Jurnal Pendidikan Ekonomi & Bisnis, 11 (1) 2023, 12-25
JURNAL PENDIDIKAN EKONOMI & BISNIS
http://journal.unj/unj/index.php/jpeb

Determining Economic Growth and Life Expectancy Linkages in Indonesia: A Simultanous Equation Model

Avi Budi Setiawan[1], **Mochammad Yusuf**[1], **Danu Yudistira**[2], **Agus Dwi Nugroho**[3]
[1] *Faculty of Economics, Universitas Negeri Semarang, Indonesia*
[2] *Faculty of Medicine, Public Health and Nursing, Gadjah Mada University, Indonesia*
[3] *Doctorate Program Hungarian University of Life Science, Godollo-Hungaria*

Article Info

Article history:
Received: 13 October 2022;
Accepted: 14 February 2023;
Published: 02 March 2023.

Keywords:
Economic Growth; Healthcare Expenditure; Life Expectancy; 2SLS Regression.

Abstract

Life expectancy become the main indicators of the health parameters in the population and development process. However, there is a relationship between life expectancy and growth which is represented by the inconsistency of previous studies. This study aims to reveal a linkage between life expectancy and economic growth, and analyzing factors that influence both of them. Two-Stage Least Square (2SLS) was used for simultaneous modelling equations to fill the existing literature gaps. Based on the 2SLS estimation relationship, it was found that there is a simultaneous relationship of life expectancy economic growth. Furthermore, it was found economic growth was significantly influenced by the decreasing dependency ratio, unemployment rate, and poverty. Furthermore, life expectancy is positively influenced by health spending and significantly decreases by the increased poverty rate. Therefore, mortality and carbon emissions had insignificant adverse effect. However, poverty and carbon emissions had a negative had insignificant adverse effect. This result suggests the government formulate policies to prioritize larger budget allocations in the education sector as a safety net program, cash transfers, and labor pensions.

Abstrak

Angka Harapan hidup merupakan salah satu indikator utama kondisi kesehatan penduduk dan perkembangan ekonomi suatu negara. Namun terdapat dugaan mengenai hubungan antara angka harapan hidup terhadap pertumbuhan yang direpresentasikan melalui adanya inkonsistensi riset penelitian-penelitian terdahulu. Penelitian ini bertujuan untuk mengungkap adanya hubungan kausalitas antara angka harapan hidup dengan pertumbuhan ekonomi serta menganlisis faktor-faktor yang mempengaruhi keduanya. Two-Stage Least Square (2SLS) digunakan untuk persamaan model simultan untuk mengisi kesenjangan literatur yang ada. Berdasarkan hubungan estimasi 2SLS, ditemukan adanya hubungan kausalitas antara angka harapan hidup dengan pertumbuhan ekonomi. Selanjutnya ditemukan bahwa pertumbuhan ekonomi dipengaruhi secara signifikan oleh penurunan rasio ketergantungan, tingkat pengangguran, dan kemiskinan. Selanjutnya pada model harapan hidup juga diketahui dipengaruhi secara positif oleh pengeluaran kesehatan dan menurun secara signifikan oleh peningkatan kemiskinan. Namun, mortalitas dan emisi karbon memiliki efek negatif tetapi tidak signifikan. Hasil penelitian ini menyarankan pemerintah untuk merumuskan kebijakan untuk memprioritaskan alokasi anggaran yang lebih besar di bidang pendidikan sebagai program safety nets, cash transfer dan pensiun tenaga kerja.

How to Cite:
Setiawan, A. B., Yusuf, M., & Yudistira, D. (2023). Determining Economic Growth and Life Expectancy Linkages in Indonesia: A Simultanous Equation Model. *Jurnal Pendidikan Ekonomi & Bisnis, 11*(01), 12-25. https://doi.org/10.21009/JPEB.011.1.2.

* Corresponding Author
mochammady333@studentsunnes.ac.id.
Mochammad Yusuf

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

INTRODUCTION

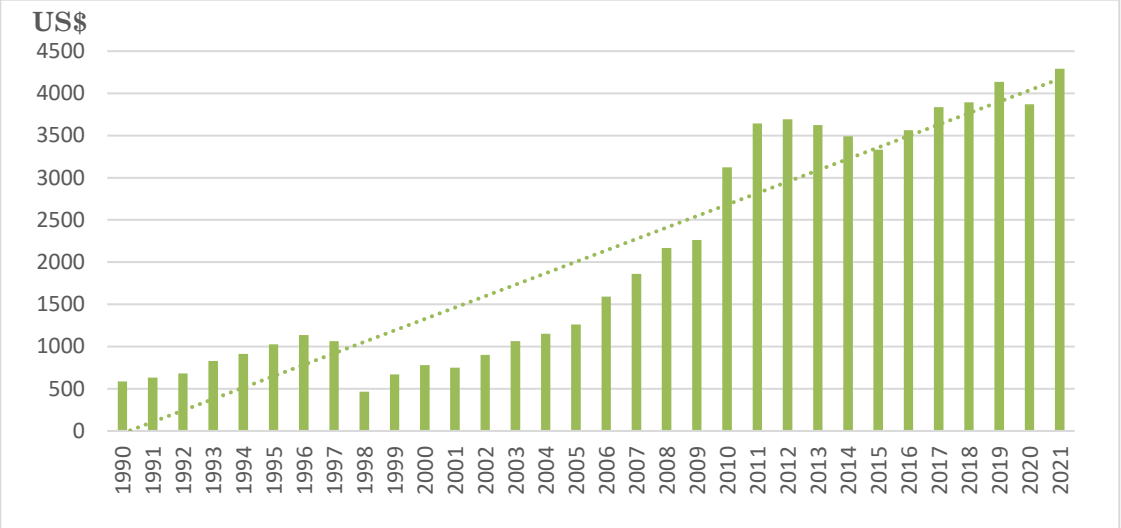
One of the goals of the economic development is to create socio-economic welfare to ensure the quality of life of the population (Mahumud et al., 2013). According to Miladinov (2020), longevity became the main indicators of the health condition of the population and the country development. In the development of the existing literature Longevity is believed to have a strong relationship with an increase in income per capita, which is also a representation of the rate of economic growth of countries around the world (Cervellati & Sunde, 2011). His concept began to be built since the development of a new growth theory in the late 1980s compiled by Romer (1986), which emphasized the importance of human capital in promoting economic growth. According to Ngangue & Manfred (2015), one of the most important components in the formation of human capital is health. By improving health conditions, it will be able to encourage life expectancy and allow the accumulation of knowledge and skills, so that in the end it will form individuals who are more productive and live longer, and are able to contribute more optimally to the national income of the country. On the other hand, individuals with poor health conditions will have a weak ability to learn and adapt to technological innovations which make them less productive (Okunade & Osmani, 2020).

