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**Article**

# Wavelet analysis of renewable, non-renewable energy consumption and environmental degradation as a precursor to economic growth : evidence from Malaysia

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# Wavelet Analysis of Renewable, Non-renewable Energy Consumption and Environmental Degradation as a Precursor to Economic Growth: Evidence from Malaysia

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**ABSTRACT**

The present study utilized continuous wavelet power range, and wavelet coherence power range estimations to analyze the relationship among renewable energy consumption, non-renewable energy consumption and environmental degradation by taking about quarterly data for the time of 1997(1) to 2017(4). Moreover, the consequences of wavelet coherence affirm that ENG and $CO_2$ emission have a bi-directional causal association with one another in the medium run and a uni-directional causal relationship where ENC is driving in a short run era. However, we found no proof of a causal relationship in a long and long run period. Finally, the aftereffects of wavelet coherence affirm that RENE and $CO_2$ emission have a bi-directional causal association with one another in short run and a uni-directional causal relationship where $CO_2$ emission is driving in medium run day and age. Nonetheless, we found a proof of a uni-directional causal relationship in a long and long run period where causality is running from renewable energy consumption to environmental degradation in Malaysia.

**Keywords:** Renewable Energy Consumption, Environmental Degradation, continuous Wavelet Transform, Wavelet Coherence, Malaysia
**JEL Classifications:** Q20, Q30, Q56

## 1. INTRODUCTION

The dimensions of contemporary economies are complexed in terms of underlined structures, operational opacities and technological dependence. In this regard, the domain of energy generation and production hold significant position in driving various modes of modern business and economy. Energy forms the basic input in industries and transportation sector (Oh et al., 2018). Businesses in the presence of excessive technology dependence cannot survive without power. Similarly, the production of various forms of energy also resulted in enhances trade opportunities and thereby beneficial to augment economic development (Alper and Oguz, 2016).

In theory, the relationship between energy consumption and economic growth can form four possible hypotheses. It might lead to

growth hypothesis, which suggests that increased economic growth resulted into increased utilization of energy. Conversely, it might result into conservation hypothesis which suggests that increased power consumption boosts economic growth and plays significant part in bringing economic development. On the other hand, the association among the both variable, unlike the earlier effects can be bi-directional suggesting that both energy and economic growth correspond each other and forms the feedback effect. Lastly, the link between the two can be resulted into neutrality hypothesis where both the variables are inadequate to impact each other. Hence, the majority of the theoretical and experimental association between energy-growth hypothesis considered the critical link among the variables.

Energy has always been the vital part of many industrial revolutions, although it has started to consider critical knowing

its adverse effects on the natural atmosphere. The excess energy dependence in contemporary economies exerts several antagonistic effects on the environment and carries numerous drawbacks to the future of mankind. It is criticized to hurt sustainable development by causing environmental pollution and health damages. The significance of fossil fuels in this regard and the emanation of carbon-di-oxide are the widespread attributes of causing environmental degradation. As rapid energy consumption underlies the potential of causing perilous effects on environment but considered significance to economic growth; the nexus of energy, environment and economic growth is complicated and upsurges several heated debates in academia. Therefore, the relationship of economic performance and power utilization with the aspect of environmental degradation has been discussed thoroughly in the literature. Among them the studies of Bloch et al. (2012); Cowan et al. (2014) and Begum et al. (2015) are notable to analyze the contribution of power consumption and economic development in influencing environmental degradation and found significant harmful influence of carbon emission in hurting natural atmosphere.

