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Review

Research on China's population aging and financial sustainability: A systematic literature review

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Abstract: The systematic literature review presented in this paper is aimed at analyzing the articles on the topic of population aging and financial sustainability in China and answering two general questions: How do various studies define financial sustainability? What effect does the aging of its population have on financial sustainability? The results show that academic definitions of financial sustainability could be classified into three aspects including, macro, meso, and micro. The macro level focuses on socioeconomic stability on the long term and intergenerational equity; the meso one is based on the actuarial balance and solvency of the pension systems, and the micro level is the concerns regarding the welfare of the individual and the elimination of elderly poverty. The paper also includes that aging population is having a direct effect to the financial sustainability in terms of declining the contributor, raising the pension spending and dependency ratio. At the same time, other drivers such as policy interventions (e.g., delayed retirement, fertility support), economic growth, population migration and technological change will act in a synergistic way with aging to determine financial sustainability. Despite the research existing, despite suggesting various reform avenues, the majority of scholars argue that there is no one policy that could be used to fully tackle the problem of financial stresses on pension systems in the long run. Rather, they need multidimensional systemic comprehensive reform strategies. Additional demographic, economic, and social considerations should be incorporated in the future study to build a more solid pension system model that will be able to handle the aging issues in China that are getting more serious.

Keywords: population aging; financial sustainability; pension system

1. Introduction

In today's world, all nations face the severe challenge of accelerating population aging, primarily driven by persistently declining fertility and birth rates alongside continuously increasing life expectancy [1]. The ageing population has passed the 1.2 billion mark and is estimated to hit 2.1 billion by the year 2050 according to the world ageing population-prospects 2024-report which is a 75% increase in the elderly population in 26 years [2]. The situation with China is even more pressing. The statistics available in the National Bureau of Statistics of China reveal that, the Chinese population of 60 and above was 310.31 million, representing 22.0 percent of total population as at the end of 2024.This marks China's entry into the stage of moderate aging [3].

The rate of population aging is increasing and the governments need to offer proper pensions and care to an increasing number of the elderly besides making the current pension schemes financially sustainable in the long term. The welfare of the

older adults can be protected by adequate personal savings and pensions which can also improve their life. But in the absence of fair and sustainable pension schemes, there is a great challenge to both the individuals and general economy due to escalated expenses on pensions, medical and long-time care thus exposing them to even greater risk of being poor later in life [4].

Sustainability has become a key discussion point across numerous issues [5–7]. The concept of sustainability widely accepted in academia is that individuals should meet their own needs without compromising the ability of future generations to meet theirs [8,9]. This concept encompasses three dimensions: Ecological, social, and economic. Precisely because sustainability incorporates multidimensional factors, it is widely applied to assess a range of significant contemporary trends [10]. In aging research, scholars' focus on sustainability has primarily centered on fiscal sustainability [11].

Population aging brings a series of hidden risks and negative impacts, such as slowing economic growth, diminishing demographic dividends, increased payment pressures on pension and medical insurance funds, and even potential payment crises [12], posing severe challenges to the sustainable development of society and the economy [13]. Although China has established a basic pension insurance system, the pension system continues to face pressures and risks including slowing economic growth [14], substantial hidden debt [15], high and annually increasing pension levels for urban employees and retired personnel from government agencies and public institutions [16], broad coverage with difficulties in expanding coverage [17], significant regional disparities in benefits [18], and weak contribution revenues [19]. Therefore, from a long-term perspective, China's financial sustainability faces complex and profound challenges.

This study reviews existing research on China's population aging and financial sustainability. The discussion centers on two core questions: First, how do different studies interpret financial sustainability? Second, what relationship exists between population aging and financial sustainability? These questions are not only useful in assisting researchers to construct a base upon which future debates on financial sustainability in aging societies can be made fundamentally based on but at current point amidst the accelerated global aging, they allow the research on China to offer insights useful to other countries confronting the issues of aging.

2. Research design and methods

This paper reviews relevant literature on population aging and financial sustainability, aiming to analyze the current state of research in this field through a systematic literature review [20]. Until now, a systematic literature review is a method of research where researchers undergo the screening of literature, its analysis, and documentation of literature based upon a set of predefined search methods and inclusion/exclusion criteria in response to a specified set of research questions or research hypotheses [21]. This analytical approach is particularly suitable for this study.

The researchers utilized Web of Science (WoS) as the retrieval database to obtain suitable literature. This database was selected due to its comprehensive coverage

across all disciplines and relatively high-quality publications. The literature retrieval was completed in January 2026. As shown in **Figure 1**, the literature screening comprised six distinct steps.

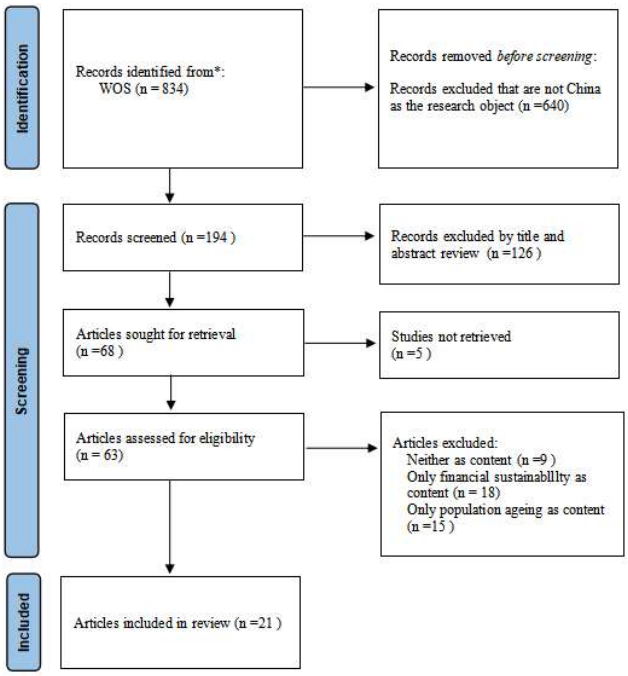

Figure 1. PRISMA flow diagram.

