An analysis of the effects of aging society on global stock markets

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Abstract

Purpose – The primary purpose of this study is to explore the effects of demographic transition toward aging populations on the performance of stock market indices across various economic developments. The research aims to provide valuable insights into the life-cycle hypothesis on savings patterns, investment behavior and the potential reverberations on global financial markets.

Design/methodology/approach – The study adopts a comprehensive global perspective, scrutinizing the effects of aging populations on stock market indices across developed, developing and transitional economies through the panel data analysis. Using annual data spanning the period from 1991 to 2020, encompassing a sample of 10 countries from each economic development level, the study employs the panel autoregressive distributed lag (ARDL) model with fixed effect estimation.

Findings – The findings unveil a statistically significant positive impact of the elderly population proportion on global stock market indices. However, the magnitude and contours of this impact exhibit considerable heterogeneity across different country groups. Specifically, the study finds that while the aging population significantly influences stock market performance in developed nations, its effect is overshadowed by other economic factors, such as consumer price indices and interest rates, in developing countries and economies in transition.

Originality/value – The originality and value of this study lie in its comprehensive global perspective, which encompasses a diverse array of economies at varying developmental stages. The research contributes to an understanding of the effects of demographic transitions on stock market performance on a global scale. The insights derived from this study hold significant implications for policymakers, financial institutions and investors seeking to navigate the challenges and opportunities posed by aging societies in an increasingly interconnected global economy. Additionally, the findings highlight the need for specific strategies and policies that account for the unique economic characteristics and developmental stages of different nations.

Keywords Cointegration, Autoregressive distributed lag model, Aging population, Stock market

Paper type Research paper

1. Introduction

In the contemporary world, we are witnessing a substantial demographic shift towards an aging population, often referred to as the “gray revolution.” This transformation is driven by several interrelated factors. Firstly, advancements in medical science and healthcare have significantly increased life expectancy, resulting in a burgeoning elderly population worldwide (He *et al.*, 2016). Additionally, the cohort born during the post-World War II baby boom era is now entering its golden years, further swelling the ranks of the elderly (Bloom *et al.*, 2015). Simultaneously, global birth rates have been trending downward, a pattern observed across both developed and developing nations. Consequently, these dynamics have profoundly altered the age structure of populations, particularly in developed countries such as Japan, Germany and Italy, where over a quarter of the population is aged 65 or above (World Population Ageing Report, 2022).

JEL Classification — A10, C01, F30

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The rising proportion of elderly individuals has far-reaching implications across various domains. In the realm of production, a shrinking workforce can lead to decreased economic productivity and innovation (Bloom *et al.*, 2010). Socially, there is a growing demand for healthcare services and robust pension systems, placing immense financial strain on these resources (Harper, 2014). Economically, nations may experience slower growth and increased public expenditure on healthcare and social support systems, potentially compromising their long-term fiscal sustainability (Ogawa *et al.*, 2009). These demographic changes collectively impact the overall wealth and well-being of each nation.

Some countries have implemented proactive policies to mitigate the challenges posed by an aging population. For instance, Japan has adopted measures such as raising the retirement age, encouraging women's participation in the workforce, and investing in robotics and automation to offset labor shortages (Coulmas, 2007). Similarly, countries like Sweden and Denmark have implemented comprehensive social welfare programs and pension reforms to support their aging populations (Sundén, 2006; Andersen, 2015). Ultimately, addressing the implications of an aging population requires a multifaceted approach, encompassing economic, social and technological initiatives tailored to each nation's unique circumstances.

This demographic shift raises significant concerns about its implications for economic sustainability and social well-being (Harper, 2014; Bloom *et al.*, 2015). Population aging can also notably impact financial markets, as individuals typically accumulate financial assets during their working years and sell these assets during retirement (Bosworth *et al.*, 2004). Consequently, younger populations may have a higher inclination to hold stocks and other assets as part of their retirement savings strategy, but this tendency generally decreases with age (Poterba, 2001). Given the changing population structure, many countries are now keenly interested in studying the impact of the elderly population on the stock market (Bakshi and Chen, 1994; Börsch-Supan, 2003; Park and Shin, 2012).

Understanding the channels through which an aging population affects asset markets is crucial for policymakers. One theoretical framework that explains the potential impact of aging populations on asset markets is the life-cycle hypothesis (LCH). According to the LCH, individuals invest in housing assets in their 20s and 30s and, as they approach retirement age, allocate more of their savings to financial assets. Therefore, there is greater demand for financial assets when individuals are in their later earning years before retirement, especially between the ages of 45 and 64. The life cycle risk aversion theory posits that an individual's relative risk aversion increases with age, explaining the reallocation of portfolios away from risky equity assets towards less risky fixed-income assets as individuals approach or reach retirement. Consequently, if the proportion of the population in their pre-retirement years is high, it will enhance the price of relatively risky financial assets. Conversely, as they retire and divest their risky equity assets in favor of fixed-income assets, it will depress the price of equity assets (Quayes and Jamal, 2016). Beyond individual investment behaviors, an aging population also impacts the stock market through its effects on business operations. As the working-age population shrinks, businesses face higher labor costs. In response, many firms increase investments in technology and machinery to offset labor shortages. This shift towards capital-intensive operations often requires additional financing, prompting companies to adjust their financial structures. Such adaptations can have significant implications for stock valuations and market dynamics (Wang and Chen, 2024).

