conover 2000), which is used to determine whether two or more population variances are equal, as this test is advised when the normality assumption is not viable, because our Friedman test yields a significant result. The Conover post hoc test was then performed at a 5% cut-off, and the false discovery rate (FDR) method was used to adjust the p -values for multiple hypothesis testing and to determine which funding scenarios are different in both strategies. This is due to the fact that the traditional Bonferroni method for correcting for multiple comparisons is overly conservative, and protecting against false positives results in a large number of missed findings (Perneger 1998, Lee and Lee 2020). The FDR was chosen because it is the rate of features that are truly null. This will allow us to account for the FDR and identify as many significant features as possible while incurring as few false positives as possible. The findings are shown in Tables 4.10 and 4.11.

The Multiple pairwise comparisons indicate significant differences in strategy A among different funding scenarios, as shown in Table 4.10. Specifically, we have seen significant differences between PR_2 and SCR scenario, NR_1 and SCR, NR_2 and SCR, NR_1 and

Table 4.10: Conover post hoc test for Strategy A

| | SCR | PR_1 | PR_2 | NR_1 | NR_2 |
|------|-----|--------|-----------|-----------|-----------|
| SCR | | 0.1142 | 0.0029*** | 0.0000*** | 0.0000*** |
| PR_1 | | | 0.1142 | 0.0000*** | 0.0054*** |
| PR_2 | | | | 0.0054*** | 0.16060 |
| NR_1 | | | | | 0.1142 |
| NR_2 | | | | | |

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4.11: Conover post hoc test for Strategy B

| | SCR | PR_1 | PR_2 | NR_1 | NR_2 |
|------|-----|--------|-----------|-----------|-----------|
| SCR | | 0.0901 | 0.0001*** | 0.0000*** | 0.0014*** |
| PR_1 | | | 0.01** | 0.0001*** | 0.0791 |
| PR_2 | | | | 0.0791 | 0.3471 |
| NR_1 | | | | | 0.0105** |
| NR_2 | | | | | |

Note: *p<0.1; **p<0.05; ***p<0.01

PR_1, NR_2 and PR_1, and NR_1 and PR_2. These findings highlight distinct variations in strategy A across these pairwise comparisons, which can have significant implications for understanding the impact of different funding scenarios on the balance standing in the RSA. The comparisons, however, found no significant differences between PR_2 and PR_1, PR_1 and SCR, and NR_2 and NR_1.

The analysis of strategy B shows significant differences in fund accumulation between pairs of funding scenarios. Specifically, there is lower fund accumulation in NR_2 compared to SCR, NR_1 compared to SCR, PR_2 compared to SCR_1, NR_1 compared to PR_1, PR_2 compared to PR_1, and NR_2 compared to NR_1. However, no significant differences were found in fund accumulation between other funding scenarios, as shown in Table 3.11. These findings highlight the specific funding scenarios where fund accumulation differs significantly, while others show comparable accumulation levels.

Table 4.12: Strategy A regression results

| <i>Results of the impact of partial and non-remittance of pension contribution:</i> | | | | | |
|---|----------------------|----------------------|----------------------|---------------------|----------------------|
| | DV: SCR | | | | |
| | OLS | $\tau = 0.25$ | $\tau = 0.5$ | $\tau = 0.75$ | $\tau = 0.99$ |
| | (1) | (2) | (3) | (4) | (5) |
| PR_1 | 2.198*** (0.102) | 2.235*** (0.050) | 2.232*** (0.230) | 2.229** (0.707) | 2.078*** (0.393) |
| PR_2 | 0.054 (0.102) | 0.017*** (0.001) | 0.021 (0.225) | 0.023 (0.706) | 0.174 (0.385) |
| NR_1 | -0.030 (0.057) | -0.010 (0.038) | -0.011 (0.130) | -0.013 (0.394) | -0.097 (0.223) |
| NR_2 | -1.222*** (0.057) | -1.243*** (0.089) | -1.241*** (0.153) | -1.240** (0.400) | -1.156*** (0.260) |
| Observations | 14 | 14 | 14 | 14 | 14 |

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4.13: Strategy B regression results

| <i>Results of the impact of partial and non-remittance of pension contribution:</i> | | | | | |
|---|----------------------|-------------------------|----------------------|----------------------|----------------------|
| | DV: SCR | | | | |
| | OLS | $\tau = 0.25$ | $\tau = 0.5$ | $\tau = 0.75$ | $\tau = 0.99$ |
| | (1) | (2) | (3) | (4) | (5) |
| PR_1 | 2.216*** (0.116) | 2.252*** (0.0001) | 2.252*** (0.075) | 2.251*** (0.367) | 2.254*** (0.437) |
| PR_2 | 0.036 (0.116) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001 (0.353) | -0.001 (0.415) |
| NR_1 | -0.020 (0.064) | -0.0004*** (0.00005) | -0.0005 (0.013) | -0.001 (0.197) | 0.001 (0.232) |
| NR_2 | -1.232*** (0.064) | -1.252*** (0.0001) | -1.252*** (0.089) | -1.252*** (0.231) | -1.253*** (0.286) |
| Observations | 14 | 14 | 14 | 14 | 14 |

Note: *p<0.1; **p<0.05; ***p<0.01

Regression results

We investigate how the effect of partial and non-remittance of pension contributions into an RSA differs across the distribution of the RSA accumulation balance using model results and the following coefficients across columns. We selected specific quantiles, each column representing the quantile regression results for the 25th, 50th, 75th, and 99th quantiles. To demonstrate how the understanding of contribution remittance effects can differ across the complete range of pension funding scenarios, we compare the quantile regression outcomes using Eqn. 4.7. and the Ordinary Least Squares (OLS) outcomes using Eqn. 4.6. Table 4.12 for strategy A and Table 4.13 for strategy B. Additionally, Fig. 4.2 and 4.3 show the coefficient outcomes for strategies A and B, along with the quantiles and magnitude of the quantile regression coefficient.

For strategy A, the OLS model shows a positive and significant effect for PR_1. This effect is also significantly positive and consistent across different quantiles (25th, 50th, 75th and 99th) in the quantile regression analysis. In contrast, PR_2 has a non-significant but positive effect in the OLS model. However, in the quantile regression, this becomes significant and positive only at the 25th quantile while remaining non-significant at other quantiles. The OLS model and the quantile regression show that NR_1 has a non-significant and negative effect at different quantiles. On the other hand, NR_2 has a significant and negative effect on the OLS regression. This effect is also significantly negative and consistent across different quantiles in the quantile regression analysis.

For strategy B, our models show a substantial and noteworthy portion of the variability in the various funding scenarios. Specifically, when examining the impact of PR_1, it is statistically significant and positively associated in the OLS regression and at all the quantiles. However, PR_2 is statistically insignificant and positive in OLS regression, only becoming significant at lower quantiles (25th and 50th) in quantile regression. On the other hand, NR_1 shows a significant and negative effect at the 25th quantile; however, it loses its significance in both OLS regression and the quantile regression at the 50th, 75th, and 99th quantiles. NR_2 consistently shows a statistically significant and negative impact across all quantiles and in the OLS regression.

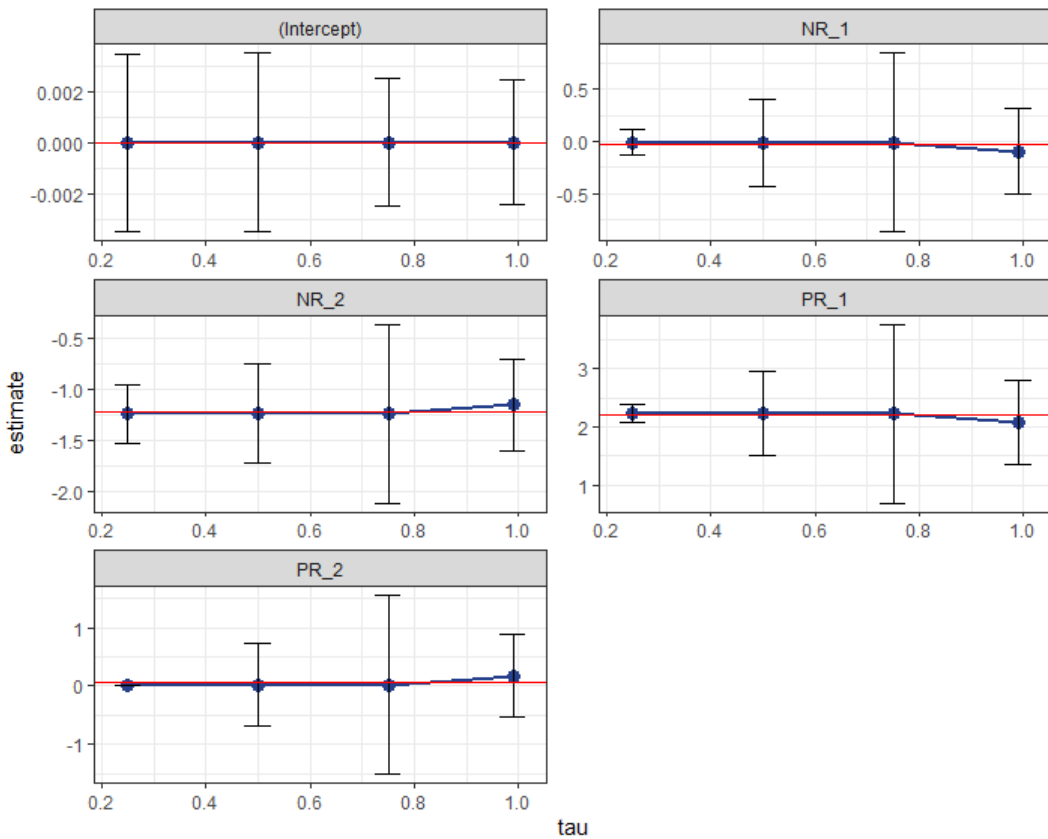


Figure 4.2: Coefficient plots for strategy A

4.4.2 Discussion and Conclusion

Scheme participants are posing the question of: What happens to the RSA balance of a CPS when contributions are remitted partially or non-remitted during various accumulation phases? In this paper, we explore this question by utilising CONUASS 2019 data and approximations for the market return of the lifestyle investment strategy. The analysis of strategy A shows distinct patterns for different variables. PR_1 consistently demonstrates a positive and statistically significant effect across the OLS and quantile regression models at all quantiles. PR_2, initially shows a statistically non-significant impact in the OLS model, this then becomes significantly positive at the 25th quantile in the quantile regression. Conversely, NR_1 has a statistically non-significant and negative effect in the OLS and quantile regression analyses. Finally, NR_2 shows a consistent and statistically significant negative impact in the OLS and quantile regression models at all the quantiles. The analysis of strategy B reveals that the impacts of different funding scenarios differ in terms of their significance across the OLS and quantile regression models. In particular, PR_1

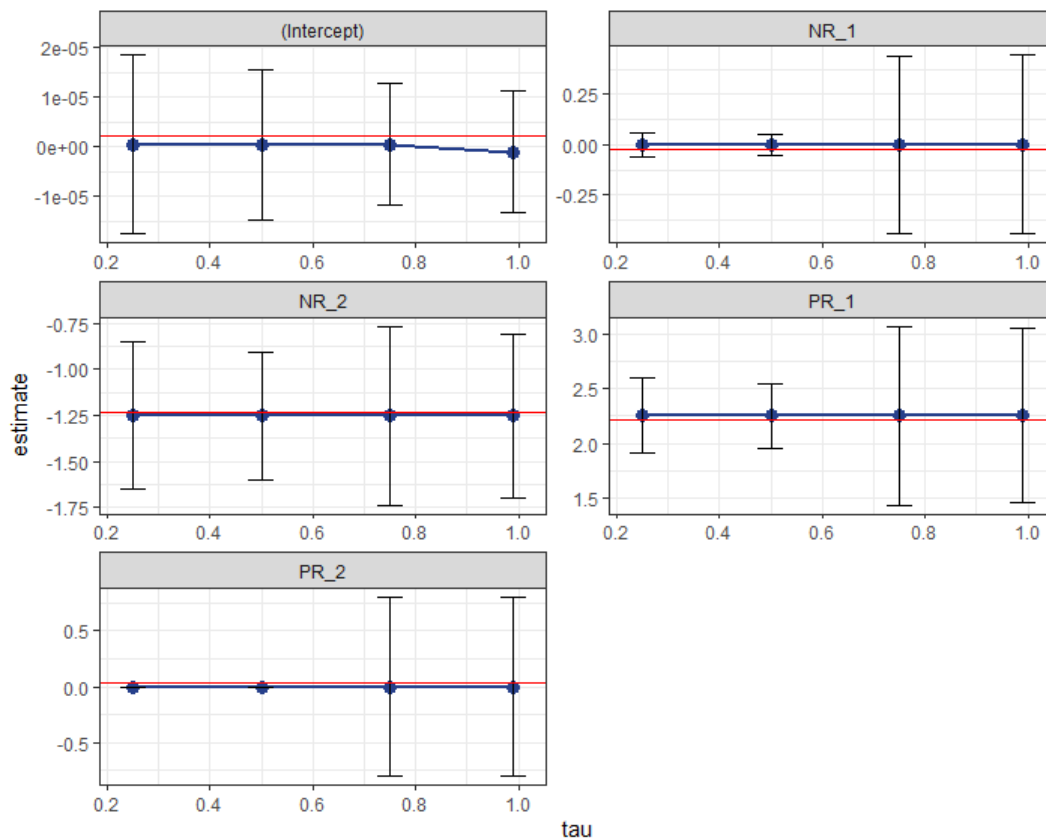


Figure 4.3: Coefficient plots for strategy B

consistently demonstrates a substantial positive effect, whereas PR_2 has a positive impact but with less consistency. Initially, NR_1 does not show significance in the OLS model but becomes significantly negative at lower quantiles. On the other hand, NR_2 consistently shows a significant negative effect across various quantiles. These findings provide valuable insights into the relationships between these funding scenario variables with SCR and strategies A and B, highlighting varying impacts across different quantiles.

The findings indicate how pension fund contributions remittance to RSAs has a notable effect on the accumulated balance in the RSAs. Specifically, we find that non-remittance and partial remittance of pension contributions, as compared to complete (statutory contribution rate) and timely remittance, result in considerably lower retirement savings, thus having adverse effects on RSA balance. We hypothesise that if RSA experiences inconsistent contribution remittance, the RSA balance will be less than the balance in an account that adheres to a statutory contribution rate. This finding validates our hypothesis and deduces that non-remittance and partial remittance of pension contributions in a CPS lead to lower

retirement savings. Our findings align with previous research on adequacy of retirement savings and contribution density (Banks et al. 2002; Cheung 2007; Antolin 2010; Van Dalen, Henkens, and Hershey 2010; Reyers 2018; Sogunro, Adeleke, and Ayorinde 2019; Rudys 2023), suggesting that the sufficiency of retirement savings adequacy is dependent on the rate and frequency of pension contribution remittance, investment returns, the investment and participation choices made by individual scheme participants, their employers, and policymakers. These results underscore the critical importance of accurate and timely contribution remittances in achieving the objectives of CPS to secure retirees' financial futures.

The outcomes of our study hold critical implications for pension risk management and the overall success of contributory pension schemes. Failure to remit contributions on time can create uncertainty about the availability of funds in RSAs at retirement, potentially undermining the scheme's objectives of providing adequate pension income. Therefore, addressing timely remittance should be a top priority throughout the lifespan of a pension fund.

As a prudent recommendation, we assert that it is crucial to promote strict compliance with regulations on pension remittance. Employers should prioritise the timely and complete remittance of their employees' pension contributions, as stipulated in Section 11(6) of the Nigerian Pension Reform Act of 2014. This commitment will improve pension fund management, benefiting both employers and employees. Also, to mitigate the impact of partial and non-remittance of pension fund contributions, we propose voluntary contributions of funds as an innovative strategy. Encouraging voluntary contributions and notifying CPS sponsors of unpaid RSA contributions and accrued interest can help minimise the loss of investment returns resulting from partial and non-remittance of mandatory contributions. These strategies may offer practical solutions for PFAs and policymakers to enhance the financial security of scheme participants.

We acknowledge some limitations in our study. Firstly, our historical securities data may not fully capture the dynamics of future market behaviour. Also, we did not examine the fixed deposit interest rate that scheme participants may be eligible for on their small cash reserve, which will depend on what the PFA is willing to offer. Second, we examine CONUASS salary data with 7-grade levels, resulting in 14 periods (the beginning and end

of the grade level) throughout assets accumulations in the RSA. Future research should examine the step levels instead of the grade level to understand the effects of funding scenarios on the RSA balance. Additionally, our study relies on university data, where career progression is contingent on scholarly publications and advanced degrees, differing from the general Nigerian labour market, where promotions and upgrades typically occur every three years. This divergence highlights the potential issue of professional stagnation. Notably, we did not delve into the specific subject of career stagnation within the workplace in this study. This can be explored in future research to examine the impact of career stagnation and breaks on future balances and accumulations in RSAs, considering different employment contexts.

In an era of evolving pension systems and economic challenges, our findings offer valuable insights for policymakers, PFAs, and participants in CPS. Addressing contribution remittance issues is imperative to ensure the financial security of retirees and the continued success of pension programs.

4.5 Appendix

4.5.1 Descriptive Statistics

Table 4.15: Descriptive statistics of responses

| Variables | Observation | Mean | <i>Std.Dev</i> |
|-------------|-------------|-------------|----------------|
| SCR | 73 | 1.68 | 0.468 |
| Yes | 23 | | |
| No | 50 | | |
| PR_1 | 73 | 1.71 | 0.458 |
| Yes | 21 | | |
| No | 52 | | |
| PR_2 | 73 | 1.58 | 0.498 |
| Yes | 31 | | |
| No | 42 | | |
| NR_1 | 73 | 1.78 | 0.417 |
| Yes | 16 | | |
| No | 57 | | |
| NR_2 | 73 | 1.7 | 0.462 |
| Yes | 22 | | |
| No | 51 | | |

Table 4.14: Respondents demographics and questionnaires

| Panel A: Demographics | |
|--------------------------------|---|
| | Obs. |
| <u>Gender</u> | 73 |
| Male | 58 |
| Female | 15 |
| <u>Age</u> | 73 |
| 26 - 35 | 29 |
| 36 - 45 | 23 |
| 46+ | 21 |
| <u>Designation</u> | 73 |
| Assistant Lecturer | 7 |
| Lecturer II | 26 |
| Lecturer I | 40 |
| Panel B: Questionnaires | |
| Q1 | There is a deduction of pensions from your payslips. |
| SCR | There is a complete remittance of pensions, encompassing both employer and employee contributions, reflected in your RSA statement. |
| PR_1 | There is either the employer or the employee, but not both remittance of pensions in your RSA statement in CONUASS 01. |
| PR_2 | There is either the employer or the employee, but not both remittance of pensions in your RSA statement in CONUASS 02. |
| NR_1 | There is neither the employer nor the employee remittance of pensions in your RSA statement in CONUASS 01. |
| NR_2 | There is neither the employer nor the employee remittance of pensions in your RSA statement in CONUASS 02. |

FUND INVESTMENT PERFORMANCE AND UNCERTAINTY

"No matter how calm you are, no matter how long-term an investor you are, no matter what your horizons, when the market is jumping around, you feel uncertainty in your gut, and it is hard to resist that"

– Peter Bernstein

This study aims to evaluate how policy uncertainty and inflation risk affect the returns of thrift saving funds (TSF) and, in comparison to their benchmarks, to determine how the fund fares. It also seeks to investigate the significance of performance measures when evaluating TSF investment returns. The sample includes TSF investments made in the US and MSCI World Index from 1989 to 2023, with data obtained from the Thrift Savings Plans and the Federal Reserve Bank of St. Louis database. The study shows that policy uncertainty and inflation risk impact TSF investment returns. When compared to benchmarks, TSF performs well by replicating them, and the choice of performance measures does not change TSF's rankings. The study highlights that uncertainty measures have varying impacts on TSF returns depending on the regime, thus challenging the idea of a uniform impact. This study provides significant insights for scheme participants, investors, financial analysts and policymakers, thus improving our understanding of TSF's performance in evolving market situations.

