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Population Aging, Healthcare Expenditure and Public Debt Sustainability in OECD and EU Countries: A Systematic Review

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Abstract:

Purpose: *This study undertakes a systematic review of the empirical and theoretical literature to examine how demographic ageing and associated expenditure categories—most notably healthcare spending and pensions—shape public debt sustainability across OECD and European Union countries.*
Design/Methodology/Approach: *The study is grounded in a systematic literature review following the six-step framework proposed by Durach et al. The search covers the period from 2000 to 2025 using Scopus and Web of Science. A final sample of 18 high-quality studies was analysed using narrative thematic synthesis.*
Findings: *The review reveals three interconnected transmission mechanisms: direct expenditure pressures through age-related spending, indirect effects via intergenerational redistribution, and political economy dynamics crowding out public investment. The relationship between ageing and fiscal sustainability exhibits substantial nonlinearity conditional on institutional quality.*
Practical Implications: *Reconciling fiscal sustainability with adequate social protection in ageing economies requires coordinated structural reforms embedding demographic constraints within medium-term fiscal frameworks while preserving intergenerational equity.*
Originality/Value: *This review contributes a novel integrated framework bridging fragmented evidence across debt sustainability analysis methodologies, econometric approaches, and overlapping generations models, identifying convergence and divergence in empirical findings.*

Keywords: *Population Aging, Healthcare Expenditure, Public Debt, Fiscal Sustainability, OECD, EU.*

JEL Codes: *H51, H63, J11, I10.*
Paper type: *Research article.*

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1. Introduction

The demographic transition, unfolding across both advanced and emerging economies, is profoundly reshaping fiscal architectures. This transformation, does not operate through a single channel but rather through multiple, interacting mechanisms. Age-related expenditure profiles are being reconfigured while governments' capacity to mobilize public revenues is simultaneously, being redefined.

Across jurisdictions demographic projections converge toward a common expectation: population ageing will exert sustained upward pressure on health expenditure, and pension outlays as shares of GDP over the coming decades (Abio, 2006; Cylus *et al.,* 2022). This evolution is uneven. Changes in age structure also affect labour-force participation and the size of the tax base—an effect that becomes particularly salient in health-financing systems, heavily reliant on employment-linked contributions (Cylus *et al.,* 2022; Thalassinos *et al.,* 2019).

From an expenditure perspective the association is well established. A higher proportion of older individuals is systematically linked to higher per-capita health spending (Abio, 2006; Wang *et al.,* 2022). Yet, ageing alone does not suffice to explain observed trends. It accounts for only a limited share of the historical expansion in health expenditure. Other forces—often more influential—are at play.

Supply-side dynamics including technological diffusion, medical innovation, and increasing treatment intensity, have repeatedly shaped spending trajectories over time (Abio, 2006). On the revenue side, adjustment processes are no less complex. Demographic ageing may depress marginal returns to capital and constrain aggregate growth paths. This effects capital and pronounces in developing economies where demographic pressures interact with structural rigidities and institutional constraints (Yu *et al.,* 2024).

Taken together, these channels compress fiscal space. They reduce governments' room for manoeuvre making shock absorption more difficult, and discretionary policy more costly. Evidence from pension systems in developing and emerging markets reinforces this interpretation illustrating how demographic pressures translate into mounting implicit liabilities and strengthen the case for institutional reforms that redistribute actuarial risks across the state, employers, and households (Peleckis *et al.,* 2025).

In Europe, the challenge is particularly visible Demographic ageing poses a direct threat to long-run fiscal balance, with both the scale and the institutional architecture of welfare-state commitments playing a central role. Darvas *et al.* (2025) report that the old-age dependency ratio—34% in 2019—is projected to rise to 59% by 2070 across EU Member States. Uniformity, however, should not be assumed.

Cross-country heterogeneity remains substantial. Fiscal pressure is concentrated in age-related spending categories—pensions, healthcare, and long-term care (Darvas *et al.,* 2025). Consider public health expenditure projected increases of around 1.1 percentage points of GDP by mid-century may appear modest in isolation. In context, they are not. Their fiscal relevance intensifies once combined with weaker potential growth, and already elevated baseline expenditure commitments.

Evidence indicating that rising health expenditure can materially strain fiscal sustainability (Tang *et al.,* 2025) is therefore especially salient for European economies. Macroeconomic feedback effects further complicate the picture, amplifying sustainability risks. Mihajlović and Miladinov (2024) estimate that a one-percentage-point increase in the old-age dependency ratio is associated with a 0.52% decline in long-run GDP per capita growth. The implication follows directly: slower growth coincides with expanding age-related outlays.

This interaction lies at the core of public debt dynamics. It erodes the denominator of debt-to-GDP ratios while simultaneously reinforcing primary expenditure pressures. Empirical evidence is consistent with this mechanism. Ramos-Herrera and Sosvilla-Rivero (2020) find that higher old-age dependency ratios are associated with a deterioration in cyclically adjusted primary balances.

While magnitudes differ across specifications and identification strategies the direction of the relationship is robust. It points to a structural tension that existing fiscal frameworks may struggle to accommodate, without reforms capable of internalizing demographic constraints and containing expenditure drift.

Against this background this study undertakes a systematic review of the empirical, and theoretical literature. Its scope is deliberate. It examines how demographic ageing and associated expenditure categories—most notably healthcare spending and where relevant long-term care—shape public debt sustainability across OECD and European Union countries.

Consistent with PRISMA 2020 reporting guidance, the introduction sets out a clear rationale for the review and articulates explicit objectives to guide study selection and synthesis.

Specifically, the review aims to (i) delineate the theoretical transmission channels linking ageing, health spending, and debt dynamics (ii) assess the Debt Sustainability Analysis (DSA) frameworks and empirical strategies applied in OECD and EU contexts and (iii) synthesize key findings on how fiscal rules and structural reforms—spanning pensions, healthcare financing, and taxation—mediate long-run sustainability risks.

