PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
2019, vol. 14, no 2, 201-212

Golden Age Population, Healthy Environment, Growth and Poverty: Are Malaysia Really in a Sustainable Condition?

Populacja Złotego Wieku, zdrowe środowisko, wzrost i ubóstwo: czy Malezja rozwija się w sposób zrównoważony?

Nanthakumar Loganathan*, Lekha Kunju Pillai Laxman, Abbas Mardani***, Dalia Streimikiene****, Asan Ali Golam Hassan*****
**

**Azman Hashim International Business School, Universiti Teknologi Malaysia,*
81310 Johor Bahru, Johor, Malaysia
E-mail: n4nantha@yahoo.com
***Azman Hashim International Business School, Universiti Teknologi Malaysia*
81310 Johor Bahru, Johor, Malaysia
E-mail: lekha@utm.my
****Azman Hashim International Business School, Universiti Teknologi Malaysia*
81310 Johor Bahru, Johor, Malaysia
E-mail: abbasmardani@utm.my
*****Lithuanian Institute of Agrarian Economics,*
V. Kudirkos g. 18-2, 03105 Vilnius, Lithuania
E-mail (corresponding author): dalia.streimikiene@knf.vu.lt
******Azman Hashim International Business School,*
Universiti Teknologi Malaysia Kuala Lumpur, 54100 Kuala Lumpur, Malaysia
Email: asanali@utm.my

Abstract
This study analyses the sustainability condition of a healthy environment, economic growth and poverty level in relation to the golden age population in Malaysia based on the quantile regression estimates covering the period of 1960 until 2016. Generally, studies on aging population have generated attention globally due to its possible impact on health care, greenhouse gas emissions, globalization, investment for the purpose of research and development, income inequality and energy consumption. More specifically, evidence from the current empirical study shows a positive sign of the bootstrap quantile regression relationship between a healthy environment and per capita income with the aging population. This ensures that, the country is facing the growth-led-aging population condition. Furthermore, the findings have also revealed that poverty is giving a negative effect with the aging population grows. This study may suggest a re-evaluating of the existing theories of aging population and provide new insights for policy-makers for the purpose of sustainable population planning for up-coming decades.

Key words: aging population, healthy environment, growth, poverty, quantile regression

Streszczenie
W niniejszym artykule dokonano analizy stanu zrównoważenia i zdrowia środowiska, wzrost gospodarczy i poziom ubóstwa w odniesieniu do populacji w Złotym Wieku w Malezji, na podstawie szacunków regresji kwantylu obejmujących okres lat 1960-2016.Uogólniając, studia odnoszące się do starzejącej się populacji wzbudzają sze-

rokie zainteresowanie z uwagi na jej możliwy wpływ na opiekę zdrowotną, emisje gazów cieplarnianych, globalizację, inwestycje w badania i rozwoju, nierówności dochodów i zużycie energii. Dokładniej rzecz ujmując, dowody z obecnego badania empirycznego pokazują pozytywny znak relacji bootstrapingowanej regresji kwantylu między zdrowym środowiskiem a dochodem na mieszkańca w stosunku do starzejącej się populacji. Wykazuje to, że kraj stoi w obliczu starzenia się społeczeństwa pod wpływem wzrostu. Ponadto okazało się, że, ubóstwo pociąga za sobą negatywny efekt w kontekście starzenia się populacji. Przeprowadzone badanie sugeruje konieczność ponownego przeanalizowania istniejących teorii starzenia się społeczeństwa i dostarcza decydentom nowych informacji na temat zrównoważonego planowania populacji na nadchodzące dziesięciolecia.

Słowa kluczowe: starzejąca się populacja, zdrowe środowisko, wzrost, ubóstwo, regresja kwantylu

1. Introduction

The concept of *golden age* in Greek mythology has a positive connotation with reference to the promise made by Prometheus, the Titan god of forethought, for a utopian situation of peace and stability when people lived long, healthy, active, and prosperous lives (World Bank, 2015). The converse is true today whereby stagnant populations and aging societies are oftentimes perceived as a challenge or threat, rather than an opportunity to be explored. In accordance to the United Nations, population ageing is a process by which older individuals constitute proportionally a larger share of the total population (Leng et al., 2016). Thus, one of the most significant social transformations of the twenty-first century will be population ageing because the rapid ageing of humanity is in all likelihood the most relevant and dynamic aspect of modern demography (Beard et al., 2012). Although the key factors influencing population ageing globally are declining fertility and increasing longevity, international migration in specific countries and regions is also playing a significant role in changing population age structures (United Nation, 2015). The key data extracted from the World Population Ageing Report 2015 revealed the following indications:

- There has been an increase of 48 percent worldwide of people aged 60 years or more in 2015 (901 million people) from the year 2000 (607 million people).
- A projected growth of 56 percent is estimated between 2015 (901 million) and 2030 (1.4 billion) in the number of people in the world aged 60 years or more and by 2050 it is projected to double its size in 2015 reaching approximately 2.1 billion.
- Two thirds of the world's oldest persons are concentrated in the developing regions with their rate of growth occurring faster than in the developed regions. In fact, 64% of the aged population are located in the less developed regions and is estimated to exceed 80% by 2050.
- The Asian region in 2015 houses 56% of the global older population (508 million), with 508 million people aged 60 or over in 2015 and this share is expected to increase to 60% by 2030.

The implications in the rate of the above changes are direr for the developing countries. Not only do they have briefer periods in terms of adapting and formulating the infrastructure and policies necessary to address the needs of their rapidly shifting demographics, they also need to devise the appropriate coping mechanisms for aging before they have the adequate economic resources to do so unlike developed countries.

When discussing about Malaysia – an upper middle-income country and amongst the nations in ASEAN with the highest life-expectancy – a similar trend is observed. The segment of its population aged above 60 years has more than doubled from about 1 million to 2.2 million from 1991 to 2010 and is estimated to increase to approximately 7 million or 17.6% of the projected population of 40 million by 2040 (Department of Statistics Malaysia (DOSM), 2018; Toy et al., 2015). Currently, 2.8 million or 9% of Malaysia's an overall population of 31.7 million consists of senior citizens aged above 60 with further projections from the United Nation, that 15% of Malaysia's total population will comprise of the elderly and thereby will become an ageing nation by the year 2030. Like other countries, the contributing factors of population ageing in Malaysia are decreased in fertility and mortality rates as well as advancements in the health system. This is evidenced by the improvements in the life expectancy at birth of the Malaysian population from 74.1 years in 2010 to 74.7 years in 2016. These developments are attributable to a number of national policies targeting the aging population of Malaysia in response to the Madrid International Plan of Action on Ageing in 2002 (Williamson, 2015) beginning with the 1990 National Social Welfare Policy that had addressed the need for the care of older persons by families and communities, and later replaced in 2005 by the 1995 National Policy for the Elderly (Hamid, 2016). Currently in force is the 2011 National Policy of Older Persons, which works together with the National Health Policy for Older Persons 2008. It is thus extremely crucial for nations encountering population aging to source for improved information and study the socioeconomic and environmental implications of demographic aging.

