# DETERMINANTS OF ENERGY CONSUMPTION: A REVIEW OF THE PHILIPPINE ENERGY SECTOR

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**Abstract:**

Energy is considered a vital component of economic growth and human development. When its availability is disrupted, several economic sectors could not function fully to its extent. Energy consumption is influenced by several variables that affect it directly or indirectly. This study was conducted to evaluate the impact of GDP, industrialization, urbanization, trade openness, financial development, and FDI on the energy consumption of the Philippines; and to present the trend of each variable from 1971 to 2014. Data on energy consumption, GDP, industrialization, urbanization, trade openness, financial development, and FDI of the Philippines from 1971 to 2014 were sourced from the World Development Indicators published by the World Bank. The Ordinary Least Squares (OLS) regression analysis was used to analyze and identify those factors that significantly affect the energy consumption of the Philippines. Results indicated that GDP, industrialization, urbanization, and financial development significantly affect the energy consumption of the Philippines. These determinants have p-values that are lower than the 5% significance level. Thus, this study provides the policy and decision-makers with ample information for decisive decision-making in the Philippine energy sector.

**Keywords:** energy consumption, GDP, industrialization, urbanization, trade openness, financial development, FDI

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## 1. Introduction

## 2. Background of the Study

World energy consumption by 2050 is predicted to be nearly 50% higher than its 2015 level (Energy Information Administration, 2019). Despite several global agreements on significantly reducing greenhouse gases and energy consumption, both are expected to increase in the coming years. High energy consumption levels would cause extreme competition for resources and cause environmental stress (Limei and Xiao, 2014). This represents our increasing contribution to climate change and proves that our current policies are ineffective (Estiri, 2014).

Energy is considered a vital component of economic growth and human development (Das, 2016). When its availability is disrupted, several economic sectors could not function fully to its extent. In developing nations, the impacts of energy supply disruptions are visible. Energy security is essential for economic progress, human development, and well-being, leading to poverty and unemployment reduction. Energy is vital in every aspect of the economy. On the demand side, energy is a composite commodity that consumers buy to satisfy their wants and derive utility. On the supply side, energy is a significant input to every economic activity aside from land, labor, and capital (ur Rehman et al., 2018).

The Philippine economy is mainly dependent on energy, despite its low consumption level than its Southeast Asian neighbors; the Philippines is a net energy importer. Oil, natural gas, and coal are some of the sources of the Philippines' energy. In electricity generation, geothermal, hydropower, and other renewable sources account for a significant share of energy (Energy Information Administration, 2020). The government has promoted energy-saving and emission-reduction measures to ensure sustainable development. However, despite the achievements of the implemented measures, the policy targets have not been reached. Therefore, knowing the key elements that impact energy consumption is very significant.

Energy consumption is influenced by several variables that directly or indirectly affect it. As a result, it is crucial to identify and analyze those factors to develop energy policies that are suitable for our country's status quo on energy (Fernandes and Reddy, 2020). Numerous researches about energy use have already been conducted in developing countries. However, most studies focus on a limited number of variables, which leads to disregarding essential variables that significantly impact energy consumption (Vasseur et al., 2019). Thus, this paper addresses those gaps by correlating a substantial number of variables that could influence the energy consumption of the Philippines.

## 2. Research Objectives

The general objective of the study is to determine the determinants of energy consumption. Specifically, the aims to:

1) To present the trends of energy consumption, GDP, industrialization, urbanization, trade openness, financial development, and FDI in the Philippines from the period of 1971 to 2014; and
2) To provide empirical evidence of the relationship between energy consumption and the following determinants:
    a. GDP;
    b. Industrialization;
    c. Urbanization;
    d. Trade Openness;
    e. Financial Development;
    f. FDI.
3) To provide empirical evidence on the significant relationship among the determinants of energy consumption.

## 2.1 Significance of the Study

This study provides valuable information on the following:

**Policymakers** – Policymakers could improve designing policies on the Philippine energy sector to address the country's energy demand and needs.

**Government** – The government could further promote energy efficiency programs and policies to implement public facilities and equipment projects that reduce energy usage during operations.

**Consumers** – Consumers would now be more considerate and appreciative in using different sources of energy supply. They would most likely reflect on the importance of saving energy and learn how to conserve it.

**Future Researchers** – This study could provide information on the determinants of energy consumption in the Philippines. Furthermore, they could integrate other variables that affect energy use and apply them for future studies.

## 3. Review of Related Literature

This section presents the various concepts, facts, and literature gathered from different authors and reading materials to clearly understand the study.

## 3.1 Energy Consumption

Energy is a significant component in improving economic and trade interactions, which are necessary inputs for long-term growth, particularly in developing countries. Energy consumption (EC) is rapidly increasing in emerging countries due to economic growth, increased population, and industrialization (Amri, 2016). It is essential to produce commodities as much as possible to address the population's growing needs.

Energy is considered the backbone and an essential resource that allows production and production activities to occur cohesive, efficient, and effective. In essence, energy is a fundamental component of production that is equivalent to none other than land, labor, and capital. Furthermore, energy consumption is a crucial predictor of

whether or not there is a current increase in economic development and growth (Ucan et al., 2014).

Energy consumption, the driving force of production, plays a vital role in the economy's growth, either directly or in conjunction with other production components. As a result, changes in energy consumption will considerably impact economies that rely primarily on energy consumption. The world has seen dramatic growth in energy consumption to bolster its rising economy for the last three decades (Alshehry and Belloumi, 2015).

The Philippines is a developing country whose shifting towards industrialization. Fossil fuels such as oil and gas are still the principal source of the country's primary energy consumption. The Philippines' immediate energy consumption in 2011 constitutes of oil, coal, geothermal, biomass, hydro, and other renewable energy sources, accounting for the country's energy by 31%, 20%, 22%, 12%, 6%, and 1% respectively (IRENA Renewables Readiness Assessment, 2017).

The Philippines is fully aware of the impact of energy subsidies, but there is still a need for urgent reforms in the energy industry. Despite the country's exponential growth in its population, reliable energy services are still not accessible to approximately 30% of Filipinos. Addressing this problem would benefit health, education, and economic growth (International Energy Agency, 2015).

## 3.2 Gross Domestic Product

Economic growth is the pace at which an economy's size and value expand, measured by gross domestic product (GDP). When GDP increases, it implies that a country is growing. To sustain economic activities and boost economic growth, more energy is required in the process (Fernandes and Reddy, 2020).

Morelli and Mele (2020) investigated the relationship between per capita GDP, CO2 emissions, and energy consumption in Vietnam using the Toda-Yamamoto test and the Johansen and Juselius technique, concluding that growth in the economy leads to increased energy consumption. Economic growth and urbanization increase electricity consumption; this was recently analyzed in Malaysia by Ridzuan et al. (2020) utilizing different macroeconomic factors. From 1972 to 2014, Kristjanpoller et al. (2018) used panel data in 74 countries to examine the causal association between energy usage and GDP. There is a single-direction causality from GDP to energy consumption in energy consumption. A bi-causal relationship was established between GDP and energy consumption in the long run.

