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# The Impacts of Oil and Gas Consumption on Life Expectancy

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**ABSTRACT**

*This research aims to fill a notable need in current scholarly works by investigating the often-neglected impact of fossil fuel consumption, particularly oil and gas, on life expectancy. To examine the correlation between economic growth, national healthcare spending, and oil and gas usage on life expectancy in Malaysia from 1980 to 2020, we employ the Autoregressive Distributed Lag (ARDL) method, acknowledging its substantial implications for sustainable development. According to the findings of our study, the growth of the economy and the rise in the amount of gasoline consumed both have a positive impact on the average lifespan of individuals. In spite of this, the rise in the cost of medical treatment and the increase in the amount of oil that is consumed have a negative effect on life expectancy, both in the short term and in the long term. The coefficients have a substantial magnitude for a prolonged duration, highlighting the enduring influence. These results emphasize the need for policymakers to prioritize alternative energy sources and enhancements in healthcare quality to foster longevity and enhance the overall well-being in Malaysia. Furthermore, our study suggests that augmenting healthcare expenditure should be coupled with measures to ameliorate environmental quality for a more substantial positive impact on human well-being.*

## 1. INTRODUCTION

The extensive use of oil and gas in a range of industries, including transportation, agriculture, and industry, has resulted in a significant increase in the amount of greenhouse gases that are released into the atmosphere. This increase has been brought about by the fact that greenhouse gases are released into the environment. It is possible for industrial growth to be driven by the utilization of these sources of energy to power engines [1]. This is in recognition of the underlying connection that exists between energy consumption and economic growth. The importance of energy consumption as a main driver of environmental deterioration and economic growth in both industrialized and developing nations is supported by a substantial body of evidence [2], [3]. Despite these correlations, the nonrenewable nature of oil and gas consumption carries detrimental consequences. The combustion of gas and oil in industrial operations generating electricity produces hazardous byproducts, including sulphur dioxide ($SO_2$), nitrogen oxides, and carbon dioxide ($CO_2$), leading to air pollution. This, in turn, jeopardizes food security and safety due to severe climate change consequences such as elevated sea levels, unpredictable extreme weather, heat stress, and declining air and water quality. Moreover, global climate change adversely affects health standards and human well-being [4], contributing to respiratory ailments, cardiovascular diseases, and malignancies, thereby diminishing life expectancy [5]. The health implications of oil and gas usage are substantial.

The research that has been done so far reveals that the consumption of energy, particularly coal and oil [6],[7], can have a detrimental effect on life expectancy. The byproducts of their combustion, carbon dioxide (CO) and monoxide (CO), are regarded to be harmful. Increases in energy consumption, which are the driving force behind economic expansion, further worsen the detrimental impact that these increases have on the life expectancy of humans.

Despite advances in transportation systems, the decline in life expectancy resulting from $CO_2$ emissions in global South nations persist [8]. The dilemma faced by nations lies in deciding whether to transition to greener energy sources or continue relying on oil and gas for economic expansion, given the associated

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negative consequences. Based on the findings of Shkolnikov *et al.* [9], Kim [10], and Afroz [11], numerous nations have the objective of achieving a positive correlation between economic development and life expectancy of their citizens. Conversely, impoverished nations characterized by limited industrial output, inadequate access to nutritious food, and insufficient infrastructure experience a diminished average lifespan.

Polcyn *et al.* [12] and Rahman *et al.* [13] have studied the relationship between energy consumption, carbon emissions, and life expectancy. However, few studies have examined the effects of oil and gas consumption. In addition, the research conducted by Wang *et al.* [7], Polcyn *et al.* [12], and Murthy *et al.* [14] did not specifically investigate the impact that the consumption of oil and other liquids had on the average lifespan. Consequently, the potential correlation between economically developing nations heavily reliant on oil and gas for prosperity and improved life expectancy remains uncertain. Emphasizing the critical role of cleaner energy sources is imperative in mitigating the substantial environmental and health hazards associated with the depletion of oil and gas. Burning oil releases toxic hydrocarbons and other chemicals, which is detrimental to health. These include sulphur dioxide, nitrogen oxides, and particulate matter, which contribute to air pollution and can cause respiratory problems. In contrast, gas, primarily composed of methane, emits fewer toxins upon combustion. This study investigates how gas and oil use affects life expectancy to increase demographic welfare through policy recommendations.

Solar, wind, hydro, and geothermal power are all examples of renewable energy sources that offer a plethora of advantages, including a low impact on the environment and the capacity to cut carbon emissions [15]. Despite these benefits, the considerable upfront investment required for renewable energy infrastructure acts as a barrier, deterring organizations and governments prioritizing short-term financial gains. Additionally, the intermittent availability of certain renewable sources, like solar and wind, limits their application as major energy retailers. Therefore, to mitigate the adverse environmental effects of energy consumption and consequently improve life expectancy, a shift from oil to gas is essential.