While the relationship between the stock market and the aging population is well-researched in the literature (Goyal, 2004; Hettihewa *et al.*, 2018; Cheng and Lee, 2022; Yuan *et al.*, 2022), the findings are often inconclusive. This may be due to differences in the level of economic development. Developed economies typically have more mature financial markets and higher levels of savings and investments among their aging populations. In contrast, developing and transitioning economies may experience different dynamics, such as weaker financial systems, less comprehensive social security and varying savings behaviors. Hence, this study offers a unique contribution by comprehensively examining the concept of LCH and investigating how aging populations impact stock markets across these varied economic contexts. Our comparative analysis spans 30 countries, representing a novel approach. By considering a broad sample that captures the diversity of demographic and market dynamics globally, our findings can provide valuable insights into how population aging may differentially influence equity markets depending on a nation's level of development. The novelty lies in uncovering potential similarities or divergences in how aging populations shape stock returns and other market characteristics across these economic development levels.

The remainder of this paper is structured as follows. Section 2 conducts a comprehensive review of the relevant literature. Section 3 outlines the data description and the variables employed in this study. Section 4 presents the study's findings, followed by a discussion in Section 5. Lastly, Section 6 offers concluding remarks.

2. Literature review

Several studies have explored the broader economic implications of population aging, such as its effects on savings rates, capital flows and pension systems (Bosworth *et al*., 2004; Poterba, 2004; Park and Rhee, 2007). However, the specific impact on stock markets remains an area of ongoing research, with conflicting evidence across different regions and economic contexts.

The impact of population aging on financial markets, especially stock market performance, has become a focal point of research in recent decades. This relationship is underpinned by several theoretical frameworks. The LCH, introduced by Modigliani and Brumberg (1954) and expanded by Ando and Modigliani (1963), suggests that individuals' consumption and investment patterns evolve throughout their lives, potentially influencing asset prices and stock valuations. Complementing this, the life cycle risk aversion theory, proposed by Bakshi and Chen (1994) and further supported by Bergantino (1998), posits that risk tolerance typically decreases with age, which may affect investment preferences and, by extension, stock market dynamics. Beyond individual behavior, institutional factors play a crucial role. Buchmann *et al.* (2023) emphasized the intricate link between aging populations and pension systems, which are often significant investors in stock markets. Demographic shifts can thus lead to changes in pension fund investment strategies, indirectly impacting stock market performance. Furthermore, Wang and Chen (2024) highlighted how an aging population alters the labor structure of businesses, potentially affecting operational costs and, consequently, stock valuations. This multifaceted relationship between demographic trends and stock markets underscores the complex interplay of individual behaviors, institutional practices and broader economic structures in shaping financial market outcomes.

Empirical studies across developed economies have largely supported the concept of the LCH, finding positive correlations between the proportion of the population in their peak savings years (ages 40–64) and stock market valuations (Bakshi and Chen, 1994; Bergantino, 1998; Börsch-Supan, 2003). However, the evidence from developing and emerging economies has been more mixed, potentially due to differences in institutional frameworks, market structures and demographic patterns.

Research on transition economies has also yielded conflicting findings, with some studies supporting the LCH and others reporting insignificant or contradictory results (Cizkowicz *et al*., 2015). These divergent findings across different economic contexts highlight the need for further investigation. Cross-country comparative studies have attempted to examine the impact of aging populations on stock markets across varying economic contexts. Börsch-Supan and Ludwig (2009) and Park and Shin (2012) found support for the LCH's concepts, but their analyses were limited in scope, focusing on a specific set of countries or regions.

Despite the extensive literature on this topic, there remains a significant gap in our understanding of how aging populations impact stock markets across diverse economic contexts, including developed, developing and transition economies. Most existing studies have focused either on specific countries or regions, or have used traditional analytical techniques that may not fully capture the relationship between aging societies and stock market performance (Boersch-Supan and Winter, 2001; Miloş and Corduneanu, 2011;

Hettihewa *et al.*, 2018). This is due to the impact of an aging society on stock markets might vary depending on specific economic conditions, suggesting that the effects could differ across different economic levels (Hettihewa *et al.*, 2018)

Our study aims to address this gap by conducting a comprehensive cross-country analysis that examines the impact of aging populations on stock markets across 30 countries with varying levels of economic development. Moreover, our study employs panel autoregressive distributed lag (ARDL) modeling to investigate this relationship. This methodological approach allows us to capture both long-run and short-run dynamics, providing insights that may have been overlooked in previous studies.

By offering a harmonized, cross-country perspective and leveraging sophisticated analytical techniques, our research contributes to the existing literature by providing a more comprehensive and robust examination of the impact of aging populations on stock markets across various economic development levels. The findings of this study can inform policymakers, investors and market participants in formulating strategies to navigate the challenges and opportunities presented by demographic shifts in their respective countries.