The endogenous growth model postulation developed by Piabuo and Tieguhong (2017), states that there linkage of longevity to economic growth formed through human capital accumulation. In line with that, Bashir et al. (2022) states that health is the most important aspect of human capital accumulation, through good health a person will be able to make a more optimal contribution from themselves, such as higher work productivity. Through the endogenous growth model, it is explained that human capital is a scarce input for a country's development, especially in the early of industrialization stages, labor is major key in maintaining economic growth, therefore the government at that time was very concerned about improving and providing health infrastructure to ensure the health of its workforce (Lawanson & Umar, 2021). Furthermore, the Preston Curve developed by Samuel H. Preston in 1975 explains the positive relationship between longevity and economics. Empirically, research on the relationship between longevity and economics has been carried out by Omotor and Osakede (2021), who found that a higher life expectancy significantly triggers sustainable economic growth.

In the development of the existing literature, the link between longevity to economic growth is the subject of research that is still being concentrated on by previous researchers until now. The topic of the direction of the link between longevity to economic outcomes is still debated whether it has a positive or adverse effect on the economy. This is reflected in the inconsistency of research results on this topic. There are various channels in which life expectancy affects economic growth Acemoglu and Johnson (2007), found that he theory of human capital briefly explained the link between health as represented by life expectancy and economic growth. predicts that increased longevity stimulating growth in accruing competence, which leads to improved employees' performance. Furthermore, higher savings rates, and thus higher rates of physical capital accumulation, can be encouraged by increased longevity (Gürler & Özsoy, 2018). Moreover, it reduces the amount of accidental inheritance, lowers investment, and therefore reduces the accumulation of physical capital (Turan, 2020).

In addition, with lower longevity, the education tax rates tends to increase, but beyond a certain threshold level; however, life expectancy can simultaneously lower tax rates, so that the accumulation of human capital initially increases but eventually decreases (Scott, 2021). However, its effect in developed countries is that life expectancy reduces economic growth (Kunze, 2014). Similarly, Sirag et al. (2020), revealed that the link between life expectancy and growth is non-linear, confirming the existence of an inverted U-shaped relationship. His research shows that intergenerational transfer in the form of familial altruism leads to an inverse U-shaped relationship between longevity and growth when inheritance does not prevail. This underlines the research inconsistence; this study attempts to demonstrate whether this assumption can be proven in developing countries such as Indonesia. Figure 1 depicts the trend of economic growth in Indonesia from 1990 to 2021.

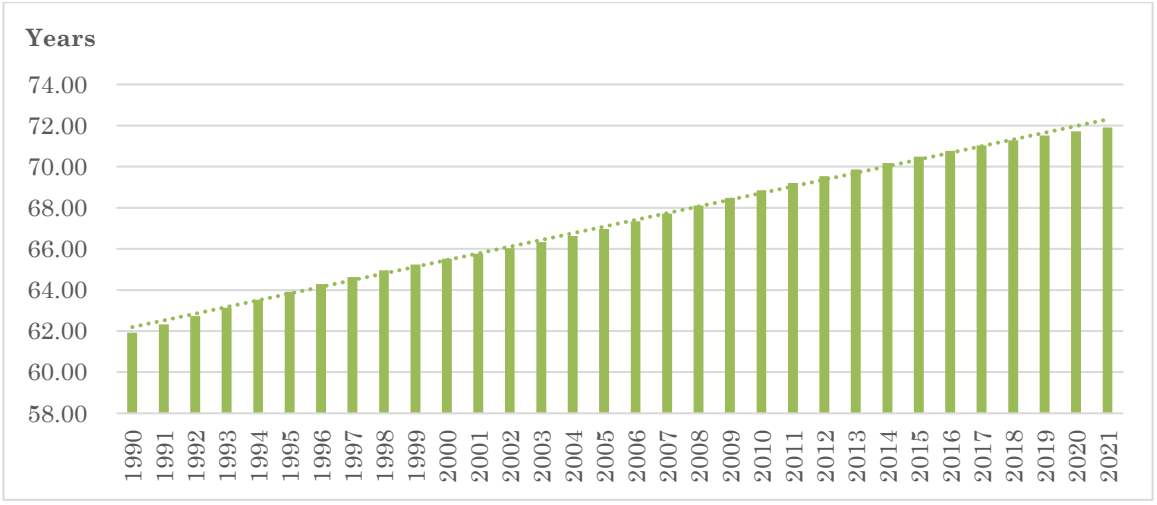
ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2



Source: Worldbank, 2021 (Processed)

Figure 1. Indonesian Gross Domestic Percapita Trend 1990-2021

Figure 1 shows the development of Indonesian economy from 1990 to 2021 through per capita gross domestic product. Overall, economic growth has a positive trendline, in the early 1990s, it was recorded at US$ 585 and continues to grow and reach US$ 4291 in 2021. Furthermore, in its development, there have been several economic contractions, especially in 1998 which became the beginning of the Asian monetary crisis which had an extreme impact and required more than 10 years to recover. Indonesia as a developing country has recorded positive economic growth as a result of the contribution of economic activities by activities of the sectors which is also strongly influenced by its human capital. Misango (2022) found that Kenya as a developing country has a trend of economic growth that increases or decreases along with the rate of life expectancy, this raises an assumption that whether life expectancy affects or is influenced by economic growth. Figure 2 shows Indonesia's life expectancy from 1990 to 2021.



Source: Worldbank, 2021 (Processed)

Figure 2. Indonesian Life Expectancy Trend 1990-2021

Reinforcing the hypothesis of the Preston Curve in Indonesia, Figure 2 shows a positive trend of life expectancy growth in line with economic growth. It was recorded that in 1990 the life expectancy in Indonesia was at 61.92 and continues to increase until now in 2021 it reaches 71.91 years. This is empirical evidence that life expectancy can affect or be influenced by economic growth. Economists have tried to explain the correlation and causality between health and income. According to Tscheuschner (2021), the Preston Curve provides an interesting insight by highlighting

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

the positive correlation between the development status and health status of a country, which is evenly distributed for high-income levels. However, the inconsistency of the results of previous studies coupled with the debates between economists and researchers regarding the relationship between life expectancy and actual economic growth requires further investigation.

