International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 4 Issue 6, September-October 2020 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Assessing the Impact of Human Capital, Energy Consumption and Environment on Sustainable Development Model of Malaysia

Faridah Pardi[1], Mohammad Yuzaimi Yasin[2], Sutina Junos[1]

[1]Faculty of Business and Management, Universiti Teknologi MARA Cawangan, Negeri Sembilan, Malaysia
[2]MSCS (M) Pte. Ltd., Malaysia

ABSTRACT
This paper investigates the impact of human capital development (life expectancy and labor productivity), energy usage, and environmental factors (carbon dioxide emissions) on the per capita economic sustainable development in Malaysia. We employed the adjusted net savings per capita (World Bank) to represent the economically sustainable development path in Malaysia. With the assumptions of possible structural breaks along the years of between 1971, and 2013, the Zivot-Andrews unit root test was performed on all of the variables concerned. Following the bounds test method, we proposed the auto-regressive distributed lag (ARDL) model for the per-capita sustainable development path in Malaysia based on the impact of human capital development and environmental factors. We found that life expectancy, carbon emissions and energy usage have mixed significant effects on adjusted net savings per capita in both the short-run and long-run in Malaysia.

KEYWORDS: *Sustainable development, Adjusted net savings per capita, Malaysia*

How to cite this paper: Faridah Pardi | Mohammad Yuzaimi Yasin | Sutina Junos "Assessing the Impact of Human Capital, Energy Consumption and Environment on Sustainable Development Model of Malaysia" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-4 | Issue-6, October 2020, pp.1274-1282, URL: www.ijtsrd.com/papers/ijtsrd33586.pdf

IJTSRD33586

INTRODUCTION
National savings have been significantly addressed in the neoclassical model of income in the economy [1]. In this circular flow of income model, the role of savings was notable as the source of funds for investment which is crucial for national income equilibrium. Savings has also appeared in the growth model approach by [2] which strongly relates savings with an investment that could gear up the economic growth. This popular model measured economic growth as the increase in the level of output for a country in a given year. Thus, economic growth has been an ultimate macroeconomic goal for every government around the globe ever since its conception.

The effort to measure economic growth begins with the calculation of gross domestic products (GDP) to indicate the wealth of nations. GDP measures a country's economic performance by looking at the monetary values of total output produced by each economic sector. However, the capability of GDP in measuring the 'true' economic growth has become a debate among researchers in recent years. GDP only calculates the gross monetary value of total output, without considering externalities or any other social costs. Countries that obtain high economic growth through its increasing figure of GDP might not be able to sustain it in the long-run if progress was accompanied by deterioration in environmental aspects and decreasing social quality. This situation brought the new idea to the national policymakers of going beyond economic growth that is achieving 'sustainable development' as a comprehensive macroeconomic goal.

The word 'sustainable development' (SD) became popular during the 1980s when the Brundlant report [3] proposed its base definition as '*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*'. The concept suggests what an economy should maintain, a growth plus development condition that would not sacrifice wealth for future generations. It is important to note that, sustainable development concept also came in various aspects of measurement and definitions, be it from the environmentalist, socialists, or even from the economists approach. All these conditions have brought them together to propose various measurements to SD. Among these measurements, the World Bank introduced the calculation of the Adjusted Net Savings rate (ANS) which took the basic theory that linked national savings to investment as mentioned earlier. ANS is measured by 'adjusting' the net value of national savings[1], having added with public education expenditure (to signify the investment in human capital) followed by deducing the depreciation in the capital (natural resources) and environmental assets. A simple indicator as noted by many, the positive value showed an economy moving at a sustainable path while negative value possesses otherwise, as when expressed as a fraction of gross national income (GNI). Although the indicator is often stated as a 'weak' sustainability indicator [4], despite some drawbacks it is useful, comprehensive and publicly comparable.

Sustainable Development in Malaysia

Malaysia is a medium-sized country strategically located in the heart of the South-east Asia region. The country has sustained rapid economic growth for more than half a century since its independence. Contributed by fast development and progress from the three main sectors – agriculture, manufacturing and services industry, the country continues to strive towards sustaining her achievement. With challenging issues such as from the environmental, social and economic aspects; it would be a tough situation for policymakers to design appropriate measures for achieving the targets. Hence, our aim for this study is to analyze the empirical impact of several factors toward sustainable development path in Malaysia which is measured through the Adjusted Net Savings (ANS).

Malaysia has obtained positive ANS rates forty years ago (which marked the start-up of successful development plans) and continues to fluctuate throughout the period (**Figure 1**). It is interesting to highlight that, while economic growth usually is measured by the GDP or per capita GDP[2], studies relating to the indicator for measuring sustainable development have also become popular in recent years. In comparison, Malaysia's per capita income (GDP per capita) keeps on rising from 1971 until 2013 at an average of US$5465.49 per year. Looking at the sustainable development path for Malaysia, the ANS per capita maintains at the average of US$825 per year during the period, slightly lower and less volatile than what we've seen from the GDP per capita. The uprising income per capita certainly showed that Malaysia's economic growth is on a progressive trend, but it is quite different when we compare with the trend of per capita economic sustainability (ANS per capita). The trend of per capita ANS in Malaysia showed a slightly plain but relatively volatile with lower values than per capita GDP.

[1] Net national savings refers to gross national savings minus depreciation on fixed capital, while gross national savings are gross national product/income plus net income abroad.

