INTERNATIONAL MONETARY FUND

Aging Gracefully: Steering the Banking Sector through Demographic Shifts

Patrick A. Imam and Christian Schmieder

WP/24/118

2024
JUN

WORKING PAPER

 WP/24/118

IMF Working Paper
Institute for Capacity Development

Aging Gracefully: Steering the Banking Sector through Demographic Shifts

Prepared by Patrick A. Imam and Christan Schmieder*

Authorized for distribution by Mercedes Garcia-Escribano

June 2024

ABSTRACT:

We analyze how aging populations might affect the stability of banking systems through changes in the balance sheets and risk preferences of banks over the period 2000-2022. While the anticipated decline in maturity transformation due to aging hints at a possible reduction in risk exposure, an older population may propel banks towards yield-seeking behaviors, offsetting the diminishing prominence of conventional lending operations. Through a comprehensive examination of advanced economies over the past two decades, our findings reveal a general enhancement in bank stability correlating with the aging of populations. However, the adaptive responses of banks to these demographic changes are potentially introducing tail risks. Given the rapid global shift towards aging societies, our analysis highlights the critical need for policymakers to be proactive and vigilant. This is particularly pertinent considering historical precedents where periods of relative stability have often been harbingers of emerging risks.

RECOMMENDED CITATION: Patrick A. Imam and Christian Schmieder, 2024, "Aging Gracefully: Steering the Banking Sector through Demographic Shifts" IMF Working Paper No. 24/118.

JEL Classification Numbers:	G21, J11, G01, G28, G32, B26
Keywords:	Aging; Demographics; Bank risk-taking; Financial Stability
Author's E-Mail Address:	Pimam@imf.org ; Christian.Schmieder@bis.org

* Patrick A. Imam (Joint Vienna Institute and International Monetary Fund); Christian Schmieder (Bank for International Settlements). The views expressed in them are those of the authors and not necessarily the views of the BIS or the IMF, their executive boards, or their respective managements.

WORKING PAPERS

Aging Gracefully: Steering the Banking Sector through Demographic Shifts

Prepared by Patrick A. Imam and Christian Schmieder [1]

[1] The authors would like to thank Claudio Borio, Udaibir Das, Sebastian Doerr, Max Fandl, Jon Frost, Gaston Gelos, Divya Kirti, Kangni Kpodar, Hyun Song Shin, Koji Takahashi, Etienne Yehoue and BIS seminar participants on February 26. The views expressed in them are those of their authors and not necessarily the views of the BIS or the IMF. The usual disclaimer applies.

Contents

Executive Summary

The global trend of aging populations, especially in advanced economies, has profound implications for the financial sector landscape. While the ramifications of an aging population on life insurance and pension fund risk profiles have garnered attention within the economic profession, the specific impacts on banking systems necessitate further exploration. To date, only a few inquiries into this domain have taken place, largely confined to bank-level analyses within national contexts, notably in Japan and the United States. Our study endeavors to fill this lacuna by scrutinizing how demographic aging influences the stability of banking systems across advanced economies.

Aging populations compel banks to recalibrate their operations, with consequential effects on both their assets and liabilities. The traditional role of banks in maturity transformation is expected to decline as the population ages, given that demand for credit is lower for older households and firms in aging countries, prompting banks to pursue alternative avenues. These adjustments may encompass a reduction in loan offerings, augmenting investments in government bonds and other securities, diversification into novel financial ventures and expanding internationally. While these strategic shifts might unlock new revenue streams, they also harbor potential risks to financial stability.

Our research, spanning banking systems in advanced economies from 2000-2022, employs a blend of descriptive and econometric analyses to gauge the demographic aging impact on banks' balance sheets, risk propensities, and the overarching stability of the banking sector. The findings – recognizing the caveat that it is very challenging to control for the various factors that are at play – reveal a bifurcated effect: on the one hand, aging leads to a decrease in the average solvency risk within the banking sector, attributed to a diminished demand for loans—which is a historically frequent precursor to banking crises; conversely, there's an increase in tail risks, attributed to banks channeling excess deposits into unfamiliar and potentially risky activities.

The presence of potential tail risks for banks in aging societies underscores the critical need for vigilant policy-making and strategic foresight as populations age and, in some cases, diminish. Although the risks posed by aging demographics may not be immediate, their gradual evolution through indirect channels is making them less visible compared to traditional factors influencing bank solvency. Larger banks with their global footprints, may possess the resilience to navigate these demographic shifts through diversifying their activities and expanding geographically if not managing them strategically. However, smaller banks may face considerably more hurdles in adapting to these demographic transformations.

This research aims to enhance the understanding of and preparedness for the nuanced interplay between demographic shifts and potential adaptations in bank behaviors over the medium to long term. Employing scenario analysis emerges as a useful tool for regulators and banking supervisors to scrutinize the extent of underlying vulnerabilities. Moreover, banks themselves will have to critically evaluate their future strategic orientations. This includes strategies for securing deposit funding in an era where wealth transitions from baby boomers to millennials and Generation Z, who may harbor distinct perspectives on lifecycle finances and wealth management. Notably, forward-thinking initiatives undertaken by private and public entities in Japan, Europe, and other Asia countries (see UK FCA for Europe and HSBC for Asia, for example) serve as proactive responses to impending demographic and financial shifts.

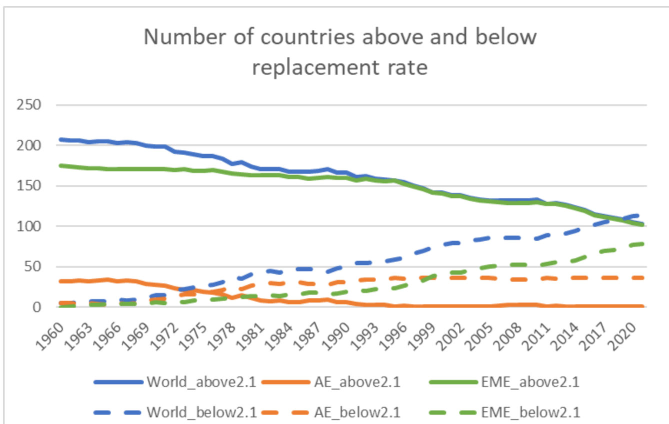
I. Introduction

The global demographic landscape is undergoing a transformative shift towards an aging population, fundamentally altering population compositions and, ultimately, influencing total population sizes. Currently, over two-thirds of the world's population live in nations where fertility rates fall beneath the replacement level of 2.1 births per woman. This trend spans across the largest 15 global economies, and transcends geographical and developmental boundaries, including China and India. Since 2019, more countries exhibit fertility rates below the replacement threshold than above it (Figure 1). This shift is a result of a two-century old demographic transition characterized by decreasing mortality and fertility rates (Lee, 2003, 2015).

In this study, we rely on demographic projections by the United Nations (UN) to 2100, confirming that the aging phenomenon is leading to a gradual increase in the global median age, from 30 years at present to 36 in 2050 and 42 by 2100.[1] UN population forecasts are typically utilized in international studies due to their consistency, standardization, and global coverage—including for countries with limited local data capabilities—which is particularly advantageous for panel data analysis. These forecasts offer a uniform methodology across countries, facilitating direct comparisons and providing long-term projections. According to the UN data, the average life expectancy, around 74 in 2022, is projected to reach 77 by 2050, and 82 by 2100. With this, the share of the elderly is projected to increase from 10 to 24 percent by 2100, and the world population is, on current trends, forecasted to peak by 2090, before declining by the end of this century (Figure 2).

Figure 1: Fertility rates have fallen substantially over time

In 2019, the share of countries below the replacement rate (dashed blue line) surpassed those with fertility rates above 2.1 (solid blue line)



AE: Advanced economies; EME: Emerging market and low-income economies

Source: World Bank (Fertility rate, total (births per woman) | Data (worldbank.org)), mainly based on UN projections.

[1] While forecasts assume smooth developments in fertility and mortality rates, as well as migration patterns—the three main drivers of demographic change—they miss shocks like the Covid-19 pandemic and country-specific patterns, like the well documented "deaths of despair" by Case and Deaton (2020). In the US, American working-class men have been seen a regression in their life expectancy, due to the opioid epidemic, suicides and alcohol.

Alternative forecasts by other bodies such as the International Institute of Applied Systems Analysis (IIASA) and the Institute for Health Metrics and Evaluation (IHME) at the University of Washington exist, with the latter two indicating a slightly more pronounced aging trend. These forecasts predict a commencement of global population decline from the 2070s and 2080s respectively. Therefore, our analysis may marginally underestimate the potential impact of aging should these alternatives be closer to the actual outcome, at least at the aggregate level.

We also recognize that the UN projections may marginally deviate from the forecasts emanating from National Statistical Institutes (NSIs), driven by their scope, methodologies, and underlying assumptions. The UN employs a uniform cohort-component method across all nations, which relies substantially on historical data and expert judgment, assessing fertility, mortality, and migration rates. Conversely, NSIs concentrate on specific national contexts, leveraging rich local datasets including census data, surveys, and administrative records. This localized focus enables NSIs to incorporate additional demographic factors such as health, education, and employment trends into their projections. NSIs have the flexibility to adapt their models to mirror recent national developments and particular regional conditions, often using a variety of statistical techniques tailored to their distinct data landscapes. NSIs also tend to make assumptions that are more reflective of current national policy shifts and economic conditions, allowing for more frequent updates to their projections in response to new information or significant policy alterations.

In conjunction with the aging phenomenon, an increasing number of nations are confronting absolute declines in population, although the extent of these declines varies significantly across different countries (Figure 2, blue line in top right panel). UN projections indicate that by the mid-21st century, 61 countries—constituting a quarter of all nations worldwide—are anticipated to see their populations decrease by at least 1 percent from their 2022 levels. Therefore, the demographic composition is undergoing profound transformations with a clear trend towards aging observable on a global scale (Figure 2, bottom right graph), and dramatic changes for specific countries such as Japan (Figure 2, bottom left graph).

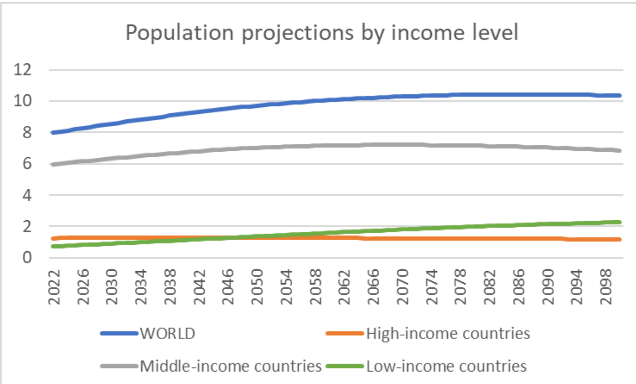
Population trends exhibit considerable variability across nations, as illustrated in Figure A2.1. Declining populations are largely attributed to low fertility rates and, in certain instances, high emigration rates as well. Notably, nations such as Bulgaria, Latvia, Lithuania, and Serbia are expected to experience substantial population decreases exceeding 20 percent by mid-century (UN, 2022). Looking further ahead, the populations of several countries, including Albania, Bulgaria, Serbia, and the Republic of Korea, are projected to diminish by more than 50 percent by the end of this century. China's population is forecasted to contract by 46 percent by 2100—a decline more pronounced than that of Japan, which is projected at 41 percent.[2] Other large economies, such as Italy, Spain, and Germany, are also expected to encounter notable population reductions. In contrast, the United States is projected to maintain a relatively youthful demographic profile, with its population anticipated to grow by 16 percent by 2100 compared to 2022.

[2] Recent projections by a research team at the Shanghai Academy of Social Sciences suggest an even steeper decline for China, from its current 1.4 billion to merely 525 million by 2100 (Peng, 2022).

Figure 2: Growth in world population is projected to come to a halt by 2090

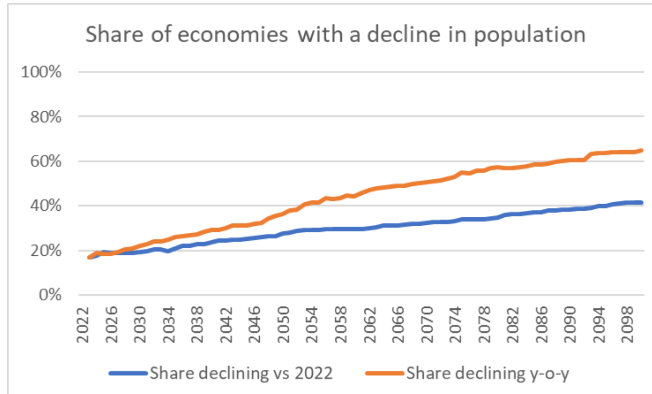
World population is projected to reach its peak in 2087 at 10.4 billion.

Billion

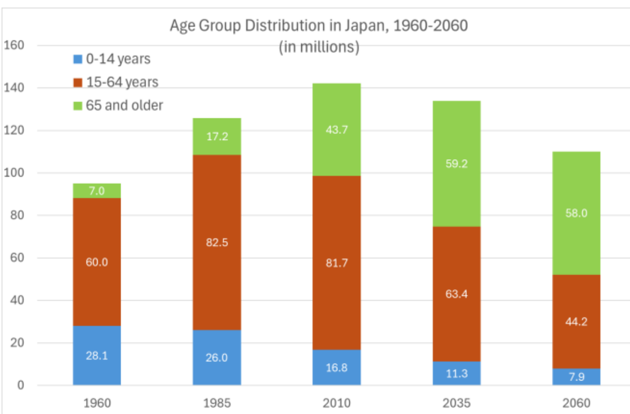


The share of countries with y-o-y population declines will increase from currently 17 to 65 percent by 2100.

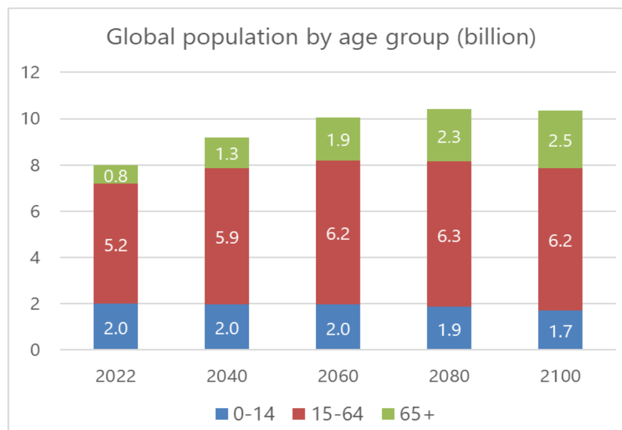
Percent



Japan is leading the aging process, with a population that is projected to age and shrink significantly at the same time.



At the global level, the share of elderly is projected to increase from 10 percent at present to 24 percent in 2100.



Source: United Nations (2022) and Japan Statistics Bureau, National Institute of Population and Social Security Research (bottom left graph).

The trends of aging and subsequent population contraction pose significant challenges to the economy, many of which have been studied (see Aksoy et al., 2019, Auclert et al., 2022). Elderly populations have distinct requirements and exhibit different consumption and saving patterns, which can significantly impact potential economic growth and escalate fiscal expenditures, notably in healthcare (see Roy, 2022 for a comprehensive overview). Whereas youthful populations can harness a "demographic dividend", older societies are likely to suffer from a “demographic tax”, where the economic benefits are outweighed by the costs associated with an aging population (Lee and Mason, 2017).

The fiscal implications of demographic transitions have been thoroughly investigated, encompassing a wide range of issues from the sustainability of public finances to the pressures on social security systems (see Bloom et al., 2010, and Horioka, 2020). Similarly, the effects of demographic changes on potential economic growth have been a focal point of research, with studies delving into how aging populations might impede long-term economic expansion (e.g., Bodnar and Nerlich, 2022; Kotschy and Blom, 2023).