First, an advanced search was conducted using the themes "population aging" and "financial sustainability," yielding a total of 834 documents (with the highest number, 147, published in 2025, as shown in **Figure 2**). Next, 194 studies relevant to China were selected. Step 3: 158 documents were left after the removal of misidentified documents (in which case, the keywords were presented only in reference list or author bio and not in the main text). Step 4: Documents that were reported to contain the keywords once in the entire text only (not enough exploration of the topics) were eliminated and only 122 papers were retained. Step 5: Removed studies of insufficient quality, leaving 63 articles. The rest of the 63 articles were selected on the basis of a quality assessment approach which involved a self-modified checklist based on Critical Appraisal Skills Program (CASP) qualitative checklist and Joanna Briggs Institute (JBI) Critical Appraisal Tool. Extensive criteria were used to classify a study as having an inadequate quality; they were (1) the absence of clear research objectives or methodological transparency; (2) the absence of rigorous data analysis procedures; (3) the inadequate justification of major assumptions made in an actuarial or simulation model; (4) the failure to inform about the limitations of the study or to discuss potential bias. Ultimately, 21 articles covering both topics were included in the analysis.

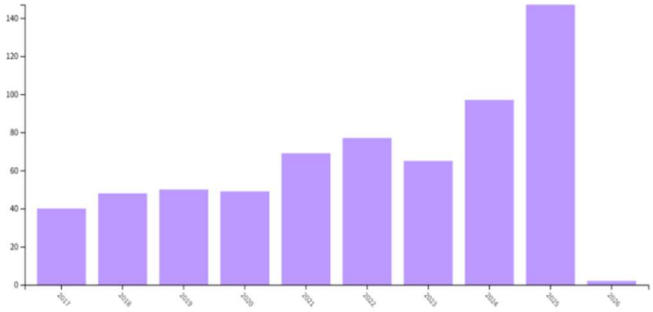

Figure 2. Number of related publications published from 2017 to 2026.

Throughout the literature screening process, researchers excluded only those documents that clearly did not meet the study objectives. If it was impossible to definitively determine whether a document met the study's exclusion criteria, it was retained in the sample for further detailed evaluation. This screening method ensures that all texts undergo thorough consideration, directing more research materials toward the final analysis phase. All analyzed texts in this study were downloadable from the Web of Science (WOS) database. There were those publishing works on which people had to pay in order to access and the other texts were offered freely to the users. They applied thematic analysis to the 21 articles that survived the screening exercise, and were grouped into various thematic types in accordance with themes that occur in all the literature included [20]. **Figure 3** shows the publication time distribution of these 21 documents.

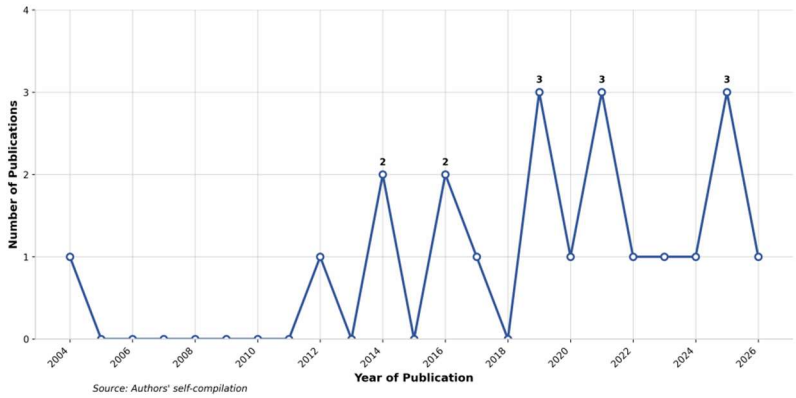

Figure 3. Publication time distribution.

It should be noted that the literature screening process for this study employed relatively strict criteria; while this ensured the quality of the included studies, it also resulted in a relatively small final sample size (reduced from 834 in the initial screening to 21). This means that some studies that may have been relevant to the topic but did not fully meet the inclusion criteria were excluded from the analysis; therefore, the findings of this study are primarily based on a specific subset of literature and may not fully encompass all relevant research perspectives and viewpoints in this field.

The short methodological evaluation of the 21 studies that were incorporated shows that all three analytical levels that were determined in this paper possess their

share of methodological advantages and disadvantages. Macroeconomic level using the computational general equilibrium (CGE) models have shown potentials of good policy simulation, but with simplistic assumptions and some may not represent the reality of the world. The actuarial model analysis studies at the meso level exhibit methodological rigor, when the tools used are cohort analysis, Leslie matrices, and Monte Carlo simulations, but they are very affected by the assumptions used regarding demographic and economic aspects. At the micro-level, the use of survey and case-studies present a great source of information on individual and household behavior, but is subject to some limitations in generalizations because of sample restrictions. In general, although the 21 studies provide solid evidence of the relationship between population aging and fiscal sustainability, all together, it is worth noting that each of the analytical strategies possesses methodological trade-offs that appeal to the readers in interpreting their results. Generally, despite the fact that the 21 studies combine to make a very good evidence on the relationship between population aging and fiscal sustainability.

Further to investigate research themes of 21 sampled articles in details, this study used a co-occurrence analysis with key word to generate results, as illustrated in **Figure 4**. This network diagram reflects high frequency keywords as nodes and co-occurrence relationship between keywords as edges. The node size is a measure of the number of times words occur, whereas the thickness of the edges is the level of co-occurrence. Analysis shows that the most used terms are Pension and Sustainability with 20 and 15 occurrence respectively and co-occurrence between the two is greatly displayed. This shows that the issue of financial sustainability of the pension systems is the most essential consideration in the contemporary research. The third most common term (7 times) is system, which creates a highly triangular picture with Pension and Sustainability showing that current research focuses on systemic analysis at the institutional level.