On the other hand, several factors that affect economic growth and life expectancy also need to be taken into account, one of the factos is demographic aspect. The transition of demographic composition can occur through changes in the working-age population, according to Cruz and Ahmed (2018), demographic transitions in labor supply caused by changes in the working-age population have a positive impact on economic growth. Due to the influences for savings and personal consumption, it also promotes capital accumulation and gross domestic product growth. Otherwise, a higher proportion of the elderly in the economy is expected to increase public spending due to increased spending on pensions and medical expenses, which is expected to have a detrimental effect on proficient sector spending (Bidisha et al., 2020). Strengthening the previous argument, a high dependency ratio will also increase the unemployment rate which will also cause a bigger burden on workers at the household level (Lee & Shin, 2021). Furthermore, the high dependency ratio at the household level will also cause several health problems, one of it is mental health (Fang, 2022). Thus, the high unemployment rate will also significantly reduce the saving and consumption capabilities of households and potentially increase poverty rates (Turner, 2021). High unemployment and poverty will have an impact on slowing economic growth.

Healthcare expenditure is one of the crucial aspects in the formation of effective health sector policies at the national and regional levels. Healthcare is also one of the most influential aspects in the formation of a country's human capital (Rahman & Khanam, 2018). According to Bein et al. (2017), increasing of healthcare expenditure has improved health outcomes including infant mortality, life expectancy at birth, and other health outcome indicators. In line with this, Bunyaminu et al. (2022), stated that there is positive relationship between healthcare expenditure on life expectancy through the effectiveness of government policies in the education and health sector in the formation of human capital. Mortality rate is also one of the important aspects in measuring the health quality of a country's population which has an impact on the formation of life expectancy (Arriaga, 2008). Furthermore, Vaupel (1986) added that decreasing age-specific mortality increases life expectancy but decreases the equality of life.

The existence of inconsistencies and biased research on the linkage of life expectancy and economic growth in previous studies. As well as the debate about the previous studies underlying the preparation of this research to provide more empirical results. Especially in Indonesia as a developing country and one of the countries with the highest population in the world. This study tries to fill the existing literature gap through the development of a previous research model conducted by Hartwig (2010), this study adds healthcare expenditure, poverty rate, and the unemployment rate to provide more specific results regarding the vital role of human capital accumulation through endogenous growth model. Furthermore, the use of the simultaneous equation model with the two-stage least square technique has never been done on this topic before, so it is hoped that this research can provide more empirical results as the basis for formulating state development policies.

METHOD

This study was structured to analyze what factors influence economic growth and life expectancy, and furthermore, this study also tries to prove a causal relationship between life expectancy and economic growth in Indonesia. The development of this research hypothesis also tries to reveal the existence of a pressure curve in Indonesia as a developing country which is also one of the countries with the highest population. The type of data used in this research is secondary data from Indonesia in the period 1990-2021 which is sourced from British Petroleum, Worldbank, Macrotrends, and Knoema. More specifically, table 1 shows the definitions of operational variables used in this study.

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

Table 1. Operational Variables Definition

Variables	Descriptions	Unit
Economic Growth	The value of gross domestic product is divided by the number of the country population in certain period.	Current US$
Life Expectancy	The estimated average age a person is expected to live	
Health Expenditure	Total healthcare expenditure in the health sector for both individual and collective services is divided by the total population in a country.	Current US$
Carbon Emission Per capita	Carbon dioxide emissions produced from burning of fossil fuels and the manufacture activity. They include carbon dioxide produced during the consumption of gas fuels, liquid, solid, and gas flaring	Metric tons Per Capita
Poverty Rate	Poverty headcount ratio at $5.50 a day is the percentage of the total population living on less than $5.50 a day based on international actual price.	Percent
Unemployment Rate	The percentage unemployed labor force but actively seeking employment and willing to work.	Percent
Dependency Ratio	The ratio of non-productive population (under 15 years plus 65 years and above) to those in the 'economically productive age group (15-64 years).	Ratio
Mortality Rate	The number of deaths occurring in a given population at risk during a specific period.	Total (death per 1000 person)

Source: Data Processed, 2022

To explain the factors that influence the linkage of life expectancy and economic growth, this study uses a quantitative approach by using an econometric model called the simultaneous equation model. The simultaneous equation model is an equation that has the characteristics of an endogenous variable) in one equation being the explanatory variable in another system of equations (Gujarati et al., 2010):

$$Y_i = \alpha_{i1}Y_1 + \alpha_{i2}Y_2 + \ldots + \alpha_{i,i-m}Y_m + \beta_{i1}X_1 + \beta_{i2}X_2 + \ldots + \beta_iX_i + \varepsilon_i \quad (1)$$

Whereas, Y_1, Y_2 …, Y_i is endogenous variable of i = 1, 2, …, m; X_1, X_2 …, X_i is exogenous variables of i = 1, 2, …, m, ε_1, ε_2 …, ε_i is error term disturbance of i= 1, 2, …, m, and α, β is coefficient parameter. This study uses simultaneous equations to formulate research hypotheses, which are specifically described in Figure 2 which shows the Schematic Framework of the Research Model.

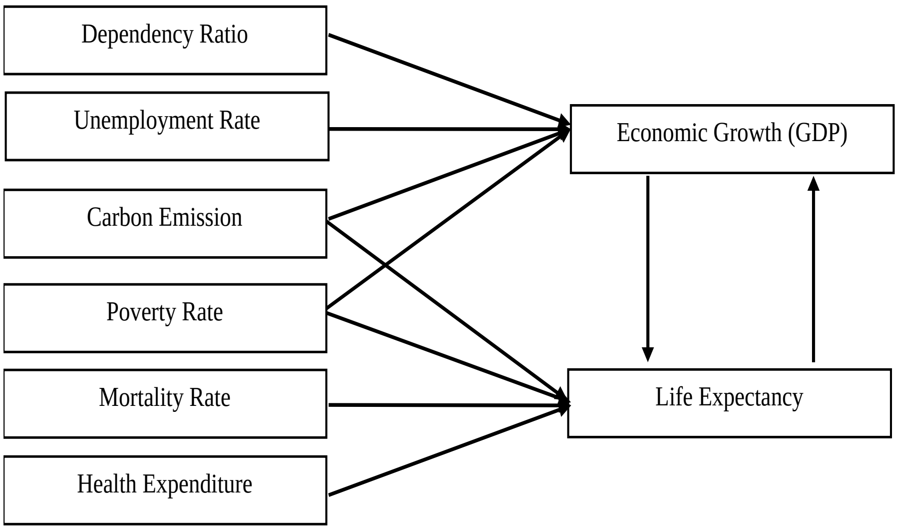


Figure 2. Schematic Framework of Research Model

However, there is one problem that found in the simultaneous equation model, namely when an explanatory endogenous variable is found that correlates with error, the OLS estimator will produce a biased and inconsistent estimator (Fomby et al., 1984). Therefore, we need another alternative estimation method called the Two Stage Least Square (2SLS) method. However, if the

