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Sustainable Development in Myanmar in the Context of Energy Consumption and Economic Growth

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Abstract **Original Research Article**

This empirical study examines the Toda and Yamamoto's Granger causality test and the Johansen cointegration approach to find a long run causal relationship between energy consumption and economic growth for the period of 1971 to 2015 using a case study of Myanmar. The results show that there is a one-way causal relationship between economic growth and energy consumption in Myanmar. As a result, the government of Myanmar needs to take measures to save fuel and protect the environment by transferring energy from unsustainable sources to other sources. Additionally, Myanmar has a unidirectional causal relationship from energy consumption, gross domestic product growth, foreign direct investment, and population growth to renewable energy consumption in both the short and long run.

Keywords: Myanmar; Energy consumption; Economic growth; Granger causality.

1. INTRODUCTION

Energy consumption is an important component of economic growth. Myanmar was selected for inclusion in this study because of its unique economic characteristics. As foreign investment has increased in recent years, Myanmar's economy is growing at an average rate of 6.9 percent per year. Changes in Myanmar's Gross domestic product (GDP) have a significant impact on increases by 1%, then energy demand is projected to grow by about 5 to 7 percent (Vo and Le, 2019). On the contrary, the use of fossil fuels has played a significant role in limiting the development of clean energy, slowing economic development, and increasing greenhouse gas emissions. Although Myanmar's renewable energies make a significant contribution to the overall energy supply, the country has the second-highest greenhouse gas emissions among the Association of Southeast Asian Nations (ASEAN) countries (Rahman, 2021). However, the author remain concerned about the lack of research on the role of renewable and non-renewable energy sources and technologies in the country's economic growth. International crude oil prices do not appear to have much of an impact on energy demand energy carriers such as natural gas and water are domestic and do not affect international oil prices. Oil demand will undoubtedly affect world oil prices, but by 2040 the share of oil will be only 33 percent. On the other hand, Myanmar spends a lot of money importing refined oil, other minerals, lubricants, and related materials. All this negatively affects the balance of payments and, as a result, economic growth. However, as the economy grows at a rapid pace, Myanmar's energy crisis and environmental pollution continue to increase, exposing more serious problems in the pattern of energy consumption. The production and use of renewable energy sources are essential as an important tool for solving environmental problems and ensuring sustainable development. Thus, the launch of renewable energy economic turnover reduces the burden on the balance of payments and contributes to economic growth. Finally, our findings are important for policies to optimize the energy balance to economic growth in Myanmar.

A few studies have reported Myanmar in ASEAN countries in their Energy Use and Sustainable Development. The author attempts to fill the gap in energy literature by using robust estimates in the case of Myanmar. To the best of our knowledge, there has not been a time-series study that employs the Johansen cointegration approach and the Toda-Yamamoto's Granger causality test to find a long-run causal relationship between energy consumption and economic growth in Myanmar. This is incongruous because Myanmar represents an important case in this regard. As a resource-rich country, Myanmar has been characterized by a considerable achievement in economic growth and it has been passed through different development stages (Phrakhruopatnontakitti *et al*., 2020; Ahmed *et al*., 2019; Chontanawat, 2020). For Example, Ahmed *et al*., (2019) investigate the dynamic relationship between renewable and non-renewable energies, CO_2 intensity, and economic growth for the period of 1990 to 2016 using a case study of Myanmar. Autoregressive distributed lag, dynamic Ordinary Least Squares (OLS), fully modified OLS, and Gregory–Hansen cointegration are applied to analyze a time series dataset over the specified period. The analysis shows that total energy use plays an insignificant role in promoting economic growth. However, decomposition analysis reveals that only renewable energy use significantly promotes, whereas non-renewable energy negatively influences, economic growth.

The objective of this study is to examine a connection between energy use and economic performance in Myanmar. The article is divided into six sections. Following this introduction in Section 1, there is a review of related literature in Section 2. Section 3 discusses the methodology and data. Section 4 examines the data analysis. Section 5 concludes with some recommendations and suggestions for future research.

