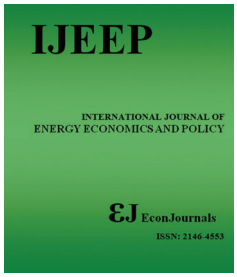

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What Difference Urban Sprawl, Industrialization and Migration Can Make in Energy Consumption? A Time-series Analysis of Thailand

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ABSTRACT

Energy consumption throughout the world is being an issue with much importance as the next generations lives depend upon how we consume energy. Thailand's energy resources in this decade have gone towards depletion. The study shows that if people start spreading by increasing urbanization and migrating then it will imply a positive effect on the energy consumption of the population. The research is contributed on the data gathered over a period of 25 years. The independent variables of the research are urban sprawl, industrialization and migration and their effect is measured on the dependent variable that is energy consumption. Moreover, control variables are also selected which are population growth and GDP of Thailand. The test used for this study include Augmented Dickey Fuller (ADF) unit root test to check for the stationarity of the variables, panel co-integration test to seek for the integration among the variables, and Autoregressive distributed time lag (ARDL) models to understand the effect in chosen time period The results state that the Urban sprawl process, industrialization and migration help in energy consumption and the population growth, as well as urban spare, has an insignificant impact on energy consumption in short.

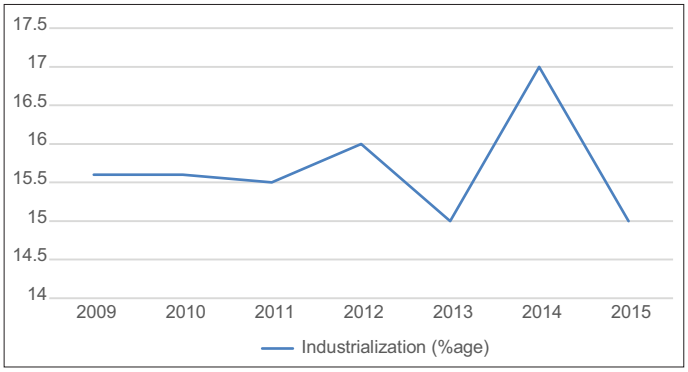
Keywords: Urban Sprawl, Industrialization, Migration, Energy Consumption
JEL Classifications: O18, O14

1. INTRODUCTION

The most significant measurement in Thailand's energy balance is the consumption of around 187.70 billion kilo watt hour of electrical energy every year. In terms of per capita, this is basically 2703 kwh on average. Thailand gives its self with the energy that is self-produced. There is 182 bn kwh production of electrical energy (Allen, 2009). It is around 97% of the countries' own use (Barbero-Sierra et al., 2013). The rest of required energy is imported through various other foreign countries. In addition to the pure consumption, exports, imports and production also play a significant role. Other sources of energy such as crude oil, gas and natural gas are also used. Renewable energies involve geothermal, biomass, solar and wind energy sources. This implies that all of the sources of energy renew themselves in shorter time period. Energy through hydropower is just a renewable energy. This is also the similar scenario in case of tidal or river power plants. Otherwise, different reservoirs or dams also make mixed forms like through pumping water within reservoirs and then making recovery of energy through these at day time, when there is more requirements for electricity. Since it is impossible to identify the amount of developed energy, all energies obtained through hydropower are depicted in a separate way. In year 2015, renewable energies made around 22.9% of the total consumption of energy within Thailand. The chart given in Figure 1 depicts the percentage share from year 1990 to year 2015.

Sprawling growth in urban region and water management issues are giving threats to the conservation efforts at ancient city

Figure 1: Industrialization in Thailand measured in percentage



of Thailand. There was a time when Bangkok was among the wealthiest cities of world, and significant port for trading. Today, Bangkok attracts more of the tourists from all around the globe who come for admiring the stone and ruin Buddha statues placed at Ayutthaya.

