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## Article

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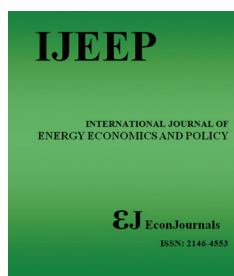
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## Energy Consumption and Economic Growth in Indonesia

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### ABSTRACT

The aim of following study was to examine the relationship between energy consumption and economic growth in Indonesia. This study has used quantitative research design for assessing the energy consumption and its link with economic growth in Indonesia for the period of 2000-2019. The independent variable in this study was energy consumption whereas; dependent variable was economic growth in Indonesia. The data is analysed through E-views using autoregressive distributed lag co-integration approach for long-run relationship, and long-run and short-run coefficients, Augmented Dickey Fuller and Johansen co-integration. The findings have revealed that economic growth and energy consumption has association with each other. Within the given historic data, energy consumption has the ability to predict economic growth in Indonesia. The research can be improved through increasing sample size, number of variables and countries for comparison. This study also provides the guideline to the policymakers that they should develop the policies related to the energy consumption that enhance the economic growth of the country.

**Keywords:** Energy Consumption, Economic Growth, Gross Domestic Product, CO<sub>2</sub> Emissions

**JEL Classifications:** P18, O47

### 1. INTRODUCTION

The consumption of energy denotes to the entire energy used to perform an activity, inhabit the building or simply produce and manufacture something. The entire consumption of energy can be dignified by observing the amount of production and the rate of energy consumption in that particular production (Tang et al., 2016). The energy plays a significant and most crucial part in the growth of economy because the energy is comprehended as the major source in the production and manufacturing sectors of the country. Therefore, the policies and regulations related to the energy are most crucial in understanding the association amongst economic growth and consumption of energy. It is identified that the economic growth and consumption both are associated, but the direction of this association is not clear at all time. It is supposed that an enhancing share of the renewable energy can be amalgamated into other energy sources of the country which support to meet the growing plea for the energy-related to the

future while impacting the economic growth. Along with this decreasing the environmental influence related to the sources of renewable energy and fossil fuels can enhance the diversity of the sources of energy. In addition, this potential of energy participated in the security of energy and to the enduring availability related to the supply of energy. The sources of renewable energy can also endorse regional growth because they can be used in underdeveloped regions without any sources of conventional energy and could decline the costs related to climate change (Pirlogea and Cicea, 2013; Tang et al., 2016).

With the increase in advent of globalisation, the population of the countries has also increased since people started migrating to other countries and start their families. Similarly, countries that had diversified their economy from oil-based businesses to tourism have seen immense growth in their population as well as economy. It has been seen that population increase and energy consumption are positively related regardless of the economic conditions because more people tend to consume more energy overall

## 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

(Aiyetan and Olomola, 2017). Indonesia, being a developing country, has also diversified its economy from palm and crude oil to tourism which has led to increase in population in turn increasing the energy consumption (Hasan et al., 2019). Though the growth of economy has been observed in the Indonesian context, there still remains a concern whether the energy consumption intends to affect the economic growth in Indonesia or not. Hence, this study is aimed at testing whether the energy consumption, in one way or the other, associated with economic growth in Indonesia.

The global trend signposts that numerous countries have struggled in achieving the economic development exclusive of the similar perceiving a boost in emissions of the CO<sub>2</sub> (Bakhtyar et al., 2017; Alam et al., 2016). On the other side, there has been increasing apprehension on the method of green growth and low carbon. The major consumption of energy in Indonesia enhances 50% in the time period of 2000-2011. Therefore, the current study enquires the relationship amongst the growth of economy and consumption of energy in consideration of Indonesia (Shahbaz et al., 2013). The research is given by Morawicki and Hager (2014) that consumption of energy during the processing of food changes varies with the nature of the product, amount of handling, the procedure intricate and the type energy used in that certain process. Therefore, it can be notified that the consumption of energy completely relies on the usage of energy.