By organizing a dispersed evidence base characterized by heterogeneous methodologies and outcome definitions, the review highlights areas of convergence

and divergence, and identifies methodological gaps. On this basis, policy-relevant insights are derived on how fiscal sustainability may be reconciled with adequate social protection in ageing economies.

The following section details the systematic review methodology including the search strategy, selection criteria, quality assessment procedures, and thematic synthesis approach used to identify and analyse the evidence base.

2. Methodology

2.1 Systematic Review Protocol

This study is grounded in a systematic literature review. The objective is precise. To capture, in a transparent and replicable manner the existing body of research examining the relationship between population ageing and public debt sustainability, in OECD and European Union countries.

The review protocol follows the six-step framework proposed by Durach *et al.* (2017) which offers a coherent sequencing for identifying, screening, and synthesizing academic contributions while preserving sufficient flexibility to accommodate the specificities of macro-fiscal and demographic research (Table 1).

Table 1. *Systematic Analysis Protocol*

Step 1: Clear and precise definition of the research question or hypotheses
Main Research Question: How does the public economics literature analyse the impact of demographic ageing and associated expenditures (pensions, health, long-term care) on public debt sustainability in OECD and European Union countries?

- ***-H₁*:** What theoretical approaches and Debt Sustainability Analysis (DSA) frameworks are used to assess debt sustainability in OECD/EU countries, accounting for population ageing?
- ***-H₂*:** What main empirical findings emerge on the relationship between ageing, social expenditures (pensions, health, long-term care), and public debt trajectory in these countries?
- ***-H₃*:** What role do fiscal rules and reforms (pensions, health, taxation) play in managing long-term debt sustainability risks?
- ***-H₄*:** What economic policy implications does the literature highlight for reconciling fiscal sustainability and adequacy of social benefits in OECD/EU countries?

Step 2: Development of a detailed protocol, including inclusion and exclusion criteria and the required characteristics of primary studies
Inclusion Criteria:

- -Articles in academic peer-reviewed journals
- -Publications only in English
- -Period between 2000 and 2025
- -Studies covering at least one OECD or EU country, or OECD/EU group
- -Analyses explicitly linking debt/fiscal sustainability to ageing, pensions, health, or long-term social expenditures

-Theoretical, empirical (time series, panel, DSA, structural models), and relevant analytical reviews

Exclusion Criteria:

-Non-academic documents (institutional reports without complete scientific apparatus)

-Purely demographic articles without explicit link to debt/fiscal sustainability

-Studies focused on a single non-OECD/EU country (unless used for comparison)

-Book chapters, conference papers, unpublished studies, and theses

Step 3: Extensive literature search in selected databases according to defined keywords and retrieval of a sample of potentially relevant literature

-Databases: Scopus, Web of Science

-Search terms and keywords: ("public debt" OR "sovereign debt" OR "fiscal sustainability" OR "debt sustainability") AND ("ageing population" OR "population aging" OR "demographic change" OR "pension expenditure" OR "health expenditure" OR "long-term care") AND ("OECD" OR "European Union" OR "EU countries")

-Search within article title, abstract, and keywords

Step 4: Critical assessment of the quality and reliability of the selected studies based on predetermined criteria and selection of relevant literature

Step 5: Analysis and synthesis of data derived from the selected studies

Step 6: Presentation and interpretation of the review findings, highlighting their significance for the scientific community

Source: *Own study.*

Research objectives structure the review process. They guide the mapping of publication dynamics, the identification of influential authors and journals and the delineation of the main analytical streams shaping debates on ageing-related fiscal pressures. A detailed protocol is established ex ante. Inclusion and exclusion criteria are defined to preserve both relevance and analytical quality.

Only peer-reviewed journal articles published in English are retained. This restriction ensures international comparability and maximizes the accessibility of findings to the global research community. Grey literature is excluded, so are policy briefs and institutional reports. Studies lacking an explicit analytical link between demographic ageing and public debt sustainability are therefore omitted, even when demographic considerations are otherwise central.

The literature search relies on Scopus and Web of Science. This choice is consequential. Both databases provide broad multidisciplinary coverage and adhere to high-quality indexing standards (Mongeon and Paul-Hus, 2016). Advanced citation-tracking functionalities matter so do journal impact indicators which assist in identifying influential and methodologically robust contributions (Falagas *et al.,* 2008).

Scopus offers wider journal coverage overall, while Web of Science includes a higher concentration of highly cited core journals. The two databases thus complement rather than substitute one another (Mongeon and Paul-Hus, 2016).

Their combined use enhances completeness transparency and reproducibility, in line with best-practice guidance for systematic reviews (Page *et al.,* 2021).

The search covers the period from 2000 to 2025. This 25-year window captures the post-demographic-transition phase during which ageing-related fiscal pressures intensified across OECD and EU countries while ensuring sufficient data availability and methodological comparability. It reflects both the early emergence of demographic-fiscal concerns, and the more recent intensification of debt sustainability debates following successive macroeconomic shocks.

The search query combines terms related to public and sovereign debt, fiscal sustainability, and demographic change including pensions, health expenditure, and long-term care. Searches are restricted to titles, abstracts and keywords This design choice maximizes precision by targeting studies explicitly focused on the ageing–debt sustainability nexus and minimizes false positives arising from tangentially related research. No additional databases are considered.

Once assembled, the initial corpus undergoes a critical quality screening. Contributions failing to meet minimum standards of methodological rigor or analytical relevance are excluded. The remaining articles are examined in depth and synthesized. This process allows recurring patterns, converging findings and persistent gaps in the literature to be identified. Final interpretation emphasizes how population ageing shapes long-run debt sustainability in advanced economies—and where the evidence remains fragmented, ambiguous or inconclusive.