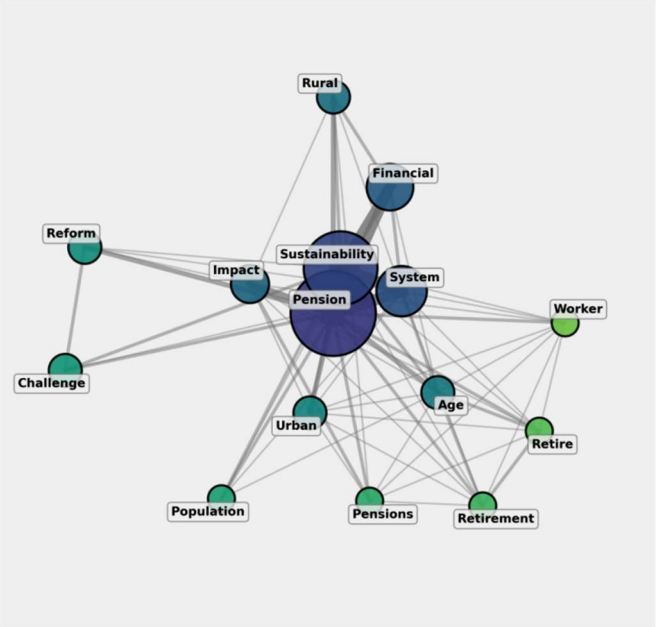

Figure 4. Keyword co-occurrence network.

3. Results

3.1. Different studies on the understanding of financial sustainability

The evaluation of 21 readings shows that the academic knowledge of the Chinese financial sustainability of the pension framework is not coherent, and significant variability in the explanations of the concept and functioning options can be identified. **Figure 5** is an analytical scheme of the way sustainability concepts are understood by the researchers and it may be identified into three levels, macro, meso, and micro.

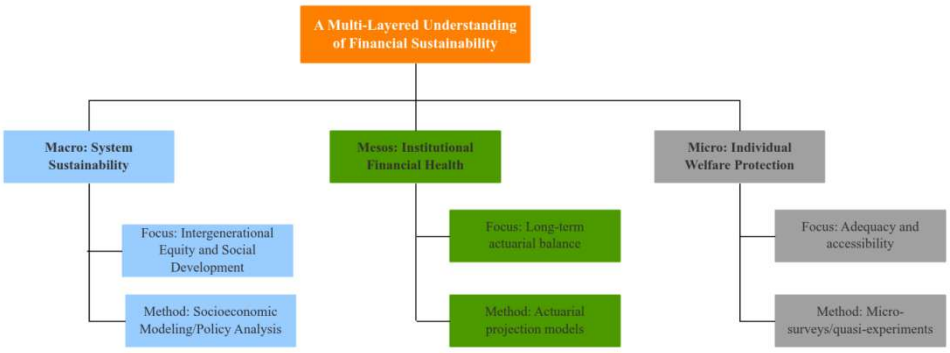

Figure 5. Multi-layered framework for understanding the concept of financial sustainability.

At the macro level, some studies [22,23] examine financial sustainability within the broader framework of national economic and social development. They view financial sustainability as a crucial pillar supporting the national pension system in upholding social equity, promoting long-term socioeconomic development, and maintaining social stability. Its core principles are intergenerational equity and social development. For instance, Wang & Ren [24] define pension financial sustainability as the system's capacity to maintain fiscal balance and adequate solvency amid long-term demographic shifts and economic slowdown. Cajková & Cajka [22] contend that pension challenges are intrinsically linked to China's broader socioeconomic stability, suggesting that parametric adjustments like retirement age changes may not fundamentally ensure financial health. Wang et al. [23] emphasize the financial unsustainability of pay-as-you-go pension disbursements, recommending the use of VAT revenues to cover transition costs, thereby achieving financial sustainability for China's new multi-pillar system. Macro-level research usually uses socio-economic models or qualitative policy analysis, the researchers being less concerned with the immediate social wellness and long-term economic development sustainability.

At the meso level, researchers define the concept of financial sustainability based on the pension system itself as the fund's long-term actuarial balance and solvency capacity [25–27]. The studies address the number of fiscal gaps, points of deficit, and other such indicators in the future. Wang & Daniel [28] define pension financial sustainability as the system's ability to maintain actuarial balance between revenues and expenditures and fulfill established benefit obligations over the long term amid demographic shifts, without requiring fundamental institutional reforms or external emergency fiscal assistance. Actuaries evaluate the financial effectiveness of the

current pension systems using actuarial models on the basis of specified demographic and economic growth hypotheses, in order to give an objective report of the changes in government parameters (e.g., increase of retirement age).

At a micro level, researchers look at financial sustainability with regard to the individual and family well-being among the aged population. These points they have made are that the financial sustainability depends on whether pensions give sufficient and foreseeable revenue to guarantee old age welfare and avoid old age poverty. For instance, Cousins [29] examined pension adequacy across different regions in China. Jin et al. [30] analyzed how sustainable pension income influences household energy consumption decisions. All these studies indicate the role of financial sustainability on the life of an individual. Among the major steps taken to ensure fiscal sustainability in the long term is increasing the retirement age, a decision that has become a national policy without alternative. Studies indicate that a sound life in the retirement stage can optimally be boosted by financial sufficiency.

However, if pension benefits increase with the age at which they become payable, this may partially offset the positive effects or even negatively impact fiscal balance [31]. **Table 1** summarizes the focal points of understanding financial sustainability across different studies and the research methodologies employed.