Every nation, including Malaysia, relies on oil and gas as catalysts for economic expansion [16]. It is crucial to understand the environmental and health consequences of both energy sources in Malaysia by monitoring their trends. Figure 1 depicts Malaysia's natural gas consumption, which increased 18-fold from 1990 to 2018, reaching 18,851 ktoe from 1,069 ktoe. This expansion was attributed to increased gas consumption in the industrial and power sectors, contributing to Malaysia's pursuit of developed status [17]. In contrast, fuel oil consumption in Malaysia doubled between 1990 and 2000 but significantly declined from 2000 to 2018, falling from 1,875 ktoe to 387 ktoe, mostly due to changes in the industrial and transportation sectors. Figure 2 illustrates the life expectancy patterns of Malaysians from 1990 to 2020. As per capita income increased, average life expectancy rose from 71.31 years in 1990 to 75.94 years in 2020, likely influenced by improved access to better nutrition and food.

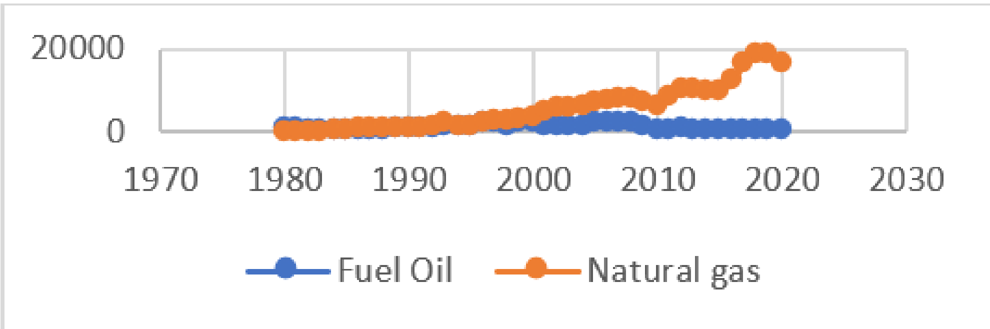


**Fig. 1. Kilotonnes of oil equivalent used by Malaysia for natural gas and fuel oil (ktoe).**
*Source: Energy Commission of Malaysia [18].*

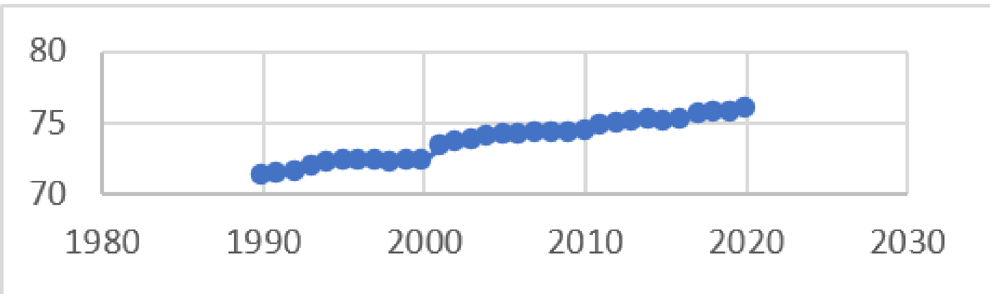


**Fig. 2. Life expectancy in Malaysia**
*Source: World Bank [19].*

This study explores how oil and gas usage influenced on life expectancy in Malaysia between 1980 and 2020, using the ARDL approach. We also examine whether Malaysia's life expectancy has risen steadily over the previous 40 years due to public health spending and economic growth. This research contributes to the understanding of human well-being and greenhouse gasses by examining the complex relationship between primary energy sources (oil and gas) and a key indicator of well-being, life expectancy. Moreover, we examine the overarching hypothesis positing that heightened public spending is most likely to be associated with a beneficial influence on life expectancy [12], [16]. We argue that an escalation in national health expenditures may not consistently lead to an extension of life expectancy, especially in scenarios where environmental degradation and subpar air quality coexist with economic growth.

A study conducted by Saleem *et al.* [20] demonstrated that there is a positive association between the increased production of non-renewable energy (fossil fuels) and the rising expenditures on healthcare in countries that are members of the Organisation for Economic Co-operation and Development (OECD). Similarly, Matahir *et al.* [21] found analogous evidence in the context of Malaysia. To ensure an elevated quality of life and well-being for their populace, we posit that nations might need to enhance environmental quality alongside an increased focus on healthcare provisions. A comparison is made between the ARDL tests and two alternative methods, namely Fully Modified Ordinary Least Squares (FMOLS) and the Dynamic Ordinary Least Squares Estimator (DOLS). This comparison is carried out in order to highlight the robustness and dependability of our findings.

## 2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

The Preston curve, originally proposed by Preston [22], is a visual depiction of the correlation between income and life expectancy. It has gained significant popularity as a valuable tool in the fields of development economics and public health. It is common practice to depict the curve in the form of a scatterplot, which displays the connection between the y-axis, which stands for life expectancy, and the x-axis, which stands for per capita income. Generally, nations with higher per capita income exhibit greater life expectancy, as evident in the curve. The Preston curve is often employed to illustrate that economic development not only involves income growth but also contributes to overall community well-being [23]. Advancements in economic development enable nations to allocate increased resources to healthcare, education, and infrastructure, potentially leading to improved health outcomes and a longer lifespan. Preston highlighted that substantial, independent increases in life expectancy have been observed in poorer nations. However, he also expressed the view that a significant portion of the potential progress in medical technology remains unrealized [24].