In compliance to the vitality of energy in economic activities and country's development process, the eminence of renewable energy is highlighted to fulfill the needful requirements of power consumption and maintaining eco-friendly image. By definition, renewable energy is the attainment of power that is derived from natural sources such as solar, wind, water etc. and carries nominal mutilation to the environment. In response to the positive attributes of renewable energy in playing environmentally friendly energy role, its acceptance around the World in augmenting with time. Among the other benefits of renewable energy, the prominent feature is its tendency to transfer the dependence of fossil fuels in performing economical activities. It helps to fulfil industrial need for energy and simultaneously fulfills the objectives of sustainable development (Hu et al., 2018). In the existing literature, the importance of renewable sources of power utilization have taken the substantial attention in considering its undisruptive effects on environment and community health (Al-Mulali et al., 2015). However, there exist very few studies that investigated the link between non-renewable energy, renewable energy and carbon-di-oxide emission (Dogan, 2015) especially in non-linear aspect. The presence of asymmetric relationship among economic variables is highlighted by several authors, yet, there exist a scarce literature that examine such crucial feature of timeseries in investigating energy and environmental performance associations (Alper and Oguz, 2016).

In order to fulfill the existing literature gap, the objective of the present study lies in capturing the uniqueness of time-frequency causal association between renewable and non-renewable power consumption with environmental degradation. In retreat from the orthodox time constant examinations, the aspect of time-varying investigation applied in the current study provides novel value addition in the existing energy-environment literature. In this regard, the present study utilized the innovative Wavelet analysis to analyze the relationship between renewable energy, non-renewable energy and carbon-di-oxide emission in Indonesia at various time and frequency intervals. The findings derived

from such advanced econometrics would help in shedding grater insights into the studied domain and aid organizations, industries and governments in articulating better environmental policies to ensure sustainability.

The remaining of the study is organized as pursues: Sections two sheds lights on the basic empirical literature identified with the field of renewable, non-renewable power source consumption and environmental degradation. Section three gives the basic comprehension of the techniques utilized in the present research. This is followed by segment four that shows the examination and outcome of the investigation. Finally, section five finishes up the investigation discoveries and proposes the basic ramifications of the relationship between renewable energy, non-renewable energy consumption and environmental degradation for the instance of Malaysia.

## 2. LITERATURE REVIEW

The existing literature of energy-emission nexus is filled with statistical investigations that are filled with mixed association and diversified approaches. Among the recent investigation, Apergis et al. (2018) also explored the impact of renewable power utilization and health expenditures in influencing environmental degradation. The authors utilized the measure of carbon-di-oxide to capture environmental degradation. The study utilized data from the period of 1995 to 2001 for forty five Sab-Saharan nations. The results for the long-term dependence suggested that both renewable power consumption and health expenses are significant to influence carbon emission. Furthermore, it is established that the increase in both variables reduce emission in the sampled nations. On the other hand, the granger causality test also revealed that all variables possessed causal connections. In this regard, the study confirmed the existence of uni-directional causal relationship between renewable power utilization and health expenses. In this regard, the outcomes reported that the direction of causal connections run from renewable utilization to health expenditures. As for the carbon emission, the study failed to find the long-run causal connection among the variables. However, in short run, the results concluded the feedback causal effect between renewable power utilization and carbon-di-oxide emission in Sab-Saharan economies.

Focusing on twenty five emerging countries, Hu et al. (2018) identified the link between renewables and emission reduction. The authors investigated the impact of renewables in terms of both size and share. The study utilized the data from the period of 1996 to 2012. The empirical investigations in the analysis is carried out by identifying long-run association from FMOLS and DOLS estimates. Furthermore, granger causality is selected to inspect the existence of causal association among the studied measures. The results of the panel analysis reported interesting findings. As for the share of renewables, the outcomes of the study highlighted that increase in renewable share declines carbon emissions. On the other hand, the size of renewables resulted into enhancement of carbon emission in the sampled countries. As in Vietnam, Tang and Tan (2015) broke down the connection between power usage and carbon outflow by studying the data from the period of 1976 to 2009. The investigation selected the empirical analytics of Granger

causality to recognize the existence of causal impact among the factors. The discoveries of the examination set up the presence of uni-directional causality running from power consumption to carbon emanations in the nation.

