ESSAYS ON PENSION FUNDS IN EMERGING MARKET COUNTRIES

SEDA PEKSEVİM

BOĞAZİÇİ UNIVERSITY

2023

ESSAYS ON PENSION FUNDS IN EMERGING MARKET COUNTRIES

Thesis submitted to the

Institute for Graduate Studies in Social Sciences

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Management

by

Seda Peksevim

Boğaziçi University

2023

Essays on Pension Funds in Emerging Market Countries

The thesis of Seda Peksevim

has been approved by:

Prof. Vedat Akgiray
(Thesis Advisor) _____

Prof. Metin Ercan
(Thesis Co-Advisor) _____

Assoc. Prof. Ali Çoşkun _____

Assoc. Prof. Neslihan Yılmaz _____

Prof. Atakan Yalçın
(External Member) _____

Dr. Kadri Özgüneş
(External Member) _____

December 2022

DECLARATION OF ORIGINALITY

I, Seda Peksevim, certify that

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;

- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution.

- this is a true copy of the thesis approved by my advisor and thesis committee at Boğaziçi University, including final revisions required by them.

Signature .....

Date .....

ABSTRACT

Essays on Pension Funds in Emerging Market Countries

This thesis consists of three essays on pension funds (PFs) in emerging market (EM) countries. The first essay focuses on designing a life-cycle fund model for the pension system in Turkey, which is adapted to its demographics and financial market structure. The findings indicate that human capital risk and its correlation with stock returns play a particularly important role in the design of life-cycle funds and significantly reduce the optimal equity allocation in the long term. Moreover, it is found that parameter uncertainty does not cause significant differences in the optimal portfolio allocations of investors, particularly those with a high degree of risk aversion. The second essay investigates the effect of PFs on stock market liquidity in 17 EM countries for the period 2006–2019 using three liquidity measures: Zeros, Roll, and Amihud. The results indicate that PFs supply liquidity to stock markets as measured by Zeros and Amihud measures, and this liquidity provision is also pronounced in times of crisis. These findings pass several robustness checks, such as a sample split, excluding crisis periods, alternative control variables, excluding outlier countries, and endogeneity bias. The third essay provides an overview of private pension systems in developing countries, including current challenges and future directions. Desirable financial, behavioral, and technological developments are suggested in this study for strengthening private pension systems in developing countries.

ÖZET

Gelişmekte olan Ülkelerdeki Emeklilik Fonları Üzerine Denemeler

Bu tez, gelişmekte olan ülkelerdeki emeklilik fonları üzerine üç makaleden oluşmaktadır. İlk makalenin amacı, yaşam döngüsü fonlarını Türkiye'nin demografik ve finansal yapısına uygun olabilecek bir şekilde modellemektir. Elde edilen bulgular, özellikle beşeri sermaye riskinin ve bu riskin hisse senetleri ile olan korelasyonunun yaşam döngüsü fonlarının modellenmesinde kritik bir rol oynadığını ve uzun vadede optimal hisse senedi alokasyonlarını önemli ölçüde azalttığını göstermektedir. Ayrıca, parametre belirsizliğinin özellikle riskten kaçınma katsayısı yüksek olan bireyler için uzun vadeli hisse senedi alokasyonlarında büyük farklılıklar oluşturmadığı görülmektedir. İkinci makale, 17 gelişmekte olan ülke için 2006-2019 döneminde emeklilik fonlarının hisse senedi piyasası likiditesine olan etkisini, Zeros, Roll, ve Amihud ölçütleri ile incelemektedir. Elde edilen bulgular, emeklilik fonlarının hisse senedi piyasası likiditesini Zeros ve Amihud ölçütleri için olumlu yönde etkilediğine ve bu etkinin kriz zamanlarında da görüldüğüne işaret etmektedir. Ayrıca, sonuçların, ayrık örneklemlere, kriz dönemleri hariç gözlemlere, alternatif kontrol değişkenlere, outlier (dışa düşen) ülke gözlemlerine, ve endojenlik sorununa karşı da sağlam olduğu raporlanmaktadır. Üçüncü makale, gelişmekte olan ülkelerdeki özel emeklilik sistemlerinin genel bir özetini karşılaşılan güçlükler ve gelecek için izlenmesi gereken yaklaşımlar çerçevesinde sunmaktadır. Bu makalede, özel emeklilik sistemlerinin geliştirilmesi için politika önerileri finansal, davranışsal, ve teknolojik uygulamalar çerçevesinde incelenmektedir.

CURRICULUM VITAE

NAME: Seda Peksevim

DEGREES AWARDED

PhD in Management, 2023, Boğaziçi University
MA in Financial Engineering and Risk Management, 2016, Özyeğin University
BA in Economics, 2010, Sabancı University

AREAS OF SPECIAL INTEREST

Pension funds, empirical asset pricing, emerging markets, behavioral finance

PROFESSIONAL EXPERIENCE

Researcher, Scientific Research Projects Council, Boğaziçi University, 2019-2022
Researcher, Center for Applied Research in Finance, Boğaziçi University, 2016-2019
Research Assistant, Center for Computational Finance, Ozyegin University, 2013-2016
L'oreal, Financial Controller, 2011-2012

AWARDS AND HONORS

Investments & Wealth Institute, Doctoral Student Research Grant, 2022
Pensions Scholarship Trust, Doctoral Research Grant, 2021
Sabancı University, High Honor Scholarship, 2009-2010

PUBLICATIONS

Peksevim, S., & Akgiray, V. (2019). Reforming the Pension System in Turkey: Comparison of Mandatory and Auto-Enrolment Pension Systems in Selected OECD Countries. OECD Discussion Papers on Private Pensions. OECD Publishing, Paris.

Akgiray, V., Peksevim, S., & Sener, E. (2016). Pension Funds and Financial Stability: Lessons from Chile and Turkey. *International Journal of Finance & Banking Studies, 5* (2), 1-20.

ACKNOWLEDGMENTS

I am immensely grateful for the continual support and encouragement of my thesis supervisors, Prof. Vedat Akgiray and Prof. Metin Ercan, who provided valuable guidance in my work and academic career. Their knowledge and experience greatly helped me to learn in detail the area of my specialization: pension funds, empirical asset pricing, and behavioral finance.

The work on the first two chapters of this thesis was financially supported by the Scientific Research Council (BAP) (Project No: 15781 and 18462), for which I express my profound gratitude. I am also deeply thankful to the Pensions Scholarship Trust and Investments and Wealth Institute for partial funding of my research.

I am greatly indebted to my professors, colleagues, and friends for their valuable comments and suggestions that led to significant improvement of this thesis. Although it would not be possible to mention all of them individually, I would like to particularly acknowledge Prof. Olivia Mitchell, Prof. Christopher Sier, Prof. Umut Çetin, Dr. Oğuz Karahan, Yaşar Kemal Peştreli, Joseph Mariathasan, Ziga Vizintin, Wojciech Sieczkowski, Manfred Jormakka, and Osman İlter for their valuable insights. I am also thankful to the members of the Thesis Committee for their high degree of professionalism and constructive feedback.

Last but not least, my special thanks go to my family for encouraging and invariably supporting this work in the pursuit of my Ph.D. degree.

DEDICATION

To my dear family (including my cat) for their boundless love, who gave me the strength and resolve to complete my Ph.D. degree.

TABLE OF CONTENTS

CHAPTER 1: OPTIMAL LIFE-CYCLE FUND DESIGN FOR THE TURKISH PENSION SYSTEM 1
1.1 Introduction 1
1.2 Literature review 4
1.3 Data description 8
1.4 Methodology 10
1.5 Results 15
1.6 Conclusion 28
CHAPTER 2: PENSION FUNDS AS LIQUIDITY PROVIDERS: EVIDENCE FROM EMERGING MARKET COUNTRIES 30
2.1 Introduction 30
2.2 Literature review 34
2.3 Data description 39
2.4 Empirical methodology 46
2.5 Results 48
2.6 Robustness checks 51
2.7 Conclusion 61
CHAPTER 3: PRIVATE PENSION SYSTEMS IN DEVELOPING COUNTRIES: CURRENT CHALLENGES AND FUTURE DIRECTIONS 63
3.1 Introduction 63
3.2 Determinants of low private pension savings 65
3.3 Auto-enrollment policy in developing countries 84
3.4 Limitations of private pension plans 87
3.5 Conclusion 89
REFERENCES 91

LIST OF TABLES

Table 1. Mean and Variance Parameters....14

Table 2. The Results of the ADF and PP Stationarity Tests of Mean Reversion 24

Table 3. The Results of the ZA Stationarity Tests of Mean Reversion 24

Table 4. The Runs Tests for Stock Returns 25

Table 5. Variance Ratio Tests of Mean Reversion 26

Table 6. Major Empirical Studies on PFs and Stock Market Volatility 37

Table 7. Major Empirical Studies on PFs and Capital Market Development....38

Table 8. Major Empirical Studies on PFs and Financial Market Liquidity 38

Table 9. Variable Definition and Sources 39

Table 10. PF Assets and Investments by Country (2009-2019)....42

Table 11. Summary Statistics....46

Table 12. Results for the Prais-Winsten Regression Model 50

Table 13. Robustness Check: Results for the EU Countries....51

Table 14. Robustness Check: Results for the Non-EU Countries....52

Table 15. Robustness Check: Excluding Crisis Periods 53

Table 16. Robustness Check: Additional Control Variable – GDP per capita 54

Table 17. Robustness Check: Additional Control Variable – Money Supply 55

Table 18. Robustness Check: Outlier Countries with the Smallest Share of PFs Equity Investments....57

Table 19. Robustness Check: Outlier Countries with the Highest Share of PFs Equity Investments....58

Table 20. Robustness Check: Endogeneity Bias....60

Table 21. Coverage of Private Pension Plans as a Percentage of the Working-age Population in Developing Countries 66

Table 22. PF Fees and their Determinants in Developing Countries 82

Table 23. Auto-enrollment Programs in Developing Countries 86

LIST OF FIGURES

Figure 1. The average annual real labor income for different age cohorts 9

Figure 2. Stochastic human capital for different ages 17

Figure 3. Stochastic human capital for different discount rates at age 45 17

Figure 4. The optimal portfolio allocation to stocks for different risk aversion coefficients 19

Figure 5. The optimal portfolio allocation to stocks for different discount rates 20

Figure 6. The optimal equity allocation for different positive correlation coefficients between human capital and stock returns 21

Figure 7. The optimal equity allocation for different negative correlation coefficients between human capital and stock returns 22

Figure 8. The optimal equity allocation for different human capital assumptions 23

Figure 9. The effect of parameter uncertainty on the equity ratio vs. the years to retirement 28

Figure 10. PF assets as a percentage of GDP 31

Figure 11. PFs' equity investments in total portfolio (%) in selected EM countries 32

Figure 12. Public pension replacement rates and voluntary pension coverage in selected developed and developing countries 68

Figure 13. GDP per capita and coverage rates for private pension plans in selected countries (based on data availability) 69

Figure 14. Self-employment as a percentage of total employment 71

Figure 15. Private pension plan members and contributors as a percentage of the working-age population 72

Figure 16. Contribution rates as a percentage of GDP in selected countries, 2019 73

Figure 17. Contribution density in private and public pension plans in developing countries (%) 74
Figure 18. Ten-year annualized real returns in private pensions in developing countries, 2009–19 (%) 78
Figure 19. Asset allocation of private PFs in developing countries in 2019 (%) 79
Figure 20. Operating costs of private PFs as a percentage of assets under management (AUM) in developing countries 81

CHAPTER 1

OPTIMAL LIFE-CYCLE FUND DESIGN FOR THE TURKISH PENSION SYSTEM [1]

1.1 Introduction

Established in 2003, the Turkish private pension system (BES) reached the size of $20 billion with over 13 million participants by the end of 2021 (Pension Monitoring Centre, 2022). The private pension system aims not only to improve the savings rate in Turkey but also to promote the growth of the economy and capital markets. However, according to Gökçen and Yalçın (2015), the net investment returns of pension funds (PFs) in Turkey are lower, on average, than those of passively managed funds. One main reason for this discrepancy is the mismatch between the investor's age and the risk-return profile that is offered. Considering the demographics of Turkey, the young generation can provide a significant boost to capital markets. Despite this fact, PF participants allocate only 15% of their investments to capital markets compared to 55% in some developed countries (OECD, 2022).

Due to the challenges facing BES, the PF asset-to-GDP ratio in Turkey is only 5%, whereas this ratio is higher in comparable economies, such as Brazil (14%) and South Africa (51%) (OECD, 2022). To boost the size of the private pension system, two important regulations were put into effect: (i) a 25% state contribution incentive and (ii) an automatic enrollment system (AES). Adopted in 2013, the government contribution aims to induce investors to save more in the long term, while the idea behind the AES is to boost the participation rate in the private pension system. Under automatic enrollment

[1] The work on this chapter was financially supported by the Scientific Research Council (BAP), Project No: 15781.

programs, employees are registered in a pension plan with a predetermined contribution rate and portfolio allocation unless they actively declare their preference to opt-out. A number of studies have documented a dramatic increase in participation rates after the introduction of AES, and the majority of people tend to stay enrolled (Madrian & Shea, 2001; Choi, Laibson, & Madrian, 2004).

The adoption of AES brings forth the need for a default fund catering to employees who have not actively made their investment choice. Most developed countries with AES introduced life-cycle funds as their default option, in which the share of risky assets is automatically reduced as investors approach their retirement. For example, in the US, a 25-year-old investor is offered an allocation of nearly 90% to equities, whereas a 60-year-old investor allocates only 10% of his pension savings to risky assets (Viceira, 2009). There are two main reasons why life-cycle funds are preferred in developed countries: (i) participants are directed to risk-return profiles that are suitable for their ages, and (ii) the funds are passively managed with transaction costs approximately three times lower compared to active funds. These features ensure that resources are transferred to the economy effectively (Schooley & Worden, 1999; Fidelity, 2019).

Although life-cycle funds catering to different age groups are allowed in the AES in Turkey, currently, there exist no passive funds that would adjust their portfolio allocation with age. However, as they are expected to be incorporated as default funds in the AES, it is important that life-cycle funds are modeled with a methodology reflecting the demographics and financial structure of Turkey. Currently, life-cycle funds in developed countries offer to young participants an allocation predominantly to stocks (approximately 90% for the first 15-20 years in the US). However, the introduction of a similar structure in a country with different demographic characteristics and financial

markets, such as Turkey, may expose participants to significant financial losses at early ages and lead to behavior that precludes risk-taking in the future (Esch & Michaud, 2014).

The purpose of this study is to develop a life-cycle fund model for the Turkish pension system reflecting the demographic and financial structure of the country. In this respect, firstly, a stochastic human capital is modeled for Turkey according to the methodology of Campbell and Viceira (2002) and Cocco, Gomes, and Maenhout (2005). Secondly, portfolio allocations of life-cycle funds are estimated based on the human capital structure that is both stochastic and correlated with stock returns. Thirdly, the mean reversion effect in the Turkish stock market is investigated using different statistical tests (unit root tests, runs tests, and variance ratio tests), and the results indicate that the hypothesis of stock prices following a random walk process cannot be rejected. Finally, investors' portfolio allocations are analyzed using the Bayesian approach of Barberis (2000), which models the uncertainty of the distribution of financial returns in the long run.

In line with the studies of Cocco et al. (2005), Benzoni, Collin-Dufresne, and Goldstein (2007), and Viceira (2010), I find that human capital risk and its correlation with stock returns are significant factors when optimizing the portfolio structure of a life-cycle fund. However, parameter uncertainty does not lead to significant differences in stock allocations in the long run, particularly for individuals with a high-risk aversion.

To the best of my knowledge, this study is the first to design a life-cycle fund methodology for Turkey. It contributes to the literature in the area of life-cycle theory and human capital and proposes a life-cycle fund model with parameter uncertainty in the context of a developing country. The findings of the study can contribute to the introduction of an efficient and low-cost default investment option in the AES in Turkey.

For future studies, it is recommended that the correlation of stochastic human capital with stocks is examined in detail for different business sectors. Moreover, real estate, which plays an important role in household investments, may be included as an alternative asset in the analysis of life-cycle funds.

The remainder of this study is organized as follows. Section 2 reviews the related literature. Section 3 introduces the data. Section 4 illustrates the methodology for modeling human and financial capital. Section 5 presents the results. Finally, Section 6 discusses the policy implications of the findings and concludes.

1.2 Literature review

This study contributes to two streams of literature: (i) the life-cycle theory and human capital and (ii) mean reversion and parameter uncertainty.

1.2.1 The life-cycle theory and human capital

The investment strategy of life-cycle funds is based on the theory of life-cycle investing (Samuelson, 1969; Bodie, Merton, & Samuelson, 1992; Jagannathan & Kicherlakota, 1996; Viceira, 2001). According to this theory, the 'age' factor should be integrated into long-term portfolio optimization as well as the expected return and risk parameters. In other words, human capital (i.e., the present value of future labor income) should also be included in the wealth maximization of individuals in addition to financial capital.

From the perspective of life-cycle investing theory, human capital represents a risk-free asset since it acts as a buffer in protecting individuals' savings from market fluctuations over the long run (Samuelson, 1969; Bodie et al., 1992). In this respect, while young investors with relatively high human capital should invest in riskier assets, older

investors with less human capital should prefer a more conservative asset allocation. Indeed, the practical application of this theory can be found in life-cycle funds offered as a part of US retirement plans (e.g., Vanguard, Fidelity, and T. Rowe Price). The portfolio structure of these funds supports a substantial allocation to equities (about 90%) for young individuals, gradually shifting to less risky allocation as investors age.

In contrast to the assumption of riskless human capital, recent studies show that human capital should be viewed as a risky asset due to the temporary and permanent fluctuations to which individuals are subject during their working life. In contrast to temporary shocks (e.g., maternity leave and short-term unemployment), permanent shocks (e.g., disability and promotion) lead to a change in the subjective expectations of earnings. A life-cycle fund's portfolio structure could be totally different compared to that of existing US life-cycle funds, depending on the size of these random shocks and the correlation between human capital and stocks (Viceira, 2001; Coco et al., 2005). For this reason, human capital risk has great importance for both long-term portfolio optimization and investors' welfare maximization (Bagliano, Fugazzo, & Nicodano, 2019).

Interestingly, previous work on human capital in Turkey often examined this issue in a macroeconomic context by focusing on the savings and consumption behavior of households (Tansel, 2004; Cilasun & Kırdar, 2009; Aktug & Kuzubaş, 2017). To my knowledge, none of these papers models deterministic or stochastic human capital to design a life-cycle fund for the Turkish capital markets.

1.2.2 Mean reversion and parameter uncertainty

Previous studies arguing that stock investments are less volatile in the long run attempt to explain this phenomenon with mean reversion (Fama & French, 1988; Poterba &

Summers, 1988; Campbell & Shiller, 2001; Siegel, 2008). Mean reversion refers to a negative correlation between realized and expected future returns when stock prices tend to fluctuate around a certain mean or a trend. In the presence of mean reversion, stock prices are partially predictable, and this leads to lower stock market volatility in the long run.

In the academic literature, mean reversion is typically analyzed using three types of tests: unit root tests, runs tests, and variance ratio tests. For example, Kawakatsu and Morey (1999) employ unit root tests and variance ratio tests to examine the stock market prices of 16 developing countries and do not find a mean reversion effect. However, using structural break unit root tests and variance ratio tests, Chaudhuri and Wu (2003) find that stock prices could be characterized as mean reverting in many developing countries. Urrutia (1995), on the other hand, reports that stock prices follow a random walk process based on runs tests for Argentina, Brazil, Chile, and Mexico. Other studies that examine the mean reversion effect in developing countries report mixed results (Hasanov & Omay, 2007; Lean & Smyth, 2007; Abakah, Alagidede, Mensah, & Ohene-Asare, 2018). There exists only a limited number of studies investigating the mean reversion effect for stock prices in Turkey (Kapusuzoğlu & İbicioğlu, 2013; Gözbaşı, 2014; Tuna & Öztürk, 2016). For example, Gözbaşı (2014) find that 7 out of 22 BIST indices demonstrate mean reversion when investors can predict future stock prices depending on their past realizations.

Recent studies, on the other hand, emphasize that parameter uncertainty should be taken into account in addition to the effect of mean reversion in long-term portfolio optimization. According to the main argument in this literature, the expected return and

variance parameters cannot be predicted precisely from the perspective of investors, and this uncertainty significantly affects portfolio allocation in the long run.

Most studies measuring the effect of parameter uncertainty, in the long run, analyze only developed countries, especially the US. Barberis (2000) and Hoevenaars, Molenaar, Schotman, and Steenkamp (2014) report that when parameter uncertainty is taken into account, the optimal stock allocation should be reduced compared to the situation when parameters are deterministic. These studies are based on the Vector Autoregression (VAR) methodology combined with distributional assumptions to model parameter uncertainty. Alternatively, Harvey, Liechty, Liechty, and Müller (2009) apply the Markov Chain Monte Carlo (MCMC) simulation approach, in which the distribution type is not necessarily specified.

One of the most comprehensive studies of parameter uncertainty (Pastor & Stambaugh, 2012) shows that stocks are more volatile in the long run than in the short run. The authors consider four different uncertainty effects (i.i.d. uncertainty, uncertainty about future expected returns, uncertainty about current expected return, and estimation risk) along with mean reversion of stock prices. By applying the MCMC methodology, the study concludes that stocks are more volatile in the long run due to these uncertainties dominating the mean reversion effect. Finally, a recent study conducted by Carvalho, Lopes, and McCulloch (2018) shows that unless investors possess extreme beliefs (priors) about return and variance parameters, the mean reversion effect is dominant, and stocks are less volatile in the long run, contrary to the results of Pastor and Stambaugh (2012).

1.3 Data description

The present study is based on three different datasets. Firstly, the Household Budget Survey (HBA) of the Turkish Statistical Institute (TURKSTAT) is used to calculate the average labor income based on age. This survey is a cross-sectional micro-dataset covering demographic and socioeconomic variables (e.g., gender, age, education, employment, insurance status, salaries, and bonus payments) of household members aged 15 and above.

Several filters are applied in line with the literature to eliminate missing values and outlier observations (Cilasun & Kırdar, 2009; Aktug & Kuzubas, 2017). I select individuals who have at least a high school education, health insurance, full-time employment, and an annual income of more than 3,000 TRY. The final sample, after data processing, contains 4,109 observations. The sum of salaries and bonus payments is taken as the basis for the calculation of the annual labor income. The estimated nominal income is adjusted for inflation using the consumer price index in 2017.

The annual average real labor income for different age cohorts is shown in Figure 1. For the youngest 20-24 age cohort, the labor income is 19,462 TRY; it reaches its peak of approximately 37,000 TRY for the 45-49 age cohort and decreases to 29,000 TRY for the 65-69 age cohort. The humpback structure of the labor income in Turkey is similar to other countries such as the US or Germany (Aktug, Kuzubaş, & Torul, 2017).

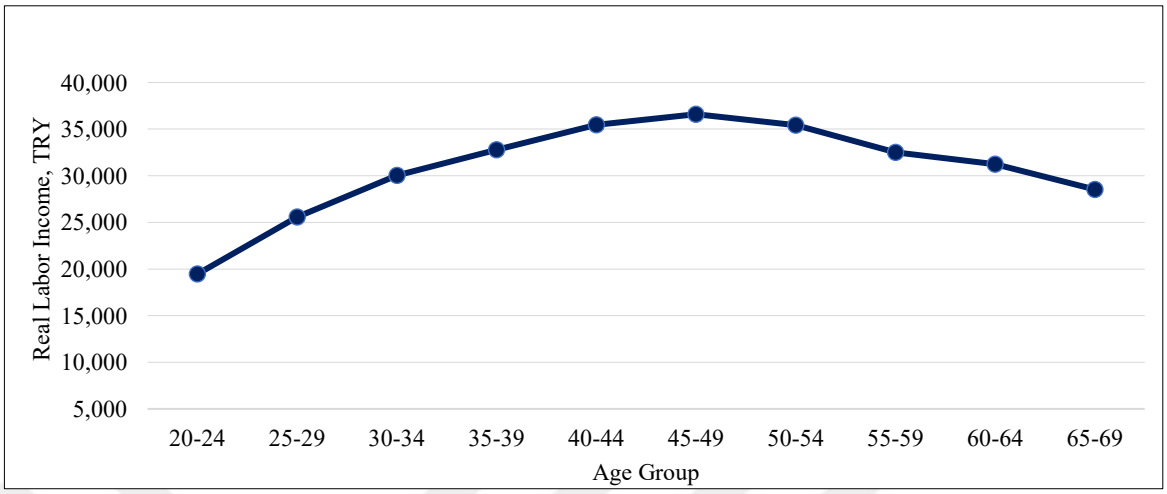

Figure 1. The average annual real labor income for different age cohorts

Source: TURKSTAT (2017).

The second dataset is the Income and Living Conditions Survey (ILCS), which is a panel survey obtained from TURKSTAT and covering the period 2014-2017. The same data filtering steps used for the cross-sectional micro-dataset are also applied to this panel survey. After missing values and outlier observations are excluded, a total of 3,285 observations are retained in the final sample.

The cross-sectional methodology of Shin and Solon (2011) and Venn (2011) is used to calculate the volatility of labor income. First, cross-sectional standard deviations of the year-to-year labor income growth are calculated on an individual basis. Then, the average of these standard deviations is estimated for the relevant period. The obtained annual labor income volatility for the average employee in Turkey is approximately 45%. When compared to Venn (2011), this value is similar to other EM countries, such as Slovakia, Portugal, Hungary, and Poland. The labor income volatility estimated from the data is used to calculate the risk premium of human capital.