[2] GDP per capita is a measure of average income per person in a country. GDP per capita divides the GDP by the population.

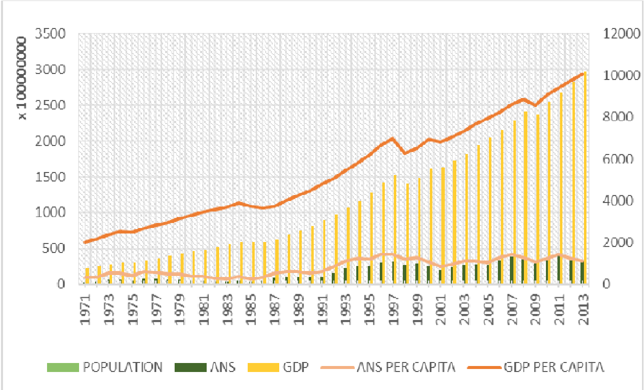

Figure 1: Per Capita Income and Sustainable Development, Malaysia (1971-2013)
Source: WDI, World Bank (various years)

Due to this situation, we anticipated some factors that may influence the path of sustainable development in Malaysia. Our hypothetical assumptions were made on the basis that factors that have an impact on economic growth might also have a possible impact on sustainability. The next section provides brief literature on the sustainable development concept and past studies regarding its determinants. The section is followed by an explanation of the research method employed in this study and the analysis of the result in detail. Implications and conclusions are presented in the last section.

LITERATURE REVIEW

The foundation of the sustainable development concept was originated from the traditional economic growth model. The initial model of economic growth was proposed by (Solow, 1956). National savings appeared in this model as one of the elements that influence the economic growth of an economy, indicated by the increase in the level of production (GDP). The growing concerns and debates about how GDP could really address social and environmental issues have pursuit some modifications to the economic growth model, such as in [5] by adding technological progress as the new factor. The modified model also suggested the concept of intergenerational equity which tries to answer the earlier question on how to sustain economic growth. It was suggested that there were possible ways to go beyond economic growth, by including some factors or variables that could sustain it. Hartwick's rule introduced by [6] was closely related to the founding of the sustainable development concept in the 1980s. The Hartwick rule's proposed that through savings and investment principles, constant streams of consumption must be maintained to the 'infinite' future from generations to another in order to keep the capital 'intact'.

The concept and main definition of sustainable development came in the early 1980s from the [7]. The initial idea came from the word 'conservation' or rather sustainable utilization – means that species and ecosystems must be utilized at levels and renewable for the upcoming future. However, this definition received critics by many, particularly from the social and economic researchers – due to its exceptional focus on environmental issues rather than others. (Brundtland et al., 1987) later corrected the term by introducing a comprehensive definition of sustainable development. It suggested a new development path for the whole planet to follow, not just in terms of wealth accumulations, but also for our next generations to inherit the wealth.

Measuring SD – Adjusted Net Savings

Since its conception in the 1980s, several attempts have been made to measure sustainable development path. These indicators have been discussed and tested for many countries; with various economic backgrounds. Most of the indicators, however, focused only on certain aspects of sustainability such as environmental effects but ignores the externalities arisen from the measurement. Adjusted net savings, introduced by the World Bank in the 1990s overcome this problem by considering all the three elements to SD – economic, social, and environmental effects. This comprehensive indicator was initially proposed by [8] which derived 'genuine' savings – to include all the investment made to human capital, deduce all the depletion in natural resources and environmental assets. [9] and [10] proposed savings as a kind of investment to link capital reserves with the future generations on the condition that current level consumption utility is maximized. Following this, studies such as by [11] came out either to redefine or improve the calculation of ANS. It had also further inspired authors across nations to developed their own calculation for ANS, such as by [12], [13] and from Malaysia, [14]. The unique characteristics of the ANS rate made it became popular among researchers when making a comparison with other indicators because it clearly distinguishes between a level of 'true' output and consumption of a nation [15].

Studies on the determinants of ANS embarked on the previous literature on economic growth and national savings. ANS was basically an extended version of savings, therefore researchers suggest that theoretically, any factors that influence savings might also have an impact on sustainability. In [16], issues of resource abundance which related with lower economic growth and less-sustainability had been addressed. Similar results were found in [17] which concluded that weak-resource management and unreliable institutional policy have an influence on the sustainable development path. A famous factor that influences growth and savings – the population; has appeared in the analyses conducted by [18] and [19] where both studies analyzed the impact of the growing population on ANS. [20] in his paper confirmed his assumption that a growing population could influence the savings rate.

In a more recent study, [21] analyzed several factors that might have an effect on the ANS rate in the selected developing country including Malaysia. While adopting a number of countries with various level of income, it was found that Human Development Index (HDI), share of natural capital, population structure variables and financial development have significant impact on sustainable development path of these countries. The studies have set some benchmarks for other studies to follow the methodologies afterward. A study by [22] examined some exogenous factors to ANS- armed conflicts, natural resources extraction and population growth. These variables were found to have a negative impact on sustainable development. A different approach to understand factors relating *to per capita sustainability* was conducted by [23]. The study examined the dynamic relationship between resource extraction, institutional quality, and armed violence with per capita sustainability.

