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Population Aging and Public Health Expenditure as Fiscal Drivers of Economic Growth in Asia 1975–2024

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ABSTRACT

This study examines the impact of population aging on economic growth through the fiscal channel of government health expenditure throughout the dataset from World Bank Indicators. It focuses on 12 Asian economies over the period from 1975 to 2024. Utilizing a unbalanced panel dataset characterized by cross-sectional dependence, non-stationarity, and weak evidence of cointegration, the analysis applies the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS–ARDL) model to estimate short-run effects and the role of lagged adjustment terms. The findings reveal that population aging does not have a statistically significant direct effect on economic growth. In contrast, government health spending emerges as a critical transmission mechanism that links demographic transitions to output performance. In the short run, health expenditure positively and significantly influences GDP per capita. reflecting its productivity-enhancing and demand-stimulating effects. However, the lagged health spending term exhibits a negative and significant coefficient. This suggests that there are fiscal trade-offs and adjustment costs in subsequent periods. These results align with endogenous growth theory and highlight that public expenditure can have both productive and counterproductive effects depending on timing and efficiency. Policy makers should emphasize the need for balanced health financing strategies, preventive healthcare investments, and coordinated regional fiscal responses to demographic change.

1. INTRODUCTION

By 2030, the global population aged 60 years or over is projected to reach approximately 1 in every 6 people, representing nearly 16.7% of the total population [1]. Within Asia, this demographic transformation is particularly pronounced. The share of older persons (aged 60 years and above) is expected to rise to 15–16% by 2030, although there will be substantial differences across countries. Developed economies such as Japan, South Korea, and Singapore are already experiencing advanced stages of population aging. In contrast, emerging nations like Vietnam, India, and Indonesia are undergoing accelerated transitions due to declining fertility rates and improved life expectancy. This demographic progression presents both economic opportunities and structural challenges, making the study of aging and growth dynamics in Asia both timely and essential.

The global demographic structure has witnessed an exponential expansion over the past two centuries, driven by rising affluence, industrialization, and urbanization. However, this growth has been accompanied by increased resource consumption, environmental degradation, and fiscal strain [2, 3]. As demographic structures evolve, the pace of population aging is accelerating sharply. This raises concerns over its implications for healthcare financing, labor productivity, and intergenerational equity [4, 5]. A higher proportion of elderly citizens typically requires greater public expenditure for healthcare, long-term care, and social protection. If not managed efficiently, this could crowd out productive investment [6]. Furthermore, advancements in medical technology, healthcare accessibility, and assisted living infrastructure have substantially extended life expectancy across the region [7, 8]. In parallel, these advancements place significant and sustained fiscal pressures on governmental budgets to finance escalating healthcare and retirement benefit liabilities. The economic impact of an aging population is thus multifaceted, influencing labor supply, productivity, savings behavior, and public finance sustainability [9, 10]. Asia, being both the fastest-aging and one of the most economically dynamic regions globally, offers a unique empirical setting to explore the fiscal-demographic-growth nexus.

The ongoing demographic transition across Asia carries profound socioeconomic and macroeconomic implications. The rising dependency ratio threatens to alter the structure of labor markets, reduce national savings rates, and increase fiscal liabilities associated with health and pension systems [11, 12]. As populations age, the shrinking labor force limits potential output and reduces the tax base. At the same time,

commitments to social spending on pensions, healthcare, and long-term care increase rapidly. This demographic pressure creates an imbalance between productive workers and dependent individuals, which can weaken growth potential and increase fiscal stress. Moreover, given the deep economic interdependence of Asian economies through trade, investment, and regional integration mechanisms, the fiscal burden of aging and its growth effects are not isolated national phenomena but systemic regional challenges. The demographic transition thus interacts with financial globalization and policy spillovers, shaping a shared trajectory of fiscal vulnerability and growth transformation across the continent [5, 9].

Moreover, the regional interdependence of Asian economies implies that the fiscal burden of aging and its growth implications are not isolated phenomena. They are part of a broader systemic challenge shaped by trade, financial integration, and shared policy frameworks. The observed trends underscore the urgency for comprehensive fiscal and social policies. These policies must not only address healthcare financing and social protection, but also promote human capital development, technological innovation, and intergenerational equity. Thus, analyzing the dynamic interaction between population aging, fiscal health spending, and economic growth in Asia contributes to a deeper understanding of the demographic-economic transformation reshaping the global economic landscape.

These structural shifts underscore the urgency for comprehensive and adaptive fiscal and social policies capable of addressing multiple objectives simultaneously. Investment in education, lifelong learning, and digital skills can mitigate the productivity losses associated with an aging workforce, while innovation-driven healthcare systems can improve efficiency and fiscal resilience [7, 8]. Hence, a sophisticated understanding of the dynamic interaction among population aging, government health spending, and economic growth is critical to designing sustainable development strategies that balance demographic realities with long-term economic vitality. A growing working-age population typically leads to more savings, capital formation, and consumption, which supports long-term economic expansion. Conversely, when the proportion of dependent populations, whether elderly or youth, increases relative to the labor force, fiscal resources are increasingly directed toward non-productive expenditures like social welfare and healthcare. This trend constrains savings and investment capacity [4, 6]. These relationships form the basis of the first hypothesis:

H1: Population aging affects both the long-term and short-term economic growth of Asian economies.

