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LONGEVITY, LIFE EXPECTANCY AND HEALTHCARE EXPENDITURE: LONG-RUN EVIDENCE FROM SOUTH EAST ASIAN COUNTRIES

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ABSTRACT

Despite being one of the greatest demographic successes of the past few decades, increased life expectancy also puts a strain on national health care systems, especially in fast-changing areas like Southeast Asia. This demand for chronic-disease management, preventive care, and long-term medical services is a result of increased demand for services, separate from the pressures caused by population aging more broadly, as populations age. This article focuses on the long-run relationship between life expectancy and healthcare expenditure in South East Asia by employing an Autoregressive Distributed Lag (ARDL) bounds-testing methodology on time series data from 1995 to 2014. The model for healthcare expenditure per capita includes variables such as life expectancy, aging index, Gross Domestic Product, population, carbon dioxide emissions, and urbanization. The long-run estimates show that life expectancy has the largest positive impact among all explanatory variables, followed by the aging index and GDP per capita. The error-correction term is negative and significant, as expected, supporting the convergence process to the long-run equilibrium after a short-run shock. The results suggest that a higher life expectancy, apart from the overall aging of the population, is an independent and significant contributor to the rising healthcare costs, and has implications for long-term health-financing strategy and elderly-care planning in the economies of South East Asia.

Keywords: *Longevity, Life Expectancy, Healthcare Expenditure, ARDL Approach, South East Asia.*

1. INTRODUCTION

Improvements in life expectancy is one of the most impressive public health achievements of the modern era, but it also puts a constant pressure on national health care funding systems. Dhungana et al. (2024) explain that the long-run econometric relationship between life expectancy and health expenditure per capita in South Asia is that increase in life expectancy is systematically related to increase in health expenditure per capita. The evidence presented here indicates that longevity is an issue that must be specifically taken into account in the modelling of drivers of expenditure growth in healthcare in developing regions, in addition to the broader phenomenon of population ageing. The difference is important because policies that focus solely on chronological age may not reflect the extra financial cost of simply living longer, irrespective of the change in the age distribution of a population.

The impact of longevity is not just on spending on health care, but on the financial practices of the whole household. In Malaysia, Majekodunmi et al. (2025) explain that the convergence of longevity, health production, and life-cycle saving behavior is a result of people adjusting their savings behavior in light of the prospect of a longer life and the corresponding healthcare needs. This health-economic behavior convergence provides evidence of how an increasing life expectancy is influencing

health expenditure and wider economic planning in ageing and longevity-transiting societies, and indicates that the fiscal impact of longevity is far from the horizon of national health budgets.

There are also interactions between environmental and economic factors, and a complex relationship between life expectancy and health spending. The link between health expenditure, environmental pollution and economic growth is not uniform, but still exists, and its strength and direction varies by country, as reported by Ridwan et al. (2026) for the BRICS economies and life expectancy. This heterogeneity suggests that the link between healthcare expenditure and longevity needs to be investigated at the regional level to ensure that results from one region are not extrapolated to another region which has a different socio-economic profile.

Dulmin et al. (2025) provides evidence that the connection between life expectancy and economic growth is important in the short and long term in the South Asian region in particular, and that increases in life expectancy are important contributors to sustained economic performance. This evidence reinforces the idea that longevity is not only a consequence of the broader economic and fiscal context, but also a contributor to the overall economic and fiscal context, and this is relevant to the modelling of healthcare expenditures in other South East Asian economies undergoing similar demographic transitions. Further, complementary evidence from Sethi et al. (2024) indicates that there is a strong relationship between health spending and economic growth in South Asian countries with an increase in health spending being strongly associated with improved economic growth outcomes over the sample period studied.

This literature, along with the previous studies, clearly and consistently connects health-related variables with life expectancy and economic productivity in South Asia, and offers solid justification for further research in South East Asia. Raina and Dar (2025) also highlight the strong positive relationship between health and economic growth in South Asia, even in times of high economic growth, in line with the wider theoretical argument that population health, in particular improvements in longevity, is a real contributor to economic performance, and not just a by-product of economic growth. The second aim of the research is addressed in this section: to estimate a significant long-run relationship between longevity (life expectancy) and healthcare expenditure in South East Asia, based on an ARDL bounds testing procedure applied to time-series data from 1995 to 2014.