While recognizing that there are various determinants of health outcomes and an imperfect correlation between wealth and life expectancy, the Preston curve serves as a practical visual aid to illustrate the general pattern of life expectancy increasing alongside income. It is crucial to acknowledge that the correlation between life expectancy and income can vary significantly across nations and time periods. Escosura [25] has provided empirical evidence that substantiates Preston's contention that there is a positive association between life expectancy and per capita income. This research suggests that this connection has grown stronger over the course of time. Countries may undergo a "health transition," where life expectancy rises with economic development to a certain level, although the pace of this link may vary. Nevertheless, the Preston curve continues to offer valuable insights into the overarching correlation between lifetime earnings and income.

A comprehensive review of previous empirical studies has been conducted to enhance understanding of the various factors influencing life expectancy across multiple nations, including ASEAN countries and China [26], [7]. Renewable energy, economic growth, urbanisation, environmental pollution, financial development, energy consumption, air pollution, democracy, government service delivery, $CO_2$ emissions, and the Gini coefficient are some of the things that are included in this list. Hendrawaty *et al.* [27] conducted a study in which they investigated the connection between the rise of gross domestic product (GDP) and the increase in life expectancy in ASEAN countries. They took into consideration both the consumption of energy and the level of economic development. The panel quantile regression method was utilised in the research carried out by Polcyn *et al.* [12] to investigate the impact of a number of factors on life expectancy in one hundred different countries. Meanwhile, using the panel ARDL technique Murthy *et al.* [14] studied the impact of $CO_2$ emissions over the quality of life among D-8 countries.

Each of the studies utilized econometric methodologies, with Polcyn *et al.* [12] employing panel quantile regression, Hendrawaty *et al.* [27] and Murthy *et al.* [14] utilizing the panel ARDL technique, and Cervantes [28] utilized the Granger causality approach to determine the socioeconomic factors that impact life expectancy in seventeen districts of Spain between 2006 and 2016. The findings indicated a positive correlation between life expectancy, per capita income, and access to medical care. However, results across studies were incongruous, with Polcyn *et al.* [12] highlighting positive effects of the Gini coefficient and government services, while Hendrawaty *et al.* [27] found energy conservation to extend life expectancy. Murthy *et al.* [14] discovered that $CO_2$ emissions have negative consequences, but economic growth, population increase, and health expenditure had beneficial impacts.

Rahman and Alam [29] discovered that environmental pollution reduced life expectancy in Australia, New Zealand, and the United States, Belgium, Netherlands, and Luxembourg (ANZUS-BENELUX nations), while Luo and Xie [26] associated increasing economic disparity with declining life expectancy in China. Life expectancy was negatively correlated with environmental deterioration, reduced energy usage, and higher financial development in Pakistan, according to Wang *et al.* [7]. While Wang *et al.* [7] investigated life expectancy trends in 134 countries, finding significant variations between regions, Salehnia *et al.* [30] examined how democracy, usage of energy, and public service delivery affected life expectancy in 100 countries, and a drop in life expectancy was discovered to be caused by both $CO_2$ emissions and the democratic process. Bunyaminu *et al.* [31]'s research examined the relationship between life expectancy and total health expenditures for 43 African countries between 2000 and 2018, using panel data. In the study, the correlation was favourable, but government effectiveness as a moderator negatively affected health expenditures on life expectancy. Several studies have shown that economic activity and education significantly affect life expectancy.

In summary, prior research on life expectancy has explored a multitude of variables, leading to varying outcomes depending on the specific circumstances of each investigation. Policymakers must design location-specific policies to enhance life expectancy. However, notably absent from these studies is an examination of the impact of fossil fuel reliance, particularly on gas and oil, on human life expectancy.

## 3. METHODOLOGY

### *3.1 Template Guide*

This study conducts a comprehensive examination utilizing fundamental characteristics and a large dataset spanning four decades to ascertain the impact of oil and gas consumption on life expectancy in Malaysia. The research makes use of information obtained from reliable sources, such as the World Bank and the Malaysia Energy Information Hub's database. These sources provide crucial information on several parameters, including per capita GDP, government health spending, and the use of oil and gas. By incorporating these varied datasets, the study's reliability is strengthened, enabling a thorough examination of the interaction among crucial components. The study spans the years 1980 to 2020 and examines the economic, social, and environmental developments that have taken place in Malaysia during this period. Extended investigations are necessary to identify trends, patterns, and long-term consequences that shorter investigations fail to detect. The analysis offers a comprehensive overview of how the correlation between life expectancy and the utilization of oil and gas has changed over the past forty years.