The third dataset employed in this study contains the time series of the BIST 100 stock index and KYD net repo index. These time series are collected from the Bloomberg

Database at a monthly frequency. Real financial log returns are adjusted for inflation and are used to represent stock and bond prices.

1.4 Methodology

1.4.1 Human capital model

In line with Cocco et al. (2005), the logarithmic labor income of an investor is modeled as follows:

$$ln(hc_x) = f(x, Z_x) + v_x + \epsilon_x$$

where $f(x, Z_x)$ is a deterministic function of the age x and income level Z_x ; $\epsilon_x \sim N(0, \sigma_\epsilon^2)$ assumes that the temporary shock follows a normal distribution; $v_x = v_{x-1} + u_x$, where $u_x \sim N(0, \sigma_u^2)$ describes the permanent shock.

The average real labor income at age x, $f(x, Z_x)$, is obtained from the TURKSTAT cross-sectional micro-dataset. The two random components in the model representing permanent and temporary shocks are assumed to be uncorrelated. The magnitude of the shocks as a fraction of labor income is obtained from Cocco et al. (2005) and Viceira (2010).

Following Campbell and Viceira (2002), the human capital is estimated as follows:

$$HC_x = \sum_{j=0}^{J} \{hc_{x+j} exp[-j(r_f + \xi)]\}$$

where HC_x refers to the total human capital and hc_x is the labor income at age x; r_f denotes the risk-free rate; and ξ is the risk premium of human capital.

1.4.2 The mean reversion effect

The mean reversion effect in the Turkish stock market is examined using three main tests:

- *Unit Root Tests:* The precondition for mean reversion is the stationarity of time series when mean, variance, and covariance do not change over time. In this context, Dickey and Fuller (1981) and Philips and Perron (1988) unit root tests are employed to determine whether stock prices follow a stationary process. Moreover, the Zivot and Andrews (1992) unit root test is also applied to detect structural breaks in BIST 100 stock returns.
- *Runs Tests:* Runs tests are used in the literature to verify whether a time series follows a random walk process. The underlying assumption on which these tests are based is the following: if a time series has too few or too many consecutive ups or downs, it is unlikely to represent a random walk, and the time series can exhibit either a mean reversion or trend behavior. In this study, the Wald and Wolfowitz (1943) test, Bartels (1982) rank test, and turning point test (Kendall, 1973), which are referred to as classical runs tests, are used to determine whether stock prices follow a random walk process.
- *Variance Ratio Tests:* Time series with independently identically distributed (i.i.d.) returns have a linearly increasing variance over time. The variance ratio methodology, based on this property, tests whether the variance of multi-period returns grows linearly. If a time series possesses a mean reversion characteristic, the variance of multi-period returns should be lower than that of an i.i.d. time series. The variance ratio statistic developed by Lo and MacKinlay (1988) can be formulated as follows:

$$VR(k) = \frac{Var(x_{t+k})}{k * Var(x_t)}$$

which compares the variance of *k*-period returns with the variance of one-period returns. According to this test, if the variance ratio $VR(k)$ is statistically less than 1, there is a mean reversion effect present; if equal to 1, the time series is a random walk; and if greater than 1, a trend effect is present. The power of the variance ratio test can be higher than that of unit root tests (Lam & Wong, 2006).

1.4.3 Optimal portfolio allocations

The optimal portfolio allocations to stocks and bonds are analyzed for different age groups and various degrees of risk aversion and discount rates. The wealth maximization problem of an investor is defined for a constant relative risk aversion (CRRA) function:

$$max_{a_x} E[U_{x+1}]$$

where $U_{x+1} = \frac{(FW_{x+1}+HC_{x+1})^{1-\gamma}}{1-\gamma}$ and $\gamma > 0$, and the financial capital follows the stochastic process that can be described as:

$FW_{x+1} = FW_x + hc_x \left[a_x e^{\left(\mu_s - \frac{1}{2}\sigma_s^2\right)+\sigma_s Z_{s,x+1}} + (1-\alpha_x)e^{r_f}\right]$, where

a_x – investment ratio for stocks ($0 \leq a_x \leq 1$);

1- a_x – investment ratio for bonds;

hc_x – labor income at age *x*;

HC_x – human capital (i.e. the discounted value of labor income);

r_f – risk-free rate of return;

S_x – the stock price at age *x*, which follows a geometric Brownian motion process:

$S_{x+1} = S_x exp\left(\mu_s - \frac{1}{2}\sigma_s^2 + \sigma_s Z_{s,x+1}\right)$;

x – investor's age;

μ_s – expected stock return;

σ_s– standard deviation of stock returns;

$Z_{s,x} \sim N(0,1)$ – i.i.d. random shocks to stock returns at age x.

1.4.4 Parameter uncertainty

The parameter uncertainty model is based on the i.i.d. compounding stock index excess returns at time t:

$$r_t = \mu + \epsilon_t$$

where $\epsilon_t \sim N(0, \sigma^2)$. Since the expected return μ and variance σ^2 cannot be known precisely from the perspective of investors, their distribution should also be modeled. This can be achieved by specifying the prior distributions and estimating the posterior distributions using the Bayesian approach.

In line with Barberis (2000), an investor facing parameter uncertainty is assumed to have a non-informative prior:

$$p(\mu, \sigma^2) \propto \frac{1}{\sigma^2}$$

For the non-informative prior, the posterior distribution of σ^2 is the inverse gamma distribution (Zellner, 1971):

$$\sigma^2 | r \sim IG\left(\frac{T-1}{2}, \frac{1}{2}\sum_{t=1}^{T}(r_t - \overline{r})^2\right)$$

where $\overline{r} = \frac{1}{T}\sum_{t=1}^{T} r_t$ and $r = (r_1, r_2, \ldots, r_T)$ are continuously compounded excess stock returns.

After the variance has been sampled from the posterior inverse gamma distribution, it can be used to derive the posterior distribution of the expected return:

$$\mu|\sigma^2, r \sim N\left(\overline{r}, \frac{\sigma^2}{T}\right)$$

The posterior distributions of the expected return and variance are obtained after 1,000,000 Monte Carlo simulations. The mean and standard deviation (in parenthesis) of the monthly expected excess return and variance are presented for the Turkish stock market in Table 1. The real logarithmic excess returns over the 2003-2020 period are used in the computations.

Table 1. Mean and Variance Parameters

2003-2020	
μ	σ^2
0.0035	0.0062
(0.0054)	(0.0006)

An investor with no parameter uncertainty can choose portfolios with a distribution based on the average values of the expected excess return and variance parameters specified in Table 1. In this case, the investor will use the distribution of stock returns $p(R_{T+\hat{T}}|r, \mu, \sigma^2)$ conditioned on the fixed parameters. Here, $R_{T+\hat{T}} = r_{T+1} + r_{T+2} + \cdots + r_{T+\hat{T}}$, where $\hat{T}$ is the investment horizon for a buy-and-hold investor. However, since the investor is exposed to parameter uncertainty, he also takes into account the standard deviations of the expected return and variance parameters reported in Table 1. In this case, the investor will use the estimated distribution $p(R_{T+\hat{T}}|r)$ based on $r = (r_1, r_2, \ldots, r_T)$ when modeling stock returns.

The expected CRRA utility at time $T + \hat{T}$ with the relative risk aversion *A* and the portfolio allocation to stocks *w,* which needs to be optimized, can be approximated with the average utility for a sufficiently large number of iterations *I*:

$$\frac{1}{I}\sum_{i=1}^{I}\frac{\left\{(1-w)exp\left(r_f\hat{T}\right)+wexp\left(r_f\hat{T}+R_{T+\hat{T}}^{(i)}\right)\right\}^{1-A}}{1-A}$$

Here, $R_{T+\hat{T}}^{(i)}$ are computed based on sampled $r_{T+1}^{(i)}, r_{T+2}^{(i)}, \ldots, r_{T+\hat{T}}^{(i)}$ for each iteration *i* using a three-step approach when, first, the variance σ^2 is sampled from the posterior inverse gamma distribution, then the expected return μ is sampled from the posterior normal distribution and, finally, each excess return is sampled from $N(\mu, \sigma^2)$. In the case of no parameter uncertainty, the first two steps are omitted.

1.5 Results

1.5.1 Stochastic human capital analysis

The findings for stochastic human capital are reported for the representative investor who starts working at age 20 and is expected to retire after reaching age 65 (with zero human capital).

The expected human capital distributions for ages 20, 30, 45, and 60 are presented in Figure 2, along with their medians and standard deviations. The median human capital of the representative investor at age 20 is 546,858 TRY, which is lower than at age 30 (589.971 TRY) and higher than at age 45 (464,509 TRY); it reaches its peak in the 30s and drops to 143,545 TRY at age 60.

The human capital for all ages in Figure 2 can be significantly affected by temporary and permanent shocks to labor income. For example, the standard deviation of

the human capital increases from age 20 (234,495 TRY) to age 30 (335,776 TRY) and 45 (370,890 TRY) due to the fact that the labor income is exposed to significant temporary and permanent shocks during the working life of the representative investor. More importantly, the standard deviation of the human capital always increases with age in relation to its median, e.g. the ratio of the standard deviation to median human capital at age 20 is less than 1/2, but it exceeds 1 at age 60 (Panel A and Panel D).

The main reason for these differences is the uncertainty that is caused by permanent shocks in future labor incomes (Viceira, 2010). Although temporary shocks affect the labor income equally at all ages, permanent shocks, modeled by the AR(1) process, grow cumulatively with increasing age. For this reason, the standard deviation for older ages approaches and can even exceed the median, e.g., the standard deviation of the human capital for a 60-year-old individual (149,977 TRY) is higher than its median value (143,545 TRY) (Panel D).

Figure 3 shows how different discount rates affect human capital distributions for the same age by comparing the distributions for the 45-year-old representative investor exposed to the 5%, 10%, and 15% discount rates. As the discount rate increases, the present value of labor income decreases, leading to a lower median and standard deviation of the human capital. However, the contribution of temporary and permanent shocks remains the same irrespective of the discount rate since the age is the same for all the panels in Figure 3. For this reason, the standard deviation decreases at the same rate compared to the median.

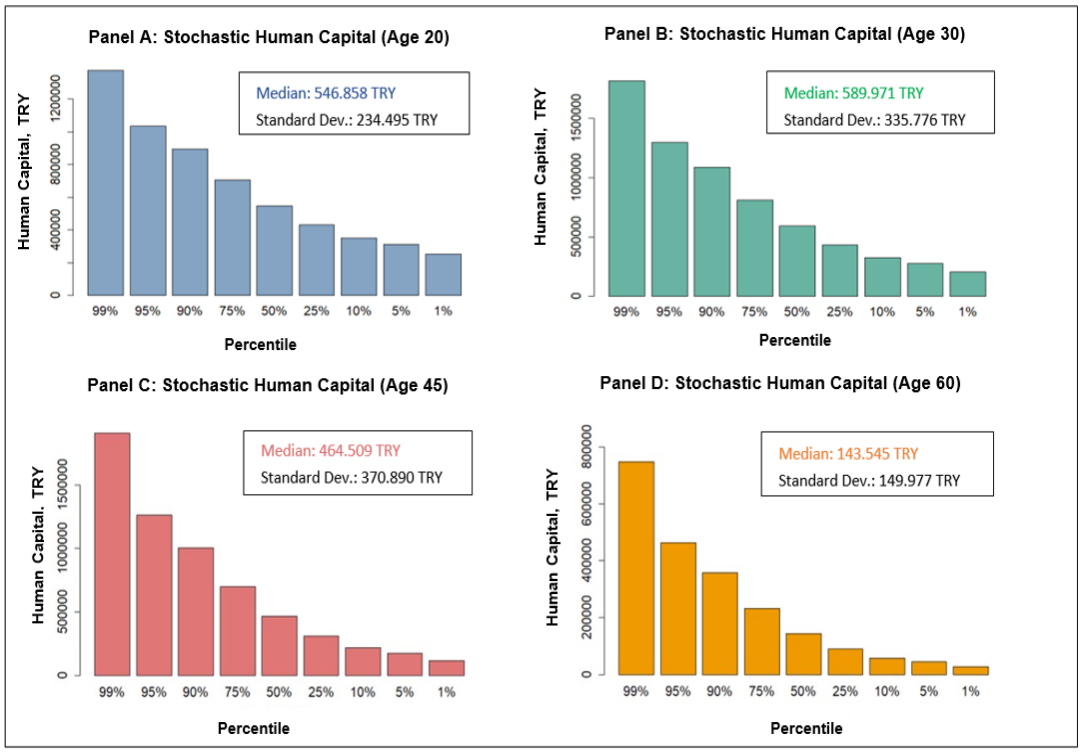

Figure 2. Stochastic human capital for different ages

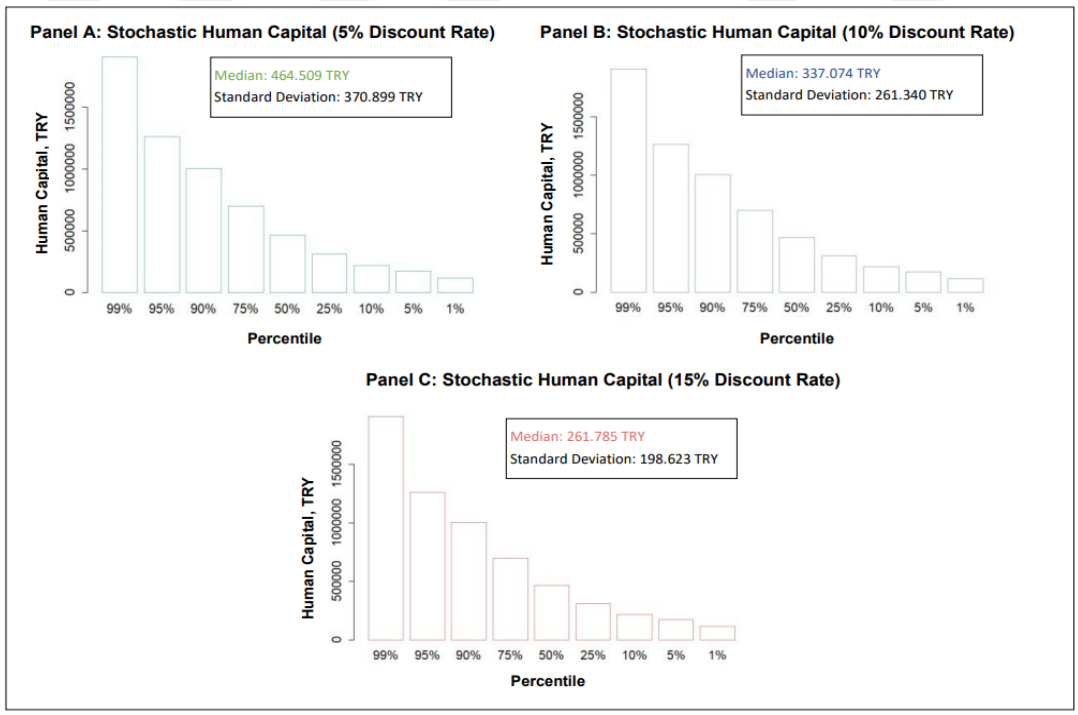

Figure 3. Stochastic human capital for different discount rates at age 45

1.5.2 The optimal portfolio distributions

This section presents life-cycle funds' portfolio distributions optimized with stochastic human and financial capital. First, the optimal equity ratios of life-cycle funds are analyzed in relation to different risk aversion coefficients and discount rates. Then, the optimal portfolios under the assumption of the stochastic human capital correlated with stocks are presented. Finally, the portfolio allocations are compared, assuming the human capital to be deterministic, stochastic, or correlated. The standard assumptions used in modeling life-cycle funds are as follows:

- The age at which the representative investor starts investment: 21;
- The retirement age of the representative investor: 65;
- Contribution rate: 5%;
- Discount rate: 5%;
- Relative risk aversion coefficient: 5.

The optimal stock allocations of life-cycle funds for different risk aversion coefficients are presented in Figure 4. According to the literature, the commonly reported risk aversion coefficient is 5. The coefficient 10 is used to indicate the highest degree of risk aversion, whereas the lowest risk aversion coefficients are either 1 or 2 (Mehra & Prescott, 1985; Cocco et al., 2005; Azar, 2006).

As it is evident from Figure 4, risk aversion greatly affects the share of the portfolio allocated to stocks. Although the representative investor with the risk aversion coefficient of 1 has a risky human capital, he selects the portfolio distribution with a 100% stock ratio for all the age groups, and the individual who has a risk aversion coefficient of 2 retires with an approximately 70% equity allocation while investing 100% in stocks up to age 50. This result is also similar to the findings of Pfau (2009). In this study, the 100% stock

allocation is specified as optimal for individuals with risk aversion coefficients of 1 and 2. Unlike Pfau (2009), the optimal stock ratio in the present study decreases more rapidly for individuals with a risk aversion coefficient 2 or higher because the human capital is modeled as stochastic rather than deterministic. Investors with risk aversion coefficients 5 and 7 have a much lower optimal stock allocation for the same age groups. For example, according to the portfolio optimization model, it is predicted that an individual who has a risk aversion coefficient 7 starts reducing the 100% equity ratio after the age of 25 and retires with an equity allocation of approximately 20%.

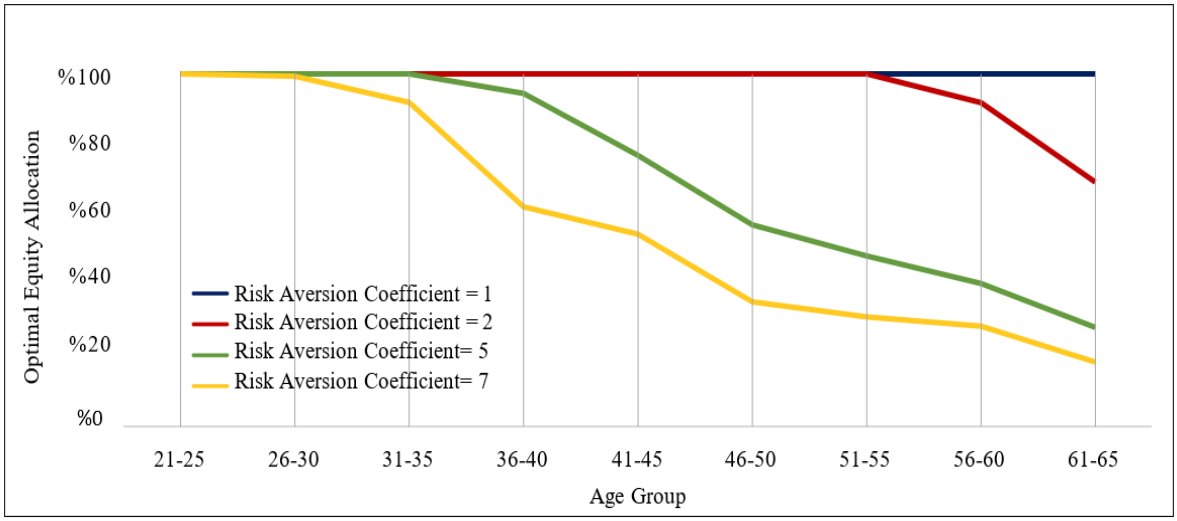

Figure 4. The optimal portfolio allocation to stocks for different risk aversion coefficients

Second, the distribution of life-cycle fund portfolios is analyzed according to different discount rates (5%, 10%, and 15%). As it is evident from Figure 5, no substantial differences are detected in the optimal portfolio distributions for varying discount rates. Although higher discount rates reduce the amount of human capital, the change in the optimal stock allocations is small because human capital is more dominant than financial capital until the age of 50. Even for the 36-40 age group with the highest dispersion in portfolio allocations due to varying discount rates, the optimal equity stakes are 94.5%,

82%, and 72% for 5%, 10%, and 15% discount rates, respectively. However, for the pre-retirement period (61-65 year old) the equity stake is approximately 27% for all three discount rates. The reason for this unanimity is that the stock ratio is optimized primarily for financial capital in older age groups.

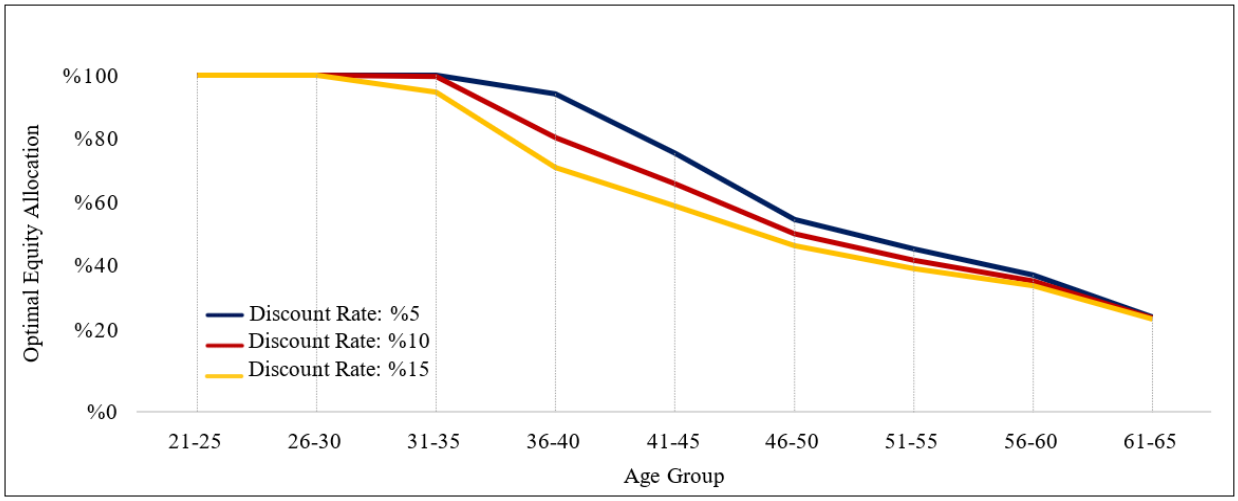

Figure 5. The optimal portfolio allocation to stocks for different discount rates

As it is discussed in the literature review, besides the risky nature of human capital, its correlation with stock returns also came to the forefront. To address it, life-cycle funds are additionally examined based on the stochastic human capital correlated with stocks. Life-cycle fund portfolios optimized for different positive correlation coefficients are presented in Figure 6. It is noteworthy that portfolio distributions corresponding to various correlation coefficients are completely different. In particular, when a positive correlation reaches 70%, portfolio distributions demonstrate increasing stock allocations with age, which is strikingly different from the distributions optimized for lower correlations when the equity share is typically falling with age.

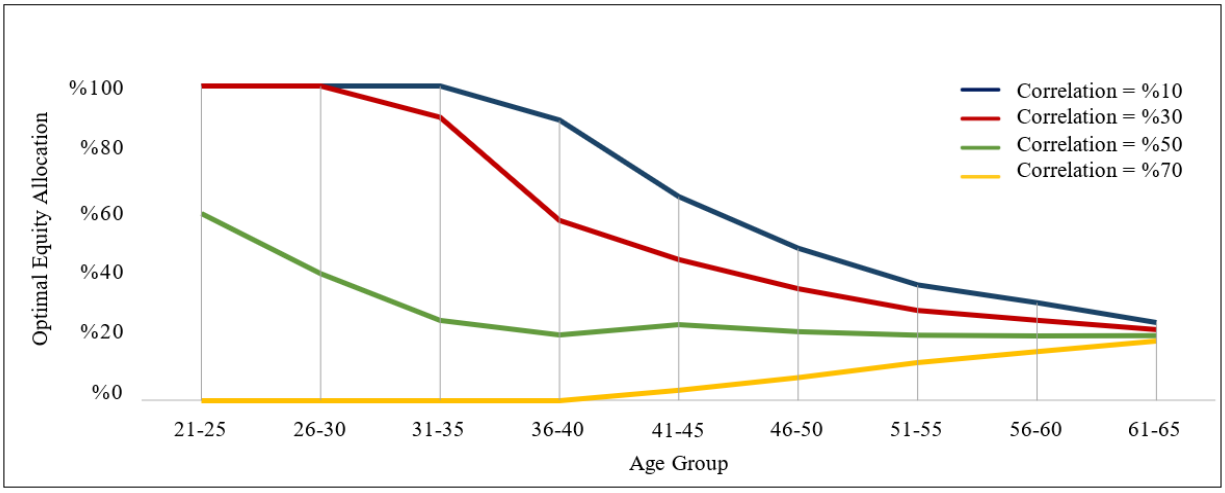

Figure 6. The optimal equity allocation for different positive correlation coefficients between human capital and stock returns

Portfolio distributions of life-cycle funds for different negative correlation coefficients between the stochastic human capital and stock returns are reported in Figure 7. It is evident that as the correlation between human capital and stock returns becomes more negative, the stock allocation for each age group increases. In other words, based on the perspective of classical portfolio optimization, the optimal stock ratio increases because the negative correlation between human capital and stocks provides diversification.