Keywords Thrift saving plan and funds, Passive fund, Policy uncertainty, Performance measures, Inflation risk

JEL Classification C58, E32, E37, E60, G12, G20, J32,

5.1 Introduction

Thrift savings plan (TSP) receives regular contributions from members to invest in five individual passive funds (G, F, C, S, and I)¹ called Thrift Savings Funds (TSF). Like other pension funds, these TSFs primarily invest in equities and bond markets to achieve their medium-to-long-term goals. With TSP being a defined contribution plan (DC), the emphasis is now on investment that optimises risk-adjusted returns rather than asset-liability immunisation. Many workers today hope to rely on their TSF assets to provide them with a suitable retirement income. These workers' TSFs must perform well over their working lifetime for them to achieve retirement income stability.

Given the TSF's passive investment strategy, it is reasonable to anticipate stable fund balances across all TSFs (Skidmore, Torrejón, and Pare 2021). The investment manager's sole fiduciary responsibility is to manage the funds in a manner that prioritises the interests of members. However, members of Congress seek to manipulate TSP funds for political reasons due to their significant financial impact. This situation could potentially affect TSF's financial stability and returns, which is a concern. Also, studies in asset pricing literature indicate that economic policy uncertainty (EPU) affects investment returns (Al-Thaqeb and Algharabali 2019; Ali et al. 2022). This is due to the systemic risk factor of EPU impacting all sectors of the economy during economic downturns (Pastor and Veronesi 2012; Pástor and Veronesi 2013; Kelly, Pástor, and Veronesi 2016; Al-Thaqeb and Algharabali 2019).

The previous literature (Nestler 2007; Redding 2009; Turner, Klein, and Stein 2016; Skidmore, Torrejón, and Pare 2021) has extensively investigated numerous facets of TSP. Nonetheless, this study delves deeper into a plethora of uncharted characteristics that have piqued the curiosity of researchers lately (Skidmore, Torrejón, and Pare 2021; Ali et al. 2022).

¹G Fund -Government Securities Investment Fund, F Fund - Fixed Income Index Investment Fund, C Fund-Common Stock Index Investment Fund, S Fund -Small Capitalisation Stock Index Investment Fund, and I Fund -International Stock Index Investment Fund.

Geopolitical risk causes volatility and uncertainty (Caldara and Iacoviello 2022; Shen and Hong 2023), leading to inflation and interest rate hikes. These may limit investment return potential. Hence, recent economic and political events have sparked renewed interest in analysing the economic impact of policy uncertainty, as demonstrated by (Bloom 2009; Baker, Bloom, and Davis 2016). To this end, various empirical studies have investigated the effects of economic policy uncertainties on returns, considering time-varying, structural shifts, and different market conditions. Notable examples include the works of (Arouri et al. 2016; Scarciuffolo and Etienne 2021; Liu et al. 2022). In addition, global economic policy uncertainty (GEPU) factors that influence economic and financial performances have been explored by (Zhu et al. 2017; Basher, Haug, and Sadorsky 2018; Hoque and Zaidi 2019; Ali et al. 2023). These empirical studies show that a nonlinear framework is necessary to understand the relationship between risk factors like policy uncertainties and return performance. The framework considers market volatilities and structural shifts in market behaviour during endogenous and exogenous events (Hoque and Zaidi 2019).

Despite these efforts, the relationship between policy uncertainty and pension funds has received relatively little attention. While (Ali et al. 2022) have investigated the impact of policy uncertainty shocks on pension funds and other institutional investment returns in New Zealand, they demonstrate that policy uncertainties pose a systematic and non-diversifiable risk factor in institutional investment returns. However, the impact of policy uncertainties on pension fund returns in a regime-shift environment remains unexplored. Therefore, it is crucial to analyse how policy uncertainties affect pension fund returns during a regime-shift environment to understand the influence of the risk-return relationship on fund performance. This investigation can provide insight into questions in asset pricing and portfolio management, offering a comprehensive view of the impact of risk factors on fund performance. Our study aims to address this gap in the literature by analysing TSF, a passive fund and answering the following questions: Does policy uncertainty risk have an impact on TSF returns? To what extent does inflation risk affect the returns of TSF? In comparison to her benchmarks, how do the returns of TSF fare? Additionally, does the choice of performance measures hold significance when evaluating TSF returns?

Hence, the contribution of our paper is threefold, Firstly, our paper seeks to contribute

to this growing body of research by conducting the first historical investigation into the impacts of policy uncertainties on TSF returns, Using monthly TSF return data dating back to 1989. We approach this developing strand of the literature from a novel perspective by exploring the role of policy uncertainties and inflation risks as determinants of TSF investment returns. We thus consider the potential presence of structural breaks and regime shifts, which can introduce disparate levels of uncertainty in a regime-switching environment (Hamilton 2010; Hamilton 2016), and subsequently influence the relationship between policy uncertainties and individual TSF investment fund returns.

Secondly, studying the performance of TSF about its benchmarks can provide insight into the funds' investment management. Previous active funds studies (Petraki and Zalewska 2017; Otero-González et al. 2021) focused on how Pension funds outperform their benchmarks by expanding their portfolios. Our study examines the performance of TSF, a passive fund, to its benchmark, offering new insights into the investment management practices of TSF. This paper is the first to discuss how TSF perform to their benchmarks.

Thirdly, we contribute to a long-standing discussion regarding asset management's importance by examining fund performance measures. While most literature on fund performance centres on mutual funds (Sharpe 1966; Carhart 1997; Eling and Schuhmacher 2007; Cuthbertson, Nitzsche, and O'Sullivan 2022), hedge funds (Fung and Hsieh 2000; Eling and Schuhmacher 2007; Baquero and Verbeek 2022), a paucity of research has been undertaken on pension funds. We examine these unexplored features of research interest in addition to the work of (Petraki and Zalewska 2017). Our paper expands on this study by analysing various performance measures on TSF. Picking the right measure is crucial for TSF investors because the literature on investment funds has conflicting findings on whether the evaluation of funds is affected by the performance measure used. Non-normal funds returns are a concern because classic Sharpe ratios may not be sufficient to evaluate them with non-normal return distributions (Dombrowski, Drobotz, and Momtaz 2023). Alternative performance measures yield consistent rankings for hedge funds (Eling and Schuhmacher 2007), mutual funds (Eling 2008; Guo and Xiao 2016), and cryptocurrency (Dombrowski, Drobotz, and Momtaz 2023). However, some research found that the choice of performance measures affects fund rankings (Adcock et al. 2020; Santomil, Fernández, and González

2022).

While (Brogaard and Detzel 2015) suggests that EPU and stock prices can have positive and negative relationships, (Hoque and Zaidi 2019; Chiang 2020) supports this argument with further evidence. Using passive fund returns, this study shows that policy uncertainty has different impacts on TSF returns in different regimes. Furthermore, our findings demonstrate that inflation rate changes show a notable negative correlation with F Fund returns, while C and S Funds show a significant positive correlation with inflation rate changes. Our results are consistent with previous studies conducted by (Campbell and Ammer 1993; Engsted and Tanggaard 2002; Kim and In 2005). Finally, TSFs demonstrate an efficient approach to tracking their respective benchmarks.

The paper's structure includes an overview of TSP and TSF before section 2. Then, section 2 presents data and preliminary analysis. Section 3 explains the methodology used, while section 4 presents empirical results with a discussion. Finally, an appendix follows in the concluding section.

5.1.1 TSP and TSF overview

The TSP is a DC retirement savings plan for all US Federal employees and uniformed service members. The Federal Retirement Thrift Investment Board (FRTIB) administers it. TSP allows participants to save for retirement by setting aside a portion of their income into a retirement savings account. Payroll deductions, known as contributions, are taken from participants' pay either before taxes are withheld (traditional contributions) or after taxes have been withheld (Roth contributions).

Members' contributions are distributed to their respective TSFs, each having unique features. The G Fund caters to conservative investors and operates as a debt owed to government employees and retirees who contributed to the Fund. The F Fund offers higher long-term returns with relatively low risk by investing in investment-grade securities. The C Fund focuses on large and mid-sized US company stocks for potential gains, and the S Fund offers potential for earnings from small-to-mid-sized US companies, providing diversification in domestic equity investments. The I Fund furnishes an opportunity for equity

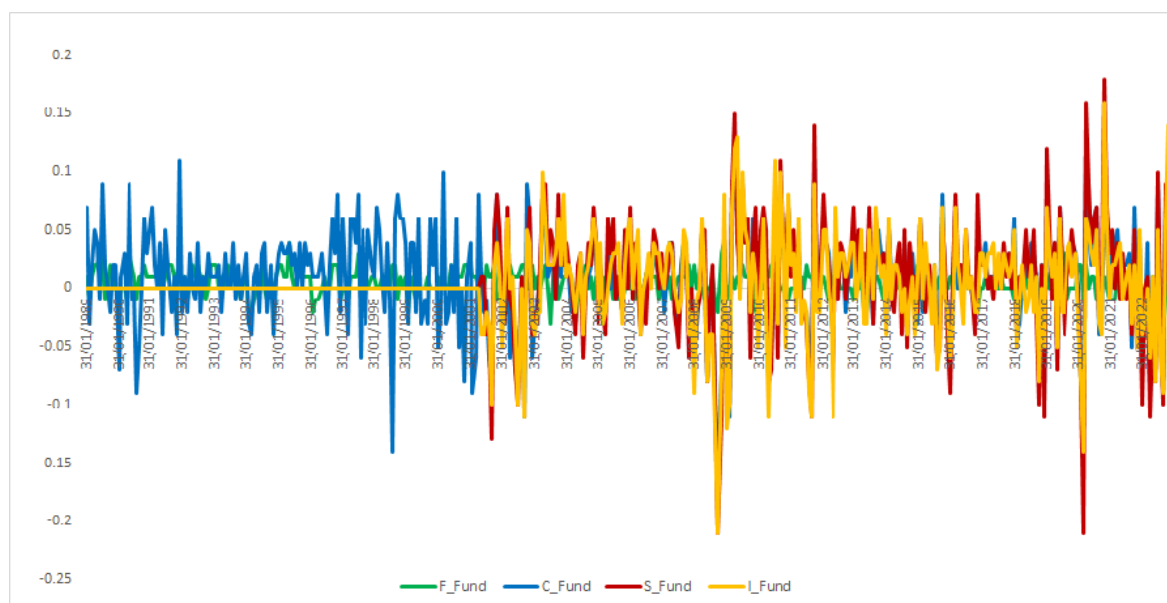
gains from non-US companies, allowing for diversification in the fund participant's stock allocation.

Blackrock Capital Advisers employs a passive management approach with reduced fees for fund investments. TSP has low investment expenses and transparent funds, which are notable in the industry. As of December 31, 2021, TSP had around 6.5 million participants (FRTIB, 2021). TSP is a large pension fund ranked fourth globally with \$774.2B in assets (Visual Capitalist, 2022). The TSP has earned the distinction of being the preeminent DC plan worldwide, thereby occupying the pinnacle position among public sector pension funds across the globe.

5.2 Data and preliminary analysis

5.2.1 Returns

Figure 5.1: Time series plot of TSP returns



We analysed monthly returns data spanning from January 1989 to February 2023 for TSP investment funds F and C; and from May 2001 to February 2023 for funds S and I, along with their respective benchmarks. TSP's performance may be affected by the benchmark characteristics. Nonetheless, the goal of TSP is to replicate the market performance, not outperform it. The F Fund matches the performances of the Bloomberg U.S. Aggre-

gate Bond Index (US_AB), the C Fund mirrors the performance of the Standard and Poor's 500 (S&P 500) Index, the S Fund aligns with the Dow Jones U.S. Completion Total Stock Market Index (DJ_TSM), and the I Fund tracks the Morgan Stanley Capital International (MSCI) index for Europe, Australasia, and the Far East (EAFE). The G Fund is not indexed. Table 5.1 summarises this information, while Table 5.2 (Panel A, B and C) presents descriptive statistics for the monthly returns distributions of the TSF and their benchmarks. The table displays statistical information regarding the first four moments of the return distribution, including mean value, standard deviation, skewness, and kurtosis. It also presents the Jarque-Bera Test and the various panel unit root tests such as the Ljung-Box statistics (Q), augmented Dickey-Fuller tests (ADF), Levin, Lin, and Chu test (LLC), and the Phillips-Perron test (PP). In the appendix, Table 5.12 shows the outcomes of the Panel cointegration test. We show the TSF returns time series plot in Figure 5.1. Thus, it illustrates that the returns exhibit a non-linear trend.

5.2.2 Economic state variables

Table 5.1 presents economic state variables for the study, while Table 5.2 (Panel D) shows the descriptive statistics, the Jarque Bera test, and variance inflation factors (VIF) for these variables. In the appendix's Table 5.11, we show the unit root and multicollinearity test results. The aim is to determine the impact of changes in EPU (GEPU) and other economic state variables on the performance and returns of TSF investment. We began by considering the EPU and the GEPU Indexes (Baker, Bloom, and Davis 2016). These indexes quantify uncertainty surrounding government policies and their economic effects, both at the national and global levels. For the credit risk, we used the Default Spread (DS). The DS represents the difference between the seasoned corporate bond yield of Moody's Aaa and the seasoned rate of Moody's Baa. This measure provides insights into the credit risk associated with investments. We employed the Term Spread (TS) to evaluate economic changes. The TS is a marker of both market prospects and economic conditions. By subtracting the three-month T-bill rate from the ten-year T-bill rate, we obtained the TS.

Our study considered the Federal Fund Effective Rate as the interest rate (IntR). This short-term interest rate provides significant information about the monetary policy envi-

ronment in the US economy. Inflation, a significant economic state variable, was proxied by the Consumer Price Index (CPI). The CPI measures changes in the prices of goods and services, helping us understand inflationary trends and their impact on investment returns. To assess real output, we employed the industrial production index (IndP). This index provides valuable information about the overall level of industrial production and serves as an indicator of economic activity. As a benchmark for changes in oil prices (OP), we used the spot crude price - West Texas Intermediate (WTI). The price of WTI is subject to influential factors, including but not limited to supply, demand, geopolitical events, and the macroeconomic climate. By considering OP, we gain insights into the impact of changes in oil prices on the investment returns of TSFs. Furthermore, we analysed equity market volatility (EMV) components, including EMV for the exchange rate (ExcR). By including these measures, we can assess the impact of policy uncertainty on the investment returns of TSFs. We hope to enhance our understanding of the relationship between these variables

and TSF investment returns.

Table 5.1: Definitions of terms and variables

| Symbol | Variables | Definitions and Source |
|----------------|--------------------------|--|
| Basic Series | | |
| | TSF | thriftsavingsplan.gov |
| G Fund | | The G Fund aims to preserve capital and achieve returns higher than short-term U.S. Treasury securities. |
| F Fund | | Fixed Income Index Investment Fund |
| C Fund | | Common Stock Index Investment Fund |
| S Fund | | Small Capitalisation Stock Index Investment Fund |
| I Fund | | International Stock Index Investment Fund |
| | Benchmark indices | thriftsavingsplan.gov |
| US-AB | | Bloomberg U.S. Aggregate Bond Index |
| S&P 500 | | Standard & Poor's 500 Stock Index |
| DJ-TSM | | Dow Jones U.S. Completion TSM Index |
| EAFE | | MSCI EAFE Stock Index |
| | Economic state variables | fred.stlouisfed.org |
| DS | | Default Spread |
| IntR | | Interest rate |
| CPI | | Consumer Price Index |
| TS | | Term Spread |
| IndP | | Industrial Production |
| OP | | Oil Price |
| ExcR | | Exchange Rate |
| EPU | | Economic Policy Uncertainty |
| GEPU | | Global Economic Policy Uncertainty |
| Derived Series | | |
| IntR | | $\Delta IntR_{i,t} = \ln \left(\frac{IntR_t}{IntR_{t-1}} \right) \times 100$ |
| CPI | | $\Delta CPI_{i,t} = \ln \left(\frac{CPI_t}{CPI_{t-1}} \right) \times 100$ |
| ExcR | | $\Delta ExcR_{i,t} = \ln \left(\frac{ExcR_t}{ExcR_{t-1}} \right) \times 100$ |
| DS | | $DS_{i,t} = (Aaa_t - Baa_t)$ |
| TS | | $TS_{i,t} = (10 \text{ Yr T-bill Rate}_t - 3 \text{ Month T-bill Rate}_t)$ |
| EPU | | $\Delta EPU_{i,t} = \ln \left(\frac{EPU_t}{EPU_{t-1}} \right) \times 100$ |
| GEPU | | $\Delta GEPU_{i,t} = \ln \left(\frac{CPI_t}{GEPU_{t-1}} \right) \times 100$ |
| IndP | | $\Delta IndP_{i,t} = \ln \left(\frac{IndP_t}{IndP_{t-1}} \right) \times 100$ |
| OP | | $\Delta OP_{i,t} = \ln \left(\frac{OP_t}{OP_{t-1}} \right) \times 100$ |

Notes: We utilised the derived series to produce viable data from the initial raw data series. Default Spread (DS): The difference between the Aaa and Baa bond yields. Term Spread (TS): The difference between the 10-year Treasury bill rate and the 3-month Treasury bill rate. $\Delta_{i,t}$ represents the monthly change of an index or variable i at time t .