Table 1. Understanding of financial sustainability.

Dimension	Focus	Research method	References
Macro	Economic growth, social stability, fiscal soundness, and intergenerational equity	macro policy simulation, computable general equilibrium (CGE) model, institutional evolution analysis, interdisciplinary system analysis	Cajková & Cajka (2021) Wang et al. (2004) Wang and Ren (2012)
Mesoscopic	The Fund Deficit, Solvency and the Optimization of the System Parameters	actuarial models (queue analysis, Leslie matrix, Monte Carlo simulation)	Wang and Béland (2014) Wang et al. (2019) Yang et al. (2025) Tian and Zhao (2016)
microcosmic	Personal Well-being Adequacy, Accessibility and Behavioral Responses	Micro-metric analysis, case study, behavioral analysis	Jin et al. (2026) Cousins (2021)

More than classification, the divergent orientations of foci at the macro, meso, and micro-levels have far-reaching theoretical assumptions regarding the systems of pensions. Intergenerational equity and social stability are central to macro-level studies [22–24] to which welfare state theory forms its foundation. Meso-level analyses [25–28] are based on actuarial science, and regard financial sustainability a technical issue of matching revenues and spending. Micro-level research [29,30] is a development of behavioral and welfare economics, focusing on the individual well-being and the disaggregated response to the change of policies. These divergent premises cause conflicts at different levels: e.g. policies that improve actuarial balance at the meso level (e.g. benefit cuts) can be inconsistent with the intergenerational equity of macro levels or poverty prevention at the micro levels. Likewise, a delayed

retirement can enhance fund solvency in actuarial models, yet its real effects are determined by heterogeneous individual behavior some workers can view the prospect of extended career as an attractive opportunity whereas others may see it as a way out that is not reflected in aggregate forecasts [31]. All these tensions across levels allude to the fact that no single point of view alone includes a complete picture of financial sustainability, and therefore there is a necessity of integrated approaches when considering the tensions that exist and take into account the nature of such contradictions.

3.2. Population aging and financial sustainability

Through literature analysis, the study reveals that the relationship between population aging and the financial sustainability of pensions is complex. As shown in **Figure 6**, population aging influences financial sustainability through the combined effects of direct pressures, policy interventions, social factors, and other elements.

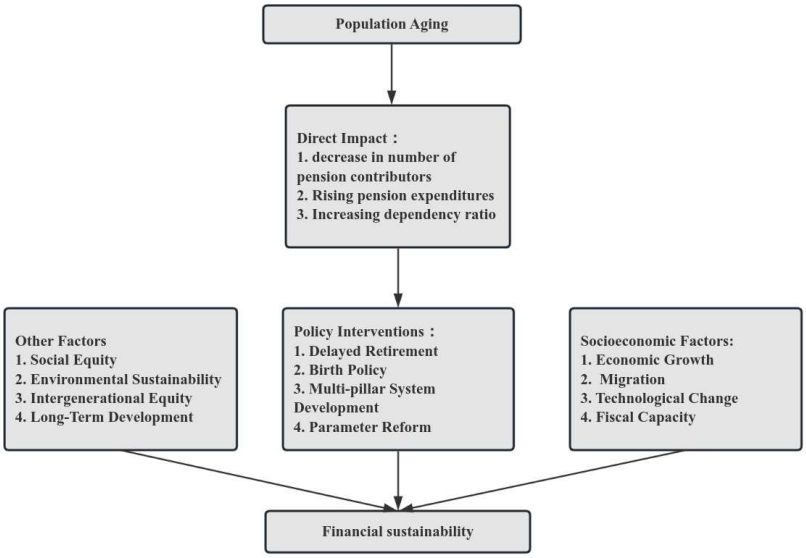

Figure 6. Mechanisms of population aging and financial sustainability.

Literature analysis reveals that the direct impact of population aging on fiscal sustainability manifests primarily in three aspects. First, the number of pension contributors declines relatively, and their contribution capacity weakens. The level of working age population declines with the resultant reduction in potential of the pension contributors. At the same time, the escalating old-age dependency ratio puts more pressure on the working-age population in terms of support and possible ability and desire to make a real contribution. Second, long life expectancy and rising population of the elderly leads to continuous growth in pension spending. Moreover, there is a societal pressure which keeps on increasing the benefits of pensions to protect the living standards that the old people live [16]. Lastly, the dependency ratio is on an upward trend and the ratio of contributors to the beneficiaries is expected to shrink to 1.5:1 in 2050 as compared to the present ratio of 3:1, straining the working-age population.

With the pattern of increasing population aging and the prevailing policy context,

the pension system in China has an increasing funding cliff and a solvency crisis in the long run. **Table 2** lists projections from various studies on the financial sustainability of China's pensions. Studies show that unless there is a revision of the policy, there will be a deficit in the basic pension fund of the urban employees by 2030, leading to a chance of the accumulated reserves being exhausted by 2040 [26,32]. On the same note, analysts estimate that the funding shortfall in the rural pension system in China will increase at an average of 10.34 percent per annum ranging between RMB 97.8 billion in 2014 and RMB 3062.31 billion in 2049 [28]. Financial sustainability is a cause for concern. Furthermore, under current policies, transitional liabilities for pensions are projected to peak in 2035, with the pension system becoming unsustainable by 2048 [33]. In the hypothetical situation the increase in the retirement age would allow making the pension system sustainable up until 2083, and such a move still will not be able to solve the financial problems in the long term. The results of such researches have shown that on its current form, the pension system in China is in a dire fiscal crisis.

Table 2. Projections on the financial sustainability of the pension.