In summary, the above-listed literature generally made on panel country analysis – that is observation was pooled together in the model estimation process. For a country-specific analysis, [24] and [25] each provided distinctive studies on the comprehensive measurement of ANS and its gap with economic growth, respectively. Due to the lack of focus for a country-specific analysis, a study has been conducted by [26] to analyze the determinants of ANS in Malaysia. The study has found that inflation, financial development, income growth and natural resources extraction have significant impact on sustainable development path (ANS rate) in Malaysia; both in short-run and long-run.

METHODOLOGY

The present study is based on a country-specific analysis – Malaysia. Our target for this study is to diverge slightly from the usual methodology which runs on panel data/countries. Therefore, this study is focusing on a time-series analysis in Malaysia. Most of the annual macroeconomic data for Malaysia were sourced from the World Development Indicators (WDI) report that is publicly available at the World Bank online site, while other local national estimates were obtained from the Statistical Department of Malaysia. For specific data on labor productivity, the series was obtained from 'TED – The Conference Board Total Economy Database' for output, labor and productivity (1950-2015). Due to some limitations in data availability, our analysis covered a range of 43 years of observation, from 1971 until 2013.

A. Dependent Variable – Per Capita ANS (ANSpc)

Our variable of concern will be the per capita Adjusted Net Savings (denoted as ANSpc). ANS is considered as a proxy to sustainability that links investment in physical and human capital with the extraction of resources. We followed the methodological term set earlier in [27] which mentioned that the per capita approach would decrease the issue of endogeneity. Moreover, since the per capita value of ANS in Malaysia is highly skewed, we took its log expression from their real values in constant 2010 US dollars.

B. Independent Variables

Human capital development variables

➢ **Life expectancy (LFEX)**

Life expectancy at birth indicates the number of years a new-born infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Data range for life expectancy in Malaysia is between 64 years until 75 years old, in both males and females during the period of 1971 – 2013. We used life expectancy as the proxy for human capital development since it is one of the elements for measuring the Human Development Index (HDI). *(Source: WDI, World Bank)*

➢ **Labor productivity (LPRD)**

Labour productivity is defined as labor productivity per person employed in 2014 US$. It measures the number of goods and services produced by one hour of labor employed; specifically, labor productivity measures the amount of real gross domestic product (GDP) produced by an hour of labor. (*Sourced from TED-The Conference Board Total Economy Database*).

Environmental variables

- **Per capita energy use (ENGY)**

Energy use refers to the use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport (kg of oil equivalent per capita). *(Source: WDI, World Bank)*

- **Per capita carbon dioxide emissions (CRB)**

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring. The CO_2 emissions data were recorded on a per capita basis, equivalent to metric tons per capita. *(Source: WDI, World Bank)*.

C. Model Specification

In measuring the impact of human capital variables and environmental variables on the sustainable development path, we took the base from the following model: -

$$LANSpc = f\{LEX, LPRD, ENGY, CARB\}$$

From (Eq. 1), we hypothesized that adjusted net savings per capita (LANSpc) is a function of life expectancy (LFEX), labor productivity (LPRD), energy use per capita (ENGY) and carbon dioxide emissions per capita (CRB). Next, the model for economic sustainability (sustainable development path) in Malaysia with the proposed determinants can be further derived as: -

$$LANSpc = \beta_0 + \beta_1 LEXP_t + \beta_2 LPRD_t + \beta_3 ENGY_t + \beta_4 CRB_t + \varepsilon_t$$

(Eq. 1)

Whereby it is assumed that; $\beta_1, \beta_2, \beta_3, \beta_4 > 0$

D. Estimation Method

We employed the Autoregressive Distributed Lag (ARDL) bounds testing procedure that was previously developed by [28]. ARDL has some advantages over conventional cointegration approaches such as (Engle & Granger, 1987) and from[29]. ARDL is applicable if variables are integrated at levels and first difference, or even if they are a mixture of both I(0) and I(1). ARDL can also be considered as a more dynamic and able to provide better results for small sample sizes than traditional techniques. Following [28]. ARDL approach for cointegration involving estimation to vector error correction (VEC) on the model of economically sustainable development path in Malaysia and its determinants can be written as follows: -

$$\Delta LANSpc_t = c_0 + \delta_1 LANSpc_{t-1} \delta_2 LEXP_{t-1} + \delta_3 LPRD_{t-1} + \delta_4 ENGY_{t-1} + \delta_5 CRB_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta LANSpc_{t-i} + \sum_{i=0}^{p} \varpi_i \Delta LEXP_{t-i} + \sum_{i=0}^{p} \phi_i LPRD_{t-i} + \sum_{i=0}^{p} \lambda_i ENGY_{t-i} + \sum_{i=0}^{p} \gamma_i CRB_{t-i}$$

(Eq. 1)

Where δ_i is a long-run coefficient, c_0 is the intercept and Δ is the first difference of variable and p is the optimum lag order.

The first step in the ARDL model is to conduct the Bounds Test procedure by estimating Equation 3 using the Ordinary Least Square (OLS) technique in order to find long-run cointegration among the variables through conducting a test of significance on variables in the error correction model. This is done through the F-statistic test. The null hypothesis of no long-run cointegration among the variables is H_0: $\delta_1=\delta_2=\delta_3=\delta_4=\delta_5=0$. On the other hand, the alternative hypothesis of long-run cointegration is H_1: $\delta_1\neq\delta_2\neq\delta_3\neq\delta_4\neq\delta_5\neq0$. The F-statistics value that is greater from the upper bound value would indicate that the null hypothesis can be rejected and the smaller value than lower bound critical values would indicate otherwise.