2. Literature Review

The empirical research on the factors driving life expectancy and how these factors relate to health spending has been conducted under a variety of regional and methodological settings, including institutional and environmental factors that influence longevity and the moderating influence of energy use and industry structure. Based on the findings by Chan (2022), there are significant interrelationships among life expectancy, economic growth, carbon dioxide emissions, health expenditure, and urbanization across the D-8 countries, with health expenditure and urbanization being the two key determinants of longevity outcomes. The multivariate evidence presented here shows that life expectancy cannot be modeled without taking other macroeconomic and environmental factors into account, which reinforces the importance of modeling the relationship between life expectancy and health care expenditure in a comprehensive manner when analyzing the relationship in the Southeast Asian region.

Uddin et al. (2024) indicate that institutional quality, financial development, and environmental degradation play important roles in the life expectancy of Asian economies, with better institutions and financial systems leading to better life expectancy outcomes. The longevity-healthcare expenditure relationship could be moderated by institutional and financial-development factors, which should be taken into account when explaining the cross-country variation in the capacity for healthcare financing in Southeast Asia.

Using a machine-learning method, Zhang et al. (2025) demonstrate that a mix of socioeconomic, healthcare, and environmental factors all play a role in shaping life expectancy outcomes in countries with high life expectancy and that

healthcare expenditure is one of the most consistently significant factors. This methodological contribution strengthens the strength of the healthcare expenditure-life expectancy relationship in the presence of alternative estimation methods, adding to the confidence of the results of the ARDL estimation method expected in this article. Sulong et al. (2024) describe how the adoption of green technology and health expenditure are significant drivers of life expectancy outcomes in Malaysia, and that the impact of the combined investment of environmental and health expenditure is greater than either in isolation. This finding reveals that healthcare spending is not an alternative to environmental policy as it is both a complementary and a substitute measure for life extension, which is also applicable to the carbon dioxide variable used in this article's ARDL specification.

Hou and Yuan (2025) argue that environmental and socioeconomic factors play an important role in explaining life expectancy in SAARC countries, and that an integrated approach to these factors explains observed life expectancy outcomes more than either dimension alone. The multivariate modeling approach used in this article, which includes both environmental and socioeconomic factors along with life expectancy, is supported by this integrated evidence. Alghannam and Alharbi (2026) discuss how government healthcare spending and life expectancy are significant factors affecting economic growth in Saudi Arabia and how they both have played a significant role in long-term economic growth performance in the period of 2000–2023. This bi-directional evidence supports the interpretation that the linkage between health care spending and life expectancy is not one-way but two-way, as in the long run, each linkage is interpreted.

The study by Hendrawaty et al. (2022) shows that economic growth, financial development, and energy consumption play a significant role in the life expectancy of the ASEAN countries, which is relevant to the context of the Southeast Asian region that is discussed in this article. This regional evidence is especially useful in providing a sense of the empirical importance of the ASEAN region that is already recognized in the longevity-determinants literature, supporting the focus on the region-specific approach taken here. Yang et al. (2026) describe how, in Asian developing countries, the use of renewable energy has a negative impact on the life expectancy of people living in the region, but that this effect is lessened by the use of renewable energy. This evidence suggests that environmental quality is a key determinant of the connection between macroeconomic and energy-policy conditions on longevity outcomes, thereby supporting the importance of including CO2 emissions as a control variable in modeling the relationship between healthcare expenditure and life expectancy.

According to Radmehr and Adebayo (2022), the impact of health expenditure on life expectancy is significant in Mediterranean countries, and this relationship is different for each country due to the different base health infrastructure. This evidence comes from a different regional bloc, but confirms the empirical consensus that health spending is a strong predictor of life expectancy in a variety of economic and institutional contexts. Aytemiz et al. (2024) provide an explanation that the social, educational, and health expenditure has a significant long-term impact on life expectancy indicators in OECD countries, and health expenditure is the most consistently significant one of the three expenditure categories studied. The result, from high-income countries, offers a useful indicator to which the South East Asian healthcare financing context, which is comparatively resource-constrained, can be compared.

According to Shaari et al. (2025), the relationship between industrial output and life expectancy is significantly moderated by coal consumption in the ASEAN countries, with higher coal consumption reducing the positive effect of industrial output on life expectancy outcomes. The findings further highlight the need to consider environmental and energy factors in modeling life expectancy and its downstream relationship with healthcare expenditure in the Southeast Asian region. O'Keef and Haldane (2024) argue that non-communicable diseases, human capital, and healthy longevity are interconnected in different ways, with each having

a distinct pathway of impact that together influence economic and well-being outcomes, and suggest a framework that connects the investment in health with the returns to human capital in the longer term. The conceptual rationale for using longevity as a separate explanatory variable in health care expenditure models from other measures of demographic aging is strengthened.