Subject	Forecast	References
Urban employee basic old-age insurance	Annual cash flow deficit will emerge in early 2030s; cumulative balance may be exhausted in 2040s	Yang et al. (2025); Zhao & Mi (2019)
New rural social pension insurance	The funding gap will grow at an average annual rate of 10.34% from 2014 to 2049, reaching 3.06231 trillion yuan.	Wang and Béland (2014)
Basic old-age insurance	Pension system to see first deficit between 2026–2028	Tian and Zhao (2016); Fan et al. (2025)
Transitional pension liability	The debt scale will peak around 2035.	Zhao et al. (2017)
Multi-policy combination effect	Even with delayed retirement and fertility incentives, the long-term (e.g. 2100) could still accumulate unprepared fund liabilities exceeding 1 trillion yuan.	Yang et al. (2025); Wang et al. (2019)

In response to the above crisis, the Chinese government has embarked on a series of reforms that have steadily seen the government implement a number of policies to slow retirement, change the fertility policies and modify the contribution rates. According to researchers, simulations suggest that a slow hike in the retirement age to 65 may have a potential of delaying the occurrence of the pension deficit by 15 to 25 years and decrease the level of the deficit during given duration of time [27,34]. However, this reform policy also has certain limitations. Postponement of retirement is basically a fringe way of correcting demographic shortages [31], which has restricted value to improving the long-term actuarial position of the pension system.

The modifications in China in relation to birth policies such as the one child policy to universal two child policy and more liberal policies are meant to restate the demographic structures in the long term and to further make the pensions fiscally

viable. Improved access to a larger pool of workers through the rise of the higher birth rate population in the short term will enhance the base of pension contributions by this increasing the number of pension payers to reduce the burden on tax revenues. Nonetheless, in the long term this new group of people will ultimately reach old age, which may act to worsen the burden of pensions in the remote future (i.e., post 2075) [25,35]. Thus, according to the literature, it is rather doubtful that by appeal to encouraging childbirth it is possible to stop a basic tendency towards the increase of the pension gaps. Other parametric reforms, including increasing the contribution rates, decreasing the rate of benefit growth, or modifying the indexation conditions are also associated with mixed results as well as policy measures to maximize the institutional environment (e.g. reduce the employer contribution rate and contribution base). As much as they might directly enhance revenues and expenditures of funds, they might also stifle jobs, household consumption or diminish the degree of retirement security, which has trade-offs between economic efficiency and social equity [34,36].

Also, the issue of socioeconomic factors and other variables might extinguish or increase the direct effect of population aging on financial sustainability. The economic growth would result in more jobs, higher wages, and contribution rates among the employed population and reduce the value of the pension gaps. On the other hand, financial crises that result in economic downturns, outshine and increase the financial weaknesses of pension systems [37]. Furthermore, large-scale population migration (between urban and rural areas, or across regions) may also affect pension contributions. Researchers have found [38] that the relationship between migration and pension solvency follows an inverted U-shaped pattern. In particular, inflows of labor may enhance the supply of pension funds in the regions at specific periods of urbanization, but underlie interregional fund imbalances at the longer-term. Additionally, change in technology, especially digital transformation, provides an indirect impact on the level of contribution to pensions, as it changes the labor markets. For instance, Han et al. [39] note that while digital economic development promotes industrial upgrading, it may affect contribution capacity for certain groups through employment polarization effects. Nevertheless, the improvements linked with the collection and administration technologies (including the full-responsibility collection by tax authorities) can contribute to the increase in the efficiency of fund mobilization. Lastly, the current pension reforms should strike a balance between financial stability and social justice (i.e., the reduction of pension disparities between formal and informal workers) [34], intergenerational justice, and policy links with other state priorities. As an example, pension payments can have a positive effect on the household change of sources toward cleanlier energy [30].

To conclude, the problem of population aging and pension financial sustainability is a complex system that is actively developing due to the interplay of various factors. This system faces deterministic impacts of the demographic changes as well as being influenced by intervention of policies, socioeconomic aspects and other variables. It implies that any further studies and policy-making process should take a holistic, systemic approach, taking into account the interrelationship at the various levels: at the financial, at the social, and at the long-term levels, to find a sustainable balance between financial stability, social equity, and long-term development. It is with such systemic knowledge alone that we can offer a scientific theoretical framework and

policy before the long term sustainable development of the Chinese pension system.

4. Discussion and implications

This study aims to explore two core issues by analyzing the relevant literature on China's population aging and fiscal sustainability: 1) how do different studies interpret financial sustainability? And 2) what relationship exists between population aging and financial sustainability? The following sections will summarize and discuss these findings, and explore their implications for policy making and future research.

Firstly, this study analyzes different interpretations of sustainability across literature at macro, meso, and micro levels. Some scholars have also proposed various definitions and measurement criteria based on fiscal operations and government debt perspectives. According to one school of thought, fiscal sustainability is the capacity of a government to create a long term fiscal equilibrium or regulation where expenditures do not go beyond the capacity of the government to collect revenue competently and such a, to ensure that the fiscal processes run smoothly [40]. This is not the mere ability of the government to maintain a long term balance between the incomes and the expenses, but also it is dealing with stabilizing the fiscal situation with the help of regulating the debts [41] and to coordinate the interplay of the economic elements toward restoring or ensuring fiscal balance [42]. The other school of thought describes fiscal sustainability as government ability to continue to borrow [43], ability to ensure that short-term deficits in the public sector are at manageable levels [44], and having solid guarantees on the ability to repay debts [45]. This is in the form of the capacity of the government to fund its fiscal activities by using debts, and confidence of the investors on its financial efficiency and the credibility on the viability of the capacity of the government to pay off their debt obligations.