Moreover, the ramifications of these demographic shifts for monetary policy have gained attention, with analyses exploring how aging could influence interest rates, inflation, and monetary policy frameworks (e.g., Imam, 2014; Goodhart and Pradhan, 2019).

While economists have studied how population aging impacts financial stability for certain segments of the market – such as the impact of "longevity risk" on the life-insurance and pension funds (see GFSR, 2012)[3], the risks faced by banking systems have largely been ignored thus far, with a few exceptions. The oversight may appear surprising, given the profound influence that aging populations could exert on savings, investment behaviors, and risk preferences within the banking sector. Yet, there are plausible reasons for this. First, the process of aging unfolds gradually and predictably, starkly contrasting with the volatile nature of banking crises, which are precipitated by a myriad of complex factors (Borio, 2012). This disparity makes it challenging to directly associate changes in banking stability risks with demographic aging, despite the latter's increasing relevance since the 1990s and especially after 2010 (Figure 1). Secondly, the primary focus of financial regulators and scholars has been on the immediate aftermath and impacts of successive financial upheavals, including the Great Financial Crisis, the Euro Area Sovereign Debt Crisis, and the Global Pandemic. This concentration on short-term crises has inadvertently sidelined the investigation of longer-term demographic trends. This contrasts with climate risk, another significant structural trend, which has successfully captured widespread attention within the financial community, probably because its impact is already becoming visible.

This study is therefore, to our knowledge, the first one scrutinizing the influence of aging on banking stability at the international level. We first examine conceptually the necessity for banks to recalibrate their business models in response to aging societies, moving away from traditional maturity transformation—a function that diminishes in relevance in older demographics.[4] This transition towards alternative activities may introduce new risks, as shown in past crises like the Great Financial Crisis (GFC), where subprime debt was held by many foreign banks, even if those crises were not primarily driven by aging. Yet, aging populations could increasingly uncover risks with the associated changes in banks´ business model. Regional banks, given their geographic concentration, may reduce their loan portfolios in areas with aging and shrinking populations.

Our research suggests that while the general level of banking stability risk might decrease in aging countries, the propensity for tail risks could concurrently escalate. To uncover potential transmission channels, we explore through the lens of the life-cycle hypothesis how demographic aging influences the financial positions of households, corporations, and consequently, banks. Recognizing the underlying caveats, especially the multifaceted nature of influencing factors, the relatively recent acceleration in demographic aging and relatively small sample, our findings highlight a critical concern: the diminishing

[3] Note that we will not focus on whether human longevity can be extended (see Olshansky and Carnes, 2019 for the most recent work on this), as this is beyond the scope of this paper.

[4] As many upcoming pensioners have paid off their mortgage, the sensitivity of credit demand to interest rates diminishes. Older households also shift to safer assets, enforcing the link between households and the sovereign, yielding new risks and a potential doom-loop. Additionally, older households face other risks such as longevity risk, which, if realized, could impact sovereign debt and equity pricing, as well as financial institutions like insurance companies (see GFSR, 2012, Imam, 2013).

role of banks in maturity transformation within aging societies. This adaptation compels banks to explore new avenues for revenue generation, such as increased investments in securities like government bonds, branching into new business sectors, and penetrating international markets. We posit that these strategic adaptations are likely to amplify tail risks, although these conclusions will benefit from further studies and longer-time periods to be substantiated.

Our novel findings at the country level for the universe of advanced economies are consistent with previous investigations looking at the regional impact of aging within a domestic context (Doerr et al., 2022, IMF, 2017). Doerr et al.'s (2022) investigation into the U.S. banking landscape in 2022 highlighted a tangible link between demographic aging and a propensity towards more lenient lending standards, such as higher loan-to-income ratios, thus elevating risk profiles. In a parallel vein, an analysis by the International Monetary Fund in 2017 shed light on the challenges faced by regional banks in Japan, where aging demographics have led to shrinking net interest margins and a decline in credit demand, adversely affecting bank profitability. As a response to these pressures, some regional banks have pivoted from traditional lending-focused models towards a greater emphasis on securities, although this strategy shift does not necessarily address underlying profitability issues.

The remainder of the paper is organized as follows: Section II examines potential transmission channels through which demographic shifts affect bank stability. Section III describes our data sources and models. Section IV presents our empirical findings and robustness tests. Section V concludes with policy implications.

II. Theory suggests that the impact of aging on bank stability is ambiguous

As a starting point, we explore possible channels through which the stability of banking systems might be affected in aging advanced economies. As outlined below, conceptual considerations suggest that the ultimate effect of aging on banks is complex and multifaceted.

A. Structural change in banks' balance sheet (balance sheet mismatch)

Modigliani's (1975) life-cycle hypothesis suggests that individuals manage consumption over their lifespan. This typically entails accumulating debt in early adulthood when earnings are lower, saving during peak income years, and subsequently utilizing those savings during retirement, leading to a hump-shaped pattern of wealth accumulation.

However, recent studies challenge the expected rapid wealth depletion post-retirement, uncovering a "Wealth Decumulation Puzzle" where retirees maintain or even increase their wealth, impacting bank deposit levels. In a study using microdata from various European countries, Horioka and Ventura (2022) reveal that less than half of the retirees are depleting their wealth and that on average, retirees slightly increase their wealth. Several factors contribute to this phenomenon, including the desire to leave a bequest, the support of substantial public pension schemes, and the reluctance of elderly homeowners to liquidate or leverage their real estate assets. These observations, consistent with Horioka's (2020) and Horioka et al.'s (2021) findings in the Japanese context, suggest that bank deposit levels are likely to remain elevated in aging societies (see also Figure 3b). However, as demographic shifts progress, a trend towards more pronounced wealth decumulation may emerge, particularly with the impending wealth transfer from the baby boomer generation to Generations X, Y, and Z, who may adopt different perspectives on financial management throughout their life cycles. Moreover, the increasing dependency ratio could exert considerable pressure on public pension systems for future retirees, potentially necessitating a more rapid decumulation of private savings.

The lifecycle composition of company balance sheets, particularly for small and medium-sized enterprises (SMEs), is closely tied to household financial behaviors. In an aging environment, there's a discernible inclination towards diminished investment activities, culminating in a lowered demand for credit facilities. This trend can be attributed to a multitude of factors (see Jones, 2022): firstly, the labor-capital ratio experiences a downturn as the segment of retirees expands more rapidly than the influx of new entrants into the workforce; secondly, there's a noticeable decrease in credit demand among the older demographic, largely because their requirements for housing or durable goods financing are less pronounced, further compounded by regulatory constraints tied to the borrower's age that cap lending terms (for instance, in Slovakia, as highlighted by Jurca et al., 2020, loans must be settled by the age of 70); and thirdly, corporate entities tend to scale back on borrowing, driven by stagnation or contraction in domestic market growth, as elucidated in the works of Imam (2013) and Mason et al. (2019).[5] Japan presents a compelling case in point, where a substantial number of companies, especially those listed on the Tokyo Stock Exchange, have scaled down their borrowing activities, with a notable portion reporting a net debt figure of zero (Kim et al., 2023).

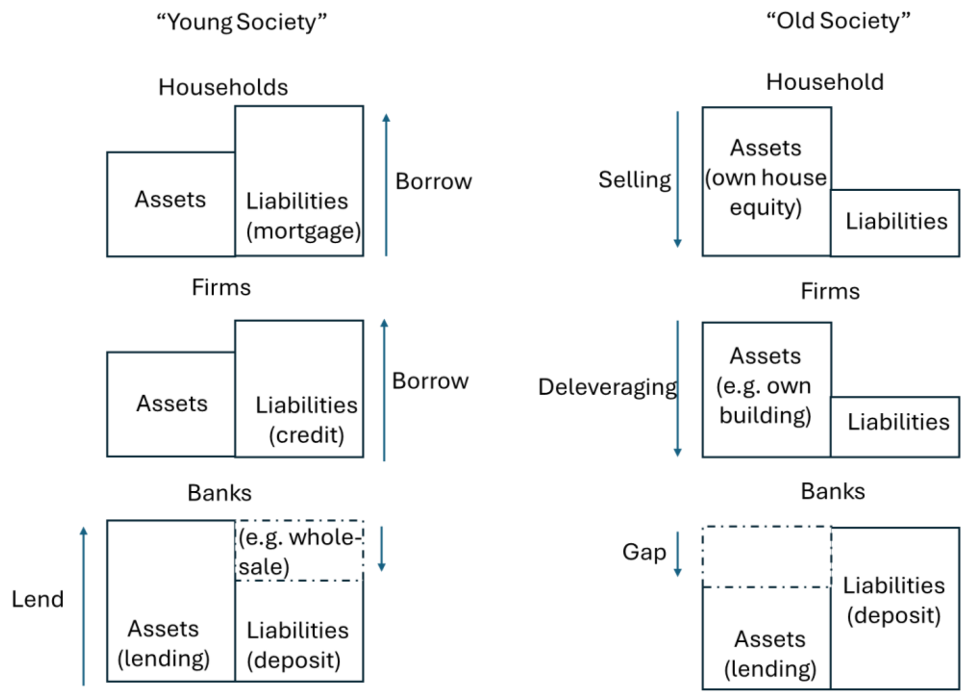
The interplay between aging demographics and economic dynamics highlights a critical trend: an older population leads to decreased productivity and investment demand, with studies indicating that a 10 percent rise in the share of individuals aged 60 and above correlates with a 5.5 percent drop in per capita GDP growth (GFSR, 2017). This finding suggests that the aging population contributes more significantly to a reduction in productivity than to changes in labor force participation, offering a new perspective on the aging-related economic growth slowdown.

Additionally in aging societies, the inclination towards secure, long-term investments amplifies, resulting in a shift from short to long-term maturities (GFSR, 2017). This dynamic contributes to the flattening of the yield curve, which can adversely affect the profitability of banks. A flatter yield curve places significant pressure on banking sector earnings. This is particularly acute for smaller, deposit-reliant banks with limited diversification. It should be highlighted that the impact of aging can be reduced by augmenting the retirement age, although there are political headwinds in many countries to do so.

[5] From a macroeconomic perspective, the gap between the supply of savings and the demand for credit ('liquidity trap') that has characterized many AEs may be driven in (large) part by demographic changes.

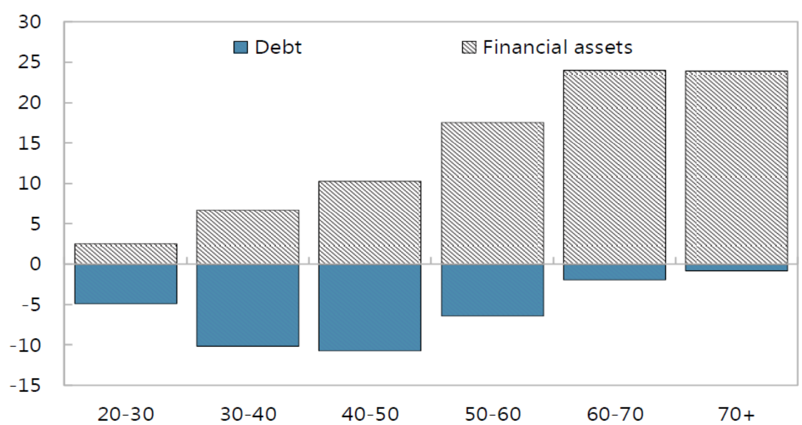
Banks' balance sheets closely mirror the financial behavior of households and non-financial firms (Figure 3a), and depend on the specific demographic trends, other regional factors, and banks' business models (see Jones, 2022).

Figure 3a: Schematic overview of the impact of aging on bank business models



(Source: authors)

Figure 3b: Japanese households´ financial assets and debt by age group in 2016 (IMF, 2017) (figures in millions of Japanese yen)



Sources: Family Savings Survey; and IMF staff calculations.

Despite these variances, certain common trends emerge as banks adapt their strategies to align with customer needs and the changing dynamics of the market:

An increase in Bank Deposits: During the phase when populations transition towards aging, there is a tendency for wealth accumulation in anticipation of the forthcoming retirement and healthcare expenses. During this phase, one should expect an accumulation of bank deposit (see Doerr et al., 2022).[6]

Contraction of Loan Portfolios: Despite marginal increases in demand for loans catering to the elderly, such as reverse mortgages or healthcare financing, these increases are generally insufficient to offset the overall decline in credit demand (see Hanewald et al., 2022).

As depicted in a stylized manner in Figure 3a and in Figure 3b, the cumulative impact of these trends suggests a secular rise in the deposit-to-loan ratio, i.e., an increased proportion of deposits relative to loans. A critical challenge becomes the effective management or "recycling" of these deposits. Over the longer term, as these deposits are likely reduced or depleted, the asset-liability imbalance may be reduced or even disappear. However, new risks may emerge during the transitory phase, which is the focal point of our analysis.

It is important to recognize that a decrease in bank lending does not necessarily suggest a diminished role for financial intermediation. If banking institutions were to curtail their lending activities, other financial institutions could step in, including through cross-selling channels. In fact, at least some of the riskier financial activities may migrate to non-bank entities, which could mitigate or escalate risks within the broader financial system. For instance, insurance companies in aging societies might expand their offerings of annuities and life insurance products, which are essential for individuals´ planning for financially secure retirements. Similarly, asset management firms might increase their focus on managing retirement portfolios with a variety of investment funds designed to generate long-term, stable returns suitable for retirees. As a result, while banks may see a relative decline in their financial services in aging regions or countries, non-bank institutions may gain prominence, bringing with them a different set of risks and regulatory challenges. This shift not only impacts the financial services landscape but also necessitates adjusted oversight and regulatory frameworks to address the new risks posed by the growing role of non-banks in critical financial activities. But as the paper is focused on the banking system, this is beyond the scope of our analysis.

B. Changes in Risk taking behavior

The propensity for risk-taking among individuals is shaped by a multitude of unique factors, including income, wealth, risk tolerance, and age, as delineated in the seminal work by Schoemaker (1993). [7]

[6] While beyond the scope of this paper, it is likely that the liability structure of banks in aging societies becomes more deposit dependent, and less wholesale dependent. As deposits tend to be sticky, and as banks cannot easily recycle the deposits into credit when demand for loans is low, the easiest way to match assets and liabilities in that case is by reducing (risky) wholesale funding. This could be stabilizing in terms of financial stability.

[7] Risk appetite is expected to rise during upswings and fall during downswings. There are also cyclical elements in risk-taking that can be overwhelming, such as for individuals who had their formative years during the Global Financial Crisis, creating cohort effects. Mounting empirical evidence from the behavioral finance literature suggests that living through a prolonged period of macroeconomic slump distorts risk preferences permanently, leading to a systematic overstatement of risk (see Hasegawa, 2011). This is because individuals' risk preferences are not stable but differ depending on the macroeconomic history they experienced over the course of their lives. Perception of risk can be systematically overstated ("fearing fear itself"), leading individuals' (and cohorts more generally) discounting fundamentals at a higher rate, thereby overpricing risk (see also Haldane 2011; Malmendier and Nagel 2011; and Sunde, 2023 for a recent summary).