Two fundamental changes, which had affected population growth of both developed and developing nations around the world, are: (i) environmental change contributed largely by global climate change and (ii) demographic transition related to changes in the size and age composition including the longevity of the population (Menz and Welsch, 2012). In consequence, numerous areas of life, such as family formation, labor market arrangements, the sustainability of public finances, and the environment will be affected (Kluge et al., 2014). The role of age cohort (65 years and above) in greenhouse emissions directly or indirectly is a crucial area of concern since globally the proportions of people in this category is growing faster than any other age cohort thereby resulting in serious challenges for government policy making in the coming years (Hassan and Salim, 2013). Furthermore, two-thirds of people aged 60 or over are from low- and middle-income countries (United Nations, 2015). According to Wan Ibrahim and Ismail (2014), Malaysia is facing a similar trend with clear signs that the population is moving towards aging. Consequently, aging in a changing climate has become one of the health and environmental issues facing this century (Alabi, 2012). The above common denominators ought to propel a unified global response in the form of effective policies to address critical societal issues that are emerging from the interface between climate change and the ageing population. This necessitates a global transition to a low carbon, resource-efficient economy that beseeches an essential shift in the context of technology, energy, economics, finance and ultimately all segments of society (European Commission, 2017). There is thus a dire need for more research, innovation and competitive strategies that optimize the synergies between *energy, transport, and circular economy, industrial and digital innovation* so as to sustainably develop present and future low carbon and energy efficient technologies on a global level (European Commission, 2017).

Although two of the current key global challenges are population ageing and climate change, there is insufficient focus on the intersection between the two (Hassan and Salim, 2013). There is evidently a research gap in previous studies even though their analyses of the relations between demographic change and emissions of the major CO_2 emissions have undertaken different perspectives, most of the projections of future emissions did not sufficiently take into account the demographic influences (O'Neill et al., 2012). Whereas, researchers who had analyzed the *levels of disaggregation that approximate life-cycle behavior* such as family or household size have uncovered complex and nonlinear relationships when exploring the relationship between age-structure and energy consumption. (Liddle, 2014). For example, studies Liddle and Lung (2010) that desegregated the working age population had uncovered a positive elasticity for young adults (aged 20-34) and a negative elasticity for older adults (aged 35-64). Other studies that had also considered cohort effects found that there was an increase of carbon emissions for those who were born after 1960 (Menz and Welsch, 2012).

The focus of current literature that examined the relationship between population factors in relation to carbon dioxide emissions were on several aspects. A short-term dynamic relationship between carbon dioxide emissions and population growth instead of long-term equilibrium relationship can be deduced from studies that had employed Granger's test of causality (Zhang and Tan, 2016). There were also studies that had taken into account additional demographic factors, along with population size and population growth, such as Cole and Neumayer (2004), Liddle (2014), Chikaraishi et al. (2014), Feng et al. (2011), Zhou and Liu (2016), Wang et al. (2013), Li et al. (2011) and Minx et al. (2011), which amongst others assessed the carbon emissions in relation to urbanization rates and average household sizes. Generally, studies on economic growth-environmental relationship had tested the environmental Kuznets curve (EKC) hypothesis with per capita income as a proxy for economic growth and CO_2 emission as proxies for environmental degradation and extensive review surveys of these literatures were provided, amongst others by Stern (2004), Dinda (2004), Luzzati and Orsani (2009), Halicioglu (2009), Acaravci and Ozturk (2010), Al-Mulali et al. (2015) and Apergis and Ozturk (2015). According to this hypothesis, the relationship between per capita income level and environmental sustainability is the inverted *U*-shape, which, alludes to the reduction of environmental quality during the initial phase of economic development, but upon attaining a specific threshold, the environmental quality is expected to improve with subsequent economic growth (Ahmed et al., 2016).

Economics-demographic structural changes is also an important aspect of the growth process. Where the economic growth affects demographic change, and demographic change further affects the long-term growth process, some of the common demographic indicators that were used to study the linkages to economic growth include population growth, population size, total fertility rates, density, crude birth rate, crude death rate, working age growth, dependency ratio, life expectancy as well as size, density and migration (Todaro, 1989). Subsequent studies had discovered that in terms of long-term economic development, there is a resultant decline in fertility level that generally follows the growth in per capita income, thereby leading to a population with a higher median age, the increased importance of the nuclear family, as well as increases in life expectancy and adult illiteracy (Hirschman, 1980). Fougere and Merette (1999) had evaluated population ageing and economic growth in seven OECD countries and found that population ageing will not only have a resultant economic impact in relation to savings and labor force but also in terms of investment in human capital and R&D. Interestingly, the findings of a study related to economic and demographic structural change in Malaysia could not detect any tendency towards convergence between the more developed states and the less developed states (Golam Hassan at al., 2012).

It is equally important to look into the paradox associated with the poverty-led-CO_2 reductions principally relevant for rapidly growing developing countries that are anticipated to become the dominant emitters of greenhouse gases within a generation, according to a 2010 report by the nonprofit Center for Global Development in Washington, D.C. This is attributable not only to their increasing populations but also to their poverty that reduces their accessibility to solar energy projects or other investments in non-fossil energy. This is particularly critical at a time in history when CO_2 emissions must be reduced to avoid climate change catastrophes (Collins and Zheng, 2015). This paradox has to be considered in the context of another trend, namely the aging population. Changes in the age composition of households are expected during the next several decades with a probable impact on energy consumption and CO_2 emissions. Moreover, Chen et al. (2016) has dispelled previous assumptions that the problem of rural poverty can be resolved merely by economic growth since the key influencing factor of poverty incidence in more rural areas is related to the increasingly serious aging of its population. A related concern that has been emerging is in relation to fuel poverty that has become another survival issue for a globally ageing population. It is caused by a combination of factors in view of longer heating and cooling requirements when combined with declining incomes has given rise to the need for urgent solutions in the context of energy saving technologies for this vulnerable group (Walker et al., 2017).

The remainder of this paper is organized as follows. The next section presents the data and model specifications focusing on conditional quantile regression. Section 3 discusses the descriptive analysis and the empirical estimation results. Finally, Section 4 provides the conclusion and policy implication.