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

2SLS method is used in non-simultaneous cases, the estimation results will be consistent but not efficient. So it is necessary to check whether the equation is simultaneous or not (Park, 1974). According to Wooldridge (2010), the method that can be used to identify simultaneous models is to apply parameter constraints in the equation known as the order condition test. The order condition testing method is a necessary prerequisite to be able to identify a simultaneous equation model (Edgerton, 1972). A simultaneous equation is said to be identifiable when it meets the following conditions:

$$K - k = or > m - 1 \quad \text{.....(2)}$$

Where K is the amount of predetermined variables in the research model, k is the amount of predetermined variables in the estimated equation, and m is the number of endogenous variables in the estimated equation. According to Cumby et al. (1983), the criteria for determining the identification of an equation model can use a two-stage least square if it includes overidentified where K – k > m – 1. If the value condition in the order condition test shows K – k = m – 1 (exactly identified) or K – k < m – 1 (underidentified), then the best technique to estimate the model is indirect least square.

According to Gujarati (2004), from the structural equation, it can be obtained the form of a reduction equation (reduce form) and the coefficients of the corresponding reduction form and the reduce-form equation formed will be equal to the number of endogenous variables. Based on the Schematic Framework of the Research model, there are 2 equations that will be solved using the Two-Stages Least Square technique which is explained as follows:

$$\text{LogEG} = \alpha_0 + \alpha_1\text{LogLE} + \alpha_2\text{LogEmc} + \alpha_4\text{LogDR} + \alpha_4\text{Unemp} + \alpha_5\text{Pov} + e_1 \quad \text{.....(3)}$$

$$\text{LogLE} = \beta_0 + \beta_1\text{LogEG} + \beta_2\text{LogHEX} + \beta_3\text{LogEmc} + \beta_4\text{LogMOR} + \beta_5\text{Pov} + e_2 \quad \text{.....(4)}$$

Where Log is logarithmic form, EG is economic growth represented by GDP per capita, LE is life expectancy, Emc is carbon emission per capita, DR is dependency ratio, Unemp is the Unemployment rate, Pov is the poverty rate, HEX is healthcare expenditure, Mor is the Mortality rate, α_0, α_1, α_2, α_3, α_4, α_5 s the parameter coefficient for the first, β_0, β_1, β_2, β_3, β_4, β_5 is the parameter coefficient of the second equation, e_1 is the error term of the first equation, and e_2 is the second equation of error term.

The Two-Stages Least Square model has several classical assumption requirements. It must be met in order for the model to be classified as Best Linear Unbiased Estimator (BLUE) so as not to produce biased estimation values. According to Gujarati et al. (2010), in the 2SLS model there are several classical assumptions that must be met, including identification, normality, autocorrelation, and heteroscedasticity tests.

RESULTS AND DISCUSSION

Indonesia as a developing country has a fairly good trend of economic growth, although in the previous three years it experienced a fairly large contraction due to the pandemic outbreak. On the other hand, life expectancy in Indonesia has a positive trend from year by year. Although, during the pandemic outbreak, life expectancy indicators still have a positive trend. This provides empirical evidence that the Indonesian government has paid enough attention to aspects of public health, especially in creating a high life expectancy with the aim of increasing the human development index as a measurement of social welfare for the community. Table 2 shows the results of the descriptive analysis of the research variables.

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

Table 2. Summary of Descriptive Statistics

Variables	Obs	Mean	Min	Max	Std. Dev
Gross Domestic Percapita	32	2071.440	463.9482	4291.813	1362.723
Life Expectancy	32	67.56625	62.32	72.14	3.021364
Health Expenditure	32	49.72359	12.09828	120.1250	41.22092
Mortality Rate	32	7.048094	6.1	8.147	0.554456
Carbon Emission Per capita	32	1.570250	0.738900	2.2972	0.451030
Dependency Ratio	32	54.15426	47.34720	67.29437	5.811278
Unemployment Rate	32	5.114679	2.598726	8.06	1.550468
Poverty Rate	32	16.01313	9.22	25.50	4.572051

Data Processed, 2022

Based on the results of descriptive statistics in table 2, the data in this study are time-series data that are annual in nature with 32 observational data. Economic growth is known to have experienced a very significant increase during the time period of this study, which is represented by an increase in gross domestic product per capita. In the initial year, it was at US$ 463 to US$ 2071 in 2021. Moreover, the average life expectancy in Indonesia is also quite good at 67.56 years. On the other hand, the poverty rate in Indonesia is still quite high, recorded at an average of 16.01 percent in the period 1990 to 2021, this is also the reason why Indonesia classified as a developing country due to high poverty rate.

Based on the Schematic Framework of the research model which prepared as the basis for determining the research hypothesis, this simultaneous equation model consists of two models of endogenous variable equations, namely economic growth and life expectancy. Each equation model has exogenous variables that become exogenous variables or independent variables. Table 3 presents the results of the two-stage least square estimation on the economic growth equation model.

Table 3. Two-Stages Least Square for Economic Growth Model

Explained Variable: Log (Economic Growth (EG))	
Log (LE)	2.428662 (4.478418)***
Log (Emc)	0.179079 (0.386469)
Log (DR)	-1.297897 (4.276772)***
Unemp	-0.660188 (-2.475059)**
Pov	-0.082390 -0.215772)**
Constant	-26.66729 (-4.336088)***
Adjusted R^2	0.933811

*Note: ***significance at p-value ≤ 0,01; **significance at p-value ≤ 0,05; t-statistics are stated in parentheses.*
Source: Data Processed, 2022

Table 3 shows the 2SLS estimation results in the economic growth equation model. The result shows that life expectancy as an endogenous variable has a significant positive effect on gross domestic product per capita. The dependency ratio is also proven to have a significant negative effect on gross domestic product per capita. This output implies that an increase in the dependency ratio by 1 ratio will slow down the GDP percapita by 1.29 percent with the assumption of ceteris paribus. The unemployment rate is proven to have a significant negative effect on gross domestic product per capita, an increase in the unemployment rate by 1 percent will reduce economic performance by 0.6 percent. Likewise, with poverty which is proven to have a significant negative impact on gross domestic product per capita, an increase in the poverty rate will slow down gross domestic product per capita by 0.21 percent. On the other hand, carbon emissions have a positive but not significant

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

impact on gross domestic product per capita, this can happen because the increase in carbon emissions represents an increase in industrial and economic activity which improves economic performance. With an adjusted R-square value of 0.933811, it means that the variables used in the research model have been able to explain the variance of gross domestic product per capita by 93 percent and the other 7 percent is explained by variables outside the model.