Generally, individuals with higher and more stable incomes exhibit a greater inclination towards risk-taking compared to their counterparts with lower and less predictable incomes. Likewise, wealthier individuals, who possess a stronger buffer against financial adversities, tend to display a higher tolerance for risk.[8]

Age significantly influences risk-taking behavior, with a discernible reduction in risk appetite as societies age, holding other factors constant, anchored in the life-cycle theory of risk, which suggests that older demographics progressively favor safer investment options (Modigliani, 1986), as risk aversion typically escalates with age. The increased risk aversion observed among the elderly, particularly around retirement age, is largely due to the constrained timeline available to recuperate from financial setbacks (Jianakoplos and Bernasek, 1998; Riley and Chow, 1992; Bakshi and Chen, 1994; Rolison et al., 2013).[9] Factors such as life transitions, shifts in motivation, and cognitive decline also contribute to this cautious approach, with cognitive aging being linked to a diminished propensity for risk-taking (Mather, 2006; Bonsang and Dohmen, 2015). Furthermore, the elderly's preference for liquidity over riskier investments marks a notable divergence from younger demographics.

The increasing risk aversion among households and firms (see Box 1) is significantly influencing the composition of banks' balance sheets. Given that the essence of banking involves maturity transformation, a decline in credit demand coupled with heightened risk aversion prompts several adjustments:

- **New Asset Allocation Strategies**: Banks are gradually modifying their business models to cater more to payment and transactional needs, moving away from traditional lending. This shift could involve a pivot towards income-generating assets such as fixed-income securities or an increased focus on fee-generating activities, which would help balance the reduced income from loans with the higher market risks involved. Furthermore, there is an anticipated increase in focus on retirement-related investment products to cater to the aging population's needs (Imam, 2013, GFSR, 2017).
- **Impact of Aging on Asset Quality**: Demographic changes, particularly the increase in the elderly population, can adversely impact the quality of bank assets. In regions with a higher proportion of elderly residents, there might be a decline in real estate values or extended selling periods, which in turn could diminish the value of banks' mortgage-backed assets (Doerr et al., 2022). Smaller banks, which often serve more localized markets, are especially vulnerable to the economic ramifications of aging in their regions due to their limited diversification.

[8] The view in the behavioral finance literature is that risk taking represents either a single personality trait or a small cluster of sub-traits (e.g., impulsivity and sensation seeking; Hansen and Breivik, 2001). Risk-taking or risk-aversion is, however, also context dependent (Schoemaker, 1990). Early studies showed that managers' attitudes toward financial risk differed from their attitudes toward personal and recreational risks (MacCrimmon and Wehrung, 1990).

[9] In the case of Japan for instance, the National Survey of Family Income and Expenditure confirms that Japanese households' financial assets peak in their 60s and decreases thereafter. They also cut the share of risky assets invested ahead of other "safe" assets. Besides the secular trends towards rising risk aversion, there is also a cyclical one (see Haswgawa, 2011; Imam 2013).

- **Adapting Product Offerings for Older Customers**: Banks may find it necessary to customize their services and products to better suit the needs of older clients. This could entail providing specialized financial advice, retirement planning products, and other services tailored to the unique requirements of an aging clientele.

The evolving shift towards more conservative investment behaviors and heightened risk aversion by households and firms has far-reaching implications for the broader financial markets and institutions, necessitating strategic adjustments and tailored offerings to meet the needs of an older demographic.

C. Impact of banks' balance sheet changes

The banking sector's traditional reliance on maturity transformation as the main source of income—characterized by the acceptance of short-term deposits for the purpose of extending longer-term loans—becomes less pronounced in aging societies. Moreover, the increased savings coupled with reduced demand for credit are likely to depress the equilibrium interest rate, thereby narrowing the spread between deposit and lending rates that banks rely on for profitability, further diminishing the appeal of traditional banking models (Summers, 2013). Moreover, the fixed costs associated with maintaining branch networks may likely become increasingly burdensome, a situation that is exacerbated by the rapid advancements in banking technology. In fact, Rachel and Summers (2019) examined the pronounced decline in neutral real interest rates across industrial economies, emphasizing the role of demographic changes alongside fiscal policies in driving this trend. Their comprehensive analysis, underpinned by econometric evidence and general equilibrium models, indicates that without the moderating influence of increased government debt, expanded pay-as-you-go pension schemes, and extensive government healthcare programs, these rates could have dipped into negative territory prior to the pandemic. The authors argue that aging populations have significantly influenced investment and saving behaviors, further exacerbating the drop in real rates. This study highlights the critical need for policy innovations to address the complex interplay between demographic dynamics and prolonged low interest rate environments.

Viewed from a static lens, the aging of populations might intuitively suggest a banking system inclined towards safety and reduced risk-taking. However, ensuring profitability in the face of these demographic and economic shifts will prompt banks to adapt their business models to sustain profitability, a trend well-documented in studies by Imam (2013), IMF (2017)[10], Heider et al. (2019) and Bubeck et al., (2020).

[10] While beyond the scope of this paper, the conduct of monetary policy is complicated in an ageing society as it has a direct impact on price development (see Imam, 2014). Maintaining price stability becomes more challenging for monetary policy as suggested by the experience of Japan over the last two decades (see Shirakawa 2011). The demographic shift (especially if it is accompanied by population decline) is likely to impact aggregate demand negatively, pushing prices down if aggregate supply does not fall commensurately. The need to resort to quantitative easing is in part a response to falling prices, with interest rates close to zero on their own not being able to stimulate demand sufficiently to generate inflation. Changes in the age structure of the population are also likely to change the monetary transmission mechanism. The demographic shift would tend to shift the relative importance of wealth effect channel and credit demand channel (see Bean 2004). Societies dominated by young households would tend to be more sensitive to interest rate changes, given the importance of smoothing consumption over the lifecycle. In ageing societies, wealth effects would gain increasing importance, since older households have less need to borrow. Indeed, lower interest rates could tend to dampen the demand of the elderly given their net creditor status (see Trichet 2007). (continued…)

Banks' risk-taking behaviors will be altered as they navigate pressures on their profitability, particularly in a low interest-rate environment. When interest rates are low, banks experience a compression in net interest margins—the difference between the income earned on assets and the cost of servicing liabilities—compelling them to seek alternative, higher-yielding investments, often steering them towards riskier assets (see Bubeck et al., 2020). This includes the acquisition of riskier financial instruments, such as high-yield bonds or complex derivatives, and by extending credit to less creditworthy borrowers. This strategic shift elevates the risk profile of their asset portfolios and exposes financial systems to heightened levels of credit and market risk. Moreover, banks may respond to persistent low rates by extending the maturities of loans or easing lending standards to attract a broader base of borrowers. While such practices can boost loan volumes, they inherently raise banks' exposure to credit risk, particularly if economic downturns impair borrowers' repayment capabilities. Additionally, the allure of cheap borrowing can encourage banks to increase leverage, potentially amplifying losses if investments falter.[11]

Concretely, the transformation in business strategies can either mitigate or amplify risks in several ways:

- **Consolidation of Banks** (cross-institutional linkages): To reap economies of scale and scope, banks may pursue mergers with other banking or financial institutions, including insurance companies. While potentially attractive at the regional level in areas impacted by aging, such strategies may raise concerns about creating entities that are "too big to fail" or "too complex to fail," particularly when larger, country-wide institutions are involved.[12]
- **Expansion into New Products** (cross-sector linkages): Banks operating in slow-growing or contracting markets might diversify into adjacent financial products. The expansion into new structured credit products by several European banks or their engagement in credit default swaps before the GFC resulted in considerable losses. Similarly, banks have ventured into realms like consulting services for specific professional sectors, as seen with smaller Japanese banks, introducing potential operational risks and stretching the competencies of both banks and supervisors.
- **Increase in Sovereign Exposure** (sovereign-bank linkages): With a decline in conventional lending sectors, banks may increasingly invest in government securities, perceived as a safe option for deposit allocation, although this strategy will not boost profitability. Moreover, this approach strengthens the sovereign-bank nexus, especially for smaller banks with limited options

This means that in case of a systemic shock, monetary policy may not be as effective in countering the shock (see also Baksa and Munkacsi, 2019).

[11] Changes in regulatory policies can also influence bank behavior in low-rate scenarios. Occasional regulatory relaxations intended to stimulate lending in sluggish economies can inadvertently foster further risk-taking. If not meticulously calibrated, such regulatory adjustments risk destabilizing the financial system, especially in scenarios where interest rates rise or market conditions deteriorate abruptly. In essence, the strategic adaptations of banks in low interest-rate environments necessitate careful oversight and robust regulatory frameworks to mitigate emerging risks and ensure systemic stability.

[12] A more concentrated banking system could also boost banks' profitability by providing banks with more market power.

for international diversification, thereby potentially constraining the fiscal authorities' capacity to act as a financial backstop during crises.

- **International Expansion** (cross-border linkages): To counterbalance the decline in domestic business, international banks seek diversification through cross-border lending, acquisitions, or expanding foreign branches and subsidiaries. This strategy, aiming to offset diminishing domestic business, is prevalent among banks from aging economies (e.g., Japanese banks in South-East Asia, Western European banks in Latin America and Eastern Europe). Diversification – often into markets with higher return but also higher risks – brings new risks, including unfamiliarity with specific credit or country risks and foreign exchange risks on both sides of the balance sheet. Banks also face geopolitical risks from such an overseas expansion, as evidenced by the experiences of foreign banks in Russia in 2022. For (smaller) banks unable to diversify overseas, the geographical concentration of their portfolio makes them more susceptible to regional economic downturns. This geographical focus, while beneficial for understanding local markets and customers, limits growth opportunities, and forces banks to manage the gradual decline.
- **Slower adoption of New Technologies** (operational risks): Banks, particularly smaller ones in aging societies, might lag in adopting new technologies and complying with evolving regulations due to resource constraints. A slower digital transformation, coupled with a customer base that may be less inclined towards technological adoption, can impact a bank's ability to attract and retain a younger clientele, further challenging its long-term viability.

In conclusion, our analysis has shed light on the complex macro-financial challenges faced by banks in societies that are both aging and experiencing population decline. These challenges are marked by a heightened sense of risk aversion and a low-growth environment that diminishes the appetite for risk among investors, as noted by Isa (2021). In such contexts, the typical procyclical approach to risk-taking may diminish, potentially reducing the influence of banks on the cyclicality of credit supply and liquidity, and consequently, on the amplitude of boom-and-bust cycles in asset prices.

As banks navigate these demographic shifts, their behavioral adjustment to sustain profitability in the face of demographic shifts may introduce new risks, which could escalate tail risks, especially as banks diversify into new activities and markets in search of growth opportunities.

III. Data and Model specifications

We propose to test two alternative hypotheses on the impact of aging on bank stability:

- **Hypothesis 1: Aging generally lowers bank financial stability risk.** This hypothesis suggests that the demographic shift towards an older population inherently leads to a more cautious approach to banking, with reduced risk-taking behaviors by both bank customers and banks themselves.
- **Hypothesis 2: Aging gives rise to potential tail risks, although the average risk might decrease:** This scenario could unfold as banks, in their quest for higher yields amidst a backdrop of decreased loan demand, engage in riskier investments or ventures, including overseas, accumulating latent risks that may only manifest during economic downturns or financial shocks.

To empirically assess these hypotheses, we undertake a comprehensive analysis across 28 advanced economies, covering the years from 2000 to 2022. The selection of countries and the period of study are detailed in Table A.1.2. This country-level analysis aims to elucidate the nuanced impacts of demographic aging on the banking sector's stability.

We run fixed effects panel regressions and operationalize aging through a binary variable that delineates countries experiencing demographic aging from those with relatively younger populations. Our foundational model uses (1) a specification that incorporates both country (i) and time (t) fixed effects. This approach allows us to isolate the impact of aging from other concurrent factors. We also introduce a post-GFC dummy variable, with a cut-off in 2010, acknowledging the significant structural changes within the financial system precipitated by the GFC. This includes the implementation of Basel III regulatory standards and the subsequent adaptation of banks' business models to the new regulatory landscape.

$$y_{i,t} = \alpha + \beta_1 Aging_{i,t} + Dummy_i + Dummy_t + Dummy_{postGFC} + e_{i,t} \qquad (1)$$

To ensure the robustness of our findings and accurately attribute variations in the dependent variables—which include changes in banks' balance sheet compositions, risk-taking behaviors, and overall banking system risk—to the effects of aging versus other macro-financial factors, we introduce an additional analytical layer, and run specification (2), controlling for macro-financial and banking system variables:

$$y_{i,t} = y_{i,t} = \alpha + \beta_1 Aging_{i,t} + \beta_{m1-3} Macro_{i,t} + \beta_{b1-2} Bank_{i,t} + Dummy_i + Dummy_t + Dummy_{postGFC} + e_{i,t} \qquad (2)$$

where:

- $Y_{i,t}$ is the dependent variable metric that captures changes in banks' balance sheets, risk taking and bank stability (see Table 1). Using alternative metrics for each dimension will increase the robustness of the results. These metrics are mainly sourced from vendor data (FitchConnect).

Table 1: Metrics to capture the effect of aging on bank balance sheets, risk taking and stability

Metric	Description of metric
Metrics to capture changes in bank balance sheets	
1	Deposits to total funding
2	Loans to assets
3	Deposits to loans deposits
Metrics to capture banks' risk taking	
1	Risk weight density (ie risk weight per unit of asset)
2	Return on equity
3	Credit loss rates
Bank stability metrics	

1	Banks' Z-Scores - A CAMEL-type metric that gauges the health of banks by country.[13] (World Bank)
2	Banks' price to book ratios – metric that compares the current market price of a company's stock to its book value, reflecting their earning capacity and solvency profile more generally.[14]
3	Banks' Expected Default Frequency (EDFs)[15] (Moody´s)
4	SRisk - A market-based metric of worst-case losses that considers interconnectedness risk.[16] (New York University[17])

In our evaluation of aggregate bank stability risks, we employ a multifaceted approach, incorporating both balance sheet-based indicators (Metric 1) and market-implied metrics of bank stability (Metrics 2-4), as detailed in Table 1. Balance sheet-based metrics are particularly adept at reflecting longer-term trends and are in harmony with the gradual nature of demographic aging. Nevertheless, they may not fully encapsulate short-term, non-linear stress events, which are more adeptly captured by market-implied metrics.

To this end, we integrate three non-linear metrics (Metrics 2-4) to gain a deeper understanding of the vulnerabilities inherent within the banking systems of the 28 analyzed countries to tail risks, especially in the context of their respective stages of aging. It's important to acknowledge the pro-cyclical behavior of market-based risk indicators, which tend to downplay risks during periods of economic expansion and amplify them during contractions.18 The analysis benefits from the complementary nature of the four metrics, enhancing the robustness and comprehensiveness of our study.

In addition, we have the following dependent variables:

- $\beta 1$ *Aging* is the differential effect between the oldest countries (for which the dummy variable Aging is 1) vs. the others, younger countries (for which Aging is 0) during the past 4-12 years; the aging metrics are sourced from the UN.
- Macro and Bank are vectors of relevant control variables for macroeconomic and bank characteristics conditions. On the macro side, we control for real GDP growth, general economic uncertainty, policy rates and the level of bank credit to GDP. To capture bank-specific characteristics, we control for bank leverage and profitability (including credit losses). These metrics are sourced from the IMF, BIS and vendor data and are all lagged by 1 year.
- $Dummy_i$ controls for country-specific fixed effects.
- $Dummy_t$ controls for time fixed effects.

[13] Z-score is estimated as (ROA+equity/assets)/sd(ROA); sd(ROA) is the standard deviation of ROA. It captures the probability of default of a country's banking system, calculated as a weighted average of the z-scores of a country's individual banks (the weights are based on the individual banks' total assets). Z-score compares a bank's buffers (capitalization and returns) with the volatility of those returns. It is estimated as (ROA+(equity/assets))/sd(ROA); sd(ROA) is the standard deviation of ROA. (Calculated from underlying bank-by-bank unconsolidated data from Bankscope). It is a probability of default, the higher, the worse.

[14] For further information see Bogdanova et al (2018), for example.