2. The data and methodology

In this paper, we attempt to explore the relationship between environment degradation, poverty and economic performance on golden aging population using the time series data span from 1960 to 2016. The data have been obtained from World Development Indicator (WDI) Database from World Bank (2018) and Global Footprint Network (2018). In general, the relationship between aging population, environmental degradation, poverty and economic growth can be tested by using the following function and the linear equation:

$$Age_t = f\left(\overbrace{Env_t}^{+}, \overbrace{Pov_t}^{-}, \overbrace{GDP_t}^{+}, \overbrace{GDP_t^2}^{-}\right) \quad (1)$$

$$Age_t = \beta_0 + \beta_1 Env_t + \beta_2 Pov_t + \beta_3 GDP_t + \beta_4 GDP_t^2 + \varepsilon_t \quad (2)$$

where, Age_t represents the amount of an aging population (population aged above 65 years); Env_t is the indices of environment degradation based on total volume of ecological indicators; Pov_t indicate the poverty condition (proxy with per capita expenditure); GDP_t represent the per capita income level measured in US dollar currency; GDP_t^2 is the squared per capita income level; and ε_t is the error term of the linear estimator. The Age_t, Pov_t, GDP_t and GDP_t^2 series are gathered from WDI database, while the Env_t series is compiled from the Global Footprint Network (2018). The GDP series also been deflated to the constant price in 2010. A graphic analysis of the aging population, environmental degradation, poverty and per capita income is shown in Figure 1. Notably, it can be found that the difference series of the variable used in this study is moved with the inconsistent fluctuation way. Generally, peaks in differences, aging population are not coinciding with through in differences of environment degradation, poverty and per capita income.

Generally, time series data will face always faced non-stationary behaviors such as random walk, cycles and trend effects, which creates a spurious indicating relationship between the series used in this study. Therefore, the non-stationary series must be transformed into fully stationary series. All series are transformed into natural logarithms prior to pursue the empirical analysis. We applied 3 types of traditional unit root test, namely the Augmented Dickey-Fuller (ADF), Philips-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Both ADF and PP faced the null hypothesis that, the series has a unit root versus the alternative hypothesis, that, the series has no unit root. While, the KPSS is differ from ADF and PP, where the null hypothesis that the series has no unit root; and the alternative hypothesis indicate that the series has a unit root. Figure 1 gives the time series plot in a different formation of the aging population, healthy environment, poverty level and the per capita income. From the panel 1 of Figure 1, we found the aging population experienced a gradual increase since the year 2000 and decreased in 2005, and then began to sharply from 2010. While, the healthy environment, poverty level and per capita income series have a fluctuated varying pattern throughout the overall period of this study.

In this study we employ Koenker and Xiao's (2004) quantile unit root test, which allows differences in the transmission of all kinds of different quantiles effects and not depending with the deterministic trend effect. This test is more accurate, flexible and reduces the uncertainty estimation. The quantile unit root test is based on the following conditional quantile autoregression (AR) model for the Age_t series:

$$Q_{Age_t}(\tau|F_t) = \alpha_0(\tau) + \alpha_1(\tau)Age_{t-1} + \sum_{j=1}^{q} \alpha_{j+1}(\tau)\Delta Age_{t-1} \quad (3)$$

where $Q_{Age_t}(\tau|F_t)$ is the conditional quantile of Age_t series to a level $r \in (0,1)$, F_t is the information

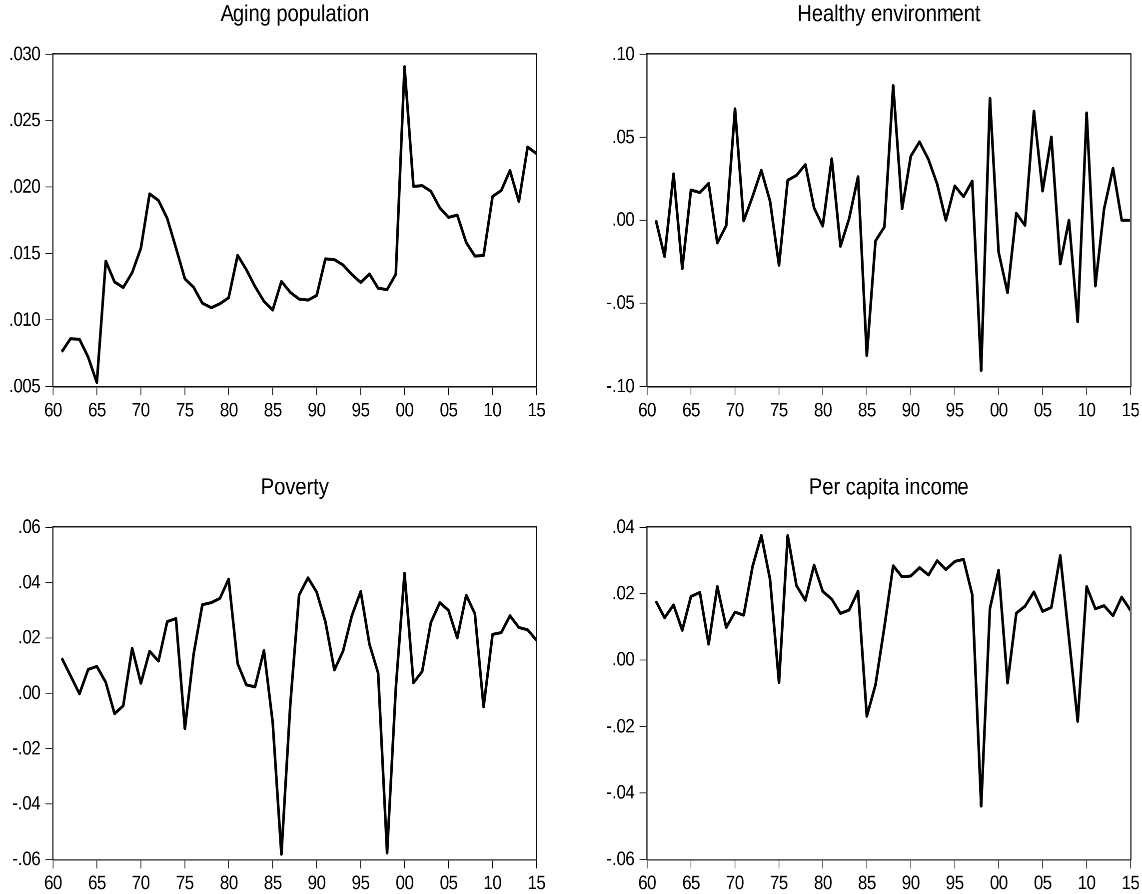

Figure 1. Time series plots in difference formation over the 1960-2016 (in logarithm formation)