- **Unit Root Test**

Before we proceed to model estimation, we firstly examined the unit root properties for all the series involved in this study. Analyzing time-series data without checking their properties might result in spurious regression and is not favorable. The first assumption of the series stationarity without concerning structural breaks were conducted on the basis of conventional unit root tests, the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) Tests. The results are then presented in Table 1. The conventional unit root tests showed us that most of the variables are stationary at their first difference, except the variable Life Expectancy (LEXP) which became stationary at its level's data.

Considering structural changes may occur to many economic time-series, an associated problem is the testing of the null hypothesis of structural stability against the alternative of a one-time structural break. If such structural changes are present in the data generating process, but not allowed for in the specification of an econometric model, results may be biased towards the erroneous non-rejection of the non-stationarity hypothesis.

In addition, conventional unit root tests such as the ADF or PP test statistic were somehow tended to ignore any structural breaks that might happen along with the serial data [30]. We took careful measure on this issue by implementing the Zivot-Andrews (ZA) Test as developed by [31]. ZA test proposed a variation to the PP original test in which they assume that the exact time of break is unknown.

Following Perron's characterization of the form of a structural break, Zivot and Andrews proceed with three models to test for a unit root: (1) model A, which permits a one-time change in the level of the series; (2) model B, which allows for a one-time change in the slope of the trend function and (3) model C, which combines one-time changes in the level and the slope of the trend function of the series. A suggestion from [32] proposed that if there is no upward trend in data, the test power to reject the no-break null hypothesis is reduced as the critical values increase with the inclusion of a trend variable.

TABLE 1: Unit Root Test Results (Model without Structural Breaks)

Variables	ADF		PP		Decision
	Level (y_t)	First Difference (Δy_t)	Level (y_t)	First Difference (Δy_t)	
LANSpc	-1.562 (0)	-6.245 (0) ***	-1.561(3)	-6.249 (2) ***	I(1)
LEXP	-7.210 (2) ***	-2.690 (3)	-20.461 (4) ***	-2.376 (4)	I(0)
LPROD	-1.779 (0)	-5.654(0) ***	-1.720 (2)	-5.669(2) ***	I(1)
ENGY	0.606 (0)	-6.4434 (0) ***	1.466 (7)	-6.638(6) ***	I(1)

[1]Number in () indicates lag order selection
[2](***) indicates a 99% level of confidence
[3]The lag order selection in the ADF test is based on Schwarz Info Criterion (SIC)
[4]Spectral estimation method in the PP test is made default using Bartlett-Kernel and bandwidth selection are automatically selected based on Newey-West bandwidth
[5]Both tests are conducted using the Eviews package ver. 9.0

In contrast, if the series exhibits a trend, then estimating the model without trend may fail to capture some important characteristics of the data. Since all series in this study depicts an upward or downward trend, we estimate model C with the inclusion of β_t term. The result of the ZA unit root test with structural breaks is presented in Table 2.

From the ZA test, we found that all of the series are integrated of order (1) except one series that is the LFEX (life ex expectancy). We can clearly reject the null hypothesis of unit root at its first differenced. While for the other series, we failed to reject the null hypothesis when they were being observed at their level properties. The test had also identified endogenously the point of the single most significant structural break in every time series, as stated in Table 2. Generally, there were time breaks indicating some significant structural changes for the Malaysian economic time series in the years 1986, 1988, 1989, 1991 and 1997.

Bounds Tests for Cointegration

We took the first step of the ARDL analysis by testing the presence of long-run relationships among the variables, as developed in [33]. As mentioned before, the bounds testing approach uses the F-statistic value to be compared with the critical values outlined by [28]. The first assumption of no structural breaks in the model leads us to the result of the F-test presented in Table 3. We found that the F-statistical value is greater than the upper bound's critical value of 5%, therefore the null hypothesis of no long-run cointegration can be rejected.

In the next condition, we assumed structural breaks happened between the years 1986 and 1987 for our model of LANSpc. Therefore, we additionally computed the dummy variables for our dependent variable – LANSpc for the years 1986 and 1987; as to indicate the influence of structural breaks or potential economic shocks.

The findings in Table 4 showed that the calculated F-statistic = 2.733 lies within the lower and upper bounds of critical values, indicating that it is inconclusive whether we should or should not reject the null hypothesis of no cointegrating relationship. In this case, the error-correction term (ECM) is a useful way of establishing cointegration, as mentioned in [34], [35].

TABLE 2: Zivot-Andrews (ZA) Unit Root Test Results (Model with structural breaks)

Variable	LEVEL		1ST DIFFERENCE		Decision
	t-statistics	Time break	t-statistics	Time break	
LANSpc	-3.809 [0]	1987	-7.302*b* [0]	1986	I(1)
LEXP	-4.917*c* [4]	1995	-3.665 [3]	1989	I(0)
LPROD	-3.638 [2]	1994	-6.617*a* [0]	1988	I(1)
ENGY	-4.644 [0]	1991	-6.279*c* [1]	1991	I(1)
CRB	-4.087 [0]	1991	-8.369 *a* [0]	1997	I(1)

i. the p-value is calculated from a standard t-distribution
ii. number in [] denotes lag order selection
iii. The critical values for the Zivot-Andrews Test are -5.57, -5.57 and -4.82 at 1%, 5% and 10% levels of significance respectively.
a denotes statistical significance at 1%
b denotes statistical significance at 5%
c denotes statistical significance at 10%