[15] A one-year Merton-model based probability of default for banking systems.

[16] SRISK measures the capital shortfall of a financial system conditional on a severe market decline, and is a function of its size, leverage and risk.

[17] We thank the New York University for providing us with country-specific time series.

[18] This results in a diminished relevance of financial market prices as indicators of fundamental values, such as expected returns or associated risks of underlying real economic activities (Brunnermeier et al., 2009).

Additional information on the definitions and underlying sources of all variables is provided in Table A.1.1 in the Appendix.

In our estimation, we explore two distinct dimensions of aging commonly employed in related research:

- Aging Metric 1: This ratio of the active population (aged 15-64) to the elderly population (aged 65+)[19] is used to assess the potential economic burden of an aging population on the working-age group, while simultanously capturing the degree of shrinking of the active population.
- Aging Metric 2: We analyze population growth by looking at the point-in-time changes compared to a decade earlier, as well as examining year-on-year growth rates, to gauge the broader demographic trends.

Recognizing that aging has a non-linear impact on banks we focus on identifying the three or five oldest societies by the end of 2022, based on the UN metrics, recognizing that the use of alternative metrics may change the ordering. We employ aging dummies for various 4-year interval cut-off points—2010, 2014, and 2018—to consider the progressive intensification of aging in recent years, most notably in the oldest countries. The use of these dummy variables serves a dual purpose: firstly, to distinguish the unique trends observed in the oldest societies from those in countries at earlier stages of aging; and secondly, to recognize that the implications of aging are progressively becoming more significant for those nations advancing into deeper stages of demographic aging.

In fact, Figure 4 illustrates that metric 1 (i.e., active population to elderly) has started dropping sharply from around 2008-10 (top left graph), a trend which is projected to continue over the next 30-40 years (bottom left graph). Most countries kept growing on a ten-year basis during the past few years, with the exception of the two eldest countries (top right graph, Table Appendix1), but going forward, many countries will start seeing their populations decline (bottom right graph).

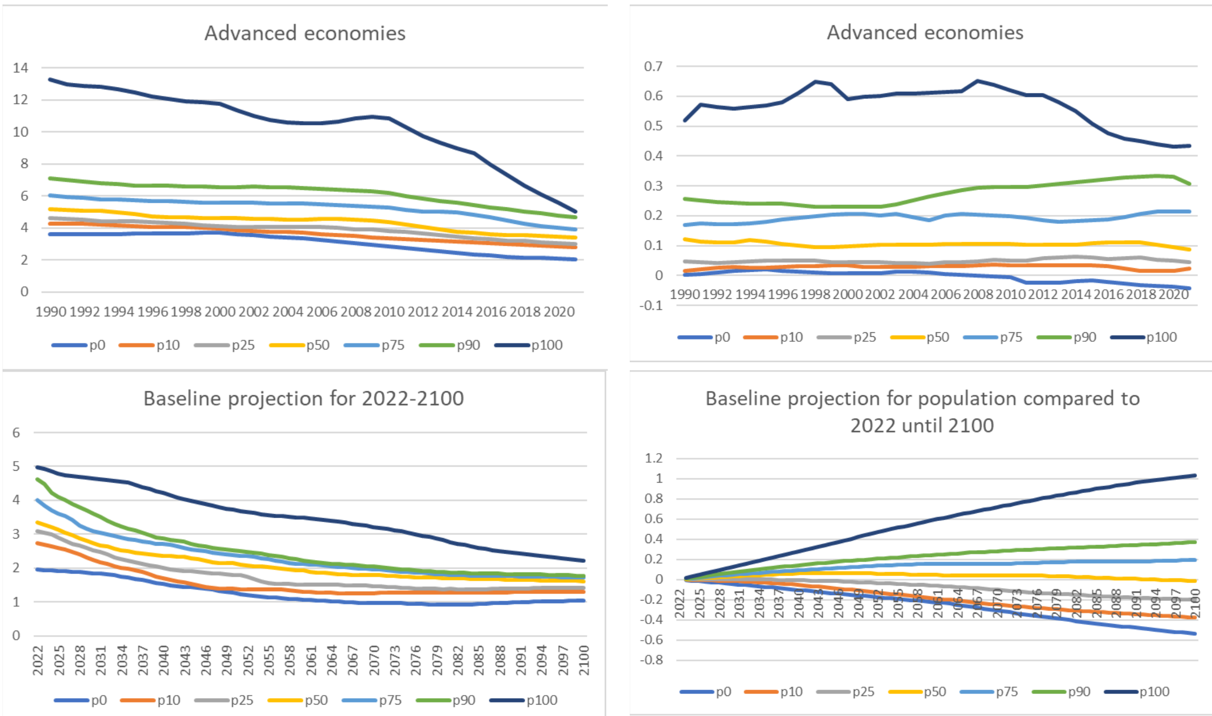
In our analysis, unless specifically indicated otherwise, we define the group of "old" countries as the five most aged, advanced economies as determined by aging metric 1. This group comprises Finland, France, Greece, Italy, and Japan (Appendix 1). When considering aging metric 2, which involves a different demographic parameter, the set of eldest economies shifts slightly to include Finland, Greece, Italy, Japan, and Spain (Appendix 1).

To ensure the robustness of our findings, we undertake sensitivity analyses by varying the composition of the "old" countries group. For instance, we examine the effects of excluding Greece and Italy from the sample. These exercises confirm the stability of our results, indicating that the identified trends and outcomes are not contingent on the specific selection of countries within the "old" category, although recognizing the small sample.

[19] We also considered two other metrics for robustness purposes: the share of the population above 65; the share above 65 to share below 15.

Figure 4: Aging metrics: percentiles

Metric 1 (Active population to population 65+) Metric 2 (Cumulative population growth vs 10 years ago)



Note: the percentiles are running metrics for each year. For the econometric analysis we define the aging dummies based on the latest data.

Source: Authors based on data from the World Bank and United Nations for 28 advanced economies.

To project the future implications of aging, our analysis leverages population growth forecasts from the United Nations, dating from 2022, suggesting an unequivocal trend: populations are both diminishing in size and advancing in age, a pattern vividly depicted in Figures 1-2 and 4. This demographic shift is expected to gain momentum over time. Moreover, alternative demographic forecasts from institutions such as the International Institute of Applied Systems Analysis and the Institute for Health Metrics and Evaluation indicate an even more rapid acceleration in aging than the UN projections, suggesting that our analysis and results may be "conservative".

IV. Empirical findings: Lower average, but higher tail risk

A. Impact of aging on banks´ assets and liabilities

The descriptive data presented in Figures 5, and Appendix 2 aligns broadly with our conceptual considerations discussed in section III.

The banks in the “oldest” countries based on their active population to elderly ratios (i.e., Finland, France, Greece, Italy, Japan) faced a differential reduction in the demand for loans, particularly during the past five years (Figure 5, blue dashed lines). This trend holds true when Italy and Greece, two nations significantly affected by the European sovereign debt crisis, are excluded from the analysis.

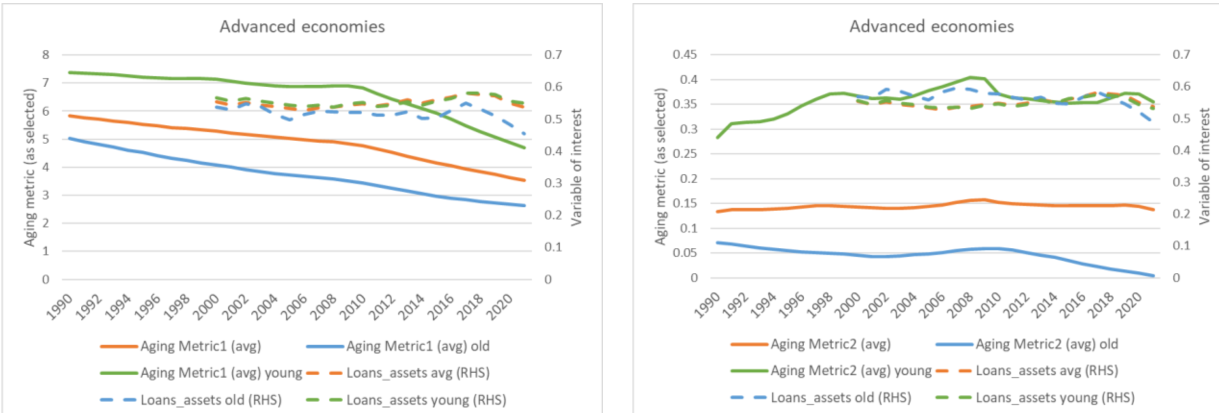
Interestingly, while the share of deposits in the total funding mix has been marginally lower in these older countries, it is still on an upward trend (Appendix 2). A plausible rationale for this is that the younger countries are at earlier stages of the demographic aging, with a significant segment of their populations—particularly the Baby Boomer generation—currently in the wealth accumulation phase of their careers, a dynamic exemplified by Japan (Figure 3b). Beyond the observed variations among countries at different stages of aging, the historically low interest rates on bank deposits might have prompted investors to seek alternative assets, such as real estate, offering higher returns. However, this trend might see a reversal in the face of the current higher policy interest rates, potentially enhancing liquidity.

Our analysis reveals a consistent pattern regarding the influence of aging on the characteristics of banks' balance sheets, observable across various metrics. When categorizing aging economies based on their ten-year cumulative population growth, the observed adjustments in banks' balance sheets attributed to aging appear less marked than anticipated (e.g., Figure 6 right graph vs left graph). This subtlety can be attributed to the fact that shifts in the relative proportion of the active workforce are likely to have a more significant impact on credit demand than mere population growth.

More generally, this trend persists across all the metrics employed in our study, highlighting a distinct difference in the impact of aging between the most aged countries and those that are younger. However, this differential effect is not as evident when comparing the youngest nations with all others, as indicated by the green lines in the graphs. This suggests that while aging has a discernible effect on banking sector dynamics in the most aged economies, its impact is less clear-cut when considering the broader spectrum of younger versus older countries.

Figure 5: Banks in most aging economies face lower demand for loans

Aging Metric 1 (Active population to population 65+) Aging Metric 2 (Population growth vs 10 years ago)



The countries classified as "old" are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect becomes more pronounced if we removed Greece and Italy for the "old" sample.

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

For both aging metrics, the reduced demand for loans in the eldest countries in recent years has led to excess deposit levels relative to loans. This trend of elevated deposit levels, notwithstanding a shrinking loan demand, is not exclusive to the oldest economies but is also discernible across a broader spectrum of advanced economies. This pattern reflects a wider phenomenon, as most of these nations have embarked on their own aging trajectories. The observation underscores a commonality among advanced economies, where the aging demographic trend is contributing to a reshaping of the banking sector's balance sheet dynamics, marked by a growing imbalance between deposits and loans (Appendix 2).

The regression analyses are in strong agreement with the descriptive trends. Our findings reveal that banks in aging countries exhibit lower loan-to-asset ratios (the coefficient b1 in formula 1 and 2 is -0.04, see Table 2 and Appendix 3), suggesting diminished demand for loans as aging progresses.

Regarding the proportion of bank deposits in total funding, we observe a negative differential effect (the coefficient β_1 in formula 2 is -0.02 to -0.03), indicating that banks in the most aged countries have lower deposit-to-total funding ratios compared to the other advanced economies, which are also aging, but at earlier stages. When considering the deposits-to-loan ratios, the aggregate differential effect is positive. This suggests that the observed reduction in loan demand in recent years has a more pronounced impact than the differential decrease in deposits among the aged societies. Overall, these results highlight the nuanced ways in which aging influences the balance sheet structures of banks, underscoring the importance of considering the stages of demographic transition across different advanced economies.

In economic terms, the differential effect of aging (i.e., the decline in the share of active population to the population over 65+), about 2-3 percentage points, on the share of loans in total assets is fairly notable, which is mirrored in the actual difference between Japan and Singapore being 15 percentage points (40 vs. 55 percent). Likewise, the differential impact observed on the deposits-to-loan ratio, 5-8 percenage points, is sizeable.

Since the average aged countries will approximately be as “old” in 20235 as the oldest advanced economies at present (Figure 4), we can expect a general drop of the loan to asset ratios and the deposits to loan ratios, respectively.

Table 2: Summary of regression results for banks´ assets and liabilities (see Tables A3.2 and A3.4)

Coefficient β1 Aging in Formula 1 and 2 Default cut-off year for aging: post 2010	Dummy for Metric 1: Active population to population 65+ (“old”: Finland, France, Greece, Italy, and Japan)	Dummy for Metric 2: Population growth vs t-10 (“old”: Finland, Greece, Italy, Japan, Spain)
Deposits to total funding (avg: 60%)	-0.04*** (expected sign: +)	-0.03** to -0.04*** (expected sign: +)
Loans to assets (avg: 55%)	-0.02*** to -0.03*** (expected sign: -)	-0.03(*) (expected sign: -)
Deposits to loans deposits (avg: 99%)	0.05*** to 0.08*** (expected sign: +)	Not significant (expected sign: +)

Significance codes: ***: 1%; **: 5%; *: 10%; (*) : 20%

For the second aging metric, our econometric findings reveal a similar differential effect for the deposits to total funding and the loans to assets metrics, while there is no differential impact for the deposit to loan ratio.

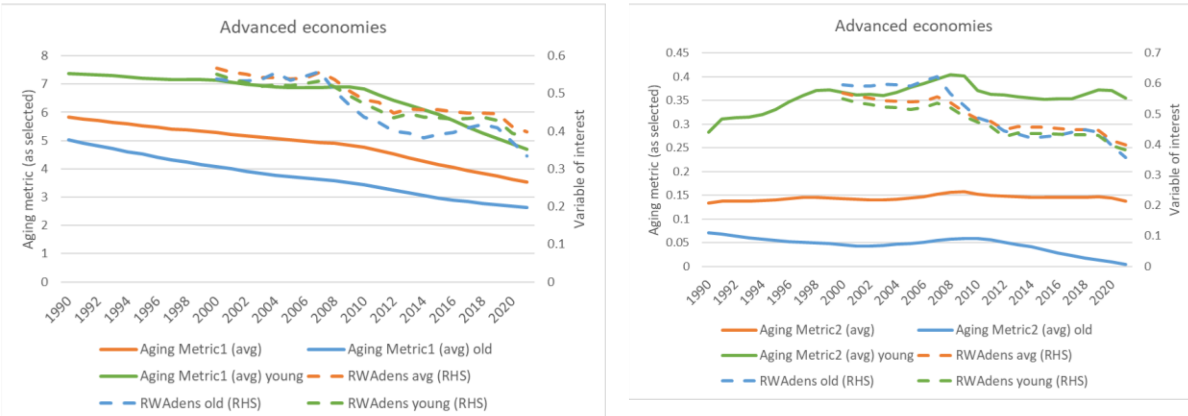
We also find signals that aging is linked to a higher share ownership of securities and government securities. For the foreign claims, we also find evidence that those have grown differentially for the oldest economies, but there may also be some indirect channels that matter, for instance through larger ownership of securities (Appendix 3).

B. Impact of aging on banks´ risk taking

Aligned with the anticipated shift towards lower risk-taking, descriptive data indicates that banks in aging advanced economies tend to reduce the per unit risk level, or "risk weight density," of their assets. This trend is more pronounced when aging is delineated by the ratio of the working-age population to the elderly, as depicted in Figure 6, left panel, rather than when defined by population growth, shown in Figure 6, right panel. It is crucial to recognize, however, that comparing risk weights across different banks and countries presents challenges, particularly for earlier periods covered in our analysis, during which banking practices were more varied (BCBS, 2016). Despite these limitations, the observed differential trend offers valuable insights into how aging might be influencing bank asset risk profiles in advanced economies.