In the Sub-Saharan countries, Inglesi-Lotz and Dogan (2018) analyzed the contribution of renewable and non-renewable power utilization in environmental degradation. Focusing on the ten highest power generating countries, the authors used the data for the examinations from the period of 1980-2011. The results of long-term dependence suggest that both non-renewables and renewables energy consumption is significant to influence carbon-di-oxide emissions in the sampled countries. The results further suggested that increase in non-renewable power utilization enhances carbon emission, whereas, the enhancements of renewable power consumption decrease toxic emission. As for the causal investigations, the results of the study applied granger tests. The outcomes therefore reported that there exists the uni-directional causal connection between non-renewables and renewables and similarly, between carbon emissions and renewables. The direction of causality in both causal connections run towards the renewables. Similarly, the presence of uni-directional causal connection is also established between carbon emission and non-renewables suggesting that the direction of causality run from non-renewable power consumption to emission in the panel countries.

Menyah and Wolde-Rufael (2010) also examined the causal impact of sustainable power source utilization on carbon discharges. The investigation used the information from the time of 1984 to 2007. The statistical discoveries of the examination reasoned that in Long-run, sustainable power source utilization has found to apply a noteworthy constructive impact on $CO_2$ emanations. Nonetheless, in short run, the investigation neglected to discover any connection between sustainable power source and carbon emanation. As for Pakistan, Mirza, and Kanwal (2017) analyzed the dynamic causal relationship between power consumption, output development and carbon-di-oxide emanations. The authors utilized data from the period of 1971 to 2009. Applying the statistical analytics of J-J co-integration and ARDL testing and VECM framework, the outcome of the study confirmed the statistical causal connection between renewable, output and carbon emissions. Furthermore, the results further suggested that there exist the bi-directional causal connections among power utilization and carbon emissions, power utilization and output growth and carbon emission and output growth.

Similarly, Al-Mulali et al. (2015) also inspected the effect of economic improvement and sustainable generation on the environmental contamination of twenty three European nations. The investigation used information from the time of 1990 to 2013. So as to quantify contamination, the study used the measure of carbon-di-oxide emanations of the inspected nations. The result of the investigation reported that co-integration exists in all variables. Moreover, the findings of fully modified OLS uncovered that the dimension of economic growth upgraded carbon outflows, in any case, renewable power tend to decrease carbon emanations in long run. So as to check the causal impacts, the investigation utilized VECM Granger causality, which demonstrated that economic

enhancements have causal association with carbon outflow and renewables generation has neglected to demonstrate the causal consequences for the dimension of carbon emanation in greater part of the models.

Recently, in Malaysia, Gill et al. (2018) examined the link between renewable power utilization and carbon-di-oxide emissions. Focusing on the presence of EKC curve, the authors focused on the emissions of greenhouse gases that may bring negative effects on the environment. In doing so, the study utilized the data from the period of 1970 to 2011. The unique aspect of this study is also present in examining the presence of greenhouse gases in renewables consumption. The outcomes of the study reported that the rise in output carried the increasing trend of greenhouse gases. However, the statistical significance of the association is rejected. The findings put stress on the view that mere reliance on GDP is insufficient to reduce adversity in the environment. On the other hand, renewable is significant to influence carbon emissions (Sinaga et al., 2019). Furthermore, the results of renewable power consumptions highlighted that increase in renewable consumption tends to decrease environmental degradation in Malaysia (Saudi et al., 2019a; Hussain et al., 2019).

For new members in Europe, Alper and Oguz (2016) analyzed the existence of causality among renewables and economic advancement. The study utilized the data from the time period of 1990 to 2009. So as to identify the long-term relationship, the study applied ARDL examination and the outcomes reported that sustainable power usage have noteworthy positive effect on economic advancement of Estonia, Poland, Slovenia and Bulgaria. In addition, the causal examination performed in the empirical process indicated blended outcomes. The discoveries of Bulgaria bolstered the existence of uni-directional causality that tends to run from renewables to output growth. On the other hand, the findings for Czech Republic reported opposite results. The outcomes highlighted that causal relationship in the country run from output to renewables. Moreover, the outcomes from non-linear causality finish up the non-existence of causal associations between sustainable power utilization and economic improvement in the nations of Hungary, Cyprus, Poland, Estonia and Slovenia.