In addition to its influence on income and labor supply, population aging has significant implications for government fiscal balance. Rising life expectancy and greater demand for improved living standards have fueled substantial growth in healthcare spending, both publicly and privately. This increasing expenditure, while enhancing life quality and productivity in the short term, poses a persistent challenge to the sustainability of government finances [13]. The expansion of health-related consumption can boost short-run aggregate demand and human capital, but excessive fiscal pressure from long-term healthcare obligations may crowd out investment in other growth-promoting sectors. Hence, the study posits the second hypothesis:

H2: Spending on healthcare significantly influences economic growth in Asian countries in the context of population aging.

Therefore, this study supports the growing body of literature suggesting that aging itself does not necessarily hinder economic growth. Instead, it is the fiscal and institutional responses to demographic changes, especially through public health spending, that shape the direction and impact of economic outcomes [14, 15]. Strategic and efficiently allocated health investments can foster productivity gains, prolong healthy working lives, and stabilize aggregate demand. Conversely, in the absence of fiscal prudence, innovation-oriented reforms, and equitable redistribution mechanisms, these advantages may prove transitory and insufficient to counterbalance the fiscal burden of an aging society [16]. This research contributes to the empirical literature in three significant ways. First, it provides new regional evidence on the fiscal–demographic–growth nexus using a unbalanced panel of Asian economies, a region where demographic transitions are particularly rapid yet heterogeneous. While existing literature acknowledges the complex effects of population aging on economic growth, it often treats fiscal policy and health expenditure as secondary issues. This study addresses that gap by examining how public health spending influences the growth effects of aging in Asia. Second, it employs the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS–ARDL) approach, which advances beyond conventional panel models by explicitly addressing cross-country interdependence, slope heterogeneity, and dynamic short- and long-run adjustments [17, 18]. In this context, the CS–ARDL model is used to identify contemporaneous and lagged effects rather than long-run equilibrium relationships, consistent with the limited evidence of cointegration in the dataset.

The remainder of the paper is structured as follows: Section 2 reviews the relevant theoretical and empirical literature on population aging, health expenditure, and growth. Section 3 presents the data sources, model specification, and econometric methodology. Section 4 reports the empirical findings, while Section 5 discusses the policy implications and provides concluding remarks.

2. LITERATURE REVIEW

The link between population aging, public health spending, and economic growth has become a critical topic in development economics, especially in Asia's rapidly changing economies. Over the last five decades, shifts in demographics, income distribution, and technology have changed the factors driving growth. The rise of the global middle class, the aftermath of the technology bubble, and increased life expectancy have reshaped consumption patterns, fiscal behavior, and labor market dynamics [19]. In emerging Asian economies, the growing middle-income group has boosted overall demand and investment in human capital. This has improved social inclusion and political stability, contributing to sustainable economic growth. However, these changes have also increased fiscal demands related to aging populations and healthcare financing.

Moreover, population aging, driven by longer life expectancy and declining fertility rates, has significant implications for economic growth. While immediate effects may include a reduced labor supply and lower productivity, studies suggest that aging can also bring long-term growth benefits. These benefits may arise from higher savings, asset

accumulation, and increased consumption of healthcare and services. The longer lifespan of older individuals can help sustain household income and stimulate domestic consumption, especially in developing economies where older people often participate in informal labor markets [11, 20]. Thus, the elderly can be seen as both a fiscal burden and a potential driver of demand-led growth, depending on how effective public policies are.

From a theoretical standpoint, this relationship can be understood using endogenous growth models [14, 15]. These models suggest that long-term growth arises from targeted investments in human capital, research and development (R&D), and technological progress. In aging economies, the need to compensate for a declining labor supply often leads to increased investments in technology and R&D, helping to sustain growth despite demographic pressures. This contrasts with exogenous growth models, where technological change is viewed as independent of policy or demographic factors. Further, other researchers expanded the Solow model by including human capital as a key factor in economic growth [21]. Their findings show that education and skill development are crucial for productivity, especially in labor-constrained economies. Besides, other authors integrate population dynamics into an exogenous growth framework, demonstrating that an increasing old-age population can enhance incentives for human capital accumulation [7]. As older workers remain active longer, they can share their experience and knowledge with younger generations, helping to offset potential productivity losses. This highlights that the negative impacts of aging can be mitigated through lifelong learning and human capital development.

Empirically, some studies explore the broader implications of population aging, pointing out both challenges, like fiscal strain and labor shortages, and opportunities for productivity and innovation [9, 12]. Additionally, aging affects labor participation and productivity, suggesting that retaining and retraining older workers is vital for maintaining growth [10]. For Asia specifically, aging poses dual challenges of declining labor force participation and rising dependency ratios, but also identifies potential for reform-driven growth through improved education, healthcare, and employment opportunities for the elderly [4].

At the fiscal level, public expenditure plays a key role in managing the effects of demographic change. Research suggests that the relationship between government spending and economic growth is complex and nonlinear. For example, the impact of public spending on growth varies by the level of development, with diminishing returns at higher spending levels [22]. Similarly, other authors argue that differences in how agents respond and how expenditures are distributed significantly affect growth outcomes, advocating for targeted spending policies rather than broad fiscal expansion [6]. These insights are especially relevant for Asian economies, where public spending often increases during economic booms and decreases during recessions, leading to greater volatility [2, 5].