The energy sectors are considered as the most important part of the economy of the country (Nawaz et al., 2019). As Indonesia is the developing country therefore, the additional losses related to the consumption of the energy are not bearable and manageable for the country. The statistics are given by British Petroleum (2019) that the energy consumption in Indonesia in the year 2018 remain insignificant. But geothermal and biomass output enhanced 8.9 per cent in 2018 and reached at 3 mega tonnes of oil equivalent. On the other side, the renewables comprehended for 5.5% of the all over the generation in 2018, which is marginally greater from 5.3% in the year 2017. The primary energy consumption of Indonesia augmented in 2018, reinforced by greater demand for the services related to transportation amongst the increasing incomes. Therefore, the basic demand for the energy enhanced by 4.9% in 2018, which is well onward of its average annual development rate of 10 years from 2007 to 2017 stated as the 2.8%. Hence, this research aimed to provide the association amongst the economic conditions and consumption of energy in Indonesia.

There are various studies in the literature related to the economic conditions and consumption of energy along with the financial conditions of the country which are related to the energy. Similarly, other studies are also defining a similar relationship with a different context. The rationale of this study is that this study specifically related the economic growth and consumption of energy in the context of Indonesia. This creates the significance of this research for the policy and decision-makers of Indonesia who are majorly dealing with economic conditions of the country. Moreover, the outcomes of this research also important for the people who want to invest in the energy sector for the business. The oil and gas companies also use the findings of this research in the forecasting of their business by relating the findings of this particular research.

There have been numerous studies conducted by various researchers in different parts of the globe which are taking part in the investigation of the variable similar to this research. For instance, the research conducted by Bhattacharya et al. (2016) had examined a sample of 38 countries with regards to both variables economic growth and along with the consumption of energy. Similarly, the results of the study found that energy consumption in the long-run had a positive and significant influence on economic growth of about half of the countries considered in sample. Similarly, another study conducted by Inglesi-Lotz (2016) examined the sample of OECD regarding the same topic. The results revealed that consuming renewable energy is more beneficial than conventional forms of energy not only for the environmental context but for the economic context as well. Another study by Isik et al. (2018) studied economic growth and consumption of energy in context of USA, Germany, China, Turkey, Italy, Spain and France. It was observed that the results were positive and significant for Spain, Germany China and Turkey but insignificant for USA, France and Italy.

The economics related to the energy has strained substantial devotion from the scholars in the current period of time. There is various researcher which have evaluated the causal association amongst the economic growth and energy consumption. This problem is an addition and important because the controls and drives of the energy handles the wheels of development of economy. Subsequently, it is obvious that energy is considered as the one of the basic resources of the production and manufacturing along with the labour and capital. Furthermore, the greater the Gross Domestic Product (GDP) per capita, the higher in demand of the energy. Therefore, the GDP per capita is directly proportional to the demand for energy. This relationship is comprehended as the intuitively appealing in terms of economic growth (Yıldırım et al., 2014). In contradiction, there are various studies which are objected to explore the enduring and continuous direction of interconnection and the relationship amongst the usage of energy and economic development. These studies have comprises various other elements for instance the financial development, urbanization, population and so forth to better comprehend the fundamental subtleties of this certain relations. Bartleet and Gounder (2010) include the labour and capital stock to define the usage of energy for some Asian nations. The findings of the aforementioned study suggest that there is a positive association amongst the demand of economy and growth of the economy which is stronger as compared to the other variables of the research. This gives the idea that the demand of the economy and a stronger influence on the economic conditions and growth of the country.

Indifference to this the study conducted by Zheng et al. (2010) illustrated the vigorous causal association amongst the GDP and energy consumption. The outcome of this research is that the growth of the economy affects the pollution and consumption in the enduring but the relation opposites on a small scale. Moreover, in the short run, the regulations should an additional focus on the emerging strategies that would outcomes in attaining the greater

deployment of savings in direction to boost the investors of the country. In addition, the desired financial policies are designed to meet the enhancing plea for energy by increasing the procedure of the capitalisation of the industry of energy which also has the same anticipations. Moreover, the restraints associated to the usage of the regulations and tools of policies are geared in relation to the restricting consumption of energy in limited time which is also the part of national energy policies as this might result in the lower economic growth. In contrast, for the continuous period of time, the government of Indonesia should convert its emphasis towards attaining the greater development, in direction to enhance its monetary growth and to endure a continuous and enduring flow of required energy. In this manner, the representatives put the focus on the growth of the domestic resources of energy to defend their native places from any threat or bad news related to the unwanted external energy given its wide-ranging reliance on energy imports (Bildirici and Gökmenoğlu, 2017).