Figure 6: Banks in the eldest countries exhibit lower risk weights per unit of asset

Aging Metric 1 (Active population to population 65+) Aging Metric 2 (Population growth vs 10 years ago)



The countries classified as “old” are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect is clearly substantial if Greece and Italy were removed from the “old” sample.

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

The data presented in the upper panels of Figure A2.4 in Appendix 2 indicate that loan loss rates, which represent credit impairments from the Profit and Loss (P&L) statement as a proportion of total loans, are notably higher in countries with aging populations. However, this differential effect dissipates when Greece and Italy, two countries with significant aging populations and unique economic challenges, are excluded from the analysis of "old" countries, as illustrated in the bottom panels of the same graph. Our regression analysis, which accounts for macroeconomic conditions and specific bank characteristics, corroborates these descriptive observations.

Descriptively, our analysis corroborates the notion that the aging-induced decline in banks' risk-taking behavior, as depicted in Figure 6, is reflected in their profitability metrics, which have tended to be marginally lower on average for banks in aging societies, as shown in Appendix 2. Moreover, profitability within these banks has exhibited greater volatility. However, when Italy and Greece are excluded from the cohort of aging countries, the observed disparities in both the levels of Return on Equity (RoE) and volatility diminish, implying that macro-financial conditions have exerted a significant influence. This suggests that the challenges faced by banks in aging countries are not solely due to their forays into non-core activities, both domestically and internationally, but are also shaped by broader economic and financial contexts.

Our econometric analysis of the three risk-taking metrics in a broader sense —risk weight density, loan loss ratios and return on equity (RoE)—corroborates the descriptive patterns. The findings, detailed in Table 3 (and in Appendix 3), reveal that banks in aging societies tend to hold portfolios with relatively lower risk weights. This trend is in line with a reduction in lending activities and an increase in the proportion of comparatively low-risk securities within their asset mix. When examining bank profitability and the extent of loan losses within the credit portfolio, the influence of aging alone does not account for the observed trends. Nonetheless, there is some evidence of potential tail risks affecting profitability metrics, reflected in higher volatality of RoEs (see also

Figure A2.5). It's noteworthy, though, that these tail risks appear diminished when countries that have undergone financial crises, such as Greece and Italy, are excluded from the cohort classified as "older." This adjustment suggests that the extreme negative outcomes in profitability might be partly attributable to crisis-specific factors in these countries, rather than aging per se. This nuanced understanding is crucial for comprehensively assessing the impacts of demographic shifts on banking sector risk profiles and financial performance.

For the risk weight densities, we observe a differential impact from aging (metric 1) amounting to approximately 1.5 to 2 percentage points. Contrasting it with the youngest country, this difference widens to approximately 3-4 percentage points, which holds some economic significance given many advanced economies exhibit risk weight density levels of 30-35 percent. Regarding credit loss rates, our analysis detects a potential positive influence of aging, albeit this effect does not reach a level of economic significance which would warrant economic concern, at least within the scope and context of our current analysis. Moreover, additional regressions provide some signal that bank loan rates are slightly higher for aging countries, which is consistent with other findings.

Table 3: Summary of regression results for banks´ risk taking (see Tables A3.2 and A3.4)

Coefficient $\beta 1$ Aging in Formula 1 and 2 Default cut-off year for aging: post 2010	Dummy for Metric 1: Active population to population 65+ (“old”: Finland, France, Greece, Italy, and Japan)	Dummy for Metric 2: Population growth vs t-10 (“old”: Finland, Greece, Italy, Japan, Spain)
Risk weight density (avg: 48.7%)	-0.015(*) to -0.02(*) (expected sign: -)	-0.03** to -0.04* (expected sign: -)
Return on Equity (RoE) (avg: 13.8%)	Not significant (expected sign: -)	Not significant (expected sign: -)
Credit loss rates (avg 1.5%)	0 to 0.002** (expected sign: +)	Not significant (expected sign: +)

Significance codes: ***: 1%; **: 5%; *: 10%; (*) : 20%, t stats in parentheses.

When considering the second aging metric, which focuses on population growth, we also find a differential effect on risk weight density while there is no statistically significant effect for profitability and credit loss rates.

Cumulatively, these results lend support to the initial hypothesis that banks operating in societies with older populations have an inclination towards lower risk-taking, which reflects the evolving strategic responses of banks to the demographic shifts characteristic of aging societies.

We find no pronounced differential impact related to banks' international expansion, as indicated by their foreign claims relative to GDP (left-hand scale of Figure A2.6 in Appendix 2), although the variable is significant in some econometric specifications (Appendix 3). It is important to consider, though, that such aggregate data may not fully capture subtler forms of international connections, such as engagements in securities markets, nor the variation of international engagement levels across banks.

To summarize, the evidence points to a strategic adjustment by banks in aging nations towards a greater focus on securities, particularly through an increased accumulation of government bonds, in contrast to the practices of banks in younger economies (right panels of Figure A2.6 in Appendix 2). This adjustment towards securities is more pronounced in the three oldest economies. The trend persists, though less markedly, when the analysis is broadened to include a larger set of aging countries, encompassing the five oldest, for which the differential effect is also statistically significant (Appendix 3). This strategic shift in asset allocation reflects how banks in aging societies are adapting their portfolios in response to the evolving demographic and economic landscapes.

C. Impact of aging on bank stability

Our analysis of the impact of aging on bank stability risk employs four synergistic metrics to provide a comprehensive understanding.

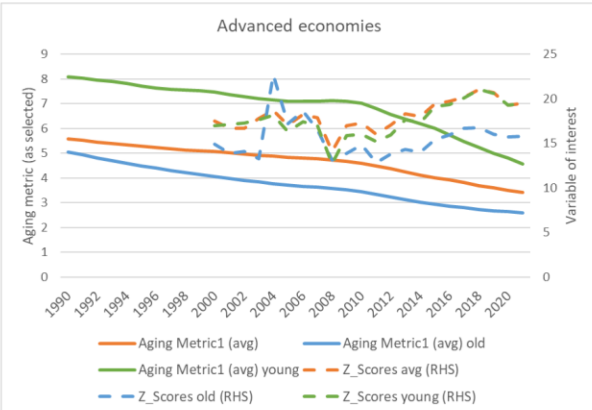
One of these metrics, the Z-Score, serves as a gauge for the default risk within a country's banking sector by comparing the buffers (namely, capitalization and profits) of banks against the volatility of their earnings. As a metric rooted in balance sheet analysis, the Z-Score is adept at capturing structural shifts rather than immediate tail risks. This characteristic suggests that banks situated in aging societies are likely to navigate less volatile business terrains.

Our descriptive anaysis (Figure 7) depicts a differential reduction in Z-Scores for banks in aging countries – i.e. their risk of failure – which is confirmed by the econometrics. Specifically, the Z-Score of banks in aging countries are found to be 2.5 to 3 percentage points lower than in median aged economies (Table 4 and Appendix 3). Compared with the youngest economy, the differential effect would about 5-6 percentage points, or one third of the average Z-Score metric across all advanced countries and over time. Extrapolating the results to the future suggests that the Z-Scores for the median aging country in 2035 would be 2.5-3 percentage points lower compared to 2022. This trend underscores the potential for demographic shifts to influence the foundational stability parameters within the banking sector, aligning with broader patterns of risk aversion and conservative financial management prevalent in aging societies.

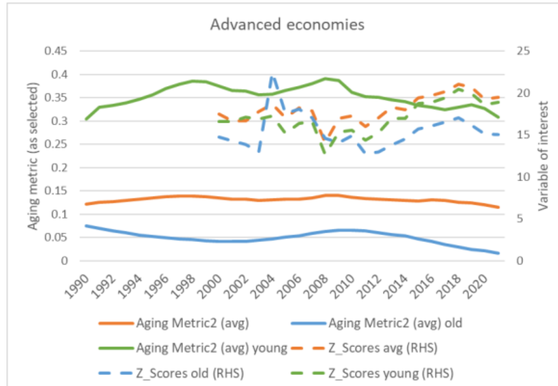
Broadening the analysis towards market-based metrics, it becomes apparent that the most aged economies have endured more adverse financial conditions during stress periods compared to their less aged counterparts. This observation is clearly reflected in the metrics for Expected Default Frequencies (EDFs) and the tail risk ratio, denoted as “Srisk,” which are depicted in Figures 8 and 9, respectively. Furthermore, this trend is corroborated by lower Price-to-Book ratios (Figure A2.7 in Appendix 2), which captures the future earnings´ potential.

Figure 7: Z Scores are lower for more aging countries, signaling lower risk

Metric 1 (Active population to population above 65)



Metric 2 (Relative population growth vs 10 years ago)



Cut-off point for aging and young society dummy: 15*th* percentile (i.e. 5 out of 28 Advanced economies classified as “old” and “young”, respectively).

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

Controlling for macro-financial conditions and bank characteristics (Table 4, Appendix 3) confirms that based on the first aging metric, average risk (Z-Score) decreases, while tail risk increases (EDF, SRisk). For population growth, aging does not yet have a significant impact.

Table 4: Summary of econometric analysis for banks’ stability risk (see also Tables A3.2 and A3.4)

Coefficient β1 Aging in Formula 1 and 2 Default cut-off year for aging: post 2010	Dummy for Metric 1: Active population to population 65+ (“old”: Finland, France, Greece, Italy, and Japan)	Dummy for Metric 2: Population growth vs t-10 (“old”: Finland, Greece, Italy, Japan, Spain)
Z-Score (avg: 18%)	-0.024** to -0.03*** (expected sign: -)	Not significant (expected sign: -)
Price to book ratio (avg: 1.5)	-0.1(*) (expected sign: -)	Not significant (expected sign: -)
EDF (avg: 0.68%)	0.004* to 0.005** (expected sign: - or +)	Not significant (expected sign: - or +)
SRisk to total assets (avg: 3.1%)	0.016(*) to 0.04** (expected sign: - or +)	Not significant (expected sign: - or +)

Significance codes: ***: 1%; **: 5%; *: 10%; (*) : 15%, t stats in parentheses.

We also find that aging has a negative contribution to price-to-book ratios, as expected. However, the economic significance is fairly low, at around 10 basis points for aging metric 1, while there is no significant differential impact for metric 2. Going forward, with banks´ earning capacity shrinking in an aging environment, one should expect a more substantial impact of aging on banks´ franchise values.

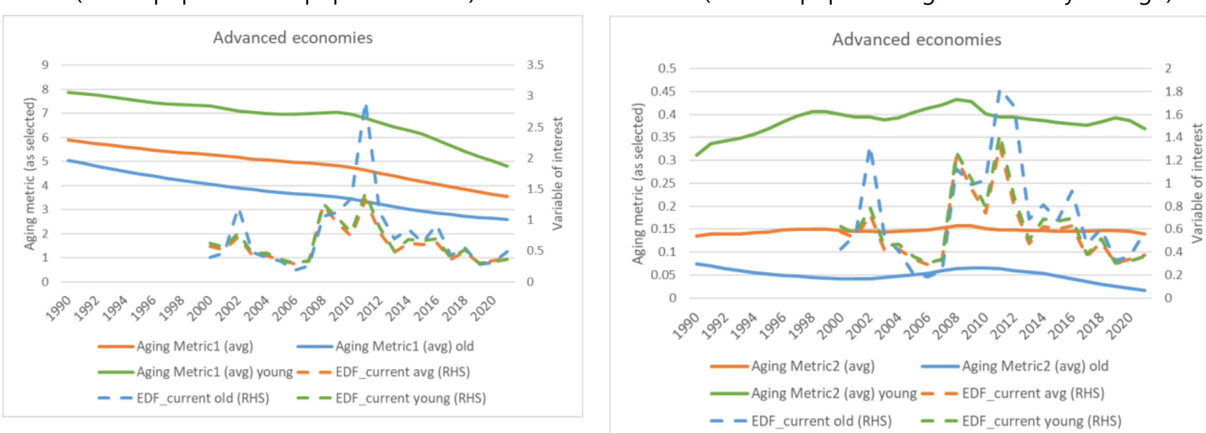
Regarding the potential drivers, our examination reveals that the availability of more deposits relative to loans contribute to tail risks and reduce price-to-book ratios, but lower EDFs (Table A3.6). Higher levels of profitability (RoE) reduce EDFs but contribute to higher tail risk (SRisk). Higher shares of foreign claims within total bank assets are not found to contribute to banks' vulnerabilities across all four system-level risk metrics, but we cannot control for the composition of foreign claims absent granular data. Conversely, a higher allocation of bank assets in government bonds and secruities more generally appears to mitigate tail risks, as indicated by the SRisk measure. Higher shares of loans contribute to higher average bank risk (ZScore) but lower tail risks and contribute positively to price-to-book ratios.

Utilizing one-year Expected Default Frequencies (EDFs), derived from a Merton-type asset pricing model, our analysis reveals that during periods of normal economic activity, the risk levels of banks in both older and younger societies are comparably aligned, as depicted in Figure 8. However, in times of severe economic stress, banking systems in aging countries exhibit a pronounced susceptibility to tail risks, indicating a heightened level of systemic fragility within these contexts. This heightened vulnerability persists even when Italy and Greece, two countries that have experienced significant financial stress, are excluded from the sample of aging countries. The exclusion results in a slight attenuation of the effect, with the coefficient decreasing by one fifth, from 0.005 to 0.004, yet the finding remains statistically significant (Table 4).

When assessing the impact of aging based on the metric of population growth (aging metric 2), our findings do not indicate a distinct differential effect on the aging dummy. However, the graphical representation (Figure 8, right panel) demonstrates elevated vulnerabilities banks faced by banks in aging countries during periods of stress, underscoring a potential nuanced interplay between demographic aging and banking system risk dynamics.

Figure 8: During crises periods, EDFs are higher for aging countries

Metric 1 (Active population to population 65+) Metric 2 (Relative population growth vs 10 years ago)



5 out of 28 Advanced economies classified as "old" and "young", respectively

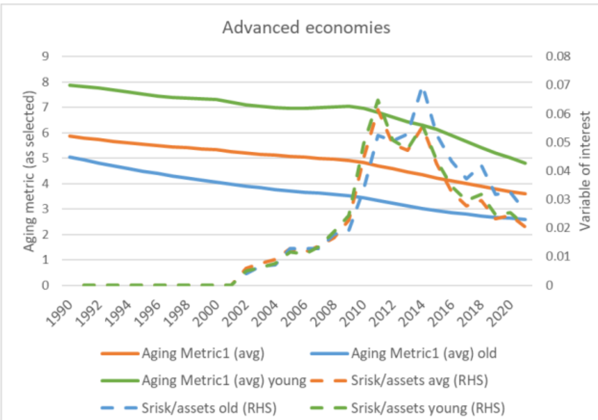
Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

SRisk is a market-based metric of worst-case losses that considers interconnectedness risk, provided by New York University (NYU).[20] With the caveat of a slightly more limited sample size, we normalize it by the total assets in the banking system. Since this metric is explicitly measuring tail risks, it is an important complement with the other metrics.

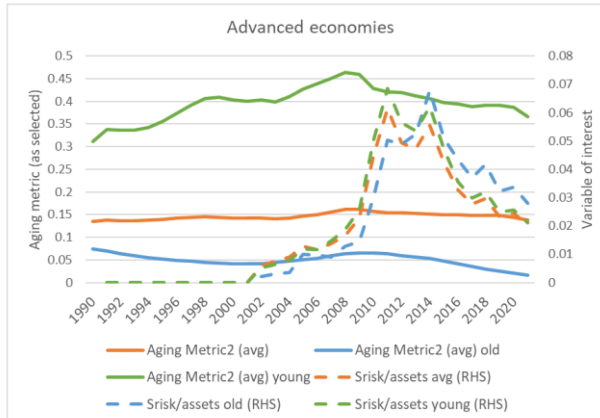
[20] We thank Brian Reis from the V-lab at the NYU Stern School of Business for providing us with country level data.