TABLE 3: Bounds Test Results for Cointegration Analysis (Model without structural breaks)

Critical value	F-statistics	**4.151**
	k	4
	Lower Bound	**Upper Bound**
1%	3.967	5.455
5%	**2.893**	**4.000****
10%	2.427	3.395
The decision of long-run cointegration	**YES**	
*Based on Narayan (2005) in Case II: Restricted intercept and no trend		

TABLE 4: Bounds Test Results for Cointegration Analysis (Model with Potential Structural Breaks – 1986 & 1987)

Critical value	F-statistics	**2.733**
	k	4
	Lower Bound	**Upper Bound**
1%	3.967	5.455
5%	2.893	4.000
10%	2.427	3.395
The decision of long-run cointegration	**INCONCLUSIVE**	
*Based on Narayan (2005) in Case II: Restricted intercept and no trend		

Next, we estimated the ARDL model based on the AIC (Akaike Info Criterion) method that is superior to others for this relatively small and low-frequency data. The short-run and long-run impact of the hypothesized variables were analyzed within two different conditions: (i) Models without structural breaks, and (ii) Models with structural breaks. The findings were exhibited in Table 5 and Table 6 respectively. From the results presented in Table 5, we found evidence of the long-run and short-run impact of hypothesized variables towards per capita sustainable development in Malaysia. During the period of analysis, life expectancy, energy consumption and carbon emissions per capita have a significant impact on per capita sustainable development – particularly for the long-run model. On the other hand, in the short-run model; only life expectancy, lagged 3 years of (t-3) of energy use per capita and carbon emissions per capita have relatively low significant values against sustainability per capita in Malaysia. The goodness of fit of the specification – the R squared and adjusted R-squared values remains superior for this model (94 percent and 92 percent, respectively). The error-correction term (ect-1) coefficient for this short-run elasticity represents the speed of adjustment of the model's convergence to return towards equilibrium. The value of (-) 0.32 we obtained from this estimation showed a moderate speed of adjustment back to the long-run equilibrium. A highly significant error correction term is likely to suggest the existence of a stable long-term relationship. The value of ECT also indicates that deviation from the long-term LANSpc will be corrected by 32 percent in the following years.

In the condition of having structural breaks between 1986 and 1987, the estimated ARDL model of short-run and the long-run co integrating relationship between ANS per capita and its determinants – life expectancy, labor productivity, per capita energy use and per capita carbon emissions were presented in Table 6. In long-run, energy use and carbon dioxide emissions have a moderate influence on per capita sustainability in Malaysia. On the other hand, in the short run, life expectancy, carbon emission, structural breaks year dummy (1986 and 1987) have weak effects but significant towards per capita sustainable development. The most significant variables are lagged 3 years of energy usage that have a strong positive impact on LANSpc. This may indicate that a short-run increase in energy usage (which is less than five years) may stimulate economic growth that could further enhance per capita sustainability in Malaysia. The dummy variables for the years 1986 and 1987 have further shown their significant influence on the model in the short-run. Moreover, the highly significant value of ect (-1) of (-) 0.28 indicates that the long-run model will be adjusted to converge to the long-run model's equilibrium by 28 percent in a year.

We further checked for the robustness of the model by employing several diagnostic tests such as Jarque-Bera (JB) normality test, Breusch-Godfrey serial correlation LM test, and Breusch-Pagan-Godfrey Test for heteroscedasticity. All the tests revealed that our estimated four models (without structural breaks and with structural breaks models) have the desired econometric properties – that the model's residuals are normally distributed, serially uncorrelated, and are homoscedastic.

TABLE 5: ARDL Estimation Results and Diagnostic Tests (Model without structural breaks)

Model 1: Long-run Elasticities			**Model 2: Short-run elasticities (ECM)**		
Regressor	**Coefficient**	**Std. Error**	**Regressor**	**Coefficient**	**Std. Error**
LFEX	0.920 (1.852)*	0.491	ΔLFEX	0.292 (2.624)*	0.111386
LPRD	-8.499 (-1.676)	0.106	ΔLPRD	0.122 (0.113)	1.079321
ENGY	-0.002 (-2.19)**	0.038	$\Delta LPRD_{t-1}$	-1.88(-1.682)	1.120691
CRB	1.287 (0.451)***	0.008	ΔENGY	-0.00006 (-0.160)	0.000370
C	27.820 (20.307)	1.370	$\Delta ENGY_{t-1}$	0.00037 (0.817)	0.000449
Model Criteria/Goodness-of-Fit:			$\Delta ENGY_{t-2}$	-0.00034 (-0.841)	0.000401
R-squared = 0.942; Adj. R-squared: 0.91520;			$\Delta ENGY_{t-3}$	0.0011 (3.174)***	0.000346
Wald F-statistics=35.097***; DW-Statistics=1.864			ΔCRB	0.214 (1.986)*	0.107832
			ect (-1)	-0.321153 (-2.988)***	0.107490

1. (*, **, ***) denotes significance at 10%, 5% and 1% level respectively.
2. The number in parenthesis indicates the t-ratio value
3. Estimated long-run coefficients using ARDL approach, ARDL (1,0,2,4,1) selected based on Akaike Info Criterion (Dependent variable: LANSpc)
4. Error Correction Model (ECM) representation based on ARDL (1,0,2,4,1) selected based on the Akaike Info Criterion (Dependent variable: LANSpc)