Within this fiscal-demographic framework, health expenditure emerges as a critical policy variable. For instance, other researchers emphasize the importance of preventive healthcare investment in maintaining economic performance amid aging populations [8]. Their analysis of OECD countries shows that preventive spending not only lowers long-term healthcare costs but also boosts labor productivity and overall welfare. Complementarily, EU countries where higher government health spending is associated with better health outcomes, such as increased life expectancy and lower mortality rates, which can foster productivity growth [13]. These findings highlight the dual nature of public health spending, as both a fiscal burden and an investment in human capital. Additionally, pension system reforms in aging populations can influence savings and labor supply [11]. When there are fewer retirees needing support, governments can sustain pension and healthcare systems with lower contribution rates. This effectively increases disposable income and encourages labor participation, suggesting that a reduction in old-age dependency can indirectly stimulate labor supply and help offset some of the growth challenges caused by demographic changes.

Despite the extensive research on aging and fiscal policy, most studies focus on aggregate relationships and developed economies, leaving a gap in understanding the unique demographic and fiscal dynamics of developing Asia. Unlike advanced economies, many Asian nations are transitioning to aging societies at lower income levels and with weaker institutional frameworks [23]. Furthermore, the region's health systems are uneven, and social protection coverage is often limited, leading to varying fiscal responses to aging. Additionally, Asia's interconnectedness, through economic integration, trade, and regional policy diffusion, complicates empirical analysis. Neglecting to consider such interdependence can lead to biased estimates and misleading conclusions regarding causal relationships [17, 24].

3. METHODOLOGY

3.1 Data and sample

The present study investigates the impact of population aging on economic growth through the channel of government health expenditure in selected Asian economies. The empirical analysis employs a unbalanced panel dataset covering 12 Asian countries over the period 1975–2024. These economies include Bangladesh, Cambodia, mainland China, Hong Kong, India, Japan, South Korea, Lao PDR, Macao, Myanmar, Pakistan, the Philippines, Singapore, and Vietnam. Due to data availability, the number of observations may vary across variables. To ensure consistency in units and avoid bias arising from mixing real and nominal values, all monetary series used in the analysis are converted into real terms. The level of economic development in each country is proxied by GDP per capita. Population aging is measured as the share of individuals aged 65 years and above in the total population, expressed as a percentage. The variable government health expenditure represents domestic general government health expenditure per capita, capturing fiscal commitment to health services and public welfare. All data are sourced from the World Bank's World Development Indicators (WDI) database, ensuring consistency and cross-country comparability. To reduce heteroskedasticity and facilitate elasticity-based interpretation, all variables are transformed into their natural logarithmic forms. By integrating demographic and fiscal channels, this study seeks to explore how shifts in the age structure influence economic growth through the mediating effect of public health spending. This is a critical policy dimension in the context of Asia's rapidly aging populations and evolving welfare systems.

Table 1 reports the descriptive statistics of the main variables: aging population, government health spending, and

economic growth measured by GDP per capita. The aging population variable records 700 observations, with a mean value of 6.76% and a standard deviation of 4.83. It suggests considerable heterogeneity in the demographic structure of Asian countries. The minimum value of 2.42% reflects relatively young populations in countries such as Bangladesh or Cambodia, whereas the maximum of 29.78% reflects rapidly aging societies such as Japan. Moreover, government health spending has a mean value of 3.66 and a standard deviation of 2.31. It indicates substantial variation in health spending efforts across countries. The minimum value (-0.65) indicates very low levels of public health spending in the early years for some lower-income economies, while the maximum (8.38) reflects high spending levels in high-income economies such as Singapore and Japan. GDP per capita, used as a proxy for economic growth, has a mean of 7.64 with a standard deviation of 1.98. This distribution underscores the income disparity across the region: from lower-income economies like Lao PDR and Myanmar to advanced economies such as Singapore and Hong Kong. Overall, the descriptive statistics reveal strong cross-country differences in demographic structure, government health spending, and economic prosperity among the selected Asian economies. The wide range of values supports the relevance of using panel data analysis to capture both temporal and cross-sectional variation. Importantly, the heterogeneity in the aging population and health spending highlights the potential of health expenditure to act as a mediating channel between demographic transition and economic growth.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	CD Statistic
Aging Population	700	6.761	4.837	2.421	29.781	61.978 ***
Health Spending	278	3.66	2.31	-0.651	8.387	35.285 ***
GDP per capita	673	7.639	1.982	3.327	11.415	58.262 ***

Note: Significance levels at 1%, 5% and 10% are denoted by * ** , * * and * respectively.
Source: Authors' calculation

The cross-sectional dependence test in Table 1 presents the results of the CSD tests for the variables used in this study. All variables exhibit cross-sectional dependence (CSD) issues, as indicated by significant CD statistics at the 1 percent level. Several factors contribute to this CSD among the variables in the Asian datasets. For instance, other researcher discusses how overall globalization, economic globalization, and political globalization enhance long-term economic growth [2]. When Western nations impose trade sanctions, regulatory standards (such as environmental, labor, and intellectual property regulations), or economic agreements, many Asian countries react similarly. These responses, changes in trade openness, investment flows, and regulatory alignment, are often contemporaneous, leading to cross-sectional dependence among variables across countries. Many Asian economies are closely integrated with Western markets through exports, imports, and foreign direct investment (FDI). Consequently, when Western demand or regulatory policies change, multiple Asian economies are affected almost simultaneously, resulting in correlated responses in variables like GDP growth, trade openness, and regulations. In addition to trade and investment openness, other complementary factors influence this growth trajectory. Deregulation, the shift toward free market economies, and liberalization policies have broadened opportunities for private sector participation. Moreover, regional blocs have increasingly coordinated infrastructure development, promoting integration and economies of scale. Common expenditure patterns are also evident across many Asian economies, including rising government consumption linked to large, young dependent populations and increased allocations for security and defense. Together, these dynamics illustrate that the growth effects of globalization are shaped not only by openness but also by domestic policy choices and regional collective actions.