2. LITERATURE REVIEW

The existing empirical literature is presented to have an idea of past empirical findings on the relationship between energy consumption and economic growth. The existing literature related to this research is reviewed under the following four categories: (I) energy consumption on economic growth, (II) energy use and sustainable development, (III) Johansen cointegration test, and (IV) Toda and Yamamoto's approach. A more detailed analysis is presented in the following categories.

The first category of existing literature on the effect of renewable energy consumption on economic growth in Organization for Economic Cooperation and Development (OECD)/European countries (Ajmi and Inglesi-Lotz, 2020; Chica *et al*., 2020) and comparative regional studies which combined a set of similar income countries, such as Asian countries (Nasreen *et al*., 2020), and others, see (Konuk *et al*., 2021; Grabara *et al*., 2021). For example, Ajmi and Inglesi-Lotz (2020) investigate the relationship between biomass energy consumption and economic growth for 26 OECD countries for the 1980 to 2013 period. This study used panel unit root analyses, panel cointegration analyses, dynamic OLS analyses, fully modified OLS analyses, and panel a vector error correction model (VECM) Granger causality to examine the relationship. The results reveal the presence of a long-run equilibrium relationship between the variables supporting the feedback hypothesis. Nasreen *et al*., (2020) analyze data from 18 Asian countries, spanning from 1980 to 2017 to determine panel long-run causality between income growth, transport energy consumption, and environmental quality. The empirical methodology of this paper considers structural breaks and cross-sectional dependence issues. In this way, our study becomes one of the few energy-GDP studies that address cross-sectional dependence in the unit root, cointegration, causality, and elasticity estimation. They attempt to fill the gap in energy literature by using robust estimates in the case of Asian countries. On the other hand, some literature showed that the increment of renewable energy consumption negatively affects economic growth because of high investment costs, for example, in Italy (Magazzino *et al*., 2021), China (Fan and Hao 2020; Xiong and Xu 2021), and Rwanda (Namahoro *et al*., 2021). Beyond the impact of clean energy consumption, some country-specific studies highlight the further effect of energy production and capital on economic growth, and again renewable energy consumption contributes to the increase of these variables (Liu *et al*., 2020; Rahman *et al*., 2020). For example, Rahman *et al*., (2020) explore the relationship between energy production, energy consumption, and GDP growth in China for the period 1981to 2016. The results of the Hatemi-J cointegration and structural-break tests supported long-term cointegration in the consumption and production of coal, oil, and natural gas. Based on the three models (coal, oil, and natural gas) of energy production and consumption, the fully-modified least square (FMOLS) method results confirmed the presence of long-term positive impact of the consumption and production of coal, oil, and natural gas on GDP growth.

The second category of the literature explores the relationship between energy use and sustainable development. Literature on energy use shows a series of debates as to whether energy use can yield equitable and sustainable development of the economy (Christley *et al*., 2021; Gunnarsdottir *et al*., 2021; Le and Van, 2020). For example, Le and Van (2020) evaluate the importance of renewable power and conventional fuels consumption in the economic growth of 20 African Emerging Markets and Developing Economies (EMDEs) towards sustainable development. The findings provide critical implications for sustainable energy policies that contribute to the sustainable development of African EMDEs. In most of the studies analyses that examined sustainable development, energy use, their results indicate that energy consumption, particularly renewable energy consumption, contributes to economic growth (Adebayo *et al*., 2021; Gjorgievski *et al*., 2021; Saraswat and Digalwar, 2021; Arroyo and Miguel, 2020; Dabbous and Tarhini, 2021). For example, Adebayo *et al*., (2021) explore the nexus between coal energy consumption, economic growth, renewable energy consumption, and

CO_2 emission between annual periods of 1980 to 2017. This study applied a battery of econometric techniques to underscore the relationship between the outlined variables. Empirical evidence gives credence to the growth-induced pollution emission in South Africa as reported by the Autoregressive distributed lag Method, fully modified ordinary least squares and dynamic ordinary least squares as robustness test for soundness of analysis. This finding suggests that South Africa's economic growth trajectory is not clean.