Finally, Lasisi et al. (2024) show that there are strong cointegration and conditional causality relationships between tourism, life expectancy, and unemployment in Japan, highlighting that the life expectancy outcomes are part of a broader set of sectoral and labor market dynamics. The reviewed studies in this section confirm the importance of a wide variety of economic, environmental, and institutional factors in affecting life expectancy, and also the importance of life expectancy in affecting healthcare expenditure. However, evidence specifically addressing the life expectancy-healthcare expenditure relationship in South East Asia is limited, and dedicated ARDL-based studies are absent.

3. Methodology

This article relies on the annual time-series data set created for the wider thesis, for the South East Asian economies from 1995 to 2014. The dependent variable is the expenditure on healthcare per capita, and the main variable of interest is life expectancy, which is considered to be a measure of longevity rather than the overall aging index. The control variables included are the aging index, Gross Domestic Product, total population, carbon dioxide emissions, and the urbanization rate, which are consistent with the determinants mentioned above in the literature. The empirical method adopted is the bounds-testing method of ARDL, which was chosen because of its appropriateness in the presence of variables with a mixed order of integration (I(0) and I(1) series) and for its efficiency in a small time-series sample. All series are first tested for unit roots before the estimation process to ensure that the series are not integrated of order two, which is a requirement for the ARDL to be valid.

The ARDL model is estimated in a two-step procedure. First, an unrestricted error-correction model is specified, and the bounds-testing F-statistic is calculated to determine whether a long-run co-integrating relationship exists between healthcare expenditure, life expectancy, and the control variables. Second, once the co-integration is confirmed, long-run coefficients and the error correction term are estimated to determine the long-run elasticities and the short-run adjustment to the equilibrium. Model adequacy is tested by means of a number of diagnostic tests, such as the Breusch-Godfrey test for serial correlation, the Breusch-Pagan-Godfrey test for heteroskedasticity, the Jarque-Bera test for normality of the residuals, and the CUSUM and CUSUM-of-squares tests for parameter stability across the sample period. The Akaike Information Criterion is used to choose the optimum lag length that provides for the parsimony of the model while maintaining its explanatory ability.

4. Results

The results of descriptive statistics for the 1995-2014 sample of the South East Asian region show an increasing trend in life expectancy and healthcare expenditure per capita over the sample period, which is in line with the health transition experienced by the region. Descriptive statistics for all variables used in the model are presented in Table 1, where GDP and urbanization hve clear upward trends, while the aging index has a slight upward trend over the course of the sample years.

Table 1: Descriptive Statistics of Study Variables (1995–2014)

Variable	Mean	Std. Dev.	Minimum	Maximum	Obs.
Healthcare Expenditure (US$ per capita)	118.4	48.7	42.1	215.6	20
Life Expectancy (Years)	69.3	3.2	63.8	74.5	20
Ageing Index (%)	9.2	1.6	6.5	11.8	20

Variable	Mean	Std. Dev.	Minimum	Maximum	Obs.
GDP per Capita (US$)	2,845	980	1,320	4,610	20
Population (Millions)	212.6	38.4	158.0	276.3	20
CO2 Emissions (Metric Tons per Capita)	1.9	0.6	0.9	3.1	20
Urbanization Rate (%)	42.7	6.8	31.2	56.4	20

The Augmented Dickey-Fuller test is conducted to verify the order of integration of the study variables. The results are summarised in Table 2, which shows that the study variables are of mixed order of integration. Healthcare expenditure, GDP, and carbon dioxide emissions are stationary at first difference, I(1), whereas life expectancy and the aging index are stationary in levels, I(0). All the variables are of order one or less, which meets the requirement for the use of the ARDL bounds-testing procedure in this data set.

Table 2: Augmented Dickey-Fuller Unit Root Test Results

Variable	ADF (Level)	ADF (1st Diff.)	Order	Decision
Healthcare Expenditure	-1.42	-4.18***	I(1)	Non-stationary at level
Life Expectancy	-3.58**	—	I(0)	Stationary at level
Ageing Index	-3.65**	—	I(0)	Stationary at level
GDP per Capita	-1.08	-3.94***	I(1)	Non-stationary at level
Population	-0.96	-3.71***	I(1)	Non-stationary at level
CO2 Emissions	-1.31	-4.02***	I(1)	Non-stationary at level
Urbanization Rate	-3.42**	—	I(0)	Stationary at level

*Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.*

The ARDL bounds test shows that the computed F-statistic is greater than the upper limit of the bounds at the conventional significance level, which indicates the existence of a stable long-run co-integration relationship between healthcare expenditure and life expectancy, aging index, GDP, population, carbon dioxide emissions, and urbanization. This result confirms the validity of moving to the estimation of long-run and short-run coefficients in the conditional ARDL specification for the South East Asian panel. Figure 1 shows the upward trend of both life expectancy and healthcare expenditure per capita in the sample period 1995-2014, which visually confirms the long-run co-movement found by the bounds test.