Figure 9: There is some differential trend for tail risk in aging countries

Metric 1 (Active population to population 65+)



Metric 2 (Relative population growth vs 10 years ago)



Cut-off point for aging and young society dummy: 15*th* percentile (i.e. 5 out of 28 Advanced economies classified as "old" and "young", respectively).

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

For SRisk, we find differential tail risk of aging, visible from Figure 9 for the most recent years for both aging metrics. Banks in aging countries exhibit a 1.5 percentage points higher SRisk to asset metric than in less aging economies (Table 4), an outcome which increases in economic significance when we exclude Italy and Greece from the "old" sample. Should the same pattern hold for all countries over time, tail risks would substantially increase in many countries.

D. Robustness of the results

Considering the complexity and the interplay among different variables of interest, it's essential to conduct thorough robustness checks. A key means to do so is to control for both macro-financial conditions and bank characteristics (Tables A3.2, A3.4 and A3.6 in Appendix 3). A significant observation from these checks is the stability of our findings across different groupings of the most aged countries, including when excluding the countries that encountered economic crises in recent years (Greece, Italy). The exclusion of these countries does not significantly affect our results for most variables, maintaining both statistical and economic significance.

Further analysis, controlling for the increasing proportion of non-bank financial intermediaries in total financial system assets (as reported by the FSB since 2002), does not alter our results. However, it is important to note that such data is only available for a limited number of countries. This additional analysis accounts for financial development outside the banking system, which may either complement or contradict the activities of banks. Conceptual considerations suggest that non-bank financial intermediaries (NBFIs) operate under the same fundamental trade-offs, which is consistent with our findings.

We further examined the robustness of our results by testing various cut-off points for the onset of aging (2010, 2014, 2018), which consistently supported our initial findings. Additionally, our analysis remains resilient when excluding data from the pandemic years (2020-2022), although some trends have become more pronounced in recent years, suggesting a potential non-linear effect of aging on bank stability risk. This hypothesis is subtly reinforced when focusing on the three most aged countries as opposed to the top five, as shown in Appendix 3, hinting at looming risks.

Utilizing year-on-year population growth, as opposed to a ten-year trend for our second aging metric, revealed a more substantial influence of aging on our outcomes (not reported separately). This aligns with the observation that aging trends have gained prominence over the last decade and are expected to exert an increasingly non-linear impact moving forward.

The robustness checks validate that our study's conclusions are not contingent upon specific countries or time frames, thereby affirming their aggregate-level robustness. However, the limited number of observations constrains our ability to pinpoint aging's influence on precise behavioral shifts within the banking sector. Although our findings hint at certain factors contributing to the varying impacts of aging (Appendix 3), a more detailed dataset would be required to dissect banks' investments in subprime assets leading up to the Great Financial Crisis and the composition of government bond holdings during pivotal periods such as the European sovereign debt crisis and recent banking disturbances. While a similar analysis could be undertaken at the individual bank level, such an approach would preclude the assessment of aggregate risk metrics at the national level.

V. Conclusion and Policy Implications

This paper delves into the ramifications of demographic shifts on banking business models and explores the avenues through which these changes might influence financial stability. In the face of aging populations, banks may reduce their role in maturity transformation, face diminished loan demand due to lower economic activity, and witness shifts in investment preferences towards more conservative avenues. Navigating these demographic shifts mitigates some of the existing risks but introduces new risks into the banking sector.

Unlike many other risk factors confronting banks, demographic changes unfold gradually over an extended period, and risks might therefore be overlooked for a long time by regulators and supervisors, a situation comparable to the "boiling frog" syndrome, bearing similarities to "Minsky moments." Hence, the early detection and diligent monitoring of demographic-induced risks are vital for a robust financial surveillance framework.

Our comprehensive analysis of advanced economies over the past two decades – with the caveat that we cannot fully control for all relevant factors that are at play – indicates a general decline in the level of risk confronting banks in aging societies, primarily due to a reduction in maturity transformation and, consequently, lower credit risk-taking. Consistent with this observation, our study finds that, on average, bank stability tends to improve in aging societies. Nonetheless, the risk metrics evaluated in this research also highlight the emergence of potential tail risks associated with banks' behavioural shifts, particularly their search for higher yields in new geographical areas, sectors and segments as a strategy to deploy excess deposits.

This research underscores the necessity for banks in aging economies to sustainably adjust their business models away from traditional maturity transformation to mitigate risks effectively. Past crises, such as the Great Financial Crisis, where foreign banks suffered from domestic (US) subprime debt exposures they had inadequately analyzed, demonstrate the challenges of such transformations, although aging may not yet have been a key contributing factor in that instance.

As demographic trends continue to evolve and banks adjust their business models, it is imperative for policymakers and regulators to refine their strategies to manage financial stability risks, especially those related to tail risks. Employing meaningful scenario analyses can guide bank strategies and public policies alike. Rigorous supervisory analysis can prompt supervisory diligence, for example in relation to banks' strategies to offset low structural profitability in home markets by venturing into riskier foreign markets or new product domains. Prudential measures could be considered, but should not further weaken banks´ solvency profiles, hence other policy instruments to backstop banks, including fiscal ones, should not be rules out.

Future research could explore the implications of aging in emerging market economies on banking system stability. Additionally, a more detailed international analysis at the bank level concerning the effects of aging on banks’ business models and risk postures would provide valuable insights.

Annex I. Data

Table A1.1: Key variables: Name, definition and source

Variable	Definition	Data availability	Source
Dependent Variables (Risk taking and systemic risk)			
Risk weight density	Risk weight per unit of assets	From 2000	FitchConnect
Loan impairments to total loans	Loan impairments from P&L to total gross loans	From 2000	FitchConnect
Return on equity		From 2000	FitchConnect
Price-to-book ratio	Current market price of bank equity to book value	From 1990	FitchConnect
Expected default frequency of banks	Weighted average one-year default risk of banking systems at the country-level	From 2000, 22 countries	Moody´s
Z Scores	Probability of default of a country's banking system, calculated as a weighted average of the z-scores of a country's individual banks	From 2000	WorldBank
SRisk	Capital shortfall of a financial system conditional on a severe market decline, and is a function of its size, leverage and risk	From 2000, 22 countries	NY Stern University
Dependent Variables (Metrics on banks assets and liabilities)			
Deposits to total funding		From 2000	FitchConnect
Loans to total assets		From 2000	FitchConnect
Credit to deposits		From 2000	FitchConnect
Aging metrics			
Metric 1	Active population to population above 65	From 1990, 240 economies	United Nations
Metric 2	Relative change of absolute population during the past 10 years and year-on-year	From 1990, 236 economies	United Nations

Covariates			
GFC dummy	Pre / post 2009	n.a.	Authors´ judgment on potential structural change in financial system
Real GDP growth	Y-o-y	From 1990	IMF WEO
Uncertainty index	Computed by counting the percent of word “uncertain” (or its variant) in the Economist Intelligence Unit country reports.	From 1990	Home - World Uncertainty Index
Leverage in the economy	Bank Credit to GDP	From 1990	BIS
Monetary policy stance	Policy rates	From 1990	BIS
Structure of the banking system	Bank concentration	From 1990	The Global Economy
Liquidity metric	Liquid assets to ST funding	From 2000	Fitch Connect
Foreign claims	Foreign bank claims to GDP	From 2000	Fitch Connect
Capital adequacy ratio	Regulatory capital to risk-weighted assets	From 2000	Fitch Connect
Leverage ratio	Capital to total assets	From 2000	Fitch Connect

Table A1.2: List of 28 economies included in the study by level of aging

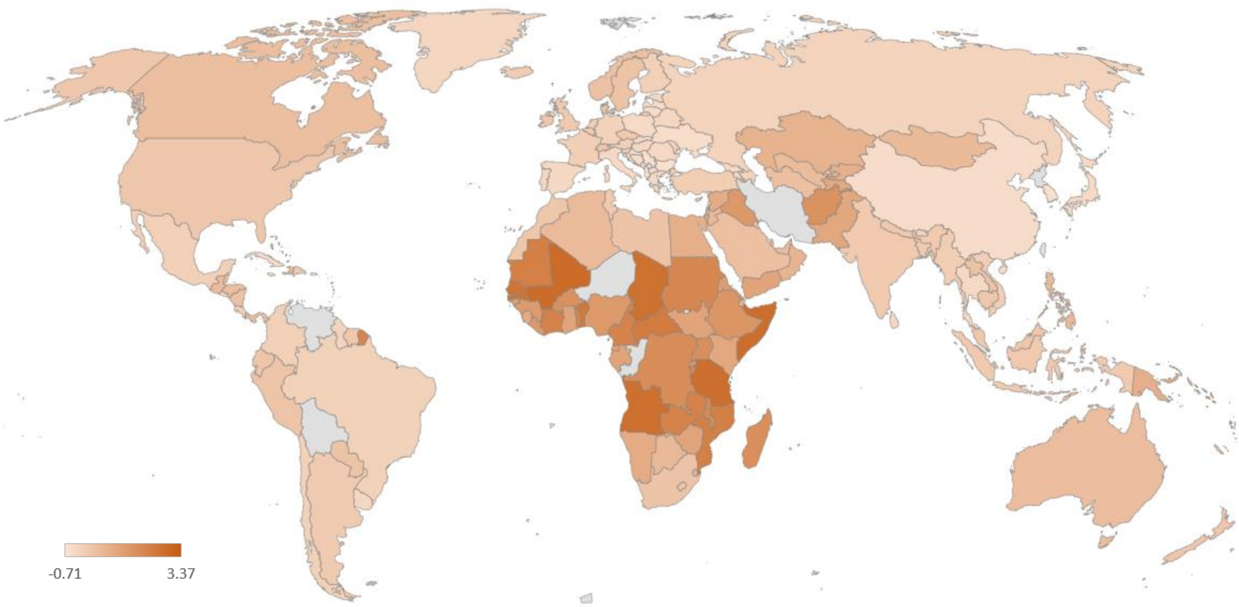
Economy	Metric 1: Active population to population above 65		Metric 2: Population growth Y-o-y		Metric 2: Population growth during the past 10 years	
Year	2022	2012	2023	2013	2022	2012
Japan (JPN)	2.0 (*)	2.7	-0.53% (*)	-0.14%	-1% (*)	3%
Finland (FIN)	2.7 (*)	3.7	0.09%	0.46%	3% (*)	4%
Italy (ITA)	2.7 (*)	3.2	-0.28% (*)	1.17%	4% (*)	5%
Greece (GRC)	2.8 (*)	3.4	-0.42% (*)	-0.72%	-4% (*)	2%
France (FRA)	2.9 (*)	3.8	0.20%	0.52%	4%	6%
Malta (MLT)	2.9	4.3	0.33%	1.41%	31%	13%
Germany (DEU)	2.9	3.2	-0.09% (*)	0.27%	4%	-3%
Sweden (SWE)	3.0	3.5	0.59%	0.85%	17%	9%
Denmark (DNK)	3.1	3.8	0.49%	0.42%	5%	4%
The Netherlands (NLD)	3.1	4.2	0.31%	0.30%	9%	10%
Spain (ESP)	3.2	3.9	-0.08% (*)	-0.33%	1% (*)	14%
Belgium (BEL)	3.3	3.8	0.26%	0.47%	5%	7%
Great Britain (GBR)	3.4	3.9	0.34%	0.67%	6%	7%
Switzerland (CHE)	3.4	4.0	0.64%	1.16%	10%	9%
Austria (AUT)	3.4	3.7	0.22%	0.59%	7%	4%
Canada (CAN)	3.5	4.8	0.85%	1.06%	11%	11%
Hong Kong (HKG)	3.6	5.7	0.04%	0.40%	5%	5%
Norway (NOR)	3.7	4.4	0.74%	1.22%	19%	16%
United States of America (USA)	3.8	5.0	0.50%	0.70%	15%	21%
New Zealand (NZL)	3.8	5.0	0.83%	0.77%	30%	24%
Australia (AUS)	3.9	4.9	1.00%	1.74%	15%	16%
Iceland (ISL)	4.0	5.5	0.65%	0.95%	30%	22%
Korea (KOR)	4.3	6.6	-0.06%	0.46%	9%	14%
Ireland (IRL)	4.3	6.0	0.67%	0.53%	28%	29%
Cyprus (CYP)	4.7	6.1	0.69%	0.90%	9%	19%
Israel (ISR)	4.7	5.9	1.51%	1.88%	43%	52%
Luxemburg (LUX)	4.8	4.9	1.11%	2.34%	43%	32%
Singapore (SGP)	5.0	10.3	0.65%	1.63%	31%	60%

Aging group (5 most aged economies): *

Annex II. Supplementary descriptive evidence

Figure A2.1 Population growth is projected to vary widely across countries

By 2100, 98 countries´ populations are projected to shrink and 139 countries are expected to grow compared to today’s levels

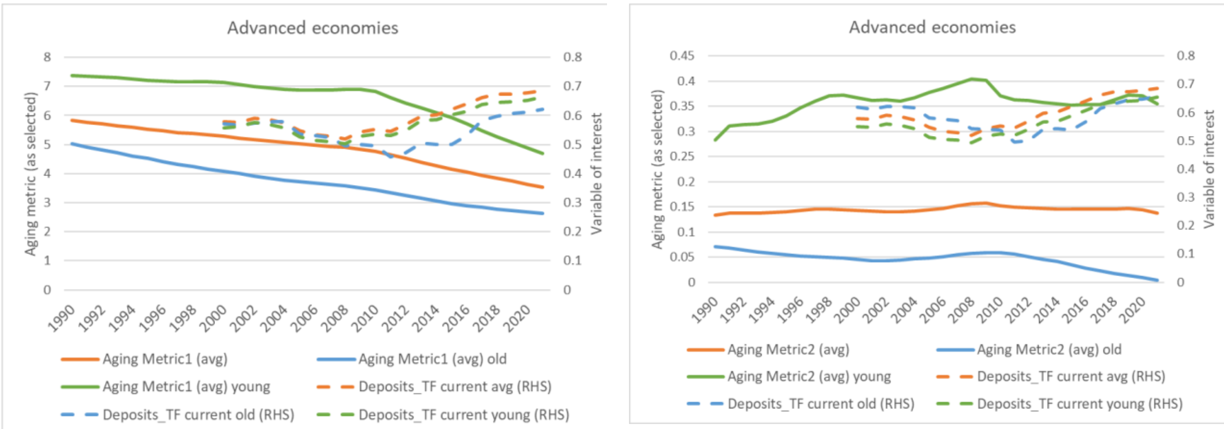


Note that “0.71” is a decline by 71 percent compared to today, and “3.37” is a 337 percent increase.