The third category of the literature investigates the short and long-run relationship between variables using the Johansen cointegration test (Naidu *et al*., 2017; Mousavi and Gandomi, 2021; Katircioglu, 2009; Turner, 2009). For example, Mousavi and Gandomi (2021) proposed based on the prediction errors of the Johansen cointegration residuals using a Recurrent Neural Network. The proposed method has been successfully tested on a long-term monitoring problem of a numerical example, a short-term monitoring problem regarding an experimental example, and long-term monitoring of an experimental example. The results demonstrate the capability of the proposed method in monitoring structures for damage even when the Johansen algorithm fails to identify a linear cointegration relationship among the frequency signals. Moreover, Turner (2009) presents Monte Carlo simulations for the Johansen cointegration test which indicate that the critical values applied in several econometrics' software packages are inappropriate. This is due to confusion in the specification of the deterministic terms included in the VECM. The result is a tendency to reject the null of no cointegration too often.

A fourth of the category of the case of economic growth, several studies were conducted using the Toda and Yamamoto (1995) approach (Sankaran *et al*., 2019; Mishra, 2014; García-del-Hoyo *et al*., 2021; Amiri and Ventelou, 2012; Adriana, 2014; Kim *et al*., 2021). Toda and Yamamoto (1995) show how we can estimate Vector Autoregression's (VAR) formulated in levels and test general restrictions on the parameter matrices even if the processes may be integrated or cointegrated of arbitrary order. They applied a usual lag selection procedure to a possibly integrated or cointegrated VAR since the standard asymptotic theory is valid. For example, Amiri and Ventelou (2012) modified version of the Granger causality test proposed by Toda and Yamamoto is used to investigate causality between GDP and healthcare expenditure in OECD countries. The findings indicate that bidirectional Granger causality is predominant. Kim *et al*., (2021) explore the connection between energy consumption and economic growth in the long run in Myanmar. They apply the Johansen cointegration test and the Toda and Yamamoto augmented Granger causality test to annual time series data from 1987 to 2016. Their results show unidirectional causality, running from economic growth toward energy consumption in the long run. That has implications for how Myanmar and other developing countries approach the promotion of fuel efficiency and energy conservation. Also, Sankaran *et al*., (2019) investigate the effects of electricity consumption, per capita income, real exchange rate, import and export on manufacturing output by using yearly time series data from 1980 to 2016 concerning 10 late industrialized nations. In the Autoregressive Distributed Lag (ARDL) bound testing approach, the way to deal with cointegration is applied to estimate the long-run connection between the variables. While the error correction method (ECM) is used to find the short-run dynamics. To test the causality among the variables, the Toda and Yamamoto test is performed. The results demonstrate the existence of short-run and long-run relationships among the variables and Toda and Yamamoto causality results support the existence of growth, conservation, feedback, and neutrality hypotheses for different nations. The difference in the results can be attributed to structural and macroeconomic parameters. In general, this research brings out a fresh lead of knowledge for late industrialized nations to strengthen their economic development through proficient utilization of energy consumption. The present study, in this case, contributes both to literature and relevant policymakers in Myanmar. Meanwhile, the research of this paper may have some reference significance for the development and consumption of clean energy and economic growth in Myanmar.

3. METHODOLOGY AND DATA

The present article follows from this literature on Energy Consumption and Economic Growth. It seeks to extend knowledge on this topic and underline the roles of renewable and non-renewable energy consumption on Energy Use and Sustainable Development, using a broad range of the latest data. The key contribution of the present research to the existing literature will be to shed light on and quantify the impact of energy consumption, economic growth, and natural resources on Energy Use and Sustainable Development in Myanmar.