Table 5.2: Descriptive Statistics on Monthly Returns and Economic State Variables

| Panel A: TSF assets and risk profile | | | | | |
|---|--------|--------|--------|--------|--------|
| | G Fund | F Fund | C Fund | S Fund | I Fund |
| Risk profile | low | low | medium | high | high |
| Assets (\$'billion) | 292.6 | 30.2 | 262.9 | 78.5 | 61.6 |

| Panel B: Descriptive statistics for the TSF | | | | | |
|--|-----------|-----------|-----------|------------|--|
| | F Fund | C Fund | S Fund | I Fund | |
| Mean return, in % | 0.44 | 0.92 | 0.54 | 0.32 | |
| Standard deviation of return, in % | 1.15 | 4.28 | 4.33 | 3.94 | |
| Min, in % | -4.31 | -16.83 | -21.4 | -20.59 | |
| Max, in % | 3.84 | 12.81 | 18.26 | 15.54 | |
| Skewness | -0.39 | -0.53 | -0.43 | -0.43 | |
| Excess Kurtosis | 1.25 | 0.96 | 4.31 | 3.82 | |
| Q(8) | 18.51** | 10.87 | 10.30 | 11.93 | |
| Q(16) | 20.89 | 15.97 | 22.76 | 20.99 | |
| Q(24) | 28.65 | 21.05 | 29.27 | D 26.83 | |
| ADF(4) | -6.09*** | -7.51*** | -7.82*** | -7.69*** | |
| ADF(4,t) | -8.53*** | -8.39*** | -8.26*** | -7.85*** | |
| PP (4) | -17.99** | -20.42** | -18.95** | -18.00** | |
| LLC | -17.41*** | -20.49*** | -18.85*** | -17.92*** | |
| Jarque-Bera Test | 38.56*** | 35.80*** | 335.55*** | 267.85**** | |
| Number of monthly returns | 410 | 410 | 262 | 262 | |

| Panel C: Benchmark Index | | | | | |
|---------------------------------|-------|---------|--------|-------|--|
| | US-AI | S&P 500 | DJ-TSM | EAFE | |
| Mean Return in % | 0.44 | 0.92 | 0.53 | 0.31 | |
| Standard Deviation in % | 1.15 | 4.30 | 4.33 | 3.89 | |
| Skewness | -0.39 | -0.53 | -0.43 | -0.54 | |
| Excess Kurtosis | 1.22 | 0.96 | 4.24 | 3.79 | |

| Panel D: : Summary statistics (Independent variables) | | | | | | | |
|--|-----|-------|--------|----------|----------|------|------------------|
| | Obs | Mean | Stdev. | Skewness | kurtosis | VIF | Jarque-Bera Test |
| IntR | 410 | 0.17 | 19.52 | 5.59 | 76.09 | 1.28 | 102074*** |
| CPI | 410 | -0.22 | 0.28 | 0.93 | 8.84 | 1.30 | 1412.3*** |
| ExcR | 262 | -0.05 | 1.74 | 0.11 | 2.86 | 1.07 | 143.1*** |
| DS | 410 | -0.95 | 0.37 | -3.24 | 15.19 | 1.19 | 4712.4*** |
| TS | 410 | 1.60 | 1.15 | -0.01 | -1.00 | 1.06 | 16.64*** |
| EPU | 410 | -0.04 | 17.37 | -0.45 | 2.40 | 1.78 | 114.29*** |
| GEPUP | 262 | -0.28 | 14.15 | -0.78 | 3.68 | 1.80 | 277.82*** |
| IndP | 410 | 0.00 | 0.01 | 6.21 | 88.97 | 1.37 | 139243*** |
| OP | 262 | 0.00 | 0.08 | 1.14 | 13.11 | 1.31 | 3062.7*** |

Notes from Table 5.2 above: In Table 5.2, we present the assets of the individual fund as of 12/31/2022 in conjunction with the risk profile outlined in Panel A. Panel B presents the results of the summary and panel unit root tests. At a lag n , the Ljung-Box statistics (Q) conforms to a χ^2 distribution with n degrees of freedom. $ADF(4)$ and $ADF(4, t)$ are the augmented Dickey-Fuller tests that use four lags and four lags with the trend, LLC is the Levin, Lin, and Chu test, while $PP(4)$ is the Phillips-Perron test with four lags. While the $Q(8)$ value implies the potential presence of some autocorrelation within the F Fund, the other funds at $Q(8,16 \text{ \& } 24)$ do not demonstrate any statistically significant autocorrelation at a significance level of 5%. The null hypothesis of a unit root is rejected based on the results of the $ADF(4)$ and $ADF(4, t)$. The LLC results show rejection of the null hypothesis of the time series having a unit root due to low p-values. The $PP(4)$ results provide convincing evidence against the null hypothesis of a unit root and favour the alternative hypothesis of stationarity for the series.

From the Panel B results of the Jarque Bera test, the p-values from the test were less than 0.001, rejecting the null hypothesis of normal distribution. Hence, none of the TSF investment returns variables follows a normal distribution. The excess kurtosis for F and C Funds is thinner than a normal distribution, while the excess kurtosis for S and I Funds is fatter than a normal distribution.

Panel C presents the summary statistics of the benchmark index. Panel D shows the summary statistics, variance inflation factor (VIF) and Jarque Bera test results of economic state and uncertainties variables. The chi-squared statistic and p-value (< 0.001) from the test reject the null hypothesis of normal distribution, concluding that none of the variables follows a normal distribution. The VIF analysis tested for multicollinearity and found that the economic state and uncertainties variables have a low correlation, as the VIF values ranged between 1.06 and 1.80, indicating low levels of multicollinearity. The *, **, and *** represent statistical significance levels of 10%, 5%, and 1%, respectively.

Table 5.3: Means and Variance measures

| Panel A: Tests on the Differences of Mean Returns | | | | | | | |
|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------|------|--|
| | Shapiro-Wilk test | | Levene test | | Wilcoxon test | | |
| F Fund vs US-AI | 0.983 vs 0.984 | | 3.09*** | | 84299 | | |
| C Fund vs S&P 500 | 0.980 vs 0.979 | | 1.60** | | 83970 | | |
| S Fund vs DJ-TSM | 0.969 vs 0.969 | | 4.37*** | | 35420 | | |
| I Fund vs EAFE | 0.976 vs 0.973 | | 462.26*** | | 35330 | | |
| Panel B: Returns and Volatility for Different Sub-sample Periods | | | | | | | |
| | 1989 - 2000 | | 2001 - 2012 | | 2013 - 2023 | | |
| | MMR | Vol. | MMR | Vol. | MMR | Vol. | |
| G Fund | 0.57 | 0.08 | 0.31 | 0.10 | 0.17 | 0.06 | |
| F Fund | 0.67 | 1.12 | 0.48 | 1.03 | 0.11 | 1.24 | |
| C Fund | 1.36 | 3.95 | 0.32 | 4.58 | 1.09 | 4.24 | |
| S Fund | | | 0.70 | 5.32 | 0.98 | 5.41 | |
| I Fund | | | 0.46 | 5.32 | 0.53 | 4.34 | |
| Panel C: Tests on the Differences of Mean Returns, Sub-sample periods | | | | | | | |
| | Levene test | | Wilcoxon test | | | | |
| | 1989 - 2000 vs. 2001 - 2012 | 2001 - 2012 vs. 2013 - 2023 | 1989 - 2000 vs. 2001 - 2012 | 2001 - 2012 vs. 2013 - 2023 | | | |
| G Fund | 1.901** | 1.652** | 20465*** | 15190*** | | | |
| F Fund | 7.114*** | 17.827*** | 11455 | 10596** | | | |
| C Fund | 2.828*** | 1.544*** | 11702 | 7860.5 | | | |
| S Fund | | 4.109*** | | 8619.5 | | | |
| I Fund | | 3.654*** | | 9051.5 | | | |

Notes: MMR and Vol. denote mean monthly returns and volatility, respectively. **, and *** represent 5% and 1% respectively.

5.3 Methods

5.3.1 TSFs returns analysis

We used the Shapiro-Wilk test to determine the normality distribution of TSF returns. In Table 5.3 Panel A, the p-values for all individual funds and their respective benchmarks are less than the 5% significance level; therefore, we reject the null hypothesis and conclude that the TSF returns do not follow a normal distribution. We proceed with Levene's test to assess the homogeneity of variance before performing the heterogeneity test (*t* - *test*). The obtained p-values are all less than 5% (in Table 5.3 Panel A), thus rejecting the null hypothesis and proving that TSFs and benchmarks differ in variance. We used the Wilcoxon test for the heterogeneity test, and Table 5.3 and Panel A contain the results. The p-values are all greater than 5%. Therefore, at the 5% significance level, we do not reject the null hypothesis that the mean returns of the TSF and their corresponding benchmarks are similar.

Table 5.3 Panel B shows the mean monthly returns and their corresponding volatility. Fund C had the highest mean monthly returns and volatility from 1989 to 2000. S Fund had the highest return and volatility from 2001 to 2012. C Fund had the highest return from 2013 to 2023, followed by S Fund, which had the highest volatility. The Wilcoxon test for the variance of G Fund returns in 1989 - 2000 vs. 2001 - 2012 and 2001 - 2012 vs. 2013 - 2023 is statistically different in Table 5 Panel C. The variance of F Fund returns from 2001 to 2012 vs. 2013 to 2023 is also statistically different. We test the TSF return sub-period variance homogeneity with Levene's test. In Table 5.3 Panel C, all p-values are less than 0.05, rejecting the null hypothesis and proving that TSF returns vary by sub-period.

It is widely acknowledged in the investment industry that relying solely on returns as a metric to evaluate and compare investment funds is inadequate (Grinblatt and Titman 1994; Ferson and Schadt 1996; Kothari and Warner 2001; Angelidis, Giamouridis, and Tesaromatis 2013). Hence, efficient portfolio construction necessitates consideration of risk and returns since investors, such as TSP participants, are generally risk-averse, and investments, such as TSF investment, exhibit inherent risk variability. The goal is to achieve the highest expected return for a given level of risk. To accurately measure investment perfor-

mance, the realised average return of a portfolio over a specific time frame must be adjusted to reflect the risk associated with the portfolio over that same period. This necessitates the use of performance measures that combine both risk and returns. The ensuing discussion will delve into the use of total and market risk as performance metrics.

5.3.2 TSFs and performance measurements

As the higher moments of the return distribution have a crucial impact on performance measures, the importance of multiple performance measures is encouraged (Ornelas, Silva Júnior, and Fernandes 2012; Dombrowski, Drobotz, and Momtaz 2023). To ascertain the significance of the performance measure selection in TSFs returns, we conduct a comparative analysis of 13 distinct performance measures. In the appendix, we provide a detailed definition of the performance measures used in the appendix page. We calculate all measures for each TSF in our sample and determine Spearman rank correlation coefficients between the performance measures of the TSFs following (Eling and Schuhmacher 2007; Dombrowski, Drobotz, and Momtaz 2023).

TSF participants and their financial advisers/managers focus on comparing the performance of the individual TSF fund. The aim is to determine if the fund's rankings are comparable or different based on the chosen performance measures. In Table 5.4, we show the Spearman rank correlation coefficients from a coherence analysis of predetermined performance measures. Strong correlations exist between most performance measures and the traditional Sharpe ratio, except for alpha 0.849 and omega ratio 0.805. The correlation with the Sharpe ratio varies across measures, while the partial moment consistently shows a correlation ≥ 0.805 with the Sharpe ratio. The Sharpe ratio's rank correlation with other performance measures is 0.927 on average. We observe significant correlations among the performance measures. The Kappa 3 and Sortino ratio exhibits the highest possible rank correlation of 1.000. The lowest correlation is 0.805 for the Omega ratio and Sharpe ratio. On average, the rank correlation between all the performance measures is 0.881. Thus, the high correlation values suggest that performance measures create similar rankings. Therefore, we can hypothesise that the choice of performance measures does not affect fund ranking.

We assess the hypothesis that a rank correlation is smaller than a specified given rank correlation x using Fisher z -transformation at a 5% significance level based on prior studies by (Eling and Schuhmacher 2007; Dombrowski, Drobetz, and Momtaz 2023). Our results demonstrate that the hypothesis that the rank correlation is smaller than x is rejected for all x smaller than 0.998, indicating that none of the performance measures significantly affect the evaluation of TSFs compared to the Sharpe ratio. Thus, our findings are consistent with previous studies (Eling and Schuhmacher 2007; Dombrowski, Drobetz, and Momtaz 2023).

5.3.3 TSFs risk-adjusted returns analysis

In Table 5.5, the downside risk shows that an F Fund with a low-risk profile has a low potential for investment returns to fall below expected returns. Other Funds (C, S and I) with medium to high-risk profiles do not share this characteristic as measured by their Value at Risk estimates. The Sharpe ratios indicate the risk-adjusted performance of each TSF. The F Fund has earned 0.39 units of excess return for each unit of risk taken. The C Fund has a moderate ratio of 0.21, indicating reasonable risk-adjusted performance. The S Fund and I Fund show weak risk-adjusted performance with ratios of 0.08 and 0.06, respectively. The S Fund has the lowest idiosyncratic volatility at 0.20, while the F and C Funds have moderate idiosyncratic volatility at 0.22 and 0.24, respectively. This indicates a moderate influence of unique factors on their performance. On the other hand, the I Fund has the highest idiosyncratic volatility at 0.41, implying a substantial proportion of its total volatility arises from unique, non-benchmark-related factors. The TSFs have varying downside risks, ranging from 1.46 to 6.94. The F Fund has low downside risk, indicating stability during negative return periods. Conversely, the C and I Funds exhibit higher downside risk, indicating greater volatility in challenging market conditions. The S Fund has a moderate level of downside risk. The F Fund's tracking error is close to zero, indicating the fund has replicated the benchmark performance. The S and C funds follow suit, while the I Fund tends to deviate from the benchmark based on the tracking error.

In Panel B of Table 5.5, significant and negative monthly alphas are observed based on the TSFs. The TSF, a passive fund, has alpha values ranging from -0.201% to -0.342% based on the risk-adjusted returns computed based on the CAPM, Fama-French three and five-

Table 5.4: Ranked correlations based on different performance measures

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. |
|--|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| <i>Traditional performance measures</i> | | | | | | | | | | | | | |
| 1. Sharpe Ratio | | | | | | | | | | | | | |
| 2. Alpha | 0.930 | | | | | | | | | | | | |
| 3. Information Ratio | 0.849 | 0.647 | | | | | | | | | | | |
| <i>Performance measures based on the value at risk</i> | | | | | | | | | | | | | |
| 4. Excess Return on VaR | 0.909 | 0.991 | 0.572 | | | | | | | | | | |
| 5. Conditional Sharpe Ratio | 0.904 | 0.993 | 0.571 | 0.999 | | | | | | | | | |
| 6. Modified Sharpe Ratio | 0.921 | 0.988 | 0.588 | 0.999 | 0.997 | | | | | | | | |
| <i>Performance measures based on partial moments</i> | | | | | | | | | | | | | |
| 7. Omega Ratio | 0.805 | 0.607 | 0.995 | 0.521 | 0.523 | 0.534 | | | | | | | |
| 8. Sortino Ratio | 0.957 | 0.988 | 0.670 | 0.990 | 0.987 | 0.994 | 0.618 | | | | | | |
| 9. Kappa 3 Ratio | 0.951 | 0.992 | 0.658 | 0.993 | 0.991 | 0.996 | 0.608 | 1.000 | | | | | |
| 10. Upside Potential Ratio | 0.936 | 0.995 | 0.630 | 0.997 | 0.997 | 0.998 | 0.581 | 0.997 | 0.999 | | | | |
| <i>Performance measures based on maximum drawdown</i> | | | | | | | | | | | | | |
| 11. Calmar Ratio | 0.990 | 0.972 | 0.790 | 0.954 | 0.952 | 0.961 | 0.747 | 0.984 | 0.982 | 0.973 | | | |
| 12. Sterling Ratio | 0.971 | 0.942 | 0.707 | 0.953 | 0.944 | 0.966 | 0.645 | 0.982 | 0.976 | 0.965 | 0.974 | | |
| 13. Burke Ratio | 0.998 | 0.906 | 0.872 | 0.884 | 0.877 | 0.898 | 0.828 | 0.939 | 0.932 | 0.914 | 0.980 | 0.962 | |
| Mean | 0.927 | 0.913 | 0.712 | 0.897 | 0.895 | 0.903 | 0.668 | 0.926 | 0.923 | 0.915 | 0.938 | 0.916 | 0.916 |
| Global Mean:0.881 | | | | | | | | | | | | | |
| Maximum:1.000 | | | | | | | | | | | | | |
| Minimum:0.521 | | | | | | | | | | | | | |

Notes: The table shows Spearman rank correlations of 13 performance measures used for comparing TSFs. These measures are categorised based on their approach to assessing the risk-return profile of TSP funds. The row-labelled "Mean" represents the average rank correlation of one performance measure to all other ratios. The study assumes the minimum acceptable return equals the risk-free monthly interest rate and uses an average interest rate for the period under consideration. Thus, a rate of $\tau = 0.22\%$ for the F and C funds and $\tau = 0.10\%$ for the S and I funds. The study analyses the top five maximum drawdowns ($N = 5$) for performance metrics. The value-at-risk-based performance measures use a significance level of $\alpha = 0.05$.

Table 5.5: Results of TSF level analysis

| Panel A: TSF characteristics | | | | |
|-------------------------------------|--------|--------|--------|--------|
| | F Fund | C Fund | S Fund | I Fund |
| Fund size (\$'Billions) | 3.41 | 5.57 | 4.36 | 4.12 |
| Age (months) | 409.18 | 409.18 | 261.14 | 261.14 |
| Idiosyncratic volatility (%) | 0.22 | 0.24 | 0.20 | 0.41 |
| Downside Risk (%) | 1.46 | 6.94 | 6.15 | 6.17 |
| Tracking error | 0.18 | 0.45 | 0.43 | 1.40 |
| Sharpe ratio | 0.39 | 0.21 | 0.08 | 0.06 |

| Panel B: TSF and risk-adjusted returns | | | | |
|---|------------------|------------------|------------------|------------------|
| | F Fund | C Fund | S Fund | I Fund |
| CAPM | -0.202***(-5.72) | -0.220***(-6.98) | - | -0.321***(-7.49) |
| | | | 0.322***(-23.85) | |
| FF-3 | -0.204***(-6.31) | -0.219***(-9.16) | - | - |
| | | | 0.325***(-11.64) | 0.332***(-10.84) |
| CH-4 | -0.201***(-8.31) | -0.211***(-7.48) | -0.323***(-8.23) | - |
| | | | | 0.331***(-10.20) |
| FF-5 | -0.203***(-6.07) | -0.216***(-9.24) | - | - |
| | | | 0.328***(-10.99) | 0.342***(-10.47) |

Notes: From Panel A, The size of the fund is determined by the logarithm of its assets. The FF-5 model (Fama and French 1993) was employed to measure Idiosyncratic volatility using $(\sqrt{Var(\epsilon_t^i)})$, in accordance with (Ang et al. 2006; Ali et al. 2022). We employed a Univariate Value at Risk (VaR) approach to analyse downside risk, following (Ali, Badshah, and Demirer 2022; Ali et al. 2022). For the S and I Funds, which exhibit an excess kurtosis beyond 3, we utilised the Modified Cornish-Fisher VaR method $(Z_{cf} = Z_c + \frac{(Z_c^2-1)S}{6} + \frac{(Z_c^3-3Z_c)K}{24} - \frac{(2Z_c^3-5Z_c)S^2}{36})$ proposed by (Zangari 1996; Favre and Galeano 2002). Panel B presents monthly risk-adjusted alphas for TSFs using various factor specifications such as CAPM, Fama-French, and Carhart. These factors control for market, size, book-to-value, momentum, operating profitability, and investment. Risk-adjusted returns for I Fund are estimated using developed market factors obtained from Kenneth French's website. All returns are reported monthly percentages with Newey-West adjusted t-statistics in parentheses. The levels of significance are denoted by ***, **, * representing confidence levels of 1%, 5%, and 10%.

factor and Carhart four model. This insignificant alpha aligns with the passive investment strategy's goal of matching rather than exceeding benchmark performance. TSF's passive funds effectively track their benchmarks, with all Funds, except I Fund, showing tracking errors below one. Passive investing is particularly suitable for long-term investors like TSP scheme participants who adhere to the efficient market hypothesis, which posits the difficulty of consistently outperforming the benchmarks. TSF's strategy of closely tracking benchmarks aims to capture long-term market returns and provides exposure to a broad range of assets within an index benchmark.