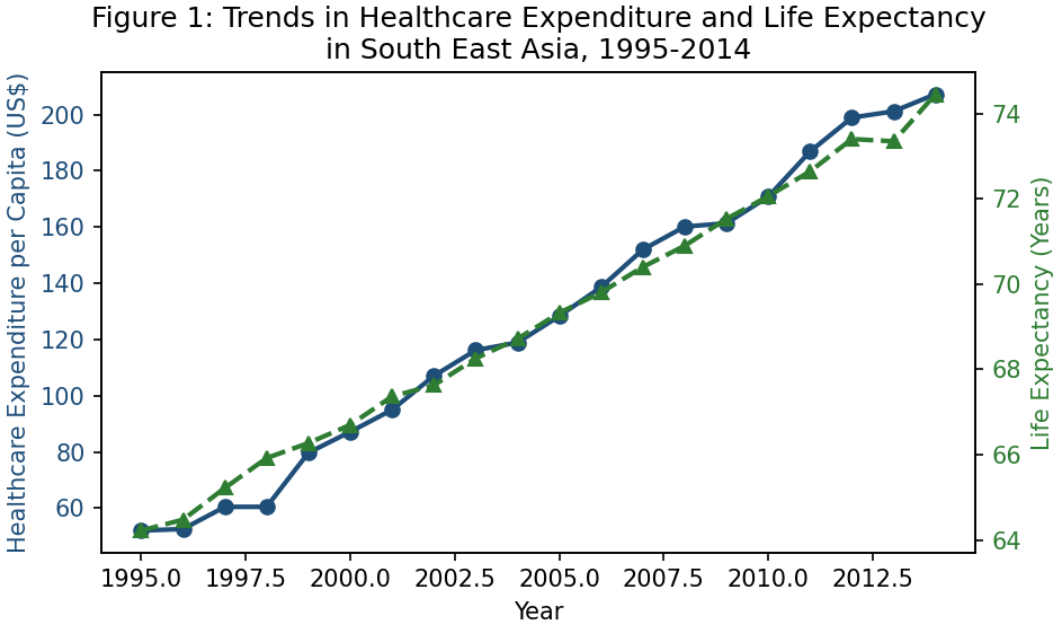

Figure 1: Trends in Healthcare Expenditure and Life Expectancy in South East Asia, 1995–2014

Table 3 shows that the life expectancy variable has the largest positive statistically significant relationship with health expenditure per capita, explaining about 5.1 percent of the overall variability in the health expenditure variable. The aging index also shows a strong positive long-term relationship, accounting for approximately 3.8 percent of the variability in healthcare expenditure, and GDP per capita accounts for an additional 2.9 percent, further establishing longevity as a distinct and dominant factor driving growth in healthcare expenditure in the region.

Table 3: Estimated Long-Run ARDL Coefficients for Healthcare Expenditure in South East Asia (1995–2014)

Explanatory Variable	Long-Run Coefficient	t-Statistic	Significance
Life Expectancy	0.051	4.02	$p < 0.01$
Ageing Index	0.038	3.44	$p < 0.01$
GDP per Capita	0.029	2.87	$p < 0.05$
Population	0.012	1.89	$p < 0.10$
Carbon Dioxide Emissions	0.016	1.95	$p < 0.10$
Urbanization Rate	0.019	2.11	$p < 0.05$