The study proposed by Guo (2018) that energy is one of the major element which directly impacting the growth of the economy. The most important drive for the economic growth of the states in the globe is only energy. Therefore, it is counted in one of the most significant resources of the association amongst the national economise. There were two oil crises seemed in the 1970s which make individuals aware of the energy and has a greater constraint on the growth of the economy. The technological progress is one of the additional and modernised factors which impact the economic growth and energy consumption. It also considered as the motive force and effecting the social-economic growth in the globe and comprehended as an indispensable material resource for global economic development. There are various resources and facts which depicts that the incongruity amongst the desire of the unlimited consumption and limited energy reserves is a global issue. Problems related to the energy which has become the global focus of humanity, and it has the most crucial strategic meaning to the growth of the economy in various countries.

One of the major problems in the energy industry today is the efficiency of the energy which is the growing price of the energy which drive to decline the emissions of greenhouse gas. The outcome of this research is that the development of the economy does not support energy consumption and vice versa. Hence, this suggests that the government can take the conservation policies, regulations and the growth of the economy simultaneously (Primayesa and Putra, 2017). The representative of previous studies on the causal association amongst the variables related to the consumption of energy. The analyses relationship that just the GDP to the consumption of energy which is the one-way causal association. Moreover, the execution of energy consumption procedures will not impact the growth of the economy (Guo et al., 2012).

In lives of humans the energy performs a significant role and in the activities related to the economic conditions of the country in terms of both as social development and a scale of the economy which is the basic humanitarian need. In this contemporary world, energy is not comprehended is only the single and unique source of generating money or used in the manufacturing and production.

In critique, the energy is also deliberated as the strategic service product that establishes the ground for international business and association amongst countries. This can be related to the Indonesian country and its economy because the consumption of energy is directly proportional to the growth. As with the growth of the population, the consumption of the products increases therefore, this consumption help to increase the operations of the companies which require the money. Hence, the company paid the taxes and other income to the government of the country eventually which is the part of the economy and resulted in the growth of the country. On the other side, there are various conditions under which the related resources of the energy are acquired and the issues practiced and confronted throughout the procedures of procurement which directly impact the rivalry at both the local and global levels. This kind of situations also design the structures of the production of the nations and found as one of main pointers which are counted as the basic economic variables. Therefore, for all aforementioned purposes energy is one of the prominent problems in the current globe.

This topic is very broad therefore there are various studies related to these topics are discussed in the literature and have a wide-ranging theoretical existence. There are numerous theories which define the existence of economic growth in which the most important theories are given as under.

The first theory is the neoclassical theory of economics which has an emphasis on the demand and supply as the driving factors behind the manufacturing, consumption and production of services and goods. It developed in around 1900 in comparison with the previous theories of classical economics (Mueller and Atesoglu, 2019). Classical economists believe that the major significant factor in the price of the product is its cost of the production. In contrast, the neo classical economists claim that the perception of the customer related to the value of a product is the dynamic element in its price. Eventually, both economists agreed that this is the difference between the retail price and production cost along with the economic surplus. One of the main and starting postulations of neoclassical economics is liked with the utility of the consumers, not the price or cost of the production (Tsoulfidis and Tsaliki, 2019; Soukup et al., 2015). The relation of the concept of the classical and neo classical theory is important for the study related to energy consumption and economic growth in Indonesia. In which the economic and cost-related ideas of the theories can be practised to sustain the advantage of energy consumption (Siudek and Zawojnska, 2014).

The other concept important to discuss is the economic nationalism which is also known as economic populism, economic patriotism and denotes to an ideology that errands state interventionism on other mechanism of the market with the rules and policies such as the local control of the economy, capital formation, labour, and even if this necessitates the obligation of prices and other restrictions related to the economy (Colantone and Stanig, 2018). This can benefit to identify the relationship between economic growth and energy in Indonesia. To reimburse for the less trade, the supporters of the economic nationalism enhanced the fiscal procedures to assist the businesses. This comprises improved

spending of the governments on the tax cuts and infrastructure of the business.