5.3.4 The impact of inflation on the returns of TSFs

The investment of TSF is mainly in stocks and bonds. The increase in inflation, accompanied by high-interest rates and a declining bond market, has prompted a renewed interest in the impact of inflation on households and their retirement portfolios. Mixed findings exist on the relationship between stock returns and economic state variables like inflation (Madadpour and Asgari 2019), nonetheless (Oxman 2012) assert that the relationship depends on the specific measure of inflation used. The hypothesis of inflation illusion (Modigliani and Cohn 1979) and the two-regime-hypothesis (Hess and Lee 1999) offers insights into the relationship between returns and inflation.

During heightened inflation, according to the inflation illusion hypothesis, investors tend to use higher discount rates, resulting in undervalued stocks during high inflation and overvalued stocks during low inflation. (Brandt and Wang 2003) further this hypothesis by suggesting that inflation affects risk aversion, leading to increased equity risk premiums due to heightened investor risk aversion. The two-regime hypothesis shows that the connection between inflation and stock premiums is affected in distinct ways by shocks to both aggregate supply and demand. Increases in the money supply and aggregate demand shocks lead to higher inflation and stock prices.

Conversely, oil price hikes and other aggregate supply shocks increase inflation but lower stock prices. Empirical studies example, (Lee 2010) found a historical shift in the relationship between inflation and equity premiums. To contribute to the current discourse,

we seek to analyse how TSF returns and changes in inflation interrelate and how this inflation rate affects TSF performance. We aim to examine the impact of inflation on TSF returns, as we believe it can affect returns. To do this, We propose the following hypotheses about this relationship:

H_1 : Inflation significantly impact the returns of TSF.

We started with the CAPM model, which assumes market efficiency and only accounts for one aspect - market risk. The CAPM asserts that the expected return on assets or portfolio is related to the risk-free rate and market portfolio return in equilibrium (Fama and French 2004).

$$E(R_{j,t}) = R_{f,t} + \beta_{j,m}[E(R_{m,t} - R_{f,t})] \quad (5.1)$$

In the above equation, the rate of return on the j^{th} asset (R_j) is determined by its systematic risk (β_j) and the rate of return on the market portfolio (R_m) at time t . The capital asset pricing model under uncertain inflation (CAPMUI) advocates, as cited in (Brueggeman, Chen, and Thibodeau 1984), argue that an asset or portfolio's equilibrium rate is determined by both market risk (in our context, measured by the covariance between the TSF investment return and the benchmark return) and inflation risk (measured by the covariance between the TSF investment return and the inflation rate). To factor in the impact of inflation on TSF returns, the model in (Eqn.5.1) was extended to include the inflation factor at time t , denoted as CPI_t , and the sensitivity of asset j to inflation, known as inflation beta ($\beta_{j,cpi}$), shown below;

$$E(R_{j,t}) = R_{f,t} + \beta_{j,m}[E(R_{m,t} - R_{f,t})] + \beta_{j,cpi}CPI_t + \epsilon_{j,t} \quad (5.2)$$

The two-factor model extended into a multi-factor model, incorporating unexpected changes in the yield of term spread between long-term and short-term treasury bills (TS), Changes in the interest rate (IntR), default spread (DS), Unexpected change in industrial output (IndP), and Changes in the inflation rate (CPI) and a lag of this rate. We examined these variables to determine their explanatory power to TSF returns. Thus;

$$E(R_{j,t}) = R_{f,t} + \beta_{j,m}[E(R_{m,t} - R_{f,t})] + \beta_{cpi}CPI_t + \beta_{cpi}CPI_{t-1} + \beta_{Intr}IntR_t + \beta_{ts}TS_t + \beta_{ds}DS_t + \beta_{indp}IndP_t + \epsilon_{j,t} \quad (5.3)$$

For the I Fund (International Stock Index Investment Fund), the model incorporates unexpected changes in the oil price (OP) and its lag and changes in the exchange rate (EXCR). Thus;

$$E(R_{j,t}) = R_{f,t} + \beta_{j,m}[E(R_{m,t} - R_{f,t})] + \beta_{op}OP_t + \beta_{op}OP_{t-1} + \beta_{excr}EXCR_t + \epsilon_{j,t} \quad (5.4)$$

5.3.5 The impact of EPU(GEPU) on the returns of TSF

Government policies, such as changes in fiscal or monetary policies, can cause unexpected changes in the economic environment resulting in economic uncertainty that impacts the economy and businesses (Abel 1983). This uncertainty tends to have broad ramifications that could affect the entire economy (Ali et al. 2022). It leads to market uncertainty and causes businesses and individuals to delay spending and investments (Al-Thaqeb and Algharabali 2019). During times of uncertainty, firms tend to adopt a more cautious approach in their pay-out policies (Panousi and Papanikolaou 2012; Walkup 2016), leading to increased cash holdings (Demir and Ersan 2017; Phan et al. 2019) and reduced capital expenditures (Gulen and Ion 2016), which can lead to disinvestment and economic contraction and ultimately impacting investment returns (Pástor and Veronesi 2013; Gilchrist, Sim, and Zakrajšek 2014). In addition to these effects, EPU can also influence inflation, interest rate hikes, and expected risk premiums, as highlighted by (Pástor and Veronesi 2013).

Hence, the impact of EPU(GEPU) on investment returns is significant due to the introduction of uncertainty into various aspects of a firm's operations, stock market and the overall economy. Empirical studies have demonstrated that EPU affects firm revenue (Al-Thaqeb and Algharabali 2019), cash inflow from operations (Riddick and Whited 2009), cost of financing (Pastor and Veronesi 2012; Kelly, Pástor, and Veronesi 2016; Çolak, Durnev, and Qian 2017; Jens 2017), bond value (Brogaard and Detzel 2015; Fang, Yu, and Li 2017), stock market returns (Pastor and Veronesi 2012; Arouri et al. 2016; Chiang 2019), and investment portfolio value (Pástor and Veronesi 2013; Gilchrist, Sim, and Zakrajšek 2014). As a result, one can surmise that changes in EPU have the potential to cause a significant impact on asset prices because they can affect the projected firm's cash inflows and discount rates (Arouri et al. 2016). To contribute to the current discourse, we explore the relationship be-

tween TSF returns and EPU(GEPU) and determine how it impacts TSF returns performance. To accomplish this, we put forth the subsequent hypotheses:

H₂. Changes in EPU(GEPU) significantly impact the returns of TSF.

We begin our analysis by examining a multifactor market model, a base model for establishing the regime-switching environment.

$$R_{j,t} = \alpha + \beta R_m + \gamma_{epu} \Delta EPU_t + \gamma_{epu_{t-1}} \Delta EPU_{t-1} + \gamma_{cpi} \Delta CPI_t + \gamma_{indp} \Delta IndP_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2) \quad (5.5)$$

$$R_{j,t} = \alpha + \beta R_m + \gamma_{gepu} \Delta GEPU_t + \gamma_{gepu_{t-1}} \Delta GEPU_{t-1} + \gamma_{op} \Delta OP_t + \gamma_{excr} \Delta EXCR_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2) \quad (5.6)$$

where $R_{j,t}$ denotes the return on the investment made by an individual fund j in the month t , while R_m is the return on the market (benchmark) index. The variables ΔEPU_t , ΔEPU_{t-1} , ΔCPI_t , $\Delta IndP_t$, $\Delta GEPU_t$, $\Delta GEPU_{t-1}$, ΔOP_t and $\Delta EXCR_t$ reflect changes in economic policy uncertainty, one lagged EPU, inflation rate, industrial production, global economic policy uncertainty, one lagged GEPU, oil price and exchange rate respectively. ϵ_{it} denotes the error term, while the residuals are presumed to follow a normal distribution.

The Markov regime-switch (MS) dynamic regression model is employed to ascertain the non-linear impacts of policy uncertainty. This approach considers the fact that the influences of transition variables on individual TSF investment returns are state-dependent S_t , following (Arouri et al. 2016; Hoque and Zaidi 2019; Orłowski and Soper 2019). This S_t variable represents a discrete regime that adopts values from the set $\{1, 2, \dots, n\}$, which follows the n -state Markov process. Eqn.5.5. and 5.6. are revised per the MS regression model, as presented below.

$$R_{j,S_t} = \alpha_{S_t} + \beta_{S_t} R_m + \gamma_{epu, S_t} \Delta EPU_t + \gamma_{epu_{t-1}, S_t} \Delta EPU_{t-1} + \gamma_{cpi, S_t} \Delta CPI_t + \gamma_{indp, S_t} \Delta IndP_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2, S_t) \quad (5.7)$$

$$R_{j,S_t} = \alpha_{S_t} + \beta_{S_t} R_m + \gamma_{gepu, S_t} \Delta GEPU_t + \gamma_{gepu_{t-1}, S_t} \Delta GEPU_{t-1} + \gamma_{op, S_t} \Delta OP_t + \gamma_{excr, S_t} \Delta EXCR_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2, S_t) \quad (5.8)$$

The present model Eqn (5.7 & 5.8) incorporates S at state, t , to indicate regime states while keeping all other criteria consistent with Eqn (5.5 & 5.6). This estimation technique enables a wide-ranging shift of variable coefficients γ across various regimes. Based on (Agnello, Dufrenot, and Sousa 2015; Hoque and Zaidi 2019; Orłowski and Soper 2019) we posit that the shift between regimes is contingent upon the identification of a transition variable, d_t such that $P\{S_t | S_{t-1}\} = P\{S_t | S_{t-1}, d_t\}$, and the corresponding transition probability matrix for the three-state Markov process is specified as:

$$P = \begin{bmatrix} P_{11} & P_{21} & P_{31} \\ P_{12} & P_{22} & P_{32} \\ P_{13} & P_{23} & P_{33} \end{bmatrix} \quad (5.9)$$

5.4 Empirical analysis and discussion

5.4.1 Results of the risks associated with inflation on the returns of TSF

The results shown in Table 5.6 show the relationship between inflation risk, market risk and TSF investment returns. In panel A, we observed a positive and significant relationship between TSF returns and the market. Additionally, the changes in the inflation rate display a significant negative relationship with the F Fund returns, whereas C and S Funds show a significant positive relationship with the inflation rate changes. The C Fund's positive impact turned negative with the lagged inflation. Furthermore, the interest rate changes demonstrate a negative and non-statistically significant impact on the returns of investment funds F and C but positive for the S Fund.

On the other hand, oil price volatility displays a positive and statistically significant impact on the returns of investment I Fund. The impact of the exchange rate on the I Fund is non-statistically significant and negative. The F, C, and S Funds have a positive and significant term spread, while the F Fund has a negative and significant default spread. The findings align with (Chen, Roll, and Ross 1986) earlier studies indicating that certain macroeconomic variables systematically impact returns. These sources of risk are priced

significantly in the returns of TSF.

This study examines robustness by estimating Eqn.5.10 and 5.11 with different specifications. The study utilises individual fund and market returns rather than excess returns from Eqn.5.3 and 5.4 because we are interested in the absolute performance of the TSFs portfolios, respectively.

$$R_{j,t} = \alpha + \beta_{j,m}R_{m,t} + \beta_{cpi}CPI_t + \beta_{cpi}CPI_{t-1} + \beta_{intr}IntR_t + \beta_{ts}TS_t + \beta_{ds}DS_t + \beta_{indp}IndP_t + \epsilon_{j,t} \quad (5.10)$$

$$R_{j,t} = \alpha + \beta_{j,m}R_{m,t} + \beta_{op}OP_t + \beta_{op}OP_{t-1} + \beta_{excr}EXCR_t + \epsilon_{j,t} \quad (5.11)$$

The specifications are as defined and specified in Eqn 5.3. and Eqn 5.4. respectively. We show our findings in Panel B of Table 5.6. We observed a significant and positive relation between the returns of TSF and the markets. CPI has a negative and statistically significant relationship with the returns of Fund F but a positive and statistically significant relationship with C and S Funds. The F Fund results align with (Campbell and Ammer 1993) findings. The results of C and S Funds conform with (Engsted and Tanggaard 2002; Kim and In 2005) research, which shows a positive correlation between stock returns and inflation. The positive impact of the C Fund became negative due to the lagged CPI. The results are consistent with the previous results of excess returns, as shown in Panel A. Unlike Panel A, the lag of OP is positive and statistically significant in this report.

We analyse the nonlinear effects of economic state variables and EPU(GEPU) on TSF returns with the MS model in the ensuing section. This model captures structural changes and regime shifts, as the relationship between returns and these state variables is not linear and varies based on variable levels (Barnes 1999).

5.4.2 Results of the impacts of risk factors on TSF returns.

Table 5.7. shows the outcomes obtained from Eqn. 5.7 and 5.8 to three states of MS dynamic regression models. These models allow for the analysis of the impact of EPU (GEPU) and other risk factors on TSF investment returns across low, high, and extreme volatility regimes. The volatility regimes exhibit differing mean returns and variances. We anal-

Table 5.6: Impact of the risks associated with inflation on fund returns

| Panel A:: Results of the impact of inflation risk on the fund returns | | | | |
|--|-----------------|-----------------|-----------------|-----------------|
| | F Fund | C Fund | S Fund | I Fund |
| Mrk | 0.99(328.70)*** | 0.99(538.20)*** | 1.00(486.81)*** | 1.00(146.52)*** |
| CPI | -0.00(-2.04)** | 0.00(3.52)*** | 0.00(2.69)** | |
| CPI(-1) | 0.00(0.01) | -0.00(-2.54)** | -0.00(-1.49) | |
| IntR | -0.00(-1.86) | -0.00(-1.27) | 0.00(0.59) | |
| TS | 0.00(7.94)*** | 0.00(1.99)** | 0.00(2.99)** | |
| DS | -0.00(-2.30)** | 0.00(0.29) | 0.00(0.66) | |
| IndP | 0.00(0.18) | -0.00(-0.66) | -0.00(-1.39) | |
| OP | | | | 0.00(2.35)** |
| OP(-1) | | | | -0.00(-0.58) |
| ExcR | | | | -0.00(-0.56) |
| Random effect | No | Yes | No | No |
| Fixed effect | Yes | No | Yes | Yes |
| Adjusted R ² | 0.99 | 0.99 | 0.99 | 0.98 |
| Hausman test | 3434.1*** | 8.05 | 14.302** | 7.91** |
| F-statistic | 15592.2*** | 44792.3*** | 42474.2*** | 6195.63*** |
| Panel B : Sensitivity analysis | | | | |
| | F Fund | C Fund | S Fund | I Fund |
| Mrk | 1.00(402.06)*** | 0.99(604.14)*** | 0.99(554.59)*** | 0.99(586.98)*** |
| CPI | -0.00(-2.57)** | 0.00(3.61)*** | 0.00(2.98)*** | |
| CPI(-1) | 0.00(1.36) | -0.00(-2.35)** | -0.00(-1.25) | |
| IntR | -0.00(-1.06) | -0.00(-0.78) | 0.00(0.15) | |
| TS | 0.00(1.25) | 0.00(0.09) | -0.00(-0.65) | |
| DS | -0.00(-0.88) | 0.00(0.26) | 0.00(1.57) | |
| IndP | 0.00(0.94) | -0.00(-0.63) | -0.00(-0.43) | |
| OP | | | | 0.00(0.08) |
| OP(-1) | | | | 0.00(2.86)** |
| ExcR | | | | -0.00(-0.08) |
| Random effect | No | Yes | Yes | Yes |
| Fixed effect | Yes | No | No | No |
| Adjusted R ² | 0.99 | 0.99 | 0.99 | 0.99 |
| Hausman test | 20.97*** | 2.48 | 9.46 | 7.72 |
| F-statistic | 23382.9*** | 397815*** | 358397*** | 358804*** |

Notes: **, and *** represent 5% and 1% respectively and t statistics are in parentheses. The variables in the first columns are as defined in Table 1.

Table 5.7: Estimations of the impact of EPU(GEPU) on the returns of TSF in a Three-state Markov Switching environment (Eqs. (5.7) and (5.8)).

| Markov-switching regression | | Fund | C Fund | S Fund | I Fund |
|-----------------------------|--------------------|-------------------|-------------------|-------------------|-------------------|
| | Volatility Regimes | F Fund | C Fund | S Fund | I Fund |
| Constant | Low | 0.00(4.04)*** | 0.001(2.83)** | 0.003(13.90)*** | 0.00(0.01) |
| | High | -0.00(-0.22) | -0.00(-0.91)*** | -0.004(-14.00)*** | 0.00(0.51) |
| | Extreme | -0.00(-2.44)** | 0.004(4.60)*** | -0.00(-0.09) | -0.00(-0.79) |
| MKT | Low | 0.99(622.38)*** | 0.96(471.56)*** | 0.91(232.09)*** | 1.00(237.14)*** |
| | High | 0.99(185.29)*** | 0.99(2875.41)*** | 0.94(168.12)*** | 0.95(90.67)*** |
| | Extreme | 1.00(72.11)*** | 0.93(96.83)*** | 1.00(1326.98)*** | 1.13(99.89)*** |
| ΔEPU | Low | -0.00(-0.51) | -0.00(-5.75)*** | -0.00(-2.09)** | |
| | High | -0.00(-0.88) | 0.00(0.31) | -0.00(-11.93)*** | |
| | Extreme | 0.00(4.86)*** | -0.00(-3.83)*** | -0.00(-2.12)** | |
| ΔEPU_{t-1} | Low | -0.00(-0.51) | -0.00(-4.78)*** | 0.00(13.89)*** | |
| | High | -0.00(-2.40)** | -0.00(-1.44) | 0.00(10.41)*** | |
| | Extreme | -0.00(-0.16) | 0.00(5.96)*** | -0.00(-2.04)** | |
| ΔCPI | Low | 0.00(1.06) | 0.003(5.01)*** | 0.00(1.64) | |
| | High | 0.001(4.40)*** | -0.00(-0.96) | 0.00(10.09)*** | |
| | Extreme | -0.003(-8.64)*** | 0.01(13.74)*** | -0.00(-3.14)*** | |
| $\Delta IndP$ | Low | -0.00(-0.590) | 0.00(0.65) | -0.00(-3.41)*** | |
| | High | 0.00(5.97)*** | -0.00(-0.84) | -0.00(-8.37)*** | |
| | Extreme | 0.003(4.98)*** | -0.002(-2.05)*** | 0.00(1.86)* | |
| ΔGPU | Low | | | | -0.00(-0.17) |
| | High | | | | 0.00(3.65)*** |
| | Extreme | | | | -0.00(-0.82) |
| ΔGPU_{t-1} | Low | | | | -0.00(-0.15) |
| | High | | | | -0.00(-13.54)*** |
| | Extreme | | | | 0.00(1.25) |
| ΔOP | Low | | | | -0.00(-0.86) |
| | High | | | | -0.00(-10.72)*** |
| | Extreme | | | | 0.04(12.13)*** |
| $\Delta EXCR$ | Low | | | | -0.00(-2.41)** |
| | High | | | | 0.00(9.66)*** |
| | Extreme | | | | -0.00(-1.03) |
| log σ : | | -8.02(-199.04)*** | -8.24(-222.30)*** | -7.53(-203.68)*** | -6.17(-152.43)*** |
| Log-likelihood: | | 2664.95 | 2757.70 | 2437.78 | 1812.52 |
| Schwartz Info. Criterion : | | -12.66 | -13.11 | -11.55 | -8.49 |
| Durbin-Watson stat. : | | 2.42 | 2.39 | 2.17 | 2.85 |

Notes: The table shows the test statistics z-statistics in parentheses. **, * and *** represent 5% and 1% respectively.

use the volatility estimates (σ) to verify the presence of volatility regimes. The TSFs show highly significant sigma coefficients, indicating the existence of regimes in the TSF investment returns. On the impact of market risk on TSF returns, our results show a positive and statistically significant influence of market risk on all TSF returns in both volatility regimes, aligning with our earlier findings on inflation-related risks impacting TSF investment returns. Thus we conclude that market returns positively impact all TSF returns in both volatility regimes, indicating time-varying effects of market risks. This finding is consistent with previous empirical studies on time-varying returns beta to market returns (Arouri et al. 2016; Hoque and Zaidi 2019).