accumulated up to the time frame of t, and the null hypothesis can be stated as $H_0: \alpha_1(\tau) = 1$ for the given quantile (τ) of this study. Next, we extended the quantile unit root test with the quantile regression relationship between specified quantile of a dependent variable. With Age_t as dependent variable and Env_t as the independent variable, the τ^{th} conditional quantile regression function can be express as follows:

$$Q_{Age}(\tau|Env) = inf\{b|F_{Age}(b|Env) \geq \tau\} = \sum_k \beta_k(\tau)Env_k = x'\beta(\tau) \quad (4)$$

where, $F_{Age}(b|Env)$ is a conditional distribution function of Age_t and Env_t series and the $\beta(\tau)$ represent the dependence relationship between both regressed series with specified quantiles (τ). According to Lin and Benjamin (2017), the estimated $\beta(\tau)$ for each quantiles are estimated by the minimization of the weighted deviation between estimated series as shown in Eq. (5):

$$\beta(\tau) = argmin \sum_{t=1}^{T} \left(\tau - 1_{\{y_t < x_t'\beta(\tau)\}}\right) |y_t - x_t'\beta(\tau)| \quad (5)$$

Allowing the coefficients to vary across quantiles (τ), we extend the existing literature by estimating the $\beta_k^{(\tau)}$ for a range of τ=0.10, 0.25, 0.50, 0.75 and 0.90. Since we aimed to show the different effects of independent variables on the dependent variable across the spectrum, therefore the specification quantile regression of this study can be written as follows:

$$Q_{Age_t}(\tau|X) = \alpha_0^{(\tau)} + \alpha_1^{(\tau)}Env_t + \alpha_2^{(\tau)}Pov_t + \alpha_3^{(\tau)}GDP_t + \alpha_4^{(\tau)}GDP_t^2 + \epsilon_t^{(\tau)} \quad (6)$$

3. Empirical results

The following Table 1 presents the overview of the summary statistics for the variables used in this study in natural logarithmic form. We found that, the J-B test rejected the null hypothesis of no normality, only for *Age* series. The most volatile series were for *GDP* (2.72%), while *Env* had the lowest volatility (1.67%) in term of unconditional standard deviation. The kurtosis coefficient was lower than 2 for all series, indicating that the distributions are not asymmetric. Moreover, we found that all series are positively skewed, except for *Env* and *GDP* series. Figure 2 represents the normal Q-Q test for *Age, Env, Pov* and *GDP* variables, where the straight line indicates the expectations of the normal distributed data. From the figures, the observation values do not fit the normal distribution fit line and does not obey the normal distribution condition. Generally, the observed quantile value of the variables deviates from the expected value of this variable in a normal distribution inter-

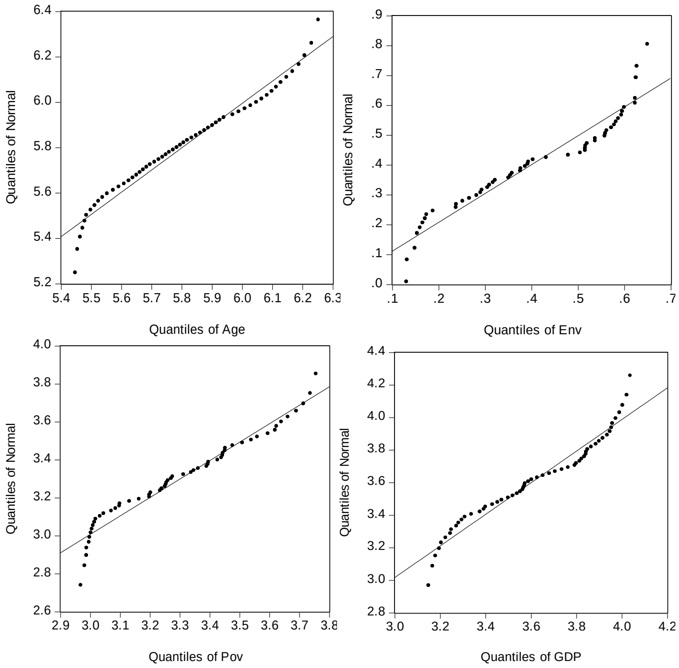

Figure 2. The normal Q-Q plot of *Age*, *Env*, *Pov* and *GDP*

Table 1. Summary statistics of the main variables

Variable	Age_t	Env_t	Pov_t	GDP_t
Mean	5.806	0.407	3.296	3.613
Median	5.788	0.392	3.265	3.595
Maximum	6.252	0.649	3.755	4.036
Minimum	5.446	0.130	2.968	3.148
Std. Dev.	0.235	0.167	0.235	0.272
Skewness	0.195	-0.176	0.261	-0.139
Kurtosis	1.928	1.642	1.936	1.728
J-B (Prob.)	0.019**	0.100	0.194	0.138

Note: The estimation based logarithm series of the variables.
* Statistical significance at the 1% level, ** Statistical significance at the 5% level, *** Statistical significance at the 10% level.

Table 2. The traditional unit root test results

	Level			First difference		
	ADF	PP	KPSS	ADF	PP	KPSS
Age_t	-2.343	-2.049	0.905*	-2.794***	-2.655***	0.240
Env_t	-0.967	-0.898	0.874*	-9.311*	-9.311*	0.059
Pov_t	-0.986	-0.988	0.896*	-5.354*	-4.632*	0.193
GDP_t	-0.856	-0.835	0.906*	-6.499*	-6.506*	0.096
GDP_t^2	-0.305	-0.310	0.906*	-6.571*	-6.571*	0.046

Note: The Akaike Information Criterion (AIC) is used to select the appropriate lag length.
* Statistical significance at the 1% level, ** Statistical significance at the 5% level, *** Statistical significance at the 10% level.

face. This indicates that, these variables are not normally distributed. Similarly, we found that all four figures have a tendency to increase in up-coming period.