To assess the stationarity properties of the series, Table 2 applies several panel unit-root tests were employed, including the Im, Pesaran, and Shin (IPS) test, Fisher-type Augmented Dickey–Fuller (ADF) test, and Fisher-type Phillips–Perron (PP) test [25]. Across all variables, the IPS and Fisher tests fail to reject the null hypothesis of a unit root, suggesting that the series are non-stationary in levels. These findings indicate that the economic variables—particularly aging population and health expenditure—follow stochastic trends over time, which is expected for macroeconomic indicators that evolve with demographic and fiscal changes. Only GDP per capita shows weak evidence of stationarity in one panel, reflecting heterogeneity in growth dynamics among the sample countries. Recognizing the non-stationary nature of these series ensures that subsequent empirical analysis avoids spurious regression results and motivates the exploration of potential long-run equilibrium relationships. Furthermore, the paper implemented second-generation panel unit root tests that are designed to remain valid in the presence of cross-sectional dependence. Pesaran's Cross-Sectionally Augmented Dickey-Fuller (CADF) results indicate that Aging Population and Health Spending are non-stationary in levels, whereas GDP per capita (GPC) is stationary. It confirms a mixed integration order among variables. This justifies the use of DCCE, as the estimator remains consistent under heterogeneity, cross-sectional dependence, and mixed integration orders.

Table 2. Panel unit root tests

	Im–Pesaran–Shin (IPS) Test	Augmented Dickey–Fuller Tests	Phillips–Perron (PP) Test	Pesaran's Cross-Sectionally Augmented Dickey-Fuller
Aging population	10.756	-3.524	-3.741	
Health spending	-0.912	-0.755	-1.921	
GDP per capita	-1.161	-0.862	1.879**	

Note: Significance levels at 1%, 5% and 10% are denoted by * ** , * * and * respectively. The Im–Pesaran–Shin (IPS) test expresses the t-bar Statistic. Both the Augmented Dickey–Fuller tests and Phillips–Perron (PP) tests show the t-statistics for modified inverse chi-squared.
Source: Authors' calculation

Non-stationarity in panel data is a common problem caused by the presence of a unit root. The presence of non-stationary variables may result in erroneous regression results, rendering the regression coefficients invalid [26]. Political regime changes often reshape fiscal priorities and can lead to significant shifts in public spending [27]. For weaker economies, exposure to external influences, such as international financial institutions and geopolitical pressures, may increase reliance on external borrowing. Other researcher argues that the rise of economic nationalism and protectionism has reshaped the landscape of international finance, leading to increased volatility and uncertainty [5]. This author also explores the role of multilateral institutions in mitigating geopolitical risks and fostering cooperation. Ultimately, the article emphasizes the need for a nuanced understanding of how geopolitical factors drive financial behavior, suggesting that policymakers must consider these dynamics to navigate the complexities of the global economy effectively. These factors introduce complexities into cross-country panel data, where institutional changes, external dependence, and shifting policy commitments contribute to heterogeneous patterns of spending and growth.

Similarly, the existence of panel co-integration, that is, the existence of a correlated linear combination of two non-stationary time series. Table 3 provides the analysis for the panel cointegration test. The long-run relationships among GDP per capita (GPC), aging population, and health expenditure were examined using Pedroni (1999, 2004), Kao (1999), and Westerlund (2007) cointegration tests. The Pedroni results show no consistent evidence of cointegration, while the Kao test provides mixed findings as only the Modified Dickey–Fuller statistic is significant at the 5% level. Similarly, the Westerlund test fails to reject the null hypothesis of no cointegration. Collectively, these results suggest the absence of a stable long-term equilibrium relationship among the variables during the sample period. This outcome is theoretically plausible, as demographic aging and government health expenditure may affect growth through short- to medium-term fiscal and structural channels rather than forming a consistent long-run proportional relationship.

Table 3. Panel cointegration tests

Pedroni Test Statistics		Kao Test Statistic		Westerlund ECM panel Cointegration Tests	
Panel V-Statistic	1.119	Modified Dickey–Fuller t	-1.8411**	Statistic	p-value
Panel Rho-Statistic	-0.1447	Dickey–Fuller t	-0.9846	Gt	0.947
Panel T-Statistic	-0.7364	Augmented Dickey–Fuller t	-1.0127	Ga	0.999
Panel ADF-Statistic	0.3777	Unadjusted modified Dickey–Fuller t	-1.6218**	Pt	1.000
Group Rho-Statistic	1.019	Unadjusted Dickey–Fuller t	-0.8753	Pa	1.000
Group T-Statistic	-0.1646				
Group ADF-Statistic	1.031				

Note: Significance levels at 1%, 5% and 10% are denoted by * ** , * * and * respectively.
Source: Authors' calculation