Carbon emission is one of the important elements as an indicator of environmental quality that comes from energy consumption for all human activities. Basically, the increase in carbon emissions will have a positive impact on economic growth, because it represents the increasing economic activity and consumption of the community that drives economic output. Ciptawaty (2022) states that the main factor that increases energy consumption. When energy consumption increases, the level of carbon emissions always increases due to economic activities to increase the gross domestic product (Zhang et al., 2021). Furthermore, Azam et al. (2016), argue that economic growth has either a positive or adverse effect on the natural chemistry of the climate relying on the composition effect. It is argued that less pollution-intensive technologies in manufacturing activities able to reduce the environmental externalities from economic activities and vice versa.

The output results show that the dependency ratio will reduce gross domestic product per capita. The results of a similar study were found by Rostiana and Rodesbi (2020), who found that the decline in gross domestic product per capita in Indonesia was caused by an increase in the dependency ratio. High dependency ratio reflects that the working age population and the economic system as a whole bear a wider burden in assisting and providing social welfare to children and parents who are intensely economically dependent (Lawton, 2018). In the long run, an increase in the dependency ratio will have adverse impact on future growth, taxation, saving, consumption, and pensions (Ingham et al., 2009).

By looking at the results in table 3, unemployment and poverty rates on gross domestic product per capita, these results are in accordance with the findings from Purnomo and Istiqomah (2019), which found that basically poverty and unemployment have a similar and vital effect on welfare and economic. According to Adams (2003), Economic growth is expected to generate job opportunities. According to empirical evidence, capital-intensive industries that do not provide community employment frequently drive economic growth. so it does not have an impact on poverty alleviation and in the end also does not have a significant impact on the economy (Efendi et al., 2019). Poverty will result in low purchasing power parity and consumption at the household level so economic performance will also not be realized optimally (Son & Kakwani, 2004). Table 4 shows the results of the 2SLS analysis of the simultaneous model equation for life expectancy.

Table 4. Two-Stages Least Square for Life Expectancy Model

Explained Variable: Log (Life Expectancy (LE))	
Log (EG)	0.002944 (2.921678)**
Log (Hex)	3.982365 (2.790376)***
Log (Emc)	-2.673902 (-1.932362)
Log (Mor)	-1.767353 (-0.277565)
Pov	-6.820181 (-2.553658)**
Constant	77.50532 (4.690539)***
Adjusted R^2	0.944780

*Note: ***significance at p-value ≤ 0,01; **significance at p-value ≤ 0,05; t-statistics are stated in parentheses.*
Source: Data Processed, 2022

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

Table 4 presents the 2SLS estimation results in the life expectancy equation model as the second simultaneous equation. The result shows that gross domestic product per capita as endogenous variable has significant positive effect on longevity. Healthcare expenditure proved significantly affect life expectancy. This output implies that every healthcare expenditure increased by 1 percent will increase life expectancy by 3,98 percent assuming ceteris paribus. The poverty rate will also significantly reduce life expectancy by 6.82 percent for every 1 percent increase in the poverty rate, the majority of which is due to weak consumption capacity and human capital investment. Carbon emissions and mortality rate as one of the substances that endanger human health in this study have insignificant adverse on life expectancy. Through the R-square value, this model is proven to be able to explain 94.4 percent of the variation in the effect of life expectancy and the other 5,6 percent is explained by variables outside the model.

Healthcare expenditure is an essential component for the government in improving public health, an increase in healthcare expenditure will also be followed by an increase in health outcomes, which is life expectancy. These results are in accordance with the research conducted by Rezapour et al. (2019), which has also proven that an increase in healthcare expenditure will be able to boost life expectancy while reducing infant mortality rate and morbidity. Zarulli et al. (2021), added that healthcare expenditure will increase the ability to consume and access individual health at the household level, which will improve the quality of their health so that they have the potential to achieve longevity. According to Radmehr and Adebayo (2022), for several decades the health sector received a larger percentage of the investment budget from the gross domestic product in several countries around the world. Developed countries will be able to consumed more on public healthcare and infrastructure, thus provide better services, while poor countries with low incomes generated will have to overcome budget deficits and debt financing, making it difficult to achieve high life expectancy.

Carbon emission is one of the main factors triggering environmental degradation through air pollution (Bashir et al., 2022). Mariani et al. (2010), showed that health and morbidity are very related to the environmental quality: water sanitation, air pollution, soil degradation, depletion of natural resources and the like, all of which can increase human mortality, thereby reducing life expectancy. In line with the findings in this study, Chontanawat (2018) found the same thing in Nigeria, that carbon emissions have a significant positive effect on increasing the morbidity and mortality rate and have an impact on reducing life expectancy. Severe air pollution is responsible for enhancing potential of chronic diseases spread (e.g. asthma, heart disease and lung cancer) and increasing premature mortality (Osabohien et al., 2021). This provides empirical evidence that carbon emissions are one of the causes of increased mortality, both of which have adverse effect on life expectancy, so the government should pay more attention to these two aspects.

Lawanson and Umar (2021) found an adverse relationship between poverty and life expectancy. The effect of poverty on longevity can be easily measured through health investment, increasing health spending can increase life expectancy. It was further explained that increasing of the health expenditure may not directly affect to poverty reduction but through other mechanisms, such as productivity enhancement and human capital accumulation. Poverty represents a weak consumption capacity that creates a variety of limited access to human capital investment in an effort to achieve prosperity at the household level. Table 5 shows the linkage between economic growth and longevity.