However, poor planning of urban sector and its influence over the management of water within the low-lying sector pose more threat to the parks. Rapid growth has made the capacity of area for defending floods to be of concern. Within current decades, a rapid industrial growth has been seen in Thailand. Rapid industrialization is causing irreversible and severe damage to the environment. Therefore, the notion of social prices, particularly as articulated in the idea of sustainable development is getting emerged as some kind of new paradigm within the economy development theory. In accordance with (Catalán et al., 2008) Thai activities of fiscal and structural reforms and aggressive promotion of exports of industrial products increased the GDP growth to around 13% from 4.5%. Within Thailand, translation migration has been seen for many years. The Chinese laborers and traders coming into Thailand made up largest immigrants' group. Now-a-days, migration and most importantly, illegal migration have become an important problem in the society of Thailand (Chen et al., 2016).

There are different researches concerning energy consumption within various countries. Different researchers have tried to explain that which factors influence energy consumption. However, still there are many factors that have not been studied well (Dupras et al., 2016). Moreover, their impact of energy consumption has not been studied in detail. For instance, it has not been identified that what differences urban sprawl, industrialization and migration can make over energy consumption. Therefore, this research has been done in order to analyze the impact of urban sprawl, migration and urbanization on energy consumption. In addition to this, this research has been done in context of Thailand, so as to provide the government of Thailand, an overview of its practices and their impact on energy consumption. Given are the objectives of this research.

1. To analyze the impact of urban sprawl on energy consumption in Thailand
2. To check the role of industrialization in energy consumption within Thailand
3. To identify the influence of migration on energy consumption in Thailand.

The researches done in past have somewhat helped the researchers to explore the impact of various factors on energy consumption. However, these researches do not involve detailed analysis of urbanization, industrialization and migration and their impact on energy consumption. This research will be beneficial for the government of Thailand to identify that which factors can influence the behavior of energy consumption.

The structure of this research is as follows: Introduction, Literature Review, Methodology, Discussion and Conclusion.

2. LITERATURE REVIEW

2.1. Urban Sprawl and Energy Consumption

Proliferation of growth of suburban growth around the centers of city results into urban sprawl. Low density of population describes such areas that get influenced through urban sprawl, as it actually separates industrial, commercial and residential zones. Within Thailand, energy consumption is higher within the suburban regions, in accordance with Hanif (2018). Individuals living in regions influenced through urban sprawl are seen more dependent over automobiles for getting to work, school or shopping. Moreover, in accordance with Hart and Milstein (1999), urban sprawl within Thailand also enhances road traffic, as individuals get more dependent over highways and roads. As an outcome, residents of suburban areas do not only use more of the energy, but also suffer from longer commutes and get more dependent over fossil fuels as compared to other urban counterparts. The residents of sub-urban areas drive more because of the lacking of public transit. The suburban areas' spread out nature results into making individuals incompatible with public transportation, walking and biking. Homes are seen nearer to public transit, for making residents enough able to have public transportation, and it mainly decreases the use of energy by around 50%. Buildings also result into 40% of energy consumption within Thailand. The homes present in suburban regions consume 80% of the energy that is consumed because of households. Multi-family homes, the kind of dwelling are mainly seen in urban areas that are seen responsible for around 15% of the residential consumption of energy (Xu et al., 2016). Homes use most of the energy for heating purposes (Bakhtyar et al., 2017). The units seen in multifamily buildings are considered as quite smaller, needing less cooling and heating as compared to the large homes that are for single-families. Smart growth is basically a factor that helps in development and it basically targets to address the issues that urban sprawl pose. In communities of smart growth, new centers of development are seen. This approach motivates residents to make use of low forms of energy thus reducing the consumption of energy. From the given analysis, this hypothesis can be proposed.

H_1: There is a significant impact of urban sprawl on energy consumption in Thailand.

2.2. Industrialization and Energy Consumption

Rapid industrialization in Thailand has resulted into growht of particular structures of production and different patterns of energy consumption. With the growht in industrialization, more of the energy is used. It is because of the fact that industries demand