3.2 Model specification

Because the dataset encompasses multiple Asian economies observed over nearly five decades, it is crucial to account for cross-sectional dependence (CSD). This dependence reflects the influence of unobserved common shocks, such as global financial crises, demographic transitions, and regional policy diffusion. These factors can simultaneously affect several countries. Ignoring such dependence can lead to biased, inefficient, and spurious parameter estimates [24]. Therefore, the econometric design of this study follows recent advances in second-generation panel data techniques for macroeconomic panels characterized by cross-sectional dependence and non-stationarity [17, 18]. Compared with other estimators, CS-ARDL offers three major advantages: (1) it yields consistent long-run estimates even under strong cross-sectional correlation; (2) it controls for omitted global shocks without requiring explicit identification of latent factors; and (3) it avoids pre-testing for cointegration, which is valuable when mixed results emerge from Pedroni or Westerlund tests. Empirically, this specification captures both short-run heterogeneity that reflects differences in fiscal capacity, institutional quality, and demographic pace and long-run commonalities arising from shared structural drivers of growth and health expenditure.

Empirical evidence from the Pesaran CD test, summarized in Table 1, indicates that all variables exhibit statistically significant cross-sectional dependence at the 1 percent level. This confirms that Asian economies are interconnected through trade, investment, and demographic linkages. Such interdependence suggests that shocks originating in one economy can rapidly spill over to others, reinforcing the necessity of employing econometric methods robust to common factors. Subsequent panel unit-root tests reported in Table 2 show that most variables are non-stationary in levels but stationary in first differences. This is consistent with the behavior of macroeconomic indicators such as GDP per capita, government health expenditure, and an aging population. The panel cointegration results in Table 3 further reveal the absence of a stable long-run equilibrium relationship. This implies that these series do not move proportionally over time, with short-run dynamics dominating the adjustment process. Together, these findings justify the adoption of dynamic rather than static estimators and motivate the use of the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) approach [17]. Mathematically, the CS-ARDL(p, q) model can be expressed as:

$$y_{\text{it}} = + \sum_{j=1}^{p} \phi_{i,j}\, y_{i,t-j} + \sum_{j=0}^{q} \beta_{i,j}\, x_{i,t-j} + \lambda_i \bar{y}_t + \delta_i \bar{x}_t + \varepsilon_{i,t} \quad (1)$$

where, $\bar{y}_{\text{t}}$ and $\bar{x}$ represent the cross-sectional averages that capture the influence of global shocks or region-wide spillovers over the time period t. Specifically, i denotes each individual country within the panel and j incorporates the dynamic adjustment effects of both the dependent and independent variables. Furthermore, p and q denote the maximum lag orders of the dependent variable (y) and the explanatory variable (x), respectively. In addition, the use of country-specific parameters (α_{i}, $\phi_{\text{i,j}}$, $\beta_{\text{i,j}}$) recognizes

heterogeneity across economies and reflect differences in fiscal capacity, institutional quality, and demographic characteristics. Specifically, $\phi_{i,j}$ represents the autoregressive coefficients, which capture the persistence or inertia in the dependent variable across time. $\beta_{i,j}$ represents the distributed lag coefficients, which reflect the short-run effects of changes in the explanatory variable (x) on the dependent variable (y) at different lag intervals. Moreover, $\lambda_i \bar{y}_t$ and $\delta_i \bar{x}_t$ are the cross-sectional augmentation terms that explicitly include the cross-sectional averages of the dependent and independent variables. These terms, along with their coefficients (λ_i and δ_i), account for the influence of the unobserved global or common spillover effects on the specific country i. $\varepsilon_{i,t}$ is the idiosyncratic error term, which is assumed to be independently and identically distributed across countries and over time after having effectively controlled for the pervasive influence of the cross-sectional dependence.

The panel cointegration tests in Table 3 do not support the existence of a stable long-run relationship among the variables. So the negative and statistically significant coefficient on the lagged dependent variable in the CS-ARDL model reflects short-run adjustment dynamics rather than convergence to a long-run equilibrium. In this context, the negative coefficient indicates that short-term fluctuations in GDP per capita tend to moderate over time. This suggests a tendency toward stabilization in the short run following fiscal or demographic shocks. Economically, the CS-ARDL specification remains valuable because it captures both within-country dynamic behavior (through lagged terms) and cross-country interdependence (through cross-sectional averages). Recent empirical studies demonstrate that the CS-ARDL model provides reliable short-run inference in panels characterized by heterogeneity and strong cross-sectional dependence [3, 28]. Therefore, in this study the CS-ARDL framework is used to estimate short-run relationships between population aging, government health expenditure, and economic growth, while avoiding any interpretation that requires cointegration. The model remains robust to contemporaneous correlations and shared regional shocks across Asian economies.

4. RESULT ANALYSIS AND DISCUSSION

4.1 Main findings

Panel unit root tests indicate that most variables are non-stationary in levels but stationary in first differences and cointegration diagnostics reveal the absence of a stable long-run equilibrium relationship. Having confirmed the presence of cross-sectional dependence (CSD) across countries, this section presents the main empirical findings from the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) model. The CS-ARDL approach is well-suited for dynamic heterogeneous panels characterized by CSD [17]. It controls for unobserved common factors and spillover effects through cross-sectional averages of both dependent and independent variables. This feature ensures that the estimates remain consistent and robust even in the presence of global shocks or interdependencies among the selected Asian economies.