Diagnostic Tests (Numbers in parenthesis is χ^2 probability value)		
LM=0.3001 (0.22);	H_0: There is no serial correlation	LM: Serial Correlation (Breusch-Godfrey Serial Correlation LM Test)
White Heteroscedasticity (F-statistic) =1.266 (0.300, 0.156);	H_0: There is no heteroscedasticity	Heteroscedasticity: Breusch-Pagan-Godfrey Test
JB=0.691(0.708);	H_0: The residuals are normally distributed	JB: Jarque-Bera Normality Test

TABLE 6: ARDL Estimation Results and Diagnostic Tests (Model with Structural Breaks)

Model 1: Long-run Elasticities			Model 2: Short-run elasticities (ECM)		
Regressor	**Coefficient**	**Std. Error**	**Regressor**	**Coefficient**	**Std. Error**
LFEX	0.839 (1.542)	0.544	ΔLFEX	0.235 (2054) *	0.1145
LPRD	-8.228 (-1428)	5.762	ΔLPRD	0.578 (0517)	1.120
ENGY	-0.002 (2.003) *	0.001	$\Delta LPRD_{t-1}$	-1.429(-1.228)	1.164
CRB	1.385 (2.486) **	0.557	ΔENGY	-0.00003 (-0.071)	0.0004
DUM86	0.404 (0.507)	0.796	$\Delta ENGY_{t-1}$	0.000165 (0.359)	0.0005
DUM87	1.137 (1.297)	0.877	$\Delta ENGY_{t-2}$	-0.000254 (-0.635)	0.0004
C	29.695 (1.245)	23.777	$\Delta ENGY_{t-3}$	0.001041 (2.992) ***	0.00035
Model Criteria/Goodness-of-Fit:			ΔCRB	0.190 (1.720) *	0.1070
R-squared = 0.948256; Adj. R-squared: 0.918072;			ΔDUM86	0.1131 (0.563) *	0.201
Wald F-statistics=31.41594***			ΔDUM87	0.319 (1.720) *	0.185
DW-Statistics=2.022014			ect (-1)	-0.2802 (-2.441) **	01148

1. (*, **, ***) denotes significance at 10%, 5% and 1% level respectively.
2. The number in parenthesis indicates the t-ratio value
3. Estimated long-run coefficients using ARDL approach, ARDL (1,0,2,4,1) selected based on Akaike Info Criterion (Dependent variable: LANSpc)
4. Error Correction Model (ECM) representation based on ARDL (1,0,2,4,1) selected based on the Akaike Info Criterion (Dependent variable: LANSpc)

Diagnostic Tests (Numbers in parenthesis is χ^2 probability value)		
LM=0.7924 (0.7292);	H_0: There is no serial correlation	LM: Serial Correlation (Breusch-Godfrey Serial Correlation LM Test)
White Heteroscedasticity (F-statistic) =0.553326 (0.7966, 0.9961);	H_0: There is no heteroscedasticity	Heteroscedasticity: Breusch-Pagan-Godfrey Test
JB=0.2325 (0.9603);	H_0: The residuals are normally distributed	JB: Jarque-Bera Normality Test

To finalize all the procedures involved in the estimation, we examined all of the model's stability using the CUSUM (cumulative sum) and CUSUMSQ (CUSUM squared) tests respectively. In general, these tests can be useful to check the constancy of coefficients in the model. For both the upper and lower panel, although the series appears to be trending upwards and downward after the crisis period, the cumulative sum statistics lie within the 5% confidence interval bands. Therefore, it is clearly showed that there is no structural instability in the residuals of the model for LANSpc in both situations of no structural breaks and with structural breaks.

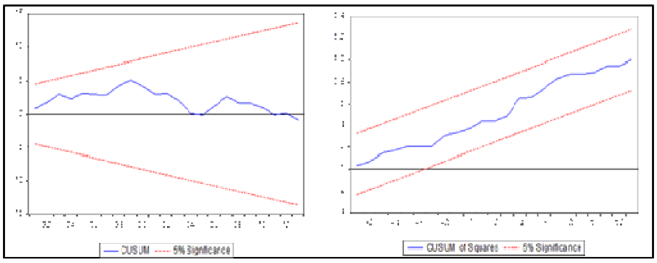

Figure 2: CUSUM and CUSUMSQ Test for Parameter Stability in Model without Structural Breaks.

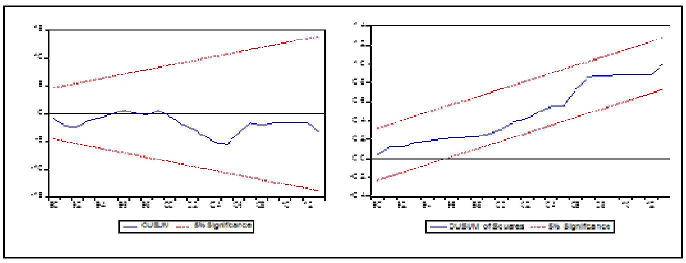

Figure 3: CUSUM and CUSUMSQ Test for Parameter Stability in Model with Structural Breaks.