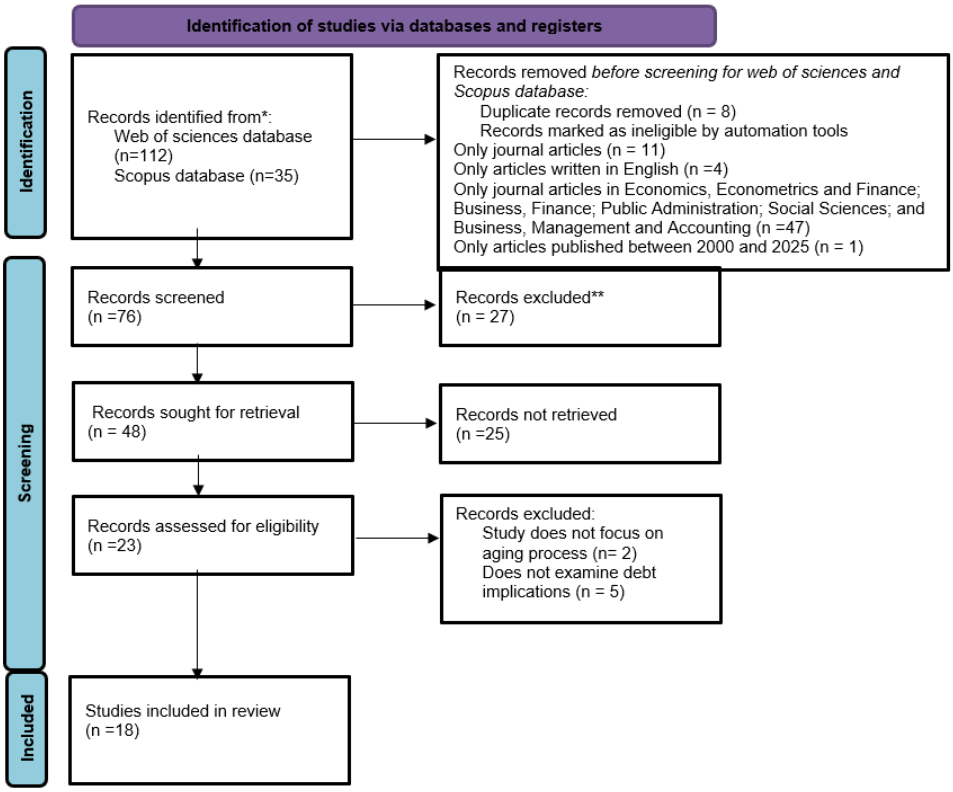
2.2 Search Strategy and Study Selection

The study selection process is summarized using a PRISMA 2020 flow diagram (Page *et al.,* 2021) in Figure 1. Identification constitutes the first stage. During this phase, 147 records are retrieved across the phase; automated duplicate screening removes 71 records. Screening follows at these stage 76 articles are assessed based on titles and abstracts.

Two independent reviewers (Author 1 and Author 2) screen all titles and abstracts. Disagreements are resolved through discussion. When consensus cannot be reached, arbitration by a third reviewer is used. This process leads to the exclusion of 27 contributions deemed unsuitable.

Full-text assessment is subsequently conducted on the remaining 49 studies, again independently by two reviewers. Geographic scope proves decisive, so does explicit engagement with fiscal sustainability. Several articles are excluded at this stage, notably those focusing exclusively on demographic trends without fiscal implications or those examining non-OECD and non-EU contexts. Inter-rater agreement is substantial with a Cohen's κ coefficient of 0.82 Eighteen primary studies satisfy all eligibility criteria and constitute the final sample (Table 4).

Figure 1. *Flow diagram of the study selection process (PRISMA 2020)*



Source: *Own study.*

Data extraction and quality criteria and sample is limited in size (n = 18):
This constraint is non-trivial. Substant criteria and heterogeneity characterize the included studies, spanning deterministic and stochastic Debt Sustainability Analysis frameworks, panel econometric approaches, overlapping-generations simulations and meta-analytical or survey-based contributions. Given this diversity, narrative thematic synthesis is deemed more appropriate than quantitative meta-analysis (Popay *et al.,* 2006).

The synthesis follows a deductive–inductive logic. Initial analytical themes are derived from four research hypotheses (H_1–H_4) specified in the review protocol (Table 1). These a priori themes are refined through iterative full-text reading, and systematic data extraction allowing emergent sub-themes and recurring analytical patterns to be identified and coded.

Thematic analysis reveals seven core themes structuring the literature on population ageing, and public debt sustainability in OECD and EU countries (Table 5). Several studies span multiple dimensions and are therefore classified under more than one theme reflecting the inherently interconnected nature of demographic, fiscal, and

macroeconomic processes. Each of the 18 studies is assigned to one or more thematic categories based on its primary focus and substantive contribution. Findings are extracted, compared across studies, and synthesized to highlight areas of convergence divergence, and methodological omission.

This classification provides the organizing backbone for the results section that follows. Each subsection presents a structured synthesis of evidence within a specific thematic domain The approach ensures transparency and reproducibility consistent with best-practice guidance for systematic reviews in public economics and applied social science (Booth *et al.,* 2016).

3. Bibliometric and Thematic Analysis Approach

The 18 selected studies exhibit a clear concentration in high-impact outlets. Over half of the articles (55.6%, n = 10) are published in Q1 journals while Q2 and Q3 journals account for 27.8% (n = 5) and 16.7% (n = 3) respectively. No studies appear in Q4 journals (Table 2). The sample spans 12 distinct journals.

Moderate concentration emerges at the top: Journal of International Money and Finance, and Economic Modelling each publish two articles (11.1%) while the remaining ten journals contribute one article each (5.6% individually) (Table 3).