Table 5. The Linkage Between Endogenous Variables using Two-Stages Least Square

Variables	Coefficient	T-Statistics	Prob.
Log (EG)	0.002944	2.921678	0.0071***
Log (LE)	2.428662	4.478418	0.0001***

*Note: ***significance at p-value ≤ 0,01; **significance at p-value ≤ 0,05*
Source: Data Processed, 2022

Based on the 2SLS estimation results on the first and second simultaneous equation endogenous variables (see tables 3 & 4), it is known that economic growth and life expectancy have probability values, respectively, namely 0.0362 and 0.0001 which are below the p-value of 5 percent. Thus, it can be concluded that the existence causality between economic growth on life expectancy

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

is accepted. The results of this study are in accordance to findings from Kulunk and Korkmaz (2016), which prove a causal longevity and economic growth causality in OECD countries through Granger causality analysis. In addition, He and Li (2020), managed to proves that there is an unidirectional causality from life expectancy to economic growth for the younger group in short term, whereas there is a unidirectional causality running from longevity and economics only for the older group. Boucekkine and Diene (2007), through their research results, also emphasize that aging-population highly determined the linkages of longevity and economics. This finding also succeeded in confirming that in Indonesia the Preston Curve hypothesis in a country, as research from various parts of the world conducted by Jetter et al. (2019), Omotor and Osakede (2021), Miladinov (2020), Leandro (2022), and Rahman et al. (2022).

Furthermore, the result implies that gross domestic product per capita is able to increase 2.4 percent of life expectancy for every increase in economic growth by 1 percent. Developing the health, education, sanitation, employment, technology development, logistics, and others need to be continued. The availability of adequate infrastructure will ease the community to achieve a decent quality of life. On the other hand, gross domestic product per capita also represents an increase in consumption and purchasing power per capita of the community which is one of the essential aspects at the household level. Therefore, economic growth implies human capital investment efforts to achieve indicators of health outcomes in the form of longevity.

In line with this, Rice and Fineman (2004), found that conomic growth has been shown to boost life span by increasing state capacity and providing public infrastructure. As the economy continues to grow, the government charges that revenues in order to obtain the resources and capacity required to provide the public goods and services that its citizens actually involve, such as health care, and basic public services, education, and social protection. According to Moga et al. (2022), rising of per capita incomes and shifts in developing countries' spending frameworks will diminished poverty, high adult literacy rates, better sanitation, accessibility to water supplies, and adequate nutrition all enhance longevity. Empirical evidence indicates that developed countries invest heavily in social sectors such as health, education, environmental management, sanitation, and other social safety nets. Ali and Ahmad (2014), also emphasized that macroeconomic instruments have major impact on longevity because rising inflation lowers household purchasing power, and in the long run, household life expectancy shows a negative trend.

This study was proven that life expectancy able to promote Indonesian economic growth rate of 0.002 percent for every one percent increase. Life expectancy represents the quality and standard of living. The linkage of longevity to economic growth and is on the quality of human capital owned, a high life expectancy means that a person is able to access supporting infrastructure in self-development such as health, education, and human capital investment. On the other hand, life expectancy is also an indication that a person will be more productive because they are in a healthy condition, conversely with an unhealthy body condition, they tend to have low productivity, so they have a smaller contribution to economic growth through absorption of energy to work.

This finding is supported Bai et al. (2018), which also found a positive effect between longevity and economic growth in Belt and Road Countries. Economic growth enhanced the supply and country capacity in providing public goods. The state can tax this income and acquire the resource and capacity needed to provide the public goods and services that citizens need, such as health care, and basic public services, education, and social protection (Sirag et al., 2020). Generally, developed countries have higher life expectancy than developing countries, arguably through more efficient health systems, high living standards, and more resources invested to enhance health outcomes (Endris, 2008). More resources become available as the economy grows to enhance nutrition, access to health care, and other conditions that greatly boost health and well-being. Moreover, Income per capita growth has a different effect on developing and developed countries, as countries with greater life spans are more influenced by shifts in Income per capita. According to our findings from both developed and developing countries, higher average income is linked to a wider life span in the income distribution (Redmond, 2022).

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

CONCLUSION

This study succeeded in confirming the linkage between economic growth and life expectancy through the endogenous growth model and proving the Preston Curves in Indonesia as a developing country as well as the world fourth largest population. This study also proved a linkage between economic growth and life expectancy, both of which basically influence each other but have the opposite direction of influence. This finding shows that economic growth was significantly influenced by the decrease in the dependency ratio, unemployment rate, and poverty. Furthermore, the life expectancy model is positively influenced by health spending and significantly decreases by the increased mortality rate. However, poverty and carbon emissions had a negative but insignificant effect. The use of the 2SLS simultaneous equation model contributes to filling the existing literature gap by proving a causal relationship between the economy and life expectancy while providing more empirical results in answering research inconsistencies and debates on this topic.

This finding also proves the important role of population demographics through life expectancy, population age, and dependency ratio on economic growth. Longevity is one of the goals of development that represents the welfare and health of the population, but on the other hand, a life expectancy that is too high can also harm the country's economy given the existence of a U-shaped relationship in it. Therefore, government needs to constructed policies to minimize the decline in economic performance due to the excessively high life expectancy which can be done by prioritizing a larger budget allocation in the education sector as a program for safety nets and labor pensions. Furthermore, the government can also formulate a cash transfer policy to help elderly people living in poverty. Through the endogenous growth model and Preston curves, this study succeeded in proving a causal relationship between economic growth and life expectancy only in Indonesia, so it is recommended for further research to extended the research scale, development of research variables, and more advanced research approaches to provide more empirical research results.

REFERENCES

Acemoglu, D., & Johnson, S. (2007). Disease and development: The effect of life expectancy on economic growth. *Journal of Political Economy*, *115*(6), 925–985. https://doi.org/10.1086/529000

Adams, R. J. (2003). Economic Growth, İnequality, and Poverty: Findings from a New Data Set. *Policy Research Working Paper*, *2972*(Poverty Reduction Group), 1–48.

Ali, A., & Ahmad, K. (2014). The Impact of Socio-Economic Factors on Life Expectancy in Sultanate of Oman: An Empirical Analysis. *Middle-East Journal of Scientific Research*, *22*(2), 218–224. https://doi.org/10.5829/idosi.mejsr.2014.22.02.21847

Arriaga, E. E. (2008). Measuring and Explaining the Change in Life Expectancies. *Population (English Edition)*, *21*(1), 83–96.