Source: United Nations (2022)

Figure A2.2 The most aging countries exhibit comparably lower deposit funding ratios

Aging Metric 1 (Active population to population 65+) | Aging Metric 2 (Population growth vs 10 years ago)

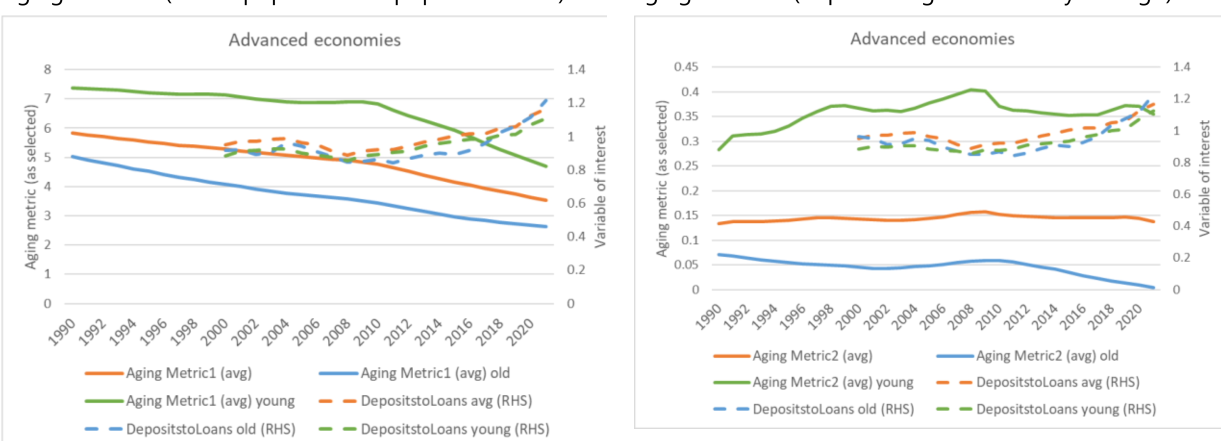


The countries classified as "old" are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect is slightly lower if Greece and Italy were removed from the "old" sample.

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

Figure A2.3 Banks in oldest economies have higher excess deposit funding

Aging Metric 1 (Active population to population 65+) | Aging Metric 2 (Population growth vs 10 years ago)

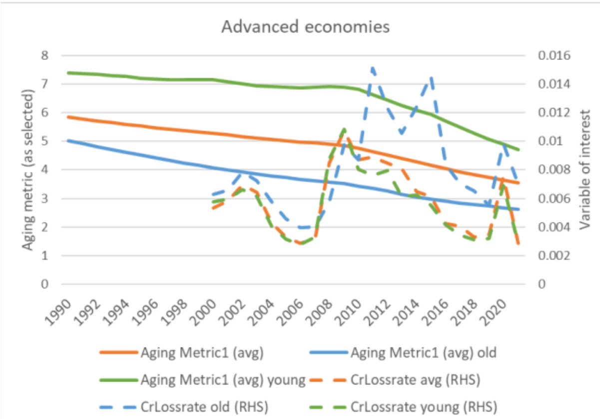


The countries classified as "old" are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect is clearly more substantial if Greece and Italy were removed from the "old" sample.

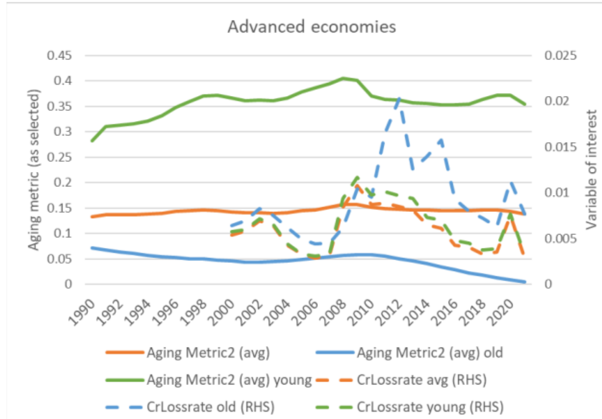
Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

Figure A2.4 Banks in the eldest countries do not necessarily face higher loan loss rates

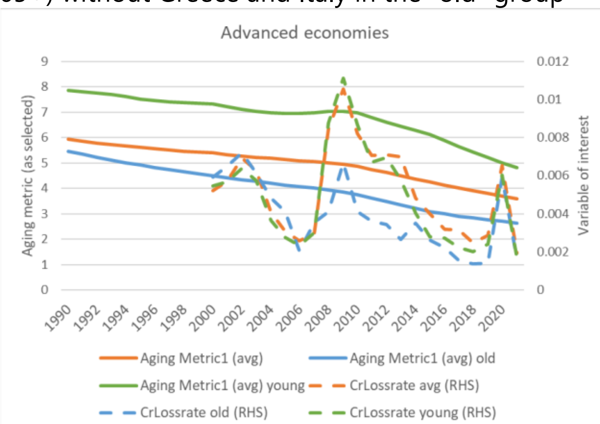
Aging Metric 1 (Active population to population 65+) with Greece and Italy in the "old" group



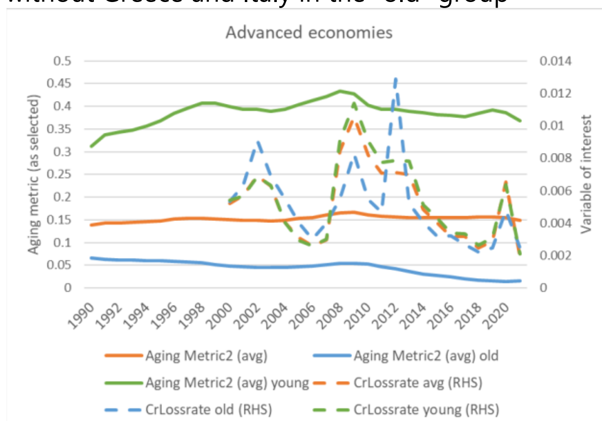
Aging Metric 2 (Population growth vs 10 years ago) with Greece and Italy in the "old" group



Aging Metric 1 (Active population to population 65+) without Greece and Italy in the "old" group



Aging Metric 2 (Population growth vs 10 years ago) without Greece and Italy in the "old" group

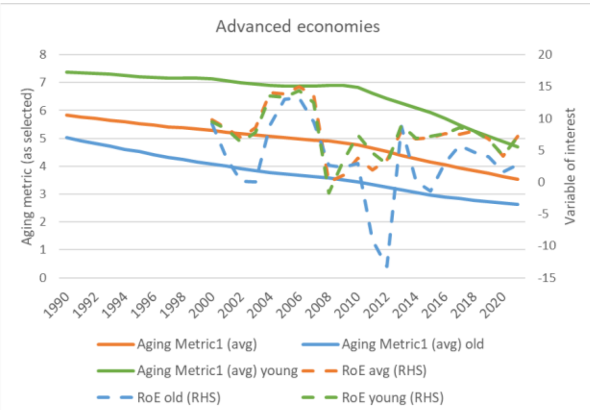


The countries classified as "old" are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect is clearly diminishing if Greece and Italy were removed from the "old" sample.

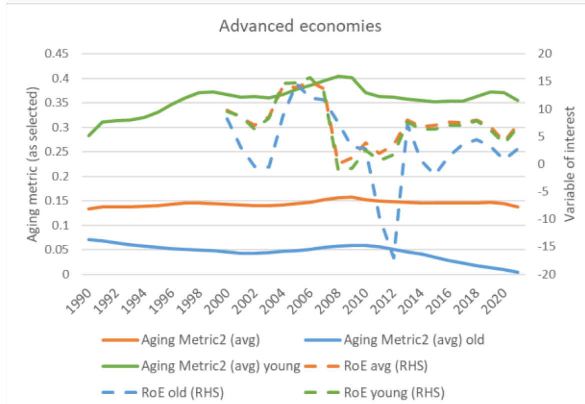
Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

Figure A2.5 Banks in aging countries tend to face deeper dips of RoEs during crises

Aging Metric 1 (Active population to population above 65)



Aging Metric 2 (Population growth vs 10 years ago)



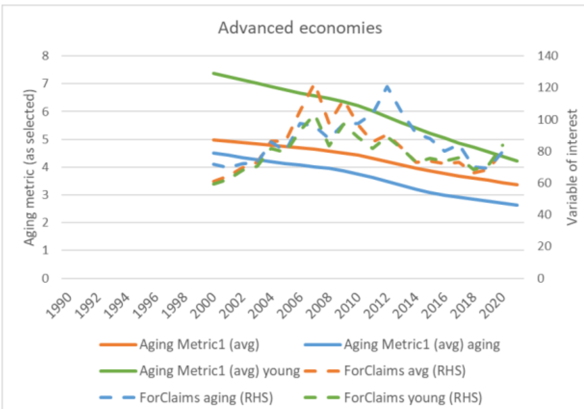
The countries classified as "old" are Finland, France, Greece, Italy, Japan in the left graph and Finland, Greece, Italy, Japan and Spain in the right graph – see Table A1.2. The differential effect is clearly diminishing if Greece and Italy were removed from the "old" sample.

Source: Authors based on data from FitchConnect (Variable of interest) and the World Bank (Aging data).

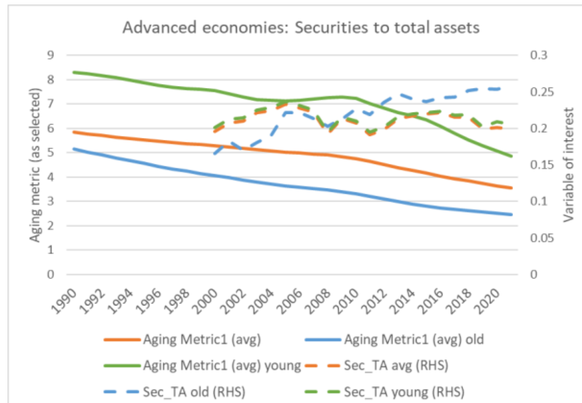
Figure A2.6 Composition of banks´ assets

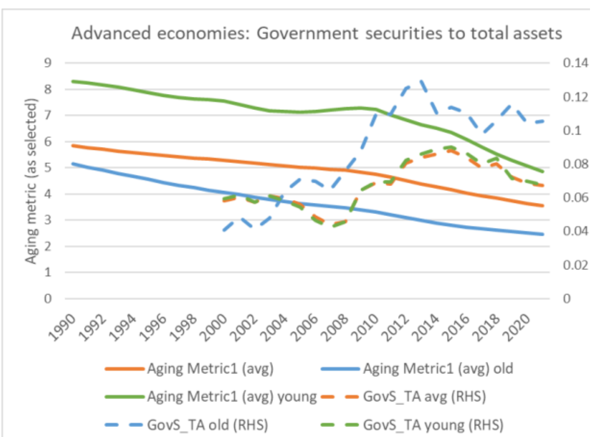
Aging metric 1 (Active population to population above 65)

There is no significant differential trend driven by aging for banks´ share of foreign claims



Banks in aging countries have accumulated more securities and government bonds in recent years



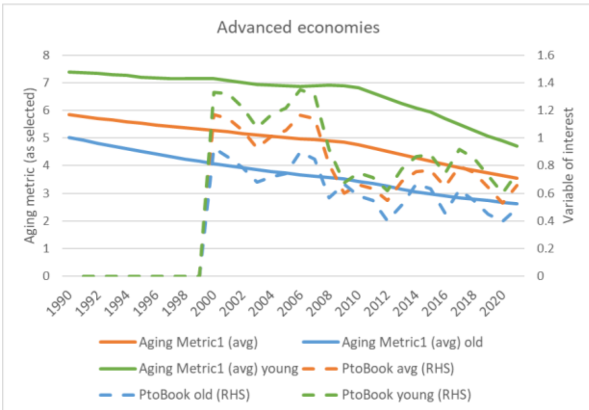


In the two graphs on the right side, we show the three eldest countries vs all other advanced countries. The left graph compares the trends of the three eldest countries excluding Italy and Greece and removing small open financial centers from the young sample.

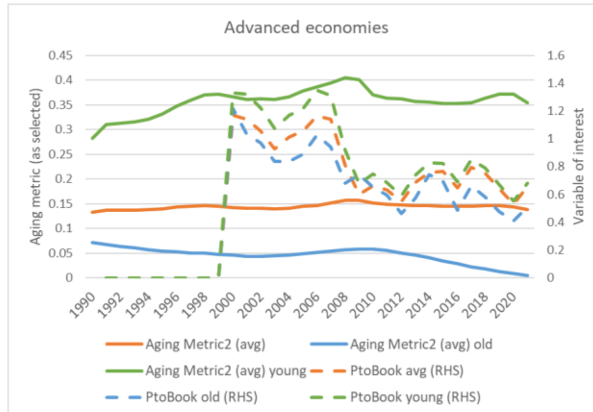
Source: Authors based on data from FitchConnect (Securities to total assets) and WorldBank (Foreign claims, Aging data).

Figure A2.7 Price-to-book ratios are lower in the most aging countries

Metric 1 (Active population to population 65+)



Metric 2 (Relative population growth vs 10 years ago)



5 out of 28 Advanced economies classified as “old” and “young”, respectively

Source: Authors based on data from FitchConnect (Variable of interest) and the WorldBank (Aging data).

Annex III. Supplementary regression results

Table A3.1: Regression results for aging metric 1 (Active population to population above 65) for formula 1 specification

Dependent variable	Deposits to total funding	Loans to assets	Deposits to loans	Risk weight density	Return on Equity	Loan loss rate	ZScore	Price-to-book ratio	EDF	SRisk to total assets
Cut-off year for aging metric	2010	2010	2010	2010	2010	2010	2010	2010	2010	2014
Agingdummy (β1) (1 for aging countries post 2010)	-0.09***	-0.04***	0.07*	-0.05***	Not sig	0.004***	-0.28***	-0.2**	0.0033**	0.015(*)
Observations	644	644	644	644	585	644	504	561	506	474
Number of countries	28	28	28	28	28	8	22	20	22	23
R^2 adjusted	0.44	0.004	0.16	0.37	0.11	0.1	0.08	0.43	0.14	0.14
R^2 within	0.48	0.08	0.23	0.42	0.18	0.17	0.16	0.49	0.21	0.22
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Significance codes: ***: 1%; **: 5%; *: 10%; (*): 20%

Note: aging dummy set to 1 for five countries with lowest ratio of active population to population above 65 in 2022 (*Finland, France, Greece, Italy, and Japan)*, otherwise 0.