We used ADF, PP and KPSS tests to determine the stationary condition of all series used in this study. Table 2 shows the results of the tests at level and first differences forms. We found that, all test results for five series used in this study has archived stationary condition at first differences or $I(1)$ form. While, for the KPSS test, we found that all series are stationary at $I(0)$ and reject the null hypothesis, that the series has no unit root. Lag selection always been an important issue when dealing with time series data analysis, to avoid misspecification in term of selecting lags, we used the most command AIC optimal lag order selections. Since we found all series are stationary at $I(1)$, therefore we continue to perform the cointegration analysis. The results from the quantile unit root tests are reported in Table 3. We conduct the quantile unit root tests in the case of trend specification and the optimal lag selection is based on the AIC. The estimated quantile unit root test confirm that all variables lead to a temporary effect, ad-

Table 3. Quantile unit root test results

Quantile	τ=0.10	τ=0.25	τ=0.50	τ=0.75	τ=0.90
Age_t					
$\alpha_0(\tau)$	-2.734 (0.009)	-1.682 (0.036)	0.087 (0.440)	0.702 (0.016)	1.337 (0.001)
$\rho_1(\tau)$	0.003 (0.163)	-0.254 (0.051)	-0.212 (0.003)	-0.067 (0.001)	0.282 (0.029)
$t_n(\tau_i)$	2.038 (0.690)	-1.993 (0.330)	-2.047 (0.170)	-3.321 (0.020)	1.828 (0.770)
QSK test	4.501 [CV: 1%=8.085, 5%=6.181, 10%=5.442]				
Env_t					
$\alpha_0(\tau)$	-2.261 (0.000)	-2.188 (0.006)	0.128 (0.388)	1.096 (0.014)	1.652 (0.000)
$\rho_1(\tau)$	-0.498 (0.000)	-0.573 (0.000)	-0.387 (0.000)	-0.235 (0.000)	-0.486 (0.000)
$t_n(\tau_i)$	-3.744 (0.990)	-3.723 (0.010)	-3.437 (0.000)	-4.187 (0.000)	4.419 (0.960)
QSK test	4.799 [CV: 15=6.452, 5%=4.997, 10%=4.166]				
Pov_t					
$\alpha_0(\tau)$	-3.037 (0.000)	-2.095 (0.009)	0.125 (0.369)	0.399 (0.070)	1.170 (0.015)
$\rho_1(\tau)$	-1.548 (0.000)	-1.091 (0.001)	-0.122 (0.001)	-0.112 (0.000)	0.473 (0.125)
$t_n(\tau_i)$	5.154 (0.950)	-2.828 (0.110)	-2.473 (0.050)	-2.878 (0.080)	2.173 (0.930)
QSK test	5.154 [CV: 1%= 9.977, 5%6.519, 10%=4.797]				
GDP_t					
$\alpha_0(\tau)$	-2.642 (0.002)	-2.777 (0.005)	0.082 (0.444)	0.248 (0.301)	1.468 (0.003)
$\rho_1(\tau)$	0.857 (0.423)	0.534 (0.190)	0.098 (0.030)	0.088 (0.235)	0.437 (0.107)
$t_n(\tau_i)$	0.284 (0.290)	-0.896 (0.640)	-1.921 (0.150)	-4.287 (0.010)	1.477 (0.770)
QSK test	4.287 [CV: 1%=6.571, 5%=4.357, 10%=4.110]				
GDP_t^2					
$\alpha_0(\tau)$	-2.302 (0.004)	-0.777 (0.161)	-0.672 (0.123)	1.043 (0.000)	1.464 (0.000)
$\rho_1(\tau)$	-0.980 (0.001)	-0.577 (0.000)	-0.178 (0.000)	-0.174 (0.000)	0.016 (0.000)
$t_n(\tau_i)$	0.074 (1.000)	-3.401 (0.040)	-2.724 (0.010)	-6.722 (0.000)	3.004 (0.900)
QSK test	9.074 [CV: 1%=7.585, 5%=6.241, 10%=7.585]				

Note: QKS denotes the Kolmogorov-Smirvov test type proposed by Konker and Xiao (2004). The numbers in [] are p-values for the corresponding tests. The quantile unit root tests are based on GAUSS estimation codes.

Table 4. Cointegration test results

Variable	OLS	DOLS	FMOLS
Env_t	0.463* (5.252)	0.797* (4.197)	0.582* (4.693)
Pov_t	-0.239** (2.269)	-0.217 (1.322)	-0.278*** (1.900)
GDP_t	0.952** (2.059)	0.639 (1.009)	0.671 (1.018)
GDP_t^2	-0.261* (-3.595)	-0.258** (-2.518)	-0.229** (-2.230)
R-square	0.802	0.806	0.802
Adj. *R*-square	0.801	0.805	0.801

Note: Figures in parentheses and [ ] are *t*-values and p-values, respectively. The lag order selection for DOLS and FMOLS estimates are based on Akaike Information Criterion (AIC).
* Statistical significance at the 1% level, ** Statistical significance at the 5% level, *** Statistical significance at the 10% level.

Table 5. Multidimensional Bayer and Hanck (2013) combine cointegration test results

Estimated models	EG-JOH	EG-JOH-BO-BDM	Cointegration decision
$Age_t = f(Env_t, Pov_t, GDP_t)$	11.543**	21.718**	Yes
$Env_t = f(Age_t, Pov_t, GDP_t)$	13.291**	24.362**	Yes
$Pov_t = f(Age_t, Env_t, GDP_t)$	12.401**	27.023**	Yes
$GDP_t = f(Age_t, Pov_t, Env_t)$	11.505**	17.631***	Yes
Significance level			
10 percentage	8.363	16.097	
5 percentage	10.637	20.486	
1 percentage	16.259	31.169	

Note: The optimal lag length selection is based on the AIC.
* Statistical significance at the 1% level, ** Statistical significance at the 5% level, *** Statistical significance at the 10% level.

just slowly at lower and middle quantile for most of the series.

To facilitate comparisons between the long-run estimates, we used the OLS, DOLS and the FMOLS techniques. Our results suggest that, *Env* have a positive effect with *Age*. Typically, OLS and FMOLS captured positive relationship between *Pov* and Age. While, only OLS estimate able to indicate positive effects of *GDP* on *Age*; and the square *GDP* series indicates a negative sign based on all three estimates. The negative sign of the squared *GDP* implies that, there is a diminishing return effect between both variables in the long-run integration. To establish the combine multidimensional cointegration relationship between variables, we constructed the Bayer and Hanck (2013). Table 5 shows that; all estimated equations significantly reject the null hypothesis of no cointegration statistically significant at the 5% level for combining Engle-Johansen cointegration test. Using the combine Bayer and Hanck (2013) estimation, it can be seen that all equations reject the null hypothesis at 5% and 10% level, respectively. Thus, the results of the overall combine cointegration tests indicate that the most combinations of the cointegration test indicate the acceptance of long-run cointegration between the series.