Table 4. Short-run dynamics and level associations among aging population, government health spending, and economic growth under the CS-ARDL model

	Variable	Coefficient	Standard Error
Short-run	Lag. Aging_Population	0.126	0.283
	Lag. Government Health Spending	-0.124*	0.057
Error correction term	L.GPC (ϕi,0)	-0.331***	0.118
Level Associations	Aging Population	-3.030	4.808
	Government Health Spending	-0.150	0.291
Average R^2	0.98		

Note: Significance levels at 1%, 5% and 10% are denoted by * ** , * * and * respectively. Average R-Squared reflects the average explanatory power across country-specific regressions. The CS–ARDL estimation was conducted using a panel of 12 countries (N = 12) observed over an unbalanced time span from 1975 to 2024, yielding a total of 266 observations. The time dimension varies across units, with an average of T ≈ 22 observations per country. The model incorporates cross-sectional averages, resulting in slightly reduced degrees of freedom (minimum T = 15 with augmentation).
Source: Authors' calculation

The CS-ARDL results reported in Table 4 indicate that GDP per capita (GPC) in the selected Asian economies exhibits strong persistence over time. This finding confirms path dependence and slow adjustment, which are typical of growth processes in developing and middle-income countries [2, 21]. The error-correction term (ECT), represented by lagged GDP per capita, is negative and statistically significant. However, this term cannot be interpreted as evidence of long-run convergence because the panel cointegration tests do not support the existence of a stable long-run relationship among the variables. Instead, the negative coefficient should be understood as capturing short-run error-correction-type–type dynamics within the autoregressive structure of the CS-ARDL model. It indicates that deviations from past values are partially corrected over time. The coefficient of -0.6688 implies that approximately 66.88% of short-run disequilibrium is corrected each year. This indicates a relatively rapid adjustment toward long-run equilibrium. This finding is consistent with other research, as it highlights the importance of dynamic reversion in heterogeneous panel systems [16, 29]. Thus, it supports the view that economic systems in Asia adjust relatively quickly to demographic and fiscal shocks. This reflects resilient macroeconomic structures and adaptive policy frameworks.

In the short-run dynamics, the coefficient for lagged aging population is positive and statistically insignificant. This suggests that aging exerts no immediate impact on economic output. So demographic aging influences growth indirectly through labor force participation, savings behavior, and fiscal reform channels, rather than through instant macroeconomic shocks. Conversely, the lagged coefficient of health spending is negative and significant. This indicates that high healthcare spending in the preceding period is associated with a short-term decline in output. This may occur due to fiscal tightening or inefficient budget allocation [13].

The estimated level coefficients for the aging population (–0.1499, p = 0.607) and health spending (–3.0302, p = 0.529) are statistically insignificant. This implies that neither variable shows a robust contemporaneous association with GDP per capita once short-run dynamics and cross-sectional dependence are accounted for. The growth effects of aging depend heavily on institutional adaptability and human capital formation rather than on the sheer size of the elderly population. Thus, aging economies may experience slower growth unless offset by increases in human capital and technological adoption. Moreover, public expenditure can have non-linear or diminishing growth effects depending on efficiency and fiscal composition [6].

Regarding overall model performance, the R-squared values demonstrate that the inclusion of cross-sectional averages substantially improves model fit. This captures most of the variance in GDP per capita through common regional dynamics. This result underscores the robustness of the CS-ARDL framework as a modern econometric approach. It effectively addresses interdependence and heterogeneity in macro-panel data [3]. Overall, these findings highlight the complex interplay between demographic transition, fiscal policy, and economic performance in Asia. While population aging alone does not directly impede growth, its impact manifests through fiscal channels and productivity effects. This reinforces the importance of efficient health spending, structural reforms, and human capital accumulation. These elements are crucial in sustaining long-term economic resilience [5, 12, 19].

4.2 Robustness checks

To ensure the reliability and stability of the main empirical results, several robustness checks were conducted. The first robustness assessment focuses on detecting cross-sectional dependence (CSD) within the panel dataset. This step is crucial for validating the suitability of the econometric framework. In macroeconomic panels, particularly those involving Asian economies, economic growth, demographic structures, and fiscal spending are rarely independent processes. Instead, they are deeply interlinked through regional and global spillovers, shared policy learning, and synchronized demographic transitions. For instance, rapid population aging in Japan and South Korea has influenced neighboring countries through regional labor mobility, pension system reforms, and health policy convergence, while global health shocks such as COVID-19 have triggered coordinated fiscal and health spending responses across Asia [5, 9].

Empirical verification using Pesaran's CD test reveals strong cross-sectional dependence across all variables in the study. The CD statistics are large and statistically significant at the 1% level. It indicates that the panel units are jointly influenced by common unobserved factors. The correlation values reported in Table 5 refer specifically to the average correlation of the cross-sectional means, not the raw variables or model residuals. High correlations among cross-sectional averages—such as values above 0.85—are expected in macroeconomic panels because these averages capture region-wide shocks, synchronized business cycles, and demographic or fiscal co-movements. By including cross-sectional averages of the dependent and explanatory variables, the CS–ARDL framework effectively filters out common global shocks and mitigates omitted-variable bias. This ensures that coefficient estimates remain consistent even when countries are strongly interconnected. The detection of significant cross-sectional dependence suggests that demographic and fiscal dynamics in Asia function within a shared regional system. If one government implements successful health policies, others may adopt similar strategies. When Asian economies experience similar economic conditions, such as growth or recession, their demographic and fiscal dynamics may respond in parallel. In this system, policy spillovers, shared demographic challenges, and synchronized economic cycles shape the transmission of demographic and fiscal shocks.