Furthermore, in low and extreme volatility regimes, changes in the inflation rate positively affect the returns of the C Fund. In high volatility regimes, changes in inflation rates have positive effects on the returns of F and S Fund but negative impacts on F and S Fund returns in extreme volatility regimes. The results indicate a partial consistency with the risk-related findings about inflation and its impact on TSF returns. Nonetheless, the significant impact and exposure to inflation risk vary depending on regime states. Thus, these findings posit that the effects of inflation on TSF returns are heterogeneous, time-varying, and reliant on the regime, which is consistent with (Li, Narayan, and Zheng 2010; Reboredo 2010). The positive impact of inflation rates on C Funds during low and extreme-volatility periods contrasts with the findings of (Arouri et al. 2016) regarding the S&P 500, except in the high-volatility regime where our results align with theirs.

This study examines the influence of oil price uncertainty on the I Fund returns in different volatility regimes. The significant impact of oil prices on the global economy and the interconnectedness of oil prices and economic policy are well-established (Lin and Bai 2021). Additionally, the relationship between long-term government bond yields of the USA and oil prices exhibits an asymmetry, which can be utilised to forecast policy uncertainty and its potential impact on returns (Ozcelebi 2021). Thus, in a high volatility regime, our results indicate that uncertainty negatively affects the returns of I Fund. While it has a positive impact on the I Fund returns in an extreme-volatility regime. The study discovered that oil price uncertainty has nonlinear and regime-dependent effects on TSF returns, which aligns with previous research on the time-varying impacts of oil prices on

returns such as (Reboredo 2010; Zhu et al. 2017; Smyth and Narayan 2018; Roubaud and Aroui 2018; Hoque and Zaidi 2019; Alola 2021).

The I Fund's returns are negatively affected by exchange rate changes during low-volatility regimes and positively impacted during high-volatility regimes. This indicates that exchange rate fluctuations impact I Fund returns differently depending on the situation, with variations over time and depending on the regime. These results are congruent with previous studies by (Chkili and Nguyen 2014; Sosa, Ortiz, and Cabello 2018; Hoque and Zaidi 2019; Konstantakis et al. 2023; Athari, Kirikkaleli, and Adebayo 2023).

The study examines the effects of changes in industrial production rate on F, C, and S Funds returns. We observed that changes in industrial production rate positively impact F Fund returns in high and extreme volatility regimes. It negatively affects the C Fund during extreme volatility and the S Fund during low and high volatility. The S Fund is impacted positively by changes in the industrial production rate during the extreme volatility regime. The study's findings demonstrate that the effects of production uncertainty on returns vary based on the regime and exhibit nonlinearity. These results align with previous research on the time-varying effects of industrial production on returns (Chevallier 2011; Demiralay and Kilincarslan 2022).

5.4.3 Results of the impact of EPU-GEPU on the returns of TSF across regimes

In this section, we present and discuss the effect of EPU-GEPU on TSF returns in various regimes. Table 5.7 shows the analysed coefficient of the uncertainties and their corresponding lag. The study shows that EPU has a positive impact on the F Fund during extreme volatility but a negative impact on the C Fund during low and extreme volatility. EPU has a negative effect on the S Fund in all regimes. GEPU impacts I Fund negatively in times of low volatility and positively in times of high volatility. These results suggest that the effects of EPU and GEPU on TSF returns vary based on time and regime.

The F Fund results indicate that the relationship between EPU and the bond market, where F Fund investments occurred, is not constant but depends on the volatility regime. In

this case, it is during the extreme volatility that EPU has a notable impact on the bond market, leading to a significant relation between EPU and the F Fund. This finding aligns with a prior study (Brière and Signori 2012), where investors seek stability and security in bonds during extreme volatility, which has consequences for financial markets and decision-makers. Our findings indicate a negative and significant relationship between the EPU and returns from the C Fund. This relationship holds in low and extreme volatility regimes, implying that policy uncertainty consistently impacts the C Fund. Thus, investors tend to be more risk-averse during periods of heightened policy uncertainty. The findings align with previous studies (Fang, Yu, and Li 2017; Al-Thaqeb, Algharabali, and Alabdulghafour 2022; Jabbouri, Farooq, and Jabbouri 2023). Our findings on the S Funds reveal a consistent negative and statistically significant relationship between EPU and the S Fund's performance within each regime.

Prior studies indicate that heightened EPU negatively affects returns in small-cap stocks, as shown in (Chen, Jiang, and Tong 2017; Batabyal and Killins 2021; Killins, Ngo, and Wang 2022). This impact is evident in the market, resulting in a negative significant impact on the returns of the S Funds. Thus, our study aligns with the previous studies. These results underscore the importance of considering policy-related factors when assessing investment in S Fund across varying market conditions. Our analysis of I Funds shows that GEPU has different effects based on volatility levels. Low volatility periods lead to negative returns due to investor preference for stability and aversion to policy uncertainties in the international stock market. Periods of low volatility, although indicating stability in the financial market, may result in negative returns due to policy uncertainties in the international stock market. Such uncertainties may heighten investor risk aversion, leading to negative returns. Thus, our findings align with previous research (Inekwe 2020; Qi, Ning, and Qin 2022). High volatility regimes lead to positive returns as investors interpret policy changes as stabilising factors during turbulent market conditions, where they view the market as less risky, leading to increased stock demand and positive returns. This finding aligns with (Hoque and Zaidi 2019) and conforms to Merton's work and capital market theory (Merton 1990). These findings emphasise the importance of considering policy uncertainty and market dynamics in I Fund investment and policy decision-making. Thus, the empirical results show that uncertainty measures have regime-dependent impacts and do not affect the returns of

TSF uniformly. The effect of EPU/GEPu on TSF returns depends on the state, indicating varying levels of investor risk aversion in different regime states.

5.4.4 Time-varying probability and expected duration

Table 5.8: Estimations of the time-varying transition probabilities Eqn. (5.9).

Panel A: : Time-varying transition probabilities, Probability of staying in

| | F Fund | C Fund | S Fund | I |
|-----------------------------|--------|--------|--------|------|
| $P_{\{low low\}}$ | 0.98 | 0.42 | 0.36 | 0.82 |
| $P_{\{low high\}}$ | 0.00 | 0.57 | 0.17 | 0.09 |
| $P_{\{low extreme\}}$ | 0.01 | 0.00 | 0.46 | 0.08 |
| $P_{\{high low\}}$ | 0.06 | 0.01 | 0.43 | 0.30 |
| $P_{\{high high\}}$ | 0.93 | 0.98 | 0.23 | 0.27 |
| $P_{\{high extreme\}}$ | 0.00 | 0.00 | 0.32 | 0.41 |
| $P_{\{extreme low\}}$ | 0.71 | 0.00 | 0.00 | 0.45 |
| $P_{\{extreme high\}}$ | 0.00 | 0.45 | 0.00 | 0.40 |
| $P_{\{extreme extreme\}}$ | 0.28 | 0.54 | 0.97 | 0.14 |

Panel B: : Expected duration

| | F Fund | C Fund | S Fund | I Fund |
|---------------------------|--------|--------|--------|--------|
| Low volatility regime | 51.57 | 1.74 | 1.57 | 5.60 |
| High volatility regime | 14.44 | 64.87 | 1.30 | 1.38 |
| Extreme volatility regime | 1.40 | 2.19 | 45.77 | 1.16 |

The study further analyses time-varying transition probabilities in Table 5.8 and observes the likelihood of shifting between states. Fund F and I have longer low volatility regimes, while C Fund and S Fund have low (high) and low (extreme) volatility regimes. The results indicate that F and I Funds exhibit more consistent low volatility regimes than C and S Funds, which experience different levels of volatility depending on market conditions. Probability estimations suggest strong persistence with low (extreme) probabilities close to zero for all funds, except for S Fund with 0.46. Estimates indicate that the C and S Funds exhibit persistence with extreme (low) probabilities nearing zero. The likelihood to switch between low and high is weak for F and I Funds, and high and extreme volatility states are weak for F and C but strong for S and I Funds with 0.32 and 0.41.

For the F Fund, we find that low volatility persists for a significant period, approximately 51.57 time units. Moderately changing, the high volatility regime lasts for an expected

duration of 14.44-time units. The brief extreme volatility regime lasts only 1.40-time units, indicating speedy and short-lived changes. The C Fund's low volatility regime lasts 1.74-time units, the high volatility regime lasts 64.87 time units, which is persistent, and the extreme volatility regime lasts 2.19 time units. The expected duration in the S Fund differs based on the volatility regime. During low volatility, it is stable at 1.57. In high volatility, it is shorter at 1.30 with more frequent transitions. In extreme volatility, it increases drastically to 45.77, indicating prolonged periods of volatility. In the I Fund, the model predicts a 5.60 expected duration for low volatility periods, indicating relative stability. Conversely, during high volatility, this drops significantly to 1.38, suggesting shorter-lived periods of volatility. In the extreme volatility regime, the model shows the shortest expected duration of 1.16, indicating brief but intense episodes of market fluctuations.

From Fig. 5.2 and 5.3, the smoothed probabilities of the different regimes, namely the low-volatility regime with probability $P(S(t) = 1)$, high-volatility regime with probability $P(S(t) = 2)$, and extreme volatility regime with probability $P(S(t) = 3)$, have revealed some of the events leading to high-volatility in the returns of TSF in the period under review.

Fig. 5.2a displays the probability of staying in the low-high-extreme volatility regime for the F Fund series. The probability of staying in a low volatility regime is around 98%. There have been some sporadic switching episodes in 2014 and post-2020 pandemic, as well as weaker ones in 2004 and 2016. Fig. 5.2b demonstrates the likelihood of remaining in the low-high-extreme volatility regime for the C Fund series. Around 42% probability is associated with being in a low volatility regime. The possibility of transitioning from a low to extreme volatility regime is negligible. The post-2020 pandemic has witnessed sporadic switching episodes, while 2004 experienced a weaker one. Fig. 5.3a shows the chance of staying in the low-high-extreme volatility regime for the S Fund series. There is a 36% chance of being in a low-volatility regime. The probability of moving from a low to an extreme volatility regime is 46%, and from extreme to low is nearly zero. We observed sporadic switching episodes during the 2008 financial crisis and the post-2020 pandemic. Fig. 5.3b depicts the probability of remaining in the low-high-extreme volatility regime for the I Fund series. The likelihood of being in a low-volatility regime is 82%. The transition probability from low to extreme volatility regime is 0%, and from extreme to low is 45%.

We noticed sporadic switching episodes during the 2008 financial crisis and the post-2020 pandemic.

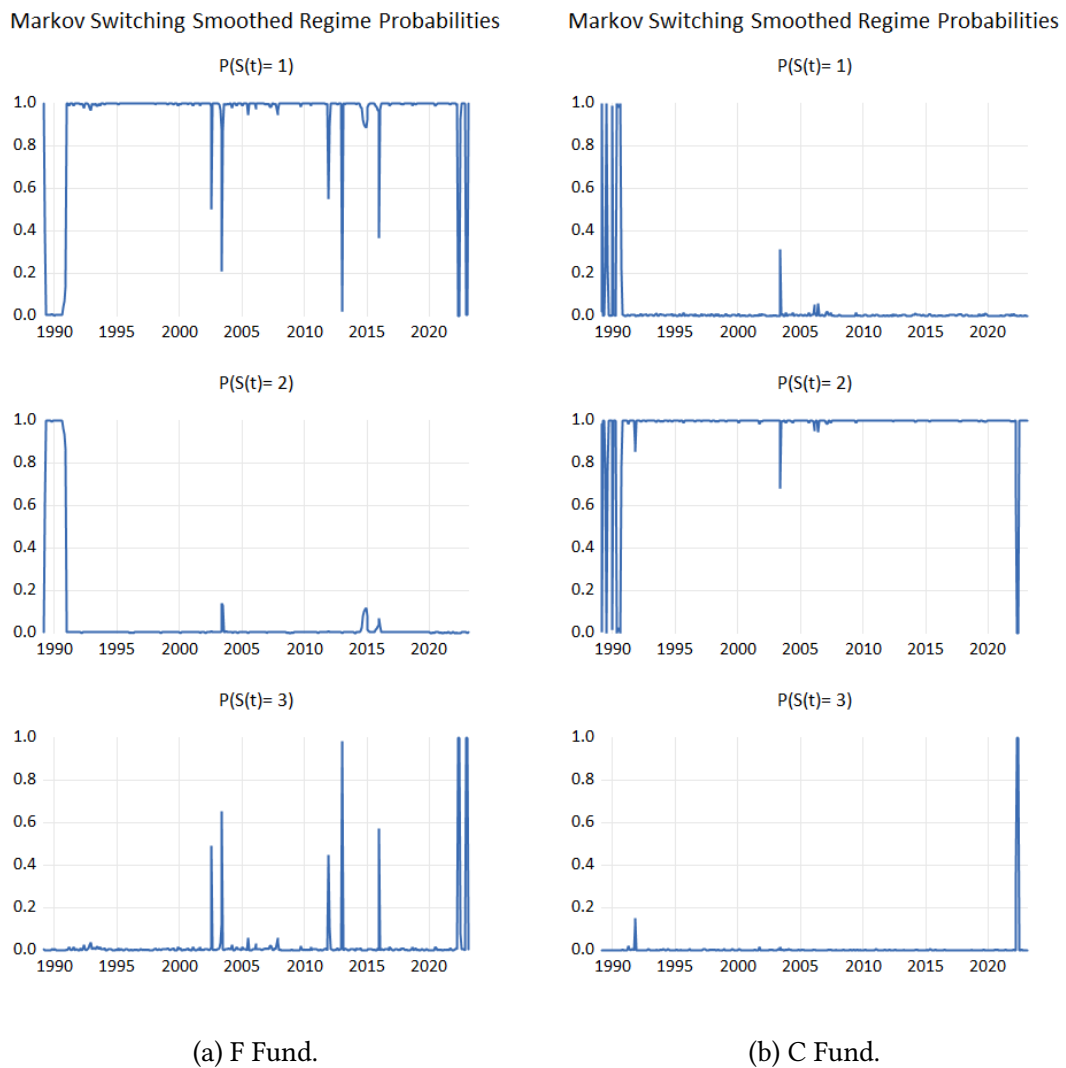


Figure 5.2: Returns and transition probabilities of the 3-regime Markov switching model for F and C Funds

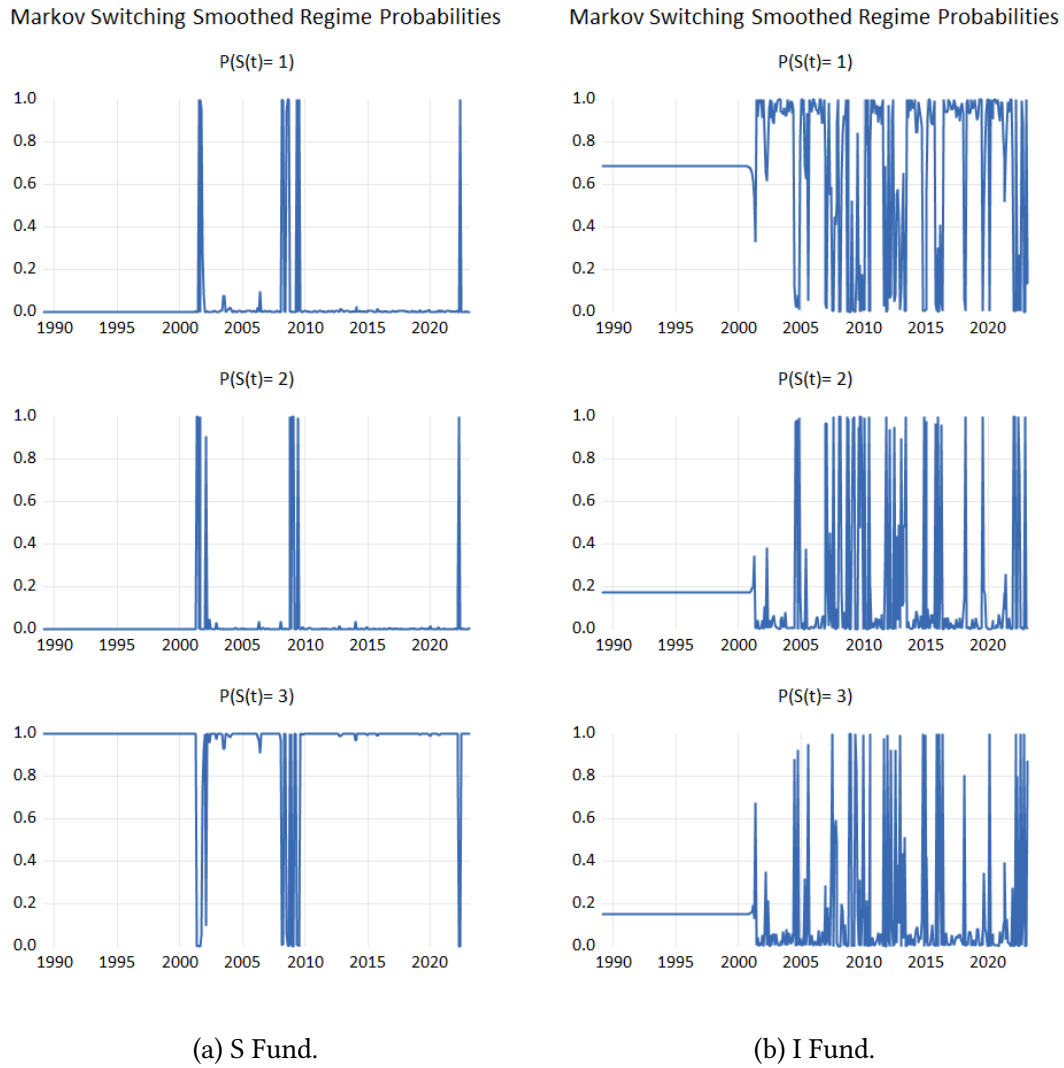


Figure 5.3: Returns and transition probabilities of the 3-regime Markov switching model for S and I Funds

Robustness test

This study tests for robustness by estimating alternative specifications of Eqn. 5.7 and 5.8, replacing individual fund and market returns with their excess returns following (Hoque and Zaidi 2019). Raw returns will capture the absolute impact of policy uncertainty on TSF's investment returns. Excess returns will show the relative performance of the TSF investment returns in the market or a risk-free asset.

$$\begin{aligned}
 (R_{j,S_t} - R_f) = & \alpha_{S_t} + \beta_{S_t}(R_{mkt} - R_f) + \gamma_{epu, S_t} \Delta EPU_t + \gamma_{epu_{t-1}, S_t} \Delta EPU_{t-1} + \\
 & \gamma_{cpi, S_t} \Delta CPI_t + \gamma_{indp, S_t} \Delta IndP_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2, S_t)
 \end{aligned} \tag{5.12}$$

Table 5.9: Estimations of the impact of economic policy uncertainty on TSP funds returns in a Three-state Markov Switching environment ROBUSTNESS (Eqn. (5.12) and (5.13)).