Table 6 displays the bootstrap quantile regression under different quantiles. Considering all quantiles estimated results, the *Env* has a positive effect on *Age* with coefficients ranged between 0.257 and 0.526. Similarly, this positive relationship between population growth and health is in line with seminal works by Xu et al. (2018), Zhang and Tan (2016). For example, Zhang and Tan (2016) found that, the aging population and population quality are positively correlated with China's carbon emissions. While, Xu et al. (2018) found that, the potential population growth and area expansion will result in a massive increase in impervious surface dominated built land and thus may impact the area's thermal environment.

On the basis of the data of Malaysia, the annual average growth of ecological indicators index has grown dramatically influenced by the industrious activities, the effect of larger industrial scale and urbanization process, mainly in quantile 0.25 with -0.526 level of the regressed coefficient. This figure supported by the aging population rate in quantile 0.10, 0.25 and 0.50, where the aging, population growth is volatile and not consistently increased over time. In addition, we found that *Pov* indicate a positive effect on *Age* under the quantile 0.1, 0.25 and 0.5, and the coefficient is between 0.247 and 0.418. This can be explained by the overall Malaysia's economic performance during the earlier period of 1980 to 2010, where the government has introduced several healthcare policies to improve the mortality and the fertility rate through the National Population Policy. DOSM (2018) estimated by the year 2040 the country has to face 14.5% of golden age population and this will change the overall demographic pyramid structure of Malaysia.

Meanwhile, the degree of *GDP* influenced on *Age* are appeared in the middle and end quantiles with the coefficients between 0.981 and 2.470. As the *GDP* level increases, the degree of *Age* proportion in the overall population were found to be gradually increasing. Furthermore, the squared *GDP* estimated coefficient is negatively significant in quantile 0.50, 0.75 and 0.90, which captured the diminishing return concept. The estimated results also show the impact on *GDP* on *Age* in quantile 0.90 is 2.470 and it is much higher than those in other quantiles. According to DOSM (2018), the annual per capita income in the upper 0.90 quantile during the period of 2000-2016 is around USD10,808, which is 3 times higher than 0.50 quantile (USD3,746). Figure 3 plots the trend coefficients across the quantiles estimated in this study, which indicate the degree of influence of the factors on the golden age population under the different quantiles. For example, as the golden aging population level increases, the poverty level quantile periods gradually decrease with unstable condition from 0.80 until 0.90 quantiles. In the case of healthy series, there is an evidence that the 95% confidence intervals have an upward trend and enter with some positive sign, except an unstable moment at the early 0.10 quantile. These features not only prove that environmental health is promoted by the increasing level of aging population for Malaysia, but that the level of positive relation keeps on increasing over the quantile period. Third and finally, the per capita income figure shows a fluctuated and decreasing level of relationship with the aging population with a sta-

Table 6. The results of the bootstrap quantile regression coefficient

Variable	Quantile bootstrap estimations				
	τ=0.10	τ=0.25	τ=0.50	τ=0.75	τ=0.90
Env_t	-0.257* (-6.092)	-0.526* (-3.018)	-0.369* (-2.951)	-0.373* (-3.221)	-0.280** (-2.525)
Pov_t	0.418* (3.595)	-0.279* (2.561)	-0.247*** (1.913)	-0.111 (0.686)	-0.017 (-0.105)
GDP_t	0.009 (0.014)	0.905 (1.667)	0.981*** (1.797)	1.833** (-2.503)	2.470** (2.575)
GDP_t^2	0.143 (1.536)	0.259 (0.443)	-0.259* (3.064)	-0.390** (-2.217)	-0.486* (-3.554)
Goodness-of-fit tests					
Pseudo R-Squared	0.897	0.917	0.925	0.930	0.935
Adj. R-square	0.889	0.910	0.919	0.924	0.930
Quantile dependent var	5.484	5.608	5.783	5.988	6.164
Sparsity	0.093	0.056	0.055	0.062	0.078
Quasi-LR stat.	407.342*	703.094*	737.491*	705.604*	587.806*
Prob. (Quasi-LR stat.)	0.000	0.000	0.000	0.000	0.000

Note: Figures in parentheses are *t*-values.
* Statistical significance at the 1% level, Statistical significance at the 5% level, *** Statistical significance at the 10% level.