3. Methodology and data

This study conducts a comprehensive cross-country analysis examining the impact of aging populations on stock markets across 30 countries spanning developed, developing and transition economies. The sample includes countries from various regions, such as the United States, Japan, Germany, United Kingdom, France, Italy, Canada, Australia, Spain, Netherlands, China, India, South Korea, Brazil, Mexico, Indonesia, Saudi Arabia, Turkey, Thailand, Argentina, Russian Federation, Ukraine, Kazakhstan, Republic of Belarus, Serbia, Bosnia and Herzegovina, Georgia, Republic of North Macedonia, Kyrgyz Republic and Montenegro. These countries were classified into three groups based on their economic development levels, as suggested by the United Nations Department of Economic and Social Affairs (UN DESA).

The study utilizes secondary panel data comprising Aging per population (APP_{it}) and macro variables such as Gross Domestic Product per capita $(GDPPC_{it})$, Gross savings (% of GDP) (GDS_{it}), interest rate (IR_{it}), Consumer Price Index (CPI_{it}) and Crude Oil Prices (COP_{it}). The dependent variable is Stock Market Index (SMI_{it}). Data is sourced from CEIC World Bank, the World Bank, Our World in Data website and IMF, spanning 30 years from 1991 to 2020 with annual observations.

The analysis employs panel data techniques, which allow for the consideration of both cross-sectional and time-series dimensions. To ensure the robustness of the results, the stationarity of the panel data is tested using the Levin, Lin and Chu (LLC) panel unit root test method.

Furthermore, a panel ARDL model is employed to investigate the long-term equilibrium relationships between the variables of interest. The equation of the panel ARDL model, which divides countries according to economic development, can be written as follows:

$$\begin{aligned}\Delta lnSMI^{ed}_{it} &= \alpha_{01} + \sum_{j=1}^{n-1}\alpha_1\Delta lnSMI^{ed}_{it-j} + \sum_{j=1}^{n-1}\alpha_2\Delta lnAPP^{ed}_{it-j} + \sum_{j=1}^{n-1}\alpha_3\Delta IR^{ed}_{it-j} + \sum_{j=1}^{n-1}\alpha_4\Delta GDS^{ed}_{it-j}\\ &+ \sum_{i=1}^{n-1}\alpha_5\Delta lnCPI^{ed}_{it-j} + \sum_{j=1}^{n-1}\alpha_6\Delta lnGDPPC^{ed}_{it-j} + \sum_{j=1}^{n-1}\alpha_7\Delta lnCOP^{ed}_{it-j}\\ &+ \beta_1 lnSMI^{ed}_{it-1} + \beta_2 ln\,APP^{ed}_{it-1} + \beta_3 IR^{ed}_{it-1} + \beta_4 GDS^{ed}_{it-1}\\ &+ \beta_5 ln\,CPI^{ed}_{it-1} + \beta_6 lnGDPPC^{ed}_{it-1} + \beta_7 ln\,COP^{ed}_{it-1} + u^{ed}_{1it}\end{aligned} \quad (1)$$

$$\Delta lnSMI_{it}^{ing} = \alpha_{02} + \sum_{j=1}^{n-1} \alpha_1 \Delta lnSMI_{it-j}^{ing} + \sum_{j=1}^{n-1} \alpha_2 \Delta lnAPP_{it-j}^{ing} + \sum_{j=1}^{n-1} \alpha_3 \Delta IR_{it-j}^{ing}$$
$$+ \sum_{j=1}^{n-1} \alpha_4 \Delta GDS_{it-j}^{ing} + \sum_{j=1}^{n-1} \alpha_5 \Delta lnCPI_{it-j}^{ing} + \sum_{j=1}^{n-1} \alpha_6 \Delta lnGDPPC_{it-j}^{ing}$$
$$+ \sum_{j=1}^{n-1} \alpha_7 \Delta lnCOP_{it-j}^{ing} + \beta_1 lnSMI_{it-1}^{ing} + \beta_2 ln\,APP_{it-1}^{ing} + \beta_3 IR_{it-1}^{ing} + \beta_4 GDS_{it-1}^{ing}$$
$$+ \beta_5 ln\,CPI_{it-1}^{ing} + \beta_6 lnGDPPC_{it-1}^{ing} + \beta_7 ln\,COP_{it-1}^{ing} + u_{2it}^{ing} \quad (2)$$

$$\Delta lnSMI_{it}^{trans} = \alpha_{03} + \sum_{j=1}^{n-1} \alpha_1 \Delta lnSMI_{it-j}^{trans} + \sum_{j=1}^{n-1} \alpha_2 \Delta lnAPP_{it-j}^{trans} + \sum_{j=1}^{n-1} \alpha_3 \Delta IR_{it-j}^{trans}$$
$$+ \sum_{j=1}^{n-1} \alpha_4 \Delta GDS_{it-j}^{trans} + \sum_{j=1}^{n-1} \alpha_5 \Delta lnCPI_{it-j}^{trans} + \sum_{j=1}^{n-1} \alpha_6 \Delta lnGDPPC_{it-j}^{trans}$$
$$+ \sum_{j=1}^{n-1} \alpha_7 \Delta lnCOP_{it-j}^{trans} + \beta_1 lnSMI_{it-1}^{trans} + \beta_2 ln\,APP_{it-1}^{trans} + \beta_3 IR_{it-1}^{trans} + \beta_4 GDS_{it-1}^{trans}$$
$$+ \beta_5 ln\,CPI_{it-1}^{trans} + \beta_6 lnGDPPC_{it-1}^{trans} + \beta_7 ln\,COP_{it-1}^{trans} + u_{3it}^{trans} \quad (3)$$