| Panel A: Markov-switching regression | | Volatility Regimes | F Fund | C Fund | S Fund | I Fund |
|--------------------------------------|---------|--------------------|-------------------|-------------------|------------------|--------|
| Constant | Low | -0.00(-3.63)*** | -0.00(-0.94) | 0.00(13.41)*** | -0.00(-0.61) | |
| | High | 0.00(3.25)** | -0.00(-0.22) | -0.00(-14.19)*** | -0.00(-0.57) | |
| | Extreme | -0.00(-0.85) | -0.00(-1.42) | -0.00(-0.03)*** | -0.00(-1.12) | |
| MKT | Low | 1.02(118.49)*** | 0.99(1891.49)*** | 0.91(233.75)*** | 1.00(254.57)*** | |
| | High | 0.99(606.56)*** | 0.91(157.10)** | 0.94(160.26)*** | 0.97(95.04)** | |
| | Extreme | 0.98(171.36)*** | 0.98(680.71)*** | 1.00(1329.74)*** | 1.14(121.43)*** | |
| ΔEPU | Low | 0.00(6.27)*** | -0.00(-0.01) | -0.00(-2.39)** | | |
| | High | -0.00(-0.54) | -0.00(-16.18)*** | -0.00(-11.89)*** | | |
| | Extreme | -0.00(-0.91) | 0.00(3.74)** | -0.00(-2.14)*** | | |
| ΔEPU_{t-1} | Low | -0.00(-1.01) | -0.00(-0.65) | 0.00(13.96)*** | | |
| | High | -0.00(-0.52) | 0.00(2.39)** | 0.00(10.48)*** | | |
| | Extreme | -0.00(-2.25)** | 0.00(3.28)** | -0.00(-2.05)** | | |
| ΔCPI | Low | -0.00(-7.40)*** | -0.00(-1.38) | 0.00(1.55) | | |
| | High | 0.00(0.94) | 0.01(12.88)*** | 0.00(10.27)*** | | |
| | Extreme | 0.001(5.04)*** | 0.00(0.83) | -0.00(-3.15)** | | |
| $\Delta IndP$ | Low | 0.00(0.62) | -0.00(-0.25) | -0.00(-3.66)*** | | |
| | High | -0.00(-0.61) | 0.00(0.11) | -0.00(-8.38)*** | | |
| | Extreme | 0.00(6.75)*** | 0.00(1.64)* | 0.00(1.88)* | | |
| ΔGPU | Low | | | | -0.00(-0.22) | |
| | High | | | | 0.00(4.14)*** | |
| | Extreme | | | | -0.00(-4.05)*** | |
| ΔGPU_{t-1} | Low | | | | 0.00(0.18) | |
| | High | | | | -0.00(-11.21) | |
| | Extreme | | | | -0.00(-3.85)*** | |
| ΔOP | Low | | | | -0.00(-0.32) | |
| | High | | | | -0.00(-12.19)*** | |
| | Extreme | | | | 0.00(13.95) | |
| $\Delta EXCR$ | Low | | | | -0.00(-2.93)** | |
| | High | | | | 0.00(12.62)*** | |
| | Extreme | | | | -0.00(-0.22) | |
| log σ : | | -8.05(-191.09)*** | -8.33(-206.80)*** | -7.53(-203.23)*** | 6.19(-152.87)*** | |
| Log-likelihood: | | 2667.76 | 2777.69 | 2438.07 | 1820.28 | |
| Schwartz Info. Criterion : | | -12.67 | -13.21 | -11.55 | -8.53 | |
| Durbin-Watson stat. : | | 2.45 | 2.60 | 2.17 | 2.85 | |

Notes: The table shows the test statistics z-statistics in parentheses. **, and *** represent 5% and 1% respectively.

Table 5.10: Estimations of the time-varying transition probabilities Eqn. (5.9).

| Panel B: Time-varying transition probabilities, Probability of staying in | | | | |
|--|--------|--------|--------|------|
| | F Fund | C Fund | S Fund | I |
| $P_{\{low low\}}$ | 0.12 | 0.97 | 0.34 | 0.84 |
| $P_{\{low high\}}$ | 0.63 | 0.00 | 0.16 | 0.05 |
| $P_{\{low extreme\}}$ | 0.23 | 0.01 | 0.48 | 0.10 |
| $P_{\{high low\}}$ | 0.00 | 0.73 | 0.43 | 0.42 |
| $P_{\{high high\}}$ | 0.98 | 0.26 | 0.23 | 0.32 |
| $P_{\{high extreme\}}$ | 0.00 | 0.00 | 0.32 | 0.25 |
| $P_{\{extreme low\}}$ | 0.25 | 0.26 | 0.00 | 0.31 |
| $P_{\{extreme high\}}$ | 0.00 | 0.05 | 0.01 | 0.37 |
| $P_{\{extreme extreme\}}$ | 0.74 | 0.68 | 0.97 | 0.31 |

| Panel C: : Expected duration | | | | |
|-------------------------------------|--------|--------|--------|--------|
| | F Fund | C Fund | S Fund | I Fund |
| Low volatility regime | 1.14 | 42.68 | 1.53 | 6.28 |
| High volatility regime | 57.04 | 1.36 | 1.30 | 1.47 |
| Extreme volatility regime | 3.99 | 3.12 | 45.31 | 1.46 |

$$\begin{aligned}
(R_{j,S_t} - R_f) = & \alpha_{S_t} + \beta_{S_t}(R_{mkt} - R_f) + \gamma_{gepu, S_t} \Delta GEPU_t + \gamma_{gepu, S_t} \Delta GEPU_{t-1} + \\
& \gamma_{op, S_t} \Delta OP_t + \gamma_{excr, S_t} \Delta EXCR_t + \epsilon_{it}; \epsilon_{it} \sim N(0, \sigma^2, S_t)
\end{aligned}
\tag{5.13}$$

The outcomes derived from Eqns. 5.12 and 5.13 are shown in Tables 5.9 and 5.10, respectively, showcasing the impact of EPU-GEPU on the TSF returns and the time-varying transition probabilities. Similar to the prior estimation, this robustness analysis also identifies the significance of sigma in the regimes and the TSF returns. However, we think that some additional information in the excess returns, as a result of R_f , may enable the model to identify some nuanced shifts in the regimes. We anticipate observing variations when considering the returns, as in the alternative specification. Table 5.9 illustrates that the estimated coefficients and the corresponding risk factors of policy uncertainty demonstrate a similar sign of effects in regime-switching settings as those presented in Table 5.8 for S Fund and I Fund. Slight changes are noticeable for the F Fund, where it is now positive and statistically significant at the low volatility regime. In the C Fund, we observe a negative statistically significant impact at the high volatility regime and a statistically significant

positive effect at the extreme volatility regime.

5.5 Summary and conclusion

This study offers an extensive analysis of TSF performance as a passive fund. It addresses significant questions about its performance, examines the impact of policy uncertainty risk and inflation risk on TSF returns, compares TSF returns to benchmarks, and emphasises the importance of selecting appropriate performance measures. The study examines all TSF investment returns of the TSP over the period spanning from 1989 to 2023.

To begin with, we assessed the alignment between TSF returns and their corresponding benchmark returns using the Wilcoxon test. Our results indicate that TSF returns and benchmark returns exhibit no significant divergence. However, we dug deeper, applying Levene's test to study TSF return variance across sub-periods. Here, we uncovered meaningful variations, shedding light on the dynamic nature of TSF returns. Notwithstanding, we recognise that mere returns evaluation falls short in the investment realm, thus we undertook a thorough performance measure analysis. We analysed 13 performance measures to determine their relevance in ranking TSF returns. Spearman's rank correlation coefficient allowed us to explore the interplay between these measures for each TSF. Our findings revealed that the choice of performance measure does not significantly impact fund rankings. Further, we sought to determine if any performance measure exerted more influence on TSF assessment than the Sharpe ratio, using the Fisher z-transformation test. As expected, none of the performance measures significantly impact TSF evaluation compared to the Sharpe ratio. Our study also scrutinised idiosyncratic volatility, our results indicate that TSF returns are influenced more by benchmark index movements than by unique specific risks. Consequently, TSF's returns tend to mirror the benchmark, fostering a consistent performance trajectory. We then turned our attention to risk considerations. The F Fund, characterised by low risk, shows limited downside potential compared to other Funds (C, S, and I) with medium to high-risk profiles. TSF's passive strategy closely matches benchmark performance, as shown by our analysis of tracking errors. Finally, We then analyse the risk-adjusted returns with the CAPM, FF-3, FF-5, and CH-4 models. The results show TSF's success in mirroring benchmark indices, capturing long-term market returns, and

offering diverse exposure to assets within the index benchmarks.

Our study yielded intriguing findings on how inflation risk, economic state variables, and TSF investment returns are interrelated. Firstly, we observed a negative relationship between inflation risk and F Fund returns, whereas the C and S Funds showed a positive association. However, it's worth noting that the C Fund's positive relationship with inflation risk turned negative when accounting for lagged inflation. Furthermore, interest rate fluctuations had a negative impact on F and C Funds but positively impacted S Funds. The I Fund, in contrast, demonstrated sensitivity to oil price volatility, with a positive effect, albeit becoming insignificant in our sensitivity analysis. On the other hand, exchange rate changes had a negative impact on the I Fund, but it was not statistically significant. Intriguingly, term spreads played a pivotal role in the performance of F, C, and S Funds, with statistically significant effects. Notably, the F Fund showed a significant negative default spread, albeit losing significance in sensitivity analysis. Our study from the MS model further showed a significant relationship between changes in inflation rates and C Fund returns in varying volatility regimes. In low and extreme volatility scenarios, the fluctuations in inflation rates had a positive effect on C Fund returns, as found by our dynamic regression model. However, in high volatility regimes, the story changed, and inflation rate changes had negative effects. Thus highlighting the significance of considering regime-dependent dynamics while examining the impact of inflation on investment returns.

Additionally, our analysis revealed that inflation rate changes had varied effects on F and S Fund returns across different volatility regimes. In conditions of high volatility, these changes positively impacted both funds. However, in extreme volatility scenarios, the effects became negative. These observations enrich our understanding of how inflation risk can affect TSF returns, emphasising the significance of regime-specific analysis. Notably, our study unveiled a distinctive pattern in the relationship between oil price fluctuations and I Fund returns. During high volatility periods, oil price fluctuations negatively impacted I Fund returns. However, in extreme-volatility regimes, these fluctuations had a surprising positive impact. This nonlinear relationship underscores the importance of considering regime-specific dynamics when assessing the effects of oil price uncertainty on TSF investments.

Furthermore, we found that exchange rate changes exerted varying effects on I Fund returns depending on the volatility regime. The effect of exchange rates on TSF returns varies depending on volatility. Low-volatility states show a negative impact, while high-volatility show a positive influence. The relationship is dynamic and context-dependent, thus making it crucial. Lastly, our study delved into the impact of changes in the industrial production rate on F, C, and S Fund returns. In high and extreme volatility conditions, the F Fund exhibited increased returns in response to changes in the industrial production rate. However, this relationship took a negative turn in extreme volatility for the C Fund and in both low and high volatility for the S Fund. These findings highlight the intricate relationship between industrial production rate changes and TSF returns, especially in volatile market conditions. The study confirms earlier research and highlights the need to account for regime-specific dynamics in evaluating the effects of economic factors on TSF investments. These insights contribute to a deeper understanding of the intricacies of investment behaviour in different market conditions, providing valuable guidance for investors and policymakers alike.

Finally, this study delves into the dynamic relationship between policy uncertainty and TSF returns, uncovering some implications that vary across regimes. Notably, EPU wields a positive influence on the F Fund returns when market volatility is at its extreme level. While conversely exerting a negative effect on the C Fund during low and extreme volatility periods. The S Fund is negatively affected by EPU under all regimes. Furthermore, GEPU shows a contrasting impact on the I Fund, yielding a negative impact during low market volatility and fostering positivity amidst heightened volatility. This compelling interplay highlights the time and regime-dependent nature of EPU and GEPU's influence on TSF returns. Our investigation also reveals a significant negative relationship between EPU and the C Fund's performance, a relationship evident in both low and turbulent market regimes, elucidating how amplified policy uncertainty consistently nudges investors towards risk aversion. In small-cap stocks, high EPU leads to lower returns for the S Fund, highlighting the importance of policy-related factors in investment decisions. The analysis of I Funds shows a distinct pattern in the influence of GEPU, wherein it induces adverse returns during periods of low market volatility, mirroring investors' preference for stability. However, during high volatility regimes, GEPU sparks optimism as investors perceive policy changes

as stabilising forces amidst market turbulence. These findings underscore the crucial role of the market regime in shaping the impacts of uncertainty measures on TSF returns, further dispelling the notion of uniform influence across different regimes.

Democrats propose divesting TSF assets from fossil fuel companies, while Republicans suggest refraining from investing in Chinese-owned companies. Further research could examine the relationship between these political moves and policy uncertainty's impact on TSF returns. Of further interest would be examining how investor sentiment and biases interact with policy uncertainty to shape market behaviour and impact the TSF returns. This investigation would deepen our understanding of the effects of policy uncertainty on TSF returns during uncertain periods.

5.6 Appendix

5.6.1 Preliminary analysis of data

Table 5.11: Results of unit root and multicollinearity test

| | LLC | ADF | PP | VIF |
|------|-----------|-----------|----------|------|
| IntR | -7.12*** | -7.08*** | -13.03** | 1.28 |
| CPI | -9.24*** | -4.49*** | -11.89** | 1.30 |
| TS | -2.70** | -1.69*** | -2.34 | 1.06 |
| DS | -4.74*** | -1.37*** | -4.01** | 1.19 |
| IndP | -14.84*** | -8.12*** | -16.27** | 1.37 |
| OP | -12.32*** | -9.23*** | -14.59** | 1.31 |
| ExcR | -8.39*** | -8.06*** | -14.68** | 1.07 |
| EPU | -14.15*** | -11.62*** | -28.54** | 1.78 |
| GEPU | -12.00*** | -11.89*** | -26.70** | 1.80 |

Notes: The table presents the results of the panel unit root tests, including the LLC test for homogeneous unit roots and the Fisher-ADF and Fisher-PP tests for heterogeneous unit roots. The null hypothesis for all tests is the presence of unit roots. The corresponding p-values for the test statistics are in parentheses and the significance levels are indicated by *, **, and *** for 10%, 5%, and 1%, respectively.

Prior to conducting empirical estimations, a preliminary analysis was undertaken, including summary statistics, normality, correlation and covariance analysis, the unit root of series, and the multicollinearity test. To address the challenges associated with pseudo-regression that arises from non-stationary data, an examination of the data properties for

Table 5.12: Panel cointegration test

| Johansen-Procedure | | | | | |
|---------------------------|--------|--------|--------|--------|------------|
| | F Fund | C Fund | S Fund | I Fund | Crit. Val. |
| $r \leq 9$ | 6.99 | 7.76 | 8.11 | 7.86 | 12.25 |
| $r \leq 8$ | 22.79 | 22.92 | 23.36 | 23.36 | 18.96 |
| $r \leq 7$ | 87.88 | 93.66 | 86.77 | 90.73 | 25.54 |
| $r \leq 6$ | 136.48 | 142.88 | 141.95 | 143.00 | 31.46 |
| $r \leq 5$ | 158.77 | 161.89 | 165.41 | 163.30 | 37.52 |
| $r \leq 4$ | 179.24 | 207.03 | 193.78 | 200.82 | 43.97 |
| $r \leq 3$ | 226.80 | 244.54 | 235.21 | 237.76 | 49.42 |
| $r \leq 2$ | 259.42 | 263.24 | 259.63 | 257.47 | 55.50 |
| $r \leq 1$ | 264.57 | 269.30 | 263.53 | 263.88 | 61.29 |
| $r \leq 0$ | 293.13 | 318.64 | 343.70 | 327.99 | 66.23 |

Notes: The table shows the test statistics and the critical values at the 5% significance level for the trace statistic test with a linear trend in cointegration. Where $r \leq 0$ to $r \leq 9$ indicates the cointegrating vectors, and as the number of cointegrating vectors decreases ($r \leq 9, r \leq 8, r \leq 7$, and so on), the test statistics generally increase, indicating a more substantial likelihood of cointegration.

stationarity was carried out using two generations of unit root tests on the panel data.

The Augmented Dickey-Fuller (ADF) test, which incorporates a regression drift with constant and lagged differenced variables, provided strong evidence against unit root presence, indicating stationarity in the series. Results from the Phillips-Perron unit root test, considering the test statistic and p-values, strongly suggest the stationarity of the variables. We further used the Levin-Lin-Chu (LLC) unit root test to examine the stationarity of the time series, with the results convincingly rejecting the null hypothesis of a unit root (non-stationarity) for all variables. As a result, as shown in Table 5.11, all of the unit root tests consistently reject the hypothesis of non-stationarity for cross-sectional data. Additionally, the variance inflation factor analysis was employed to test for multicollinearity, which revealed that the uncertainty, macroeconomic risk and economic state variables have low multicollinearity, indicating a weak correlation.

Subsequently, the Johansen Test for Cointegrating Time Series was employed to examine whether there is a cointegrating relationship among the variables while considering a linear trend component. The test type used was the trace statistic with a linear trend, accounting for the level and trend components in the cointegration analysis. Table 5.12

presents the results that all test statistics reject the null hypothesis that there is no cointegration relationship.

5.6.2 Performance measures variables

This section presents the measures utilised to assess the performance of individual TSP funds in Table 5.4, which have been categorised based on their risk-return approach. The measures of performance used are from traditional measures, value at risk, lower partial moments, and maximum drawdowns. To derive VaR-based ratios, we used a significance level of $\alpha = 5\%$. We constrained the partial moment measures to a minimum acceptable return of 0%. In the instance of Sterling and Burke ratios, the assessment is grounded on the five most substantial drawdowns ($N = 5$).

Traditional performance measures

1. Sharpe Ratio $= \frac{(r_p - r_f)}{\sigma_p}$. r_p represents $p'S_{Fund}$ monthly return, r_f is the risk-free rate per month, and σ_p shows the standard deviation of p_{Fund} monthly excess returns (Sharpe 1966).
2. Alpha $\alpha_{p,fmkt} = r_p - (r_f + \beta_{i,m} \times (r_m - r_f))$. The sensitivity of $p'S_{Fund}$ returns to index m 's returns is represented by $\beta_{p,m}$, r_m is the monthly return of the benchmark index, $\frac{Cov(r_p, r_m)}{Var(r_m)}$ can be used to express $\beta_{p,m}$. The Fund benchmark index is $m = fmkt$ (Sharpe 1964).
3. Information Ratio $= \frac{\alpha_{p,fmkt}}{\sigma_{\epsilon_{p,fmkt}}}$. $\alpha_{p,fmkt}$ represents monthly alpha for the $p'S_{Fund}$ and $\sigma(\epsilon_{p,fmkt})$ is the tracking error, which measures the deviation between Fund returns and the benchmark index's returns (Sharpe 1994).

Performance based on Value at Risk measures

1. Excess Return on VaR $= \frac{(r_p - r_f)}{VaR_p}$. VaR_p is the representation of the Fund's value at risk. This is determined by the formula $VaR_p = -(r_p + Z_\alpha \cdot \alpha_p)$, where Z_α is the standard normal distribution quantile at the significance level α (Dowd 2000).