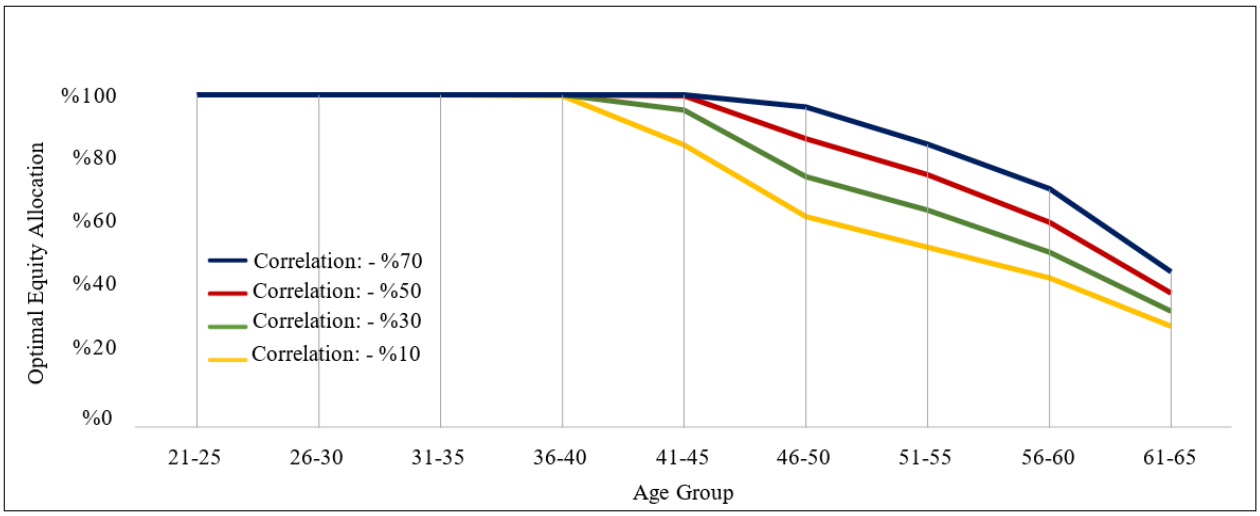

Figure 7. The optimal equity allocation for different negative correlation coefficients between human capital and stock returns

Finally, the distribution of life-cycle fund portfolios modeled for the deterministic, stochastic, or correlated human capital is presented in Figure 8. It emphasizes the importance of risky and correlated human capital in determining the optimal portfolio distribution. Here, the savings rate is assumed to be 3%, which is the minimum contribution in the automatic enrollment system in Turkey, and the correlation between human capital and stock returns is 30%, in addition to the previously reported assumptions. As shown in Figure 8, the optimal equity ratio to be allocated under the assumption of risk-free human capital is 100% up to the 46-50 age group and starts decreasing from the 36-40 age group if human capital is stochastic. For the stochastic and correlated human capital (with a positive correlation coefficient), the optimal equity ratio starts decreasing from the 31-35 age group and reaches a 23% stock allocation at retirement.

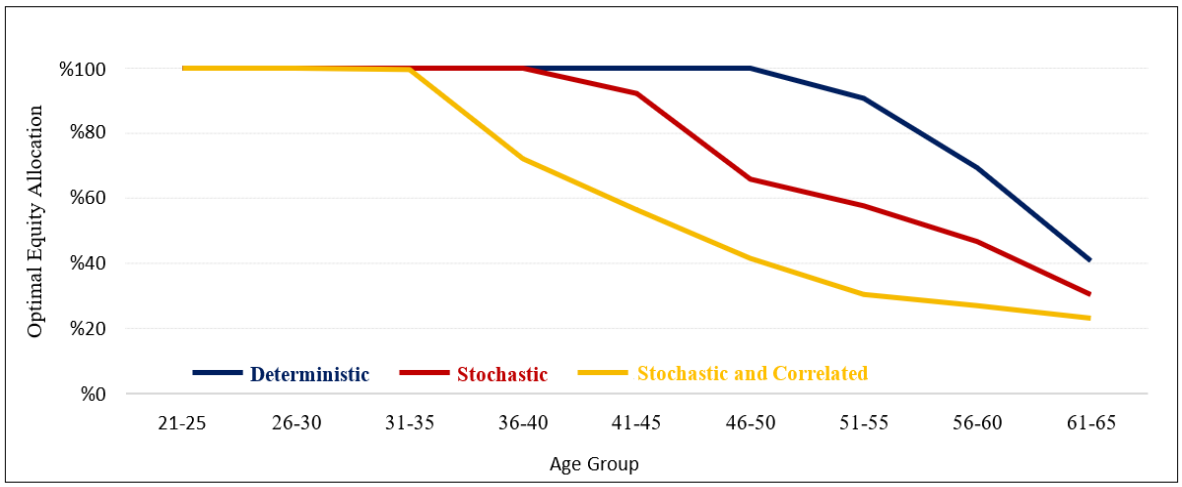

Figure 8. The optimal equity allocation for different human capital assumptions

The analysis in this section clearly demonstrates the importance of stochastic and correlated human capital in determining long-run portfolio distributions. For example, if an employee in the construction industry has a portfolio of stocks mostly belonging to the construction industry, then there is a positive and strong correlation between the human capital and stock returns for that employee. In this context, such an employee should have a very different stock allocation compared to the classical life-cycle funds offered in the US.

1.5.3 Mean reversion test results

The results of the three types of tests (i.e., unit root tests, runs tests, and variance ratio tests) that are mentioned in the methodology section are included to measure the effect of mean reversion. First, the results of the unit root tests, in which the stationarity of stock prices is analyzed, are presented in Tables 2 and 3. In addition to Augmented-Dickey Fuller (ADF) and Philips-Perron (PP) tests, which are frequently used in the literature, Zivot-Andrews (ZA) unit root tests, which take into account structural breaks in time series, are also applied. The estimation results of the ADF and PP unit root tests are

presented in Table 2. Both approaches yield consistent results for levels and first differences. The null hypothesis of a unit root is always rejected for first differences, and it is also rejected for stock prices at the level, but not when a trend is included.

Table 2. The Results of the ADF and PP Stationarity Tests of Mean Reversion

ADF Test	**Level**		**First difference**	
	Constant	Constant + Trend	Constant	Constant + Trend
	-3.8083 (0.0031)	-2.2127 (0.4808)	-18.5300 (0.000)	-18.9491 (0.000)
PP Test	**Level**		**First difference**	
	Constant	Constant + Trend	Constant	Constant + Trend
	-3.8032 (0.0032)	-2.2129 (0.4805)	-18.5298 (0.000)	-18.9448 (0.000)

The results of the Zivot Andrews (ZA) unit root test, which allows for an internal structural break in time series, are presented in Table 3. The null hypothesis of this test is stationarity and the absence of structural breaks. It is rejected for stock prices only with the 10% statistical significance for the model with a trend. For the first difference, it is found that the null hypothesis of stationarity is always rejected at the 1% significance level. Although the structural break dates are associated with different periods for the analysis at the level, the break point of December 1999 is determined for the constant and constant with trend models in the first difference analysis.

Table 3. The Results of the ZA Stationarity Tests of Mean Reversion

ZA Test	**Level**			**First Difference**		
	Constant	Trend	Constant + Trend	Constant	Trend	Constant + Trend
Test statistic	-3.9349	-4.3084	-4.8093	-19.862	-19.2904	-19.846
p-value	0.4129	0.0885	0.1214	0.01	0.01	0.01
Break date	12/1995	01/2000	01/1999	12/1999	11/1990	12/1999

To summarize, based on the majority of the unit root tests with a trend, it is possible to conclude that stock prices are not stationary at the level but are stationary with

the 1% statistical significance in the first differences, which supports the hypothesis that stock prices follow a random walk I(1) process.

Second, the results of the runs tests with the null hypothesis of a random walk process are presented in Table 4. The alternative hypothesis is that of a negative autocorrelation associated with mean reversion, which can be tested using all three runs tests (the Wald-Wolfowitz test, Bartels rank test, and Turning point test). According to the findings, the hypothesis that the stock returns are independently randomly distributed cannot be rejected by any of the tests. In other words, the number of runs (i.e., consecutive ups and downs) in stock returns in Turkey is not statistically different from the number of runs that should be encountered in a random walk time series. Moreover, no statistical differences are detected either for daily or weekly, nominal or real, or sub-period returns.

Table 4. The Runs Tests for Stock Returns

Runs Test	**Alternative Hypothesis**	**Number of Observations**	**Test Statistic**	**p-value**
Wald-Wolfowitz Test	There is no random walk process	378	-0.2060	0.8368
Wald-Wolfowitz Test	There is a first-order autocorrelation	378	-0.2060	0.5816
Bartels-Rank Test	There is no random walk process	378	-0.0061	0.9951
Bartels-Rank Test	There is a negative autocorrelation	378	-0.0061	0.5024
Turning Point Test	There is no random walk process	378	0.3269	0.7437
Turning Point Test	There is a negative autocorrelation	378	0.3270	0.3719

Finally, the variance ratio test results that are applied to stock returns are reported in Table 5. According to the results reported up to a 60 month period, the null hypothesis that stock returns are i.i.d. cannot be rejected. In other words, the decrease in variance ratios cannot be confirmed, and the null hypothesis that the variance ratios are equal to 1 for each specified period cannot be rejected. In this case, it can be argued that stock returns

do not possess the mean reversion characteristic. The variance ratio test is also applied to daily and weekly, nominal and real returns, and for different sub-periods. Overall, although no mean reversion effect is found for any frequency and analysis type, the trend effect associated with a positive autocorrelation is detected for daily and weekly returns.

Table 5. Variance Ratio Tests of Mean Reversion

Period	Variance Ratio	Standard Error	Z-Statistic	p-value
2	0.9429	0.0861	-0.6632	0.5072
4	0.8218	0.1596	-1.1170	0.2640
8	0.7973	0.2474	-0.8191	0.4127
10	0.7739	0.2787	-0.8111	0.4173
12	0.7369	0.3057	-0.8606	0.3894
14	0.7131	0.3297	-0.8703	0.3841
16	0.6538	0.3516	-0.9847	0.3248
20	0.5198	0.3911	-1.2280	0.2194
30	0.3511	0.4709	-1.3781	0.1682
36	0.3288	0.5103	-1.3154	0.1884
40	0.3348	0.5338	-1.2461	0.2127
42	0.3343	0.5449	-1.2218	0.2218
50	0.3152	0.5851	-1.1704	0.2418
60	0.2714	0.6287	-1.1588	0.2465

In conclusion, no statistically significant mean reversion effect is found in the Turkish stock market based on the reported test results. The findings obtained in this section play a decisive role in choosing the methodology of modeling parameter uncertainty: as the stock prices follow a random walk process, the optimal portfolio distributions under parameter uncertainty are estimated using i.i.d. returns.

1.5.4 Optimal portfolio distributions under parameter uncertainty

Finally, the optimal portfolio distributions that are modeled according to the parameter uncertainty methodology of Barberis (2000) are examined in this section. Following the parameter uncertainty argument, younger people should hold fewer stocks in their

portfolio than older people because stocks are more volatile in the long run from the investor's perspective. The results in this section are presented under the assumption that stock returns are i.i.d. The portfolio distributions with and without parameter uncertainty are reported in Figure 9 for the representative investor with risk aversion coefficients A equal to 5 and 10. First, when the parameter uncertainty is not taken into account for the representative investor with a moderate risk aversion coefficient (A=5), the optimal equity ratio is constant and equal to only 23% due to the high volatility of the Turkish stock market. Since parameter uncertainty affects portfolio distributions more in the long run, the equity ratio for younger investors, who have more years before their retirement, is lower. For example, the representative investor with A=5 allocates around 15% to stocks at age 55 but around 22% at age 64, one year before retirement. When the risk aversion coefficient becomes 10, the optimal equity allocation reduces by 50%.

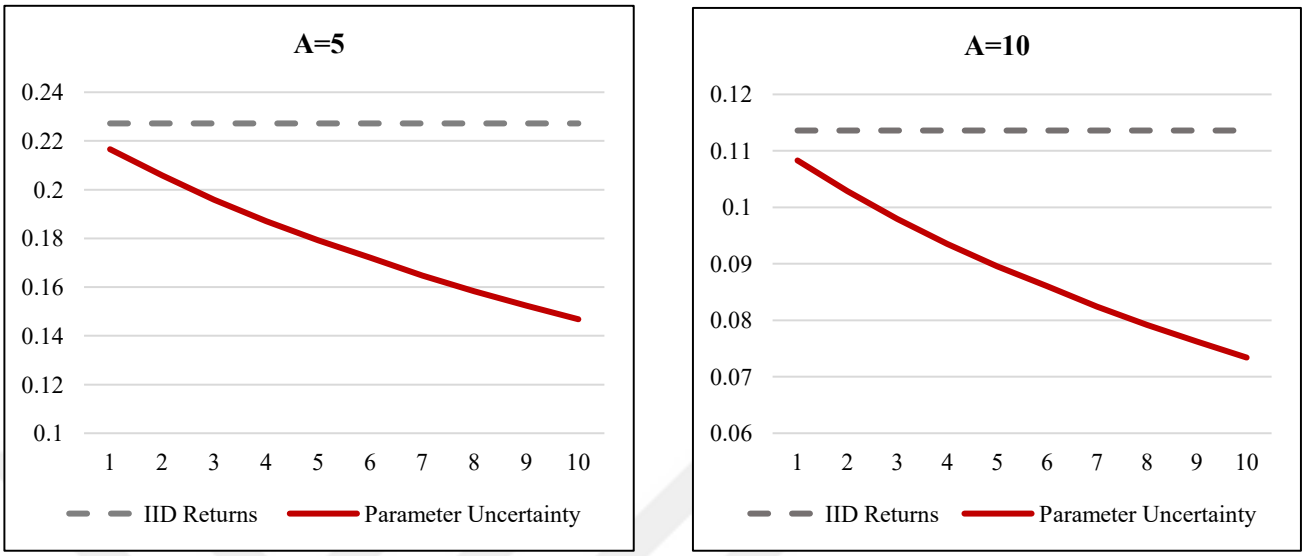

Figure 9. The effect of parameter uncertainty on the equity ratio vs. the years to retirement

1.6 Conclusion

This study models the optimal portfolio allocation of life-cycle funds in the context of the demographic and financial structure of Turkey. The findings, in line with the studies of Cocco et al. (2005), Benzoni et al. (2007), and Viceira (2010), indicate that human capital risk and its correlation with stock returns play a particularly important role in long-term portfolio optimization. However, although this study confirms that different risk aversion coefficients significantly affect portfolio distributions, the effect of varying discount rates is found to be small. Moreover, the mean reversion property of stock prices that can potentially affect financial capital is examined in detail, and no statistically significant mean reversion effect is detected in the Turkish stock market. Following this, it is found that parameter uncertainty, which is modeled according to (Barberis, 2000), does not cause significant differences in the portfolio distributions of investors, particularly with high-risk aversion coefficients.

This study contributes to the life-cycle investing and human capital as well as to the mean reversion and parameter uncertainty literature by modeling the optimal life-cycle fund portfolio structure in a developing country. It is expected that the derived conclusions will facilitate the introduction of an efficient and low-cost default investment option to the automatic enrollment system in Turkey. It is also anticipated that the findings of this study will be actively applied by PFs and portfolio management companies.

For future studies, the correlation of stochastic human capital with stocks should be examined in detail for different business sectors. Moreover, it is expected that more robust results will be obtained by adding real estate investments to the portfolio along with stocks and bonds, as they play an important role in household savings in Turkey.

CHAPTER 2

PENSION FUNDS AS LIQUIDITY PROVIDERS: EVIDENCE FROM EMERGING MARKET COUNTRIES [2]

2.1 Introduction

The PF industry has experienced a significant expansion worldwide over the past two decades. The assets under the management of PFs exceeded $35 trillion by the end of 2020, with more than half managed by US pension funds (OECD, 2021). A similar trend can be observed not just in developed markets: the role of PFs is rapidly growing in emerging markets (EMs) as well, following the introduction of funded pension systems. Despite the considerable losses due to the Global Financial Crisis (GFC) in 2008 and the European Sovereign Debt Crisis (EDC) in 2011, total PF assets relative to GDP have increased from 13% to 20% in EM countries and from 43% to 63% in developed countries during the last decade (Figure 10).

In the wake of the GFC and EDC episodes, EM countries experienced almost $150 billion in foreign investors' portfolio outflows, leading to a severe drying-up of market liquidity (IIF, 2014). At this point, domestic and long-term investors could play a stabilizing role by buying up liquidated assets (Adler, Djigbenou, & Sosa, 2016). Given their major importance and long-term outlook, PFs have gained increased attention when addressing the stability of financial markets in EM countries.

[2] The work on this chapter was financially supported by the Scientific Research Council (BAP), Project No: 18462.

The advantage of PFs over other institutional investors derives from the fact that their liabilities are long-term (their investments are funded by pensioners' contributions). Since they also have predictable cash outflows, PFs are unlikely to face unanticipated short-term liquidity demands. These characteristics of PFs allow them to behave like deep-pocket investors who can buy a large amount of assets when prices drop and benefit from a subsequent price increase (Barajas & Catalan, 2011; Schembri, 2014). Therefore, the patient capital of PFs favors counter-cyclical investment strategies (i.e. buy low sell high), particularly in times of crisis. A study by the Financial Stability Board (FSB, 2013) highlights the importance of PFs by stating that *'they finance their investments with contributions and are not leveraged. In fact, PFs are major providers of liquidity and collateral to the financial system, even in times of market stress'.* According to the OECD (2010) statistics, PFs in several EM countries followed a counter-cyclical approach during GFC by increasing their exposure to equity investments (Figure 11).

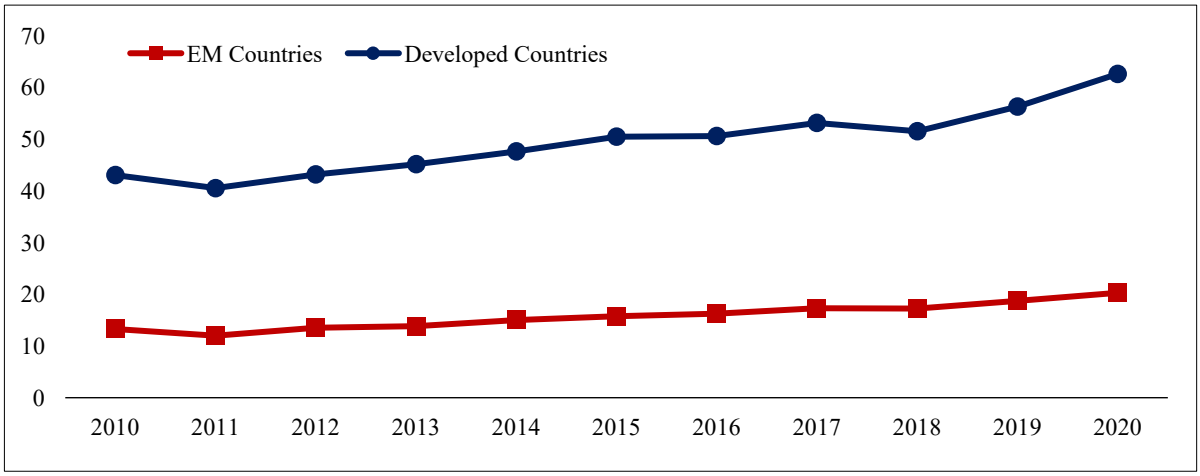

Figure 10. PF assets as a percentage of GDP

Source: OECD (2021).

Note: EM countries include: Brazil, Bulgaria, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Estonia, Hungary, India, Korea, Mexico, Peru, Portugal, Romania, Russia, Slovak Republic, Slovenia, South Africa, Thailand, Turkey, and Uruguay. Developed countries include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

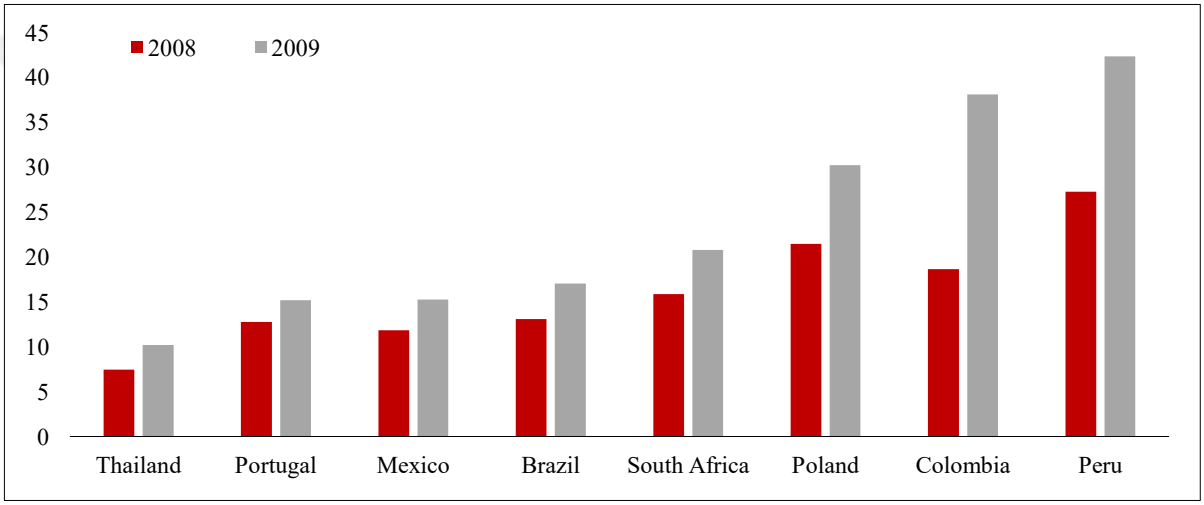

Figure 11. PFs' equity investments in total portfolio (%) in selected EM countries

Source: OECD (2010).

This study investigates the effect of PFs on stock market liquidity using panel data for 17 EM countries over the 2006–2019 period. This effect is evaluated based on three measures – the Zeros measure of Lesmond, Ogden, and Trzcinka (1999), Roll's measure of Roll (1984), and Amihud illiquidity ratio measure of Amihud (2002) – capturing the resiliency, tightness, and depth dimensions of market liquidity (Lesmond, 2005). The empirical analysis is performed using the Prais-Winsten fixed-effects regression with panel-corrected standard errors (PCSE) and includes multiple robustness checks.

The results reveal a robust negative relationship between PFs and two stock market illiquidity measures (Zeros and Amihud). Furthermore, the study explores whether the effect of PFs on market liquidity is time-varying, particularly during times of market stress, by focusing on two recent crisis periods, GFC and EDC. The results indicate that the effect of PFs on liquidity measures is equally significant during crisis times. Moreover, the results are robust to i) a sample split (EU vs. non-EU countries), ii) excluding crisis periods, iii) alternative control variables, iv) outlier countries, and v) endogeneity bias. Overall, the findings are consistent with the earlier literature documenting that PFs provide market liquidity and enhance financial stability (Anand, Irvine, Puckett, & Venkataraman, 2013; Timmer, 2018).

This study contributes to the existing empirical literature in the following ways. First, it complements the recent PFs and financial stability literature, which has mainly focused on the effects of PFs on financial market volatility and capital market development (Lakonishok, Shleifer, & Vishny, 1992; Rocholl & Niggemann, 2010). This study presents evidence of market liquidity provision by PFs in EM countries, for which there exists only limited research (Walker & Lefort, 2002; Bohl, Brzeszczyński, & Wilfling, 2009; Thomas, Spataro, & Mathew, 2014).

Second, the reported findings add new evidence to the institutional investors and market liquidity literature focusing on financial crises (e.g., Anand et al., 2013; Ciarlone & Miceli, 2016; Timmer, 2018). Concurring with these papers, this study shows that PFs, as long-term investors, play a stabilizing role in stock markets during crisis periods.

Finally, these findings offer useful insights for policymakers in EM countries, in particular, implying that PFs are crucial for maintaining the liquidity of stock markets. To that end, EM governments can try to automatically enroll new participants in pension

plans – automatic enrollment policy – to increase the size of PFs in their economies (Madrian & Shea, 2001; Choi et al., 2004).

The rest of the paper is organized as follows. Section 2 reviews the related literature on PFs and financial stability, as well as institutional investors and market liquidity. Section 3 describes the dataset and reports summary statistics. Section 4 presents the estimation methodology. Section 5 discusses the empirical results. Section 6 offers robustness checks. Finally, Section 7 discusses policy implications and concludes.

2.2 Literature review

2.2.1 PFs and financial stability

The relationship between PFs and financial stability received attention starting with Reilly and Wachowicz (1979) and Lakonishok et al. (1992) studies, where they noted that PFs may stabilize market prices by acting in a countercyclical way (i.e., buy low sell high). According to such a view, these institutional investors bring market prices closer to their fundamentals by buying up fire-sold assets anticipating to benefit from future price gains. The majority of empirical studies until the last decade focused on the US market and analyzed PFs along with other institutional investors (Levy & Cohen, 1998; Dennis & Strickland, 2002; Faugere & Shawky, 2003).

Given the growing presence of PFs, financial researchers started paying attention to their role in EM countries over the last decade. The existing literature in this area mainly consists of two groups of studies. The first group examines the effect of PFs on stock market volatility and concludes that given their long-term liability structure, PFs can absorb short-term market fluctuations and diversify financial risks over time (Table 6) (for Poland: Bohl et al. (2009); China: Li and Wang (2010); OECD countries: Thomas et al.

(2014); developing countries: Xue, He, and Hu (2021)). For example, using a Markov-Switching GARCH model, Bohl et al. (2009) show that the volatility of the Polish stock market diminished after the first entrance of PFs into capital markets. Similarly, Thomas et al. (2014) find that PFs can dampen stock market volatility in 34 OECD countries over the period 2004–2014.