Also, there are those scholars who view fiscal sustainability as the debt repayment viewpoint, where it is seen as the way in which the government could settle the debts to the exact amount, and within the allocated period before any incidences of default have occurred. The issue of whether the government has the capacity of settling its debts [46] and makes the debt levels consistent with its fiscal revenues is its main part. In pursuit of fiscal sustainability, governments should ensure they have stable fiscal policies, which include tax change or expenditure change policies. Fiscal sustainability is not only based on the present debts payment ability, but it is priority on the debts ability that is sustainable at some time in the future. Its most important aspect is the ability of the government to repay its debts within the right time and fiscal sustainability has a form of its sustainability to government debt. Hence, fiscal sustainability and debt sustainability are not only limited to the present but also to the future such that present debts must be paid in time both in the present and in the future.

Summarizing it up, the idea of fiscal sustainability on the macro level focuses on the idea of long-term fiscal balance [40–42], coherent with the existing literature defining the concept of pension sustainability through the prism of intergenerational equity and socioeconomic stability [22–24]. This debt sustainability view [43,45,46] is paralleled with the meso-level attention to actuarial balance and solvency [25–28]. In the meantime, the concern, implicitly raised about the possibility of the government to manage its commitments without affecting the social welfare [46], indicates the

micro-level priorities of the individual welfare [29,30] and poverty prevention [29,30]. All these interpretations at the various levels when put together hence constitute a multidimensional interpretation of fiscal sustainability, offering a more solid insight to policy makers. Combination of these perspectives should be made in an organic nature in meeting the challenges of population aging in order to ensure that a balance between a financially sound, socially fair and the long-term development of the pension system is achieved.

Secondly, studies show that the fiscal sustainability is affected by the population aging, as a direct pressure, policy intervention, social factors, and other factors. Other studies also emphasize the direct influence of population aging on fiscal sustainability. Population aging is said to have major implications on the fiscal sustainability that are influenced by these three lines: labor supply, household consumption, and security of social pensions. Regarding labor supply, aging leads to more workers exiting the labor market, thereby reducing sources of fiscal revenue. Regarding household consumption, on one hand, older adults exhibit stronger savings propensities and lower investment willingness, potentially suppressing consumption demand. On the other hand, increased spending by seniors on higher-tier services like medical care and health supplements may partially boost fiscal revenues [47]. With regards to social security, aging is a disturbance to the revenue expenditure balance among pension programs, exerting increased pressure on payments and financing strains on government social security funds [48].

It is worth noting that the macro-meso-micro analytical framework proposed in this study does not imply that these three levels are isolated from one another. Rather, there exist complex interaction and transmission mechanisms among them. Taking the delayed retirement policy as an example, this macro-level policy intervention first directly affects the actuarial balance of the pension system at the meso level—by extending contribution periods and shortening benefit receipt periods, it improves the system dependency ratio and delays the emergence of fund deficits [26].The improvement of this meso-level parameter finally transfers to the micro level, having a direct impact on the way individuals will plan and perceive their welfare life later in life. Nonetheless, micro-level personal behavioural changes do not lack activity in that individuals can respond to a higher payoff in delayed retirement by either changing the household savings levels or consumption patterns, or even energy consumption choices. As an example, at the microscopic level, it is demonstrated by Jin et al. [30] that the expectations of the stable pension income affect rural households more in their energy transition decisions- this micro-level behavioral change, in its turn, is environmentally recalculated in the appropriate macro-level sustainable development objectives via the overall economic structure and consumption patterns.

In the same way, macro-level policies of the fertility support have their objective of removing pension payment pressures by changing the population structure, but the manifestation of this policy impact is so contingent on the micro-level household fertility choices, and the completeness of the pension system is just one of the factors that has been identified to influence household fertility intentions. These micro level fertility behaviors end up adding up to macro level changes in demography and represents a chain of feedback loop. Thus, the population aging and financial sustainability studies on China should be analyzed through this macro-meso-micro

interplay. It is only through developing this multi-level interactive systems thinking that would we fully understand the financial sustainability issues involved in the context of aging.

The analytical usefulness of this framework is susceptibility to trace the manner in which macro-level policies are conveyed through meso-level institutions to shape micro-level outcomes, and in which the micro-level responses are subsequently fed back to cause systemic sustainability. This two-way look shows the dynamic processes that have to operate behind the financial sustainability which cannot be reflected in the static classifications.

Given the negative impact of population aging on fiscal sustainability, researchers primarily propose countermeasures such as delaying retirement and supporting childbirth. They argue that extending labor participation years or boosting birth rates could alleviate labor supply shortages caused by aging populations. However, the potential for labor supply expansion is limited. An extension can be faced with issues of labor market flexibility and social inception, whilst the impact of fertility assistance policies often contain considerable time delays, which makes it hard to alleviate fiscal maintainable stress in the immediate run. Thus, the effects of the adjustments made on the supply side can be not completely adequate to overcome the problems related to the fiscal sustainability presented by the ageing population.

Meanwhile, the Chinese government is gradually promoting the development of the third pillar of pension insurance, encouraging individuals to voluntarily participate in commercial pension insurance. At the micro level, commercial pension insurance improves the sufficiency and stability of personal retirement funds, making it easier for people and families to deal with living longer, so there is less pressure on money at the small scale. But the development of commercial pension insurance in China is still quite slow. Public awareness is not enough, the products do not attract much attention, and institutions do not give much incentive, which has slowed down its popularity. By implementing several methods such as giving tax breaks, making new products, and teaching people about it, we can make commercial pension insurance grow faster. It might also be possible to develop it as an important breakthrough in dealing with the problem of population aging.

Consequently, policy-makers need to transition to the combined policy reforms in order to sustain themselves financially. Rather, they are to implement a multi-pronged strategy that includes parameter changes (i. e. the scientific postponement of retirement), structural changes (faster growth of second and third pillars), optimization of governance (increasing the efficiency of collection and investment), and other supportive facilities (i.e. family friendly policy) [33,49]. Moreover, the policy should be designed in consideration of the regional differences in the extent of aging and financial capacity [29] and should adopt a policy of local trial but gradually expanding the activity throughout the nation.