This dispersion across publication venues—ranging from international finance and macroeconomic modelling to policy-oriented, and sustainability-focused journals—underscores the multidisciplinary character of research on the ageing–debt sustainability nexus.

Systematic quality appraisal is conducted using predefined criteria drawn from established methodological guidance (University of North Carolina at Chapel Hill, 2022; Shaheen *et al.,* 2023). Six dimensions are assessed: sample representativeness, temporal coverage, methodological rigor, data quality, control for confounding factors, and overall credibility (Wells *et al.,* n.d.).

Results are reported in Table 4. A large majority of studies (72.2%, n = 13) receive a "High" quality rating, while the remaining 27.8% (n = 5) are classified as "Medium" No study is rated as "Low".

High-quality studies consistently feature representative OECD/EU samples (typically 14–36 countries), extended temporal horizons (20–40 years), rigorous empirical methods—including Panel VAR, IV-2SLS, PSTR models, and stochastic DSA frameworks—and systematic control for confounding variables.

These characteristics reinforce the robustness and internal validity of the synthesized findings (Afonso and Jalles, 2015).

Table 2. *Distribution of Included Studies by Journal Quartile*

Quartile	**Number of Articles**	**Percentage**
Q1	10	55.6%
Q2	5	27.8%
Q3	3	16.7%
Q4	0	0%
Total	**18**	**100%**

Source: *Own study.*

Table 3. *Distribution of Included Studies by Journal*

Rang	**Journal**	**Nombre d'articles**	**Pourcentage**	**Quartile**
1	Journal of International Money and Finance	2	11.1%	Q1
1	Economic Modelling	2	11.1%	Q1
2	Panoeconomicus	1	5.6%	Q2
2	International Journal of Health Care Finance and Economics	1	5.6%	Q2
2	Competition & Change	1	5.6%	Q2
2	Journal of Policy Modeling	1	5.6%	Q1
2	Economic Computation and Economic Cybernetics Studies and Research	1	5.6%	Q3
2	European Research Studies Journal	1	5.6%	Q2
2	Macroeconomic Dynamics	1	5.6%	Q1
2	Journal of the Economics of Ageing	1	5.6%	Q2
2	Applied Economics	1	5.6%	Q2
2	Journal of Macroeconomics	1	5.6%	Q2
2	Ekonomicky Casopis	1	5.6%	Q2
2	Sustainability (MDPI)	1	5.6%	Q2
2	European Journal of Political Economy	1	5.6%	Q1
2	Socio-Economic Planning Sciences	1	5.6%	Q1

Source: *Own study.*

Table 4. *Methodological Quality Assessment of Included Studies*

Authors	**Year**	**Sample/Countries**	**Time Period**	**Methodology**	**Data Quality**	**Control Variables**	**Overall Quality Score**
Cho & Lee	2022	14 European countries	1970-2014	Panel Smooth Transition Regression (PSTR)	High	Yes	High
Popescu et al.	2018	EU-28	2016	PCA, MCA	High	Yes	Medium
Darvas et al.	2025	EU-27	2025-2052	Stochastic and deterministic DSA	High	Yes	High
Heylen et al.	2024	OECD-17	1981-2018	Panel data fixed effects, IV-2SLS	High	Yes	High
Honda & Miyamoto	2021	OECD-19	1985-2018	Local Projection Method (LPM)	High	Yes	High

Popa et al.	2022	CEEC-6 (Central and Eastern Europe)	2008-2018	OLS pooled, Fixed effects, Cross-section and period fixed effects	High	Yes	Medium
Cho & Rhee	2024	OECD-24	1985-2019	Local Projection Method (LPM), State-dependent	High	Yes	High
Culotta et al.	2022	Liguria Region (Italy)	2015-2019	Lifetables, Bootstrapping, Tax/subsidy rates	High	Yes	Medium
Cho & Lee	2025	OECD-15	2002-2019	Panel Smooth Transition Regression (PSTR)	High	Yes	High
Verbič & Spruk	2014	OECD-33 (30 OECD + 3)	1998-2008	IV-2SLS Fixed effects	High	Yes	High
An et al.	2016	OECD-21	1980-2005	Panel linear Fixed effects	High	Yes	High
Silva et al.	2024	OECD-26	1995-2019	PARDL + PQARDL	High	Yes	High
Mihajlović & Miladinov	2024	CEE-8 emerging economies	1990-2019	ARDL PMG estimator	High	Yes	High
Jäger & Schmidt	2016	OECD-19	1971-2007	Panel cointegration (DOLS + ECM)	High	Yes	High
El Mekkaoui & Martins	2014	OECD-22	1970-2009	Life-cycle model + Panel	High	Yes	High
Fernández-Bastidas & Pycroft	2025	EU-5 (DE, FR, IT, ES, PL)	2022-2070 (projections)	OLG Dynamic General Equilibrium	High	Yes	High
Kranke & Yarrow	2024	World Bank + EU institutions	Contemporary	Qualitative documentary analysis	High	Yes	Medium-High
Bayar	2013	EU-27	2010-2060 projections)	Descriptive + AWG projections	High	Yes	Medium-High

Source: *Own study.*

Table 5. *Thematic Classification of Included Studies*

Theme title	Included studies (authors, year)
1. Debt Sustainability Analysis (DSA) frameworks and projection methodologies	Darvas et al. (2025); Kranke and Yarrow (2024)
2. Econometric evidence on the ageing–debt–growth nexus	Cho and Lee (2022); Mihajlović and Miladinov (2024); Jäger and Schmidt (2016)