The second group of papers investigates the impact of PFs on capital market development (Table 7). Thanks to their long-term investment horizon, PFs can invest in illiquid assets and thereby provide a long-term supply of funds to capital markets (Impavido, Musalem, & Tressel, 2003, Meng & Pfau, 2010, Nageri, Adekunle, & Muritala, 2019). Additionally, they improve the depth of stock and bond markets by increasing the demand for financial assets and strengthening the domestic investor base (Walker & Lefort, 2002; Raddatz & Schmukler, 2008; Rocholl & Niggemann, 2010). For example, using Granger causality tests, Walker and Lefort (2002) investigate the impact of pension reforms on capital markets in seven Latin American countries and find that the savings accumulated by PFs can promote their development. Similarly, using a unique list of 87 PF reforms in 57 countries between 1976 and 2007, Rocholl and Niggemann (2010) find that stock and bond market capitalization increased after the reforms and relative to other countries with no reforms. Besides these quantitative effects, PFs can also enhance transparency in financial markets and improve corporate governance practices (Davis, 2002).

2.2.2 Institutional investors and market liquidity

The GFC has highlighted the role of liquidity in the stability of financial markets (Allen & Carletti, 2008; Brunnermeier & Pedersen, 2009; Gorton & Metrick, 2010). A growing number of empirical studies focuses on the market behavior of institutional investors and their impact on liquidity during crisis periods. Most studies in this field examine the impact of leveraged institutional investors such as mutual funds, investment banks, and hedge funds on market liquidity. The common thread among these studies is the notion that due to their short-term liability structure, these financial institutions may be forced to sell their assets at fire sale prices to meet investor redemptions, thereby exacerbating market illiquidity (for mutual funds: Fratzscher (2012) and Broner, Didier, and Schmukler (2013); investment banks: Adrian and Shin (2010), Jotikasthira, Lundblad, and Ramadorai (2012) and Goldstein, Jiang, and Ng (2015); and hedge funds: Aragon and Strahan (2012), and Franzoni and Plazzi (2012)).

In the last few years, additional research has been conducted on the stabilizing role of domestic and long-term investors that have the potential to exploit the liquidity shortage faced by other investors (mainly foreign and leveraged investors) (Alberola, Erce, & Serena, 2016; Adler et al., 2016). Considering structural characteristics, such as a long-term investment horizon and the absence of unexpected withdrawals, several studies focus on the behavior of long-term investors during the financial crisis. Manconi, Massa, and Yasuda (2012), Merrill, Nadauld, Stulz, and Sherlund (2014), Ellul, Jotikasthira, Lundblad, and Wang (2014), Becker and Ivashina (2015), and Bijlsma and Vermeulen (2016) offer evidence confirming a counter-cyclical role of insurance companies, and Clark and Monk (2010), Raymond (2010), and Ciarlone and Miceli (2016) provide similar evidence regarding sovereign wealth funds. Although these studies reveal an important

connection between long-term investors and market liquidity, their empirical evidence is based on a single country (mainly the US).

To my knowledge, only a handful of papers examine the effect of PFs on market liquidity and financial stability. Furthermore, most of these studies focus on developed markets using trade-level data (Table 8) (for the US: Anand et al. (2013); the UK: Blake et al. (2017); and Germany: Timmer (2018)). For example, Timmer (2018) uses unique security-level data from Germany and finds that while banks and investment funds behave procyclically in financial markets, insurance companies and PFs act countercyclically. More importantly, from the point of view of the present study, none of the mentioned papers assesses whether the liquidity supplied by PFs varies during times of market stress.

This study contributes to the two streams of literature in the following ways. First, it complements the PFs and financial stability literature by investigating the impact of PFs on market liquidity in EM countries. Second, it evaluates whether PFs, as long-term investors, provide liquidity to financial markets during financial crisis times.

Table 6. Major Empirical Studies on PFs and Stock Market Volatility

Author(s)	Period	Country	Methodology	Results
Bohl et al. (2009)	1994-2003	Poland	Markov-Switching GARCH	PFs dampen stock market volatility
Li and Wang (2010)	2002-2004	China	GMM regression	Institutional investors reduce stock market volatility
Thomas et al. (2014)	2000-2010	OECD Countries 47 developed and	Prais-Winsten and random effects panel regressions	PFs reduce stock market volatility
Xue et al. (2021)	1995-2016	developing countries	Fixed-effects model	PFs reduce stock market volatility

Table 7. Major Empirical Studies on PFs and Capital Market Development

Author(s)	Period	Country	Methodology	Results
Walker and Lefort (2002)	1986-1992	33 developing countries	Fixed-effects panel and GLS regressions	PFs promote stock market development
Impavido et al. (2003)	Different time periods	32 developing and developed countries	Dynamic GMM regression	PFs promote stock and bond market development
Raddatz et al. (2008)	1995-2005	Chile	Momentum measure	PFs promote stock and bond market development
Rocholl and Niggemann (2010)	1976-2007	57 developing and developed countries	DID (Difference in differences)	PFs promote stock and bond market development
Meng and Pfau (2010)	1988-2008	32 developing and developed countries	LSDV (Least squares dummy variable) regression	PFs promote stock and bond market development in countries where financial development is high
Nageri et al. (2019)	2006-2018	Nigeria	ARDL regression	PFs promote stock and bond market development in the long-run

Table 8. Major Empirical Studies on PFs and Financial Market Liquidity

Author(s)	Period	Country	Methodology	Results
Anand et al. (2013)	1999-2010	US	Fixed-effects panel regression	PFs provide stock market liquidity during crisis times
Blake et al. (2017)	1987-2012	UK	Lakonishok (1992) herding measure	PFs provide short-term liquidity into financial markets
Timmer (2018)	2005-2014	Germany	Fixed-effects panel regression	PFs increase stock market liquidity by playing a countercyclical role in financial markets

2.3 Data description

I construct a quarterly panel dataset for 17 EM countries (Brazil, Chile, Colombia, Croatia, Czech Republic, Estonia, Hungary, Korea, Latvia, Lithuania, Mexico, Peru, Poland, Slovenia, South Africa, Thailand, and Turkey) over the period from 2006Q1 to 2019Q4. The number of countries and time period mainly depends on the availability of the PFs' equity investment data. Table 9 lists the variables employed in this study, along with their definition and sources.

Table 9. Variable Definition and Sources

Variable	Definition	Source
ZEROS	Quarterly Zeros measure: $ZEROS$= (# of days with zero returns) / T where T is the number of trading days in a quarter.	Datastream
ROLL	Quarterly Roll measure: $ROLL = \begin{cases} 2\sqrt{-cov(\Delta P_t, \Delta P_{t-1})} \\ 0 \end{cases}$ $cov(\Delta P_t, \Delta P_{t-1}) < 0$ $cov(\Delta P_t, \Delta P_{t-1}) \geq 0$ where $\Delta P_t$and ΔP_{t-1} are the changes in daily closing prices from *t* to *t*–1 and *t*–1 to *t*–2, respectively.	Datastream
AMIHUD	Quarterly Amihud measure: $AMIHUD = ln\left(1 + \frac{\lvert R_t \rvert}{P_t * VO_t}\right)$ where $\lvert R_t \rvert$ is the absolute log-return in the local currency, P_t is the adjusted closing price in the local currency, and VO_t is the total number of shares traded.	Datastream
PF	The share of PFs' equity investments in the total portfolio (%)	OECD Global Pension Statistics Database, International Association of Pension Fund Supervisors (AIOS), Associação Brasileira das Entidades Fechadas de Previdência Complementar (ABRAPP), South African Reserve Bank, Thai Provident Fund, Takasbank

CRISISGFC	A dummy variable equal to 1 for the crisis period (2008-2009) and 0 otherwise	The author
CRISISEDC	A dummy variable equal to 1 for the crisis period (2010-2011) and 0 otherwise	The author
*PF*CRISISGFC*	The interaction term between pension funds' equity investments *(PF)* and a crisis dummy variable (*CRISISGFC)*	The author
*PF*CRISISEDC*	The interaction term between pension funds' equity investments *(PF)* and a crisis dummy variable *(CRISISEDC)*	The author
RET	The quarterly percentage change in the average stock market index	Datastream
VOL	The quarterly standard deviation of returns on the average stock market index	Datastream
SMCAP	The natural logarithm of the quarterly stock market capitalization	Datastream
PFA/VO	The ratio of the PF assets to the volume of the stock market index	OECD Global Pension Statistics Database, International Association of Pension Fund Supervisors (AIOS), Associação Brasileira das Entidades Fechadas de Previdência Complementar (ABRAPP), South African Reserve Bank, Thai Provident Fund, Takasbank, and Datastream
INT	The quarterly interest rate on the 10-year government debt index	IMF International Financial Statistics
GDP	The quarterly growth rate of the real GDP	IMF International Financial Statistics
CPI	The quarterly percentage change of the consumer price index	IMF International Financial Statistics

2.3.1 PFs' equity holdings

To examine the relationship between PFs and stock market liquidity, I use the share of PFs' assets invested in equities (*PF*) as an explanatory variable. The PFs' equity allocation by country is mainly collected from the OECD Global Pension Statistics Database and the International Association of Pension Fund Supervisors (AIOS). For four countries, I use

data from national supervisory authorities: ABRAPP (Brazil), South African Reserve Bank (South Africa), Thai Provident Fund (Thailand), and Takasbank (Turkey). The sample includes stocks in defined contribution (DC) pension plans, which can be both mandatory or voluntary. Overall, the data account for over 70% of DC PF assets in EM countries.

To my knowledge, this is the broadest dataset of EM PFs' equity holdings in terms of the number of countries and data frequency. Previous studies using the same data mostly focused on one-country analysis (for Poland: Zalewska (2006), U.S.: Mohan and Zhang (2014), and Bradley, Pantzalis, and Yuan (2016)) or developed markets (Dreassi, Miani, and Paltrinieri (2017) and Boon, Brière, and Rigot (2008)). The closest dataset to this study is constructed by Thomas et al. (2014) for OECD countries, who use the annual share of PF assets invested in equities as an explanatory variable. Taking advantage of a quarterly panel dataset, this study examines the effect of PFs on stock market liquidity based on a higher number of observations.

Table 10 shows the snapshot picture of EM PF portfolios for the countries in the sample. Over the ten-year period (2009-2019), while the average PF size (PF assets as a percentage of GDP) increased from 16.4% to 24.2%, PFs' share in equities declined from 15.6% to 13.6%. In terms of the PF size, the biggest PF market by the end of 2019 is reported in South Africa (95.1%) and Chile (80.8%). On the other hand, in Thailand, PF assets represent less than 10% of the GDP. Currently, the highest share of PF assets invested in stocks is observed in Poland (82.4%). On the other hand, Korea, Lithuania, and the Czech Republic allocate less than 1% of their assets to equities.

Table 10. PF Assets and Investments by Country (2009-2019)

	PF Assets to GDP		PF Equities (% of total portfolio)	
Country	**2009**	**2019**	**2009**	**2019**
Brazil	18.9	26.2	17.0	9.5
Chile	61.8	80.8	13.9	7.2
Colombia	13.4	26.7	38.1	14.8
Croatia	9.2	30.0	-	17.8
Czech Republic	5.5	8.8	1.6	1.0
Estonia	8.2	18.5	3.8	14.7
Hungary	12.9	5.4	10.8	7.9
Korea	8.5	28.2	0.1	0.5
Latvia	6.0	16.7	0.8	1.6
Lithuania	4.1	8.3	-	0.7
Mexico	12.6	18.5	15.3	8.4
Peru	18.9	22.6	41.7	11.5
Poland	13.3	8.0	30.2	82.4
Slovenia	4.9	7.3	2.9	2.3
South Africa	74.7	95.1	20.8	18.1
Thailand	5.3	7.3	10.2	17.9
Turkey	0.9	2.9	26.5	14.6
Average	16.4	24.2	15.6	13.6

2.3.2 Stock market liquidity measures

To calculate stock market liquidity measures for each country, I compile a list of stocks from major exchanges that have the largest total market capitalization for each country. I include only common stocks denominated in the local currency and discard other types of equity securities, such as Exchange-Traded Funds (ETFs), Real Estate Investment Trusts (REITs), preferred shares, and closed-end funds. To avoid the survivorship bias, all data is extracted both for active as well as inactive stocks that have been merged or delisted throughout the sample period. Following this data screening procedure for each individual stock, I collect the daily total return index (RI), the daily adjusted closing price denominated in the local currency (P), the daily turnover volume measured by the total

number of shares traded (VO), and the quarterly market capitalization at the beginning of each quarter in U.S. dollars (MV) from Datastream.

Following Ince and Porter (2006), Griffin, Kelly, and Nardari (2010), and Schmidt, Schrimpf, Arx, Wagner, and Ziegler (2015), several data filtering steps are applied. First, any day is treated as a non-trading day in which more than 90% of stocks have zero returns for a given exchange. Second, individual stocks with a proportion of zero-return days higher than 80% in a given quarter are removed. Third, any daily observations are deleted if the total RI for either the current day or the prior day is less than 0.01. Fourth, stock-day observations in the upper and lower 0.1% quantile of the cross-sectional distribution for a given country are eliminated. Finally, stock-quarter observations are discarded if the stock returns of firm i in quarter t or t–1 are greater than or equal to 300%.

This study examines three different dimensions of market liquidity proposed in the theoretical literature: depth, tightness, and resiliency (Kyle, 1985). Based on daily data, I construct the following three quarterly illiquidity measures: the Zeros measure of Lesmond et al. (1999) that indicates the percentage of zero trading days (resiliency), Roll's measure of Roll (1984) as a proxy of trading costs (tightness), and Amihud illiquidity ratio of Amihud (2002) that captures the price impact of trades (depth).

2.3.2.1 Zeros measure

Lesmond et al. (1999) introduce a market liquidity measure based on the proportion of zero-return days in a trading period. The economic intuition behind this measure is that a rational and informed investor will engage in trading activity only if the market transaction costs are less than the value of a new information signal. In the opposite case, where there is a net loss from trading, investors will choose not to trade, leading to a higher frequency

of zero return days. Therefore, the frequency of zero-return days implicitly indicates higher transaction costs from trading. I estimate the Zeros measure as follows:

$$ZEROS = (\#\text{ of days with zero returns}) / T,$$

where T represents the total number of trading days in a quarter.

This liquidity measure is computed for each quarter and every stock in the sample. Then the average value of all the stocks is estimated to obtain the aggregate liquidity measure for each country.

2.3.2.2 Roll measure

Roll (1984) proposes an effective bid-ask measure that addresses the tightness dimension of market liquidity. This measure is based on the insight that under the efficient market assumption and stationary price changes, transitory movements in asset prices arise from a bid-ask bounce, whereas random buy and sell orders cause transaction prices fluctuate between bid and ask prices. Since a bid-ask bounce leads to negatively serially correlated price changes, the effective bid-ask spread can be proxied by the covariance between consecutive returns. Thus, Roll (1984) illiquidity measure is defined as:

$$ROLL = \begin{cases} 2\sqrt{-cov(\Delta P_t, \Delta P_{t-1})} & \text{if } cov(\Delta P_t, \Delta P_{t-1}) < 0 \\ 0 & cov(\Delta P_t, \Delta P_{t-1}) \geq 0 \end{cases}$$

where $ROLL$ is the Roll's illiquidity ratio, and ΔP_t and ΔP_{t-1} are the changes in daily closing prices from *t* to *t*–1 and *t*–1 to *t*–2, respectively. When the sample serial covariance is positive, the formula above is undefined, and following Goyenko, Holden, and Trzcinka (2009) is replaced with 0. The quarterly Roll's measure for each stock is computed by calculating the covariance of daily returns over each quarter.

2.3.2.3 Amihud measure

The Amihud's (2002) measure aims to capture the depth dimension of market liquidity by calculating the ratio of absolute price changes to a trading volume. The intuitive interpretation of this measure is that liquid stocks can absorb large order flows with a minimum price impact. Therefore, everything else equal, a higher trading volume leads to a lower Amihud ratio and higher market liquidity. The daily Amihud's (2002) illiquidity measure is defined as follows:

$$AMIHUD = ln\left(1 + \frac{|R_t|}{P_t * VO_t}\right)$$

where $AMIHUD$ is the Amihud illiquidity measure, $|R_t|$ is the absolute log-return in the local currency, P_t is the adjusted closing price in the local currency, and VO_t is the total number of shares traded. The quarterly Amihud measure is computed by taking the average of daily Amihud ratios within the quarter. Following the previous studies (Lee, 2011; Karolyi, Lee, & Van Dijk, 2012), I add a constant and take a natural logarithm of the Amihud ratio to reduce the effect of outliers.

2.3.3 Control variables

As the third group of variables in the dataset, I employ a set of financial and macroeconomic control variables. Following the existing literature on stock market liquidity determinants (Lee, Sapriza, & Wu, 2016, Aouadi, Arouri, & Roubaud, 2018; Ma, Anderson, & Marshall, 2019), I include quarterly stock market returns (*RET*), quarterly standard deviation (volatility) of daily stock market returns (*VOL*), the natural logarithm of the stock market capitalization (*SMCAP*), and PF assets-to-volume (*PFA/VO*) variables. All data is obtained from Datastream and regulatory agencies. Regarding the

macroeconomic variables, I employ interest rate (*INT*), real GDP growth ratio (*GDP*), and inflation rate (*INF*) derived from the IMF International Financial Statistics (Debata, Dash, & Mahakud, 2018; Lee and Chou, 2018).

This study also aims to examine whether the liquidity supplier role of PFs differs in crisis and non-crisis times. To this end, I introduce two dummy variables, *CRISISGFC* and *CRISISEDC*, that take the value of 1 for the years 2008-2009 (GFC) and 2010-2011 (EDC), respectively, and 0 otherwise. I interact these dummy variables with PFs equity investments (*PF*CRISISGFC* and *PF*CRISISEDC*) to assess the additional impact of PFs on stock market liquidity during crisis times relative to non-crisis periods. Table 11 presents the summary statistics of all the variables used in this study.

Table 11. Summary Statistics

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
ZEROS	952	0.3109	0.2059	0	0.7887
ROLL	896	0.0089	0.0058	0	0.0383
AMIHUD	952	0.0206	0.0698	0.00001	0.9272
PF	846	0.1469	0.1737	0	0.8531
CRISISGFC	952	0.1071	0.3094	0	1
CRISISEDC	952	0.1428	0.3501	0	1
*PF*CRISISGFC*	952	0.0143	0.0606	0	0.5562
*PF*CRISISEDC*	952	0.0204	0.0737	0	0.5475
RET	951	0.0115	0.1108	-0.5819	0.5430
VOL	951	0.1104	0.0783	0.014	0.6906
SMCAP (million dollar)	952	195779	267670	241.77	1471571
PF/VO	896	0.0283	0.0490	0	0.3639
INT	611	0.0513	0.0277	-0.0007	0.1450
GDP	868	0.0075	0.0158	-0.1285	0.0912
INF	826	0.0354	0.0305	-0.0375	0.2236

2.4 Empirical methodology

I analyze the effect of PFs on stock market liquidity using the following panel regression model:

$$Liq_{i,t} = a_i + \beta_1 PF_{i,t} + \beta_2 CRISISGFC_t + \beta_3 CRISISEDC_t + \beta_4 PF_{i,t} * CRISISGFC_t + \beta_5 PF_{i,t} * CRISISEDC_t + \beta_6 X'_{i,t} + u_{i,t},$$

where $Liq_{i,t}$ is one of the three market illiquidity measures described earlier (Zeros, Roll, and Amihud), for country *i* at time *t*, $PF_{i,t}$ is PFs' equity investments, $X'_{i,t}$is a matrix of control variables (financial and macroeconomic), a_i, is the country *i* fixed effect, and $u_{i,t}$ is the error term.

In this panel regression framework, I use two crisis dummies: $CRISISGFC_t$ *and* $CRISISEDC_t$, where each dummy equals to 1 during the 2008-2009 and 2010-2011 crisis years, respectively, and 0 for the other years. The crisis dummies model the difference in market liquidity between the crisis years and the average of the non-crisis years. I also interact the crisis dummies with the PFs' equity investments variable ($PF_{i,t} * CRISISGFC_t$ and $PF_{i,t} * CRISISEDC_t$) to analyze whether PFs' impact on stock market liquidity is different during crisis periods.

Before moving to the results, the following panel regression tests are performed. First, I conduct a Hausman (1978) test to decide between fixed effects and random effects estimation methods. The test result favors the use of the fixed-effects approach for three illiquidity measures.[3] Next, I use a number of diagnostic tests to identify potential serial correlation, heteroskedasticity, and cross-sectional dependence problems in the panel data. I employ a Wooldridge (2010) test to check the presence of first-order serial correlation in the residuals. The null hypothesis is rejected for all three liquidity

[3] For Zeros (*p*-value=0.013), Roll (*p*-value=0.024), and Amihud (*p*-value=0.003).

measures.[4] To account for the possibility of heteroskedasticity in the residuals' distribution, I use a Likelihood Ratio (LR) test suggested by Wiggins and Poi (2003). The results provide evidence of heteroskedasticity for Zeros and Roll measures.[5] Finally, I employ the test statistic proposed by Pesaran (2004) to check the cross-sectional dependence in the panel data. The results suggest the presence of cross-sectional dependence in the residuals for Zeros and Amihud measures.[6]

To summarize the test results, the data is prone to serial correlation, heteroskedasticity, and cross-sectional dependence. In order to address these issues, following the studies of Thomas et al. (2014) and Xue et al. (2021), I estimate a fixed-effects Prais and Winsten (1954) regression model with PCSEs.

2.5 Results

Table 12 presents the results for the fixed effects Prais-Winsten panel regression model with PCSEs. Overall, the results indicate that *PF* and stock market illiquidity are negatively correlated at the 1% level for Zeros and Amihud measures, whereas there is no significance for the Roll's measure. Crisis dummies are insignificant as they are likely to be proxied by other variables such as GDP growth (a crisis is defined as a contraction of economy). The interaction terms *PF*CRISISGFC* and *PF*CRISISEDC* are not statistically significant, indicating that the effect of PFs on stock market liquidity does not differ between crisis and non-crisis times.

---

[4] The null hypothesis of 'there is no first-order autocorrelation' is rejected for all three illiquidity measures (for Zeros p-value=0.043, Roll p-value=0.021, Amihud p-value=0.061).

[5] The null hypothesis of 'the variance of error terms is constant' is rejected for Zeros and Roll measures and can not be rejected for Amihud measure (for Zeros p-value=0.000, Roll p-value=0.000, Amihud p-value=0.114).

[6] The null hypothesis of 'there is no cross-sectional dependence' is rejected for Zeros and Amihud measures (p-value=0.000), whereas it can not be rejected for Roll measure (p-value=0.145).

Stock market returns (*RET*) are statistically significant only for the Roll's illiquidity measure, with the negative sign of the coefficient indicating that the markets are less liquid when stock prices are declining. Higher volatility (*VOL*) reduces Zeros measure, since there is a higher probability that the prices will change when volatility is high. On the contrary, higher volatility, which is associated with the tendency of prices to oscillate around the mean, positively affects Roll's measure based on mean reversion. Amihud's illiquidity measure shows only a statistically weak correlation with volatility. Stocks with a higher capitalization demonstrate a higher liquidity captured by all three measures, as expected, whereas the *PFA/VO* ratio is not significant for any of these measures.

Interest rates and inflation have a significant effect only on the Zeros and Amihud's illiquidity measures. A higher interest rate leads to drying up liquidity as money is rotated from the stock to the bond market, which becomes more attractive due to increased yields. On the contrary, a higher inflation rate makes the stock market relatively more attractive and liquid, as the bond market offers reduced yields when inflation is high. Higher GDP growth rates negatively affect liquidity when it is measured using the Roll's measure, as the prices tend to trend over longer periods when economic conditions are good, reducing the likelihood of mean reversion. On the contrary, liquidity is increased when measured by Amihud's ratio since prices are likely to experience a slower, steadier rise on the same volume during economic expansion compared to contraction. There is no statistically significant correlation between the real GDP growth and the Zeros measure.

Table 12. Results for the Prais-Winsten Regression Model

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.4807***	-0.0036	-0.2102***
	[<0.001]	[0.163]	[0.003]
CRISISGFC	0.0121	-0.0008	0.0016
	[0.359]	[0.435]	[0.903]
CRISISEDC	0.0108	-0.0004	0.0002
	[0.499]	[0.769]	[0.991]
*PF*CRISISGFC*	-0.0058	0.0005	0.01967
	[0.893]	[0.867]	[0.664]
*PF*CRISISEDC*	0.0121	0.0022	0.0105
	[0.826]	[0.547]	[0.871]
RET	0.0081	-0.0037**	-0.0107
	[0.655]	[0.028]	[0.426]
VOL	-0.1797***	0.0078**	-0.0466*
	[<0.001]	[0.016]	[0.098]
SMCAP	-0.0042***	-0.0009**	-0.0180***
	[<0.001]	[0.014]	[<0.001]
PFA/VO	0.0025	0.0002	-0.0081
	[0.293]	[0.112]	[0.225]
INT	2.1828***	0.0004	1.1542**
	[<0.001]	[0.976]	[0.035]
GDP	-0.2108	0.0484***	-0.2464**
	[0.112]	[0.001]	[0.023]
INF	-0.8999***	0.0055	-0.5456**
	[0.002]	[0.702]	[0.021]
Constant	0.6524***	0.0101***	0.1213***
	[<0.001]	[<0.001]	[0.001]
R^2	0.79	0.32	0.41

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10 % levels, respectively.