Osigwe and Arawomo (2015) researched the link between energy use, economic growth, and oil price in Nigeria. They have found that a bidirectional causality exists between energy consumption and economic development. In 2013, Shahbaz et al. discovered that GDP and energy use has no causal relationship in the case of Indonesia. Several researchers have studied the relationship between energy usage and economic growth. Caraiani et al. (2015), for example, explored the causal relationship between primary energy consumption and GDP for European countries between 1980 and 2012-2013. Paul and Bhattacharya (2004) advocated that India's economic growth and energy

consumption from 1950-1960 have a bidirectional causal relationship. Similarly, Aqeel and Butt (2001) found a positive impact of a country's economic growth on a country's utilization of petroleum.

In Pakistan, Wahid et al. (2021) used the Johansson cointegration approach to study the projection of coal usage from 1972-2015. To determine their purpose, several economic and social variables were analyzed. The use of coal is influenced by GDP per capita, cement industry production, and coal imports. ARIMA is being applied to estimate Pakistan's future trends for 2016-2030.

According to a study conducted by Pirlogea and Cicea (2012), a unidirectional relationship, both short term and long term, exists from energy consumption to GDP after examining different energy sources in Romania, Spain, and the EU 27. In addition, Apergis (2010) and Payne (2011) proposed that economic development and renewable energy consumption have a bidirectional relationship. They further proved that renewable and nonrenewable energy affect real GDP for 80 countries. Elasticity estimates for both energy resources are of minimal difference.

Energy demand is also influenced by economic growth, urbanization, and access to energy (Hassan, 2018). Akinlo (2008) discovered that the consumption of power and the development of the economy of Cameroon and Cote d'Ivoire do not have a significant correlation. Meanwhile, in Sudan and Zimbabwe, economic growth significantly affects energy use. Thus, every African nation should have different policies on energy.

## 3.3 Industrialization

Energy serves as the engine of industrial activities and is essential in every economic activity of any given nation (Dalei, 2016). According to studies, emerging countries are shifting their reliance from agriculture to industry and services. The industrialization of a country depends heavily on energy consumption and other primary factors of production. Energy helps other factors of production to produce output and thus facilitate in promoting economic growth. Due to the increasing growth of industries, there is a rise in demand for various types of energy to sustain output (Fernandes and Reddy, 2020).

In the case of South Africa, Gungor and Simon (2017) examined the relationship between energy consumption, financial development, economic development, industrialization, and urbanization from 1970 to 2014. Results indicated that these variables have a long-run equilibrium correlation. Urbanization, FD, and industrialization are all favorably and strongly related to energy consumption in the long run. Findings also show the long-term bi-directional causation between energy consumption and industrialization, energy consumption and financial development, and industrialization and financial development.

Danmaraya and Hassan (2016) found that electricity consumption, manufacturing productivity, and capital cointegrated using the autoregressive distributed lag technique and granger causality test. This was after they have investigated Nigeria's electricity consumption and manufacturing productivity from 1980-2013. Furthermore, it was

confirmed that manufacturing productivity and energy consumption have a bidirectional causality.

In Turkey, Akbaz and Fuat (2015) researched the influence of financial development (FD), economic growth, urbanization, and industrialization on Turkey's energy consumption. The data being utilized was from 1970 to 2012. They employed a structural vector autoregression model. It was discovered that these factors have a long-term correlation and forecasted considerable impacts. Industrialization and FD have significant effects on energy consumption. While for urbanization, an absence of relationship was established with energy usage.

In India, Mahalik and Mallick (2014) found that the urban population favorably and substantially influences energy consumption but is adversely and firmly impacted by industrial output, financial development, and economic growth. In their study, the ARDL approach to cointegration was utilized. From 1980 to 2011, four drivers of electricity consumption were found to influence Nigeria's electricity consumption. They are real income (proxy per GDP), population, industrial sector production, and power prices, according to Ngutsav and Aor (2014).

An emphasis is being put on the importance of continuing industrialization and globalization in economic activity, rising energy consumption, and the stock market (Punnam and Ferreria, 2014). Industrialization may be accelerated by introducing new items and technology into the manufacturing process, utilizing more energy than conventional industries.

Shahbaz and Lean (2012) investigated the link between energy consumption, economic growth, industrialization, urbanization, and financial development in Tunisia (2012). It was discovered that a bidirectional causality exists between industrialization and energy consumption in the long run. The importance of industrialization for economic growth was highlighted, along with other control variables.

### 3.4 Urbanization

Urbanization has accelerated in recent decades. According to the United Nations, 55% of the total world population lives in urban regions. It is estimated that by 2050, it will have increased by 68 percent. The increased burden on present urban infrastructures, such as housing, transportation, education, and other public services, will increase urbanization. Urban people utilize more energy and resources, which significantly impacts ecology. According to the International Energy Agency, 67.77% of the world's energy is consumed by those who live in cities; this proves that energy usage will be significantly impacted when people move to urban areas (Shahbaz et al., 2016).

It was estimated that in 2020, 47.41% of the Philippines' entire population would live in urban areas. In addition, the Philippines has 33 highly urbanized cities, 16 of which are located in Metro Manila. Coal is the primary power source for Luzon, Visayas, and Mindanao. According to research conducted by Ho et al. (2021), urbanization in the Philippines reduces coal consumption in the long run. The energy demand is directly proportional to the rate of urbanization. The need for energy rises as cities grow. Some of

the beneficial effects of urbanization include establishing work opportunities, enhancing infrastructures, and improving living standards.

A significant number of people hypothesized that urbanization has something to do with energy usage. That is why scholars across regions have studied the correlation between urbanization and energy consumption. According to Shahbaz et al. (2016), urbanization can increase energy consumption since people who live in cities are more linked to electrical appliances than those who live in rural regions. Urbanization may also enhance productivity, resulting in increased demand for energy services such as lighting, cooling, heating, power, and transportation (Kemp, 2019).

Wang et al. (2019) used a panel data analysis to study the effect of factors like energy prices, urbanization, and GDP on energy consumption. The research covered 186 countries, and the period was from 1980 to 2015. They discovered that energy prices have an inverse relation with energy consumption in low and middle-income countries. According to the research, urbanization considerably influences energy use per capita. Komal and Abbas (2015) also support the idea of Wang et al. (2019), where urbanization has a positive effect on energy usage, along with GDP, financial development, and urbanization. It was also confirmed that energy costs have a negative relationship with energy use in Pakistan.

The relationship between energy usage and urbanization has been extensively researched in the theoretical and empirical literature. According to Sadorsky (2013), the correlation between energy intensity and urbanization is influenced by factors, including income level, stage of industrialization and development, and population density in urban areas, which is linked to the kind of energy pattern (nonrenewable or renewable energies). Hemmati (2006) observed that the increase in urban population and growth in the industry sector on energy usage vary between places by optimizing for a country's industrial growth and technological advancement.