In addition to supply-side reforms, also investment cannot be made in the demand side through increased awareness and incentives of the population on the importance of saving on retirement. This is by instilling the habit of early financial planning and savings among the people to their own retirement. Some of the key responses include enhancement of retirement financial education, enhancement of the personal pension system and making more retirement financial products more diverse and accessible.

These efforts will create a more secure retirement system where the government, the market, and the individual will contribute towards securing the long-term financial challenges of aging population, through the systematic and robust means of dealing with them.

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References

1. Lobo CS, Falleiro SP. A cross-national empirical analysis of the contribution of fertility, life expectancy and net migration in driving contemporary and future population ageing. Population and Economics. 2024; 8(4): 64–91. doi: 10.3897/popecon.8.e118982
2. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects 2024: Online edition. 2024. Available online: https://population. un.org /wpp/ (accessed on January 2, 2026).
3. Ministry of Civil Affairs, National Office for Aging. 2024 National Aging Development Bulletin. 2025. Available online: https://www. gov.cn/l ianbo/bumen/202507/content_7033724.htm (accessed on January 3, 2026).
4. Ustyuzhanin V, Zinkina J, Korotayev A. Global aging and demographic policies: A reconsideration. Journal of Global Studies. 2025; 12(1): 45–68. doi: 10.30884/jogs/2025.01.04
5. Wallis H, Loy LS. What drives pro-environmental activism of young people? A survey study on the Fridays for future movement. Journal of Environmental Psychology. 2021; 74: 101581. doi: 10.1016/j.jenvp.2021.101581
6. Komp-Cukkunen K. A life-course perspective on older workers in workplaces undergoing transformative digitalization. The Gerontologist. 2023; 63(9): 1413–1418. doi: 10.1093/geront/gnac181
7. Marra, M. Bridging the gaps in sustainability assessment: A systematic literature review, 2014–2023. Evaluation and Program Planning. 2025; 110: 102557. doi: 10.1016/j.evalprogplan. 2025.102557
8. Chikwe CF, Eneh NE, Akpuokwe CU. Conceptual framework for global protection against technology-enabled violence against women and girls. International Journal of Science and Research Archive. 2024; 11(2): 279–287. doi: 10.30574/jsra.2024.11.2.0415
9. Kamunzyu E, Makopondo R, Opondo J. Analysis of effects of green practices on sustainability in urban hotels in Kenya. African Journal of Hospitality, Tourism and Leisure. 2024; 13(3): 589–596. doi: 10.46222/ajhtl.19770720.543
10. Amor SB, de Almeida AT, de Miranda JL, et al. Advanced studies in multi-criteria decision making. CRC Press; 2019. doi: 10.1201/9781315181363
11. Shrivastava P, Ali S, Ali SS. Analyzing the impact of aging populations on healthcare system sustainability. Journal of Neonatal Surgery. 2025; 14(1S): 393–397. doi: 10.52783/jns.v14.1554.
12. Zheng X. Research on countermeasures for the sustainability risks of China's pension funds. Journal of Business and Marketing. 2024; 1(4): 117–120. doi: 10.62517/jbm.202409417

13. Stoodley I, Conroy S. An ageing population: the benefits and challenges. Medicine (UK Edition). 2024; 52(11): 710–712. doi: 10.1016/j.mpmed.2024.08.013
14. Song JY, Gao CS. Population aging, pension expenditures, and high-quality economic development (Chinese). Journal of Jinan University (Philosophy and Social Sciences Edition). 2023; 45(2): 98–114. doi: 10.11778/j.jnxb.20222014
15. Ren J. Reflections on the challenges of old-age security and policy options for an ageing population. Science, Technology and Social Development Proceedings Series. 2024; 1: 283–290. doi: 10.70088/6vg2gb74
16. Zhang S, Zhu Y. How should pension replacement rates adapt to demographic changes (Chinese). Gansu Social Sciences. 2023; (3): 171–180. doi: 10.3969/i.issn.1003-3637.2023.03.020
17. Xue HY, Wu XY. Individual account overspending, fund pressure, and fiscal burden in China's Employee Pension Insurance: 2024–2050-An actuarial analysis based on representative individuals and the fund as a whole (Chinese). Insurance Research. 2024; (5): 85–104. doi: 10.13497/j.cnki.is.2024.05.007.
18. Du P. Current status of population aging and development of China's social security system (Chinese). Social Security Review. 2023; 7(2): 31–47.
19. Zhang LL, Wang Z, Liu QF. Analysis of China's pension gap and countermeasures against population aging (Chinese). Journal of Fudan University (Social Sciences Edition). 2023; 65(1): 138–149.
20. Lenon Atat M, Zuber Abd. Majid M. Student dropouts and their economic impact in the post-pandemic era: A systematic literature review. International Journal of Academic Research in Business & Social Sciences. 2024; 14(9): 22873. doi: 10.6007/ijarbss/v14-i9/22873
21. Dhillon JK, Gill NC. Deciphering the system of a systematic review. Dental Research Journal. 2024; 11(5): 531–536.
22. Čajková A, Čajka P. Challenges and sustainability of China's socio-economic stability in the context of its demographic development. Societies. 2021; 11(1): 22. doi: 10.3390/soc11010022
23. Wang Y, Xu D, Wang Z, et al. Options and impact of China's pension reform: A computable general equilibrium analysis. Journal of Comparative Economics. 2004; 32(1): 105–127. doi: 10.1016/j.jce.2003.10.003
24. Wang XJ, Ren WD. Population ageing and the financial sustainability of social pension system in China. In Proceedings of 2012 China International Conference on Insurance and Risk Management. 2012. https://www.semanticscholar.org/paper/Population-Ageing-and-the-Financial-Sustainability-Wendong-Xiaojun/4ff6a2cde9bf732352f730ecc767c701e322a60b
25. Wang H, Huang J, Sun S. Assessment of the financial sustainability of China's new rural pension plan: Does the demographic policy reform matter? Sustainability. 2019; 11(18): 5110. doi: 10.3390/su11185110
26. Yang H, Sun Y, Zeng S, et al. Forecasting the sustainability of workers pension systems in China: A comparative analysis of pre-and post-delay retirement policies. Applied Economics. 2025; 1–15. doi:10.1080/00036846.2025.2548413
27. Tian Y, Zhao X. Stochastic forecast of the financial sustainability of basic pension in China. Sustainability. 2016; 8(1): 46. doi: 10.3390/su8010046
28. Wang LJ, Béland D. Assessing the financial sustainability of China's rural pension system. Sustainability. 2014; 6(6): 3271–3290. doi: 10.3390/su6063271
29. Cousins M. The sustainability of China's urban employees' pension programme: A case of getting old before getting rich? International Social Security Review. 2021; 74(1): 59–77. doi: 10.1111/issr.12257
30. Jin B, Zhou C, Zhao M, et al. Pensions as hidden green levers: The impact of China's new rural pension scheme on household energy transition. Energy Policy. 2026; 210: 115022. doi: 10.1016/j.enpol.2025.115022
31. Wang X, Shan G. Raising the retirement age: The impact on the individual and actuarial balance for Chinese urban workers' basic pensions. Economic and Political Studies-EPS. 2016; 4(4): 17. doi: 10.1080/20954816.2016.1251135
32. Zhao Q, Mi H. Evaluation on the sustainability of urban public pension system in China. Sustainability. 2019; 11(5): 1418. doi:10.3390/su11051418
33. Zhao YQ, Bai MY, Liu YL, et al. Quantitative analyses of transition pension liabilities and solvency sustainability in China. Sustainability. 2017; 9(12): 2252. doi: 10.3390/su9122252
34. Gao H, Lu B. Reforming China's public pension system: Fiscal sustainability and the challenge of formality-based inequality. Economic Modelling. 2025; 153: 107336. doi: 10.1016/j.econmod.2025.107336
35. Liao P, Su H, Pamučar D. Will ending the one-child policy and raising the retirement age enhance the sustainability of China's basic pension system? Sustainability. 2020; 12(19): 8172. doi: 10.3390/su12198172