As for ASEAN countries, Liu et al. (2017) examined the link between renewable power utilization, agriculture development and environmental degradation in Malaysia, Philippine, Indonesia and Thailand. The authors utilized the measure of carbon-di-oxide to capture environmental degradation. The study utilized data from the period of 1970 to 2013 for the selected ASEAN nations. The results for the long-term dependence suggested that both renewable power consumption and agriculture are significant to influence carbon emission. Furthermore, it is established that the increase in both variables reduce emission in the sampled nations. On the other hand, the granger causality test also revealed that all variables possessed causal connections. In this regard, the study confirmed the existence of short-run uni-directional causal relationship between non-renewable power to carbon-di-oxide and from non-renewable power to agriculture. Similarly, the results also confirmed the short-run causality from output development to agriculture and from agriculture to renewable power. However, in

long-run, the results concluded the feedback causal effect between renewable power utilization, non-renewable power utilization and carbon-di-oxide emission in selected ASEAN economies. Lastly, the examination failed to validate the confirmation of EKC framework and establishment the inverted U-shaped link between carbon emission and output growth in the sampled economies (Saudi et al., 2019b; Sinaga et al., 2019b).

The study aimed Concerning the Group of Seven nations, Ajmi et al. (2015) examined the relationship among power utilization and carbon discharge. The discoveries of the causal impacts recommended the existence of uni-directional causality from power utilization to carbon emanations in France. On the other hand, the results of United States reported that the causal connection between power consumption and emission endures the bi-directional relationship. Similarly, Al-Mulali et al. (2016) also inspected the incorporation of sustainable powers' contribution in the Environmental Kuznets curve. The study utilized the data from the time-period of 1980 to 2010. In order to perform the empirical examinations, the authors opted the statistical analytics of Dynamic Ordinary Least Square. The technique helped to identify the presence of long-run relationship among the studied variables. The discoveries of the examination affirmed the existence of the long-run negative impact of renewables on ecological degradation in the form of carbon emissions in United States, Central and Eastern Europe, East Asia and Pacific, Western Europe and South Asia. As for the remaining regions that are analyzed, the authors reported the absence of any significant link among the variables in the nations of Sub-Saharan Africa and Middle East and North Africa.

In another panel estimation for Sab-Saharan emerging nations, Hanif (2018) investigated the utilization of fossil energy, solid energy and renewable power on carbon emissions in thirty four Sab-Saharan economies. The author utilized data for the empirical examinations from the period of 1995 to 2015. Applying GMM technique, the outcomes of the study reported that utilization of fossil and solid energies have significant positive impact on environmental degradation. Similarly, the study also confirmed the substantial contribution of renewable power consumption in reducing environmental degradation. The examination also validated the confirmation of EKC framework and established the inverted U-shaped link between carbon emission and output growth (Ali and Haseeb, 2019; Haseeb et al., 2018; Haseeb., 2019; Suryanto et al., 2018).

# 3. METHODOLOGY

The datasets used in the present research contains of yearly observation of renewable energy consumption, non-renewable energy consumption and carbon dioxide emission which is the proxy of environmental degradation. The data of renewable energy consumption and non-renewable energy consumption is measured as the total energy consumption (in the form of Metric ton of oil equivalent) whereas, we collect the data of carbon dioxide emission as a proxy of environmental degradation and it is measured in the form of Metric ton of oil equivalent. Entire information is assembled focusing the time of 1960-2017 from

World Bank official site. The yearly time arrangement is then changed over into quarterly arrangement by a quadratic match-sum procedure. Along these lines likewise makes alterations for cyclic deviations in the information when the information is changed over from low domain into a high domain by lessening the point-to-point information variations (Shahbaz et al., 2017; Sbia et al., 2014; Raza et al., 2017; Sharif and Raza, 2016; Sharif et al., 2017a; Afshan et al. 2018; Taib et al., 2018). Finally, the information is changed into the logarithmic distinction arrangement to get the return series with the perspective of making our outcomes consistent and reliable (Sharif and Afshan, 2018; Sharif et al., 2017b; Sharif et al., 2018; Sharif and Afshan, 2016; Qazi et al., 2017a; Qazi et al., 2017b).