Another study by Zhou et al. (2012) aims at discovering the relationship connection between urban growth and energy demand. Urbanization, they said, had a significant influence on energy demand. This is due to an increase in residential household demand, which has increased the transportation and production of building materials.

Inglesi and Pouris (2016) advocated reviewing South Africa's electricity usage energy literature. They wanted to find out which factors affect the country's electricity usage. Population and industrialization were the main determinants for electricity consumption, as in the studies of Esso (2010) and Kahsai et al. (2012).

## 3.5 Trade Openness

Trade openness boosts economic activity, promoting economic growth and production capacity. It also affects the consumption of energy because of its composition. Through the scaling effect, trade openness stimulates local production and the energy use of a given country (Paramati et al., 2018).

Rafindadi and Ilhan (2017) looked at financial performance, trade openness, and economic expansion and discovered that all three variables lead to rising energy usage.

Furthermore, Shahbaz et al. (2015) discovered that urbanization, capital stock, and trade openness contribute to increasing energy usage. Both pieces of research proved that trade impacts a country's energy consumption.

Import and export of goods are included in the trade, and there are a variety of reasons why export might influence energy consumption. Machinery and equipment for loading and transporting export commodities should be supplied to ports, airports, or unloading stations to enhance exports. Any rise in exports leads to an increased economic activity and energy consumption since production resources and transportation used for export all require primary energy. As a result, exporting produced items need energy for transportation, which means that if there is insufficient energy for transportation, export expansion is hampered (Abidin et al., 2015). Imports can also have an impact on the EC. Imports that comprise machinery, equipment, and new technologies boost production and energy efficiency. Furthermore, items are imported via the transportation system, which raises demand for the transport system (Sadorsky, 2013).

Using the Bayer Hank combined cointegration test, the ARDL bounds test, and the VECM Granger causality test, Rafindadi (2015) concluded that financial progress, trade, and capital use reduce the energy demand of Germany. In the case of Asian countries, Nasreen and Anwar (2014) explored the causality between trade, GDP, and energy consumption. It was concluded that all those factors significantly impacted energy consumption. In addition, Sadorsky (2012) confirms that a bi-direction relationship exists between exports and energy use in the short run. While trade and energy usage, in the long run, has a causal relationship.

In the Organization of Islamic Conference countries, Gamoori et al. (2017) investigated the nexus between international trade, investment flows, and financial development to the use of energy. They found out that all three determinants significantly affect energy usage. In the case of OECD nations, Dedeolu and Kaya (2013) discovered bidirectional causality between trade, and GDP on energy usage, while Sadorsky's research in the Middle East in 2011 revealed a more vital linkage between usage of energy and the exports of a given nation.

Khraief (2016) conducted another study in Algeria, estimating the demand function of electricity consumption by taking economic growth, urbanization, and trade openness into account as sources of power demand. A population series was utilized to convert the data unit into per capita. After the energy crisis in 1972, the research period spanned 40 years (1972–2012). Khraief (2016) used a combination of cointegration and cointegration bound tests, as well as an Innovative Accounting Approach (IAA). According to empirical findings, economic development and urbanization play a significant role in electricity consumption; however, trade openness reduces power demand in Algeria. In Lin et al.'s (2015) research, it was discovered that trade openness negatively influenced power consumption derived from renewable resources in China.

A study was conducted by Kumar et al. (2015) in South Africa, investigating the effects of energy, trade openness, and financial growth on the nation's economic growth using ARDL. The Granger causality test showed a unidirectional causality from capital stock and energy use to output and capital stock to trade openness. Trade openness and

output have a bidirectional causality, while neutrality theory was proven between trade and energy and financial growth and output.

### 3.6 Financial Development

The nexus between financial development and energy consumption in various countries has diverse effects. Several studies have looked at financial development's impact on energy consumption using cross-country statistics. Riti et al. (2017) claim that financial growth has a significant impact on the energy usage of high-income economies, while a minimal impact was identified on low- and middle-income nations. According to research, financial development in high-income countries helps them reduce carbon emissions. Several country-specific studies have focused on the relationship between these two variables.

Only a few researchers have used nonlinear models to investigate the relationship between financial development and energy usage. Chang (2015) used a classic panel threshold model to study the nonlinear association between financial growth and energy usage. Financial development metrics based on the banking market indicators increase energy consumption in low-income nations, while financial development metrics based on the stock market indicators decrease it.

A study conducted by Saud et al. (2018) explored the influence of globalization and identified financial development as a determinant for energy consumption. They utilized a panel cointegration approach in their study. On the other hand, in the Middle East and North Africa (MENA) region, financial growth showed a positive effect on the use of renewable energy. The results were administered through a panel vector autoregressive (PVAR) research. Meanwhile, Denisova (2020) confirms an insignificant relationship between financial growth and energy demand.

Yue et al. employed the PSTR model with financial development as a criterion in 2019. It was revealed that different financial development indices have distinct effects on energy usage for a sample of 21 transitional economies. The banking industry's development would increase energy use. The relationship between stock market growth and energy consumption is inverted U-shaped, but the relationship between FDI and energy is U-shaped. Because changes in financial development might have diverse consequences on energy use, it is vital to explore these areas (Shahbaz et al., 2017).

Different statistical approaches analyze the correlation between energy consumption and financial development. Models that make use of linear approaches are the linear dynamic panel model, the VECM (vector error-correction model), the autoregressive distributed lag (ARDL) technique, and the generalized method of moments (GMM) models. In a study conducted by Mahalik et al. (2017), the ARDL technique was utilized to confirm the positive link between financial development and energy usage from 1971-2011. It was verified that a long-run positive correlation exists between these two variables.

Bekhet et al. (2017) employed the ARDL method to determine the association between financial development and energy usage. Data imply that development in the financial sector boosts energy usage in various Gulf Cooperation Council (GCC)

countries. The VECM Granger causality approach was utilized by Charfeddine and Khediri (2016) to analyze the negative impact of financial growth on energy demand. In the case of China, Ouyang and Li (2018) discovered that a comprehensive indicator of financial development may be efficiently reduced by utilizing a panel VAR model in a GMM (Generalized Method of Moments) framework.

Using the nonlinear ARDL model, Shahbaz et al. (2017) discovers no significant association between financial development and energy consumption in India, verified by Sehrawat et al. (2015). In 2016, Shahbaz et al. discovered that using the nonlinear autoregressive distributed lag (NARDL) approach, energy consumption is significantly affected by bank market indicators.

### 3.7 Foreign Direct Investment

Foreign Direct Investment (FDI) can boost energy consumption (EC) by expanding the industrial, logistic, and manufacturing sectors, even though energy is required to sustain industrialized processes. The link between EC and FDI is a poorly explored issue that requires additional research using advanced econometric methodologies and the latest available data (Abidin et al., 2015).

The presence of foreign companies in the local market impacts a country's productivity and growth. FDI may reduce energy consumption by promoting technology to the host nation, encouraging reduced energy usage by improving energy efficiency. By reforming the industrial process, FDI can also increase the host country's energy use efficiency (Paramati, 2018).