3. Health expenditure and fiscal sustainability	Popescu et al. (2018); An et al. (2016); Silva et al. (2024)
4. Pension systems, demographic ageing, and structural reforms	Verbič and Spruk (2014); Cho and Lee (2025); Culotta et al. (2022); Fernández-Bastidas and Pycroft (2025); El Mekkaoui de Freitas and Oliveira Martins (2014); Bayar (2013)
5. Fiscal policy effectiveness and fiscal multipliers in ageing economies	Honda and Miyamoto (2021); Cho and Rhee (2024)
6. Population ageing and public investment dynamics	Jäger and Schmidt (2016)
7. Institutions, governance, and fiscal rules	Popa et al. (2022)

Source: *Own study.*

4. Research Results and Discussion

4.1 DSA Frameworks and Projection Methodologies

Debt sustainability analysis (DSA) frameworks constitute essential instruments for assessing the impact of population aging on European fiscal viability (Darvas *et al.,* 2025; Kranke and Yarrow, 2024). Darvas *et al.* (2025) applied the EU's new DSA framework (Regulation 2024/1263) to all 27 member states, integrating stochastic simulations (probability ≥70% of debt decline over 5 years) and deterministic simulations (stress tests over 10 years) (Darvas *et al.,* 2025; Kranke and Yarrow, 2024).

Their projections through 2052 reveal that required structural primary balance adjustments reach 2–4% of GDP during the initial period (2025–2031), with aging costs progressively absorbing fiscal capacity and exerting historically high pressures on non-aging-related budget components (Darvas *et al.,* 2025).

Alternative scenarios demonstrate that increased labour market participation among 55–74-year-olds and enhanced immigration partially mitigate these pressures (Darvas *et al.,* 2025; Kranke and Yarrow, 2024). However, Kranke and Yarrow deconstruct these quantitative methodologies, arguing that they function as anticipatory governance devices that circumscribe national policy space by transforming fundamental uncertainty into seemingly measurable risks, blending consensual demographic projections with contested neoliberal macroeconomic assumptions, and excluding a priori alternatives such as massive public investment or fiscal union (Kranke and Yarrow, 2024).

These analyses reveal the tension between technical rigor and normative presuppositions in contemporary DSA frameworks (Kranke and Yarrow, 2024).

4.2 Econometric Analyses of Ageing-debt-growth Nexus

Econometric evidence reveals complex nonlinear relationships between population aging, public debt, and economic growth across European contexts, with institutional quality and fiscal frameworks critically mediating demographic pressures (Cho and Lee, 2022; Mihajlović and Miladinov, 2024; Cristea and Thalassinos, 2016). Cho and Lee analysed 14 European countries (1970–2014) using Panel Smooth Transition Regression (PSTR) with aging as the transition variable, demonstrating that demographic change produces divergent fiscal outcomes conditional on governance capacity (Cho and Lee, 2022).

In non-crisis countries (Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Sweden, UK), the marginal response of primary balance to debt (MRPS) increased with aging and remained positive, satisfying Bohn's sufficient conditions for fiscal solvency, whereas crisis countries (Greece, Ireland, Italy, Portugal, Spain) exhibited declining and negative MRPS despite facing similar demographic pressures (Cho and Lee, 2022).

The long-run elasticity of pension and health expenditures to aging reached approximately 1.21 in crisis countries compared to 0.49 in non-crisis countries, reflecting slower adjustment mechanisms and less effective social security reforms (Cho and Lee, 2022).

Mihajlović and Miladinov employed panel ARDL methodology across eight Central and Eastern European emerging economies (2000–2020), revealing that a 1% increase in the old-age dependency ratio reduced GDP per capita growth by 0.52% and total GDP growth by 0.53% in the long run, with impacts more pronounced in emerging than advanced economies (Mihajlović and Miladinov, 2024).

Extending this nexus to public investment, and extending this nexus to the interest-growth differential, Heylen *et al.* (2024) demonstrated through panel regression analysis with country fixed effects across 17 OECD countries (1981–2018) that aging populations, particularly those aged 75 and above, increase interest-growth differential through dis-saving effects, while increased life expectancy and total factor productivity growth reduces interest-growth differential with projections indicating negative interest-growth differential over the next two decades in Europe but positive interest-growth differential in the United States, and debt-to-GDP ratios above 90% raising interest-growth differential by approximately 3 basis points per GDP point (Heylen *et al.,* 2024).

4.3 Health Expenditure and Fiscal Sustainability

Empirical evidence illuminates complex interactions between health expenditure dynamics, fiscal conditions, and sustainability pressures in European contexts (Popescu *et al.,* 2018; An *et al.,* 2016). Popescu *et al.* (2018) constructed a

composite health system performance index via Principal Component Analysis across EU-28 countries, examining relationships between health outcomes (life expectancy, mortality indicators, healthcare access) and fiscal sustainability measures (debt-to-GDP ratios, budget balances) (Popescu *et al.,* 2018).

Their analysis revealed significant variability in health system performance and fiscal sustainability across member states, with aging demographics exerting mounting pressure on public health expenditures while technological investments and pharmaceutical costs compound fiscal strains (Popescu *et al.,* 2018).

Extending this nexus, An, Zhao, and Zhou (2016) employed panel fixed-effects models across 21 OECD countries (1980-2005), demonstrating that public pension expansion constitutes a significant determinant of aggregate health spending through intergenerational redistribution mechanisms: a 1% increase in public pension payments per elderly person generated approximately 0.30–0.35% increases in per capita health expenditures, explaining over one-fifth (21%) of observed health spending growth during the period (An *et al.,* 2016).

Critically, income elasticity remained below unity (0.66–0.80), indicating healthcare is not a luxury good, while demographic aging variables showed non-significant direct effects (An *et al.,* 2016). Silva *et al.* (2024) advanced this literature through Panel ARDL and Panel Quantile ARDL methodologies across 26 European OECD countries (1995-2019), revealing strong public-private substitutability: 1% increases in public health expenditures reduced private spending by 0.13% (long-run), with effects more pronounced at higher private expenditure quantiles (-0.23% at 90th quantile) (Silva *et al.,* 2024).