3.1 Source of Model and Data

The purpose of this section is to examine a connection between energy use and economic performance in Myanmar between 1971 and 2015. The author proceeds to test the existence of cointegrating relations among the Relationship between Energy Consumption and Economic Growth using the Johansen (1988) cointegration test and the short-run dynamic causal relationship by using the Toda and Yamamoto (1995) procedure.

$$GDP_t = f(EPC, EPO, EPG, EPH, FDI, POP, \omega) \quad \ldots\ldots\ldots\ldots (1)$$

The model is then converted to a natural logarithm to bring the data to the same units, reduce the variance as well as interpret the coefficients in terms of elasticities.

$lnGDP_{it} = \alpha_0 + \beta_1 lnEPC_{it} + \beta_2 lnEPO_{it} + \beta_3 lnEPG_{it} + \beta_4 lnEPH_{it} + \beta_5 lnFDI_{it} + \beta_6 lnPOP_{it} + \omega_{it}$ ………………. (2)

Where, ω and ω_{it} is the error term for Equation (1) and (2). t is time period, α_0 is constant, β_t is drift component variables are the independent variables and ω_i represents white noise error processes. To study the Relationship between Energy Consumption and Economic Growth, time-series data for Myanmar was used, covering 45 years. This study collected data from official sources, including the World Development Indicators (WDI), International Energy Agency (IEA) statistics, and International Monetary Fund (IMF) database. The study uses the Gross domestic product (GDP) is annual per capita in constant 2010 US dollars is applied for economic growth at Myanmar's level from 1971 to 2015, as reported in the official database, to measure the dependent variable. The independent variables are Energy production from coal (EPC) sources (% of total), Energy production from oil (EPO) sources (% of total), Energy production from natural gas (EPG) sources (% of total), Energy production from hydroelectric (EPH) sources (% of total), Foreign direct investment (FDI), net inflows (BoP, current US$), and Population (POP), a total of Myanmar's population. For the estimates of the coefficient of the variables, the following empirical model is formulated. Stata 16.0 econometrics software was used for the analysis.

3.2 Unit Root Tests

The descriptive statistics in Table 1 shows the logarithmic variable data. The simplest study of data properties begins with a study of relative averages, variances, Jarque-Bera, Skewness, and Kurtosis of the data. Table 2 presents the overall mean values and units of measure for the 45 years of the survey between 1971 to 2015. Table 3 also shows the AIC, SBIC, sequential modified LR test, final prediction error (FPE), and Hannan-Quinn information criterion (HQIC) delays at a significance level of 0.05. The chart below (Figure 1) describes the evolution of the levels and growth rates of the variables as logarithmic values.

3.3 Toda and Yamamoto Granger Test

Toda and Yamamoto (1995) argue that F-statistic used to test for traditional Granger causality may not be valid as the test does not have a standard distribution when the time series data is integrated or cointegrated. This procedure is that it does not require the pretesting of the time series for cointegration properties so long as the order of integration of the process does not exceed the true lag length of the model. Toda and Yamamoto (1995) methodology of the Granger causality test by directly performing the test on the coefficients of the level's VAR, minimizes the risk associated with possibly wrongly identifying the orders of integration of the series and the presence of cointegration relationship (García-del-Hoyo *et al*., 2021; Sankaran *et al*., 2019). The hypothesis is tested using a standard Wald statistic test which has an asymptotic Chi-square distribution with m degrees of freedom. In the case of a bivariate relationship, Toda and Yamamoto (1995) causality test is represented as the following equation:

$Y_{1t} = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} X_{1,t-i} + \sum_{j=k+1}^{d_{max}} \alpha_{2i} X_{1,t-j} + \sum_{i=1}^{k} \varphi_{1i} X_{2,t-i} + \sum_{j=k+1}^{d_{max}} \varphi_{2j} X_{2,t-j} + \omega_{1t}$ …………….. (3)