According to Zeng et al. (2020), FDI is a significant factor in an economy's growth and development. Rapid growth would mean an increase in the level of energy consumption. Foreign direct investment (FDI) may aid in the economic growth of any developing country. To begin with, FDI aids in the improvement of standard productivity. When foreign direct investment (FDI) comes in, capital accumulates in the industry, town profits rise, and excess labor from rural regions floods the city. This movement aids in the development of employment scales and institutions in developing countries. Second, spillovers from FDI can improve technology transfer to indigenous enterprises. It makes new technology available and encourages innovation. Foreign direct investment (FDI) is a critical source of productivity increase. It might assist the host country's domestic industry is catching up to foreign technology and stimulate upgrading its industrial capability.

Furthermore, FDI aids in establishing an open and better market system in the host nation. To promote FDI, government officials must carefully assess the impact of its insurance policies and initiatives on market competitiveness, creating a more transparent and equitable investment climate. More FDI inflows can be attracted if the investment climate is fairer and more transparent (Sbia et al., 2014).

Sadorsky (2010) researched the impact of stock market development and FDI on energy usage. Using GMM, it was discovered that financial growth significantly impacts emerging countries' demand for energy. FDI makes it easier for businesses to obtain financial capital at a lower cost. These can be utilized to improve their existing operations,

increasing energy consumption. However, an absence of causality was being established for both variables.

FDI drives energy demand through the development of the industry sector and the advancement of the manufacturing and transportation sectors; this was verified through a study conducted by Foon Tang (2009) in Malaysia. Few authors also proposed that FDI had no discernible impact on energy usage locally. Hübler and Keller (2010) failed to demonstrate the influence of FDI on domestic energy consumption since they have ignored the endogeneity within the given set of data.

According to Adom (2015), the energy-saving potential of FDI inflows has been examined along with three components: size, composition, and technological influence. Hübler (2011) concluded that foreign direct investment (FDI) inflows caused China's energy intensity to reduce. In Adom and Kwakwa, the same conclusion is reached in 2014. Paramati et al. (2016) observed that inflows in foreign direct investment (FDI) in developing economies impact renewable energy consumption.

## 4. Methodologies

### 4.1 Theoretical Framework
This study is anchored by Fisher and Kaysen's (1962) consumption function model, which states that energy demand is determined by income and prices, population, weather, and other factors in the long-run consumption. Energy demand arises from the requirement of economic activities as a factor input, thus a derived demand. That is why energy consumption is essential as a factor input in economic processes since it supplies the utility of households and firms' production costs. Energy consumption is necessary to fulfill human needs such as heat, lighting, electricity, transportation, business, industrialization, and public services. Energy demand showcases the amount of energy purchased at a specific price within the constraints of income and how changes in price and income affect demand, i.e., the unsatisfied side of demand. When energy consumption occurs after the purchase choice has been made, demand is satisfied. Demand and consumption of energy are used as a switching mechanism (Wahid et al., 2021).

## 4.2 Conceptual Framework

**Figure 1:** Conceptual Framework of the Study

| Independent Variable | Dependent Variable |
|---|---|
| GDP<br><br>Industrialization<br><br>Urbanization<br><br>Trade Openness<br><br>Financial Development<br><br>FDI | Energy<br><br>Consumption |
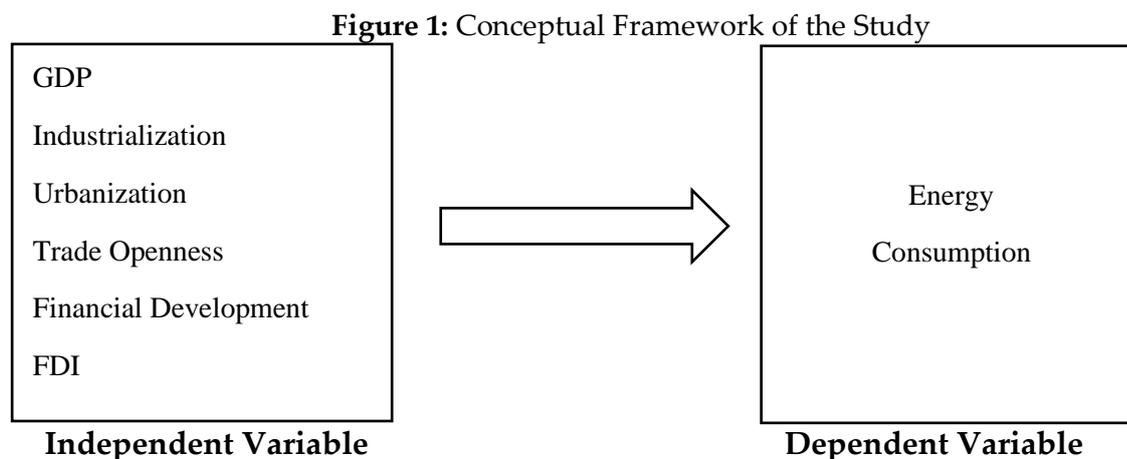
## 4.3 Research Design

This study utilized an inferential statistics approach to evaluate the determinants of energy consumption in the Philippines. The collected data is measurable and represents an entire population. Quantitative data is considered a reliable measurement evaluated for statistical analysis (M. Goerten, 2017); this provided accurate findings that met the objectives of the study.

## 4.4 Data Sources

Data on energy consumption, GDP, industrialization, urbanization, trade openness, financial development, and FDI of the Philippines from 1971 to 2014 were sourced from the World Development Indicators published by the World Bank (see appendix G). The period of study is 44 years. According to Bhattacharya et al. (2017), a higher series frequency in a study would give more reliable and robust results. The chosen variables of the study are based on data availability and the commonality of variables across the literature.

The considered variables of the study are measured as follows:
- Energy consumption is measured in kilogram of oil equivalent (kgoe) per capita.
- GDP is measured in GDP per capita, in constant 2010 USD.
- Industrialization is measured by the industry, value added (% of GDP).
- Urbanization is measured by urban population (% of the total population).
- Trade openness is measured by total trade (% of GDP).
- Financial development is measured by domestic credit to the private sector (% of GDP)
- Foreign Direct Investment is measured in net inflows (% of GDP).

## 4.5 Economic Model

The economic model to be used will be the following form:

$$Y = (X_1, X_2, X_3, X_4, X_5, X_6) \qquad (1)$$

Where;

$Y$ = Energy Consumption

$X_1$ = GDP

$X_2$ = Industrialization

$X_3$ = Urbanization

$X_4$ = Trade Openness

$X_5$ = Financial Development

$X_6$ = FDI

The Ordinary Least Squares (OLS) regression was used to analyze the given data. It is a statistical tool that estimates the relationship between one or more independent variables and a dependent variable by minimizing the sum of the squared errors. OLS is the best linear unbiased estimator (BLUE) if the required assumptions are fulfilled:

a.) $E(\varepsilon) = 0$

This implies that the mean of the error terms is zero.

b.) $Var(\varepsilon) = \sigma^2$

This is the property of homoscedasticity, i.e., the errors have a common variance.

c.) $Cov(\varepsilon_i, \varepsilon_j) = 0$ where $i \neq j$.