Fiscal consolidation (improved budget balances) reduced private health spending by 4.21% long-term through disposable income channels, while elevated public debt (>60% GDP) increased private expenditures by 0.21%, raising equity and universal health coverage concerns (Silva *et al.,* 2024).

4.4 Pension Systems and Structural Reforms

Empirical evidence across OECD and European contexts reveals multifaceted interactions between demographic aging, institutional quality, actuarial equity, and gender dynamics in determining pension sustainability trajectories (Verbič and Spruk, 2014; Cho and Lee, 2025).

Verbič and Spruk employed panel fixed-effects with instrumental variable estimation across 33 OECD countries (1998-2008), establishing critical parametric reform elasticities: each one-year increase in effective retirement age reduced pension expenditures by 0.26-0.36% of GDP, while one additional child per woman decreased pension spending by 2.9% of GDP through extended contribution bases.

Conversely, one-year life expectancy gains increased expenditures by 0.28-0.31% of GDP (0.40-0.58% when measured at age 65), with one-percentage-point dependency ratio increases generating 0.07-0.14% GDP spending pressures (Verbič and Spruk, 2014).

Extending nonlinear governance analysis, Cho and Lee (2025) demonstrated through Panel Smooth Transition Regression across 15 OECD economies (2002-2019) that aging's negative impact on pension sustainability (net contribution ratios) intensified significantly under weak government effectiveness (threshold $\gamma=1.713$): the old-age dependency ratio coefficient reached -4.126 ($p<0.05$), with government effectiveness moderating effects at +0.356 ($p<0.10$), though unable to fully offset demographic pressures (Cho and Lee, 2025).

Actuarial fairness concerns emerged prominently in Culotta et al.'s Italian Liguria study (2015-2019), where employed populations exhibited 0.86-year greater life expectancy at retirement ages (65-75) than general populations, generating implicit subsidies of 6.24% through uniform national longevity factors in NDC systems—violating actuarial neutrality and creating intergenerational inequities while threatening fiscal sustainability (Culotta *et al.,* 2022).

Gender equity dimensions proved substantial through Fernández-Bastidas and Pycroft's dynamic general equilibrium simulations across five major EU countries: complete employment gap closure over 30 years reduced payroll tax requirements by 0.8 percentage points (Germany) to 5.0 points (Italy)—magnitudes comparable or superior to two-year retirement age delays, with Italian effects (12% labour supply increase) exceeding parametric reforms (Fernández-Bastidas and Pycroft, 2025).

Complementing structural reforms, El Mekkaoui de Freitas and Oliveira Martins documented across 22 OECD countries (1970-2009) that one-percentage-point increases in replacement rates reduced household saving rates by 1.089 points, while health expenditure increases of 1% GDP decreased savings by 0.95 points—nearly one-for-one displacement—indicating welfare state expansion crowds out private savings with fiscal sustainability implications (El Mekkaoui de Freitas and Oliveira Martins, 2014).

Bayar's EU-27 assessment confirmed reform heterogeneity: pre-2010 parametric adjustments (retirement age indexation, benefit formula modifications) limited projected 2010-2060 expenditure growth to 14.2% despite dependency ratio doubling (26% to 52.5%), though country-specific trajectories varied dramatically (Luxembourg +103%, Italy -reduction) (Bayar, 2013).

4.5 Fiscal Policy Effectiveness and Multipliers

Empirical evidence reveals demographic aging fundamentally alters fiscal multiplier magnitudes through employment channel disruptions, with debt levels critically

moderating effects in non-aged economies (Honda and Miyamoto, 2021; Cho and Rhee, 2024).

Honda and Miyamoto employed state-dependent local projections across 19 OECD countries (1985-2018), demonstrating that aging economies (old-age dependency ratio ≥23.5%) exhibited statistically insignificant fiscal multipliers regardless of business cycle conditions, while non-aged economies showed pronounced cyclical variation: recession multipliers reached 2.2 on impact versus 1.2 (non-significant) in aged economies, with employment channels completely blocked in aged contexts due to insufficient working-age populations (Honda and Miyamoto, 2021).

Extending this analysis to debt interactions, Cho and Rhee documented across 24 OECD economies (1985-2019) that high public debt (≥60% GDP) generated contractionary multipliers (-2.0 impact, -3.5 cumulative year-4) in non-aged economies through Ricardian channels, contrasting sharply with expansionary low-debt multipliers (+3.1 impact, +5.8 year-4).

Critically, aged economies demonstrated policy ineffectiveness across all debt regimes, with consumption, investment, employment, and business confidence channels uniformly non-responsive implications demanding fiscal space construction during economic expansions before demographic transitions advance (Cho and Rhee, 2024).

4.6 Public Investment and Capital Accumulation

Demographic aging generates substantial crowding-out effects on public capital formation through political economy mechanisms favouring consumption-oriented elderly voters (Jäger and Schmidt, 2016). Jäger and Schmidt employed panel cointegration analysis across 19 OECD countries (1971-2007), demonstrating that each one-percentage-point increase in the elderly share (population aged 65+) reduced public investment ratios by 0.88–1.74% of GDP, with aging explaining over half of observed public investment decline during the period.

Long-run Granger causality flowed exclusively from aging to investment without reverse causation, robust to controls for public debt, GDP per capita, private investment, and population size. Functional decomposition revealed strongest reductions in economic affairs infrastructure (34.7% of total public investment) and education (15.8%), while health investments (7.0%) proved less affected—indicating intergenerational distributional shifts prioritizing current consumption transfers over future-oriented capital accumulation (Jäger and Schmidt, 2016).