CONCLUSION

In this study, we assumed several variables as proxies to human capital development and the environment to analyze their impact on per capita sustainable development in Malaysia. The human capital development variables are life expectancy and labor productivity, while energy use (consumption) per capita and carbon (dioxide) emissions per capita were employed as environmental variables. Our variable of concern to indicate per capita sustainable development is the Adjusted Net Savings per capita (LANSpc) for Malaysia during the period of 43 years, from 1971 until 2013. In addition to conventional unit root test (ADF and PP Test) for time series analysis, we also presumed structural breaks to the series in avoiding erroneous rejection of non-stationarity; using the Zivot-Andrews (ZA) unit root test. With the mixture order of integration between in levels and in their first difference in all of the tests, we estimated the hypothesized model of LANSpc using the Autoregressive Distributed Lag (ARDL) – bound testing approach. The analysis covered both cases – the model without structural breaks and the model *with* structural breaks.

In the case of model without concerning structural breaks, we found the existence of long-run cointegration among the variables prior to the ARDL estimation. Life expectancy (LFEX), as a proxy to human capital development, has a significant positive impact on LANSpc in both the short-run and long run. The finding is generally acceptable since a major indicator for human capital development, the Human Development Index (HDI) has already been associated with sustainability. Another variable of proxy to human capital development, labor productivity (LPRD), however, shows no significant impact in both periods towards sustainable development. This is quite contrary to previous literature on economic growth relative to sustainability where basically, productivity is found to be correlated with growth. As for the environmental variables, energy use per capita has a significant negative influence on sustainability in the long-run, and no impact from it in the short run. This condition generally implies the basic rule of sustainable development, whereby prolong reduction of natural capital assets (such as energy) would deter the path to sustainability. We also found another contradicting result from the previous growth model, that carbon (dioxide) emissions per capita have a strong positive impact on LANSpc for the long-run model and a significant positive impact in the short-run. Despite its unfavorable impact on climate change and the global environment, carbon dioxide (CO2) is indisputably essential for life, as all life is carbon-based and the primary source of this carbon is the CO2 in the global atmosphere. Supposed a steep decline in CO2 concentrations were to take place in the future, and continues for many decades or centuries, it may eventually fall into levels insufficient to support plant life. Consistently, the most "dangerous" change in climate in long term would be to one that would not support sufficient food production to feed the increasing world's population. The findings of a robust cointegrating relationship between carbon emissions per capita, energy use per capita, life expectancy, and the dependent variable - Adjusted Net Savings per capita; suggest that any change in the former variables would be closely related to later, that is sustainability path in Malaysia.

For the second case of the model with structural breaks, the ZA test results revealed that the variables were having a mixture order of integration, which is between I(0) and I(1). This condition has further assured the compatibility of the variables to be estimated using the ARDL model. However, an interesting finding is obtained from the F-statistics bounds test for long-run cointegration that the value lies in between the lower and upper bound of critical values (Narayan & Saud, 2005). The inconclusive decision on whether there exists a cointegrating relationship is further examined from the error correction term value in the short-run elasticity model followed after that. The ect (-1) value that we obtained has, fortunately, showed the evidence of the cointegrating relationship among the variables. The results in both the short-run and long-run model revealed a small difference from what we found in the former case model. With the assumption of structural breaks between 1986 and 1987, in the short-run; only energy use (lagged 3 years) has a strong significant positive impact on per capita sustainability, while other variables such as life expectancy, carbon dioxide emission and year dummies have a weak significant impact. Per capita carbon dioxide emissions, on the other hand, showed a moderate positive significant impact, similar to the findings from the model without structural breaks. The strong significant ect (-1) value that is negative 0.28 has proven that a cointegrating relationship does exist between the variables. It shows that almost 28 percent of divergence from equilibrium is adjusted back to converge in the short-run by the long-run model. Further diagnostic tests on the residuals have also exhibited that the model is free from serial correlation and heteroscedasticity problem. In addition, the residuals are also normally distributed, indicating that there is minimal disturbance of white noise in the residuals. For parameter stability, the CUSUM and CUSUMSQ test showed a stable estimation whereby the sum of squares calculated lies in between the lower and upper boundary of a 5% level of significance.

As a country that progressively moves toward achieving its latest vision of TN50 (National Transformation 2050) in order to form a caliber nation-state as well as with par excellent mind-set, Malaysia has to take cautious actions in its development policies. In such, environmental policy should be designed ameliorable and more effective to ensure intergenerational equity will be consigned to posterity. Human capital development is important to economic growth, must also be ensured to ascertain the sustainability path. As found in literature, longevity or long-life expectancy means a high development of human capital and thus, leads to sustainable development.

Acknowledgment

We are deeply grateful and indebted to the Department of Statistics (Malaysia), Universiti Teknologi MARA, family and friends, department colleagues, and anyone who had helped us with the greatest support and advice towards completing this paper.

References

[1] Keynes, J. M., *The General Theory of Employment, Interese and Money*. 1936, Cambridge: King's College.

[2] Solow, R. M. *A Contribution to the Theory of Economic Growth*. The Quarterly Journal of Economics, 1956. 70, 65-94.

[3] Brundtland, G., et al., *Our Common Future (\'Brundtland report\')*. 1987.

[4] Warner, J. D. S. a. A. M. *Natural Resource Abundance And Economic Growth*. NBER Working Paper No. 5398, 1997.

[5] Solow, R. M. *Intergenerational Equity and Exhaustible Resources*. The Review of Economic Studies, 1974. 41, 29-45.

[6] Hartwick, J. M. *Intergenerational Equity and the Investing of Rents from Exhaustible Resources*. The American Economic Review, 1977. 67, 972-974.