## 3.1. A Short Note on Wavelet
### 3.1.1. Continuous wavelet transform (CWT)
Subsequent Wavelet Transform $W_x(m,n)$ is one that is accomplished investigate the unequivocal wavelet $\psi$ (Haseeb) in inconsistency of the time succession $x(t) \in L2(R)$, i.e.

$$W_x(m,n) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{n}} \overline{\psi\left(\frac{t-m}{N}\right)} dt$$

Ceaseless Wavelet Transform can possibly deteriorate the time arrangement and flawlessly recover the resulting time series $x(t) \in L^2(\mathbb{R})$:

$$x(t) = \frac{1}{c_\psi} \int_0^\infty \left[ \int_{-\infty}^{\infty} W_x(m,n)\psi_{m,n}(t)du \right] \frac{dn}{N^2}, N > 0$$

In addition, this particular framework encourage the impact of the obtained grouping in time

$$\|x\|^2 = \frac{1}{c_\psi} \int_0^\infty \left[ \int_{-\infty}^{\infty} |W_x(m,n)|^2 \, dm \right] \frac{dn}{N^2}$$

In this manner, in the present research, we relate the previously mentioned importance of the wavelet coherence to count the level of the intrinsic connection of the researched energy, renewable energy consumption and environmental degradation time series model.

### 3.1.2. Wavelet coherence
If the motivation of investigation is to consider the relationship of the 2-time arrangement in a bi-variate course of action in the time frequency occasion, the approach of wavelet coherence is most appropriate. The methodology of wavelet coherence slopes to characterize regions for time and frequency rupture. Moreover, the obtained arrangement of time changes simultaneously, in any case, don't vary basically hold the generous shared power. Referenced beneath is the condition for balanced coefficient of wavelet coherence as recognized by Torrence and Webster (1999):

$$R^2(m,n) = \frac{\left| N\left(N^{-1}W_{xy}(m,n)\right) \right|^2}{N\left(N^{-1}\left|W_x(m,n)\right|^2\right)N\left(N^{-1}\left|W_y(m,n)\right|^2\right)}$$

The relationship of linear approach in the previously mentioned method between the stationary arrangement of bi-variate factors is available at each measurement. Additionally, the connection is reliable to the squared relation coefficient in linear type of regression analysis. Meanwhile, the theoretical circulation for the wavelet coherence isn't perceived, along these lines in the present examination, this is completed by using the technique for Monte Carlo methodology.

## 4. DATA ANALYSIS AND DISCUSSION

Shown in Table 1 are the results of unit root test used in the present investigation. They incorporate the investigation of Augmented Dickey and Fuller (1979) and Phillips and Perron (1988). The motivation behind the referenced unit root tests is to assess the stationary properties inside the time-arrangement factors of the investigation i.e. renewable energy, non-renewable energy and environmental degradation. The aftereffects of unit root hence proposed that both the factors are non-stationary at the dimension yet gain the stationarity at first differential series. The discoveries along these lines grasp that renewable, non-renewable energy consumption and environmental degradation don't incorporate the issue of unit root.

The continuous wavelet examination is moderately effortlessly decoded as it offers increasingly perceptible and obvious recurrence proof. Therefore, to set up the discoveries of the wavelet transform, continuous wavelet analysis in investigating the relationship between renewable energy consumption and environmental degradation is utilized. Figure 1 shows the continuous wavelet power range in the two arrangement.