4.7 Institutions, Governance, and Fiscal Rules

Institutional quality and governance effectiveness critically determine social insurance budget sustainability in transition economies facing demographic

pressures (Popa *et al.,* 2022). Popa *et al.* employed panel OLS fixed-effects models across six Central and Eastern European countries (2008–2018), demonstrating that governance indicators exerted substantial impacts on social insurance revenues (% GDP): regulatory quality coefficients reached +3.68 to +3.91, while corruption control generated effects of +4.26.

Conversely, excessive tax burdens reduced revenues by −0.136 to −0.158 percentage points through underground economy expansion. Business freedom showed positive but weaker associations (+0.068), whereas labour freedom proved statistically insignificant. Overall, governance quality and regulatory capacity outweighed economic freedom measures in sustaining contributory social insurance systems under aging and emigration pressures (Popa *et al.,* 2022).

Table 6. *Summary Table of Main Findings*

Theme	Included Studies	Key Quantitative Results	Main Implications
1. Debt Sustainability Analysis (DSA) frameworks	Darvas et al. (2025); Kranke & Yarrow (2024)	Structural primary balance adjustments: 2-4% of GDP (2025-2031); old-age dependency ratio: 34% (2019) to 59% (2070) in EU-27	Alternative demographic scenarios (enhanced immigration, labor participation aged 55-74) partially mitigate fiscal pressures; DSA frameworks embed institutional assumptions that constrain policy space
2. Ageing-debt-growth nexus	Cho & Lee (2022); Mihajlović & Miladinov (2024); Heylen et al., (2024)	1% increase in old-age dependency ratio reduces GDP per capita growth by 0.52%; 1 percentage point increase in elderly share reduces public investment by 0.88–1.74% of GDP; long-run elasticity of pension/health spending 1.21 in crisis countries versus 0.49 in non-crisis countries; aging population 75+ increases r−g; debt-to-GDP above 90% raises r−g by approximately 3 basis points per GDP poin	Early fiscal rules and effective social security reforms moderate expenditure sensitivity; institutional quality critically mediates demographic pressures; political economy favors consumption over capital formation; higher life expectancy and TFP growth reduce aging-driven r−g increases
3. Health expenditure and fiscal sustainability	Popescu et al. (2018); An et al. (2016); Silva et al. (2024)	1% increase in public pensions raises health expenditure by 0.30-0.35%, explaining 21% of spending growth (1980-2005); public debt above 60% of GDP increases private health spending by 0.21 percentage points; income elasticity: 0.66-0.80 (below unity)	Pension system expansion drives health spending through redistribution channels; high debt threatens universal coverage via household burden shifting; coordination between pension and health policies necessary
4. Pension	Verbič &	1 year increase in retirement	Parametric reforms

systems and structural reforms	Spruk (2014); Cho & Lee (2025); Culotta et al. (2022); Fernández-Bastidas & Pycroft (2025); El Mekkaoui & Martins (2014); Bayar (2013)	age reduces pension spending by 0.26-0.36% of GDP; gender employment gap closure reduces required contributions by 0.8-5.0 percentage points; 1 percentage point increase in replacement rate reduces household savings by 1.09 percentage points	(retirement age, benefit formulae) and gender-focused labor policies enhance sustainability; government effectiveness moderates demographic pressures but cannot fully offset them; actuarial fairness requires socio-occupational differentiation
5. Fiscal policy effectiveness and multipliers	Honda & Miyamoto (2021); Cho & Rhee (2024)	Aged economies (old-age dependency ratio ≥23.5%): fiscal multipliers statistically insignificant across all business cycle states; recession multipliers: 2.2 (non-aged) vs 1.2 (aged, non-significant); high debt (≥60% GDP): multiplier -2.0 on impact (non-aged economies)	Employment channels blocked in aged economies due to insufficient working-age population; fiscal stimulus ineffective in aged contexts regardless of debt levels; fiscal space construction necessary before demographic transitions advance
6. Public investment dynamics	Jäger & Schmidt (2016)	1 percentage point increase in elderly share reduces public investment by 0.88-1.74% of GDP; ageing explains over 50% of observed investment decline (1971-2007); infrastructure (-34.7%) and education (-15.8%) most affected	Political economy mechanisms systematically crowd out public capital formation; intergenerational conflicts favor current consumption transfers over future-oriented investment; long-run growth implications substantial
7. Institutions, governance, and fiscal rules	Popa et al. (2022)	Regulatory quality improvements: +3.68 to +3.91 percentage points of GDP on social insurance revenues; corruption control: +4.26 percentage points; tax burden increases: -0.14 to -0.16 percentage points; model fit: R^2=0.49-0.76	Governance quality and regulatory capacity dominate economic freedom measures in sustaining social insurance systems; excessive taxation drives underground economy expansion; institutional effectiveness critical under demographic pressures

Source: *Own study.*

This systematic review brings together findings from 18 high-quality studies on demographic ageing, healthcare expenditure, and public debt sustainability in OECD and EU countries, population ageing exerts multifaceted pressures on public finances, not only through spending but also via revenue channels, institutional quality matters and policy design can either amplify or mitigate these effects, the required fiscal adjustment varies across countries, shaped by demographic trends, welfare state structures, and reform capacities.

Seven interconnected themes emerge in the literature on ageing and debt, empirical evidence is clear, rising old-age dependency ratios generate strong fiscal pressures, across EU member states structural primary balance adjustments of 2–4% of GDP are projected for 2025–2031 (Darvas *et al.,* 2025).

OECD projections echo this trend, public health spending may jump from 8.8% of GDP in 2018 to 11.2–11.8% by 2040 (Heylen *et al.,* 2024; Popescu *et al.,* 2018), growth often fails to keep up with spending, revenue alone is insufficient to close the gap, micro-level studies and macro forecasts align, the fiscal trajectory looks robust but alarming.