2.6 Robustness checks

2.6.1 Sample split (EU and non-EU Countries)

To check the robustness of the results, the Prais-Winsten regression model for the three illiquidity measures is additionally estimated for EU and non-EU countries. Similarly to the baseline results (Table 12), PFs also contribute to stock market liquidity when analyzed separately for EU (Table 13) and non-EU countries (Table 14). Moreover, in the EU and non-EU context, PFs' liquidity provision does not differ during crisis and non-crisis times (based on the interaction terms in Tables 13 and 14). Most of the coefficient signs of the control variables remain similar for EU and non-EU countries, with the exception of the share of PFs' assets in the stock market volume (*PFA/VO*). The model explanatory power is lower for non-EU compared to EU countries due to more proclaimed differences between non-EU countries.

Table 13. Robustness Check: Results for the EU Countries

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-1.0385***	-0.0137	-0.6704***
	[0.000]	[0.359]	[0.001]
CRISISGFC	-0.0476	0.0053	-0.0101
	[0.337]	[0.154]	[0.591]
CRISISEDC	-0.5268	-0.0003	-0.0387
	[0.193]	[0.850]	[0.339]
*PF*CRISISGFC*	1.0362	0.0858	0.3484
	[0.127]	[0.231]	[0.160]
*PF*CRISISEDC*	0.6178	0.0024	0.7470
	[0.261]	[0.930]	[0.168]
RET	0.0489	-0.0063*	0.0090
	[0.120]	[0.076]	[0.547]
VOL	0.1651***	-0.0003	-0.0546*
	[0.006]	[0.953]	[0.095]
SMCAP	0.0129***	-0.0211***	-0.0181***
	[0.000]	[0.000]	[0.001]
PF/VOL	-0.0279**	-0.0003	-0.0326***

	[0.011]	[0.349]	[0.001]
INT	-0.3904	0.0497***	-0.3397
	[0.307]	[0.005]	[0.505]
GDP	-0.2640	-0.0236	-0.2383
	[0.420]	[0.453]	[0.109]
INF	0.7486*	0.0557***	-0.2010
	[0.100]	[0.009]	[0.565]
Constant	0.4229***	0.0098***	-0.0324
	[0.000]	[0.000]	[0.362]
R^2	0.75	0.47	0.49

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10 % levels, respectively.

Table 14. Robustness Check: Results for the Non-EU Countries

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.5492***	0.0025	-0.2567***
	[0.000]	[0.164]	[0.000]
CRISISGFC	0.0126	-0.001	0.001
	[0.548]	[0.951]	[0.673]
CRISISEDC	-0.0344	-0.0006	0.0015
	[0.251]	[0.260]	[0.365]
*PF*CRISISGFC*	0.0160	-0.0006	-0.1557
	[0.769]	[0.806]	[0.146]
*PF*CRISISEDC*	0.1060	0.0033	0.0015
	[0.233]	[0.122]	[0.782]
RET	-0.0091	-0.0030	0.0025
	[0.800]	[0.117]	[0.454]
VOL	0.2734***	-0.0004	0.0160***
	[0.000]	[0.899]	[0.005]
SMCAP	0.0711***	-0.0009	-0.0018***
	[0.000]	[0.119]	[0.005]
PFA/VOL	0.0095***	0.0001**	0.0007***
	[0.000]	[0.048]	[0.000]
INT	-0.5034	0.0077	0.1097***
	[0.176]	[0.560]	[0.000]
GDP	-0.4301	0.0068	-0.1626
	[0.138]	[0.669]	[0.446]
INF	0.3402	0.0119	0.0194***
	[0.154]	[0.193]	[0.008]

Constant	0.6832***	0.0056***	0.0083***
	[0.000]	[0.003]	[0.004]
R^2	0.69	0.36	0.25

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.6.2 Excluding crisis periods

Table 15 includes the estimation of the same three illiquidity measures only for non-crisis periods. In accordance with Table 12, the positive effect of PFs on stock market liquidity is also confirmed (although the result becomes insignificant for Roll's measure). The crisis dummies and their interaction terms are insignificant, indicating that PFs' liquidity provision does not differ between crisis and non-crisis times. The coefficient signs at the control variables remain highly consistent with the baseline regression results.

Table 15. Robustness Check: Excluding Crisis Periods

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.4036***	-0.0002	-0.2185***
	[0.000]	[0.912]	[0.000]
RET	-0.5902	-0.0045	-0.0009
	[0.211]	[0.154]	[0.884]
VOL	0.4783***	-0.0113*	0.0065
	[0.000]	[0.069]	[0.605]
SMCAP	0.0665***	-0.0043***	-0.0261***
	[0.000]	[0.000]	[0.000]
PFA/VO	0.0054*	0.0005***	0.0008***
	[0.054]	[0.000]	[0.000]
INT	3.3452***	0.0224	0.0966*
	[0.000]	[0.240]	[0.056]
GDP	0.1712	0.0331	0.0177
	[0.735]	[0.262]	[0.781]
INF	0.4953	-0.0203	-0.0601
	[0.250]	[0.184]	[0.186]
Constant	0.2425***	0.0127***	0.0155***
	[0.000]	[0.000]	[0.000]

R^2	0.75	0.35	0.40

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.6.3 Alternative control variables

Tables 16 and 17 report the results of additional robustness checks involving model modification by including additional control variables: GDP per capita (*GDPCapita*) in Table 16 and money supply (*MSUPPLY*) in Table 17. Similarly to the baseline results, these robustness checks also confirm the role of PFs in enhancing stock market liquidity based on the Zeros and Amihud measures. The crisis dummies are not statistically significant at any level. Their interaction terms are likewise insignificant, indicating a continued provision of liquidity by PFs in crisis times. Overall, the sign of the coefficients at the other control variables and their significance is similar to Table 12.

Table 16. Robustness Check: Additional Control Variable – GDP per capita

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.4490***	-0.0029	-0.2165***
	[0.000]	[0.159]	[0.002]
CRISISGFC	-0.0133	-0.0009	-0.0035
	[0.403]	[0.418]	[0.804]
CRISISEDC	0.0056	-0.0004	-0.0011
	[0.607]	[0.689]	[0.951]
*PF*CRISISGFC*	0.07185	-0.0006	0.0318
	[0.165]	[0.850]	[0.503]
*PF*CRISISEDC*	0.0399	0.0018	0.0150
	[0.341]	[0.607]	[0.812]
RET	0.0215	-0.0035**	-0.0067
	[0.150]	[0.031]	[0.549]
VOL	0.1541***	0.0080**	-0.0450
	[0.000]	[0.012]	[0.108]
SMCAP	0.0591***	-0.0010***	-0.0285***
	[0.000]	[0.001]	[0.000]

PFA/VO	0.0041	0.0002**	-0.0080**
	[0.184]	[0.044]	[0.028]
INT	0.1871	0.0198	-0.7488
	[0.692]	[0.302]	[0.301]
GDP	0.3958***	0.0516***	-0.2879**
	[0.002]	[0.000]	[0.014]
INF	0.9661***	0.0074	-0.5030**
	[0.000]	[0.571]	[0.018]
GDPCapita	0.2734***	-0.0021*	0.0467
	[0.000]	[0.063]	[0.140]
Constant	2.1912***	-0.0114	-0.3644
	[0.000]	[0.325]	[0.291]
R^2	0.80	0.33	0.42

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 17. Robustness Check: Additional Control Variable – Money Supply

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.5562***	0.0257	-0.2896***
	[0.000]	[0.124]	[0.000]
CRISISGFC	-0.0046	-0.0004	-0.0164
	[0.773]	[0.541]	[0.289]
CRISISEDC	0.0014	0.0001	-0.0120
	[0.898]	[0.851]	[0.564]
*PF*CRISISGFC*	0.0472	0.0009	0.0496
	[0.340]	[0.689]	[0.272]
*PF*CRISISEDC*	0.0393	0.0002	0.0541
	[0.412]	[0.936]	[0.438]
RET	0.0309*	-0.0025*	0.0032
	[0.087]	[0.089]	[0.778]
VOL	-0.1764***	0.0075**	-0.0270
	[0.000]	[0.011]	[0.300]
SMCAP	-0.0551***	0.0014**	-0.0289***
	[0.000]	[0.020]	[0.001]
PFA/VO	-0.0001	0.0001	-0.0016
	[0.960]	[0.649]	[0.522]
INT	1.1677***	0.0109	-0.8494
	[0.003]	[0.230]	[0.141]
GDP	-0.3359***	0.0279***	-0.3100**

	[0.008]	[0.006]	[0.022]
INF	-0.8423***	0.0049	-0.0381
	[0.000]	[0.593]	[0.871]
MSUPPLY	-0.0342***	-0.0022***	-0.0288***
	[0.000]	[0.000]	[0.001]
Constant	0.7442***	0.0213***	0.2697***
	[0.000]	[0.000]	[0.000]
R^2	0.81	0.33	0.42

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.6.4 Outlier countries

Tables 18 and 19 report the results for the Prais-Winsten regression model estimated after excluding outlier countries. First, the Czech Republic, Latvia, and Korea, that have the smallest share of PFs' equity investments, are excluded from the sample (Table 18). Second, only the countries with the highest share of PFs' investments (Peru, Poland, and South Africa) are excluded (Table 19). Similarly to the baseline regression results (Table 12), the effect of the PFs on market liquidity remains positive and statistically significant for the Zeros and Amihud measures. The crisis dummies and their interactions are not significant, confirming the results for the baseline regression. The control variables have similar significances as in Table 12.

Table 18. Robustness Check: Outlier Countries with the Smallest Share of PFs Equity Investments

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.2954***	-0.0047	-0.1191***
	[0.000]	[0.113]	[0.000]
CRISISGFC	0.0207	0.0001	0.0073***
	[0.120]	[0.882]	[0.000]
CRISISEDC	0.0064	-0.0003	-0.0001
	[0.551]	[0.688]	[0.922]
*PF*CRISISGFC*	-0.0154	-0.0019	-0.0185
	[0.696]	[0.489]	[0.231]
*PF*CRISISEDC*	0.0251	-0.0007	0.0051
	[0.509]	[0.826]	[0.133]
RET	0.0149	-0.0034**	-0.0055*
	[0.331]	[0.036]	[0.090]
VOL	-0.1014***	0.0100***	0.0094
	[0.006]	[0.001]	[0.193]
SMCAP	0.0381***	0.0004	-0.0101**
	[0.001]	[0.422]	[0.049]
PFA/VOL	0.0034	0.0001	0.0007***
	[0.158]	[0.123]	[0.000]
INT	-0.9495***	0.0380***	-0.0695***
	[0.004]	[0.000]	[0.002]
GDP	-0.2157	0.0497***	-0.0160
	[0.107]	[0.000]	[0.363]
INF	-0.4280**	-0.0145	-0.0480***
	[0.030]	[0.140]	[0.009]
Constant	0.4146***	0.0073***	0.0227***
	[0.000]	[0.000]	[0.000]
R^2	0.68	0.33	0.36

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 19. Robustness Check: Outlier Countries with the Highest Share of PFs Equity Investments

	Prais-Winsten Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.4790***	-0.0771	-0.1905***
	[0.001]	[0.179]	[0.002]
CRISISGFC	-0.0271	-0.0023	-0.0109
	[0.172]	[0.217]	[0.304]
CRISISEDC	0.01044	-0.0001	-0.0068
	[0.620]	[0.898]	[0.777]
*PF*CRISISGFC*	0.4001*	0.0159	0.1482
	[0.097]	[0.267]	[0.118]
*PF*CRISISEDC*	0.0806	0.0014	0.0769
	[0.489]	[0.837]	[0.565]
RET	-0.0041	-0.0039**	-0.0073
	[0.815]	[0.023]	[0.518]
VOL	-0.1489***	0.0081***	-0.0387
	[0.000]	[0.014]	[0.179]
SMCAP	-0.0033***	-0.0013**	-0.0225***
	[0.000]	[0.012]	[0.000]
PFA/VOL	0.0027	-0.0099	-0.0101**
	[0.396]	[0.569]	[0.024]
INT	-2.2953***	-0.0123	-1.0434
	[0.000]	[0.455]	[0.117]
GDP	-0.2040	0.0520***	-0.1453*
	[0.143]	[0.001]	[0.054]
INF	-1.1974***	0.0076	-0.4287*
	[0.000]	[0.605]	[0.098]
Constant	0.6473***	0.0100***	0.1302***
	[0.000]	[0.000]	[0.001]
R^2	0.77	0.34	0.39

Note: Robust p - values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.6.5 Endogeneity

The baseline regression results do not allow a causal interpretation since the dependent and independent variables might be determined by some omitted variables, such as investment restrictions imposed by PFs for certain asset classes. Moreover, there may be a reverse causality problem since instead of PFs equity investments having a causal effect on stock market liquidity, a high level of market illiquidity may lead to lower PFs investments in equities. Hence, in order to identify the causal effect of PFs on market liquidity, I employ a two-stage least squares instrumental variables (2SLS IV) regression model estimated with fixed-effects country clustered standard errors.

Following Thomas et al. (2014) and Xue et al. (2021), I use lagged PFs' equity investments and life expectancy at birth as instrumental variables. As indicated by the Anderson and Canon (1982), Cragg and Donald (1993), and Sargan (1958) tests, the instruments are valid, and according to the endogeneity tests, both instrumental variables are exogenous (Table 20).

Although the significance of the PFs' effect on market liquidity has decreased, it still remains significant at the 5% level for the Zeros and Amihud's liquidity measures confirming the results of the baseline model (Table 12). Also, the significance of control variables has decreased when modeling endogeneity. Crisis dummies and their interaction terms remained non-significant.

Table 20. Robustness Check: Endogeneity Bias

	2SLS Regression Model		
Dependent Variable	Zeros	Roll	Amihud
PF	-0.4729**	0.0072	-0.1471**
	[0.026]	[0.501]	[0.019]
CRISISGFC	-0.0136	-0.0013	0.0157
	[0.723]	[0.458]	[0.541]
CRISISEDC	0.0191	0.0007	-0.0012
	[0.494]	[0.641]	[0.671]
*PF*CRISISGFC*	0.2020	-0.0070	-0.0455
	[0.157]	[0.287]	[0.401]
*PF*CRISISEDC*	-0.0325	0.0002	0.0075
	[0.791]	[0.968]	[0.540]
RET	0.0382	-0.0061	0.0265***
	[0.688]	[0.176]	[0.005]
VOL	-0.0118	0.0123**	0.0435***
	[0.913]	[0.016]	[<0.001]
SMCAP	0.0013	-0.0005*	0.0017
	[0.720]	[0.092]	[0.234]
PFA/VOL	0.5194***	-0.0002	-0.0112
	[0.001]	[0.979]	[0.486]
INT	-0.3070	0.0044	-0.0554
	[0.491]	[0.832]	[0.212]
GDP	-0.0793	0.0092	-0.1456***
	[0.877]	[0.700]	[0.004]
INF	-1.0421***	0.0078	-0.0210
	[0.002]	[0.628]	[0.539]
Anderson Canon Test (p-value)	0.0000	0.0000	0.0000
Cragg-Donald-Wald F Statistic	390.418	314.792	360.415
Sargan Test (p-value)	0.1049	0.9021	0.1550
Endogeneity Test (p-value)	0.2758	0.6967	0.4172

Note: Robust *p*-values are indicated in brackets. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

2.7 Conclusion

PFs have experienced significant growth in EM countries over the last decade. Given their growing presence and unique characteristics (i.e., long-term liabilities), PFs' importance to financial stability in EMs has attracted increased attention, particularly following the GFC.

Using data from 2006Q1 to 2019Q4, I investigate the effect of PFs on stock market liquidity in 17 EM countries. I employ three market liquidity measures - Amihud, Roll, and Zeros - that capture different dimensions of market liquidity, namely resiliency, tightness, and depth. The main findings can be summarized as follows. First, PFs supply liquidity to stock markets, as measured by Zeros and Amihud's measures. Second, liquidity provision by PFs to stock markets is not time-varying and is not reduced in times of crisis. Moreover, these findings are robust to several robustness checks, such as (1) a sample split (EU vs. non-EU countries), (2) excluding crisis periods, (3) alternative control variables, (4) excluding outlier countries, and (5) endogeneity bias.

Overall, my results are in line with the earlier literature that PFs have a stabilizing role in financial markets by supplying liquidity during periods of crisis (Anand et al., 2016; Becker & Ivashina, 2015; Timmer, 2018). These empirical findings allow policymakers to gain further insights into the behavior of domestic investors and PFs. From a policy perspective, the positive impact of PFs on market liquidity is supportive of such policies as automatic enrollment recently initiated by governments to increase the size of PFs.

Automatic enrollment programs aim to increase participation rates by enrolling employees into pension plans with a default contribution rate and asset allocation unless they actively choose not to participate. During the last decade, automatic enrollment

practices were implemented at the national level in some developed (Italy, New Zealand, and the United Kingdom) and EM countries (Chile, Turkey, and Poland). A number of studies documented a dramatic increase in participation rates in retirement saving plans due to automatic enrollment (Madrian & Shea, 2001; Choi et al., 2004). Since the majority of EM countries have PF sizes below the OECD average, policymakers have the option of adopting automatic enrollment as a policy tool, which can allow them to mitigate market illiquidity.

CHAPTER 3

PRIVATE PENSION SYSTEMS IN DEVELOPING COUNTRIES: CURRENT CHALLENGES AND FUTURE DIRECTIONS

An earlier version of this study appeared as a Pensions Institute Working Paper. (Peksevim, S. (2021) 'Pension Systems in the Developing World: Current Challenges and Future Directions'. Pensions Institute, Discussion Paper, PI-2101)

3.1 Introduction

Developing countries are aging faster than developed ones and are expected to eventually have a much lower share of their young populations. By 2050, approximately two-thirds of the global population will reside in developing countries (United Nations Department of Economic and Social Affairs, 2015). In the long run, this will increase the cost of public pensions, resulting in a lower standard of living for pensioners. While private PFs could provide an alternative source of income to retirees, they are still limited in most developing countries.

Several challenges explain the low levels of private pension savings in developing countries. In terms of coverage rates and contributions, the high proportion of public pensions, lack of affordability, and labor informality are the main problems to be addressed. Regarding the investment performance of PFs, the preference for fixed-income assets over risky long-term securities is the main reason for low portfolio returns. Moreover, relatively high fees reduce the investment performance of PFs in some developing countries.

In most developing countries, fiscal incentives (e.g., tax subsidies and state contributions) and financial education programs have been implemented to encourage pension savings. These traditional measures, however, typically fail to lead to sufficiently high levels of participation and contribution rates. Consequently, some developing countries have introduced auto-enrollment policies (the practice of enrolling employees automatically into pension plans) that have been effective in promoting private pension savings in developed countries, such as the UK and New Zealand. Although auto-enrollment has reduced administrative fees in private pension plans, opt-out rates remain high in developing countries.

Against this backdrop, this study aims to analyze the principal challenges faced by private pension systems in developing countries and present relevant policy suggestions on pension issues, which are generally discussed only in the context of developed countries. Developing countries, in this study, are defined as emerging and frontier market countries, as categorized by Morgan Stanley Capital International (MSCI). The MSCI country classification adopts three criteria: sustainability of economic development, size and liquidity of financial markets, and openness to foreign investors (MSCI, 2021). A similar approach has also been employed in other studies focusing on research in developing countries (Gürgün & Ünalmış, 2014; Zouaoui, Mazioud, & Ellouz, 2018).

The study drew on secondary data from regulatory agencies—the Organisation for Economic Co-operation and Development (OECD), the World Bank, the International Monetary Fund (IMF), the European Commission, the International Organisation of Pension Supervisors (IOPS), and Asociación Internacional de Organismos de Supervisión de Fondos de Pensiones (AIOS) — as well as academic articles and governmental and non-governmental reports. The following key variables are analyzed to discuss the

determinants of low private pension savings in developing countries; *for coverage* – the share of public pensions, income level, and informal population; *for contribution*– contribution rates and contribution density; *for investment performance*– asset allocation and management fees. Data, mostly from 2019 and 2020, are analyzed using correlation and comparative analyses.

The rest of the essay is structured as follows. Section 2 discusses the determinants of low private pension savings in terms of coverage, contributions, and investment performance and provides respective policy suggestions. Section 3 briefly describes auto-enrollment policies in developing countries, Section 4 discusses the limitations of private pensions, and Section 5 concludes.

3.2 Determinants of low private pension savings

3.2.1 Coverage

Table 21 shows mandatory and voluntary pension coverage (OECD, 2012) as measured by the percentage of the working-age population (15–64 years) in selected developing countries. Overall, participation rates for mandatory pensions are significantly higher than for voluntary pensions but still far from full coverage.

The OECD average for mandatory pension coverage is 72.8%, whereas it is only 23.3% for voluntary pensions. The Latin American and CEE countries with mandatory pension plans, except Turkey, Peru, and Colombia, have coverage rates of 65% or more. In Turkey, the majority of compulsory pension coverage is provided by the Turkish Armed Forces Pension Fund (OYAK). However, this plan has limited participation as it only provides pension benefits to military personnel (Peksevim & Akgiray, 2019). In Peru and

Colombia, the high proportion of informal employment is the main reason for low pension coverage.

Table 21. Coverage of Private Pension Plans as a Percentage of the Working-age Population in Developing Countries

Country	Mandatory	Voluntary
Chile	87.9	NA
Czech Republic	X	64.1
Estonia	88.2	11.1
Hungary	X	18.4
Mexico	68.1	1.9
Poland	X	66.4
Turkey	1.5	12.7
Brazil	X	10.9
Indonesia	NA	1.5
Russia	79.1	4.8
Peru	34.4	NA
Colombia	51.2	NA
OECD Average	72.8	23.3

Notes: 'NA' = Not available; 'x' = Not applicable; '~' = Approximately

Source: AIOS (2019) and OECD (2020a).

Table 21 shows that in most developing countries, private pension provision in voluntary pension schemes is covered only to a limited extent, except for Poland and the Czech Republic. In Poland, the second-pillar pension scheme was mandatory until the nationalization process started in 2014 (Polakowski & Hagemejer, 2018). Therefore, the coverage rate in Poland remains high because of the existing members of the former system. In the Czech Republic, the high rates of coverage are attributed to the large government subsidies and tax incentives (Rutecka-Gora, Vostatek, & Turner, 2018).

The main reasons for low pension participation in developing countries include a high proportion of public pensions, lack of affordability, and informal employment.

3.2.1.1 High proportion of public pensions

Previous studies have found that participation in voluntary pension plans tends to be low when retirees receive relatively large state pension benefits (Antolín, 2008; European Commission, 2019). This trade-off is illustrated in Figure 12 by showing the gross replacement rate (ratio of retired workers' benefits to their salaries) in public PAYG plans and coverage rates in voluntary pension plans in selected developed and developing countries. Overall, regardless of whether the country is developed or developing, there is a strong negative relationship between the importance of public pensions and the participation rate in voluntary plans, with a correlation coefficient of about 80%. In the countries with the highest public pension replacement rates (Austria, Italy, Luxembourg, Portugal, and Turkey), the share of voluntarily covered pensions is below 20%. In contrast, in countries where state pensions are less important (Germany, Japan, Ireland, and Poland), voluntary pension coverage rates are over 50%. In Belgium, public and private pensions are equally important.

Here, it is worth noting that, due to the rapid aging trend, most state pension systems are expected to suffer from sustainability and adequacy problems in the long term (Amaglobeli et al., 2019); therefore, the development of private pension systems is crucial.

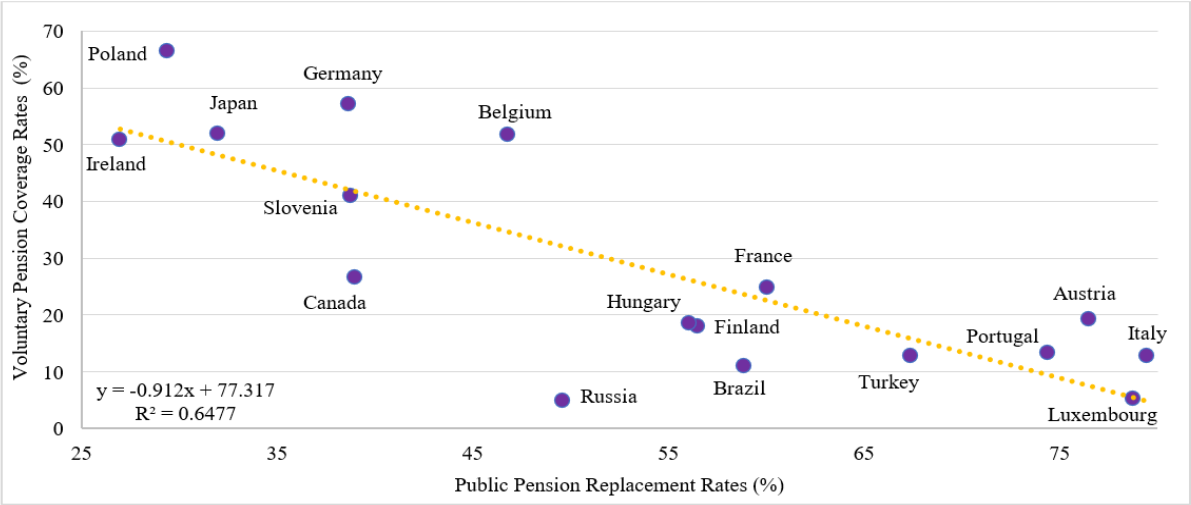

Figure 12. Public pension replacement rates and voluntary pension coverage in selected developed and developing countries

Source: OECD (2019c, 2020).

3.2.1.2 Unaffordability

The income level is also an important determinant of pension plan participation (Holzmann, Robalino, & Takayama, 2009; Demirgüç-Kunt, Klapper, & Panos, 2016). In this respect, Figure 13 shows the correlation between nominal GDP per capita and the coverage rates for mandatory and voluntary pension plans in selected countries in 2018.