### 4.1. Continuous Wavelet and Wavelet Coherence Results (RENE-CO$_2$)

The aftereffect of continuous wavelet power range offers the fluctuation impacts of the factors in three areas of time, frequency and color bar. Shown in Figure 1 are the aftereffects of renewable energy consumption and environmental degradation in logical time-frequency relationship. The discoveries propose that the variations of renewable energy consumption are high in the short-term running from the time of 2001 to 2004. Concerning medium-run, the solid variation of the variable is recognized in the time of 1999-2005. Besides, the power of the variance can be distinguished from the shading range from the side bars. In this specific situation, the outcomes can likewise translate that the changes in renewable energy consumption are higher in short run having dim red shading yet moderately bring down in the medium time period as the group shading code is changed to orange-red.

Moreover, the outcomes for environmental degradation is shown on the right side of Figure 1. The discoveries recommend that the fluctuation of environmental degradation is high in the short-run period from the time of 2006 to 2008. With respect to medium-run, the strong fluctuation of the environmental degradation is distinguished in the time of 2004-2009. Besides, so as to distinguish the power of the fluctuation, the outcomes propose that like renewable energy consumption the variety of environmental degradation are also stronger in short run having dull red shading than in the medium time period for consuming orange red shading.

The aftereffects of wavelet coherence between renewable energy consumption and environmental degradation are introduced

**Table 1: Stationary test results**

| Variables | Augmented Dickey-Fuller | | | | Phillips-Perron | | | |
|---|---|---|---|---|---|---|---|---|
| | I (0) | | I (1) | | I (0) | | I (1) | |
| | C | C&T | C | C&T | C | C&T | C | C&T |
| ENG | 2.134 | 1.895 | −7.482 | −6.920 | 1.963 | 2.020 | −6.942 | −6.324 |
| RENE | −0.743 | −0.801 | −3.940 | −4.082 | −0.893 | −0.792 | −4.392 | −4.127 |
| CO$_2$ | −1.484 | −1.587 | −5.032 | −5.182 | −1.284 | −1.012 | −5.049 | −4.896 |

Source: Authors' estimation. The critical values for ADF and PP tests with constant (c) and with constant & trend (C&T) 1%, 5% and 10% level of significance are −3.596, −2.931, −2.604 and−4.194, −3.522, −3.219 respectively
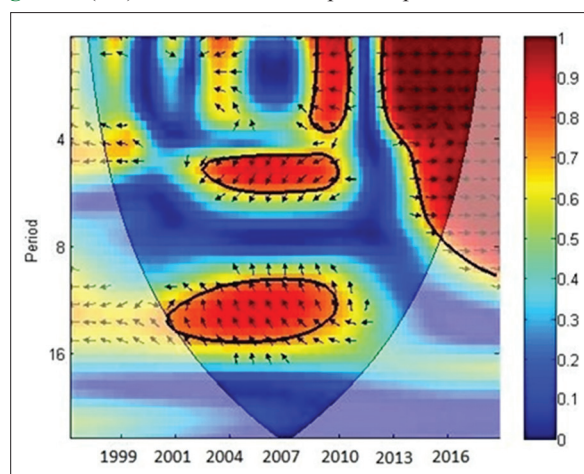
**Figure 1:** (a-b) Continuous wavelet power spectra of RENEW and CO$_2$
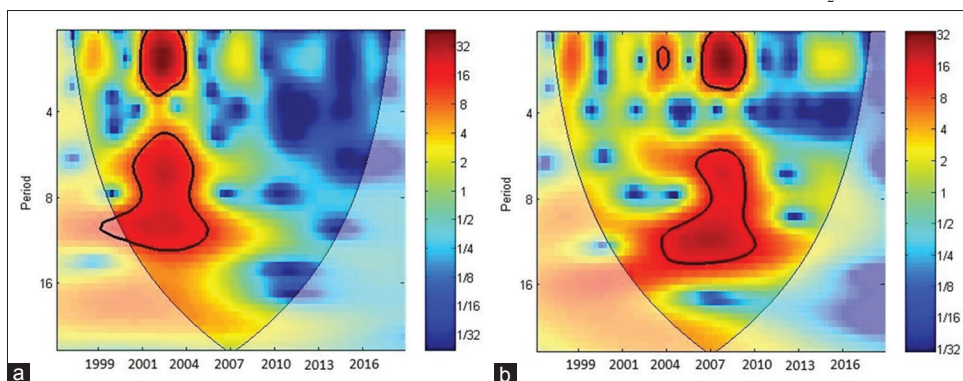