more of the energy resources. For instance, for industrialization purposes, different natural resources are used, like water, oil, coal, petroleum etc. Industries consume a lot of resources like petroleum and fuel in order to transport their products from one city to another city. Moreover, industries also use coal for heating or burning purposes. In addition to this, oil is also used for very industrial purposes in Thailand. Within Thailand, industrialization has resulted into a major increment in energy consumption as studied by Lin and Zhu (2017). The rapid increment of industrailization within Thailand has boosted industries to make use of more of the energy resources. These energy resources are consumed at a faster rate. Moreover, these industries also exert different harmful chemicals that can even disturb the air and can pollute it. In the past like in 19th century, the industrial sector of Thailand was not much developed and therefore more of its energy resources were saved. However, within 20th century, Thailand has got more developed, because of the development of world. In order to keep up with the pace of technology and innovation, Thailand is making more struggle to boost its industrial sector (Liu and Bae, 2018). As a result of this, it has started utilizing more of the energy resources. However, these energy resources are consumed in a higher rate in the start, but with the further development and growth of industry, the industries also develop different new sources of energy for the country. However, the rate of their consumption of energy is still very high as compared to the rate of their production. In accordance with Ma et al. (2018), in order to be progressive in the world, the country should have effective industrialization sector, therefore even if it consumes more energy, industrialization is important for Thailand. It is becuae of the reason that the industrialization can give a lot of benefits to Thailand. Based on the over analysis, the following hypothesis has been developed.

H_2: There is a significant impact of industrialization on energy consumption in Thailand.

2.3. Migration and Energy Consumption

The factor that if the influence of migration should be considered important is seen dependent over the fact; that if living conditions of non-migrants and migrants present in urban regions are different or not. Shahbaz et al. (2017) have identified that migrants present in Thailand remit money towards their residential regions. Migrants do maintenance of stronger links with the family present in other towns and villages. The strong family connections that are seen in between the migrants play a significant role in identifying the consumption of energy, economic advantages and migration cost. In case if family links negatively or positively affect the disposable income level, then the features of energy consumption among non-migrants and migrants can be quite different. In other words, it can be stated that under given scenarios, non-migrants and migrants can show various tendencies within the given patterns of energy consumption. Various tendencies related to consumption of energy among non-migrants and migrants can also be defined through alterations seen in the lifestyles of migrants to match the new homes. Current migrants that have shifted to Thailand may not be enough able to make use of home appliances or the devices for cooking due to their insufficient savings or because of other personal preferences. For instance, Tan et al. (2016) have identified that migrants within Thailand have some of the significant appliances such as washing machines, refrigerators and televisions, which rural migrants may not be likely to use or they may not know that how to use it. In accordance with the research of Wang et al. (2016), within Thailand, migrants present within urban regions consume lesser energy as compared to non-migrants present in similar regions. From this analysis, the given hypothesis can be generated.

H_3: There is a significant impact of migration on energy consumption in Thailand.

3. METHODOLOGY

3.1. Data

The present research includes the data for Energy consumption (EC), Urbanization (URB), Migration (MIG), Industrialization (IND), Population growth (PG) and GDP. EC measured in kWh, GDP measured per capita, URB measured by total urban population, MIG measured by monarchs per hour and PG measured in per square kilometer or square mile. The data for all of these variables is taken from the data of the past 25 years extending from a time period of 1995 to 2019. This time span was accurately sufficient to use the A.R.D.L approach to conduct the analysis on the time series type of data and research. The data of past 25 years was collected from the data base of World Bank and related websites as well.

3.2. Model Specification and Econometric Methodology

3.2.1. Model

The aim of this study is to study the relationship between EC, URB, MIG, IND, PG and GDP. According to the study of (Lin and Liu, 2016), it is stated that because of the increase in population, heavy migrations and the increase in urbanization because of those migrations, the energy consumption has increased to a considerable value and this increase in the energy consumption has also triggered the need of even more industrialization, increasing demands and needs are asking for increased supply as well which can only be made possible if the industrialization enhances and production increases as well. The population growth and urbanization has also triggered the need of increased energy consumption and GDP, increased population will keep triggering the demand for increased GDP and demand will continue to trigger the process of supply. In advocacy of the above-mentioned variables and their relationships and impact on each other, a model to study these which is given below:

$$EC_t = \beta_0 + \beta_1 URB_t + \beta_2 MIG_t + \beta_3 IND_t + \beta_4 PG_t + \beta_5 GDP_t + \varepsilon_t \quad (1)$$