For mandatory pension schemes, the correlation between GDP per capita and coverage rates is around 70%. Figure 13 shows that countries with GDP per capita above $50,000 (Australia, Finland, Iceland, Sweden, and Switzerland) have coverage rates above 70%, whereas such rates are rare in developing countries. Some CEE countries (e.g., Croatia and Estonia) have achieved coverage rates close to those of developed countries due to the low informality in their economies.

There is a strong correlation between income level and coverage rates for voluntary pension plans, with a correlation coefficient of around 80%. This is because

most countries have introduced voluntary schemes to complement mandatory pension plans. As a result, people with medium to high-income levels are more likely to participate in voluntary pension schemes. In countries with low GDP per capita (up to $20,000), coverage rates for voluntary plans are limited (below 20%), and in wealthy developed countries (Iceland, Ireland, and the US), these coverage rates range from 35–50%.

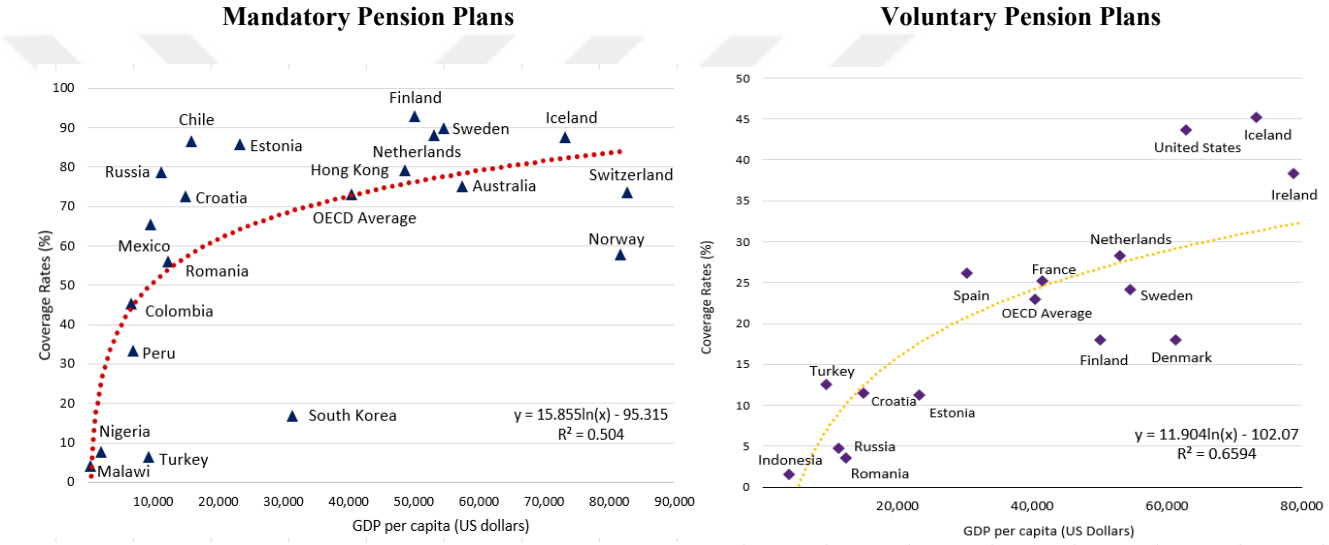

Figure 13. GDP per capita and coverage rates for private pension plans in selected countries (based on data availability)

Source: AIOS (2019), World Bank (2019b), and OECD (2020a).

3.2.1.3 Informal employment

The coverage rate of mandatory pension plans is higher than that of voluntary schemes. However, the low participation rates in developing countries may persist even if mandatory participation is the status quo. This reality can be attributed to the high level of informal employment, which limits the coverage of both public and private pensions.

According to Jütting and De Laiglesia (2009), *"informal employment refers to jobs or activities in the production and sales of legal goods and services which are not regulated or protected by the state".* Informal employment includes employees without social security benefits or formal contracts, self-employed workers, and people working for their families unpaid. Self-employment accounts for about 60% of informal employment in developing countries and serves as a good indicator of informality (Bonnet, Vanek, & Chen, 2019).

Figure 14 shows self-employment as a percentage of total employment in selected countries. As illustrated, most developing countries have high rates of self-employment compared to developed regions. In some African countries, the highest rates are observed at around 80%. Despite its high unemployment rates, South Africa has lower informality than other African countries because of its strong, well-integrated formal sector (Kingdon and Knight, 2001). Following Africa, Latin America and South Asia have high self-employment rates, ranging from 25–75%. Only CEE countries enjoy low rates of informality, around 10–15%. Self-employment rates are relatively low in developed countries, with the highest rate in Italy (23%) and the lowest rate in the US (6%).

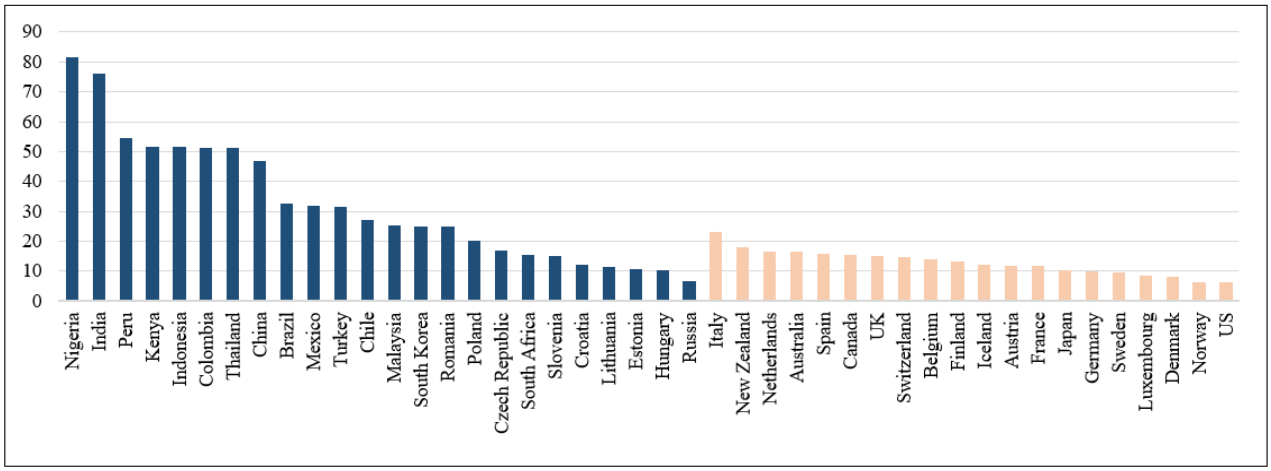

Figure 14. Self-employment as a percentage of total employment

Source: International Labor Organization (2019).

In this study, coverage rate has been defined as the proportion of individuals enrolled in a pension plan. However, under high informality, even those enrolled in compulsory plans may not contribute regularly. Figure 15 briefly summarizes the gap between members and contributors in private pension plans of selected countries with available data. The gap between affiliates and contributors is considerably higher in Latin American countries than elsewhere, notably because of high informality. In Chile, about half of the members are regular contributors, but in El Salvador, Mexico, and Colombia, less than one-third are. Even in Uruguay, which has the lowest difference between members and contributors, the coverage rates drop from 63% to 37%. In contrast, in developed countries (except Germany), the difference between affiliates and contributors is negligible.

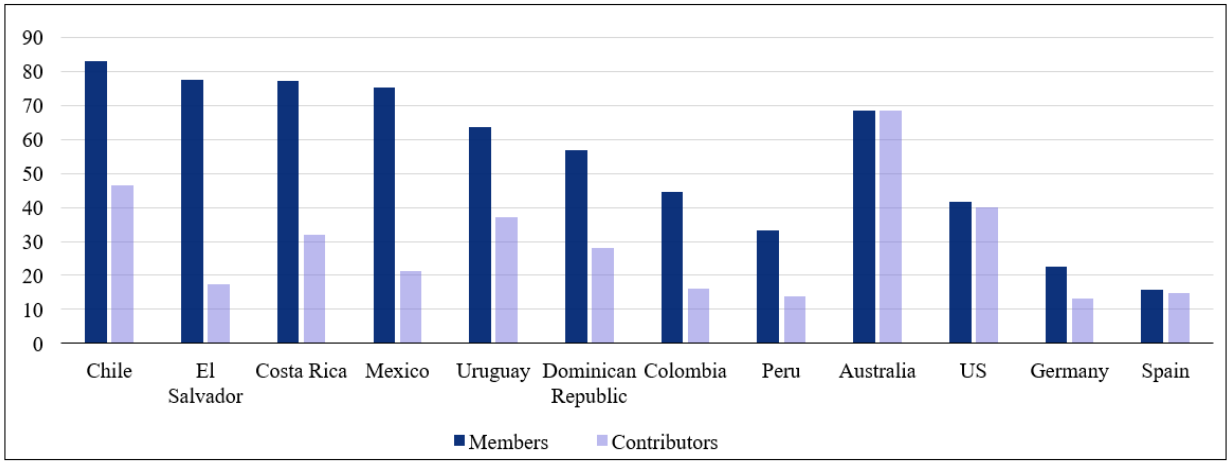

Figure 15. Private pension plan members and contributors as a percentage of the working-age population

Note: Data refer to 2018, except for Colombia (2017), and Australia, the US, Germany, and Spain (2012).

Source: OECD (2012), AIOS (2019), and World Bank (2019a).

3.2.2 Contribution

3.2.2.1 Contribution rates

Apart from individual decisions on participation in retirement plans, another important determinant of pension savings is the level of contribution. Figure 16 presents the total contributions from employees, employers, and the state of selected countries in 2019. Contribution rates are calculated as a percentage of GDP rather than wages in order to assess the relevance of contributions to the economy. I report the total contribution rates only for some countries due to a lack of data.

Three patterns emerge in this figure. First, developed countries have higher average contribution rates (OECD Average - 3.2% of GDP) than developing countries (1.6% of GDP). Second, employer contributions account for the bulk of contributions in

the former, whereas employee contributions are the main source of financing in the latter. Third, state contributions are negligible compared to employee and employer contributions for the countries in the sample. While Iceland has the highest contribution rate, India and Hungary have the lowest, accounting for a negligible share of the GDP. Compared to other developing countries in the sample, South Africa, South Korea, and Chile have higher contribution rates, over 4% of the GDP; this contributes to explaining the large PF size in South Africa and Chile.

Among developing countries, Estonia and Kenya have the largest employer contributions at approximately 1% of the GDP. However, state contributions to the economy are negligible for all countries in the sample except for New Zealand and the Czech Republic.

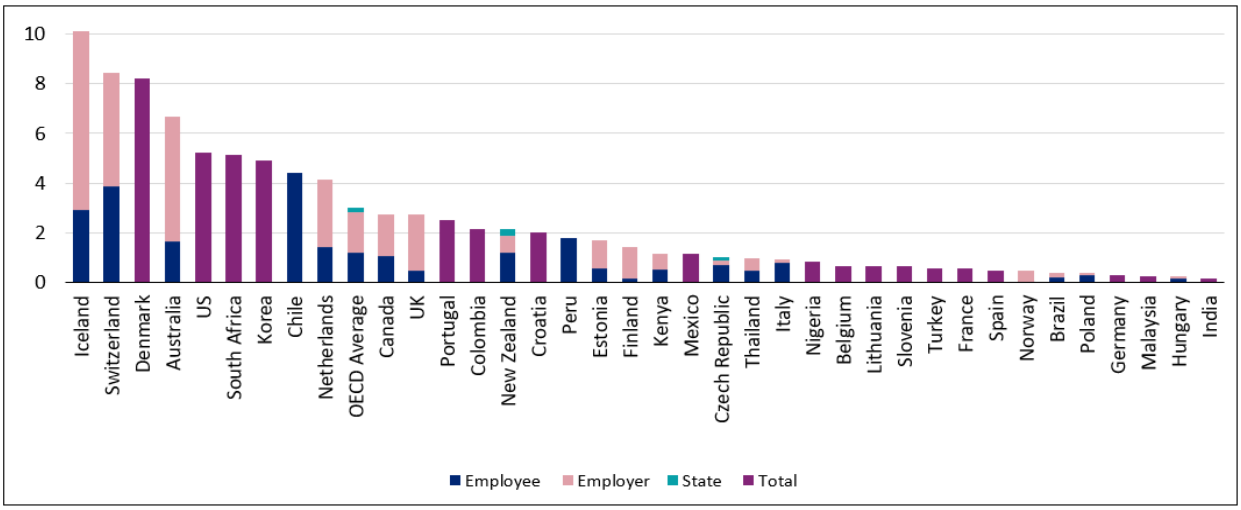

Figure 16. Contribution rates as a percentage of GDP in selected countries, 2019

Source: OECD (2020a).

3.2.2.2 Contribution density

Contribution density is another important determinant of total savings, indicating the average number of months per year during which pension participants make regular contributions over their working life (Forteza & Mussio, 2017).

Figure 17 shows pension members' contribution density in developing countries for which data are available. The average contribution density is 64%, which means pension plan participants contribute, on average, for approximately 7.5 months per year. Because of high rates of informal employment, most Latin American countries have contribution densities under 70%. In contrast, the highest contribution densities are observed in CEE countries, where informal employment rates are low.

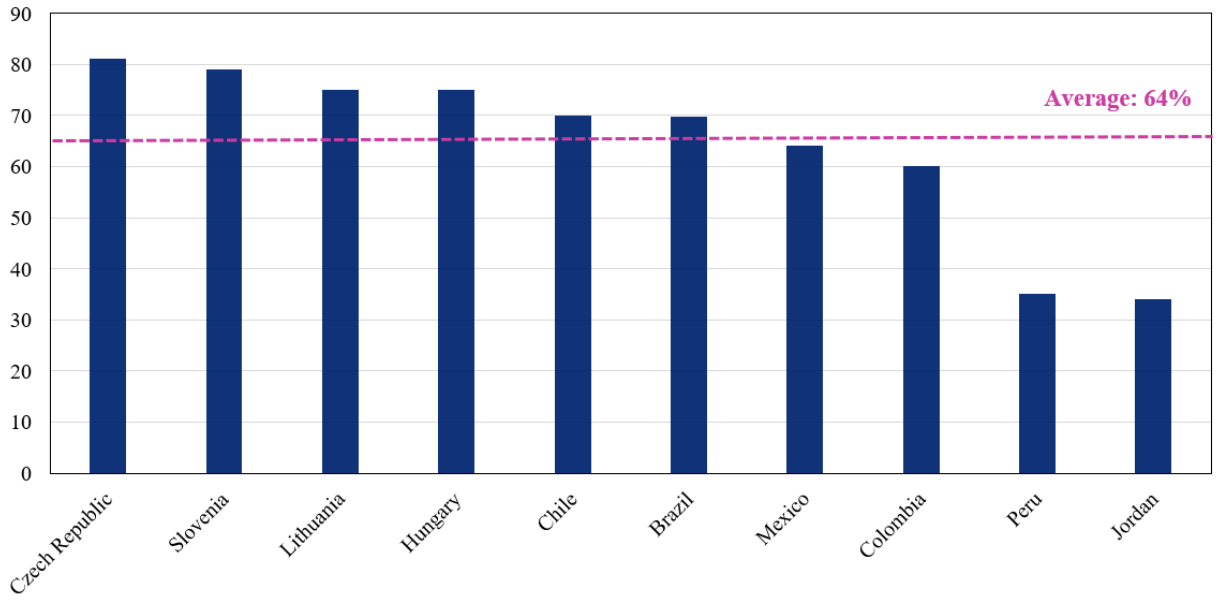

Figure 17. Contribution density in private and public pension plans in developing countries (%)

Note: This measure shows the frequency of contributions in mandatory private or public pension plans in all countries, except Brazil, where contribution density is presented for voluntary pensions.

Source: Forteza and Mussio (2017), Afonso (2015), Marques and Honorati (2016), Figliuoli et al. (2018), and Holzmann et al. (2019).

Against this backdrop, some behavioral and technological developments have the potential to expand pension coverage and contributions among low-income and informally employed populations. Following are some policy suggestions to mitigate the low coverage and contribution rates.

3.2.3 Policy suggestions for low coverage and contributions

3.2.3.1 Behavioral and technological developments

Digital nudging tools. Digital nudges can encourage private pension savings by incorporating behavioral and economic insights. Most recently introduced digital nudges include round-up apps, gamification tools, and saving through consumption platforms, among others.[7]

The purpose of saving-through-consumption platforms is to increase pension savings, especially among low-income households, self-employed individuals, and women. While their features vary, these platforms function in the following way: when someone purchases an item (such as food, clothing, or a cinema ticket) from a selected retailer, a certain portion of their payment is automatically transferred to their pension account. In other words, these tools automatically transform spending behavior into saving habits.

[7] Round-up apps round up an individual's daily purchases and invest the spare amount into their savings accounts. Gamification tools integrate gaming elements, such as increased challenges, reward systems, and penalties, into real-world practices (Bayuk & Altobello, 2019).

One of these applications is a low-cost platform called Miles for Retirement, which encourages pension savings among low-income and self-employed individuals (Hernández et al., 2020). Similarly, a Spanish start-up developed a mobile application called 'Pensumo', which offers its members the opportunity to save through socially responsible activities (such as recycling and road safety initiatives) as well as through consumption (Benavides, 2019). Another important function of these platforms is that they can be used to reduce the gender gap in private pensions, which has been reported in several studies for developed as well as developing countries (Ginn & MacIntyre, 2012; Collins, 2020). For instance, the 'SuperSuper' platform aims to reduce the gender gap in retirement income and increase pension savings among Australian women (Collett, 2018).

Fintech applications. With the rise of artificial intelligence, big data analytics, cloud-based apps, and other fintech tools, pension communication between members and providers can become more efficient, compliance processes can be improved, and robo-advisory services can be offered (OECD, 2017).

Fintech tools can also contribute to the development of digital micro-pensions. Micro-pensions are long-term products of the microfinance industry, which allow members to set aside small contributions with irregular intervals. These arrangements are ideal for developing countries with low income and informal sector workers comprising a significant share of their labor force (Iwelumo & Olanipekun, 2017). Various applications for micro-pensions are available in some African (e.g., Kenya and South Africa) and Asian countries (e.g., Bangladesh and India), but they remain limited and require further technological development (Shankar & Asher, 2011; Albouy & Noguès, 2019). Fintech tools can provide digital payment and distribution services to micro-pension participants at a low cost.

Blockchain technology. While fintech tools can facilitate pension communication and investment management, distributed ledger technology - also called 'blockchain' - may provide more powerful solutions for certain aspects of pension system design. In addition to reducing operating costs in funded pension schemes, blockchain technology can enhance transparency, trust, and security in pension plans (Van der Schans, Cramwinckel, & Ivanov, 2018; Allessie, Sobolewski, Vaccari, & Pignatelli, 2019).

While blockchain technology is increasingly used in banking and financial services, its application to PF administration and management has been limited. Nevertheless, APG and PGGM, two of the largest PFs in the Netherlands, have a pilot project building blockchain infrastructure for pensions (PGGM, 2019). The Bangladeshi government also plans to improve its primary school teachers' e-pension system with IBM's blockchain technology (Pension Policy International, 2020).

As systems become more complex, blockchain platforms become more expensive due to the higher costs associated with authentication and processing large amounts of data (Javed et al., 2020). This technology may therefore be particularly beneficial in developing countries with small-scale private pension systems.

3.2.4 Investment performance

Investment performance is another critical determinant of total pension savings. Figure 18 shows the ten-year real geometric average of investment returns in private PFs for 2009–19 in selected developing countries. Except for the Czech Republic, Turkey, and Nigeria, all listed developing countries have displayed positive annualized real returns over the last decade. There is substantial heterogeneity in funds' investment performance, ranging from

5.1 % in Colombia to –1.2 % in Nigeria. In general, Latin American countries have relatively high returns compared to other countries.

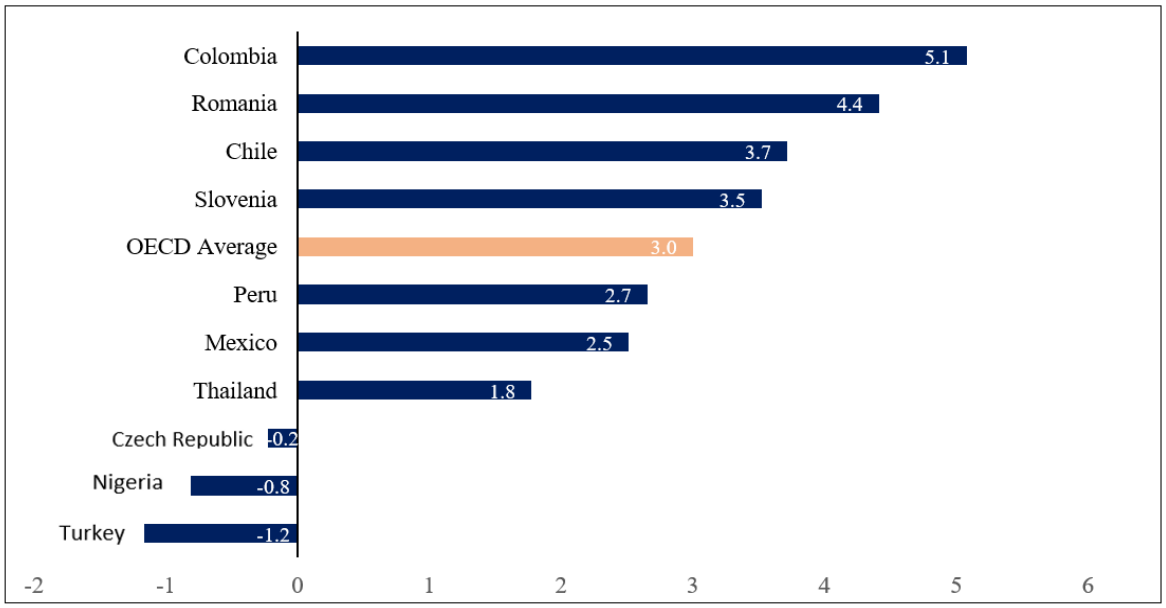

Figure 18. Ten-year annualized real returns in private pensions in developing countries, 2009–19 (%)

Note: Real returns are net of investment expenses.

Source: OECD (2020a).

Discussed below are two important factors—asset allocation and management fees—that affect PFs' investment performance.

3.2.4.1 Asset allocation

Either plan sponsors or members can make asset allocation decisions. In defined-benefit (DB) plans, only plan sponsors (e.g., employers, pension companies, and governments) take on investment risk, whereas in DC schemes, losses in fund portfolios belong to the participants.

Figure 19 breaks down selected developing countries' pension assets in 2019 into bills and bonds, cash and deposits, equities, and other investments. The 'other' category includes alternative asset classes (e.g., real estate, infrastructure funds, private equity) and mutual fund investments.

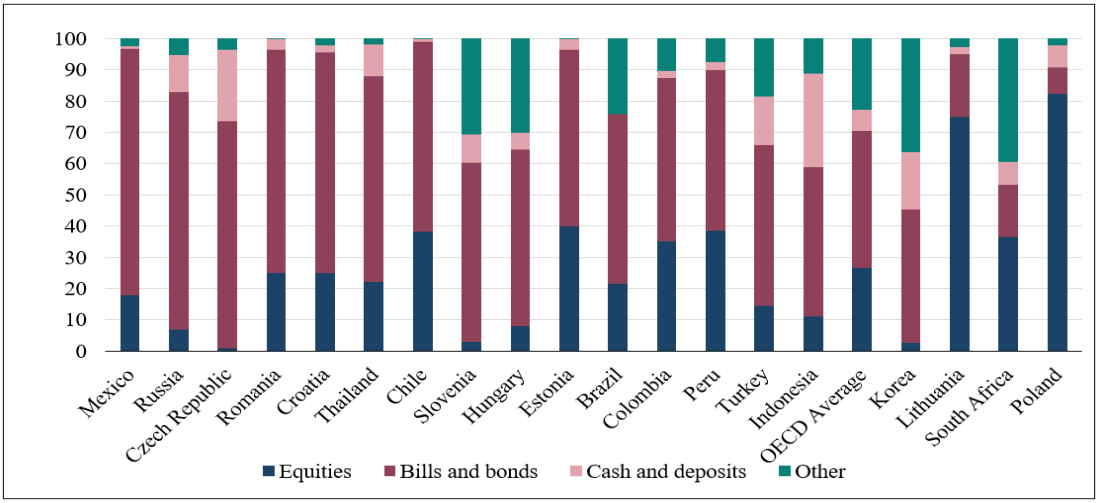

Figure 19. Asset allocation of private PFs in developing countries in 2019 (%)

Source: OECD (2020a).

Bills and bonds are the dominant asset class in the PF portfolios of developing countries, except in South Africa and Poland. The nationalization of private pensions explains their low share in Poland, which has been caused by the transfer of treasury securities to the public PAYG system. As opposed to government securities, there is less preference for riskier high-return assets, such as equities and other investments. However, in a few developing countries (Chile, Estonia, Colombia, and Peru), equity investments account for over 30% of PFs' portfolios. In comparison, the other investment category represents less than 20% of total pension assets in most countries. Finally, cash and deposit holdings account for a negligible portion of total pension assets in most developing countries.

Besides domestic investments, PFs can diversify their portfolios across international assets. According to the OECD (2020a) report, the highest proportion of foreign investments (over 60%) is observed in some CEE countries. Furthermore, in Chile, Colombia, and Peru, PFs allocate about 35–40 % of their assets to foreign investments, while most other countries invest much less.