### 3. METHODOLOGY

The following paper has utilized quantitative research design for assessing the energy consumption and its link with economic growth in Indonesia. The deductive approach seems appropriate for this study since the hypothesis is being tested (Razzaqi et al., 2011). The method of data collection was secondary therefore, time-series data for energy consumption, labour force, CO<sub>2</sub> emission and economic growth of Indonesia is taken for the past years ranging from 2000 to 2019 of annual frequency. In furtherance, the analysis ash been conducted on E-views.

#### 3.1. Unit Root Testing - Augmented Dickey Fuller (ADF)

Macroeconomic data usually contain unit root due to random trends. In this case, it becomes necessary to tests the stationarity of the data for which usually ADF test is implemented. The mentioned tests is related to the t-statistics of the  $\delta_2$  coefficient presented in the following regression model:

$$\Delta z_t = \delta_0 + \delta_1 t + \delta_2 z_{t-1} + \sum_{i=1}^n n_i \Delta z_{t-i} + \varepsilon_t \quad (1)$$

In equation (1), the  $\Delta$  can be deemed as the difference operator of 1<sup>st</sup> order with “n” number of lags. In addition, “z” is the time- series under investigation, “t” is the time period reflecting years while  $\varepsilon_t$  is the stationary random error term attributed to the adjustment of the autocorrelation. The  $H_0$  assumes that  $z_t$  is a non-stationary time series (having unit root). In this concern, the following condition is tested:

$$H_0 : \delta_2 = 0$$

$$H_1 : \delta_2 < 0$$

For the determination of optimal lag length, the paper uses Akaike information criterion (AIC). According to the rule of thumb, the model with lowest AIC is preferable. In case, the data possess unit root then the researchers usually opt for cointegration, for instance, JJ cointegration where the linear combination is evaluated. With respect to the mentioned technique, the equation has been written as follows;

$$\Delta z_t = \Pi z_{t-1} + \sum_{i=1}^{n-1} \tilde{\Lambda}_i \Delta z_{t-i} + P x_t + \varepsilon_t \quad (2)$$

$\Pi$  is the coefficient matrix which with the lagged value of “z” represents error term while  $\Gamma_i$  is the estimated parameter. However, “P” is the coefficient of exogenous regressor.

#### 3.2. Auto-regressive Distributed Lag Model (ARDL) Approach to Cointegration

In relation to the model of the study, the log-log model generally can be written as follows:

$$LGDP_t = \beta_1 + \beta_2 LEU_t + \beta_3 LE_t + \beta_4 LCO_t + \vartheta_t$$

Where,

LGDP: Log ofGross domestic product

LEU: Log of Energy consumption

LE = Log of Total employment

LCO: Log of CO<sub>2</sub> emission

$\vartheta$ : error term

The underlying reason of unusing ARDL approach is associated with the fact that whether the data is I(0) or I(1), it can be utilised with both individually and in combination as stated by the study of Nkoro and Uko (2016). Therefore, the results generated would not be rendered as invalid. It also produces robust results when the sample size is small and the case here is same with 20 observations in each variable.

In furtherance, the ARDL’s error correction model (ECM) can be written as follows:

$$\begin{aligned} \Delta LGDP_t = & \beta_1 + \sum_{i=1}^{p1} \partial_1 \Delta LGDP_{t-i} + \sum_{j=1}^{q1} \rho_{1j} \Delta EU_{t-j} \\ & + \pi_1 EU_{t-1} + \pi_1 LGDP_{t-1} + \sum_{j=1}^{q1} \rho_{1j} \Delta LE_{t-j} \\ & + \pi_2 LE_{t-1} + \sum_{j=1}^{q1} \rho_{1j} \Delta LCO_{t-j} + \pi_3 LCO_{t-1} + \vartheta_t \quad (3) \end{aligned}$$