In the equation above, β_0 is the constant term, EC_t represents energy consumption measured in kWh, GDP_t representing the real GDP measured as per capita, URB_t represents the urbanization measured by total urban population, MIG_t represents the migration level measured by monarchs per hour, PG_t represents the population growth measured in per square kilometer or square mile, IND_t represents the industrialization and at last ε_t is the measure of error. For the reduction of the potential heteroscedasticity, all of the variables present in the equation 1 are to be converted in the

natural logarithms. For a conversion to the per capita form from the series form, series have been divided using population series. The converted logarithm form of the model is given as:

$$\ln EC_t = \beta_0 + \beta_1 \ln URB_t + \beta_2 \ln MIG_t + \beta_3 \ln IND_t + \beta_4 \ln PG_t + \beta_5 \ln GDP_t + \varepsilon_t \quad (2)$$

In the above equation 2, β_0 is a constant factor, β_i (in which i = 1, 2, 3, 4, 5) are the values of elasticity for the URB, MIG, IND, PG and GDP in the long term. The first equation has been converted into the second one, where $\ln EC_t$ (Natural log of energy consumption in kWh) and $\ln GDP_t$ (Natural log of the real GDP per capita), $\ln URB_t$ (Natural log of urbanization in total urban population), $\ln MIG_t$ (Natural log of the migration level in monarchs per hour, $\ln PG_t$ (Natural log of population growth in per square kilometer or square mile), $\ln IND_t$ (Natural log of industrialization). The expected signs for β_1, β_2, β_3, β_4 and β_5 are positive.

3.3. Estimation Model

3.3.1. Unit root

For the analysis of the stationarity of the present data the unit root test will be used, this test is also used in order to check that whether or not the presented model is feasible for the study under conduct. Another difficulty is to select the right test for the model as well. In the study under conduct, "Augmented Dickey Fuller test (1981), Philips-Perron (P.P.) test (1988), Kwiatkowski Philips-Schmidt-Shin (K.P.S.S.) unit root test" are used, which will make sure of the integration of the series and will also provide confirmation for the presence of the unit roots in the variables selected.

3.3.2. Bounds test of co-integration

The study implements the "Pesaran, Shin, and Smith (2001) A.R.D.L. bounds test" on the series which has been confirmed of its integration, this application is now done for confirmation of co-integration. This test of co-integration is flexible as compared to other ones. The ARDL model is used in order to study long term relationships of the variables and it is done so by an optimal lag length. The identification of dependent and independent variables can be done in ARDL model "Wald test of joint significance or F-test" is used determine long term relationships in equation 3:

$$\begin{aligned}\Delta \ln EC_t &= \beta_0 + \sum_{i=0}^{p} \beta i \Delta \ln EC_{t-i} + \sum_{j=0}^{q} \beta j \Delta \ln URB_{t-j} \\ &+ \sum_{k=0}^{r} \beta k \Delta \ln MIG_{t-k} + \sum_{l=0}^{s} \beta l \Delta \ln IND_{t-l} \\ &+ \sum_{m=0}^{t} \beta m \Delta \ln GDP_{t-m} + \sum_{n=0}^{u} \beta n \Delta \ln PG_{t-n} + \lambda_{EC} \ln EC_{t-1} \\ &+ \lambda_{URD} \ln URD_{t-1} + \lambda_{MIG} \ln MIG_{t-1} + \lambda_{IND} \ln IND_{t-1} \\ &+ \lambda_{PG} \ln PG_{t-1} + \lambda_{GDP} \ln GDP_{t-1} + \upsilon_t \end{aligned} \quad (3)$$

Here, the error factor is represented by υ_t, Δ is there to represent the short term, as Wald test is also used for more than 1 variables in the short term, co-efficient of all of the differenced variables in short term are equal to 0. There are 2 bounds, the upper and lower one, if value of estimated F-statistic is more than upper bound null hypothesis is rejected and it is not rejected if it is beneath that value. After this estimation of co-integration, the estimation of long term and short-term elasticity can be studied as under in equation 4 and 5:

$$\begin{aligned}\ln EC_t &= \alpha_1 + \sum_{i=1}^{P} \varphi 1_i \ln EC_{t-i} + \sum_{j=1}^{q} \omega 1_j \ln URB_{t-j} \\ &+ \sum_{k=1}^{r} \emptyset 1_k \ln MIG_{t-k} + \sum_{l=1}^{s} \partial 1_l \ln IND_{t-l} \\ &+ \sum_{m=1}^{t} \upsilon 1_m \ln GDP_{t-m} + \sum_{n=1}^{u} \Omega 1_n \ln PG_{t-n} + \mu_t \end{aligned} \quad (4)$$

$$\begin{aligned}\ln \Delta EC_t &= \gamma_0 + \sum_{i=1}^{p} \gamma 1_i \ln EC_{t-i} + \sum_{j=1}^{q} \gamma 1_j \ln URB_{t-j} + \\ &+ \sum_{k=1}^{r} \gamma 1_k \ln MIG_{t-k} + \sum_{l=1}^{s} \gamma 1_l \ln IND_{t-l} + \sum_{m=1}^{t} \gamma 1_m \ln GDP_{t-m} \\ &+ \sum_{n=1}^{u} \gamma 1_n \ln PG_{t-n} + \psi ECT_{t-1} + \mu_t \end{aligned} \quad (5)$$

In equation 5, the ECT_{t-1} is the error correction term, moreover, it must be negative and value of coefficient should be between 0 and 1. From the 2 equations above long term and short-term elasticity can be studied.

3.4. Model Stability and Diagnostic Tests

The diagnostic tests are used to identify heteroscedasticity, residual serial correlation and correlogram of residuals. Test of cumulative sum C.U.S.U.M is used for stability test of coefficients for the long-term. In this, Granger causality test is used for testing the causality direction for the estimated variables. After confirmation of long-term relation through equation 2, the error correlation model is developed as in equation 6 below:

$$\begin{aligned}&\begin{bmatrix}\Delta \ln EC \\ \Delta \ln URB \\ \Delta \ln IND \\ \Delta \ln MIG \\ \Delta \ln GDP \\ \Delta \ln PG\end{bmatrix} = \begin{bmatrix}a1 \\ a2 \\ a3 \\ a4 \\ a5 \\ a6\end{bmatrix} + \begin{bmatrix}S11,1 & S12,1 & S13,1 & S14,1 \\ S21,1 & S22,1 & S23,1 & S24,1 \\ S31,1 & S32,1 & S33,1 & S34,1 \\ S41,1 & S42,1 & S43,1 & S44,1 \\ S51,1 & S52,1 & S53,1 & S54,1 \\ S61,1 & S62,1 & S63,1 & S64,1\end{bmatrix} \\ &\times \begin{bmatrix}\Delta \ln ECt-1 \\ \Delta \ln URBt-1 \\ \Delta \ln INDt-1 \\ \Delta \ln MIGt-1 \\ \Delta \ln GDPt-1 \\ \Delta \ln PGt-1\end{bmatrix} + \begin{bmatrix}S11,1 & S12,1 & S13,1 & S14,1 \\ S21,1 & S22,1 & S23,1 & S24,1 \\ S31,1 & S32,1 & S33,1 & S34,1 \\ S41,1 & S42,1 & S43,1 & S44,1 \\ S51,1 & S52,1 & S53,1 & S54,1 \\ S61,1 & S62,1 & S63,1 & S64,1\end{bmatrix} \\ &\times \begin{bmatrix}\Delta \ln ECt-m \\ \Delta \ln URBt-m \\ \Delta \ln INDt-m \\ \Delta \ln MIGt-m \\ \Delta \ln GDPt-m \\ \Delta \ln PGt-m\end{bmatrix} + \begin{bmatrix}\varphi 1 \\ \varphi 2 \\ \varphi 3 \\ \varphi 4 \\ \varphi 5 \\ \varphi 6\end{bmatrix} \times \left(ECT_{t-1}\right) + \begin{bmatrix}\eta 1t \\ \eta 2t \\ \eta 3t \\ \eta 4t \\ \eta 5t \\ \eta 6t\end{bmatrix}\end{aligned} \quad (6)$$

In equation 6 Δ represents first difference operator and ECT_{t-1} represents the lagged error correction term which must be between

0 and 1 with a negative sign. Equation 2 gives a confirmation of short-term relationship and VECM model confirms long term relationship among variables. F-statistic will be used for knowing about weak or short-term Granger causality.