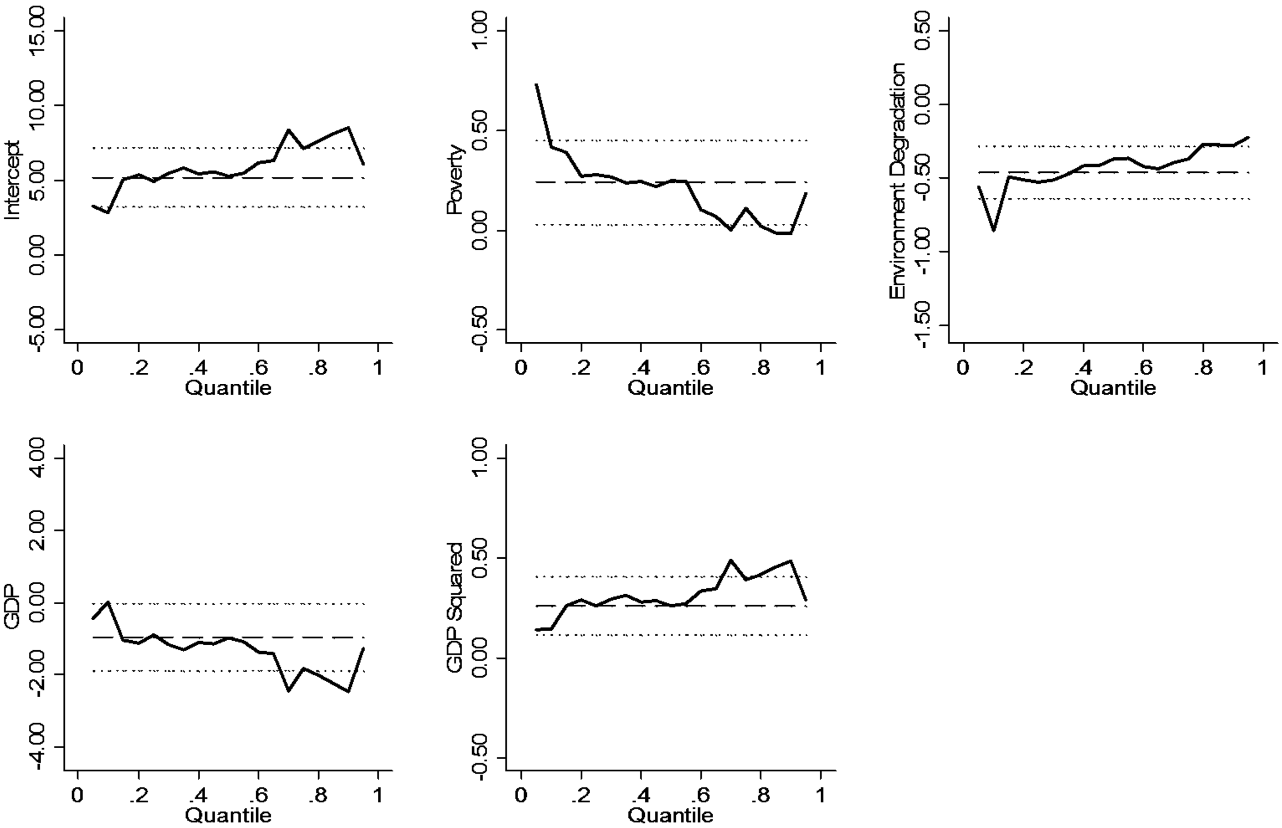

Figure 3. Changes in quantile regression coefficients
Note: The upper and lower dashed line represents the corresponding OLS estimates with 95% confidence interval

ble mode of the condition throughout the estimated quantiles. This is consistent with the findings of Hassan (2010), where there is a negative long-run causal relationship flowing from per capita income to population for China. While, empirical findings of Hajamini (2015) indicate that there is a non-linear relationship between population growth and per capita income both developed and developing countries.

4. Discussion and concluding remarks

The global human impact on the environment and the undisputable importance of environmental health has long been given recognition with the Stockholm and Rio Declarations which resulted from the first and second global environmental conferences, respectively, namely the United Nations Conference on the Human Environment in Stockholm, June 5-16, 1972, and the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, June 3-14, 1992. The latter in particular had recognized the intimate interaction between environmental quality and human health and consequently many countries had proceeded to implement the National Environmental Health Action Plan (NEHAP) consisting of strategies for the improvement of environmental health within the country whilst defining the roles and responsibilities of relevant stakeholders. Since the healthy environment issue is highly complex and cuts across various sectors and agencies, the Malaysian government had established the NEHAP (2013) to ensure that sustainable environment and health as well social determinants of health are at the core of its development strategies.

From the findings of this study we can deduce that while there is positive relationship between environmental health and per capita income in an aging population, a negative indication was found in terms of poverty level. Our results further indicate that there is a growth-led-aging population condition for Malaysia from the middle and end quantiles. The study provides the following policy recommendations:

(a) Environmental protection and public health goals are mutually replenishing one another and thus should be given more specific attention by the stakeholders and the government agencies to ensure the sustainability nexus between the aging population growth-environment-growth.

(b) We need to redefine the modes of protecting vulnerable populations due to climate change that is a significant and emerging threat to public health in the case of Malaysia.

(c) The government need to integrate the efforts of all relevant agencies into a long-term sustainable plan to effectively address this emerging issue that influences environmental health and population growth.

(d) The 11th Malaysia Plan (11MP), has also emphasized that the Government will adopt a sustainable production approach to ensure economic growth, but will not do so at the expense of the quality of the environment. This aspect should be also highlighted to ensure that sustainable growth is in line with the aging population growth.

(e) It is also essential to reinforce the collaboration and cooperation between different sectors involved in the environmental and health areas in order to effectively execute the relevant strategies implemented under the national framework.

In conclusion, we advocate that sustainable development ought to encompass the nurturing of the environment, prioritize sustainable growth and social equity to reduce poverty, improve the health and well-being of all segments of population, as well as inculcate sustainable partnerships and cooperation among various stakeholders within and across countries in the region. Therefore, we propose that policy makers to undertake continuous improvement by planning and developing green policies that transcend in time and place capable of enhancing environmental health and health equity for all to sustain in a globalized world.

Acknowledgement

This study is sponsored by the Ministry of Higher Education under the Fundamental Research Grant Scheme (FRGS/1/2017/SS08/UTM/02/5). The authors are thankful to Omid Ranjbar for his excellent guides with a quantile unit root test using the GAUSS software and special thanks to all anonymous referees of this journal.

References

1. ACARAVCI A., OZTURK I., 2010, On the relationship between energy consumption, CO_2 emissions and economic growth in Europe, in: *Energy*, 35(12), p. 5412-5420.
2. AHMED K., REHMAN M. U., OZTURK I., 2016, What drives carbon dioxide emissions in the long-run? evidence from selected South Asian countries, in: *Renewable and Sustainable Energy Reviews*, 70, p. 1142-1153.
3. ALABI S. A., 2013, Climate change and the ageing population: enforcing the rights to life and health under human rights, health and climate change regimes, in: *Pittsburgh Journal of Environmental and Public Health Law*, 7(1), p. 79-126.
4. AL-MULALI U., WENG-WAI C., SHEAU-TING L., MOHAMMED A. H., 2015, Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation, in: *Ecological Indicators*, 48, p.315-323.
5. APERGIS N., & OZTURK I. (2015). Testing environment Kuznets curve hypothesis in Asian countries, in: *Ecological Indicators*, 52, p. 16-22.
6. BAYER C., HANCK C., 2013, Combining non-cointegrating tests, in: *Journal of Time Series Analysis*, 34(1), p. 83-95.
7. BEARD J., BIGGS S., BLOOM D., FRIED L., HOGAN P., KALACHE R., OLSHANSKY J., 2012, Global population ageing: peril or promise?, in: *PGDA Working Paper*, 89.
8. CHEN J., WANG Y., WEN J., FANG F., SONG M., 2016, The influences of aging population and economic growth on Chinese rural poverty, in: *Journal of Rural Studies*, 47(Part B), p. 665-676.
9. CHIKARAISHI M., FUJIWARA A., KANEKO S., POUMANYVPNG P., KOMATSU S., KALUGIN A., 2015, The moderating effects of urbanization on carbon dioxide emissions: a latent class modeling approach. *Technological Forecasting and Social Change*, 90, p. 302-317.