[7] IUCN, *WORLD CONSERVATION STRATEGY- LIVING RESOURCE CONSERVATION FOR SUSTAINABLE DEVELOPMENT*. 1980, United Nations Environment Programme (UNEP) World Wildlife Fund (WWF). p. 77.

[8] Pearce, D. W. and G. Atkinson *Are National Economies Sustainable? Measuring Sustainable Development*. CSERGE Working Paper GEC 92-11, 1992.

[9] Hamilton, K., G. Atkinson, and D. Pearce *Genuine Savings As An Indicator Of Sustainability*. The Centre for Social and Economic Research on the Global Environment (CSERGE) Working Paper, 1997.

[10] Pearce, D. and G. Atkinson *The concept of sustainable development: An evaluation of its usefulness ten years after Brundtland*. REVUE SUISSE D ECONOMIE POLITIQUE ET DE STATISTIQUE, 1998. 134, 251-270.

[11] Bolt, K., M. Matete, and M. Clemens *Manual for Calculating Adjusted Net Savings*. 2002.

[12] Dosmagambet, Y. *Calculating genuine saving for Kazakhstan*. 2010. 10, 271-282.

[13] Ferreira, S. and M. Moro *Constructing Genuine Savings Indicators for Ireland, 1995-2005*. Stirling Economics Discussion Paper 2010-10, 2010.

[14] Jamal Othman, Roby Falatehan, and Y. Jafari *Genuine Savings for Malaysia: What Does It Tell?* IJMS, 2012. 19, 151-174.

[15] Temple, J. *The New Growth Evidence*. Journal of Economic Literature, 1999. 37, 112-156.

[16] Barbier, E. B., A. Markandya, and D. W. Pearce, *Environmental Sustainability and Cost-benefit Analysis.* Environment and Planning A, 1990. 22(9): p. 1259-1266.

[17] Atkinson, G. and K. Hamilton *Savings, Growth and the Resource Curse Hypothesis*. World Development, 2003. 31, 1793-1807.

[18] Hamilton, K. *Sustaining Economic Welfare: Estimating Changes in Wealth per Capita*. in *26th General Conference of The International Association for Research on Income and Wealth*. 2000. Cracow, Poland.

[19] Arrow, K. J., Partha Dasgupta, and K. -G. Mäler *The Genuine Savings Criterion and The Value of Population*. Economic Theory, 2003. 21, 217-225.

[20] Herzog, R. W. *A Dynamic Panel Model of GDP growth, Saving, Age Dependency, and Trade Openness*. 2012.

[21] Hess, P., *Determinants of the adjusted net saving rate in developing economies.* International Review of Applied Economics, 2010. 24(5): p. 591-608.

[22] Boos, A. *The theoretical relationship between the Resource Curse Hypothesis and Genuine Savings*. in *International Studies Association Annual Conference "Global Governance: Political Authority in Transition*. 2011.

[23] Carbonnier, G. and N. Wagnera *Oil, Gas and Minerals: The Impact of Resource-Dependence and Governance on Sustainable Development*. 2012.

[24] Othman, J., R. Falatehan, and Y. Jafari, *GENUINE SAVINGS FOR MALAYSIA: WHAT DOES IT TELL?* LIST OF CONTRIBUTORS/SENARAI PENYUMBANG, 2012. 19(1): p. 151-174.

[25] Othman, J., Y. Jafari, and T. Sarmidi, *Economic growth, foreign direct investment, macroeconomic conditions and sustainability in Malaysia.* Applied Econometrics and International Development, 2014. 14(1): p. 213-223.

[26] Faridah Pardi, Arifin Md Salleh, and A.S. Nawi *Determinants of Sustainable Development in Malaysia: A VECM Approach of Short-Run and Long-Run Relationships*. American Journal of Economics, 2015. 5, 9 DOI: 10.5923/c.economics.201501.35.

[27] Carbonnier, G. and N. Wagner, *Oil, gas and minerals: The impact of resource-dependence and governance on sustainable development.* 2011.

[28] Pesaran, M. H., Y. Shin, and R. J. Smith, *Bounds testing approaches to the analysis of level relationships.* Journal of applied econometrics, 2001. 16(3): p. 289-326.

[29] Johansen, S. and K. Juselius *Maximum Likelihood Estimation and Inference on Cointegration - With Applications to the Demand For Money*. Oxford Bulletin of Economics and Statistics, 1990. 52, 169-209.

[30] Waheed, M., T. Alam, and S. Ghauri, *Structural breaks and unit root: evidence from Pakistani macroeconomic time series*. 2006, University Library of Munich, Germany.

[31] Zivot, E. and D. W. K. Andrews *Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis*. Journal of Business & Economic Statistics, 1992. 10, 251-271.

[32] Ben-David, D. and D. H. Papell *Slowdowns and Meltdowns: Postwar Growth Evidence From 74 Countries*. NBER Working Paper No. 6266, 1997. 6266, 34.

[33] Narayan, P. K. and A. Saud, *An empirical investigation of the determinants of Oman's national savings.* Economics Bulletin, 2005. 3(51): p. 1-7.

[34] Banerjee, A., J. Dolado, and R. Mestre, *Error-correction mechanism tests for cointegration in a single-equation framework.* Journal of time series analysis, 1998. 19(3): p. 267-283.

[35] Kremers, J. J., N. R. Ericsson, and J. J. Dolado, *The power of cointegration tests.* Oxford bulletin of economics and statistics, 1992. 54(3): p. 325-348.