4. EMPIRICAL ANALYSIS

4.1. Unit Root Test Results

Th unit test is conducted in this research to see the stationarity of the variables over the time that was used for this study. Th enull hypothesis of the Augmented Dicky Fuller (ADF) inidctaes that the variables are non-stationary. Looking at the results below we can conclude the results of ADF test and the LLC test at the level intercept and at the first differences of the variables. The results are shown in Table 1.

Here the ADF test result indicates the stationarity and non-stationarity of the variables. At level, Urban sprawl, industrialization, the population growth and the GDP of Thailand have been significant. Therefore, we reject the null hypothesis of non-stationarity and consequently state that these variables are stationary over the time. However, energy consumption, and migration have not been significant thereby indicating the non-stationarity of the constructs. At the first differences, all the constructs turned out to be significant. Therefore, we can say that these variables are stationary over the time at their first differences.

At the LLC test results, we can see that at the level, Urban sprawl, energy consumption, energy consumption and population growth has been significant. Therefore, we reject the null hypothesis of non-stationarity and consequently state that these variables are stationary over the time. However, industrialization, migration, and GDP of Thailand have not been significant thereby indicating the non-stationarity of the constructs. At the first differences, all the constructs turned out to be significant. Consequently, we can say that these variables are stationary over the time at their first differences.

4.2. Co-integration Test Results

The co-integration test is conducted to see for the integration among the variables as how these relate to each other. This test indicates the long-run relation of the variables among each other. If the estimation of the evaluated F-insights is higher than the upper basic limits esteem, that infers the dismissal of inacceptable theory against the alternate theory. However, If the F-statistics value lies in between or beneath the threshold value, then the null hypothesis Ho will not be rejected and hence, we conclude that there is no co-integration between the variables. The results for the table are shown in Table 2.

The F-statistic value turns out to be highly significant at 10% level of significance and is 22.758 in this analysis. The lower bound critical value and the upper bound critical values are 2.976 and 3.754 respectively at the 10% level of significance. F-insights is higher than the upper basic limits value, that infers that we reject the null hypothesis of no co-integration between the variables and conclude that there is co-integration among the variables.

4.3. ARDL Short Run and Long Run Test Result

The Autoregressive time lag method is used to see the effect of change on the dependent variable which is energy consumption because of the independent variables that are industrialization and migration though short run analysis and long run analysis in this study. The results are shown in Table 3.

Here, energy consumption has been significantly affected by the difference in industrialization and migration. The long-run results state that Urban sprawl, industrialization, migration, population growth, and GDP have significantly impacted the energy consumption in Thailand. An increase in Urban sprawl will make an effect of 38.76% on the energy consumption and has the highest impact on energy consumption. A one unit increase in migration will cause an effect of 38% on the energy consumption. Similarly, all variables effect the energy consumption. The adjusted R square value implies that all the variables jointly make an effect of 67 % on the energy consumption.

However, in the short run, not all variables have a significant impact. Urban sprawl has been insignificant with only 18% impact on energy consumption. Industrialization and migration have

Table 1: ADF and LLC unit root

Constructs	ADF test		LLC test	
	Level	1st diff.	Level	1st diff.
US	0.399*	1.304***	−0.675*	−1.375***
IM	1.390*	2.395***	−1.332	−3.365***
MI	0.384	3.494***	−0.385	−1.275***
PG	0.397*	2.954***	−2.305*	−4.363***
GDP	1.905*	4.394***	−0.389	−4.366***
EC	0.384	2.293***	−3.394*	−2.353***

Table 2: Co-integration test

O.P.L. length (A.I.C)		(3,0,1,0,0,0)	
F-Stat. (Bound test)		22.758***	
V.C	1%	5%	10%
L.B.C.V.	3.676	3.243	2.976
U.B.C.V.	4.865	4.123	3.754