The ageing-debt relationship is far from linear, crisis-hit countries show expenditure elasticities around 1.21, more than double the 0.49 in non-crisis nations (Kranke and Yarrow, 2024), same demographic shift, drastically different outcomes, governance and reform implementation make the difference. Cho and Lee (2025) anticipated this, demographics alone do not dictate fiscal sustainability, past work shows old-age dependency raises cyclically adjusted primary balances (Darvas *et al.,* 2025), institutions determine whether pressures become crises or manageable adjustments.

Three transmission mechanisms dominate, first, direct expenditure channels such as pensions and healthcare expand mechanically as populations age, emerging European economies feel this acutely, +1% old-age dependency reduces long-run GDP per capita growth by 0.52% (Mihajlović and Miladinov, 2024), the scissors effect emerges as spending rises while growth weakens.

Second, health expenditure dynamics, ageing alone is not the sole driver, pension expansion fuels healthcare spending, +1% pension per elderly person generates +0.30–0.35% per capita health expenditure (An *et al.,* 2016), this explains 20% of observed health growth between 1980–2005, income elasticity below 1 (0.66–0.80) signals healthcare is not a luxury, policy interdependencies are substantial.

Third, political economy mechanisms, elderly populations crowd out investment, OECD panel data show +1% elderly share reduces public investment by 0.88 to 1.74% of GDP (Jäger and Schmidt, 2016), infrastructure and education are hit hardest while healthcare remains relatively protected, intergenerational conflict drives this outcome, older cohorts favour current consumption over future growth.

Policy implications are clear, parametric pension reforms are effective, raising retirement age by 1 year reduces pension spending by 0.26 to 0.36% of GDP (Verbič and Spruk, 2014), gender-focused labour market policies may have even stronger effects, closing employment gaps reduces payroll tax contributions by 0.8–5% (Fernández-Bastidas and Pycroft, 2025), reform hierarchy may need reconsideration, labour market interventions sometimes outperform pension tweaks.

Healthcare financing requires integrated approaches, high public debt exceeding 60% of GDP shifts costs to households, raising private health spending by 0.21% (Silva *et al.,* 2024), public-private interactions matter, +1% public health spending reduces private spending 0.13–0.23% long-term, fiscal restraint can backfire.

Fiscal stimulus is less effective in aged economies, old-age dependency ≥23.5% leads to multipliers near zero (Honda and Miyamoto, 2021), working-age population bottlenecks block Keynesian channels, fiscal space must be built early, not during crises.

Limitations exist, only 18 studies with heterogeneous methods (deterministic vs. stochastic DSA, panel models, OLG simulations, meta-regressions), narrative synthesis introduces subjectivity, OECD/EU focus limits global generalizability (Darvas *et al.,* 2025; Kranke and Yarrow, 2024; Cho and Lee, 2022; Heylen *et al.,* 2024; Popescu *et al.,* 2018), temporal coverage varies, pre-COVID studies may misestimate current realities, climate change and productivity effects often ignored (Popa *et al.,* 2022), causal inference remains challenging, endogeneity, reverse causality, unobserved confounders persist (Kranke and Yarrow, 2024; Cho and Lee, 2025).

Future research priorities emerge, compare healthcare financing models including public-private mixes, technology diffusion, and demand beyond demographics (Popescu *et al.,* 2018; An *et al.,* 2016; Silva *et al.,* 2024), examine governance as a moderator and political economy of reform adoption, investigate intersectional transitions such as digitalization, climate, and geopolitics (Cho and Lee, 2025; Popa *et al.,* 2022), subnational fiscal analyses are needed, methodological innovation such as machine learning, regime-switching, and nonlinear thresholds can identify when ageing triggers crises versus manageable adjustments (Kranke and Yarrow, 2024; Mihajlović and Miladinov, 2024; Cho and Lee, 2025).

5. Conclusions, Proposals, Recommendations

This systematic review synthesized evidence from 18 high-quality studies examining how demographic ageing and healthcare expenditure shape public debt sustainability across OECD and European Union countries.

The principal findings reveal three interconnected transmission mechanisms: direct expenditure pressures through age-related spending categories, indirect effects via intergenerational redistribution channels linking pension and healthcare systems, and political economy dynamics systematically crowding out public investment in aged societies.

Critically, the relationship between ageing and fiscal sustainability exhibits substantial nonlinearity conditional on institutional quality, with crisis-affected

countries displaying expenditure elasticities more than double those observed in non-crisis jurisdictions despite confronting comparable demographic transitions.

The review contributes a novel integrated framework bridging fragmented evidence across debt sustainability analysis methodologies, econometric approaches, and overlapping generations models. By systematically mapping seven thematic research streams and identifying convergences and divergences in empirical findings, the synthesis addresses persistent knowledge gaps regarding mechanism heterogeneity across institutional contexts.

For policymakers, the evidence demonstrates that parametric pension reforms and gender-focused labour market interventions yield comparable fiscal sustainability gains, challenging conventional reform hierarchies. Theoretically, the findings invalidate monocausal demographic explanations, revealing that pension system design independently drives healthcare expenditure trajectories through income redistribution mechanisms.

Several limitations warrant acknowledgment. Geographic concentration on OECD/EU contexts constrains generalizability to emerging economies, while methodological heterogeneity precluded quantitative meta-analysis. Temporal coverage variations mean some studies predate pandemic-induced fiscal disruptions that may have altered baseline conditions.

Future research should prioritize comparative healthcare financing analyses accounting for public-private configurations, institutional mechanisms moderating demographic pressures, and intersectional examinations of how ageing interacts with digitalization and climate adaptation. Subnational fiscal sustainability investigations and machine learning approaches for identifying nonlinear thresholds represent promising methodological frontiers.

Ultimately, reconciling fiscal sustainability with adequate social protection in ageing economies requires coordinated structural reforms embedding demographic constraints within medium-term fiscal frameworks while preserving intergenerational equity. The evidence base assembled here provides rigorous foundation for such policy design.

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