Table A3.2: Additional results for aging metric 1 with and without macro-financial and bank controls subject to variation of "old" sample

Coefficient β1 Aging in Formulas 1 and 2 Default cut-off year for aging: 2011	Metric 1: Active population to population 65+ (Finland, France, Greece, Italy, and Japan)		Metric 1: Active population to population 65+ (Finland, France and Japan)	
	without macro / bank controls	with macro / bank controls[1]	without macro / bank controls	with macro / bank controls[1]
Banks' balance sheet structure				
Deposits to total funding (avg: 60%)	-0.09*** (-6.86) R2 adj: 0.43	-0.04*** (-3.73) R2 adj: 0.60	-0.08*** (-5.13) R2 adj: 0.43	-0.04*** (-3.24) R2 adj: 0.60
Loans to assets (avg: 55%)	-0.04*** (-3.31) R2 adj: 0.004	-0.02* (-1.53) R2 adj: 0.13	-0.07*** (-5.72) R2 adj: 0.04	-0.03** (-1.78) R2 adj: 0.12
Deposits to loans (avg: 99%)	Not sign (post 2018: 0.07* (1.8)) R2 adj: 0.16	0.05*** (2.28) R2 adj: 0.52	0.08** (2.25) R2 adj: 0.16	0.08*** (3.23) R2 adj: 0.6
Banks' risk taking				
Risk weight density (avg: 48.7%)	-0.05*** (-3.42) R2 adj: 0.42	-0.015(*) (-1.07) R2 adj: 0.61	-0.07*** (-3.99) R2 adj: 0.36	-0.02(*) (-1.1) R2 adj: 0.59
Return on Equity (RoE) (avg: 13.8%)	Not significant	Not significant	0.05** (2.08) R2 adj: 0.13	Not significant
Loan loss rate (avg: 1.5%)	0.004*** (3.30) R2 adj: 0.1	0.002** (1.94) R2 adj: 0.36	-0.002*** (-1.67) R2 adj: 0.12	Not significant
Solvency of the banking system, i.e. systemic risk				
ZScore (avg: 18%)	-0.028*** (-3.05) R2 adj: 0.08	-.003*** (-3.39) R2 adj: 0.34	-0.021** (-2.07) R2 adj: 0.09	-0.024** (-2.36) R2 adj: 0.37
Price-to-book ratio (avg: 1.5)	-0.2** (-2.12) R2 adj: 0.44	-0.09(*) (-1.30) R2 adj: 0.66	-0.13(*) (-1.16) R2 adj: 0.41	-0.1(*) (-1.15) R2 adj: 0.65
EDF (avg: 0.68%)	0.0034** (2.15) R2 adj: 0.14	0.005** (2.23) R2 adj: 0.19	0.0023(*) (1.32) R2 adj: 0.11	0.004* (1.62) R2 adj: 0.16
SRisk to total assets (avg: 3.1%)	Not significant (post 2014: 0.015(*) (1.5)) (post '14) R2 adj: 0.14	Not significant (post 2014: 0.016(*) (1.31)) (post '14) R2 adj: 0.25	0.014(*) (1.48) R2 adj: 0.15	0.04** (2.27) R2 adj: 0.27

1/ we control for real GDP growth, general economic uncertainty, policy rates, the level of bank credit to GDP, bank leverage, and profitability.
Significance codes: ***: 1%; **: 5%; *: 10%; (*): 20%, t stats in parentheses

Table A3.3: Regression results for aging metric 2 (Population growth during the past 10 years) for time and country dummies only

Dependent variable	Deposits to total funding	Loans to assets	Deposits to loans	Risk weight density	Return on Equity	Loan loss rate	ZScore	Price-to-book ratio	EDF	SRisk to total assets
Cut-off year for aging metric	2014	2010	2010	2010	2010	2010	2010	2010	2010	2010
Agingdummy (β1) (1 for aging countries post 2010)	Not sign	-0.03(*)	0.05*	-0.05*	Not sig	Not sig	Not sig	Not sig	Not sig	Not sig
Observations	644	644	644	644	585	644	504	561	506	474
Number of countries	28	28	28	28	28	28	22	20	22	23
R^2 adjusted	0.39	-0.01	0.16	0.36	0.11	0.08	0.06	0.43	0.13	0.14
R^2 within	0.44	0.07	0.23	0.41	0.18	0.15	0.15	0.48	0.20	0.22
Year Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Country Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Significance codes: ***: 1%; **: 5%; *: 10%; (*): 20%

Note: aging dummy set to 1 for five countries with lowest 10 year population growth in 2022 (*Finland, Greece, Italy, Japan, Spain)*, otherwise 0.

Table A3.4: Additional results for aging metric 2 with and without macro-financial and bank controls subject to variation of "old" sample

Coefficient β1 Aging in Formula 1 and 2 Default cut-off year for aging: 2011	Metric 2: Population growth during the past 10 years, rolling (Finland, Greece, Italy, Japan, Spain)		Metric 2: Population growth during the past 10 years, rolling (Finland, Japan, Spain)	
	without macro / bank controls	with macro / bank controls[1]	without macro / bank controls	with macro / bank controls[1]
Banks' balance sheet structure				
Deposits to total funding (avg: 60%)	Not significant	-0.04*** (-1.73) R2 adj: 0.58	Not significant	-0.03** (-1.52) R2 adj: 0.59
Loans to assets (avg: 55%)	-0.03(*) (-1.45) R2 adj: -0.013	Not significant	-0.03(*) (-1.52) R2 adj: -0.011	-0.03(*) (-1.21) R2 adj: 0.13
Deposits to loans (avg: 99%)	0.05* (1.56) R2 adj: 0.16	Not significant	Not significant	Not significant
Banks' risk taking				
Risk weight density (avg: 48.7%)	-0.05(*) (-1.73) R2 adj: 0.36	-0.04(*) (-1.30) R2 adj: 0.52	-0.05* (-1.74) R2 adj: 0.35	-0.04(*) (-1.36) R2 adj: 0.5
Return on Equity (RoE) (avg: 13.8%)	Not significant	Not significant	Not significant	Not significant
Credit loss rate (avg: 1.5%)	Not significant	Not significant	Not significant	Not significant
Solvency of the banking system, i.e. systemic risk				
ZScore (avg: 18%)	Not significant	Not significant	Not significant	Not significant
Price-to-book ratio (avg: 1.5)	Not significant	Not significant	Not significant	Not significant
EDF (avg: 0.68%)	Not significant	Not significant	Not significant	Not significant
SRisk to total assets (avg: 3.1%)	Not significant	Not significant	Not significant	Not significant

1/ we control for real GDP growth, general economic uncertainty, policy rates, the level of bank credit to GDP, bank leverage, and profitability.
Significance codes: ***: 1%; **: 5%; *: 10%; (*): 20%, t stats in parentheses

Table A3.5: Differential impact of aging metric 1 on balance sheet structure metrics: Supplementary results

Dependent variable	Securities to Total Assets	Government securities to total assets	Foreign claims
Agingdummy ($\beta 1$) (1 for aging countries post 2010), oldest three economies, controlling for macro and bank effects	Not sign	Not sign	+**
Agingdummy ($\beta 1$) (1 for aging countries post 2010), oldest five economies, controlling for macro and bank effects	+***	Not sign	Not sign

Significance codes: ***: 1%; **: 5%; *: 10%; (*) : 20%

1/ Not significant if Italy and Greece are removed from the sample.

Note: aging dummy set to 1 for five countries with lowest ratio of active population to population above 65 in 2022, otherwise 0

Table A3.6: Marginal[1] differential impact of each of the covariates for aging metric 1, controlling for macro and bank characteristics

Dependent variable	ZScore	Price-to-book ratio	EDF	SRisk to total assets
Agingdummy x loans to assets	+(*)	+**	Not sign	-***
Agingdummy x deposits to loans	Not sign	-***	-***	+***
Agingdummy x risk weight density	- (*)	Not sign	Not sign	-***
Agingdummy x return on equity	Not sign	Not sign	-***	+**
Agingdummy x foreign claims	Not sign	Not sign	-*	Not sign
Agingdummy x share of securities	Not sign	Not sign	- (*)	Not sign
Agingdummy x share of government securities	Not sign	Not sign	-***	-(*)

Significance codes: ***: 1%; **: 5%; *: 10%; (*) : 20%

Note: aging dummy set to 1 for five countries with lowest ratio of active population to population above 65 in 2022, otherwise 0. The result is comparable for dropping Greece and Italy from the "old" sample.

[1] We add – one-by-one – the interaction terms shown in Table A3.6 to specification 2 shown in section III.

References

Aksoy, Yunus, Henrique S. Basso, Ron P. Smith, and Tobias Grasl, 2019, “Demographic structure and macroeconomic trends”, *American Economic Journal: Macroeconomics*, Vol.11, pp.193–222

Auclert, Adrien, Hannes Malmberg, Frederic Martenet, and Matthew Rognlie, 2021 “Demographics, wealth, and global imbalances in the twenty-first century”, *NBER Working Paper, 29161*

Baksa, Daniel and Zsuzsa Munkacsi, 2019, “More Gray, More Volatile? Aging and (Optimal) Monetary Policy" IMF Working Paper 198

Bakshi, G., and Z. Chen, 1994 “Baby boom population ageing, and capital markets.” *Journal of Business*, Vol. 67,pp.165–202

Basel Committee on Banking Supervision (BCBS), 2023, “Reducing variation in credit risk-weighted assets - constraints on the use of internal model approaches,”, Reducing variation in credit risk-weighted assets - constraints on the use of internal model approaches (bis.org).

Bloom, D.E., Canning, D., Fink, G. (2010). “Implications of population ageing for economic growth.” *Oxford Review of Economic Policy* Vol. 26 (4), 583–612. ISSN 1460-2121.

Borio, Claudio (2012), “The financial cycle and macroeconomics: what have we learnt?”, BIS Working Papers No 395.

Bodnar, Katalin, and Carolin Nerlich (2022). “The macroeconomic and fiscal impact of population ageing,”, ECB Occasional Papers No 296 / June 2022, The macroeconomic and fiscal impact of population ageing (europa.eu).

Bubeck, Johannes, Angela Maddaloni and José-Luis Peydró, 2020. "Negative Monetary Policy Rates and Systemic Banks' Risk-Taking: Evidence from the Euro Area Securities Register," *Journal of Money, Credit and Banking*, Vol. 52, pp. 197-231.

Case, A. and A. Deaton (2020) “Deaths of despair and the future of capitalism” (Princeton: Princeton University Press)

Causa, O., N. Woloszko and D. Leite (2019), “Housing, wealth accumulation and wealth distribution: Evidence and stylized facts”, OECD Economics Department Working Papers*, No. 1588*, https://doi.org/10.1787/86954c10-en.

Doerr, Sebastian, Kabaş, Gazi and Ongena, Steven (2022), “Population aging and bank risk-taking”, BIS Working Paper no 1050.

Dohmen, T, A Falk, B Golsteyn, D Huffman and U Sunde (2017), “Risk attitudes across the life course”, *Economic Journal* 127(605): F95-F116.

Economist (2023), “Global fertility has collapsed, with profound economic consequences - What might change the world’s dire demographic trajectory?, 1 June 2023, Global fertility has collapsed, with profound economic consequences (economist.com)

Franzen, D. (2010). “Managing Investment Risk in Defined Benefit Pension Funds”, OECD Working Papers on Insurance and Private Pensions, No. 38, OECD Publishing. doi: 10.1787/5kmjnr3sr2f3-en

Global Financial Stability Risk (2012). “The Financial Impact of Longevity Risk” https://www.elibrary.imf.org/display/book/9781616352479/ch004.xml

Hanewald, Katja, Hazel Bateman Hanming Fang and Tin Long Ho (2022) “Long-Term Care Insurance Financing Using Hone Equity Release: Evidence from an Online Experimental Survey” (NBER Working Paper No.29689)

Hanley, S. (2012). Chapter 2: Explaining the success of pensioners’ parties: a qualitative comparative study of 31 polities. In: Vanhuysse, P., Goerres, A. (Eds.), Ageing Populations in Post-industrial Democracies: Comparative Studies of Policies and Politics. Routledge, Oxford, pp. 23–53.

Heider, Florian, Saidi Farzad and Glenn Schepens, 2019. "Life below Zero: Bank Lending under Negative Policy Rates," *Review of Financial Studies*, Vol. 32, pp.3728-3761.

Horioka, C. (2020). "Does the Life Cycle Hypothesis Apply in the Case of Japan?," ISER Discussion Paper 1074, Institute of Social and Economic Research, Osaka University.

Horioka, Charles Yuji, Emin Gahramanov, Aziz Hayat and Xueli Tang (2021). "The impact of bequest motives on labor supply and retirement behavior in Japan: A theoretical and empirical analysis," Journal of the Japanese and International Economies, vol 62.

Horioka, C. and L. Ventura (2022). "Do the Retired Elderly in Europe Decumulate Their Wealth? The Importance of Bequest Motives, Precautionary Saving, Public Pensions, and Homeownership," AGI Working Paper Series 2022-08, Asian Growth Research Institute.

International Monetary Fund (2017), “Japan: Financial Sector Assessment Program-Technical Note-Long-Term Challenges for Financial Intermediation”, September.

Imam, Patrick (2013), “Demographic shift and the financial sector stability: the case of Japan”. *Journal of Population Ageing* Vol. 6 (4), 269-303

Imam, Patrick (2014), “Senior Shock” *Finance and Development*, March 2014, Vol. 51, No. 1, https://www.imf.org/external/pubs/ft/fandd/2014/03/imam.htm

Imam, Patrick and Christian Schmieder, 2024, “Funding of Banks in Aging and Shrinking Societies: Where are we headed? (in progress)

Isa, Tomoki (2021). “Demographic Effects on Prices: Is Aging Deflationary?” PRI Discussion Paper Series No.6 https://www.mof.go.jp/pri/research/discussion_paper/ron342.pdf

Jones, Randall, 2022, “The Japanese Economy: Strategies to Cope with a Shrinking and Ageing Population” (Routledge)

Pavol Jurca ; Ján Klacso ; Eugen Tereanu ; Marco Forletta ; Marco Gross, 2020 “The Effectiveness of Borrower-Based Macroprudential Measures: A Quantitative Analysis for Slovakia” https://www.imf.org/en/Publications/WP/Issues/2020/07/17/The-Effectiveness-of-Borrower-Based-Macroprudential-Measures-A-Quantitative-Analysis-for-49581

Kim, Seho, Pablo Lopez Murphy and Rui Xu (2023). “Drivers of Corporate Cash Holdings in Japan.” IMF Selected Issues Paper (SIP/2023/029). Washington, D.C.: International Monetary Fund.

Kotschy, Rainer and David Blom (2023). "Economic growth prospects in the face of population ageing,", VOXEU column, Economic growth prospects in the face of population ageing | CEPR.

Lee, R.D. (2003). The demographic transition: three centuries of fundamental change. *Journal of Economic Perspectives* Vol. 17 (4), pp. 167–190.

Lee, R.D.(2015). "Becker and the Demographic Transition" *Journal of Demographic Economics* V.81, pp.67-74.

Lee, Ronald and Andrew Mason (2017) "How demography contributes to slower economic growth in rich nations", *Finance & Development* (March) Vol. 54, No. 1.

Malmendier, U and S Nagel (2011), "Depression babies: Do macroeconomic experiences affect risk-taking?", *Quarterly Journal of Economics* 126(1): 373-416.

Mason, Andrew, Sang-Hyop Lee, Ronald Lee, and Gretchen Donehower, 2019, "Macroeconomics and Policies in Aging Societies", Economics of Population, David Bloom (editor), CEPR eBook.

Modigliani, Franco (1975). "The life-cycle hypothesis of saving twenty years later," in Michael Parkin, ed., Contemporary Issues in Economics, Manchester. Manchester University Press. Pp 2–35

Modigliani, F. (1986). Life cycle, individual thrift and the wealth of nations. American Economic Review,76(3), 297–313

Olshansky SJ, Carnes BA (2019). "Inconvenient Truths About Human Longevity". J Gerontol A Biol Sci Med Sci. 2019 Nov 13;74(Suppl_1):S7-S12. Inconvenient Truths About Human Longevity - PubMed (nih.gov)

Peng, Xiujian, (2022). "China's population is about to shrink for the first time since the great famine struck 60 years ago. Here's what it means for the world". https://theconversation.com/chinas-population-is-about-to-shrink-for-the-first-time-since-the-great-famine-struck-60-years-ago-heres-what-it-means-for-the-world-176377

Roy, Amlan, (2022). "Demographics Unravelled: How Demographics Affect and Influence Every Aspect of Economics, Finance and Policy" (Chichester: Wiley)

Schoemaker, P.J.H. (1993). "Determinants of risk-taking: Behavioral and economic views". Journal of Risk Uncertainty Vol. 6, pp.49–73.

Summers, L.H. (2014). Reflections on the 'new secular stagnation hypothesis'. In: Teulings, C., Baldwin, R. (Eds.), Secular Stagnation: Facts, Causes and Cures, A VoxEU.org eBook. Centre for Economic Policy Research (CEPR).

Summers, L.H. (2015). Demand side secular stagnation. Am. Econ. Rev. Pap. Proc. 105 (5), 60–65.

Sunde, Uwe (2023). "Age, longevity, and preferences" *Journal of the Economics of Ageing,* Vol.24, pp.100427

Xu, P (2015), "Risk Taking and Firm Growth", RIETI Discussion Paper 15-E-061. https://www.rieti.go.jp/en/publications/summary/15050016.html

UN (2022). "World Population Prospects 2022", available at

https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_summary_of_results.pdf

PUBLICATIONS