2. Conditional Sharpe Ratio = $\frac{(r_p - r_f)}{CVaR_p}$. The conditional value at risk is $CVaR_p$, which is expressed as $CVaR_p = E[-r_{p,t} \mid r_{p,t} \leq -VaR_p]$, (Agarwal and Naik 2004).
3. Modified Sharpe Ratio = $\frac{(r_p - r_f)}{MVaR_p}$. The computation of $MVaR_p$, which is the modified value at risk, is based on the Cornish-Fisher expansion (Favre and Galeano 2002; Gregoriou and Gueyie 2003; Dombrowski, Drobetz, and Momtaz 2023). It is determined by means of the equation $MVaR_p = -(r_p + \sigma_p \cdot (Z_\alpha + (Z_\alpha^2 - 1) \cdot \frac{S_p}{6} + (Z_\alpha^3 - 3 \cdot Z_\alpha) \cdot \frac{E_p}{24} - (2 \cdot Z_\alpha^3 - 5 \cdot Z_\alpha) \cdot \frac{S_p^2}{36}))$. S_p and E_p represent the skewness and excess kurtosis of the individual p' s_{Fund} returns, respectively.

Performance based on Lower Partial Moments

1. Omega Ratio = $\frac{(r_p - \tau)}{LPM_{1,p}(\tau+1)}$. Lower partial moments (LPMs) are a measure of negative return deviations in relation to a minimally acceptable return, denoted as τ . Specifically, LPM is calculated as $LPM_{n,p}(\tau) = \frac{1}{T} \sum_{t=1}^T \max[\tau - r_{p,t}, 0]^n$; LPMs are of order $n = 1$ for the Omega Ratio, (Keating and Shadwick 2002)
2. Sortino Ratio = $\frac{(r_p - \tau)}{\sqrt[2]{LPM_{2,p}(\tau)}}$. The LPMs have a magnitude of order $n = 2$, (Sortino and Van Der Meer 1991)
3. Kappa 3 Ratio = $\frac{(r_p - \tau)}{\sqrt[3]{LPM_{3,p}(\tau)}}$. The LPMs have a magnitude of order $n = 3$, (Kaplan and Knowles 2004).
4. Upside Potential Ratio = $\frac{(HPM_{1,p}(\tau))}{\sqrt[2]{LPM_{2,p}(\tau)}}$. Higher partial moments ($HPMs$) are a means of quantifying positive return deviations in relation to a baseline minimal acceptable return, represented by τ . HPM of order $n = \frac{1}{T} \sum_{t=1}^T \max[r_{p,t} - \tau, 0]^n$. The order of $HPMs$ is identified as $n = 1$, whereas the order of $LPMs$ is $n = 2$, (Sortino, Van Der Meer, and Plantinga 1999).

Performance based on Maximum Drawdowns

1. Calmar Ratio = $\frac{(r_p - r_f)}{(-MDD_{p,k})}$. Maximum drawdowns (MDs) are a measure of risk which quantifies the largest return losses incurred by p_{Fund} during the sample period. Thus, $MDD_{p,k}$ denotes the maximum decline experienced by p_{Fund} . Here, k represents

the number of drawdowns, with $k = 1$ denoting the maximum drawdown, $k = 2$ denoting the second largest drawdown, $k = 3$ denoting the third largest drawdown, and so on (Young 1991).

2. Sterling Ratio = $\frac{(r_p - r_f)}{\frac{1}{K} \sum_{k=1}^K (-MD_{p,k})}$. The assessment of risk is conducted through the calculation of the mean value of the K most substantial declines in Fund value (Kestner 1996).

3. Burke Ratio = $\frac{(r_p - r_f)}{\sqrt[2]{\sum_{k=1}^K MD_{p,k}^2}}$. The approach to evaluating risk involves the computation of the square root of the aggregate of the K most significant squared drawdowns (Burke 1994).

Part III

Conclusion

GENERAL CONCLUSION

“The question is not at what age I want to retire, it is at what income.”

– George Foreman

This chapter encompasses a comprehensive discourse on the theoretical contributions, managerial implications, limitations, and prospects for future research regarding the articles that constitute chapters 3, 4, and 5 of the thesis.

6.1 Theoretical Contributions

This thesis delves into the intricacies of pension plan participation beyond the socio-demographic point of view, funding via contributions remittance, and investment analysis within the framework of contemporary financial dynamics. By exploring these dynamics, this thesis sheds light on the opportunities and challenges confronting the scheme participants, the funds and its investment performances. It illuminates how these challenges, such as enrolment and participation, contribution remittance to ensure adequate funding, optimising investment strategies and appraising the fund performance in uncertain periods, demand innovative solutions.

Theoretical contributions to the micro pension plan In the first essay, Chapter 3, titled "*Micro Pension Plan for Informal Sector Workers in the Nigerian Informal Economy*," we examine the influence of behavioural constructs on the enrollment and participation of individ-

ual household workers in the informal sector. MPP provides both short-term and long-term savings options. Where participants can access their funds in the short term. The long-term component focuses on investments in longer-term assets. Given the substantial role that the informal economy plays in Nigeria, the non-enrollment and non-participation of workers in the informal sector of this economy in MPP could potentially lead to an increase in poverty among the sector workers during retirement. Hence, it is crucial to understand the factors beyond socioeconomic and demographic variables that influence enrollment and participation in MPP.

We have found a statistically significant negative relationship between attitude, subjective norm, and the intention to enrol in and participate in the MPP. These results can be explained by the fact that workers in informal sector households have a negative attitude towards savings and investments, resulting in a lack of interest in the MPP. Additionally, our findings indicate that household workers in the informal sector who do not perceive any social pressure or norms to enrol in the MPP are consequently less inclined to participate. Furthermore, our study reveals that workers in the informal sector hold varied opinions regarding enrollment in the MPP due to their perceived control over financial matters. Consequently, this leads to an insignificant association between perceived control and the intention to enrol and participate in the MPP. Nonetheless, our study does identify a positive and significant relationship between the consumer financial education of informal workers and their inclination to enrol and participate in the MPP. Hence, the results imply that as the understanding of consumer financial education among workers in the informal sector within this informal economy improves, their eagerness to enrol and participate in the MPP also increases.

This study enhances the existing body of literature on the MPP by presenting novel evidence regarding the informal sector within the Nigerian informal economy. In this context, the workers in the informal sector play a significant role in fostering entrepreneurship, generating employment opportunities, and stimulating economic growth. However, they often do not receive employment benefits such as pensions and frequently face economic shocks, health issues, and unemployment during their later years. Consequently, they may encounter challenges in maintaining their standard of living and may need to continue

working beyond retirement age or rely on family support for elderly care. By conducting this research, we provide valuable insights that contribute to a deeper understanding of retirement planning dynamics, thereby facilitating the development of targeted strategies for this particular population. Furthermore, investigating the relationships between behavioural constructs and the behavioural intention to enrol and participate in the MPP within the Nigerian informal economy enhances our understanding of the determinants of MPP among workers in the informal sector in this economy.

6.1.1 Theoretical contributions to the pension schemes funding through contribution remittance

In the second essay, Chapter 4, "*The Impact of Contribution Remittances on Retirement Savings in Contributory Pension Schemes*," we investigate the impact of not remitting or partially remitting pension fund contributions into retirement savings accounts (RSA). It is worth noting that the process of accumulating contributions from scheme participants, earning interest from investments, and paying out pension benefits to the members spans several years before the process is complete. As a result, scheme participants would not know how effective the scheme is until they access the benefits. Our research shows that non-remittance and partial remittance of pension contributions significantly reduce retirement savings compared to complete and timely remittance at the statutory contribution rate. These, in turn, have adverse effects on the balance of RSA. We postulate the hypothesis that inconsistent contribution remittance in RSA leads to lower RSA balances, and we compared remittance in an RSA that adheres to the statutory contribution rate. Our findings support this hypothesis and show that non-remittance and partial remittance of pension contributions in a CPS result in lower retirement savings balances in the RSA.

The accuracy of contribution remittances directly affects the standing balance of members, as these funds are highly susceptible to market timing, tactical asset allocation decisions, and out-of-market risks. Consequently, there is uncertainty surrounding the final benefits available upon retirement. These results emphasise the critical importance of accurate and timely contribution remittances in achieving the objectives of the CPS, particularly in securing the financial futures of retirees. Our study makes valuable contributions to the

existing literature on funding the DC scheme in the context of RSA. Specifically, we investigate the impact of contribution remittance on an RSA within a DC scheme.

It is worth noting that previous studies have primarily focused on fund adequacy, examining the effect of different funding scenarios on the balance of an RSA using a lifestyle investment strategy as the lens through which to analyse these scenarios is our major contribution. This research gap is significant because participants in the scheme bear the investment risk, while the fund manager is responsible for making investment decisions. This is crucial in an economy such as the study context marked by a notable level of financial illiteracy. In addition, due to the absence of a singular pension model that can be universally implemented in all nations due to their distinct economic characteristics and circumstances, it is crucial to address this matter in our unique economic context.

6.1.2 Theoretical contributions to the pension funds performance and uncertainty

In the third essay, Chapter 5, titled "*Thrift Savings Plan: Funds Performance and Uncertainty*," we assess the impact of policy uncertainty and inflation risk on the returns of thrift saving funds (TSF). Additionally, we compare these returns to their respective benchmarks to assess the fund performance. Furthermore, we examine the importance of performance measures in evaluating the investment returns of TSFs. This is significant as many individuals in the current workplace aspire to depend on their TSF assets to secure a fitting income during their retirement years. The performance of these individuals' TSFs must remain commendable throughout their tenure in the workforce, as this will directly contribute to achieving a stable retirement income. The results demonstrate that both the uncertainty of policies and the risk of inflation influence the returns of TSF investments. Concerning relative performance, TSF shows commendable performance by effectively replicating its benchmarks, and the selection of performance metrics does not modify the rankings of TSF. The analysis emphasises that measures of uncertainty yield diverse consequences on the returns of TSF depending on the prevailing circumstances, thereby challenging the concept of a uniform impact. Our essay endeavours to make a valuable addition to the expanding corpus of literature by embarking on the first historical inquiry into the effects of policy

uncertainties and inflation risk on the returns of the TSF. Additionally, our study examines the performance of the TSF, which is a passive fund, vis-à-vis its benchmark, thus providing fresh insights into the investment management practices employed by the TSF. Lastly, we contribute to an ongoing discussion on the significance of asset management practice by analysing performance measures for TSF funds.

6.2 Managerial implication

The findings of chapter 3 of this thesis hold critical managerial implications for the effective promotion and implementation of the MPP within the Nigerian informal economy. Specifically, it highlights the need to address the negative attitudes towards savings and investments among workers in the informal sector through targeted awareness campaigns and financial education. Leveraging social norms can be essential, with strategies harnessing social pressure to drive MPP participation. Improving consumer financial education among informal workers is crucial, as our study in this chapter indicates it significantly boosts their willingness to enrol and participate. To accommodate the unique characteristics of the informal sector, PFA's who are the administrators of MPP should offer customised solutions, such as marketing and selling MPP through an agency model. Recognising the vital role of the informal sector in the Nigerian economy, encouraging MPP participation can mitigate future poverty risks and ensure the financial security of these workers during retirement, contributing to a more economically secure future for this vital segment of the workforce.

Furthermore, chapter 4 delves into the pivotal issue of pension contribution remittances into individuals' RSA and unravels its significant managerial implications. The process of accumulating contributions, earning investment returns, and disbursing pension benefits spans several years, leaving scheme participants uncertain about their retirement security until they access the benefits. Our findings underscore the critical importance of accurate and timely contribution remittances in securing the financial futures of retirees. Non-remittance and partial remittance of pension contributions markedly reduce retirement savings, casting a shadow on the RSA balance. We highlight that the accuracy of these contributions directly affects members' standing balances, amplifying market tim-

ing and asset allocation risks. These results stress the urgency for precise contribution management in achieving the objectives of the CPS. Our study, which uniquely focuses on the impact of contribution remittance within a DC scheme, offers invaluable insights into funding strategies. Our contribution becomes indispensable because the investment risks rest with participants in an environment marked by financial illiteracy. Thus, addressing this gap is crucial, particularly in our distinct economic characteristics and circumstances, where a one-size-fits-all pension model is impractical.

Lastly, chapter 5 of the thesis study's findings carry crucial managerial implications for TSF and retirement planning. Recognising TSFs' consistent benchmark replication informs fund managers' investment decisions, supporting enduring commendable performance. TSFs play an increasingly central role in retirement income planning. A long-term perspective in managing TSF assets is essential, as performance over an individual's career directly contributes to securing a stable retirement income. Additionally, adaptability to changing economic contexts and continuous monitoring of policy developments and inflation trends are paramount for mitigating risks and optimising returns, ensuring a solid financial foundation for retirement.

6.2.1 Limitations and future research

Despite its theoretical contributions and managerial implications, this thesis also has limitations.

The first limitation of Chapter Three concerns methodology. We used PLS-SEM, which is useful for prediction and exploring associations, though it cannot convincingly prove causality based solely on observed associations. This PLS-SEM does control for confounding factors and does not effectively address endogeneity or reverse causality, which are essential for causal inference. Therefore, as a direction for future research, we hope for further research that will provide a more informative economic study by complementing our PLS-SEM approach with rigorous causal inference techniques, such as instrumental variables, difference-in-differences, or regression discontinuity design. Also, data availability and accessibility have limited the scope of this research. We were unable to investigate

Table 6.1: Summary of Chapter Contributions

| | Chapter 3 | Chapter 4 | Chapter 5 |
|-------------------|--|---|--|
| Research Question | What are the determinants of low enrollment and participation in the MPP among Nigerian informal sector workers? | What is the impact of partial or non-remittance of contributions on the RSA balance in a CPS during different accumulation phases, and how do variations in contribution remittances affect the accumulated RSA balance within the CPS model? | How do policy uncertainty and inflation risk impact the returns of TSF and their performance relative to benchmarks? |
| Methodology | Empirical studies | Empirical studies | Empirical studies |
| Sample | A nationally representative data set of 14,510 informal sector workers in Nigeria | Salary data of 2019, Nigerian stock exchange, pension index, and macroeconomic data. | TSF Investments in US and MSCI World Index (1989-2023) |
| Main Results | <ol style="list-style-type: none"> 1. Attitude negatively influences MPP enrollment intention. 2. Subjective norm negatively affects MPP participation intention. 3. Consumer financial education positively drives MPP intention. 4. Positive intention correlates with actual MPP participation. | <ol style="list-style-type: none"> 1. Partial remittance increases the RSA balance more than non-remittance. 2. Partial remittance still leads to a lower RSA balance compared to SCR-funded accounts. 3. Non-remittance decreases the RSA balance, falling behind both partial and SCR-funded RSAs. 4. Non-remittance and partial contribution remittances result in lower retirement income in the RSA compared to SCR. | <ol style="list-style-type: none"> 1. Policy uncertainty and inflation risk affect TSF investment returns. 2. TSF performs well by replicating benchmarks, with consistent rankings across different performance measures. 3. Uncertainty measures have varying impacts on TSF returns depending on the regime, challenging the notion of a uniform impact. |

trust in financial institutions due to unavailable data. Trust in financial institutions may play a significant role in economies with a large informal sector like Nigeria. This variable requires further examination in future research.

Our analysis of the contributions remittance has some limitations worth noting. Firstly, historical securities data may not fully capture future market dynamics, and we did not consider fixed deposit interest rates for small cash reserves, which depend on PFAs. Secondly, our study used CONUASS salary data with 7-grade levels, which resulted in 14 periods for assets in RSAs. Future research should explore step levels for a better understanding of funding scenarios. While our study focused on a university context with career progression tied to publications and degrees, not the broader Nigerian job market, which has different promotion cycles, this raises questions about professional stagnation. However, we have not delved into career stagnation within workplaces in this study, suggesting an avenue for future research to explore its impact on RSAs in various employment contexts.

Finally, democrats put forth a proposition to divest assets of the TSF from companies in the fossil fuel industry, whereas Republicans propose abstaining from investing in companies owned by the Chinese. A potential area for further study could involve analysing the relationship between these political actions and the influence of policy uncertainty on the returns of the TSF. Another area of interest would be to explore how the sentiment and biases of investors interact with policy uncertainty, ultimately shaping market behaviour and impacting the returns of the TSF. This investigation would significantly contribute to our comprehension of the repercussions of policy uncertainty on TSF returns during periods of uncertainty.

RÉSUMÉ DE THÈSE

Aujourd'hui, les progrès des sciences médicales et des technologies modernes ont permis aux individus de vivre plus longtemps que par le passé (Goss et al. 2016). Par conséquent, il est impératif de prendre en compte la nécessité de préparer la phase de retraite. Il est de la plus haute importance que les individus soient encouragés à planifier de manière adéquate leur sécurité financière pendant leurs années de travail afin d'atténuer les risques potentiels associés à la retraite.

Le modèle de consommation et de prêt d'intérêt (Samuelson 1958) est une théorie économique fréquemment associée aux régimes de retraite. Cette théorie a eu un impact significatif et constitue le fondement d'un large éventail de recherches en finances publiques et en macroéconomie, notamment les études sur les retraites et la sécurité sociale, l'analyse de la dette nationale, la fiscalité et l'accumulation du capital, la courbe de Phillips, le cycle économique et les fondements de la théorie monétaire (Geanakoplos 1989; Ascah 1995). Le modèle suppose que les individus ont une vie à deux périodes. Au cours de la première période, ils travaillent, gagnent un salaire et épargnent. Au cours de la seconde période, ils prennent leur retraite et consomment leur épargne (Samuelson 1958). En outre, le cycle de vie d'un individu comprend une période d'emploi actif suivie d'une retraite. Cela oblige les ménages à redistribuer leur consommation entre leurs années de travail, pendant lesquelles ils gagnent des revenus, et leurs années de retraite, pendant lesquelles les ressources peuvent être limitées (Modigliani 1986; Blake, Wright, and Zhang 2013). Quel que soit le niveau d'expertise, d'efficacité, d'activité et de productivité d'un individu sur son lieu de travail actuel, le moment viendra à l'avenir où la retraite deviendra une réalité en raison de l'atteinte de l'âge de la retraite. Toutefois, il est essentiel de reconnaître que les frais de subsistance tels que la nourriture, les soins médicaux, l'assurance, les paiements hypothécaires et les autres factures de services publics ne cessent pas avec la retraite.

Outre l'épargne dans les banques ou l'investissement dans des instruments financiers, la participation à un régime de pension est un moyen d'épargner pour l'avenir. Ce régime implique la mise de côté d'une somme d'argent spécifique, soit par l'employeur, soit par l'employé, soit par les deux parties, afin de garantir une source continue de soutien financier

sur laquelle l'employé peut compter pendant sa période de retraite. Aujourd'hui, la pension est une forme de sécurité sociale contre les risques liés à la vieillesse, à la longévité, à la pauvreté et à d'autres incertitudes. Selon (Davis 2003), les fonds de pension sont une épargne à long terme et une forme d'investissement institutionnel qui collecte, met en commun et investit les fonds versés par les promoteurs et les bénéficiaires pour assurer les futurs droits à pension. Comme indiqué dans (Blake 2006), ces fonds permettent aux individus d'accumuler de l'épargne tout au long de leurs années de travail pour répondre à leurs besoins de consommation pendant la retraite, soit par un paiement unique (somme forfaitaire), soit par le versement régulier d'une somme d'argent fixe (retraits programmés ou annuités). En outre, ces fonds peuvent également servir à des entreprises, à d'autres ménages (par le biais de prêts titrisés) ou à des gouvernements pour réaliser des investissements, par exemple par le biais de fonds à usage spécifique, ce qui stimule la croissance économique (Davis 1998; Davis and Hu 2004; Davis 2005; Inderst 2009; Corpataux, Crevoisier, and Theurillat 2009; Thomas and Spataro 2016).