This is the property of no autocorrelation, i.e., no errors are serially correlated.

The economic model (1) will be converted to an empirical model, through regression analysis, to explain the relationship between the independent variables to the dependent variable, ceteris paribus (Hill et al., 2000). The OLS estimator is consistent when the regressors are exogenous, there is no multicollinearity, and optimal in the class of the best linear unbiased estimators (BLUE) when the errors are homoscedastic and uncorrelated (B. Stewart, 2016).

When assumptions are violated, multicollinearity, heteroscedasticity, and autocorrelation arise. Moreover, when more and more variables are added to the model, it would lead to a problem of multicollinearity because one variable might be related to other variables. In this case, there is no guarantee that the data will be "rich in information," nor that it will be possible to isolate the economic relationship or parameters of interest (Hill et al., 2000). Having time-series data, observations follow a natural flow of order through time. There is always a possibility that successive errors will be correlated. This correlation between errors is called autocorrelation, which is the violation of the third assumption. It could be detected by the Durbin-Watson (DW) exact statistic. The DW statistics, D, is defined below;

$$D = \frac{\sum_{t=2}^{t=T}(\hat{e_t} - \hat{e_{t-1}})}{\sum_{t=2}^{t=T} \hat{e_t}^2}$$

Lastly, an important point to be considered in the heteroscedasticity problem is the violation of the second assumption. If such problems exist, there should be an application of the generalized least squares (GLS) procedure to eliminate the cause of the said problems.

## 4.6 Empirical Estimation

Equation (1) is the basis for the model of the study. The empirical model will be expressed as:

$$EC_i = \beta_0 + \beta_1 GDP + \beta_2 IND + \beta_3 URB + \beta_4 TR + \beta_5 FD + \beta_6 FDI + \varepsilon_i,$$

Where;
$EC_i$ = Energy consumption in kgoe per capita
GDP = GDP per capita, in constant 2010 USD
IND = Industry, value added (% of GDP)
URB = Urban population (% of total population)
TR = Total trade (% of GDP)
FD = Domestic credit to the private sector (% of GDP)
FDI = Foreign Direct Investment, net inflows (% of GDP)
$\varepsilon_i$ = error term

## 5. Results and Discussion

### 5.1 Graphical Presentation of the Variables
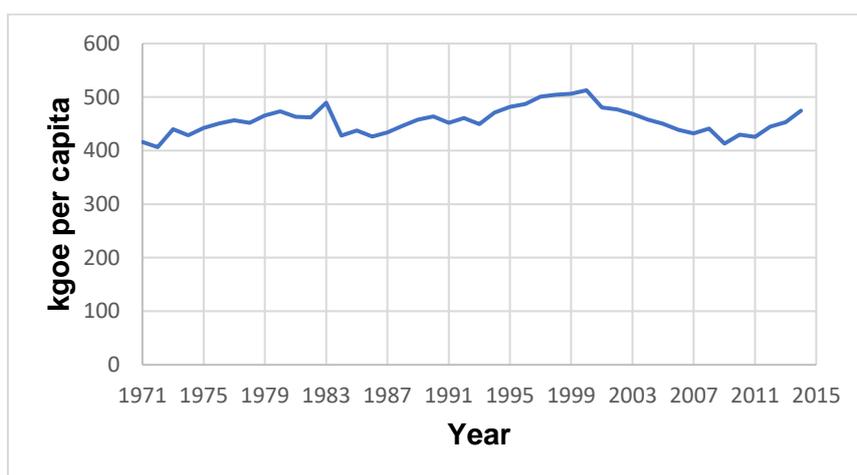


**Figure 2:** Energy Consumption, in kg of oil equivalent (kgoe)
per capita, of the Philippines from 1971-2014

Figure 2 shows the energy consumption of the Philippines from the period of 1971-2014. It exhibits a relatively stable behavior. The average energy consumption of the Philippines for 44 years is 455.79 kgoe per capita. It recorded its lowest point at 1972, wherein the energy consumption was 406.52 kgoe per capita. Energy price fluctuations

affected the Philippine economy during the 1970s due to increased oil prices (Kilian, 2008). The country was placed under Martial Law in the same year, and Typhoon Konsing wreaked havoc in Luzon (Tiglao, 2017). However, in the next ten years, energy consumption increased by 13.2%. During 1980-1990, the Philippines was confronted by an oil price shock and a crisis in the electrical generating capacity (Dolan, 1991); the Philippines' average level of energy consumption was 452.93 kgoe per capita during these years. By 2000, it reached its peak with an energy consumption of 512.74 kgoe per capita. In the past decade, the energy consumption of the Philippines has been relatively stabilized. By 2014, energy consumption was 474.29 kgoe per capita.
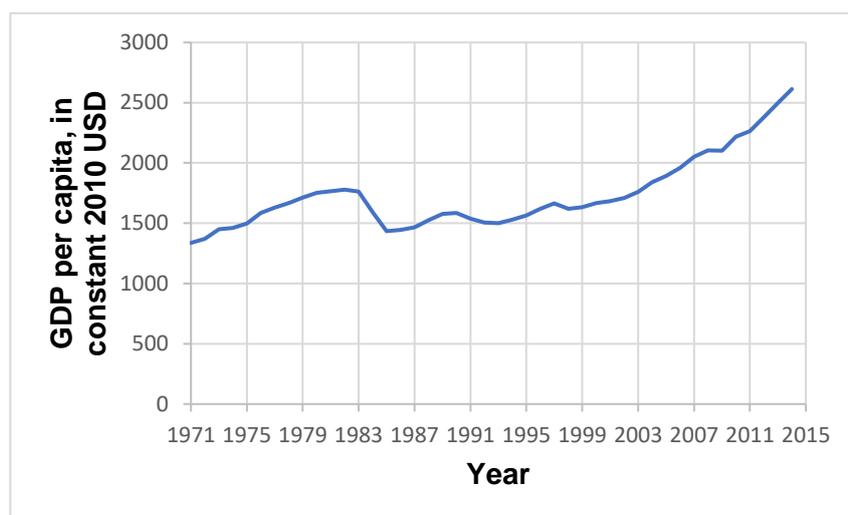