where Δ denotes the first difference operator of the respective variable and α and β are represent the estimated coefficients of the short-run and long-run. *ed* is the developed country, *ing* is a developing country and *trans* is the economy in a transition country.

Comparing study results from the Panel ARDL analysis, categorizing countries by economic development, provides insights into the dynamics within each group. This modeling approach facilitates the examination of both short-run and long-run relationships between aging and stock market performance across a diverse sample of countries. Crucially, it enables comparative analyses across the three economic development groups: developed, developing and economies in transition.

To validate the presence of long-term equilibrium relationships, the panel cointegration test is employed, utilizing the Wald test (*F*-test method) proposed by Pesaran *et al.* (2001). The null hypothesis is $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0,$ while the alternative is $H_0: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq 0.$

Following this, we will estimate the long-run relationship using the selected ARDL model based on the Akaike Information Criterion (AIC). Upon confirming cointegration, we will proceed to estimate the error correction model.

$$\Delta lnSMI_{it}^{ed} = \gamma_{01} + \sum_{j=1}^{n-1} \gamma_1 \Delta lnSMI_{it-j}^{ed} + \sum_{j=1}^{n-1} \gamma_2 \Delta lnAPP_{it-j}^{ed} + \sum_{j=1}^{n-1} \gamma_3 \Delta IR_{it-j}^{ed} + \sum_{j=1}^{n-1} \gamma_4 \Delta GDS_{it-j}^{ed}$$
$$+ \sum_{i=1}^{n-1} \gamma_5 \Delta lnCPI_{it-j}^{ed} + \sum_{j=1}^{n-1} \gamma_6 \Delta lnGDPPC_{it-j}^{ed} + \sum_{j=1}^{n-1} \gamma_7 \Delta lnCOP_{it-j}^{ed} + \rho ECT_{it-1}^{ed} + \varepsilon_{1it}^{ed} \quad (4)$$

$$\Delta lnSMI_{it}^{ing} = \gamma_{01} + \sum_{j=1}^{n-1} \gamma_1 \Delta lnSMI_{it-j}^{ing} + \sum_{j=1}^{n-1} \gamma_2 \Delta lnAPP_{it-j}^{ing} + \sum_{j=1}^{n-1} \gamma_3 \Delta IR_{it-j}^{ing} + \sum_{j=1}^{n-1} \gamma_4 \Delta GDS_{it-j}^{ing} + \sum_{i=1}^{n-1} \gamma_5 \Delta lnCPI_{it-j}^{ing} + \sum_{j=1}^{n-1} \gamma_6 \Delta lnGDPPC_{it-j}^{ing} + \sum_{j=1}^{n-1} \gamma_7 \Delta lnCOP_{it-j}^{ing} + \rho ECT_{it-1}^{ing} + \varepsilon_{1it}^{ing} \quad (5)$$

$$\Delta lnSMI_{it}^{trans} = \gamma_{01} + \sum_{j=1}^{n-1} \gamma_1 \Delta lnSMI_{it-j}^{trans} + \sum_{j=1}^{n-1} \gamma_2 \Delta lnAPP_{it-j}^{trans} + \sum_{j=1}^{n-1} \gamma_3 \Delta IR_{it-j}^{trans} + \sum_{j=1}^{n-1} \gamma_4 \Delta GDS_{it-j}^{trans} + \sum_{i=1}^{n-1} \gamma_5 \Delta lnCPI_{it-j}^{trans} + \sum_{j=1}^{n-1} \gamma_6 \Delta lnGDPPC_{it-j}^{trans} + \sum_{j=1}^{n-1} \gamma_7 \Delta lnCOP_{it-j}^{trans} + \rho ECT_{it-1}^{trans} + \varepsilon_{1it}^{trans} \quad (6)$$

where ρ is the coefficient indicating the speed of adjustment back to the long-run equilibrium following a short-run shock (error correction term).

4. Empirical results

4.1 Results of the panel unit root test

Several panel unit root tests, including Levin *et al.* (2002), Im *et al.* (2005), and Fisher-ADF of Maddala and Wu (1999), are conducted to assess the stationarity of the data and examine its order of integration, typically denoted as I(0), I(1), or I(2). This test evaluates whether the data is stationary (I(0)), integrated of order 1 (I(1)), or integrated of order 2 (I(2)).