The significance of all the independent variables has been tested using F-statistics. In the equation,  $\partial$ ,  $\rho$ , and  $\pi$  are the parameter estimates and “p” and “q” are the lag orders of dependent and exogenous regressors respectively. However, if the model posses unit root, then cointegrating relationship would be evaluated as follows:

$$\begin{aligned} \Delta LGDP_t = & \beta_2 + \sum_{i=1}^{p2} \partial_2 \Delta LGDP_{t-i} + \sum_{j=0}^{q2} \rho_{2j} \Delta EU_{t-j} \\ & + \sum_{j=0}^{q2} \rho_{2j} \Delta LE_{t-j} + \sum_{j=0}^{q2} \rho_{2j} \Delta LCO_{t-j} + \vartheta_{2t} \quad (4) \end{aligned}$$

$$\begin{aligned} \Delta LGDP_t = & \beta_3 + \sum_{i=1}^{p3} \partial_3 \Delta LGDP_{t-i} + \sum_{j=0}^{q3} \rho_{3j} \Delta EU_{t-j} + \\ & \sum_{j=0}^{q3} \rho_{3j} \Delta LE_{t-j} + \sum_{j=0}^{q2} \rho_{2j} \Delta LCO_{t-j} + \\ & \delta \varepsilon_{t-1} + \vartheta_{3t} \quad (5) \end{aligned}$$

In the above equation, the variabile of  $\delta$  is the coefficient of the model’s error which is corrected. If it possess negative sign then it implies the speed of convergence towards the equilibrium.

### 4. RESULTS

In this study, the researcher had used different statistical techniques for determining the impact of energy consumption and its link with

economic growth in Indonesia. As clearly mentioned along with equation in previous section that secondary data was collected through published country reports, Reuters and World banks website. The independent variable in this study was energy consumption whereas; dependent variable was economic growth in Indonesia. In the following section, a comprehensive analysis is presented that discusses the results of statistical tests and reveal whether the assumptions made in existing studies are true or not regarding energy consumption and economic growth. The relationship has been assessed by various researchers in previous studies as well as in current literature but the results below will reveal the scenario of Indonesia.

#### 4.1. ADF Test

The first tests that was conducted was ADF test which helps in determining unit root of the variables that are selected in this study and are made part of the model. The model was designed in previous sections of the study. The results are shown in the Table 1.

The significance value was 95% which means that any value of the variable obtained should be ideally less than the significance value in order to validate the presence of unit root in the selected variable. The Table 1 shows that except GDP growth and labour force, unit root is present among all other variables. This leads to the fact that the data collected of CO<sub>2</sub> emissions and energy consumption is found to be stationary. However, on the other hand, a trend is being observed on the remaining variables.

#### 4.2. ARDL

The next table of results shown below that is Table 2 is of ARDL co-integration approach which helps in understanding the long run relationship.

**Table 1: ADF test**

ADF test	T-statistic	Prob.
GDP growth	-5.184134	0.0001
CO <sub>2</sub> emissions	-0.016976	0.9526
EC KWH per capita	7.937465	1.0000
Labour force	-17.03603	0.0000

**Table 2: ARDL**

Variable	Coefficient	SE	t-Statistic	Prob.*
GDP_GROWTH(-1)	0.326533	0.126101	2.589468	0.0128
EC_KWH_PER_CAPITA	0.120677	0.050335	2.397492	0.0205
EC_KWH_PER_CAPITA(-1)	-0.199745	0.070142	-2.84773	0.0065
EC_KWH_PER_CAPITA(-2)	0.082217	0.048837	1.683514	0.0989
CO <sub>2</sub> _EMISSION_PC	4.336176	3.315227	1.307957	0.1972
CO <sub>2</sub> _EMISSION_PC(-1)	-5.555635	3.44637	-1.61203	0.1137
TOTAL_LABOUR_FORCE	-248.9432	102.3531	-2.4322	0.0189
TOTAL_LABOUR_FORCE(-1)	236.2358	96.04858	2.459545	0.0176
C	106.4496	58.26968	1.826844	0.0741
R-squared	0.378168	F-statistic	3.572896	
Adjusted R-squared	0.272325	Prob(F-statistic)	0.002598	

After the unit root testing was done and the variables with unit root tests were found so, the next step was to test the auto-correlation so that the future values can be predicted out of it. However, in this case, the lag technique was used in order to predict the values. The current study that has been taken into consideration was time series data and it consists of unit root hence, to determine whether causality exists between the variables or not so, ARDL was applied and used as statistical technique of measurement. The current studies conducted in similar domain has revealed that ARDL is basically a model and a method of predicting the future values based on the log values obtained. However, it is important to mention here that the purpose of developing this ARDL model was to run regression as the data was time series in nature and includes multicollinearity.