**Figure 3:** GDP per capita, in constant 2010 USD, of the Philippines from 1971-2014

Figure 3 presents the GDP per capita of the Philippines from 1971-2014. It can be observed that economic growth follows an increasing trend. However, the GDP took a massive drop from 1983-1984. The era following the 1970 crisis and preceding the 1983 crisis was known as the "debt-driven growth" period. The decline of the GDP in 1983 signaled the end of the debt-driven growth period (Montes, 1987). In 1983, international financial institutions suddenly lost trust and confidence in our country's financial capabilities, known as the balance of payment crisis. It took until 1984 to directly address the crisis by reaching an agreement with the IMF. The drop in the trend was 16.8%. In the following year, the GDP rose from 1,434.79 to 1,444.44. Moreover, for the next three decades, the GDP was able to go back to its trend and continued to rise until 2014, wherein the Philippines had a GDP of 2,612.86 constant 2010 USD. This was driven by a growth of the manufacturing sector and the service sector, particularly trade, real estate, and business activities.
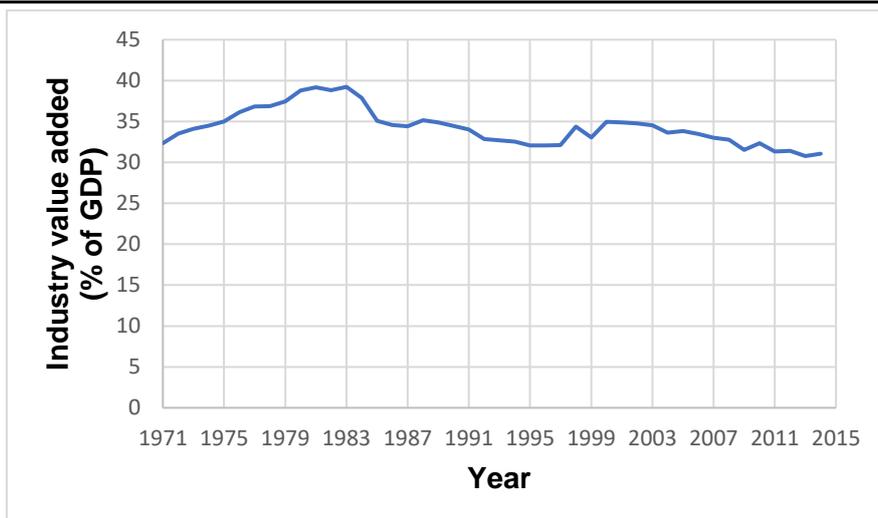
**Figure 4:** Industrialization, industry value added (% of GDP),
of the Philippines from 1971-2014

Figure 4 provides the trend of industrialization in the Philippines from 1971-2014. During the period, it shows a decreasing behavior. Industrialization was increasing at the beginning of the 1970s with an average rate of 36.47%. Industrialization was at its highest point during 1983 with a value of 39.23%. However, in the middle of 1983, the balance of payments crisis led to low earnings and low productivity development. There was a rising unemployment trend during this period, which led to a problem of our country's labor force (Sicat, 1984). From 39.23% down to 34.43% in the year 1987. During the 1990s, the industry value added of the Philippines played between 32.06% to 34.47%. Even though industrialization was somewhat stable during these years, the country never re-entered the industrial growth club (de Dios and Williamson, 2013). This sudden transition resulted in the country being a high political risk for investors. By the year 2000, industrialization was at 34.97%. There have been minor improvements in the trend during the early 2000s, with an average rate of 34.79%. In the final recorded year, the rate of industrialization was 31.04%.
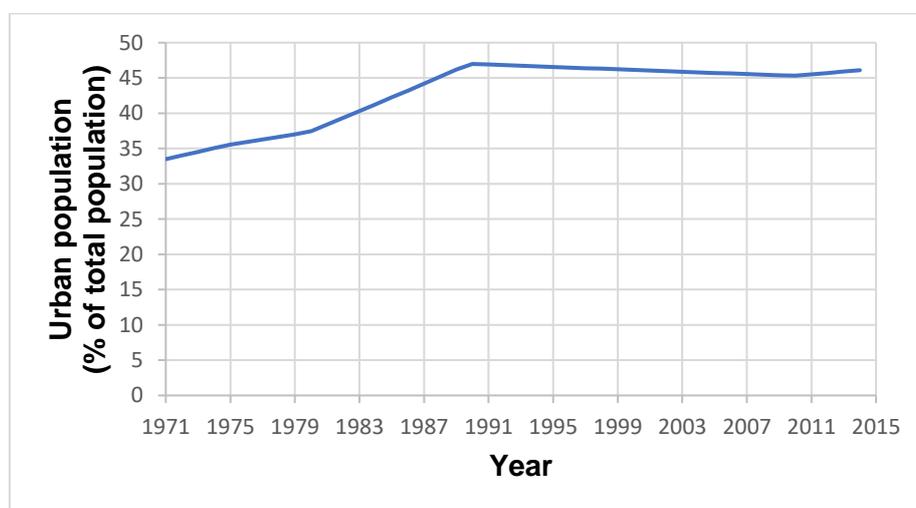


**Figure 5:** Urbanization, urban population (% of the total population),
of the Philippines from 1971-2014

During 1971-2014, the urbanization of the Philippines was increasing at first, then started to become stabilized in the year 1990 (see figure 5). In 1980, the Philippines had a 37.45% level of urbanization with an urban population of 18 million. Then the level of urbanization increased to 9.5% from 1980 to 1990; this suggests that growth in the number of people living in urban areas contributed significantly to the growth in the urban population (Bravo, 2017). Notably, in 1990, it peaked with a 46.98% share of the total population. Young and technically-skilled Filipinos in the metro region and other cities were given new work opportunities due to the creation of information, and communication technologies (ICT) jobs in the 1990s that provide new services to the global economy (Porio, 2009).

Meanwhile, internal political developments and the implementation of the Urban Development and Housing Act (UDHA) in 1992 are also attributed to the rise in the level of urbanization in the Philippines; through decentralizing the functions of the national government and democratizing the urban governance. The level of urbanization in 2000 was 46.13%. Since 1990, the Philippines' urbanization rate has remained stable at 46.8% despite the steady growth of the urban population; this implies that there is also growth in rural areas.
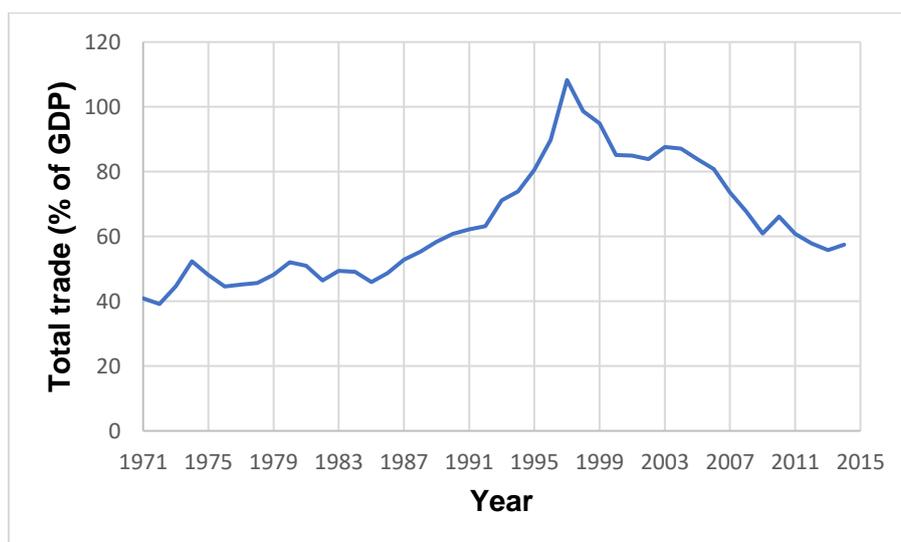