Selon (Davis 2003), un programme de retraite sert deux objectifs essentiels. Le premier est de lisser la consommation d'un individu tout au long de sa vie, ce qui signifie qu'une pension fournit un revenu pendant la retraite, lorsque l'individu ne travaille plus, en échange des cotisations versées au régime de pension pendant qu'il travaille. Le second objectif est de fournir une assurance, en particulier contre le risque de vivre plus longtemps que prévu. (Blake 2006) suggère que les politiques publiques peuvent avoir deux objectifs supplémentaires pour un régime de retraite. Le premier objectif est de réduire la pauvreté, c'est-à-dire qu'une société vise à garantir à ses retraités un niveau de vie minimum à la retraite. Le second objectif est de distribuer des ressources supplémentaires à des groupes spécifiques, tels que les femmes ayant des enfants (et/ou celles qui ont pris un congé pour élever leurs enfants) ou les personnes exerçant certaines carrières. La pension étant un moyen de transférer le revenu des années de travail aux années de retraite, le principe fondamental qui sous-tend les régimes de pension englobe une interaction harmonieuse de facteurs économiques (assurer une source de revenu adéquate pour les retraités), de facteurs actuariels (gérer les risques associés aux investissements et à la longévité) et de facteurs sociaux (fournir un filet de sécurité aux personnes âgées) (Woodall and Hagemeyer 2009; Blake 2016; Ogg 2021).

Cette thèse se concentre sur le régime de retraite à cotisations définies, dans lequel l'employé et l'employeur versent un pourcentage fixe ou un montant spécifique du salaire de l'employé au fonds de pension, généralement déduit directement du salaire de l'employé. Les fonds reçus sont ensuite investis dans divers instruments financiers, y compris, mais sans s'y limiter, des actions, des obligations, des fonds communs de placement et d'autres véhicules ou instruments, le tout conformément aux règlements établis par le régime. Les prestations de retraite fournies par le régime à cotisations définies dépendent des cotisations versées par l'employeur et l'employé, ainsi que du rendement des investissements générés par ces cotisations. Contrairement à un régime de retraite à prestations définies (PD), les prestations de retraite d'un régime à cotisations définies ne sont pas décidées à l'avance, mais déterminées par l'importance des cotisations versées par l'employeur et le salarié, ainsi que par les performances des investissements. Le régime est géré par un prestataire de retraite désigné (par exemple une institution financière), responsable de l'investissement et de la gestion des fonds. Une période d'acquisition des droits, variable selon le régime, oblige les salariés à travailler pendant une durée déterminée pour avoir droit aux prestations de retraite. Ce régime offre notamment la transférabilité, ce qui permet aux salariés de transférer leurs fonds de pension lorsqu'ils changent d'emploi, garantissant ainsi une épargne-retraite ininterrompue. Lorsqu'ils atteignent l'âge légal de la retraite, les bénéficiaires d'un régime à cotisations définies peuvent choisir différentes options pour les prestations de retraite, notamment le versement d'une somme forfaitaire, d'une rente ou de paiements réguliers (retraits dans le cadre d'un programme).

Le régime à cotisations définies présente plusieurs avantages. Tout d'abord, il offre aux salariés une plus grande maîtrise et une plus grande souplesse dans la gestion de leur épargne-retraite. Les employés peuvent exercer un pouvoir discrétionnaire sur l'investissement de leurs cotisations. Ils ont ainsi la possibilité de personnaliser leur plan d'épargne-retraite en fonction de leurs objectifs financiers et de leur goût du risque. Deuxièmement, le régime permet la transférabilité, ce qui permet aux salariés de conserver leurs prestations de retraite lorsqu'ils changent d'emploi. En outre, le régime à cotisations définies allège la charge financière des employeurs par rapport aux régimes à prestations définies, car il n'y a pas de garantie de revenu de retraite ou de paiement des arriérés dus à de mauvaises performances d'investissement.

Toutefois, ce régime de retraite à cotisations définies présente également des inconvénients. Le revenu de retraite n'est pas garanti et dépend des performances d'investissement des cotisations. Cela expose les individus à la volatilité des marchés, à l'incertitude et au risque de rendements inférieurs. En outre, les salariés peuvent manquer de connaissances financières et prendre de mauvaises décisions en matière d'investissement, ce qui se traduit par une épargne-retraite insuffisante.

Néanmoins, dans le monde d'aujourd'hui, l'épargne dans un régime de retraite est devenue cruciale pour les individus afin de créer le revenu nécessaire pour subvenir à leurs dépenses quotidiennes pendant la retraite. Les gouvernements du monde entier sont conscients de l'obligation et de la responsabilité de mettre en place des stratégies et de fournir une stabilité économique aux individus dans leur phase post-emploi.

Cette thèse se concentre sur trois aspects essentiels du financement des retraites à cotisations définies : l'adhésion et la participation, le financement de l'épargne-retraite par le biais du versement des cotisations, et les performances d'investissement et l'incertitude des fonds de pension. La thèse se compose de trois essais indépendants. Les deux premiers essais concernent les fonds de pension nigériens, tandis que le troisième essai se concentre sur les performances d'investissement et l'incertitude du principal fonds de pension à cotisations définies au niveau mondial. Dans cette section, nous présentons une vue d'ensemble de chacun de ces domaines de recherche et je développe les contributions de chaque essai à son sujet respectif.

Pour commencer, l'Organisation mondiale de la santé ([WHO](#)) affirme que, d'ici 2030, une personne sur six dans le monde sera âgée de 60 ans ou plus, passant de 1 milliard en 2020 à 1,4 milliard. D'ici à 2050, ce groupe doublera pour atteindre 2,1 milliards, et le nombre de personnes âgées de 80 ans ou plus triplera. Initialement observé dans les pays à revenu élevé comme le Japon, le vieillissement de la population est désormais prépondérant dans les pays à revenu faible ou intermédiaire, les deux tiers des personnes âgées de plus de 60 ans se trouvant dans ces régions d'ici à 2050. Le vieillissement pose des défis importants aux gouvernements du monde entier en raison de l'augmentation potentielle des dépenses de santé et de la nécessité de fournir des pensions et d'autres nécessités liées à l'âge. L'augmentation prévue de la population de retraités ou de personnes proches de la

retraite est directement liée à une demande croissante de régimes de retraite dans les pays à revenu faible et intermédiaire, en particulier au Nigeria, qui compte une population importante. Il est donc crucial de mettre en place un système de pension solide et résistant dans le pays, surtout si l'on considère l'escalade des déficits des pensions gouvernementales, les conditions économiques instables, la pauvreté et l'allongement de l'espérance de vie.

Le chapitre 2, intitulé "Fund participation", étudie le faible taux d'adhésion et de participation des travailleurs du secteur informel nigérian au régime de micro-pension (MPP), qui offre une combinaison de composantes d'épargne à court et à long terme, la composante à court terme permettant aux participants d'accéder à leurs fonds à court terme et la composante à long terme se concentrant sur les rendements à long terme par le biais d'investissements dans des actifs à plus long terme. Étant donné le rôle important que joue l'économie informelle au Nigeria, le fait que les travailleurs du secteur ne s'inscrivent pas et ne participent pas au MPP pourrait entraîner une aggravation de la pauvreté des personnes âgées et de la pression financière sur les ménages du secteur informel et sur l'économie. Il est essentiel de comprendre les facteurs qui, au-delà des variables socioéconomiques et démographiques, influencent l'inscription et la participation au MPP. Ce chapitre utilise un ensemble de données représentatives au niveau national et une version étendue de la théorie du comportement planifié (TPB), qui intègre l'éducation financière des consommateurs. L'influence des concepts de la TPB (attitude, norme subjective, contrôle comportemental perçu et éducation financière du consommateur) sur les intentions des travailleurs de s'inscrire et de participer au MPP est étudiée à l'aide du modèle d'équation structurelle des moindres carrés partiels (PLS-SEM). Le chapitre 2 a donc pour but d'étudier la manière dont ces concepts liés au comportement des agents affectent l'inscription et la participation des travailleurs du secteur informel au MPP. Les résultats du chapitre indiquent une relation négative entre l'attitude et l'intention de participer au MPP. Une attitude négative se traduit par une intention comportementale négative de participer au MPP. Les individus ont souvent une vision pessimiste de l'épargne à long terme, des investissements et de la planification financière, ce qui affecte leur décision de s'inscrire et de participer à un régime tel que le MPP. En conséquence, ils ne donnent pas la priorité à la sécurité financière à long terme et ne s'engagent pas à épargner et à investir à long terme, ce qui devrait encourager l'adhésion et la participation. Il existe également une relation négative entre les

normes subjectives et l'intention comportementale d'adhérer et de participer au MPP. Les travailleurs du secteur informel manquent de pression sociale pour participer au MPP, ce qui se traduit par une baisse de l'intention de s'inscrire et de participer au MPP. Les travailleurs du secteur informel ont des opinions différentes sur l'adhésion au MPP en raison du contrôle qu'ils ont l'impression d'avoir sur leurs finances. Toutefois, le contrôle perçu n'a pas d'incidence significative sur la propension à participer au MPP. L'éducation financière des consommateurs a une relation positive avec l'intention. Une meilleure éducation financière des consommateurs se traduit par une plus grande volonté de participer au MPP. En outre, lorsque les travailleurs du secteur informel connaissent les produits et services financiers, ils prennent des décisions éclairées concernant leurs finances et sont conscients de leurs droits en tant que consommateurs. Ils comprendront également les termes du contrat, géreront leur insatisfaction et sauront où déposer leurs plaintes. Il existe une relation positive entre l'intention de participer et la participation effective au MPP.

Chapitre 3. "Funding retirement savings via contributions remittance". Dans le passé, la société nigériane, à l'instar de nombreuses autres sociétés, s'appuyait sur un système traditionnel dans lequel les enfants apportaient un soutien financier à leurs parents âgés en guise de sécurité sociale pendant leur vieillesse. Cependant, ce système est devenu dysfonctionnel. Les parents vieillissants, dont l'espérance de vie est plus longue, sont confrontés à la réalité décourageante de savoir si leurs fonds de retraite seront suffisants pour subvenir à leurs besoins (Mitchell and Smith 1991; Orth 2006; Novy-Marx and Rauh 2009; Kitao 2015). Par conséquent, dans ce chapitre de la thèse, nous nous penchons sur une question cruciale concernant le sort du solde d'un compte d'épargne-retraite dans le cadre d'un modèle de régime de retraite contributif lorsque les cotisations sont partiellement ou pas versées au cours des différentes phases d'accumulation. Sur la base de données provenant du Nigeria et d'une stratégie d'investissement basée sur le style de vie, ce chapitre analyse l'impact de ces variations dans les scénarios de financement sur le solde final du compte d'épargne-retraite. Le chapitre désigne comme stratégie A les titres à revenu variable maximum avec les titres à revenu fixe minimum dans la structure du fonds (I, II et III). Inversement, les titres à revenu variable minimum avec les titres à revenu fixe maximum dans la structure du fonds (I, II et III) sont la stratégie B. Cette structure de fonds vise à aligner l'âge et le profil de risque des titulaires de comptes d'épargne-retraite en divisant le fonds de ces

comptes en trois types de fonds actifs (I, II et III). Les participants peuvent choisir le fonds I sur demande. Le fonds II est le fonds par défaut pour les participants âgés de 49 ans et moins. Le Fonds III est le fonds par défaut pour les participants âgés de 50 ans et plus. Le chapitre révèle que le non-versement et le versement partiel des cotisations de retraite, par rapport au versement complet (taux de cotisation légal) et au versement dans les délais, ont un impact significatif sur la réduction de l'épargne-retraite dans les deux stratégies A et B, entraînant ainsi des effets négatifs sur l'équilibre du compte d'épargne-retraite. La thèse émet l'hypothèse que si le compte d'épargne-retraite fait l'objet d'un versement incohérent des cotisations, le solde du compte d'épargne-retraite sera inférieur à celui d'un compte qui respecte strictement un taux de cotisation légal. Les résultats de ce chapitre confirment l'hypothèse et déduisent que le non-versement et le versement partiel des cotisations de retraite dans un CPS entraînent une diminution de l'épargne-retraite.

Au chapitre 4. Sur la performance des investissements et l'incertitude des rendements des fonds de pension. Dans ce chapitre, nous cherchons à répondre aux questions suivantes : La présence d'un risque d'incertitude politique a-t-elle un effet perceptible sur les rendements des fonds d'épargne des caisses d'épargne-retraite ? Dans quelle mesure l'existence d'un risque d'inflation influence-t-elle les rendements des fonds d'épargne-logement ? Comment les rendements des plan d'épargne "Thrift" se comparent-ils à ceux de leurs indices de référence ? En outre, le choix des mesures de performance a-t-il une importance dans l'évaluation des rendements des plan d'épargne "Thrift"? Afin de répondre à ces questions, le chapitre utilise des données qui englobent les rendements des investissements réalisés par les plans d'épargne "Thrift" aux États-Unis, en plus de l'indice MSCI World, couvrant la période de 1989 à 2023. Les données utilisées dans ce chapitre proviennent de la base de données de plans d'épargne "Thrift" et de la Federal Reserve Bank of St. Les résultats montrent que l'incertitude politique et le risque d'inflation ont un impact sur les rendements des investissements du plan d'épargne "Thrift". En ce qui concerne la performance relative, le FSP obtient des résultats louables en reflétant étroitement ses indices de référence et la sélection des mesures de performance ne modifie pas le classement des plan d'épargne "Thrift". L'étude souligne que les mesures d'incertitude ont des effets variables sur les rendements des FSP en fonction des circonstances, remettant ainsi en question la notion d'impact uniforme. Ce chapitre fournit des informations précieuses pour les participants au système,

les investisseurs, les analystes financiers et les décideurs politiques, améliorant ainsi notre compréhension de la performance du FSP dans des conditions de marché en constante évolution.

En conséquence, cette thèse montre que les attitudes négatives à l'égard de l'épargne et des investissements à long terme, la pression ou les normes sociales restreintes et l'impact positif de l'éducation financière des consommateurs influencent les intentions comportementales d'adhérer et de participer au MPP. Nous avons également constaté que le non-versement et le versement partiel réduisent considérablement l'épargne-retraite, soulignant ainsi l'importance de respecter les taux de cotisation légaux. Enfin, les résultats montrent que l'incertitude politique et le risque d'inflation ont un impact sur les rendements, tandis que le plan d'épargne "Thrift" affiche des performances favorables par rapport aux indices de référence. L'ensemble de ces chapitres contribue à une compréhension globale des questions liées aux retraites, y compris les obstacles à la participation, les défis de financement et la performance des investissements, fournissant des informations précieuses pour une prise de décision éclairée en matière de planification de la retraite.

Cette thèse contribue à la littérature sur le financement des retraites et la sécurité sociale de plusieurs manières. Tout d'abord, elle reconnaît l'importance croissante de la planification de la retraite et la manière dont elle a été influencée par l'incorporation des idées comportementales dans l'économie et la finance (Tomar et al. 2021). Ces connaissances se sont avérées précieuses pour comprendre les décisions d'épargne-retraite à long terme. Les chercheurs se concentrent désormais sur les facteurs comportementaux qui influencent la probabilité que les ménages planifient, adhèrent et participent à des régimes de retraite. La littérature existante suggère que ces facteurs peuvent affecter de manière significative les décisions de planification de la retraite (Jacobs-Lawson and Hershey 2005; Tomar et al. 2021; Peter and Ambilikumar 2021; Horák, Kukučková, and Dobeš 2022). Cependant, le faible taux d'inscription et de participation des travailleurs du secteur informel au MPP a attiré l'attention des chercheurs. L'étude utilise les concepts comportementaux de la théorie du comportement planifié (Ajzen 1991) et de l'éducation financière des consommateurs pour comprendre l'inscription et la participation au MPP. Grâce à cette analyse, l'étude vise à fournir de nouvelles informations sur les raisons qui expliquent le faible taux d'inscription

et de participation des travailleurs du secteur informel au MPP.

Deuxièmement, cette recherche élargit également la littérature en explorant le contexte sous-exploré des économies en développement, en particulier le MPP du Nigéria pour les travailleurs du secteur informel. Ce contexte particulier a fait l'objet d'une attention limitée dans le passé. En approfondissant ce domaine, l'étude fournit des informations précieuses qui contribuent à une meilleure compréhension de la dynamique de la planification de la retraite à l'échelle mondiale. En fin de compte, ces informations permettront d'élaborer des stratégies ciblées pour cette population spécifique.

Troisièmement, nous avons élargi la littérature limitée sur la densité des cotisations et les études sur l'adéquation de l'épargne-retraite. Des recherches antérieures ont exploré les facteurs affectant la densité des cotisations et le financement du compte d'épargne retraite pour garantir une épargne-retraite suffisante (Banks et al. 2002; Cheung 2007; Antolin 2010; Van Dalen, Henkens, and Hershey 2010; Reyers 2018; Sogunro, Adeleke, and Ayorinde 2019; Rudys 2023). Dans notre étude, nous allons plus loin en examinant différents scénarios de financement du point de vue d'une stratégie d'investissement axée sur le style de vie, telle qu'elle est perçue par les participants au régime. Cette étude est la première à examiner comment le versement des cotisations affecte le compte d'épargne retraite par le biais de stratégies d'investissement axées sur le style de vie. Cette étude s'ajoute aux recherches existantes sur le financement des retraites, qui se sont principalement concentrées sur les prestations et l'adéquation des fonds. Notre étude contribue à une meilleure compréhension de l'impact du non-versement des cotisations de retraite sur le compte d'épargne retraite de la CPS.

Quatrièmement, notre étude vise à contribuer à la recherche existante sur l'impact des incertitudes politiques sur les rendements des plans d'épargne "Thrift". Nous avons mené la première étude historique en utilisant les données mensuelles de rendement des plans d'épargne "Thrift" à partir de 1989. Notre approche est unique car nous explorons le rôle des incertitudes politiques et des risques d'inflation dans la détermination des rendements des investissements des plans d'épargne "Thrift". Nous prenons en compte la présence potentielle de ruptures structurelles et de changements de régime, qui peuvent introduire différents niveaux d'incertitude dans un environnement de changement de régime (Hamilton

2010; Hamilton 2016). Ces facteurs peuvent ensuite affecter la relation entre les incertitudes politiques et les rendements individuels des fonds d'investissement de type "Thrift" .

Enfin, l'examen de la performance des plans d'épargne "Thrift" par rapport à leurs indices de référence peut fournir des perspectives précieuses sur la gestion des investissements des fonds. Les études antérieures sur les fonds actifs (Petraki and Zalewska 2017; Otero-González et al. 2021) se sont principalement concentrées sur la manière dont les fonds de pension surpassent leurs indices de référence grâce à l'expansion de leurs portefeuilles. En revanche, notre étude se penche sur la performance des plans d'épargne "Thrift", un fonds passif, par rapport à son indice de référence, offrant ainsi un nouvel éclairage sur les pratiques de gestion d'investissement employées par les plans d'épargne "Thrift" . Cet article constitue la première exploration de la performance du plans d'épargne "Thrift" par rapport à ses indices de référence.

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