The research utilizes the Autoregressive Distributed Lag (ARDL) approach as its analytical methodology. ARDL is a method of analyzing time-series data that is especially effective for studying the long-term connections between variables. By utilizing ARDL, the purpose of this study is to shed light on the intricate relationship that exists between the consumption of oil and gas, the per capita GDP, the expenditures of the government on health care, and the life expectancy in Malaysia. The decision to use this modeling approach demonstrates a careful analysis of the dataset's properties and the goals of the research, enabling a thorough investigation of both immediate and long-lasting impacts. The correctness and dependability of study outcomes depend on model specifications. Standard practice is to list the variables, their operationalization, and the statistical methods used in the present study model specification. Having a clear model specification allows other researchers to replicate and build on the study's findings.

$$LE = \alpha + \beta_1 OC + \beta_2 GC + \beta_3 GDP + \beta_4 HE + \varepsilon \qquad (1)$$

The symbol α is commonly used to represent the intercept in Equation 1. This intercept is a measure that indicates the value that is projected to be associated with the dependent variable when all of the independent variables are set to zero. Based on the coefficients, which are denoted by the symbols $\boldsymbol{\beta_1}$ to $\boldsymbol{\beta_4}$, it can be determined that each independent variable exerts a certain amount of impact on the dependent variable.

Oil consumption (OC) and gas consumption (GC), measured in kilotons, are independent variables. Health spending includes GDP per capita (GDP) to indicate health sector investment and economic progress. The error term (ε) represents the variance in the dependent variable not explained by the independent variables. Log-transformed data for each variable in this study minimized non-linearity and heteroscedasticity. Another goal is to estimate elasticities to improve the findings' interpretability and significance. The model coefficients can be interpreted as elasticity, which is a dimensionless measure of the percentage change in the dependent variable resulting from a one percent change in the independent variable when a logarithmic transformation is applied. The log transformation generates a new model:

$$\begin{aligned} \ln LE = \alpha + \beta_1 \ln OC + \beta_2 \ln GC + \beta_3 \ln GDP \\ + \beta_4 \ln HE + \varepsilon \end{aligned} \qquad (2)$$

In Equation 2, the symbol "ln" represents the natural logarithm function, which is applied to the variables lnOC, lnGC, lnGDP, and lnHE. This transformation aims to establish a linear relationship between variables, hence facilitating interpretation in terms of percentages. For example, it enables us to measure the exact percentage shift in the dependent variable that occurs as a result of a 1% rise in the independent variable.

The analysis process involves several key steps:

i. Unit Root Test: This test evaluates whether a time series variable is stationary or demonstrates a unit root, indicating non-stationarity. Stationarity is a property of a series where the mean and variance do not change over time. This is important for modeling because it ensures accuracy.
ii. ARDL Test: The ARDL test determines long-term relationships between model variables. Adding

lagged data lets us assess short-term and long-term trends.

iii. Diagnostic Tests: These tests assess regression model validity.They include examining assumptions such as normality, homoscedasticity (constant variance of errors), and absence of autocorrelation (independence of errors).

iv. Stability Tests: These tests are employed to identify structural breaks or alterations in the correlation between variables over a period of time. The Cumulative Sum (CUSUM) and CUSUM Square tests assess if model coefficients are stable or deviate significantly, which may suggest model specification errors.

### *3.2 Unit Root Test*

Numerous econometric models assume stationarity in time series data analysis utilizing the Augmented Dickey-Fuller (ADF) unit root test. The ADF test determines whether a time series is non-stationary and random walk, which might affect statistical analysis reliability. Data unit root detection is the ADF test's principal goal. Unit roots indicate non-stationarity, meaning the time series is erratic and has no stable average. Conversely, the lack of a unit root signifies stationarity, implying that the time series demonstrates a consistent and predictable trend.

The ADF test compares a test statistic to significance-level values. The null hypothesis of a unit root is rejected if the test statistic is below the critical value, showing stagnant data. If the test statistic exceeds the critical threshold, the null hypothesis cannot be rejected, suggesting non-stationary data. This study tested oil, gas, GDP per capita, and health spending stationarity using ADF. Time-series analysis requires stationarity of these variables since non-stationary data may yield inaccurate results. Data differencing or logarithmic corrections may be needed to establish stationarity if any of these variables are non-stationary.

Data differencing involves calculating the changes between consecutive observations, aiming to eliminate trends or seasonality in the data. Logarithmic transformations, on the other hand, are applied to mitigate the impact of extreme values and compress data with exponential growth patterns. The acknowledgment and correction of non-stationarity in the independent variables are vital steps in ensuring the reliability of subsequent statistical analyses. Failure to address non-stationarity can lead to spurious correlations, misinterpretations of causal relationships, and unreliable predictions.

When it comes to establishing whether or not time series data are stationary, it is possible to get the conclusion that the ADF unit root test is a crucial component of the process. The robustness of subsequent studies is ensured by its application to key independent variables in this study, which include oil and gas prices, overall gross domestic product per capita, and health spending. If non-stationarity is detected, appropriate transformations or differencing techniques must be applied to enhance the credibility of the study's findings.

### *3.3 ARDL Approach*

The Autoregressive Distributed Lag (ARDL) model, introduced by Pesaran *et al.* [32] and based on the research of Pesaran [33], is very suitable for analysing variable connections in non-stationary data. It has numerous benefits compared to alternative econometric approaches. It offers various advantages over other econometric methods. One key strength of the ARDL cointegration method is its flexibility regarding the integration order of variables. In contrast to many other cointegration strategies, the ARDL methodology does not need all variables involved to have the same order of integration. This flexibility allows for the inclusion of variables with different integration properties, such as I(1), I(0), or fractionally integrated regressors. I(0) indicates they are stationary without needing to be differenced, while I(1) means they are stationary when differencing. This feature improves the usefulness of the ARDL model in various economic scenarios where variables may have different levels of integration.