**Figure 6:** Trade Openness, total trade (% of GDP), of the Philippines from 1971-2014

In Figure 6, it can be seen that the trade openness of the Philippines from the early years has an increasing behavior. Notably, it reached its peak in 1997 (108.25%). Beginning in the 1980s, the country's attempts toward a more assertive trade policy contributed to developing the country's trade openness. This was also a result of lower shipping costs and an improvement in the system of ICT, which aided the creation of sophisticated GVCs, notably in electronics, allowing businesses to have more efficient production management (Dudley, 2017). However, after 1997, the trend successively plunged for the next remaining years. Trade openness in 1997 was 108.25% and 57.4% in 2014. That is a 50.85% drop in trade. However, with the country's progress towards globalization, the overall trade can rise even more; this partly comes with the country's significant expansion towards ICT-BPO services (Guinigundo, 2018).
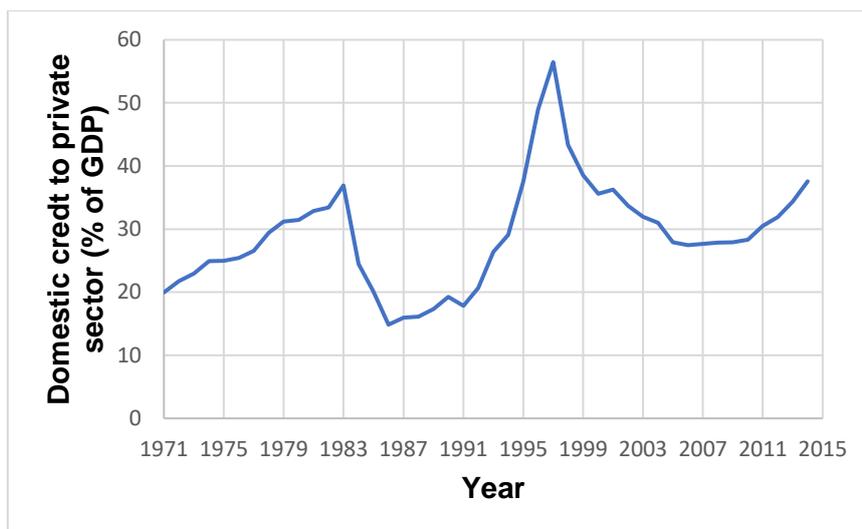
**Figure 7:** Financial Development, domestic credit to the
private sector (% of GDP), of the Philippines from 1971-2014

Figure 7 manifested the behavior of the Philippines' financial development from 1971-2014. As can be noticed, the trend follows a seesaw pattern. During the 1980s, specifically in 1983, it can be observed that the financial development of the Philippines was declining; this illustrates that the Philippine economy faced a major crisis in the financial sector during these years. The staggering decline beginning in 1983 (36.91%) can be attributed to a borrowing momentum that could not be sustained and an economy that discouraged independent investment (Dohner and Intal, 2007). The Aquino assassination worsened the situation, leading to a series of commercial credit line closures. (Montes, 1987). The country's performance in financial development in 1986 was at its worst with 14.85%. It was also in the year 1986, where Philippine foreign currency loan debt was at 26 billion USD. From 1986-1997 financial development recovered by 280%, with a final value of 56.45% in 1997. By continuing the policy that pegs the peso to the dollar via dirty float, the Philippines was able to re-enter the international capital market (Mijares, 1999). However, a turning point in 1997 erupted, the Asian financial crisis. In the Philippines, Asian enterprises had a low debt-to-equity ratio and several macroeconomic imbalances. Despite this, the Philippines' robust financial system where most of the bank loans went to the more productive economic sector, the country was not as heavily affected as its Asian neighbors (Noland, 2000). Until 2014, the Philippines' financial development grew steadily with 4.97% beginning in 2006.
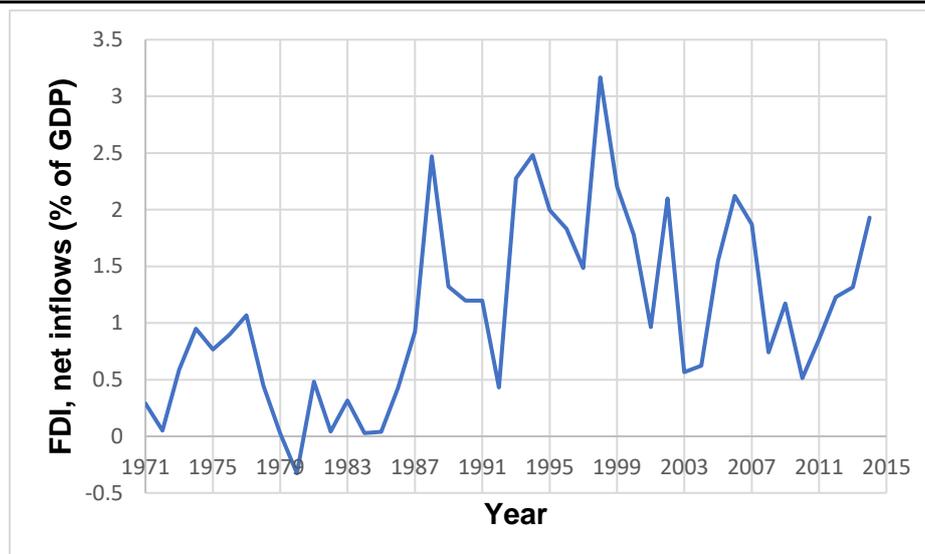
**Figure 8:** FDI, net inflows (% of GDP), of the Philippines from 1971-2014

As one may observe in Figure 8, the FDI of the Philippines displays a fluctuating trend from 1971-2014. During the period, the average rate of FDI is at 1.09%. The highest point was in 1997, and the lowest point was during 1980 with 1.48% and -0.32% respectively. As part of the Philippine government's 'counter-cyclical strategy,' the country started a significant push into business investments in 1979. Technically, this meant increasing the rate of foreign borrowing under government guarantee, which pushed up the investment rate. As international credit became increasingly limited, the massive increase in the budget deficit was supported mainly by taking on foreign debt; this resulted in a 250% increase in FDI (Montes, 1987). While the Philippines started to liberalize the foreign exchange (FX) regulatory system in the 1990s, capital inflows were dampened by the Tequila (Mexican peso) financial crisis in 1995 and the Asian financial crisis in 1997–98 (Tetangco, 2005). Former president Fidel V. Ramos served during 1992-1998. Throughout the year, he accumulated $9,482.7 billion of FDI. That is why the trend on the graph was increasing. The electric power crisis caused the dip during the period, but it was solved through investment promotions providing high returns on investments (Sicat, 2013). In 1998-2001, former president Joseph Estrada's rocky leadership caused the country's FDI to collapse by 2.2%. The FDI during the time of former president Gloria Macapagal Arroyo (2001-2010) was also fluctuating. She was able to accumulate $16,012.4 billion of FDI flows. The disruption in FDI flow during the 2000s shows that the spillover effects of FDI are not automatically generated (Aldaba and Aldaba, 2010). The declines in the FDI can also be attributed to the crisis (Asian financial crisis and housing crisis) experienced by the country (Alburo, 1998). By 2010, the trend went upward until 2014, with an FDI of 1.92%. The fluctuations in the FDI of the Philippines observed in the graph throughout the years are mainly caused by the policies and initiatives proposed by different presidents (Sicat, 2013).