Azam, M., Khan, A. Q., Abdullah, H. Bin, & Qureshi, M. E. (2016). The impact of CO2 emissions on economic growth: evidence from selected higher CO2 emissions economies. *Environmental Science and Pollution Research*, *23*(7), 6376–6389. https://doi.org/10.1007/s11356-015-5817-4

Bai, R., Wei, J., An, R., Li, Y., Collett, L., Dang, S., Dong, W., Wang, D., Fang, Z., Zhao, Y., & Wang, Y. (2018). Trends in life expectancy and its association with economic factors in the belt and road countries—evidence from 2000–2014. *International Journal of Environmental Research and Public Health*, *15*(12), 1–11. https://doi.org/10.3390/ijerph15122890

Bashir, A., Liliana, L., Hidayat, A., & Suhel, S. (2022). The Relationship between Air Pollution, Economic Growth, and Life Expectancy: Empirical Evidence from Indonesia. *Signifikan: Jurnal Ilmu Ekonomi*, *11*(1), 125–144. https://doi.org/10.15408/sjie.v11i1.23334

Bein, M. A., Unlucan, D., Olowu, G., & Kalifa, W. (2017). Healthcare spending and health outcomes: Evidence from selected East African countries. *African Health Sciences*, *17*(1), 247–254. https://doi.org/10.4314/ahs.v17i1.30

Bidisha, S. H., Abdullah, S. M., Siddiqua, S., & Islam, M. M. (2020). How Does Dependency Ratio

ISSN 2302-2663 (online)

DOI: doi.org/10.21009/JPEB.011.1.2

Affect Economic Growth In the Long Run? Evidence from Selected Asian Countries. *The Journal of Developing Areas*, *54*(2). https://doi.org/10.1353/jda.2020.0015

Boucekkine, R., Diene, B., & Azomahou, T. (2007). A closer look at the relationship between life expectancy and economic growth. *Discussion Paper*. Département des Sciences Économiques de l'Université catholique de Louvain Institut de Recherches Économiques et Sociales.

Bunyaminu, A., Mohammed, I., Yakubu, I. N., Shani, B., & Abukari, A. L. (2022). The effect of health expenditure on average life expectancy: does government effectiveness play a moderating role? *International Journal of Health Governance*, *27*(4), 365–377. https://doi.org/10.1108/IJHG-03-2022-0027

Cervellati, M., & Sunde, U. (2011). Life expectancy and economic growth: The role of the demographic transition. *Journal of Economic Growth*, *16*(2), 99–133. https://doi.org/10.1007/s10887-011-9065-2

Chontanawat, J. (2018). Decomposition analysis of CO2 emission in ASEAN: An extended IPAT model. *Energy Procedia*, *153*, 186–190. https://doi.org/10.1016/j.egypro.2018.10.057

Ciptawaty, U. (2022). Spatial Relationship Between Low Income Population and Regional Development Index in Mesuji District. *Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi Dan Pembangunan*, *23*(1), 146–154. https://doi.org/10.23917/jep.v23i1.16907

Cruz, M., & Ahmed, S. A. (2018). On the impact of demographic change on economic growth and poverty. *World Development*, *105*, 95–106. https://doi.org/10.1016/j.worlddev.2017.12.018

Cumby, R. E., Huizinga, J., & Obstfeld, M. (1983). Two-Step Two Stage Least Squares Estimation in Model with Rational Expectation. *Journal of Econometrics*, *21*, 333–355.

Edgerton, D. L. (1972). Some Properties of Two Stage Least Squares as Applied to Nonlinear Models. *International Economic Reveiw*, *13*(1), 26–37.

Efendi, R., Indartono, S., & Sukidjo, S. (2019). The Relationship of Indonesia's Poverty Rate Based on Economic Growth, Health, and Education. *International Journal of Multicultural and Multireligious Understanding*, *6*(2), 323. https://doi.org/10.18415/ijmmu.v6i2.704

Endris, S. (2008). Life Expectancy and Economic Growth: the Role of the Demographic Transition. *Journal of Economic Growth*, *7*(27), 2008–2010. https://doi.org/10.1007/s

Fang, D. (2022). The Effect of Household Dependency Ratio on the Mental Health of Workforce: Evidence From China. *Frontiers in Public Health*, *10*(April). https://doi.org/10.3389/fpubh.2022.848114

Fomby, T., Johnson, B., & Hill, M. (1984). Introduction to Simultaneous Equations Models in Advanced Econometric Methods. *Springer*, *1*, 439–450.

Gujarati, D. N. (2004). *Basic Econometrics*. McGraw− Hill.

Gujarati, D. N., Dawn, C., & Porter. (2010). *Basic Econometrics* (5th ed.). McGraw− Hill.

Gürler, M., & Özsoy, Ö. (2018). Exploring the relationship between life expectancy at birth and economic growth in 56 developing countries. *Journal of Global Health Reports*, *3*. https://doi.org/10.29392/joghr.3.e2019001

Hartwig, J. (2010). Is health capital formation good for long-term economic growth ? – Panel Granger-causality evidence for OECD countries. *Journal of Macroeconomics*, *32*(1), 314–325. https://doi.org/10.1016/j.jmacro.2009.06.003

He, L., & Li, N. (2020). The linkages between life expectancy and economic growth: some new evidence. *Empirical Economics*, *58*(5), 2381–2402. https://doi.org/10.1007/s00181-018-1612-7

Ingham, B., Chirijevskis, A., & Carmichael, F. (2009). Implications of an increasing old-age dependency ratio: The UK and Latvian experiences compared. *Pensions*, *14*(4), 221–230. https://doi.org/10.1057/pm.2009.16

Jetter, M., Laudage, S., & Stadelmann, D. (2019). The Intimate Link Between Income Levels and

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

Life Expectancy: Global Evidence from 213 Years*. *Social Science Quarterly*, *100*(4), 1387–1403. https://doi.org/10.1111/ssqu.12638

Kulunk, I., & Korkmaz, S. (2016). Granger Causality Between Life Expectancy, Education and Economic Growth in OECD Countries. *The Economic Research Guardian*, *6*(1), 2–17.

Kunze, L. (2014). Life expectancy and economic growth. *Journal of Macroeconomics*, *39*(PA), 54–65. https://doi.org/10.1016/j.jmacro.2013.12.004

Lawanson, O. I., & Umar, D. I. (2021). The life expectancy–economic growth nexus in Nigeria: the role of poverty reduction. *SN Business & Economics*, *1*(10), 1–26. https://doi.org/10.1007/s43546-021-00119-9

Lawton, P. (2018). Age Dependency Ratios and GDP Growth in Developing Countries. *International Economic Reveiw*, *2*(2), 29–45.