Another significant benefit is the decreased susceptibility to changes in sample size. Cointegration procedures are generally influenced by the duration of the time series data. The ARDL approach, however, demonstrates a more robust performance across varying sample sizes, making it a valuable tool for researchers working with datasets of different lengths. This characteristic contributes to the reliability and generalizability of the findings, especially in situations where obtaining extensive time series data might be challenging.

Even when dealing with endogenous regressors, the ARDL model is able to produce trustworthy t-statistics and estimates in the long run that are free from bias. It is crucial in the context of this study to consider factors that may be affected by endogeneity issues. The unbiasedness of long-run model estimates ensures that the relationships identified are not distorted by endogeneity issues, contributing to the overall validity of the study's findings. The ARDL-bounds testing approach examines the relationship between long-term and short-term oil and gas consumption and economic growth. The ARDL model facilitates comprehension of the intricate and evolving characteristics of energy consumption and its influence on economic progress by unveiling the dynamic interconnections among these factors.

$$\Delta \ln LE_t = \propto + \rho_1 \ln LE_{t-1} + \rho_2 \ln OC_{t-1} + \rho_3 \ln GC_{t-1} + \rho_4 \ln GDP_{t-1} + \rho_5 \ln HE_{t-1} + \rho_{6i} \sum_{i=1}^{p} \ln LE_{t-i} + \rho_{7i} \sum_{i=1}^{q} \ln OC_{t-i} + \rho_{8i} \sum_{i=1}^{r} \ln GC_{t-i} + \rho_{9i} \sum_{i=1}^{r} \ln GDP_{t-i} + \rho_{10i} \sum_{i=1}^{s} \ln HE_{t-i} + \pi_t \quad (3)$$

Where $\Delta \ln LE_t$ represents the first difference of life expectancy. meaning the model is analyzing the change in lnLE, rather than its absolute level. $\rho_1 \ldots . \rho_5$ show the long-run coefficients, and $\rho_6 \ldots \ldots . \rho_{10}$ represent the short-run coefficients.

A combined F-statistic, also known as a Wald statistic, is utilized in the cointegration analysis that is conducted utilizing the limits testing methodology. There is no cointegration, which indicates that all coefficients are exactly zero, as stated by the null hypothesis (H0), which states that there is no cointegration. This is the assumption that is made. On the other hand, the alternative hypothesis (H1) takes into account the existence of cointegration, which implies that at least one of the coefficients is not equal to zero. The alternative hypothesis for cointegration is expressed as follows: $(H1: \rho_6 \neq \rho_7 \neq \rho_8 \neq \rho_9 \neq \rho_{10} \neq 0)$, while the null hypothesis is correctly formulated as $(H1: \rho_6 = \rho_7 = \rho_8 = \rho_9 = \rho_{10} = 0)$.

It is possible to obtain critical values for a particular degree of significance [34] and [32] if all of the variables in the ARDL model are integrated of order I(0) or I(1). In the event that the crucial upper limit is exceeded by the computed test statistic, the null hypothesis is rejected, thereby demonstrating that there is convincing evidence of cointegration. In the event that the F-statistic is found to be within the boundaries of the prescribed range, the cointegration test will not produce a definitive result. Under the condition that the F-statistic is much lower than the lower bound, it is not possible to reject the null hypothesis. In light of this, it can be concluded that the hypothesis of cointegration is not supported by adequately sufficient data.

### *3.4 Robustness Check*

After the ARDL tests have been carried out, it is absolutely necessary to carry out robustness testing in order to guarantee the dependability of the results. For this investigation, we utilized two methodologies, DOLS and FMOLS, to assess the reliability of our results. The DOLS method is a popular robustness test that estimates a model's long-run parameters while correcting for any potential biases in the short-run coefficients. When there is a lingering question regarding the stationarity of the variables, which has the potential to influence the outcomes of the ARDL, this method can be of assistance. By using the DOLS method, we can estimate the long-run parameters with less concern about the stationarity of the variables. The FMOLS method is a frequently employed technique for estimating the enduring associations between variables, serving as a robustness test. This method allows for endogeneity in the model, which can occur when the independent variables are correlated with the error term. By using the FMOLS method, we can obtain more accurate estimates of the long-run parameters, as it corrects potential endogeneity bias. By using both the DOLS and FMOLS methods, we can ensure that our findings are robust and reliable. Suppose the results of the ARDL tests are consistent with those of the DOLS and FMOLS methods. Therefore, this will offer compelling data to substantiate the enduring correlation between oil consumption, gas consumption, GDP per capita, health expenditure, and life expectancy in Malaysia.