**Table 1:** OLS Regression Analysis Results

| Variable | Estimated Coefficient | Standard Error | P-Value |
|---|---|---|---|
| GDP | −0.0230327 | 0.00949825 | 0.0203* |
| Industrialization | 4.77729 | 1.14877 | 0.0002* |
| Urbanization | 2.44578 | 0.882838 | 0.0087* |
| Trade Openness | −0.132436 | 0.276615 | 0.6349[NS] |
| Financial Devt. | 2.14279 | 0.412975 | <0.0001* |
| FDI | 6.91833 | 3.45581 | 0.0527[NS] |
| CONSTANT | 165.484 | 54.1746 | 0.0042* |

**\***Significant at 5%; NS=Not Significant; $R^2$ = 0.7665

The estimated coefficients generated using the Ordinary Least Square (OLS) regression analysis are presented in Table 1. Results revealed that four variables significantly affect energy consumption among the determinants. GDP, industrialization, urbanization, and financial development significantly impact energy consumption, as indicated in their p-values lower than the 5% significance level.

Based on the model, industrialization, urbanization, financial development, and FDI have a positive coefficient sign. This implies that a 1 unit increase in industrialization, urbanization, financial development, and FDI will increase energy consumption by 4.77, 2.44, 2.14, and 6.91 units, respectively. Moreover, GDP and trade openness have a negative coefficient sign. When GDP and trade openness increase by 1 unit, energy consumption decreases by 0.02 and 0.13 units, respectively. Furthermore, the model registered an $R^2$ of 0.7665, which indicates 76.65% of the variation of energy consumption determinants is explained by the model. The remaining 23.35% is explained by the other factors not included in the study.

Our findings are supported by the work of Fernandes and Reddy (2020), in which they have focused on identifying the determinants of energy consumption in newly industrialized countries of Asia. Using the OLS regression analysis, they found that GDP, industrialization, and financial development significantly affect energy consumption. In addition, urbanization was found to significantly affect energy consumption in a study conducted by Gungor and Simon (2017). They have utilized South Africa's annual data from 1970 through 2014 and employed a granger causality test.

According to studies, emerging countries are shifting their reliance from agriculture to industry and services. Due to the increasing growth of industries, there is a rise in demand for various types of energy to sustain output. Moreover, urbanization causes the energy demand to increase due to people living in urban areas with greater access to electricity than individuals living in rural areas (Shahbaz et al., 2016). Financial development also influences energy consumption since bolstering consumer and business confidence increases economic activity and demand for energy. GDP has a significant impact on energy consumption but has an indirect relationship; this is mainly due to the unrecorded economic activities in developing countries. When official GDP is not measured correctly, it may not give reliable results (Karanfil, 2008).

Trade openness and FDI were revealed to have an insignificant relationship with energy consumption. The same results were found in the study conducted by Rafindadi

(2015), which demonstrated no causality linkage between trade openness and energy consumption in the case of Germany. Trade openness only increases the demand for energy if a country largely depends on exports instead of imports (Paramati et al., 2018). In the case of FDI, it decreases energy consumption through technology transfer to the host country, which promotes less energy consumption but increases energy efficiency. FDI also improves the efficiency of energy consumption of the host country by restructuring the production process.

## 6. Summary

This study was conducted to evaluate the determinants of energy consumption in the Philippines from 1971-2014 using the OLS method. The findings of the study were summarized below:

1) GDP can significantly affect the energy consumption of the Philippines. The 0.0203 p-value is lower than the 5% level of significance. That is why it is deemed insignificant. Also, when GDP increases by 1 unit, energy consumption will decrease by 0.023 units.

2) Industrialization can significantly affect the energy consumption of the Philippines. It has a p-value of 0.0002, lower than the 5% significance level. Moreover, there will be a 4.777 unit increase in energy consumption if industrialization increases by 1 unit.

3) Urbanization significantly affects the Philippines' energy consumption. Its p-value of 0.0087 is less than the 5% level of significance. Furthermore, when urbanization increases by 1 unit, it will increase energy consumption by 2.445 units.

4) Trade openness does not significantly affect the energy consumption of the Philippines. It has a p-value of 0.6349, higher than the 5% significance level. In addition, energy consumption decreases by 0.132 units for every 1 unit increase in trade openness.

5) Financial development significantly affects the Philippines' energy consumption. The p-value (<0.0001) is less than the 5% significance level. Additionally, energy consumption will increase by 2.142 units when financial development increases by 1 unit.

6) FDI does not significantly affect the Philippines' energy consumption. Its p-value of 0.0527 is above the 5% significance level, making it insignificant. When FDI increases by 1 unit, energy consumption will increase by 6.918 units.

## 7. Conclusions

The result of the study revealed that among the determinants of energy consumption, GDP, industrialization, urbanization, and financial development significantly affect the energy consumption of the Philippines. These determinants have p-values that are less than the 5% significance level. This can be resonated with the works of Fernandes and Reddy (2020) and Gungor and Simon (2017), who studied different countries in Asia and

South Africa, respectively. Using the OLS regression analysis, these determinants have affected energy consumption directly and indirectly. According to studies, emerging countries are shifting their reliance from agriculture to industry and services. Due to the increasing growth of industries, there is a rise in demand for various types of energy to sustain output. Moreover, urbanization causes the energy demand to increase due to the people living in urban areas with greater access to electricity than individuals living in rural areas (Shahbaz et al., 2016). Financial development impacts energy consumption since boosting consumer and business confidence stimulates economic activity and energy demand. GDP has an indirect relationship with energy consumption and significantly impacts it. This is mainly due to the unrecorded economic activities in developing countries. When official GDP is not measured correctly, it may not give reliable results (Karanfil, 2008). Thus, this paper provides decision-makers and policymakers with ample information for decisive decision-making in the Philippine energy sector.

## 8. Recommendations

The following recommendations are made based on the findings and conclusion:
1) Policymakers should improve energy efficiency policies and instigate a drive towards renewable-energy development to ensure sustainable growth in the future.
2) The government should invest more in renewable energy and develop new energy sources and technologies to ensure energy security and affordability.
3) Consumers should consider adapting to renewable energy resources and be educated on the use of efficient energy.
4) Future researchers should conduct further analysis on other possible factors that affect energy consumption and apply other econometric time series models to address inconsistencies in the literature.

**Conflict of Interest Statement**
The authors declare no conflicts of interest.

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