$Y_{2t} = \beta_0 + \sum_{i=1}^{k} \beta_{1i} X_{2,t-i} + \sum_{j=k+1}^{d_{max}} \beta_{2i} X_{2,t-j} + \sum_{i=1}^{k} \theta_{1i} X_{1,t-i} + \sum_{j=k+1}^{d_{max}} \theta_{2j} X_{1,t-j} + \omega_{2t}$ ………..….. (4)

Where k is the optimal lag order, d_{max} is the maximal order of integration of the series in the system, and ω_{it} is assumed to be white noise. It needs to determine the maximal order of integration, and author then construct a VAR model in their levels with a total of lags $(k + d_{max})$. To test that X_2 does not Granger cause X_1, the restriction $\varphi_{1i} = 0$ for $1 \leq k$ is tested. Likewise, to test that X_1 does not Granger cause X_2, the restriction $\theta_{1i} = 0$ for $1 \leq k$ is tested. The zero restriction is tested by computing the modified Wald test statistic. This method is applicable whether the VAR's stationery, integrated of arbitrary order or co-integrated of arbitrary order.

3.4 Johansen's Cointegration Test

The Johansen's (1988) cointegrating test is used in a multivariate framework. Before the Johansen's co integration procedure can be applied to determine the number of co-integrating relationships between the dependent and independent variables, we have to determine whether the variables are $I(0)$ or $I(1)$ variables. If all the variables used in this study are $I(1)$ variables, Johansen's cointegration test can be used to determine the number of co-integrating relationships between the dependent and independent variables. The Johansen trace test attempts to determine the number of cointegrating vectors among variables. There should be at least one cointegrating vector for a possible cointegration (Katircioglu, 2009). Johansen's methodology takes its starting point in the VAR of order p given below (Johansen and Juselius, 1990):

$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \beta_3 Y_{t-3} + \cdots + \beta_n Y_{t-n} + \omega_t$ …………….. (5)

Where Y_t is the vector of for the $I(1)$ dependent and independent variables, Y_{t-n} is the vector of the non-random variable, and ω_t is the error correction term. β_n is contains information about the long-run properties of the model.

4. EMPIRICAL RESULTS

4.1 Unit Root Tests Results

Table 1 provides the descriptive analysis of the variables. A look at the descriptive analysis shows that the investigated variables display some insignificant variances in the statistics. The average and standard deviation values of GDP are 5.8229 and 0.6734 respectively. The average and standard deviation values of EPC stand at 0.9633 and 1.1236 respectively. EPO, EPG, EPH, FDI, and POP use have mean values of 1.6380, 3.2117, 3.9433, 17.8988, and 17.5334 respectively, while the respective standard deviations are 1.6802, 0.7508, 0.2717, 3.4712, and 0.1895 respectively. The large standard deviations of the variables are indications of large variations of the values around their averages, hence, large disparities. To test the distribution properties of these variables, the study uses Jarque-Bera, Skewness, and Kurtosis as indicators. In a normal distribution Kurtosis is 3, and skewness is 0. In what follows, more properties of these variables are presented.

Table 1: Descriptive statistics of variables

	Mean	Std. Dev.	Min	Max	Variance	Skewness	Kurtosis	Jarque-Bera
lnGDP	5.8229	0.6734	5.1250	7.2359	0.4535	0.8829	2.2868	0.0334
lnEPC	0.9633	1.1236	-1.9724	2.5923	1.2625	-0.8732	2.1308	0.0325
lnEPO	1.6380	1.6802	-1.0659	3.4448	2.8233	-0.5689	1.6034	0.0477
lnEPG	3.2117	0.7508	1.3628	4.2569	0.5637	-0.7892	2.5816	0.0821
lnEPH	3.9433	0.2717	3.1079	4.3331	0.0738	-1.0737	1.6104	0.0012
lnFDI	17.8988	3.4712	10.3089	22.1303	12.0498	-0.9886	2.6017	0.0473
lnPOP	17.5334	0.1895	17.1446	17.7797	0.0359	-0.5322	2.0593	0.1508

Notes: All variables are expressed in their logarithms, Std. Dev.=standard deviation, Min=minimum, and Max=maximum. Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015).