The Table 2 shows all variables along with their log values. GDP growth was the dependent variable and the probability value was 0.0128 which is less than the sig value of 5% hence indicating long term relation with energy consumption. Moving to the next variable was energy consumption which has been computed through its two lags. In the first as well as second lag, the probability value is less than sig value of 0.05 which indicates that long term association exists between the variables.

Similarly, the next variable shown in the model in Table 2 was CO<sub>2</sub> emissions with one lag. The probability value was 0.137 whereas the T-statistics value was -0.1.6 therefore, it is evident that no association exists. Moreover, the last variable shown in the above model is CO<sub>2</sub> emissions. The probability value was 0.016 whereas the T-statistics value was -0.1.6 therefore, it is evident that no association exists. The last variable in this model was total labour force which shows the total employment. The probability value of first lag was 0.0176 which shows that association exists between the variables as the probability value is less than the sig-value of 0.05.

#### 4.3. Johansen Cointegration

Another method which is readily used by researchers for determining the long term association between variables is Johansen cointegration. The purpose of using this statistical model is the fact that the entire data collected is time series and most of the models that were analysed above are non-stationary in nature. The aim of this research was to examine the impact of energy consumption on economic growth in the context of Indonesia.

The above illustrated Table 3 shows the Johansen Cointegration test conducted for examining the relationship between energy consumption and economic growth in Indonesia. From the Table 3, it can be seen that hypothesized values show the cointegrating equation of none, at most 1, at most 2, and at most 3. The critical values to considered here are the probability values which carry

**Table 3: Johansen cointegration**

Hypothesized	Trace	0.05	Prob.**
Number of CE(s)	Statistic	Critical value	
None*	95.71648	47.85613	0.0000
At most 1*	51.27073	29.79707	0.0001
At most 2*	20.66852	15.49471	0.0076
At most 3	2.954680	3.841466	0.0856

a threshold level of being  $<0.05$  for the association of time series to be cointegrated. The very first value of none hypothesized cointegration equation shows significance at 5% threshold level indicating that energy consumption and economic growth in Indonesia have an existence of 1 cointegrating equation with P-value being 0.000. With regards to at most 1 cointegrating equation, the probability value is again seen to be 0.0001 which is less than threshold of 0.05 indicating that 2 cointegrating equations exists between the variables of energy consumption and economic growth. With the next hypothesized cointegrating equation, the value is 0.0076 which is  $<0.05$  hence, it can be inferred that 3 cointegrating equations are present between economic growth and energy consumption.

The cointegrating equations here show that a linear association among the two variables exist that emphasizes on them having a relationship over the sample period of 19 years. This relationship is existent despite of the fact that there are potential deviations in the short-run for these variable values from equilibrium. The entire process tends to show that energy consumption and economic growth in Indonesia tend to have both short-term cointegration as well as long-run cointegration. This can be referred back to the literature where numerous studies have shown that energy consumption leads to economic growth since industrial consumption of energy tends to increase output as well as unemployment which add value to the GDP of a country and hence, Indonesia has enjoyed increased economic growth over the past 19 years.

## 5. CONCLUSION

In order to conclude the above study, it can be stated that the aim of this paper was to shed light on the relationship or the association between energy consumption and economic growth in case of Indonesia. This paper has used quantitative method of research design along with secondary data. The data was collected from 2000 to 2019 from published country reports, Reuters and World banks website. The findings above revealed that economic growth and energy consumption has association with each other. It was also found from this paper that CO<sub>2</sub> emissions impact economic growth whereas, total employment has is an important variable in this study to examine its impact on economic growth. However, for future, this study can be improved through collecting large data and using more variables because a large sample size always increases reliability and makes study more valid. Moreover, in future, this study can also be improved by comparing 2 or 3 countries data because this study has only used Indonesia for analysis hence, the findings cannot be generalised. Overall, this study has formed the basis for determining the significance of energy consumption and economic growth in light of existing literature and current statistical findings.

The main limitation of this study was its scope as the study was focused only on Indonesia rather covering other regions too. The findings of this study cannot be applied on other countries as the data was specifically collected from Indonesia. Also, sample size was another limitation because the researcher was unable to find data of more than 20 years hence, the current and previous trends

cannot be compared. The variables selected were limited too and researcher had not incorporated any control variables in order to make the study more reliable and authentic.

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