Table 1 displays the results of the stationarity tests for the variables. It can be observed that all variables tend to become stationary at the first difference. When all variables require no more than first-order differencing (I(1)), panel ARDL model estimation can proceed confidently. However, it's important to note that if one or more variables display I(1) characteristics, estimating the model with non-stationary variables introducing spurious regression. Therefore, beyond confirming individual variable stationarity, conducting a panel

Table 1. Results of panel unit root tests

Variable	LLC I(0)	I(1)	IPS I(0)	I(1)	HW I(0)	I(1)
$lnAPP_{it}$	−5.943***		−0.1654	−4.4745***	61.829	84.662*
$lnGDPPC_{it}$	0.314	−22.516***	−1.1531	−4.153***	35.24	90.214***
GDS_{it}	−3.974***		−1.1681	−5.7751***	25.743	175.133***
IR_{it}	−4.941***		−0.9340	−8.1378***	51.627	283.970***
$lnCPI_{it}$	−9.228***		−0.9975	−4.744***	68.001	155.191***
$lnCOP_{it}$	−1.621	−22.070***	−1.5535	−3.2714**	62.463	89.589*
$lnSMI_{it}$	−0.361	−17.976***	−1.5713	−5.9266***	47.52	188.601***

Note(s): ***denotes significance at the 1% level. LLC, IPS and HW are Levin, Lin, and Chu, Im, Pesaran, and Shin and Maddala and Wu tests, respectively
Source(s): Authors' calculations based on using *R* program

cointegration test using the F-test becomes essential. This test helps identify the long-run relationship among the data variables.

The method proposed by Pesaran *et al*. (2001) was employed to test the long-term equilibrium relationship. The results, as reported in Table 2, reveal a significant F-statistic value of 23.4972, surpassing the critical value at the 0.01 significance level. This indicates that the variables have indeed cointegrated in the long run. As a consequence, the estimation of the panel ARDL model is immune to spurious regression issues.

4.2 The panel ARDL results with all countries

Table 3 reports the results of the estimated long-run ARDL model and the ARDL short-run error correction model (1,1,1,1,1,1) used to analyze the impact of the elderly population on the global stock market. The analysis starts by examining the error correction term (ECT), which measures the short-term adjustments necessary to restore long-term equilibrium. The ECT coefficient is found to be −0.2771, which is statistically significant at the 0.01 level. This negative coefficient indicates that any short-term deviations from the long-run equilibrium are corrected at a rate of 27.71% per period. The statistical significance of the ECT coefficient confirms that the variables indeed adjust to maintain long-term equilibrium, highlighting the effectiveness of the ARDL model in capturing both short-term dynamics and long-term relationships.

Table 2. Results of panel cointegration test using the F-test method

Test statistic	Value	p-value
F-statistic	23.4972***	0.0000

Note(s): "***" denotes significance at the 1% level
Source(s): Authors' calculations based on using *R* program

Table 3. Results of long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1)

Variable	Coefficient	Standard error	p-value
Long – Run Coefficient			
$lnAPP_{it-1}$	0.6658***	0.2153	0.0021
IR_{it-1}	−0.0268***	0.0053	0.0000
GDS_{it-1}	−0.0103	0.0079	0.1967
$lnCPI_{it-1}$	0.3334***	0.0789	0.0000
$lnGDPPC_{it-1}$	0.1675	0.1093	0.1259
$lnCOP_{it-1}$	0.0087	0.0856	0.9185
Short – Run Coefficient			
$\Delta lnAPP_{it-1}$	1.7458	1.7176	0.3098
ΔIR_{it-1}	0.0083	0.0072	0.2499
ΔGDS_{it-1}	0.0252***	0.0076	0.0011
$\Delta lnCPI_{it-1}$	−0.3284	0.3252	0.3129
$\Delta lnGDPPC_{it-1}$	0.0692	0.1494	0.6431
$\Delta lnCOP_{it-1}$	0.1883***	0.0502	0.0002
Constant	1.8080***	0.2684	0.0000
ECT	−0.2771***	0.0373	0.0000

Note(s): "***" denotes significance at the 1% level
Source(s): Authors' calculations based on using *R* program

Examining the long-term cointegration results, we find several statistically significant variables impacting the global stock market index. The proportion of elderly to population $(lnAPP_{it})$ is significant at the 0.01 level with a coefficient of 0.6658, indicating a positive long-term relationship with the stock market index. The interest rate (IR_{it}) is also significant at the 0.01 level, but with a coefficient of −0.0268, suggesting an inverse relationship. The Consumer Price Index $(lnCPI_{it})$ shows a significant positive relationship at the 0.01 level with a coefficient of 0.3334. Conversely, gross savings level (GDS_{it}), gross domestic product per capita $(lnGDPPC_{it})$ and crude oil price $(lnCOP_{it})$ are not statistically significant, indicating no discernible long-term impact on the stock market index. These findings suggest that while the proportion of the elderly population, interest rates and CPI have significant long-term relationships with the stock market, other variables like gross savings, GDP per capita and crude oil prices do not. This underscores the importance of demographic and economic factors in understanding stock market dynamics while highlighting areas where further research may be needed to explore indirect effects or interactions with other variables.