To examine the intensity of multi-collinearity, the results of the correlation matrix are reported in Table 2. The correlation coefficient between GDP and EPC is 0.5183, implying that the relationship between GDP and FDI is 80.31%. The relationship between GDP and EPO is approximately 94.07% in a positive direction, while the relationship between GDP and POP is strong by 85.5%. The relationship between GDP and EPG is approximately 35.45%, while the relationship between GDP and EPH is 27.94%. The relationship between EPH and FDI is approximately 4.56% in a positive direction, while the relationship between EPO and POP is strong by 90.49%. The results show that GDP is weakly correlated with EPC, EPG, EPO, and EPH.

Table 2: Correlation matrix of variables

	lnGDP	***lnEPC***	***lnEPO***	***lnEPG***	***lnEPH***	***lnFDI***	***lnPOP***
lnGDP	1.0000						
lnEPC	0.5183	1.0000					
lnEPO	-0.9407	-0.5499	1.0000				
lnEPG	0.3545	-0.1070	-0.4959	1.0000			
lnEPH	0.2794	0.1992	-0.0612	-0.6989	1.0000		
lnFDI	0.8031	0.2056	-0.8517	0.6563	-0.0456	1.0000	
lnPOP	0.8550	0.2811	-0.9049	0.7607	-0.1503	0.9258	1.0000

Notes: All variables are expressed in their logarithms. Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015).

After analyzing the descriptive statistics and correlation matrix, it is one of the challenging tasks to utilize the VAR to find out a selection of the optimal lag length. It requires precision, as the addition of lags to time series models has a direct impact on the estimation process, and four lags have been suggested by the SBIC method (Table 3). The likelihood ratio, sequential modified LR test, the FPE, the AIC, the HQIC, and the SBIC selected lag 3 as shown by the asterisk at the 0.05 significance level. This is sufficiently long for an annual data study to capture the dynamic relationship so that the AIC statistic could then be used to choose the best VAR models.

Table 3: Lag length selection order criteria

	LL	LR	FPE	AIC	HQIC	SBIC
0	19.9006		4.7e-10	-1.61257	-1.59526	-1.27456
1	266.409	493.02	1.8e-20	-26.3011	-26.1626	-23.597
2	2153.95	3775.1	8.e-116*	-256.118	-255.859	-251.048
3	3362.29	2416.7*		-406.287*	-406.01*	-400.878

Endogenous: *lnGDP*, *lnEPC*, *lnEPO*, *lnEPG*, *lnEPH*, *lnFDI*, and *lnPOP*. Exogenous: constant, *Lag selection by the criteria. LR = sequential modified LR test (each test at 5% level); FPE = Final prediction error; AIC = Akaike information criterion; HQIC = Hannan-Quinn information criterion and SBIC- Schwarz's. Bayesian information criterion. Source: Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015).

The chart below (Figure 1) describes the evolution of the levels and growth rates of the variables as logarithmic values. From 1971 to 2015, GDP and Population growth (POP) were slowly reduced in Myanmar. From 1971 to 1987, FDI decreased annually. From 1988 to the present, there has been a rapid increase. The EPG has grown dramatically from 1971 to 1997 and has been moving up and down since 1998. From 1994 to 2005, EPC has been growing rapidly and is likely to continue to increase. From 2002 to 2015, EPO has been increasing rapidly down. The EPH has been dramatically moving up and down from 1971 to 2015. Variable trends include FDI and GDP, Energy production from natural gas, and hydroelectric (EPG and EPH) as a percentage of total energy consumption. From these, we can see that the EPG, FDI, and GDP of Myanmar are expected to continue to grow. On the contrary, The EPC and EPO (fossil fuel) is expected to decline further.