The strong preference for treasury securities in PFs portfolios is in part caused by regulatory constraints, such as investment restrictions, minimum return guarantees, lack of diversification rules, and reporting requirements (Antolín, 2008; Stewart, 2014).

3.2.4.2 Management fees

Beyond asset allocation decisions, management fees play an important role in determining the net investment performance of PFs. These fees highly depend on PFs' operational costs. Figure 20 shows private PFs' total operating expenses, split into administrative and investment costs, in developing countries where the data are available. As illustrated, total operating costs show large heterogeneity, from 0.24% in Thailand to 1.75% in Turkey. PFs in Latin America and South Asia have lower operating expenses than their CEE counterparts; in the latter, investment costs account for the largest proportion of total costs.

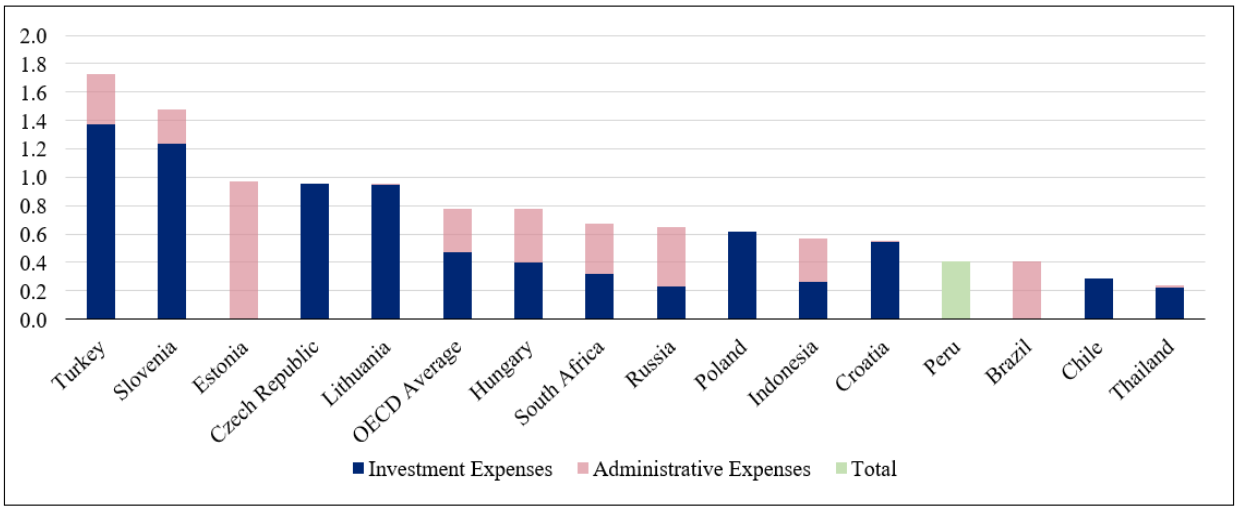

Figure 20. Operating costs of private PFs as a percentage of assets under management (AUM) in developing countries

Source: AIOS (2019) and OECD. Stat (2020).

To cover their operating expenses, PFs charge management fees for participants' investments. Table 22 shows the total annual management fees expressed as a percentage of assets under management (AUM) and the key determinants of fees (number of investment funds, maturity and size of the pension system, and contribution collection type) across developing countries for which data are available.

As Table 22 illustrates, management fees are similar to the total operating costs mentioned above. Some further patterns are also discernable. For example, Turkey, which has the highest management fees, also has the largest number of investment funds and the smallest PF size in the sample. Chile has both the lowest management fees and the largest PF size (i.e., PF assets to GDP ratio). Another important cause of lower fees in Chile may be maturity, as Chile privatized its pension system in 1981. Centralized pension systems may have lower management fees because of less expensive record-keeping (Tapia & Yermo, 2008). However, in developing countries, centralized pension systems do not seem to be an influential factor.

Table 22. PF Fees and their Determinants in Developing Countries

Country	Number of PFs	Maturity	Size	Collection type	Fees as % of AUM
Turkey	404	2003	2.90%	Decentralized	2.00
Mexico	55	1995	18.50%	Centralized	1.00
Estonia	20	2002	18.50%	Centralized	0.96
Peru	12	1992	22.60%	Decentralized	0.88
Hungary	48	1998	5.40%	Decentralized	0.62
Poland	25	1999	8.00%	Centralized	0.58
Chile	30	1981	80.8%	Decentralized	0.50

Note: 'Size' denotes the PF size, measured as PF assets as a percentage of GDP and 'AUM' denotes the assets under management.

Source: Brunton (2005), Tapia and Yermo (2008), Tuesta (2011), Hirose (2011), OECD (2016, 2019c, 2020a), IMF (2019), Ortiz, Duran, Urban, Wodsak, and Yu (2018), AIOS (2019), Peksevim and Akgiray (2019), and Turkish Capital Markets Association (2021).

3.2.5 Policy suggestions for low investment performance

3.2.5.1 Financial developments

Life-cycle funds. Recent studies have shown that private pension plan participants are incapable (owing to financial illiteracy, choice complexity, and overload) or too passive (owing to behavioral biases such as inertia, procrastination, and present bias) when making their own investment decisions and, thus, risk ending up with an inadequate pension income (Benartzi & Thaler, 2007; Alessie, Van Rooij, & Lusardi, 2011). This tendency has highlighted the relevance of default funds, as many participants adopt default investment options in private pension plans and stay in those funds afterwards (Madrian & Shea, 2001; Ring, 2012).

In many developed and developing countries, life-cycle funds (also called 'target-date funds') are becoming the dominant default option. These are long-term investment

vehicles that reduce investors' exposure to risky assets as investors approach retirement. Life-cycle funds make possible portfolio allocations based on age and have lower transaction costs due to passive management (IOPS, 2012).

Although a common feature of these funds is that they reduce equity allocation as investors age, the financial services industry uses different approaches to calculate optimal equity allocation by age. In this context, some studies have emphasized the role of human capital in calculating the optimal equity allocation in these funds. Cocco et al. (2005) and Viceira (2010) show that human capital should be modeled according to each country's labor income and the risks to it over the life cycle. This requires considering differences in workers' age–earnings profiles and incorporating temporary and permanent shocks to labor income in modeling human capital for each country.

ESG investments. Environmental, social, and corporate governance (ESG) investments have become increasingly important to European pension funds in recent years. PFs can meet members' needs for responsible investment, fulfill sustainability requirements, and reap the benefits of diversification by allocating some portion of their assets to ESG investments. Few developing countries, however, use ESG investments in their PF portfolios. Among them are South Africa and Brazil, where PF legislation has been implemented to incorporate ESG factors into long-term investment strategies. In 2017, the Government Employees Pension Fund, the biggest PF in South Africa, allocated 5% to social investments, including renewable energy, agriculture, and economic and social infrastructure. A Brazilian pension fund, Valia, invests about 4% of its portfolio in green equity (OECD, 2019b).

Despite their minimal importance, ESG investments can offer diversification benefits to PFs in developing countries, which prefer fixed-income instruments in their

portfolios. With developing countries' growing interest in auto-enrollment policies, ESG investments may be offered as a default option in pension plans, such as in the UK.

Decumulation-phase investment products. A variety of annuities have been designed to protect pensioners from running out of savings during retirement due to an increase in life expectancy. Annuity markets, however, remain undeveloped in most countries due to supply-side (e.g., low annuity products, high annuity prices, adverse selection issues) and demand-side (e.g., the complexity of annuity products, low financial literacy, and behavioral biases) constraints (Rusconi, 2008; Rocha, Vittas, & Rudolph, 2011).

A number of alternative investments to annuities have been developed by academics and industry researchers, focusing on the accumulation and decumulation phases of retirement planning. For example, Muralidhar and Merton (2020) have developed a new pension bond, SeLFIES, which pays periodic coupons to participants as pension payouts. SeLFIES bonds are liquid, low-cost, and low-risk instruments that incorporate accumulation and decumulation phases, compounding, and inflation adjustments. Decumulation-phase investment products that also consider the accumulation stage of retirement planning may emerge in developing countries as lower-cost and less risky alternatives to annuities.

3.3 Auto-enrollment policy in developing countries

To encourage higher retirement savings, developing countries have already introduced some fiscal incentives. In most developing countries, pension plan members enjoy tax exemptions, mainly on their contributions and investment returns, and employers and the state offer matching contributions and flat-rate subsidies. However, the effectiveness of

these tools in generating other retirement savings is limited (Holzmann, Hinz, Tuesta, & Takayama, 2013). As discussed earlier, the Czech Republic is the only exception, as it promotes pension savings through generous financial incentives.

In addition to fiscal incentives, several developing countries offer financial education policies, such as information on investment products and seminars on financial literacy. Indeed, financial education has been shown to promote retirement savings, particularly among low-income populations (Lusardi, 2003, 2019; Wagner, 2019).

Compared to financial incentives and educational tools, behavioral policies, such as auto-enrollment programs, offer more effective and economical solutions for low retirement savings (Benartzi et al., 2017). Auto-enrollment programs enroll employees in private pension plans with a predetermined contribution rate and portfolio allocation unless they actively indicate their preference for non-participation. Following the automatic enrolment experiences of developed countries, such as the UK and New Zealand, several developing countries have also adopted such policies to promote pension savings (Collard, 2013; OECD, 2019a).

Table 23. Auto-enrollment Programs in Developing Countries

Country	Implementation Year	Target Population	Contribution Rates	Opt-out Period	Financial Incentives	Default Fund Option	Default Fund Fee (% of AUM)	Opt-Out Rates
Chile	2012–17	Self-employed workers	Employee: 10%	Submission of the income tax declaration	Tax incentives	Life-cycle funds	0.77%	75%
Brazil	2015	Public servants	Employer contribution up to 8.5% of employee earnings	Anytime	Tax incentives	-	High (7% of contributions)	14%
Turkey	2017	Employees < 45 years of age	Employee: 3%	2 months	Tax incentives + state subsidies	Interest-bearing and interest-free funds	0.85% (capped)	~60%
Poland	2019	Employees < 55 years of age	Employee: 2%, Employer: 1.5%	Anytime	Tax incentives + state subsidies	Life-cycle funds	0.6% (capped)	~70%
Lithuania	2019	Employees < 40 years of age	Employee: 3%, State: 1.5%	6 months	Tax incentives	Life-cycle funds	As of 2021-0.5% (capped)	-
Georgia	2019	Employees < 40 years of age	Employee: 2%, Employer: 2% State: 2%	-	-	Life-cycle funds	-	-

Source: IOPS (2012), Veshapidze and Karalashvili (2018), Han and Stańko (2018), Krzyzak (2018, 2019), Peksevim (2018), OECD (2019a, 2019c, 2020b), Rudolph (2019), Sullivan (2019), Peksevim and Akgiray (2019), and Puls Biznesu (2020).

Table 23 illustrates the main parameters of auto-enrollment programs in developing countries. Chile was the first developing country to introduce an auto-enrollment system, which was limited to the self-employed. Similarly, Brazil introduced auto-enrollment only for public servants. Brazil differs from other developing countries as its auto-enrollment plan, Funpresp, was originally an opt-in scheme that later became

an opt-out scheme; this change reduced opt-out rates from 71% to 14%. In 2017, Turkey followed Brazil by introducing an auto-enrollment scheme covering all employees under forty-five years old. In 2019, three CEE countries (Poland, Lithuania, and Georgia) introduced auto-enrollment into their existing occupational plans or as part of new plans. Overall, total contribution rates vary from 3% in Turkey to 10% in Chile. Turkey has generous financial incentives with a flat-rate subsidy, matching contributions, and an annuity bonus. Similar to developed countries, life-cycle funds are the most popular default investment option. Whereas management fees are lower under auto-enrollment, opt-out rates are quite high in Chile, Turkey, and Poland, at more than 60%; in comparison, total opt-out rates in the auto-enrollment systems are around 16% in New Zealand and 10% in the UK (OECD, 2019a).

Regarding the main reasons for high opt-outs in auto-enrollment systems, qualitative research from several countries points to the same factor – lack of affordability. Another important reason cited is limited trust in long-term investment and pension providers (Foster, 2017; Prabhakar, 2017; Insurance Association of Turkey, 2018).

3.4 Limitations of private pension plans

As mentioned above, due to the rapid aging trend, public pensions are not sustainable and adequate in the long run. While, in this respect, private PFs should be further encouraged in developing countries for the provision of retirement income, they also have some limitations. Three critical issues around this topic include their contribution to income inequality, cases of failure due to the poor management and regulation of private pension plans, and the responsibility of participants in their private pension savings.

It is criticized that private pension plans, compared to public pension plans, may contribute to income inequality and poverty among the elderly. In this respect, it is argued that public pension systems have the advantage of providing smoother income distribution among the elderly since retirees' benefits in those systems are related to the years of service of workers and show relatively fair outcomes among the older population. On the other hand, in private pension plans, there is no redistribution of wealth among individuals (Hughes & Stewart, 2004; Been, Caminada, Goudswaard, & Van Vliet, 2017). Furthermore, tax advantages provided by governments have benefited wealthy groups disproportionately, as these subsidies are provided based on income in most countries.

The second criticism of private pension plans is that they are vulnerable to failure due to certain reasons. According to the International Labour Organization (ILO), the main causes of these failures are poor management of private pension plans, which have higher administrative costs, and inefficient provision of benefits (Ortiz et al., 2018). Moreover, pension plans in developing countries are weakly regulated, which makes them vulnerable to corruption. For example, some developing countries, such as Hungary and Romania, have nationalized their private pension systems in recent years.

Finally, as there is no government guarantee on the participants' contributions in private pension plans, retirees have a risk of not having adequate income at retirement. Since their contributions are directly linked to their benefits in private pension plans, some participants may end up with very low replacement rates in the case of low contribution rates and low investment performance of funds. Considering the behavioral tendency that most people do not change their asset allocation in their retirement plans, the asset allocation of private pension plans plays a critical role in having adequate benefits for pensioners at retirement (Benartzi & Thaler, 2007).

3.5 Conclusion

This article aims to provide an overview of private pension systems in the developing world, including current challenges and future directions. The most significant factors for low coverage rates and contribution levels in developing countries' private pensions are the widespread adoption of public pensions, the lack of affordability, and labor informality. Although the inability to save is common across developing countries, a high proportion of informal employment is a concern in Africa and Latin America and less so for CEE countries. Concerning the investment performance of PFs, the strong preference for government securities and the weaker preference for more risky and high-return assets, such as equities and other investments, can be considered the main reason for low portfolio returns. In some developing countries, such as Turkey, a high level of administrative fees is an important factor in reducing the investment performance of PFs.

Certain desirable financial, behavioral, and technological developments may be critical for strengthening private pensions in developing countries. Concerning behavioral and technological developments, digital nudging tools, fintech applications, and blockchain technology have great potential to increase coverage of and contribution to private pension systems in developing countries.

Regarding financial developments, designing life-cycle funds based on each country's labor income and the risks to it, adopting ESG investments in private pension plans, and introducing new decumulation-phase products as alternatives to annuities are important developments to improve the investment efficiency of private pensions.

To encourage pension savings, most developing countries have introduced fiscal incentives and financial education tools. However, these traditional policies do not generate sufficient participation and contribution rates, except in some countries, such as

the Czech Republic. For this reason, developing countries have adopted auto-enrollment policies, which aim to promote pension savings in developed countries. However, high opt-out rates are observed in Chile, Poland, and Turkey. Investigating the reasons behind this limited success again points to a lack of affordability. A lack of trust in long-term investment among plan participants highlights the relevance of default fund design in auto-enrollment plans.

It is also worth noting that while encouraging private pension systems in developing countries has major advantages, these systems also have some limitations, such as their contribution to income inequality, the possibility of failure due to poor management and regulation of private pension plans, and the responsibility of participants in the provision of retirement income.

Certain limitations of this study would encourage further research. For instance, to provide detailed and comparative information on developing countries' pension systems, the study has employed a comparably descriptive approach. As a potential future research direction, a case study approach employing a more analytical framework may be adapted to provide a more detailed critical analysis of private pension systems in developing countries. Furthermore, as another important issue in private pension systems, the gender gap in private pension savings in developing countries may be further examined. Nevertheless, the study aims to provide valuable insights into the private pension systems in developing countries, where there is a paucity of such research.

REFERENCES

Abakah, E. J. A., Alagidede, P., Mensah, L., & Ohene-Asare, K. (2018). Non-linear approach to Random Walk Test in selected African countries. *International Journal of Managerial Finance*.

Adler, G., Djigbenou, M. L., & Sosa, S. (2016). Global financial shocks and foreign asset repatriation: Do local investors play a stabilizing role? *Journal of International Money and Finance, 60*, 8-28.

Adrian, T., & Shin, H. S. (2010). Liquidity and leverage. *Journal of Financial Intermediation*, *19*(3), 418-437.

Afonso, L. E. (2015). Progressivity and distributive aspects of Brazil's social security system: an analysis using microdata from administrative records.

AIOS (Asociación International de Organismos de Supervisión de Fondos de Pensiones) (2019) 'Boletin Estadistico AIOS – Diciembre de 2019'.

Aktug, E., Kuzubas, T., & Torul, O. (2017). *An Investigation of Labor Income Profiles in Turkey* (No. 2017/04). Bogazici University, Department of Economics.

Alberola, E., Erce, A., & Serena, J. M. (2016). International reserves and gross capital flows dynamics. *Journal of International Money and Finance, 60,* 151-171.

Albouy, F. X. and Noguès, M. (2019) 'Micro-Pensions in sub-Saharan Africa: the solution to population ageing?', *17th International Workshop on Pensions, Insurance and Savings*, Université Paris Dauphine, 27–28 May.

Alessie, R., Van Rooij, M., & Lusardi, A. (2011). Financial literacy and retirement preparation in the Netherlands. *Journal of Pension Economics & Finance*, *10*(4), 527-545.

Allen, F., & Carletti, E. (2008). The role of liquidity in financial crises. *Available at SSRN 1268367*.

Allessie, D., Sobolewski, M., Vaccari L. and Pignatelli, F. (2019) *Blockchain for Digital Government*, Luxembourg: Publications Office of the European Union.

Amaglobeli, D., Chai, H., Dabla-Norris, E., Dybczak, K., Soto, M. and Tieman, A. F. (2019) 'The future of saving: The role of pension system design in an aging world', *Aging, 19,* 01.

Amihud, Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, *5*(1), 31-56.

Anand, A., Irvine, P., Puckett, A., & Venkataraman, K. (2013). Institutional trading and stock resiliency: Evidence from the 2007–2009 financial crisis. *Journal of Financial Economics*, *108*(3), 773-797.

Anderson, T.W. and Cheng Hsiao (1982). Formulation and Estimation of Dynamic Models Using Panel Data. *Journal of Econometrics 18*(1), 47-82.

Antolín, P. (2008) *Pension Fund Performance*, OECD Working Papers on Insurance and Private Pensions, No. 20, Paris: OECD Publishing.

Aouadi, A., Arouri, M., & Roubaud, D. (2018). Information demand and stock market liquidity: International evidence. *Economic Modelling, 70,* 194-202.

Aragon, G. O., & Strahan, P. E. (2012). Hedge funds as liquidity providers: Evidence from the Lehman bankruptcy. *Journal of Financial Economics*, *103*(3), 570-587.

Azar, S. A. (2006). Measuring relative risk aversion. *Applied Financial Economics Letters*, *2*(5), 341-345.

Bagliano, F. C., Fugazza, C., & Nicodano, G. (2014). Optimal life-cycle portfolios for heterogeneous workers. *Review of Finance*, *18*(6), 2283-2323.

Barajas, M. A., & Catalan, M. M. (2011). Market Discipline and Conflicts of Interest Between Banks and Pension Funds. International Monetary Fund.

Barberis, N. (2000). Investing for the long run when returns are predictable. *The Journal of Finance*, *55*(1), 225-264.

Barrientos, A. (2002) *Comparing Pension Schemes in Chile, Singapore, Brazil and South Africa*, Geneva: United Nations Research Institute for Social Development.

Bartels, R. (1982). The rank version of von Neumann's ratio test for randomness. *Journal of the American Statistical Association*, *77*(377), 40-46.

Bayuk, J., & Altobello, S. A. (2019). Can gamification improve financial behavior? The moderating role of app expertise. *International Journal of Bank Marketing*, *37*(4), 951-975.

Becker, B., & Ivashina, V. (2015). Reaching for yield in the bond market. *The Journal of Finance*, *70*(5), 1863-1902.

Been, J., Caminada, K., Goudswaard, K., & van Vliet, O. (2017) 'Public/private pension mix, income inequality and poverty among the elderly in Europe: An empirical analysis using new and revised OECD data.', *Social Policy & Administration, 51*(7), 1079-1100.

Benartzi, S., & Thaler, R. (2007). Heuristics and biases in retirement savings behavior. *Journal of Economic Perspectives*, *21*(3), 81-104.

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., ... & Galing, S. (2017). Should governments invest more in nudging?. *Psychological Science*, *28*(8), 1041-1055.

Benavides, M. (2019) 'En profundidad: ahorrar para la jubilación consumiendo, la propuesta de Pensumo', *Boletín Digital*.

Benzoni, L., Collin-Dufresne, P., & Goldstein, R. S. (2007). Portfolio choice over the life-cycle when the stock and labor markets are cointegrated. *The Journal of Finance*, *62*(5), 2123-2167.

Benzoni, L., Collin-Dufresne, P., & Goldstein, R. S. (2007). Portfolio choice over the life-cycle when the stock and labor markets are cointegrated. *The Journal of Finance*, *62*(5), 2123-2167.

Bijlsma, M., & Vermeulen, R. (2016). Insurance companies' trading behaviour during the European sovereign debt crisis: Flight home or flight to quality?. *Journal of Financial Stability*, *27*, 137-154.

Bikker, J. A. and de Dreu, J. (2007) 'Operating costs of pension schemes', in O. Steenbeek and S. van der Lecq (eds.), *Costs and Benefits of Collective Pension Systems*, Berlin, Heidelberg: Springer, 51–74.

Blake, D., Sarno, L., & Zinna, G. (2017). The market for lemmings: The herding behavior of pension funds. *Journal of Financial Markets*, *36*, 17-39.

Bodie, Z., Merton, R. C., & Samuelson, W. F. (1992). Labor supply flexibility and portfolio choice in a life cycle model. *Journal of Economic Dynamics and Control*, *16*(3-4), 427-449.

Bohl, M. T., Brzeszczyński, J., & Wilfling, B. (2009). Institutional investors and stock returns volatility: Empirical evidence from a natural experiment. *Journal of Financial Stability*, *5*(2), 170-182.

Bonnet, F., Vanek, J. and Chen, M. (2019) *Women and Men in the Informal Economy: A Statistical Brief*, Manchester: WIEGO.

Boon, L. N., Brière, M., & Rigot, S. (2018). Regulation and pension fund risk-taking. *Journal of International Money and Finance*, *84*, 23-41.

Bradley, D., Pantzalis, C., & Yuan, X. (2016). The influence of political bias in state pension funds. *Journal of Financial Economics*, *119*(1), 69-91.

Broner, F., Didier, T., Erce, A., & Schmukler, S. L. (2013). Gross capital flows: Dynamics and crises. *Journal of Monetary Economics*, *60*(1), 113-133.

Brunnermeier, M. K., & Pedersen, L. H. (2009). Market liquidity and funding liquidity. *The Review of Financial Studies*, *22*(6), 2201-2238.

Brunton, P. D. and Masci, P. (2005) *Workable Pension Systems: Reforms in the Caribbean*, New York: IDB Publications.

Campbell, J. Y., & Shiller, R. J. (2001). Valuation ratios and the long-run stock market outlook: An update.

Campbell, J. Y., Viceira, L. M., & Viceira, L. M. (2002). *Strategic asset allocation: portfolio choice for long-term investors*. Clarendon Lectures in Economic.

Carvalho, C. M., Lopes, H. F., & McCulloch, R. E. (2018). On the long-run volatility of stocks. *Journal of the American Statistical Association*, *113*(523), 1050-1069.

Chaudhuri, K., & Wu, Y. (2003). Random walk versus breaking trend in stock prices: Evidence from emerging markets. *Journal of Banking & Finance*, *27*(4), 575-592.

Choi, J. J., Laibson, D., & Madrian, B. C. (2004). Plan design and 401 (k) savings outcomes. *National Tax Journal, 57*(2), 275-298.

Ciarlone, A., & Miceli, V. (2016). Escaping financial crises? Macro evidence from sovereign wealth funds' investment behaviour. *Emerging Markets Review*, *27*, 169-196.

Cilasun, S., & Kirdar, M. (2009). A cross-sectional analysis of income, consumption and saving behavior of Turkish household. *IKTISAT ISLETME VE FINANS*, *24*(280).

Clark, G. L., & Monk, A. H. (2010). The legitimacy and governance of Norway's sovereign wealth fund: the ethics of global investment. *Environment and Planning A*, *42*(7), 1723-1738.

Cocco, J. F., Gomes, F. J., & Maenhout, P. J. (2005). Consumption and portfolio choice over the life cycle. *The Review of Financial Studies*, *18*(2), 491-533.

Collard, S. (2013). Workplace pension reform: Lessons from pension reform in Australia and New Zealand. *Social Policy and Society*, *12*(1), 123-134.

Collett, J. (2018) 'A new scheme lets you earn superannuation while you shop', *The Sydney Morning Herald*, 13 November.