4.3 Comparing the impact of the elderly population on the stock market across different economic development groups

In this section, this study compares the impact of the elderly population on the stock market across different economic development groups of countries using the estimation of the panel ARDL again. Long-term equilibrium relationships are tested through the *F*-test method to confirm that, in long-term equilibrium, both the independent and dependent variables are related in each sub-sample.

The results of the panel cointegration test presented in Table 4 indicate significant findings across developed, developing and economies in transition countries. The test statistics, represented by the F-statistic, are notably high for all three categories, with values of 36.8921 for developed countries, 17.2662 for developing countries and 13.1376 for economies in transition countries. These statistics are associated with very low *p*-values, indicating statistical significance at the 1% level. In the context of panel cointegration testing, high F-statistics coupled with low *p*-values suggest that the variables under consideration have indeed achieved long-term equilibrium relationships. This implies that the variables have adjusted over time to maintain a stable relationship, ensuring the reliability of the panel ARDL model estimation and avoiding issues such as spurious regression. Overall, these findings provide strong evidence that the variables in the model are co-integrated, meaning they move together in the long run despite short-term fluctuations. This co-movement in the long term highlights the importance of considering the proportion of the elderly population when analyzing stock market dynamics across different economic development levels.

Table 5 reports the results of the estimated long-run ARDL model and the ARDL short-run error correction model (1,1,1,1,1,1) to analyze the impact of the elderly population on the stock market for developed countries. The ECT coefficient is −0.3013, statistically significant at the 0.01 level, indicating that deviations from long-term equilibrium are corrected at a rate of 30.13% per period. Examining the long-term cointegration results, we find that the proportion of the elderly to the population $(lnAPP_{it})$ and the gross savings rate (GDS_{it}) are statistically

Table 4. Results of panel cointegration test for developed countries using the *F*-test method

Test statistic	*F*-stat	*p*-value
Developed countries	36.8921***	0.0000
Developing countries	17.2662***	0.0000
Economies in transition countries	13.1376***	0.0000

Note(s): "***" denotes significance at the 1% level
Source(s): Authors' calculations based on using *R* program

Table 5. Results of long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1) for developed countries

Variable	Coefficient	Standard error	*p*-value
Long – Run Coefficient			
$lnAPP_{it-1}$	2.0275***	0.4233	0.0000
IR_{it-1}	0.0205	0.0230	0.3739
GDS_{it-1}	0.1054***	0.0189	0.0000
$lnCPI_{it-1}$	0.7708	0.5137	0.1350
$lnGDPPC_{it-1}$	0.4115	0.3001	0.1718
$lnCOP_{it-1}$	−0.1839*	0.0993	0.0654
Short – Run Coefficient			
$\Delta lnAPP_{it-1}$	−1.2751	2.9775	0.6689
ΔIR_{it-1}	−0.0028	0.0094	0.7606
ΔGDS_{it-1}	0.0214	0.0148	0.1497
$\Delta lnCPI_{it-1}$	−1.0746	1.0851	0.3231
$\Delta lnGDPPC_{it-1}$	−0.5381	0.2147	0.0130
$\Delta lnCOP_{it-1}$	0.2222***	0.0284	0.0000
Constant	0.8441***	0.1714	0.0000
ECT	−0.3013***	0.0581	0.0000

Note(s): "***" denotes significance at the 1% level
Source(s): Authors' calculations based on using *R* program

significant at the 0.01 level, with coefficients of 2.0275 and 0.1054, respectively, indicating a strong positive relationship with the stock market index. Additionally, the crude oil price $(lnCOP_{it})$ is significant at the 0.10 level with a coefficient of −0.1839, suggesting an inverse relationship with the stock market index. Conversely, the variables for interest rate (IR_{it}), consumer price index $(lnCPI_{it})$ and gross domestic product per capita $(lnGDPPC_{it})$ are not statistically significant, implying no long-term equilibrium relationship with the stock market index in developed countries. These findings highlight that aging demographics and gross savings positively influence stock market growth, while higher crude oil prices negatively impact it. The lack of significance for interest rates, consumer price index and GDP per capita suggests these factors may not directly affect the stock market in the long run for developed countries, or their effects are captured through other variables. Overall, the significant ECT coefficient underscores the model's robustness in adjusting short-term disequilibria and maintaining the stability of long-term relationships.

In the case of developing countries, Table 6 reports the results of the estimated long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1). The ECT coefficient is found to be −0.3158, statistically significant at the 0.01 level, indicating short-term adjustments to restore long-term equilibrium at a rate of 31.58% per period. Examining the long-term cointegration results, we find that the consumer price index and crude oil price are statistically significant at the 0.01 level, with coefficients of 0.7679 and 0.6646, respectively. This suggests a positive long-term relationship between the stock market index and both the consumer price index and crude oil price. Additionally, the gross domestic product per capita is statistically significant at the 0.10 level with a coefficient of −0.2703, indicating an inverse relationship with the stock market index in the long run. However, the variables for the ratio of elderly to population, interest rate and gross savings level are not statistically significant, indicating no significant long-term equilibrium relationship with the stock market index. These findings imply that, in developing countries, the consumer price index and crude oil prices positively influence stock market performance, while higher GDP per capita has a negative impact. The lack of significance for other variables suggests their effects might be either indirect or captured by other factors within the model.