Table 5. Average correlation coefficients & Pesaran CD test

Variable	CD-Test	p-value	Cross-Sectional Mean
GDP per capita	33.68	0.000	0.864
Aging Population	37.26	0.000	0.956
Government Health Spending	35.28	0.000	0.905

Note: Significance levels at 1%, 5% and 10% are denoted by * ** , * * and * respectively. Correlation values represent average correlations of cross-sectional means, not variable-level or residual correlations.
Source: Authors' calculation

Further, the model was re-estimated using an alternative lag structure, namely the ARDL(2,2,2) specification. It helps to capture deeper dynamic interactions among economic growth, demographic aging, and government health expenditure. This extension allows for richer temporal dynamics, recognizing that fiscal policy effects and demographic transitions often manifest with multi-period delays rather than instantaneous responses [29, 30]. The robustness analysis generally confirms the persistence of GDP per capita growth, evidenced by the continued statistical significance of the lagged dependent variable, while revealing that the health spending–growth nexus becomes less robust once longer lags are introduced.

In the baseline model, health expenditure exhibited a positive short-run and statistically significant effect. However, after extending the lag structure, Table 6 indicates that both the contemporaneous and lagged coefficients of health spending turn negative and statistically insignificant. This indicates that the initially observed fiscal transmission channel, where government health investment stimulates short-term output growth, may not persist once longer dynamic adjustments are accounted for. Other authors also agree that the growth effects of public spending depend on its efficiency and composition rather than its aggregate volume [6]. Moreover, the weakening of the fiscal-growth link under extended lags suggests that health spending may generate short-run multipliers that dissipate over time.

While the aging population variable remains insignificant in the baseline specification, the ARDL(2,2,2) model presents weak evidence of a delayed positive effect. Specifically, the second lag of the aging population exhibits a borderline significant coefficient (p = 0.074). This implies that demographic shifts may influence growth with a time lag.

Such effects could reflect the gradual reallocation of resources, intergenerational wealth transfers, and accumulated experience among older workers [4, 23]. These delayed effects also align with another research [7]. They emphasize that the macroeconomic implications of aging unfold slowly through labor supply, human capital accumulation, and savings behavior. First, the persistence of economic growth remains robust across models. This underscores the path-dependent nature of output dynamics in Asian economies. Second, the fiscal channel, captured through health spending, appears to be short-run driven and sensitive to lag length. This suggests that fiscal stimuli in the health sector may provide temporary growth impulses rather than sustainable long-term effects. Third, while aging population effects are mostly insignificant, they exhibit weak and delayed positive signals. This highlights that the economic influence of demographic aging may materialize gradually rather than contemporaneously [10, 12].

Table 6. Robustness checks CS-ARDL(2,2,2)

	Variable	Coefficient	Standard Error
Short-run	Lag1. GDP per capita	0.628***	0.132
	Lag2. GDP per capita	-0.062	0.087
	Lag1. Aging Population	-1.064	0.831
	Lag2. Aging Population	0.601*	0.336
	Lag1. Government Health Spending	-0.073	0.067
	Lag2. Government Health Spending	-0.052	0.067
Level Associations	Aging Population	0.466	0.587
	Government Health Spending	-2.628	1.818
Average R^2	0.98		

Note: Significance levels at 1%, 5% and 10% are denoted by * **, * * and * respectively. The CS–ARDL estimation was conducted using a panel of 12 countries (N = 12) observed over an unbalanced time span from 1975 to 2024, yielding a total of 266 observations. The time dimension varies across units, with an average of T ≈ 21 observations per country. The model incorporates cross-sectional averages, resulting in slightly reduced degrees of freedom (minimum T = 15 with augmentation). All results are derived from the xtdcce2 estimator in Stata.
Source: Authors' calculation

The final robustness test employs the Pooled Mean Group Autoregressive Distributed Lag (PMG–ARDL) estimator. This estimator incorporates an error-correction mechanism (ECM) to re-examine the dynamic relationship among economic growth, population aging, and government health expenditure. The PMG–ARDL framework developed by Pesaran et al. [29] allows for heterogeneous short-run dynamics across countries. However, it imposes long-run homogeneity, thereby enabling comparisons between short-run adjustments and steady-state equilibria. The difference of PMG–ARDL results with those from the Cross-Sectionally Augmented ARDL (CS–ARDL) model highlights both consistencies and divergences in empirical findings. These differences reflect the varying assumptions and econometric structures underlying each approach.

Table 7 compares the two models to synthesize the main differences. Both models confirm the persistence of GDP per capita and the short-run fiscal channel. In this channel, health spending drives growth temporarily. However, their long-run implications diverge. The result shows that population aging has no direct or immediate impact on economic growth across Asian economies. This result aligns with prior evidence suggesting that the demographic transition primarily affects growth through indirect fiscal and labor market channels. In contrast, it does not significantly impact growth through the direct size of the elderly population [4, 10, 23]. Moreover, this approach also confirms that government health spending has a significant short-run positive effect on GDP per capita. This underscores the importance of fiscal policy as a short-term stabilizing and demand-augmenting mechanism [6]. In the short-run block of the PMG–ARDL results, the coefficient for health spending is positive and statistically significant. This corroborates the growth-enhancing role of public health investment. This finding is consistent with previous studies [8, 13, 31]. These studies emphasize that healthcare expenditure contributes to productivity gains and human capital formation in the short run by improving workforce efficiency and reducing morbidity-related output losses.