Leandro, P. (2022). Health, Income, and the Preston Curve: A Long View. *Centre for Economic Policy Research*, *DP17151*, 1–23. https://www.researchgate.net/publication/359618781_Health_Income_and_the_Preston_Curve_A_Long_View

Lee, H. H., & Shin, K. (2021). Decomposing effects of population aging on economic growth in oecd countries. *Asian Economic Papers*, *20*(3), 138–159. https://doi.org/10.1162/asep_a_00839

Mahumud, R. A., Hossain, G., Hossain, R., Islam, N., & Rawal, L. (2013). Impact of Life Expectancy on Economics Growth and Health Care Expenditures in Bangladesh. *Universal Journal of Public Health*, *1*(4), 180–186. https://doi.org/10.13189/ujph.2013.010405

Mariani, F., Pérez-Barahona, A., & Raffin, N. (2010). Life expectancy and the environment. *Journal of Economic Dynamics and Control*, *34*(4), 798–815. https://doi.org/10.1016/j.jedc.2009.11.007

Miladinov, G. (2020). Socioeconomic development and life expectancy relationship: evidence from the EU accession candidate countries. *Springer*, *76*(1). https://doi.org/10.1186/s41118-019-0071-0

Misango, K. M. (2022). Health Status and Economic Growth in Kenya. *School of Business and Economics*, *3*(2), 72–82. https://doi.org/10.47747/jismab.v3i2.670

Moga Rogoz, A. T., Sart, G., Bayar, Y., & Gavriletea, M. D. (2022). Impact of Economic Freedom and Educational Attainment on Life Expectancy: Evidence From the New EU Member States. *Frontiers in Public Health*, *10*(June), 1–10. https://doi.org/10.3389/fpubh.2022.907138

Ngangue, N., & Manfred, K. (2015). The Impact of Life Expectancy on Economic Growth in Developing Countries. *Asian Economic and Financial Review*, *5*(4), 653–660. https://doi.org/10.18488/journal.aefr/2015.5.4/102.4.653.660

Okunade, A. A., & Osmani, A. R. (2020). Effects of life expectancy on economic growth: new results using the flexible Box–Cox power transformation model. *Applied Economics Letters*, *27*(20), 1681–1684. https://doi.org/10.1080/13504851.2020.1713976

Omotor, D. G., & Osakede, U. A. (2021). Is there a life expectancy Preston Hypothesis for Africa ? *African Journal of Health Economics*, *10*(2), 19–34.

Osabohien, R., Ayomitunde, A. T., Bose, A. D., & Bose, J. L. (2021). Carbon emissions and life expectancy in Nigeria. *International Journal of Energy Economics and Policy*, *11*(1), 497–501. https://doi.org/10.32479/ijeep.10834

Park, S. B. (1974). Indirect Least Squares Estimation of a Simultaneous Equation System. *The Canadian Journal of Statistics*, *2*(1), 75–82.

Piabuo, S. M., & Tieguhong, J. C. (2017). Health expenditure and economic growth - a review of the literature and an analysis between the economic community for central African states (CEMAC) and selected African countries. *Health Economics Review*, *7*(1), 1–13. https://doi.org/10.1186/s13561-017-0159-1

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2

Purnomo, S. D., & Istiqomah, I. (2019). Economic Growth and Poverty: The Mediating Effect of Employment. *Jejak*, *12*(1), 238–252. https://doi.org/10.15294/jejak.v12i1.18591

Radmehr, M., & Adebayo, T. S. (2022). Does health expenditure matter for life expectancy in Mediterranean countries? *Environmental Science and Pollution Research*, *29*(40), 60314–60326. https://doi.org/10.1007/s11356-022-19992-4

Rahman, M. M., & Khanam, R. and R. M. (2018). Health care expenditure and health outcome nexus : New evidence from Abstract : *Globalisation and Health*, *14*(2018), 1–30.

Rahman, M. M., Rana, R., & Khanam, R. (2022). Determinants of life expectancy in most polluted countries: Exploring the effect of environmental degradation. *Research Square*, *17*(1 January), 1–27. https://doi.org/10.1371/journal.pone.0262802

Redmond, M. (2022). Living Too Long. *EMBO Report: Science and Literature*, *77*(1), 29–55. https://doi.org/10.1525/ncl.2022.77.1.29

Rezapour, A., Mousavi, A., Lotfi, F., Movahed, M. S., & Alipour, S. (2019). The effects of health expenditure on health outcomes based on the classification of public health expenditure: A panel data approach. *Shiraz E Medical Journal*, *20*(12). https://doi.org/10.5812/semj.88526

Rice, D. P., & Fineman, N. (2004). Economic implications of increased longevity in the United States. *Annual Review of Public Health*, *25*, 457–473. https://doi.org/10.1146/annurev.publhealth.25.101802.123054

Rostiana, E., & Rodesbi, A. (2020). Transisi Demografi dan Pertumbuhan Ekonomi Indonesia. *Jurnal Economia*, *16*(1), 1–17.

Scott, A. J. (2021). The longevity economy. *The Lancet Healthy Longevity*, *2*(12), e828–e835. https://doi.org/10.1016/S2666-7568(21)00250-6

Sirag, A., Nor, N. M., & Law, S. H. (2020). Does higher longevity harm economic growth? *Panoeconomicus*, *67*(1), 51–68. https://doi.org/10.2298/PAN150816015S

Son, H. H., & Kakwani, N. (2004). Economic Growth and Poverty Reduction: Initial Conditions Matter. *United Nations Development Programme: International Poverty Centre - Working Papers*, *2*, 29. http://ipc-undp.org/publication/27404

Tscheuschner, P. (2021). Endogenous Life Expectancy and R&D-Based Economic Growth. *Hohenheim Discussion Paper in Business, Economics, and Sciences*, *01*.

Turan, B. (2020). Life expectancy and economic development: Evidence from microdata. *Review of Development Economics*, *24*(3), 949–972. https://doi.org/10.1111/rode.12665

Turner, B. (2021). *Demographic Transition for Economic Development in Taipei, China: Literature and Policy Implications* (Issue 1222). https://doi.org/10.1007/978-1-349-67278-3_116

Vaupel, J. W. (1986). How change in age-specific mortality affects life expectancy*. *Population Studies*, *40*(1), 147–157. https://doi.org/10.1080/0032472031000141896

Wooldridge, M. J. (2010). *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

Zarulli, V., Sopina, E., Toffolutti, V., & Lenart, A. (2021). Health care system efficiency and life expectancy: A 140-country study. *PLoS ONE*, *16*(7 July), 1–11. https://doi.org/10.1371/journal.pone.0253450

Zhang, Z., Chen, Y. H., & Wang, C. M. (2021). Can CO2 Emission Reduction and Economic Growth Be Compatible? Evidence From China. *Frontiers in Energy Research*, *9*(July), 1–11. https://doi.org/10.3389/fenrg.2021.693767

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.011.1.2