Table 6. Results of long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1) for developing countries

Variable	Coefficient	Standard error	*p*-value
Long – Run Coefficient			
$lnAPP_{it-1}$	0.2690	0.4480	0.5488
IR_{it-1}	0.0008	0.0069	0.9060
GDS_{it-1}	−0.0084	0.0200	0.6718
$lnCPI_{it-1}$	0.7679***	0.1430	0.0000
$lnGDPPC_{it-1}$	−0.2703*	0.1620	0.0966
$lnCOP_{it-1}$	0.6646***	0.1690	0.0001
Short – Run Coefficient			
$\Delta lnAPP_{it-1}$	6.0139*	3.0674	0.0512
ΔIR_{it-1}	0.0164	0.0190	0.3882
ΔGDS_{it-1}	0.0237**	0.0111	0.0348
$\Delta lnCPI_{it-1}$	−0.0389	0.4635	0.9331
$\Delta lnGDPPC_{it-1}$	0.6420***	0.2278	0.0053
$\Delta lnCOP_{it-1}$	−0.0518	0.0971	0.5941
Constant	1.5984***	0.4334	0.0003
ECT	−0.3158***	0.0811	0.0001

Note(s): "***" denotes significance at the 1% level
Source(s): Authors' calculations based on using *R* program

Finally, Table 7 reports the results of the estimated long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1) to analyze the impact of the elderly population on the stock market for economies in transition countries. The ECT coefficient is −0.3381, statistically significant at the 0.01 level, indicating that deviations from long-term equilibrium are corrected at a rate of 33.81% per period. Examining the long-term cointegration results, we find that the interest rate and the gross savings rate are statistically significant at the 0.01 and

Table 7. Results of long-run ARDL model and ARDL short-run error correction model (1,1,1,1,1,1) for economies in transition countries

Variable	Coefficient	Standard error	*p*-value
Long – Run Coefficient			
$lnAPP_{it-1}$	−0.7187	0.6549	0.2737
IR_{it-1}	−0.0366***	0.0068	0.0000
GDS_{it-1}	−0.0214**	0.0090	0.0179
$lnCPI_{it-1}$	0.4178***	0.1097	0.0002
$lnGDPPC_{it-1}$	0.3907*	0.2296	0.0903
$lnCOP_{it-1}$	−0.1160	0.2039	0.5698
Short – Run Coefficient			
$\Delta lnAPP_{it-1}$	3.5544	3.3099	0.2841
ΔIR_{it-1}	0.0030	0.0032	0.3482
ΔGDS_{it-1}	0.0091*	0.0053	0.0909
$\Delta lnCPI_{it-1}$	0.2688	0.3628	0.4596
$\Delta lnGDPPC_{it-1}$	0.1406	0.2068	0.4972
$\Delta lnCOP_{it-1}$	0.2699**	0.1081	0.0133
Constant	0.4089	0.2824	0.1491
ECT	−0.3381***	0.0771	0.0000

Note(s): ***, ** and * denote significance at the 1%,5% and 10% levels, respectively
Source(s): Authors' calculations based on using *R* program

0.05 levels, with coefficients of −0.0366 and −0.0214, respectively. This suggests an inverse long-term relationship between the stock market index and both the interest rate and gross savings rate. Additionally, the consumer price index and the gross domestic product per capita are statistically significant at the 0.01 and 0.10 levels, with coefficients of 0.4178 and 0.3907, respectively, indicating a positive long-term relationship with the stock market index. Conversely, the proportion of the elderly population and crude oil price are not statistically significant, implying no significant long-term equilibrium relationship with the stock market index. From these results, it is evident that the ratio of the elderly population affects the stock market index only in developed countries. In contrast, in developing countries and economies in transition countries, the proportion of elderly people does not have a significant impact on the stock market index. This highlights the varying influences of aging society on stock market performance across different stages of economic development, with other variables such as interest rates, gross savings rates, consumer price index and GDP per capita playing more significant roles in economies in transition.

5. Discussion

One of the key factors influencing stock market performance across different groups of countries is the proportion of the elderly population, which is a demographic indicator of an aging society. The analysis reveals that an increasing elderly population has a statistically significant positive impact on stock market indices, both in the global context and in developed countries specifically.

Globally, a 1% increase in the elderly population led to a 0.6658% rise in the stock market index, aligning with the life-cycle investment theory (Bakshi and Chen, 1994) and the findings of Boersch-Supan and Winter (2001). This positive relationship can be attributed to the investment patterns of older individuals as they approach retirement age. According to the life-cycle investment theory, individuals tend to shift their investment portfolios toward riskier assets, such as stocks, as they accumulate wealth and near retirement, contributing to increased demand for stocks and potential stock market growth (Bakshi and Chen, 1994; Quayes and Jamal, 2016).