Table 3: ARDL estimation results

Run long results	B	t-value	Summary and diagnostic test	
EC	2.353***	-	R^2	0.690
EC (−1)	2.565**	-	Adj. R^2	0.678
EC (−2)	1.243***	-	D.W.	2.34
US	0.242	3.876**	X^2SC	0.242 (0.676)
IN	0.186	2.986**	X^2W	2.353 (0.454)
MII	0.206	3.865**	X^2AR	0.132 (0.564)
PG	0.123	2.976**		
GDP	0.132	2.865*		
C	4.755	5.865**		
Short run results	**B**	**t-value**	**Summary and diagnostic test**	
US	0.132	1.877	R^2	0.686
IN	0.243	2.987**	Adj. R^2	0.662
MII	0.132	2.567***	X^2SC	1.547 (0.244)
PG	0.089	1.086	X^2W	4.976 (0.876)
GDP	0.035	1.564	X^2AR	3.097 (0.354)

significant effects of 29% and 25% effect on energy consumption respectively. However, GDP and population growth have also been insignificant in impacting the energy consumption in the short run. The adjusted R square value implies that all the variables jointly make an effect of 66 % on the energy consumption.

5. DISCUSSION AND CONCLUSION

5.1. Discussion

The role of urbanization, migration and urban sprawl is very essential in different countries. These terms help to analyze the different factors. However, the primary purpose of the following paper is to analyze the impact of urban sprawl, migration as well as industrialization on energy consumption in Thailand. The above results and findings illustrate the ADF, LLC unit test as well as co-integration test. Urban sprawl is basically another word for urbanization, It refers to the migration of a population from populated towns and cities to low density residential development over more and more rural land. All results and tables indicate that the urban sprawl process significantly affects energy consumption. The results prove that the Urban sprawl process can make energy consumption. It is obvious that fact that more people move towards urban regions and migrate, the more energy will consume and vice versa. A study illustrates that people who live in areas affected by urban sprawl tend to be more reliant on automobiles to get to school and work or go shopping. Similarly, when people move from rural to urban areas, they tend to utilize resources, energy, and facilities. This shows that the Urban sprawl process helps in energy consumption (Faisal et al., 2018).

The results tables such as ADF and LLC unit root test analyze that there is a significant impact of industrialization on energy consumption. The results analyze that industrialization help in the industrial revolution. The previous studies also analyze the relationship between industrialization and energy consumption. Urbanization and industrialization, which are often used as indicators of modernization, occur as economies develop (Shen et al., 2018). As the base of an economy moves from agriculture economy to manufacturing, the number of people living in urban areas increases and industrial value-added as a share of GDP increases. Increased industrial activity, like high-value-added manufacturing, uses more energy than does traditional agriculture or basic manufacturing (Sayama, 2018). Moreover, the migration activities also affect energy consumption in Thailand. A recent study illustrates that the migration process and activities lead to an increase in income or a move to a less hospitable climate, migrants may be more likely to consume more energy services, which, other things being equal, would increase emissions. Therefore, this cannot be neglected that the migration process affects energy consumption. The more people will migrate, the more energy will be consumed. The results also indicate that the population growth, as well as urban spare, has an insignificant impact on energy consumption in short.

5.2. Implications

The results and findings of the study demonstrate that Urban Sprawl, Industrialization and Migration can significantly make energy consumption in Thailand. The previous studies, as well as the results, analyze the urbanization has a negative impact on energy usage and consumption. This cannot be neglect that people are moving from rural to urban for the better facilities of resources. Therefore, In Thailand context migration and urbanization has a positive impact.

5.3. Limitations/Recommendations

The limitations are the part of a research study, the current study majorly focuses on urbanization and industrialization and their impact on energy consumption. While it has recommended that the study must highlight the other aspects such as the impact of urbanization and industrialization on sustainable energy production, etc.

5.4. Conclusion

Emerging economies are going through a remarkable transformation in economic development that is affected by different factors. The primary purpose of the given paper is to understand the difference between Urban Sprawl, Industrialization, and Migration on energy consumption. At the same time, the population growth and urban spare act as control variables. The results have been analyzing through different tests such as unit root tests, ADF, unit co-integration and ARDL estimation results. The table of ARDL estimation indicates that in the long run, all hypotheses accepted. While in the short-run, the control variables such as population growth and the urban spare have a negative impact.

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