However, notable divergences emerge when comparing the long-run dynamics of the two models. In the CS–ARDL specification, health spending exhibited contemporaneous positive but lagged negative effects. This suggests fiscal trade-offs and adjustment costs associated with reallocating government budgets and intertemporal fiscal constraints. By contrast, the PMG–ARDL model produces a positive but statistically insignificant level coefficient for health spending (4.49, p = 0.362). The accompanying error-correction term (ECT) in the PMG specification is also positive. This implies divergence rather than convergence toward a long-run equilibrium. Its insignificance suggests that any broader association between health expenditure and income levels is weak once the homogeneity restrictions of PMG are imposed. In the CS–ARDL specification, health spending exhibited contemporaneous positive but lagged negative effects. This suggests fiscal trade-offs and adjustment costs associated with reallocating government budgets and intertemporal fiscal constraints. Meanwhile, the PMG–ARDL results imply that the influence of health spending is largely transient and does not translate into a robust level relationship across countries. The aging variable remains consistently insignificant in both models, reaffirming that the demographic–growth connection operates primarily through indirect channels such as labor-force participation, technological upgrading, and human-capital adaptation [7, 9, 12, 32]. So the robustness checks highlight that the fiscal channel is the primary short-run mechanism linking public health expenditure to economic activity, whereas broader income-level associations are sensitive to model assumptions and institutional contexts. This pattern aligns with the wider literature on nonlinear and heterogeneous fiscal-growth effects [6]. It also suggests that in

aging economies, health expenditure may enhance near-term productivity and aggregate demand. However, it does not necessarily lead to sustained increases in income levels without complementary structural reforms, improved spending efficiency, and innovation-driven governance frameworks.

Table 7. Robustness checks PMG (Pool Mean Group) -ARDL

Variable	Coefficient	Standard Error
Error correction term	0.004	0.003
D. Aging Population	0.114	0.188
D. Government Health Spending	0.303***	0.095
Government Health Spending	4.494	4.935

Note: Significance levels at 1%, 5% and 10% are denoted by * **, * * and * respectively. The PMG–ARDL estimation was conducted using a panel of 12 countries (N = 12) observed over an unbalanced time span from 1975 to 2024, yielding a total of 266 observations. The time dimension varies across units, with an average of T ≈ 22 observations per country. The model converges after four iterations, yielding a final log-likelihood of 378.69, indicating a stable model fit.
Source: Authors' calculation

5. CONCLUSION

This research explores how population aging affects economic growth through the fiscal channel of government spending in Asian countries from 1975 to 2024. Utilizing an unbalanced macro-panel dataset that exhibits cross-sectional dependence, non-stationarity, and weak evidence of cointegration, the study employs the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS–ARDL) model to analyze both short-run dynamics and level associations. This approach is particularly fitting for Asian economies, which are characterized by strong regional linkages and frequent exposure to common macroeconomic shocks. The empirical results reveal that the direct impact of population aging on economic growth is statistically insignificant. However, government health spending emerges as a key transmission mechanism linking demographic change to economic performance. In the short run, health expenditure exerts a positive and significant contemporaneous effect on GDP per capita. This underscores its role in stimulating output through improved health infrastructure, labor productivity, and aggregate demand. However, the lagged health spending variable exhibits a negative and statistically significant effect. This indicates potential fiscal trade-offs and adjustment costs. This duality suggests that while expansionary health budgets may boost short-term economic activity, they can also generate budgetary constraints or inefficiencies in subsequent periods. Such outcomes occur if these budgets are not complemented by effective fiscal discipline and productivity-enhancing reforms. In accordance with the endogenous growth framework, public spending can have both productive and distortionary effects depending on the efficiency, composition, and timing of fiscal interventions.

From a policy perspective, these results highlight several important implications. First, governments in aging societies should structure health expenditure in a way that supports short-run economic activity while maintaining medium-term fiscal discipline. This involves prioritizing preventive healthcare, investing in productivity-enhancing health measures, and implementing well-targeted social protection programs that ease demographic pressures without imposing ongoing fiscal burdens. Second, the strong regional interdependence observed in the data highlights the need for policy coordination among Asian economies. Such coordination is essential for managing shared demographic transitions, public health challenges, and macroeconomic shocks that are transmitted across the region. Third, policymakers should develop human-capital strategies to address the shrinking labor force in aging societies. These strategies may include lifelong learning systems, labor market reforms, and the adoption of productivity-boosting technologies.

The study has certain limitations. The sensitivity of results to lag structure variation indicates that the fiscal-demographic channel is likely short-term in nature. Additionally, the lack of robust cointegration indicates that the relationships among aging, public spending, and economic growth may not yet demonstrate a stable long-term pattern across Asian economies. Future research should employ more granular datasets. For example, researchers could use disaggregated health spending by function or efficiency metrics. They should also explore nonlinear or threshold effects of fiscal policy under demographic pressure. Additionally, incorporating structural heterogeneity, institutional quality, and policy interaction effects into dynamic panel models, such as CS–ARDL, PMG–ARDL, or Dynamic Factor Models (DFMs), could offer deeper insights. These insights would enhance understanding of the temporal and cross-country heterogeneity of demographic-economic linkages.

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