10. COLE M. A., NEUMAYER E., 2004, Examining the impact of demographic factors on air pollution, in: *Population and Environment*, 26(1), p. 5-21.
11. COLLINS D., ZHENG C., 2015, Managing the poverty–CO_2 reductions paradox: the case of China and the EU, in: *Organization & Environment***,** 28(4), p. 355-373.
12. Department of Statistics Malaysia, 2018, *Population Demographics,* https://www.dosm.gov.my/ (8.01.2018).
13. DINDA S., 2004, Environmental Kuznets curve hypothesis: a survey, in: *Ecological Economics*, 49, p. 431-455.
14. European Commission, 2017, *Climate Action: Paris Agreement*, https://ec.europa.eu (10.07.2017).
15. Feng Z. H., Zou L. L., Wei Y. M., 2011, The impact of household consumption on energy use and CO_2 emissions in China, in: *Energy*, 36, p. 656-670.
16. FOUGERE M., MERETTE M., 1999, Population ageing and economic growth in seven OECD countries, in: *Economic Modelling,* 16, p. 411-427.
17. Global Footprint Network, 2018, http://www.footprintnetwork.org, (10.07.2017).
18. GOLAM HASSAN A. A., & MOHD MUSTAFA M., 2012, Regional Disparities, Income Inequality, and Poverty: A Cumulative Causation from Malaysia's experience, in: *Poverty and Global Recession in Southeast Asia*, ISEAS, Yusof Ishak Institute, p. 106-152.
19. HALICIOGLU F., 2009, An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey, in: *Energy Policy*, 37, p. 1156-1164.
20. HAMID T. A., 2016, *National Policies on Aging, Malaysia*, http://www.unescap.org/ (10.07.2017).
21. HASSAN K., SALIM R., 2015, Population ageing, income growth and CO_2 emission: empirical evidence from high income OECD countries, in: *Journal of Economic Studies*, 42(1), p. 54-67.
22. HASSAN M. S., 2010, The long-run relationship between population and per capita income growth in China, in: *Journal of Policy Modeling*, 32(3), p. 355-372.
23. HIRSCHMAN C., 1980, Demographic trends in Peninsular Malaysia, in: *Population and Development Review*, 6, p. 103-125.
24. KLUGE F., ZAGHENINI E., LOICHINGER E., VOGT T., 2014, The advantages of demographic change after the wave: fewer and older, but healthier, greener, and more productive?, in: *PLoS ONE,* 9(9), e108501, doi.org/10.1371.
25. KOENKER R., XIAO Z., 2004, Unit root quantile autoregression inference, in: *Journal of American Statistical Association,* 99, p. 775-787.
26. LENG O. T. S., KHAN S., VERGARA R. G., KHAN N., 2016, Policies and protections for ageing society in Malaysia, in: *Journal of Southeast Asian Research*, 2016, p. 1-8.
27. LI F., DONG S., LI X., LIANG Q., YANG W., 2011, Energy consumption-economic growth relationship and carbon dioxide emissions in China, in: *Energy Policy*, 39, p. 568-574.
28. LIDDLE B., 2014, Impact of population, age structure, and urbanization on carbon emissions/energy consumption: evidence from macro-level, cross-country analyses, in: *Population and Environment*, 35(3), p. 286-304.
29. LIDDLE B., LUNG S., 2010, Age structure, urbanization, and climate change in developed countries: revisiting STIRPAT for disaggregated population and consumption-related environmental impacts, in: *Population and Environment*, 31, p. 317-343.
30. LIN B., BENJAMIN N. I., 2017, Influencing factors on carbon emissions in China transport industry: a new evidence from quantile regression analysis, in: *Journal of Cleaner Production,* 150, p. 175-187.
31. LUZZATI T., ORSINI M., 2009, Investigating the energy-environmental Kuznets curve, in: *Energy*, 34(3), p. 291-300.
32. MENZ T., WELSCH H., 2012, Population aging and carbon emissions in OECD countries: accounting for life-cycle and cohort effects. In: *Energy Economics*, 34, p. 842-849.
33. MINX J. C., BAIOCCHI G., PETERS G. P., WEBER C. L., GUAN D., HUBACEK K. A, 2011, Carbonizing dragon: China's fast growing CO_2 emissions revisited, in: *Environmental Science & Technology*, 45(21), p. 9144-9153.
34. National Environment Health Action Plan (NEHAP), 2013, *Guidance Paper of the National Environment Health Action Plan for Malaysia*, http://www.nehapmalaysia.moh.gov.my (22.08.2017).
35. O'NEILL B. C., LIDDLE B., JIANG L., SMITH K. R., PACHUARI S., DALTON M., FUCHS R., 2012, Demographic change and carbon dioxide emissions, in: *The Lancet*, 380(9837), p. 157-164.
36. STERN D. I., 2004, The rise and fall of the environmental Kuznets curve, in: *World Development,* 32(8), p. 1419-1439.
37. TEY N. P., SIRAJ S. B., KAMARUZZMAN S. B. B., CHIN A. V., TAN M. P., SINNAPPAN G. S., MÜLLER A. M., 2016, Aging in multi-ethnic Malaysia, in: *The Gerontologist*, 56(4), p. 603-609.
38. TODARO M. P., 1989, *Economic Development in the Third World*, Longman, London.
39. United Nations, 2015, *World population prospects: the 2015 revision*, Working Paper No. 241.
40. WALKER G., TAYLOR A., WHITTET C., LYNN C., DOCHERTY C., STEPHEN B., GALLOWAY S., 2017, A practical review of energy saving technology for ageing populations, in: *Applied Ergonomics*, 62, p. 247-258.
41. WAN I.W.A., IBRAHIM W. A., ISMAIL Z., 2014, Some demographic aspects of population aging in Malaysia, in: *World Applied Sciences Journal*, 30(7), p. 891-894.
42. WANG P., WU W. S., ZHU B. Z., WEI Y. M., 2013, Examining the impact factors of energy-related CO_2 emissions using the STIRPAT model in Guangdong Province, China, in: *Applied Energy*, 106, p. 65-71.
43. WILLIAMSON C., 2015, *World population ageing 2015*, http://www.refworld.org (22.08.2017).
44. WORLD BANK, 2015, *Feature Story: The Promise of Prometheus-Golden Aging in Europe and Central Asia*, http://www.worldbank.org/ (10.06.2017).
45. WORLD BANK, 2018, *World Development Indicator,* http://www.worldbank.org/ (2.02.2018).
46. XU H., SHI T., WANG M. FANG C., LIN Z., 2018, Predicting effect of forthcoming population growth-induced impervious surface increase on regional thermal environment: Xiong'an new area, North China, in: *Building and Environment,* 136, p. 98-106.

47. ZHANG C., TAN Z., 2016,. The relationship between population factors and China's carbon emissions: does population aging matter?, in: *Renewable and Sustainable Energy Reviews* 65, p. 1018- 1025.
48. ZHOU Y., LIU Y., 2016, Does population have a larger impact on carbon dioxide emissions than income? evidence from a cross-regional panel analysis in China, in: *Applied Energy*, 180, p. 800-809.