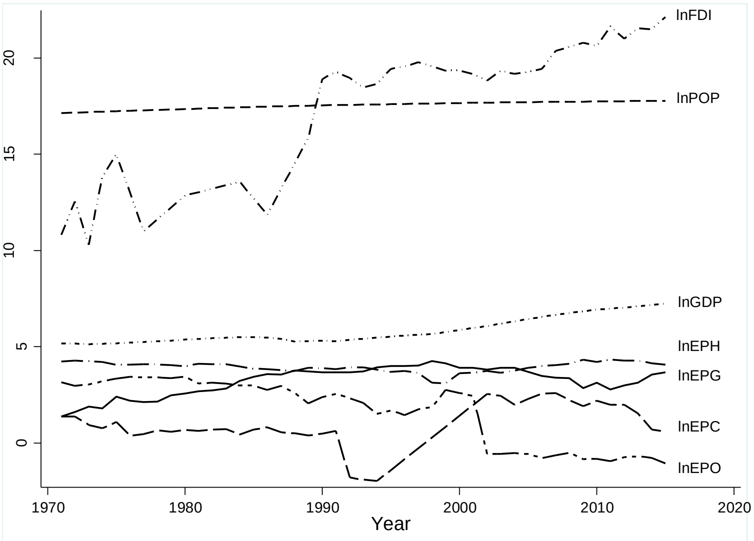

Figure 1: Levels and growth rates of the variables. Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015)

4.2 Toda and Yamamoto Granger Test Result

The result of the Toda and Yamamoto Ganger test using modified Wald test statistics, critical values of the leverage bootstrap, and asymmetric causality based on the underlying empirical data employed in this study are presented in Table 4 above indicates that there is bi-directional causality between FDI and GDP. The modified Wald test statistic was conducted with the addition of the optimum lag length with the maximum order of integration $k + d_{max}$ in each of the exogenous variables included in the model. It is important to note that the $k = 4$, while $d_{max} = 1$. This, however, implies that an increase in economic growth will lead to an increase in FDI inflow to Myanmar, the same is the case with an increase in FDI. Meaning that an increase in the inflow of FDI causes GDP to increase positively. This however conforms to the endogenous growth theory. The result also reveals that there is a unidirectional causality between FDI and GDP with causation running from GDP to FDI. This however implies that an increase in FDI causes GDP also to increase. The result also reveals that there is a unidirectional causality between EPO and EPG with causation running from EPG to EPO indicating that a change in EPO will cause EPG to also change positively. The joint causation between FDI and all the components of foreign capital inflow included in the model shows that an increase in foreign capital inflow causes FDI to increase as well. The result does not show any evidence of feedback causality in the asymmetric causality test.

Table 4: Result of Toda and Yamamoto Granger test and bootstrap simulation

Variables	Chi-sq.	df.	Prob.	test	CV 1%	CV 5%	CV 10%	p-value
lnGDP to *lnEPC*	53.263	2	0.000	-1.709	-4.233	-3.536	-3.202	0.7468
lnEPC to *lnEPO*	247.70	2	0.000	1.925	-4.316	-3.572	-3.223	1.0000
lnEPO to *lnEPG*	6.6818	2	0.035	-3.183	-4.224	-3.532	-3.199	0.0878
lnEPG to *lnEPH*	61.585	2	0.000	-1.641	-4.224	-3.532	-3.199	0.7761
lnEPH to *lnFDI*	37.190	2	0.000	-1.529	-4.224	-3.532	-3.199	0.8190
lnFDI to *lnPOP*	5.0113	1	0.025	-2.547	-4.380	-3.600	-3.240	0.3048
lnPOP to *lnGDP*	27.522	2	0.000	-3.144	-4.260	-3.548	-3.209	0.0961
lnGDP to *ALL*	2.8e+06	11	0.000					

Notes: All variables are expressed in their logarithms. Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015).