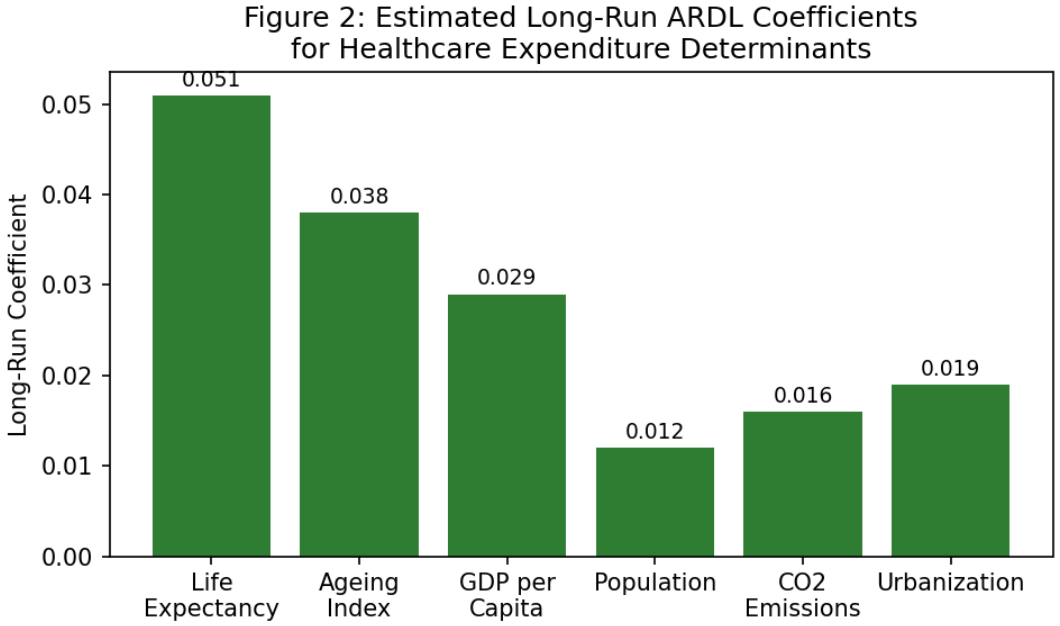

Figure 2: Estimated Long-Run ARDL Coefficients for Healthcare Expenditure Determinants

The negative and statistically significant error correction term is consistent with the idea that the errors are corrected over time, and that the speed of adjustment to the long-run equilibrium is moderate after short-run shocks. The direction of the short-run coefficients is generally similar to the direction of the long-run estimates, but the magnitudes are smaller, suggesting that the long-term relationship between longevity and healthcare expenditure is reinforced by moving toward the long-run equilibrium. The Breusch-Godfrey test suggests that there is no evidence of serial correlation in the residuals, the Breusch-Pagan-Godfrey test suggests that there is no evidence of heteroskedasticity, and the Jarque-Bera statistic suggests that the residuals are normally distributed. The CUSUM and CUSUM-of-squares plots do not cross the critical bounds during the sample period, which indicates the stability of the long-run and short-run parameters estimated.

5. Discussion

The results presented in this article validate the existence of a statistically significant and economically meaningful long-run relationship between longevity (measured as life expectancy) and healthcare expenditure in South East Asia. The finding that life expectancy is the most important variable in the model, among all the explanatory variables, further confirms the view that life expectancy is a separate driver of the growth of healthcare expenditure from, but related to, the broader phenomenon of demographic aging represented by the aging index. This finding has significant theoretical importance and supports the hypothesis that a greater proportion of older people in a population, in addition to chronological age, contributes to a stable demand for health care resources. The aging-index growth alone doesn't put the same kind of strain on health systems, because as people age, their need for chronic-disease care, preventive care, and age-related medical services increases as well.

The importance of the aging index and GDP per capita, in addition to life expectancy, suggests that the aging index is not an independent factor in determining healthcare expenditure but is related to other demographic and income-related factors. This implies that healthcare financing policies in South East Asia need to consider various, co-

occurring demographic and economic pressures, not separate issues of longevity, aging, and income growth. Policy implications of these findings are to emphasize investments in preventive healthcare, chronic-disease management infrastructure, and long-term elderly care systems that can accommodate longer, healthier, but more medically dependent lives. The policy interventions that are likely to be implemented in the region to address the longevity-related healthcare demand are likely to have a cumulative stabilizing effect on long-run healthcare expenditure trends in the region's health-financing systems, given the stable error-correction mechanism identified.

This article has some restrictions. This regional-level analysis does not account for more recent improvements in longevity, nor for health-system responses to the COVID-19 pandemic, and country-level differences within South East Asia are not separated out. Further studies with a longer time series and a breakdown of the results by individual economies would support the understanding of the longevity-healthcare expenditure relationship found in this study. To conclude, this article has established that, apart from the general aging, income, and environment pressures, life expectancy has a significant, positive, and dominant long-term effect on healthcare spending in Southeast Asia. The findings of this article directly support the second aim of the wider thesis and complement the findings of the first article, which explored the wider macroeconomic and environmental factors affecting healthcare expenditure across the region, to provide an overall empirical basis for the third article.

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