## 4. FINDINGS

Non-stationarity is demonstrated by all variables, with the exception of gas consumption, as shown by the results of the Augmented Dickey-Fuller (ADF) unit root test, which are presented in Table 1. Gas consumption, on the other hand, does not show any noticeable trend. In order to make the variables stationary, the process of initial differencing is employed. When referring to variables that have a unit root and may be turned into stationary variables through the use of differencing, the term "Integrated of order 1," which is represented by the symbol I(1), is used specifically. Upon inclusion of trends in the ADF unit root tests, gas consumption and health expenditure exhibit stationarity, while the others do not. This suggests that gas consumption and health expenditure may exhibit trend-stationarity, implying the presence of a deterministic trend that can be modeled and eliminated to achieve stationarity in the series. The significance of this insight lies in the fact that it highlights the appropriateness of the ARDL technique for modelling the variables in question. The ARDL approach, known for its versatility in handling mixed-order integration, is well-suited to accommodate the diverse integration properties of the variables under consideration. This capability enhances the robustness of the ARDL technique in capturing the complex dynamics inherent in the data, contributing to the validity of the subsequent analyses.

Table 2 exhibits our ARDL bound test findings, and the F-statistic is 30.836, which is significant at any level. This shows that the lagged variable model is substantial and can explain the dependent variable's behaviour. The model chosen is (1, 1, 1, 0, 0). The lower and higher bounds for the 10%, 5%, and 1% significance levels are also displayed in the table. A noteworthy model has an F-statistic of 30.836 above the top bound. These results indicate that the specified ARDL model fits the data well and can be utilised for further analysis and interpretation.

**Table 1. Unit root tests results.**

| Variable | Constant | | Constant and trend | |
|---|---|---|---|---|
| | Level | 1st difference | Level | 1st difference |
| Heath Expenditure | -1.995 | -3.934*** | -2.818 | -4.129** |
| Oil Consumption | -1.300 | -6.359*** | -1.387 | -3.967** |
| Gas Consumption | -3.587** | -4.336*** | -3.638** | -5.053*** |
| Economic Growth | -1.131 | -4.761*** | -1.563 | -4.762*** |
| Health Expenditure | -1.582 | -6.987*** | -3.993** | -6.915*** |

Note: *** and ** denote significance level in the range of 1% and 5%, accordingly.

**Table 2. ARDL bounds test results.**

| F-statistic | 30.836*** | |
|---|---|---|
| Selected Model | (1, 1, 0, 1, 1) | |
| Significance | Lower Bound | Upper Bound |
| 10% | 2.20 | 3.09 |
| 5% | 2.56 | 3.49 |
| 1% | 3.29 | 4.37 |

Note: *** indicates the significance level of 1%.

According to the findings presented in Table 3, all of the independent variables are statistically significant in both the short-run and the long-run ARDL calculations. Economic growth and gas consumption have a positive long-term and short-term association, meaning that they improve life expectancy. Health expenditure and oil use are negatively correlated, affecting life expectancy and both in the near term and the long term. The intercept (C) is statistically significant, with a t-statistic of 31.847 and a p-value of 0.000. The error correction term (ECT) has a negative coefficient of -0.371 and is statistically significant in the short term. It signifies the model is correctly presented and the variables have reached their long-run equilibrium.

Increased healthcare spending is expected to improve health and life expectancy [16], [35], although this study may not demonstrate this. This may be attributed to the fact that inadequate healthcare quality can lead to unfavorable health outcomes, even with considerable expenditures. If healthcare personnel lack the necessary experience or equipment, or if infrastructure is inadequate, patients may not receive the care they require to improve their health. Furthermore, increased healthcare spending may favour disease treatment over healthy lifestyle promotion. Maintaining good health and prolonging life necessitates treating illnesses, preventing them, and fostering a healthy lifestyle. However, the results demonstrate that higher healthcare expenditure may necessitate other improvements in quality of life (*i.e.*, environmental quality). In contrast, Matahir *et al.* [21] demonstrated that Malaysian healthcare spending increases energy consumption.

**Table 3. Long-run and long-run estimates results.**

| Long run | | | |
|---|---|---|---|
| Variable | Coefficient | t-Statistic | Prob. |
| Health Expenditure | -0.066 | -4.753 | 0.000 |
| Economic Growth | 0.049 | 11.389 | 0.000 |
| Gas Consumption | 0.004 | 4.280 | 0.000 |
| Oil Consumption | -0.005 | -5.005 | 0.000 |
| C | 3.069 | 31.847 | 0.000 |
| Short run | | | |
| Variable | Coefficient | t-Statistic | Prob. |
| Health Expenditure | -0.009 | -3.440 | 0.002 |
| Economic Growth | 0.030 | 5.032 | 0.000 |
| Gas Consumption | 0.001 | 2.780 | 0.009 |
| Oil Consumption | -0.002 | -5.941 | 0.000 |
| ECT | -0.371 | -5.311 | 0.000 |

It is possible that the development of Malaysia's economy would lead to an increase in the standard of living, which will, in turn, result in improvements in health and the average lifespan. The Preston curve in Malaysia provides evidence that there is a positive correlation between economic development and life expectancy. This finding lends credence to the findings of previous studies [16], [26], and [7], the findings of which are validated by the Preston curve. One example of how economic expansion can enhance health outcomes and longevity is by increasing access to clean water, sanitation, housing, and nutrition [35]. This can also reduce the burden of infectious diseases [36], which can lead to better health outcomes. Economic growth can also increase healthcare research and development, resulting in new medications and technologies that improve health and longevity.