4.3 Johansen's Cointegration Test Result

The author now employs Johansen's (1990) cointegration test to examine whether the logarithms of variables included GDP, EPC, EPO, EPG, EPH, FDI, and POP are co-integrating relationships by computing the long-run coefficients. Unrestricted cointegration rank test with no intercept or trend in cointegrating equation resulted with trace statistics indicating 5 cointegrating vectors and maximum eigenvalue statistics also indicating 5 cointegrating equation at 5% level of significance. Both trace test and maximum eigenvalue test are based on pure unit root assumption. As can be seen in Table 5, there is a co-integrating relationship between the series. The trace statistics indicated 1 cointegrating vector since, at the null hypotheses of cointegration rank ($r = 0$), the trace value of 78.2203 is greater than the 5% critical values of 68.52. The maximum eigenvalue statistics also indicated 1 cointegrating equation since the maximum eigenvalues of 28.112 are greater than the 5% critical values of 33.46. Results reveal that there is a co-movement between all data series in this research article. The result of the Johansen statistics of the residuals, therefore, rejects the null hypothesis of no cointegration between energy consumption and economic growth in Myanmar and conference that it could be used to make a long-run prediction about economic growth in the country.

Table 5: Johansen's cointegration test result

				Maximal Eigenvalue statistic		Trace Eigenvalue statistic	
rank	parms	LL	Eigenvalue	Statistic	5% CV	Statistic	5% CV
At most 1	30	374.28191	.	28.112	33.46	78.2203	68.52
At most 2	39	388.33826	0.47993	23.7771	27.07	50.1076	47.21
At most 3	46	400.22681	0.42475	16.3772	20.97	26.3306*	29.68
At most 4	51	408.4154	0.31673	7.2070	14.07	9.9534	15.41
At most 5	54	412.01891	0.15431	2.7463	3.76	2.7463	3.76
At most 6	55	413.39209	0.06187				

Notes: All variables are expressed in their logarithms. Source: Compiled by the author based on WDI, IEA, and IMF database (1971-2015). * denotes rejection of the hypothesis at the 5% level.

5. CONCLUSION AND RECOMMENDATIONS

Energy consumption sustainable development directly to energy security, reduction of greenhouse gas emissions, energy efficiency, environmental sustainability economic growth. The purpose of this study is to investigate the relationship between energy consumption in Myanmar and economic performance. In this empirical study, the Johansen cointegration approach and Toda and Yamamoto's Granger causality test were used to determining the long-term causal relationship between energy consumption and economic growth from 1971 to 2015 using the example of Myanmar. The results show that there is a one-way causal relationship between economic growth and energy consumption in Myanmar. As a result, the government of Myanmar needs to take measures to save fuel and protect the environment by transferring energy from unsustainable sources to other sources. Energy efficiency improvements are aimed at improving energy efficiency and increasing the production of environmentally friendly energy. Thus, replacing traditional fossil fuels with renewable energy has the potential to explore other energy market opportunities and support economic growth. Renewables should focus on accelerating Myanmar's sustainable economic growth. To reduce the demand for fossil fuels in the future, the renewable energy market needs to constantly use hydropower, solar/PV energy, and biomass. If Myanmar achieves high economic growth, energy demand will increase. Gross domestic product is very sensitive to energy demand. In addition, there is a one-way causal relationship in Myanmar from energy consumption, gross domestic product growth, foreign direct investment, and population growth to short run and long run consumption of renewable energy. Therefore, it is necessary to introduce innovative renewable energy policies as a possible way to improve sustainable economic development and energy efficiency. The policy aims to improve infrastructure for biomass energy, an important source of renewable energy, to further support Myanmar's economic growth.

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