36. Tang Y, Ma W, Zhou Q. Is China's enterprise employees' basic pension plan sustainable? Evidence from two northeastern provinces in the double-drop era. Journal of Aging & Social Policy. 2021; (1): 1–17. doi: 10.1080/08959420.2021.1926863
37. Fan W, Meng J, Yang H. Change in population structure, policy adjustment, and China's public pension sustainability. PLoS One. 2025; 20(9): e0331739. doi: 10.1371/journal.pone.0331739
38. Hu H, Wang W, Feng D, et al. Relationships between migration and the fiscal sustainability of the pension system in China. PLOS ONE. 2021; 16(3): e0248138. doi: 10.1371/journal.pone.0248138
39. Han W, Yao X, Gao H, et al. The impact of digital economic development and government intervention on China's pension insurance fund income: Moderated chain mediation effects. Social Sciences. 2024; 13(12): 672. doi: 10.3390/socsci13120672
40. António A, José C. Fiscal sustainability, fiscal reactions, pitfalls and determinants. Applied Economics. 2025; 57(26): 3560–3571. doi: 10.1080/00036846.2024.2337808.
41. Nisar A, Rafique R, Hondroyiannis G. Fiscal strategies for sustainable debt management in developing economies: dynamic common correlated effects approach. Economic Change and Restructuring. 2025; 58(4): 64. doi: 10.1007/s10644-025-09909-9.
42. Chang Z. How to coordinate the roles of fiscal policy and monetary policy. GBP Proceedings Series. 2025; 1: 47–54. doi: 10.71222/93b47r76
43. Zhang P, Shi Y, Chen C, et al. Measuring and benchmarking fiscal health: A study of Chinese provincial governments. International Journal of Public Administration. 2026; 49(4): 258–274. doi: 10.1080/01900692.2024.2357116
44. Onyele K, Ikwuagwu E, Opara CC. Government debt sustainability and investments in Nigeria: Trends and risk thresholds amidst macroeconomic swings. PanAfrican Journal of Governance and Development (PJGD). 2023; 4(1): 18–52. doi: 10.46404/panjogov.v4i1.4481
45. Mutai NC, Farag K, Ibeh L, et al. AI driven fiscal risk assessment in the eurozone: A machine learning approach to public debt vulnerability. FinTech. 2025; 4(3): 27. doi: 10.20944/preprints202504.2189.v1
46. Hassan MN, Muhammed-Gani SH, Odonye OJ. Public debt and economic growth in nigeria: an empirical analysis (1986–2024). African Journal of Management and Business Research. 2025; 20(1): 175–204. doi: 10.62154/ajmbr.2025.020.01020
47. Lang Y. The impact of population aging on China's macroeconomy: A study based on the consumption possibility frontier. Advances in Economics Management and Political Sciences. 2023; 47(1): 249–257. doi: 10.54254/2754-1169/47/20230405
48. Yu HY. The impact of population aging on local fiscal sustainability (Chinese). Financial and Economic Issues Research; 2022; 11: 100–109. doi: 10.19654/j.cnki.cjwtyj.2022.11.010.
49. Wang M, Pan Y, Jing P. Balancing economic growth and pension adequacy: The combined effects of contribution rate reduction and retirement age postponement. International Review of Economics & Finance. 2025; 102(000): 104362. doi: 10.1016/j.iref.2025.104362.