Collins, M. L. (2020). Private pensions and the gender distribution of fiscal welfare. *Social Policy and Society*, *19*(3), 500-516.

Cragg, J. G., & Donald, S. G. (1993). Testing identifiability and specification in instrumental variable models. *Econometric Theory*, *9*(2), 222-240.

Davis, E. P. (2002). Prudent person rules or quantitative restrictions? The regulation of long-term institutional investors' portfolios. *Journal of Pension Economics & Finance*, *1*(2), 157-191.

Debata, B., Dash, S. R., & Mahakud, J. (2018). Investor sentiment and emerging stock market liquidity. *Finance Research Letters*, *26*, 15-31.

Demirgüç-Kunt, A., Klapper, L. and Panos, G. A. (2016) *Saving for Old Age*, Policy Research Working Paper, No. 7693, Washington, DC: The World Bank.

Dennis, P. J., & Strickland, D. (2002). Who blinks in volatile markets, individuals or institutions?. *The Journal of Finance*, *57*(5), 1923-1949.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Dreassi, A., Miani, S., & Paltrinieri, A. (2017). Sovereign pension and social security reserve funds: A portfolio analysis. *Global Finance Journal*, *34*, 43-53.

Ellul, A., Jotikasthira, C., Lundblad, C. T., & Wang, Y. (2014). Mark-to-market accounting and systemic risk: Evidence from the insurance industry. *Economic Policy*, *29*(78), 297-341.

Esch, D. N., Michaud, R. O., & New Frontier Advisors, L. L. C. (2014). The false promise of target date funds. *Journal of Indexes*, *17*(1), 50-59.

European Commission. (2010) *Progress and Key Challenges in the Delivery of Adequate and Sustainable Pensions in Europe* (A Joint Report on Pensions), Occasional Papers, 71.

European Commission. (2019) *Final Report of the High Level Group of Experts on Pensions*, Brussels: European Commission.

Fama, E. F., & French, K. R. (1988). Permanent and temporary components of stock prices. *Journal of Political Economy*, *96*(2), 246-273.

Faugère, C., & Shawky, H. A. (2003). Volatility and institutional investor holdings in a declining market: A study of Nasdaq during the year 2000. *Available at SSRN 480982*.

Fernyhough, J. (2017) 'Nest backs eco-friendly investment with UBS', *Financial Times*, 24 February.

Fidelity (2019). Fidelity Freedom Funds.

Figliuoli, L., Flamini, V., Mowatt, R., Puig, J., Lambert, F., Lissovolik, B., Galdamez, M., Li, M., Klemm, A., Soto, M., Thomas, S., Freudenberg, C. and Orthofer, A. (2018) *Growing Pains: Is Latin America Prepared for Population Aging?* Washington, DC: IMF.

Forteza, A., & Mussio, I. (2017). Contribution Densities, Transitions and Pension Rights: The Case of Jordan. *Journal of International Development*, *29*(1), 67-88.

Foster, L. (2017). Young people and attitudes towards pension planning. *Social Policy and Society*, *16*(1), 65-80.

Franzoni, F., & Plazzi, A. (2012). Hedge funds' liquidity provision and trading activity. *University of Lugano and Swiss Finance Institute Working Paper, November*.

Fratzscher, M. (2012). Capital flows, push versus pull factors and the global financial crisis. *Journal of International Economics*, *88*(2), 341-356.

FSB (2013) Assessment Methodologies for Identifying Non-Bank Non-Insurer Global Systemically Important Financial Institutions. Financial Stability Board.

Ginn, J., & MacIntyre, K. (2013). UK pension reforms: is gender still an issue?. *Social Policy and Society*, *12*(1), 91-103.

Goldstein, I., Jiang, H., & Ng, D. T. (2017). Investor flows and fragility in corporate bond funds. *Journal of Financial Economics*, *126*(3), 592-613.

Gorton, G., Metrick, A., Shleifer, A., & Tarullo, D. K. (2010). Regulating the shadow banking system [with comments and discussion]. *Brookings papers on economic activity*, 261-312.

Goyenko, R. Y., Holden, C. W., & Trzcinka, C. A. (2009). Do liquidity measures measure liquidity?. *Journal of Financial Economics*, *92*(2), 153-181.

Gökçen, U., & Yalçın, A. (2015). The case against active pension funds: Evidence from the Turkish Private Pension System. *Emerging Markets Review, 23*, 46-67.

Gözbaşı, O. (2014). BORSA İSTANBUL HİSSE SENEDİ PİYASASINDA DOĞRUSAL OLMAYAN YÖNTEMLER İLE PİYASA ETKİNLİĞİNİN TEST EDİLMESİ. *Verimlilik Dergisi*, (4), 7-18.

Grech, A. (2015) *The Financial Crisis and Differences in State Pension Generosity Across EU Countries,* CESifo DICE Report, 2/2015.

Griffin, J. M., Kelly, P. J., & Nardari, F. (2010). Do market efficiency measures yield correct inferences? A comparison of developed and emerging markets. *The Review of Financial Studies*, *23*(8), 3225-3277.

Gürgün, G., & Ünalmış, İ. (2014). Is gold a safe haven against equity market investment in emerging and developing countries?. *Finance Research Letters*, *11*(4), 341-348.

Han, T. and Stańko, D. (2018) *Update on IOPS Work on Fees and Charges*, IOPS Working Papers on Effective Pensions Supervision, No. 32, Paris: IOPS.

Harvey, C. R., Liechty, J. C., Liechty, M. W., & Müller, P. (2009). Portfolio selection with higher moments. *Quantitative Finance*, *10*(5), 469-485.

Hasanov, M., & Omay, T. (2007). Are the transition stock markets efficient? Evidence from non-linear unit root tests. *Central Bank Review*, *7*(2), 1-7.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, 1251-1271.

Hernández, A., Galindo, F., López, J. and Salas, F. (2020) 'Saving with gusto', *Journal of Applied Business and Economics,* 22, 13, doi:10.33423/jabe.v22i13.3899.

Hinz, R., Rudolph, H. P., Antolín, P. and Yermo, J. (2010) *Evaluating the Financial Performance of Pension Funds*, Washington, DC: The World Bank.

Hirose, K. (2011) *Pension Reform in Central and Eastern Europe: In Times of Crisis, Austerity and Beyond*, Geneva: International Labour Organization.

Hoevenaars, R. P., Molenaar, R. D., Schotman, P. C., & Steenkamp, T. B. (2014). Strategic asset allocation for long-term investors: Parameter uncertainty and prior information. *Journal of Applied Econometrics*, *29*(3), 353-376.

Holzmann, R., Hinz, R., Tuesta, D. and Takayama, N. (2013) *Matching Contributions for Pensions: A Review of International Experience*. Washington, DC: The World Bank.

Holzmann, R., Palmer, E., Palacios, R. and Sacchi, S. (2019) *Progress and Challenges of Nonfinancial Defined Contribution Pension Schemes: Volume 1. Addressing Marginalization, Polarization, and the Labor Market*, Washington, DC: The World Bank.

Holzmann, R., Robalino, D. A. and Takayama, N. (2009) *Closing the Coverage Gap: Role of Social Pensions and Other Retirement Income Transfers*, Washington, DC: The World Bank.

Hughes, G. and Stewart, J. (2004) *Reforming Pensions in Europe: Evolution of Pension Financing and Sources of Retirement Income,* Cheltenham: Edward Elgar.

IIF (2014) Institute of International Finance. IIF Portfolio Tracker 2014.

IMF (International Monetary Fund) (2019) *Turkey: Selected Issues*, IMF Country Report No. 19/396, Washington, DC: IMF.

Impavido, G., Musalem, A. R., & Tressel, T. (2003). The impact of contractual savings institutions on securities markets. *World Bank Policy Research Working Paper*, (2948).

Ince, O. S., & Porter, R. B. (2006). Individual equity return data from Thomson Datastream: Handle with care!. *Journal of Financial Research*, *29*(4), 463-479.

Insurance Association of Turkey (2018) 'Automatic *enrolment practice in the* Turkish *private pension system*'.

International Labour Organization (2019) *ILOSTAT Database*.

IOPS (2012) *Supervising Default Investment Funds*, IOPS Working Papers on Effective Pensions Supervision, No. 18.

Iwelumo, M. and Olanipekun, T. (2017) *Micro Pensions: The New Frontier.* London: PWC Advisory Outlook.

Jagannathan, R., & Kocherlakota, N. R. (1996). Why should older people invest less in stocks than younger people. *Federal Reserve Bank of Minneapolis Quarterly Review*, *20*, 11-20.

Javed, M. U., Rehman, M., Javaid, N., Aldegheishem, A., Alrajeh, N., & Tahir, M. (2020). Blockchain-based secure data storage for distributed vehicular networks. *Applied Sciences*, *10*(6), 2011.

Jotikasthira, C., Lundblad, C., & Ramadorai, T. (2012). Asset fire sales and purchases and the international transmission of funding shocks. *The Journal of Finance*, *67*(6), 2015-2050.

Jütting, J. and De Laiglesia, J. R. (2009) *Is Informal Normal? Towards More and Better Jobs in Developing Countries*, Paris: OECD Publishing.

Kapusuzoğlu, A., & İbicioğlu, M. (2013). Portföy çeşitlemesi: İMKB'de sektörel endeksler üzerine bir analiz. *Muhasebe ve Finansman Dergisi*, (58), 119-138.

Karolyi, G. A., Lee, K. H., & Van Dijk, M. A. (2012). Understanding commonality in liquidity around the world. *Journal of Financial Economics*, *105*(1), 82-112.

Kawakatsu, H., & Morey, M. R. (1999). An empirical examination of financial liberalization and the efficiency of emerging market stock prices. *Journal of Financial Research*, *22*(4), 385-411.

Kendall, MG. (1973) Time-Series. London: Griffin.

Kingdon, G. and Knight, J. (2001) *Why High Open Unemployment and Small Informal Sector in South Africa?* Oxford: CSAE.

Krzyzak, K. (2018) 'Lithuania plans major overhaul of second-pillar pensions', *IPE Magazine*, 17 April.

Krzyzak, K. (2019) 'Georgia's auto-enrollment pension law faces constitutional challenge', *IPE Magazine*, 22 January.

Lakonishok, J., Shleifer, A., & Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, *32*(1), 23-43.

Lean, H. H., & Smyth, R. (2007). Do Asian stock markets follow a random walk? Evidence from LM unit root tests with one and two structural breaks. *Review of Pacific Basin Financial Markets and Policies*, *10*(01), 15-31.

Lee, C. H., & Chou, P. I. (2018). Financial openness and market liquidity in emerging markets. *Finance Research Letters*, *25*, 124-130.

Lee, K. H. (2011). The world price of liquidity risk. *Journal of Financial Economics*, *99*(1), 136-161.

Lee, K. H., Sapriza, H., & Wu, Y. (2016). Sovereign debt ratings and stock liquidity around the World. *Journal of Banking & Finance*, *73*, 99-112.

Lesmond, D. A. (2005). Liquidity of emerging markets. *Journal of Financial Economics*, *77*(2), 411-452.

Lesmond, D. A., Ogden, J. P., & Trzcinka, C. A. (1999). A new estimate of transaction costs. *The Review of Financial Studies, 12*(5), 1113-1141.

Levy, H., & Cohen, A. (1998). On the risk of stocks in the long run: revisited. *Journal of Portfolio Management*, *24*(3), 60.

Li, W., & Wang, S. S. (2010). Daily institutional trades and stock price volatility in a retail investor dominated emerging market. *Journal of Financial Markets*, *13*(4), 448-474.

Lo, A. W., & MacKinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. *The Review of Financial Studies*, *1*(1), 41-66.

Lusardi, A. (2003) 'Saving and the effectiveness of financial education', in O. S. Mitchell and S. P. Utkus (eds.), *Pension Design and Structure: New Lessons from Behavioral Finance*, Oxford: Oxford University Press, 157-84.

Lusardi, A. (2019) 'Financial literacy and the need for financial education: evidence and implications', *Swiss Journal of Economics and Statistics*, 155, 1, doi:10.1186/s41937-019-0027-5.

Ma, R., Anderson, H. D., & Marshall, B. R. (2019). Risk perceptions and international stock market liquidity. *Journal of International Financial Markets, Institutions and Money*, *62*, 94-116.

Madrian, B. C., & Shea, D. F. (2001). The power of suggestion: Inertia in 401 (k) participation and savings behavior. *The Quarterly Journal of Economics*, *116*(4), 1149-1187.

Manconi, A., Massa, M., & Yasuda, A. (2012). The role of institutional investors in propagating the crisis of 2007–2008. *Journal of Financial Economics*, *104*(3), 491-518.

Marques, J. S. and Honorati, M. (2016) *Ghana: Social Protection Assessment and Public Expenditure Review*, Washington, DC: The World Bank.

Meghir, C. and Pistaferri, L. (2011) 'Earnings, consumption and life cycle choices', in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics* (Vol. 4), Amsterdam: Elsevier, 773–854.

Mehra, R., & Prescott, E. C. (1985). The equity premium: A puzzle. *Journal of Monetary Economics*, *15*(2), 145-161.

Meng, C., & Pfau, W. D. (2010). *The role of pension funds in capital market development* (pp. 10-17). GRIPS Policy Research Center.

Merrill, C. B., Nadauld, T., Stulz, R. M., & Sherlund, S. M. (2014). Were there fire sales in the RMBS market?. *Charles A. Dice Center Working Paper*, (2014-09).

Mohan, N., & Zhang, T. (2014). An analysis of risk-taking behavior for public defined benefit pension plans. *Journal of Banking & Finance*, *40*, 403-419.

MSCI (2021) *MSCI Market Classification Framework,* Morgan Stanley Capital International Inc.

Muralidhar, A., & Merton, R. (2020). SeLFIES: A New Pension Bond and Currency for Retirement. *Journal of Financial Transformation*, *51*, 8-20.

Nageri, K. I., Adekunle, A. T., & Muritala, T. A. (2019). Pension Fund and Capital Market Development in Nigeria: ARDL Bound Testing Approach.

Needleman, R. (2005) 'Social security privatized: the case of Chile', *New Labor Forum, 14*(3), 77–80.

Nevondwe, L. (2010) 'South African social security and retirement reform: a long journey towards the redrafting of the new Pension Funds Act', *Pensions: An International Journal*, *15*, 287–96.

Niggemann, T., & Rocholl, J. (2010). Pension funding and capital market development. *Unpublished Working Paper*.

OECD (2012) *Pensions Outlook 2012,* Paris: OECD Publishing.

OECD (2016) *Pension Markets in Focus,* Paris: OECD Publishing.

OECD (2017) *Technology and Pensions*, Paris: OECD Publishing.

OECD (2019a) *Financial Markets Insurance and Pensions: Inclusiveness and Finance*, Paris: OECD Publishing.

OECD (2019b) *Annual Survey of Large Pension Funds and Public Pension Reserve Funds*, Paris: OECD Publishing.

OECD (2019c) *Pensions at a Glance 2019: OECD and G20 Indicators.* Paris: OECD Publishing.

OECD (2020a) *Pension Markets in Focus,* Paris: OECD Publishing.

OECD (2020b) *Pensions Outlook 2020,* Paris: OECD Publishing.

OECD (2021) 'Net pension replacement rates' (indicator), doi:10.1787/4b03f028-en.

OECD (2021) Pension Markets in Focus, 2021. OECD Publishing: Paris.

OECD (2022) OECD Stats, Funded Pension Indicators.

OECD Stats (2010) Funded Pension Indicators, Asset Allocation.

OECD. Stat (2020) 'Funded pension indicators'.

Ortiz, I., Duran, F., Urban, S., Wodsak, V. and Yu, Z. (2018) *Reversing Pension Privatization: Rebuilding Public Pension Systems in Eastern European and Latin American Countries (2000–18)*, Geneva: International Labour Organization.

Pai, Y. (2006) *Comparing Individual Retirement Accounts in Asia: Singapore, Thailand, Hong Kong and PRC*, Washington, DC: The World Bank.

Pástor, Ľ., & Stambaugh, R. F. (2012). Are stocks really less volatile in the long run?. *The Journal of Finance*, *67*(2), 431-478.

Peksevim, S. (2018) 'Turkey: rethinking auto-enrolment', *IPE Magazine,* November.

Peksevim, S. and Akgiray, V. (2019) *Reforming the Pension System in Turkey: Comparison of Mandatory and Auto-Enrolment Pension Systems in Selected OECD Countries*, Paris: OECD Publishing.

Peksevim, S. (2021) 'Pension Systems in the Developing World: Current Challenges and Future Directions'. Pensions Institute, Discussion Paper, PI-2101.

Pension Monitoring Centre (2022). Private pension system statistics, 2022.

Pension Policy International (2020) 'IBM trials blockchain platform for primary teachers' pensions in Bangladesh'.

Pesaran, M. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric reviews*, *34*(6-10), 1089-1117.

Pfau, W. D. (2009). Life-cycle funds and wealth accumulation for retirement: Evidence for a more conservative asset allocation as retirement approaches. *Financial Services Review*, *19*(1).

PGGM (2019) *Annual Report of PGGM N.V.*, Zeist: PGGM.

Phillips, P.C.B. and Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika, 75,* 335-346.

Polakowski, M. and Hagemejer, K. (2018) *Reversing Pension Privatization: The Case of Polish Pension Reform and Re-Reforms, ESS Working Paper*, No. 68, Geneva: International Labour Organization.

Poterba, J. M., & Summers, L. H. (1988). Mean reversion in stock prices: Evidence and implications. *Journal of Financial Economics*, *22*(1), 27-59.

Prabhakar, R. (2017) 'Why do people opt-out or not opt-out of automatic enrolment? A focus group study of automatic enrolment into a workplace pension in the United Kingdom', *Journal of European Social Policy*, 27, 5, 447–57.

Prais, S. J., & Winsten, C. B. (1954). *Trend estimators and serial correlation* (Vol. 383, pp. 1-26). Chicago: Cowles Commission discussion paper.

Puls Biznesu (2020) 'Borys: participation in the PPK is 30.4%'.

Queisser, M. (1999) 'Pension reform: lessons from Latin America', *Law and Business Review of the Americas*, *5*(4), 544–66.

Raddatz, C. E., & Schmukler, S. L. (2008). Pension funds and capital market development. *World Bank Policy Research Working Paper*, (4787).

Raymond, H. (2010). Sovereign Wealth Funds as domestic investors of last resort during crises. *International Economics*, *123*, 121-159.

Reilly, F. K., & Wachowicz, J. M. (1979). How institutional trading reduces market volatility. *The Journal of Portfolio Management*, *5*(2), 11-17.

Ring, P. J. (2012). Trust: a challenge for private pension policy. *Journal of Comparative Social Welfare*, *28*(2), 119-128.

Rocha, R., Vittas, D. and Rudolph, H. P. (2011) *Annuities and Other Retirement Products: Designing the Payout Phase,* Washington, DC: The World Bank.

Roll, R. (1984). A simple implicit measure of the effective bid-ask spread in an efficient market. *The Journal of Finance*, *39*(4), 1127-1139.

Rudolph, H. P. (2019) *Pension Funds with Automatic Enrollment Schemes: Lessons for Emerging Economies*, Policy Research Working Paper, No. 8726, Washington, DC: The World Bank.

Rusconi, R. (2008) *National Annuity Markets: Features and Implications*, OECD Working Papers on Insurance and Private Pensions, No. 24, Paris: OECD Publishing.

Rutecka-Gora, J., Vostatek, J. and Turner, J. A. (2018) 'Extending pension coverage: tax versus non-tax incentives', *Economic Studies & Analyses/Acta VSFS*, 12, 2, 107–24.

Samuelson, P. A. (1969). Lifetime portfolio selection by dynamic stochastic programming. *Stochastic Optimization Models in Finance*, 517-524.

Sargan, J. D. (1958). The estimation of economic relationships using instrumental variables. *Econometrica: Journal of the Econometric Society*, 393-415.

Schembri, L. (2014). Double coincidence of needs, pension funds and financial stability. Bank of Canada.

Schmidt, P. S., Schrimpf, A., Von Arx, U., Wagner, A. F., & Ziegler, A. (2015). Size and momentum profitability in international stock markets.

Schooley, D. K., & Worden, D. D. (1999). Investors' asset allocations versus life-cycle funds. *Financial Analysts Journal, 55*(5), 37-43.

Shankar, S., & Asher, M. G. (2011). Micro-pensions in India: Issues and challenges. *International Social Security Review*, *64*(2), 1-21.

Shin, D., & Solon, G. (2011). Trends in men's earnings volatility: What does the Panel Study of Income Dynamics show?. *Journal of Public Economics*, *95*(7-8), 973-982.

Siegel, J. J. (2014). Stocks for the Long Run: The Definitive Guide to Financial Market Returns and Long-Term Investment Strategies.

Stewart, F. (2014) *Proving Incentives for Long-Term Investment by Pension Funds: The Use of Outcome-Based Benchmarks*, Policy Research Working Paper, No. 6885, Washington, DC: The World Bank.

Sullivan, M. (2019) 'Auto-enrolment grows globally', *IPE Magazine,* February.

Tansel, A., & Tasci, H. M. (2004). Determinants of unemployment duration for men and women in Turkey. *Available at SSRN 512222*.

Tapia, W. and Yermo, J. (2008) *Fees in Individual Account Pension Systems: A Cross-Country Comparison,* OECD Working Papers on Insurance and Private Pensions, No. 27, Paris: OECD Publishing.

Thomas, A., Spataro, L., & Mathew, N. (2014). Pension funds and stock market volatility: An empirical analysis of OECD countries. *Journal of Financial Stability*, *11*, 92-103.

Timmer, Y. (2018). Cyclical investment behavior across financial institutions. *Journal of Financial Economics*, *129*(2), 268-286.

Tuesta, D. (2011) *A Review of the Pension Systems in Latin America*, BBVA Research Working Papers, No. 11/15, Madrid: BBVA Research.

Tuna, G., ve Öztürk, M. (2016). Piyasa Etkinliğinin Yapısal Kırılmalı Birim Kök Testleri İle İncelenmesi: Türkiye Pay Senedi Piyasası Uygulaması. *Uluslararası Yönetim İktisat ve İşletme Dergisi, 30*, 548-559.

Turkish Capital Markets Association (2021) *Data Bank*.

TURKSTAT (2017) Household Budget Survey, Micro Dataset, 2017.

TURKSTAT (2017) Income and Living Conditions Survey, Micro Dataset, 2014-2017.

United Nations Department of Economic and Social Affairs (2015) *World Population Ageing 2015* (ST/ESA/SER.A/390), New York: UNDESA.

Urrutia, J. L. (1995). Tests of random walk and market efficiency for Latin American emerging equity markets. *Journal of Financial Research*, *18*(3), 299-309.

Van der Schans, M., Cramwinckel, J. and Ivanov, S. (2018) 'Nudge: improving decisions about pensions using blockchain technology', *VBA Journal*, 34, 134, 13–7.

Venn, D. (2011). Earnings Volatility and its Consequences for Households. OECD Social, Employment and Migration Working Papers, No. 125, OECD Publishing.

Veshapidze, S. and Karalashvili, S. (2018) 'Pension reform in Georgia', *Ecoforum*, *7*(2), 120–25.

Viceira, L. (2010). Application of advances in financial theory and evidence to pension fund design in developing economies. *Evaluating Financial Performance of Pension Funds*.

Viceira, L. M. (2001). Optimal portfolio choice for long-horizon investors with nontradable labor income. *The Journal of Finance*, *56*(2), 433-470.

Viceira, L. M. (2010) 'Application of advances in financial theory and evidence to pension fund design in developing economies', in R. Hinz, H. P. Rudolph, P. Antolín and J. Yermo (eds.), *Evaluating the Financial Performance of Pension Funds*, Washington, DC: The World Bank, 203–41.

Wagner, J. (2019) 'Financial education and financial literacy by income and education groups', *Journal of Financial Counseling and Planning*, *30*(1), 132–41.

Wald, A., & Wolfowitz, J. (1943). An exact test for randomness in the non-parametric case based on serial correlation. *The Annals of Mathematical Statistics*, *14*(4), 378-388.

Walker, E. and Lefort, F. (2002) *Pension Reform and Capital Markets: Are There Any (Hard) Links?* Policy Research Working Paper, No. 24082, Washington, DC: The World Bank.

Walker, E., & Lefort, F. (2002). Premios por plazo, tasas reales y catástrofes: Evidencia de Chile. *El Trimestre Económico*, 191-225.

Wiggins, V., & Poi, B. (2003). How do I test for panel-level heteroscedasticity and autocorrelation. *STATA Frequently Asked Questions*.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT press.

World Bank (2019a) 'Population estimates and projections'.

World Bank (2019b) 'World development indicators'.

Xue, W., He, Z., & Hu, Y. (2021). The stabilizing effects of pension funds vs. mutual funds on country-specific market risk. *Journal of Multinational Financial Management*, *60*, 100691.

Zalewska, A. (2006). Is locking domestic funds into the local market beneficial? Evidence from the Polish pension reforms. *Emerging Markets Review*, *7*(4), 339-360.

Zellner, A. (1971). Bayesian and non-Bayesian analysis of the log-normal distribution and log-normal regression. *Journal of the American Statistical Association*, *66*(334), 327-330.

Zivot, E. and Andrews, D.W.K. (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business and Economic Statistics, 10*, 251-270.

Zouaoui, H., Mazioud, M. and Ellouz, N. Z. (2018) 'A semi-parametric panel data analysis on financial development-economic volatility nexus in developing countries'*, Economics Letters*, *172,* 50-5.