According to the study's empirical data, gas use enhances life expectancy whereas oil use diminishes it. Because gasoline produces less pollutants than oil [37]. Combustion of oil leads to the emission of sulphur dioxide, nitrogen oxides, and particulate matter, all of which have the potential to cause respiratory issues as well as cancer. Burning gas produces fewer pollutants, which improves air quality and respiratory health. More gas instead of oil reduces greenhouse gas emissions. Environmental and health benefits can result. Extreme weather, natural disasters, and disease epidemics can result from greenhouse gas emissions and climate change. We can lower health hazards by adopting cleaner fuels, such as gas, to reduce greenhouse gas emissions.

Oil consumption affects life expectancy, similar to other research that showed that carbon emissions reduce longevity [12],[14],[16]. We concur with other data indicating that air pollution from carbon emissions affects longevity and neonatal mortality [36],[37], However, our findings indicate that not all energy sources shorten life expectancy. Cleaner energy such as gas and renewable sources reduce carbon dioxide emissions while improving life quality and longevity [26].

These findings from the FMOLS and DOLS tests, which are provided in Table 4, not only provide support for the results of the ARDL test, but they also illustrate that the coefficients that were computed are accurate. This conclusion is presented in the table. In accordance with both of these theories, there is a positive association between the expansion of the economy and the use of gasoline, as well as the average lifespan. On the other side, the amount of money spent on medical care has a detrimental effect on the average lifespan There is a negative association between the amount of oil used and the average lifespan, which is yet another item that has been found out via research. As a result, the findings offer substantial evidence to back up the conclusion that the factors that were discovered have a considerable impact on life expectancy.

**Table 4. FMOLS and DOLS results.**

| | FMOLS | | DOLS | |
|---|---|---|---|---|
| Variable | Coefficient | Prob. | Coefficient | Prob. |
| Health Expenditure | -0.017 | 0.066 | -0.042 | 0.002 |
| Economic Growth | 0.052 | 0.000 | 0.062 | 0.000 |
| Gas Consumption | 0.007 | 0.000 | 0.008 | 0.000 |
| Oil Consumption | -0.003 | 0.008 | -0.005 | 0.001 |

**Table 5. Diagnostic tests results.**

| Diagnostic Test | F-statistic | Probability |
|---|---|---|
| Serial Correlation | 1.437 | 0.254 |
| Heteroscedasticity | 0.415 | 0.886 |
| Jarque-Bera | 0.399 | 0.819 |
| Ramsey RESET | 0.738 | 0.397 |

In light of the findings of the diagnostic tests that are presented in Table 5, it can be concluded that the model that was utilized in the study offers precise estimations. There is no substantial evidence of serial correlation or deviation from normalcy in the residuals, as indicated by the F-statistics for serial correlation and the Jarque-Bera tests. In addition, the results of the heteroscedasticity test indicate that the model does not contain any heteroscedastic qualities. At long last, the Ramsey RESET test reveals that there is no misspecification of the model. Therefore, the results of the diagnostic tests confirm the validity, robustness, and dependability of the estimated coefficients contained inside the model.

The CUSUM and CUSUM of Squares tests assess estimated coefficient stability over time. For both experiments, the findings show blue lines within red lines. This demonstrates that the expected coefficients are stable, making structural instability and parameter shifts unlikely. Thus, the model is reliable, and the predicted coefficients can be used to draw conclusions about the relationships between the variables. The stability of the anticipated coefficients over time implies that the analytical model is valid and reliable.

Our research yields valuable policy recommendations for policymakers to consider. Firstly, transitioning to cleaner energy sources has the potential to elevate the life expectancy of Malaysians. Reducing reliance on fossil fuels can contribute to an overall improvement in well-being. Secondly, to enhance citizen health, the government may need to simultaneously increase healthcare funding and address environmental degradation. In Malaysia, the concurrent rise in environmental deterioration and healthcare costs, as highlighted by Matahir *et al.* [21], poses a challenge and may offset the anticipated life expectancy benefits of healthcare investments, a phenomenon observed in other regions [16],[35].