The impact of an aging society on stock market performance is particularly pronounced in developed countries, where the elderly population proportion exhibited a strong positive effect on stock market indices, with a coefficient of 2.0275. This finding aligns with the life-cycle investment theory and highlights the potential consequences of demographic shifts in developed economies with aging populations, As a larger proportion of the population approaches retirement age, there may be increased demand for stock market investments, driving stock prices higher (Poterba, 2001). Our finding is also consistent with the results of Hettihewa *et al*. (2018).

Interestingly, the elderly population proportion did not exhibit statistical significance in developing countries or economies in transition countries. This could be due to various factors, such as differences in investment behavior, retirement planning practices, or the availability and attractiveness of alternative investment options in these economies (Buchmann *et al.*, 2023; Lusardi and Mitchell, 2011). The effects of an aging society on stock market performance have important implications for policymakers, financial institutions and individual investors alike. Governments and policymakers in countries with aging populations may need to consider measures to ensure the sustainability of retirement systems and encourage adequate savings and investment for retirement (Bloom *et al.*, 2010; Bosworth *et al.*, 2004). Financial institutions and asset managers may need to adapt their products and services to cater to the investment needs of an aging population, potentially offering more retirement-focused investment options or advisory services (Sialm *et al.*, 2015; Horneff *et al.*, 2015).

Furthermore, individual investors should be aware of the potential impacts of demographic shifts on stock market performance and consider adjusting their investment strategies accordingly. Those nearing retirement age may benefit from increasing their exposure to stocks, while younger investors may need to factor in the potential effects of an aging society on stock market dynamics over the long term (Gomes and Michaelides, 2005; Cocco *et al*., 2005).

Overall, the analysis highlights the significant role that an aging society plays in shaping stock market performance across different groups of countries, particularly in developed economies. Addressing the challenges and opportunities posed by demographic shifts will be crucial for maintaining stable and sustainable financial markets in the face of an aging global population (Poterba, 2001).

6. Conclusion and policy implications

The aging population globally affects economies, societies and wealth, impacting retirement savings and investment patterns, notably in stocks. This study explores this impact on the global stock market, examining macroeconomic factors in developed, developing and economies in transition countries. Using data from 10 countries per group from 1991 to 2020, it analyzes variables like the aging per population, GDP per capita, gross savings rate, interest rates, consumer price index and crude oil price. Through tests for data stability and panel analysis, the study confirms long-term relationships and employs the panel ARDL model for detailed examination.

Ensuring data stability is crucial in panel analysis to avoid misleading results. Using standard tests, the study finds some variables like the aging population and interest rates are stable, while others like GDP per capita and oil prices require adjustment. With stable data, the panel ARDL model uncovers significant impacts of variables like the aging per population, interest rates and consumer price index on the global stock market. However, variables like gross savings rate, GDP per capita and crude oil price show no significant influence on stock markets.

Examining country groups by development level reveals varying impacts. In developed countries, aging per population significantly affects the stock market, aligning with previous research. Yet, in developing and economies in transition countries, aging per population has less impact on stock markets. This nuanced understanding underscores the need for proactive policies to address challenges posed by aging per population in economies and societies. Such measures are essential for maintaining economic stability and growth amid demographic shifts.

To address the challenges and opportunities posed by an aging global population, policymakers should consider implementing a range of measures. Firstly, governments should prioritize the sustainability and adequacy of retirement systems, ensuring that the elderly have access to sufficient retirement income and can maintain their desired standard of living. This could involve reforms to pension systems, encouraging greater personal savings and investments during working years, and promoting financial literacy programs focused on retirement planning.

Additionally, policymakers should aim to foster an environment conducive to stock market investment by the elderly population, particularly in developed countries where the impact of aging on stock markets is more pronounced. This could involve measures such as tax incentives for retirement accounts, streamlining investment processes and providing educational resources to help older individuals navigate investment opportunities. Furthermore, collaboration between policymakers, financial institutions and asset managers is crucial in developing tailored financial products and services that cater to the unique needs and risk profiles of an aging population. This might include retirement-focused investment funds, annuity products, or advisory services that help individuals manage their portfolios effectively during retirement. Lastly, policies should be implemented to facilitate the integration of the elderly into the workforce and promote entrepreneurship opportunities, enabling them to contribute to economic growth and potentially mitigate the impact of reduced savings and investments associated with an aging population.

For future research directions building upon this study's findings, it is suggested to expand the analysis by incorporating more granular data specifically related to the elderly population. This could include variables such as their savings rates, investment dividend income and factors affecting their financial stability like life insurance, social security and pension systems. Incorporating such data could provide deeper insights into how the changing financial circumstances of the elderly directly impact stock market dynamics. Additionally, conducting a study that categorizes and compares the impact of an aging society on stock markets before and after major economic events or crises on a global scale could be beneficial. Stock prices are heavily influenced by news and events, so analyzing the effects of an aging population during different economic periods (pre-crisis, crisis and post-crisis) could reveal variations in the relationship and potential changes in investment behavior among the elderly in response to economic shocks. This comparative analysis could shed light on how aging demographics interact with broader economic trends and events, offering valuable insights for policymakers, investors and researchers alike.

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