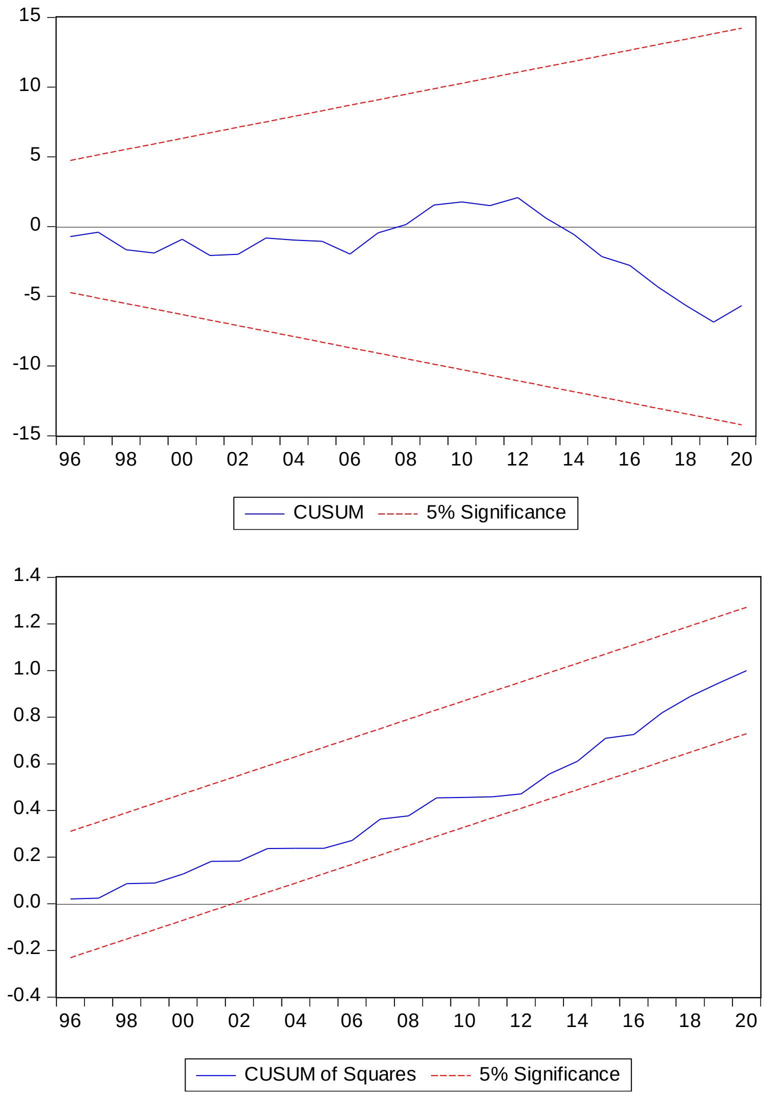


**Fig. 3. CUSUM and CUSUM of squares results.**

High $CO_2$ emissions and inefficiencies in healthcare services are linked to increased healthcare costs, as noted by Apergis *et al.* [38]. Thirdly, pro-growth economic policies have the potential to extend longevity in Malaysia by improving health, and access to food. Our groundbreaking study delves into the intricate relationship between gas and oil usage and life expectancy, urging governments to reassess their environmental and healthcare policies. We add new insights into the effects of oil, gas, and healthcare expenditure on life expectancy in Malaysia, supplementing recent studies on environmental factors and life expectancy [14] and healthcare expenditure efficiency [21]. It may be imperative for environmental quality and healthcare spending to progress hand in hand to foster overall well-being.

## 5. CONCLUSION

For the purpose of analyzing the intricate connection that exists between the consumption of oil and gas and the average life expectancy in Malaysia from 1980 to 2020, our research makes use of the ARDL method. According to the data, there appears to be a positive association between the expansion of the economy and the consumption of gas, as well as the short-term life expectancy. On the other hand, it is believed that the amount of money spent on medical treatment and the amount of oil that is consumed have a negative influence on the average lifespan. Conversely, the severity of these effects is far less visible in the near term in compared to the long run, which underscores the significance of taking into consideration the length of time for policy consequences. In other words, the long run is more significant than the immediate term. These findings have significant repercussions for policymakers, as they offer valuable insights that can be used to influence decision-making and the development of initiatives that are aimed at enhancing the quality of life and expanding the lifespan in Malaysia. The study emphasizes the importance of strategic and long-term planning in the process of policy formation. It also underlines the necessity of sustainable economic expansion and the implementation of cleaner energy options, such as natural gas, in order to improve the general welfare of the Malaysian population. To promote the durability and welfare of Malaysians, it is imperative for policymakers to give utmost importance to the advancement of environmentally friendly energy sources, with a special emphasis on natural gas, as recommended by our research. Enforcing rules and regulations that provide incentives for businesses to shift from oil to natural gas or other sustainable energy sources can be essential in accomplishing this goal. Furthermore, we support ongoing endeavours to promote economic growth, since our research indicates a direct relationship between economic expansion and enhanced quality of life and well-being in Malaysia. The study specifically emphasizes a detrimental correlation between health cost and life expectancy, suggesting that even with substantial investments, the quality and results of healthcare may not be proportional. Policymakers may need to focus on building and enhancing healthcare facilities, ensuring they are equipped with advanced technology and sufficient resources to provide high-quality care. The potential necessity for environmental modifications to enhance overall well-being in tandem with increased healthcare spending in Malaysia is a key consideration emerging from these findings.

This study not only offers useful empirical insights into the relationship between oil and gas consumption and life expectancy in Malaysia, but it also offers practical implications for policymakers. In conclusion, this study delivers both of these things. The importance of adopting sustainable economic and energy policies, promoting greener energy sources, and addressing healthcare quality are central to fostering improved life quality and longevity for the Malaysian population.

Despite achieving its objective of examining the impacts of oil and gas consumption on life expectancy, this study has several limitations that should be addressed in future research. Firstly, the study focuses solely on Malaysia; expanding the scope to include other countries, such as those in the ASEAN region, could provide a more comprehensive understanding. Additionally, future research could benefit from employing panel data analysis instead of relying solely on time-series data analysis, as this would allow for the examination of cross-sectional variations and improve the robustness of the findings. Last but not least, although this study only takes into account oil and gas, it is recommended that future studies incorporate additional non-renewable energy sources, such as coal, in order to present a more comprehensive picture of the influence that energy use has on individuals' life expectancy.

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