The thick black contour represents the 5% significance level against the red noise. The color code for power ranges from blue (low power) to red (high power)

in Figure 2. In short run (0-4 period), we have two significant gatherings of red shading. Amid the year 2009-2011, we have an arrow left side upward which implies both the variable are out-stage and have an anticyclic impact in which renewable energy consumption is driving (renewable energy consumption affects negatively to environmental degradation). Besides, amid the era of 2012-2016, we have arrow are right side upwards showing that the two factors are in-stage and having cyclic impact in which environmental degradation is leading ($CO_2$ has a positive causal association with RENEW). In medium run (4-8 period), we have again two significant clusters of red color. During the period of 2002-2010, we found a cluster where all the arrows are left side down indicating that both variables i.e. renewable energy consumption and environmental degradation are out-phase and have an anti-cyclic effect where $CO_2$ is leading (environmental degradation has a negative causal influence on renewable energy consumption in Malaysia. Finally, in the long run (8-16 period), we found one cluster having a red color. In this cluster all the arrows are left side up indicating that both variables are out-phase and have anti cyclic effect on each other in long run period (renewable energy consumption has a causal negative influence on environmental degradation in Malaysia).

**Figure 2:** (a-b) Wavelet coherence power spectra of RENW-$CO_2$



The thick black contour represents the 5% significance level against the red noise. The color code for power ranges from blue (low power) to red (high power)

However, we found no proof of a causal relationship in a very long run period.

## 4.2. Continuous Wavelet and Wavelet Coherence Results (ENG-$CO_2$)

The outcomes of continuous wavelet power range offer the fluctuation impacts of the factors. Shown in Figure 3 are the aftereffects of energy consumption and environmental degradation in logical time-frequency relationship. The discoveries propose that the variations of energy consumption are high in the short-term running from the time of 2003 to 2006. Concerning medium-run, the solid variation of the variable is recognized in the time of 2004-2005. Besides, the power of the variance can be distinguished from the shading range from the side bars. In this specific situation, the outcomes can likewise translate that the changes in renewable energy consumption are higher in short run having dim red shading yet moderately bring down in the medium time period as the group shading code is changed to orange-red. However, in the long run period, solid variation of the variable is recognized in the time of 2001-2008.

The results of wavelet coherence between energy consumption and environmental degradation are presented in Figure 4. In short run (0-4 period), we have two considerable bunches of red shading. Amid the year 1997-1999, we have a arrows right side upward which implies both the variable are in-stage and have a cyclic impact in which environmental degradation is driving ($CO_2$ emission affects ENG). Besides, amid the day and age of 2007-2010, we have arrows are correct side upwards and furthermore right-side descending demonstrating that the two factors are in stage and cyclically affecting one another (ENG and $CO_2$ has a bi-directional causal association with one another). In the time of 16-32, we have a solitary group in which all arrows are right side upwards which are plainly demonstrating that the two factors are in-stage and having cyclic impact in which environmental degradation is driving. In synopsis, the aftereffects of wavelet coherence affirm that $CO_2$ emission and ENG have a bi-directional causal association with one another in short run and a uni-directional causal relationship where $CO_2$ emission is driving. Whereas, no proof of a causal relationship in a medium run period.

**Figure 3:** Continuous wavelet power spectra of ENG and $CO_2$
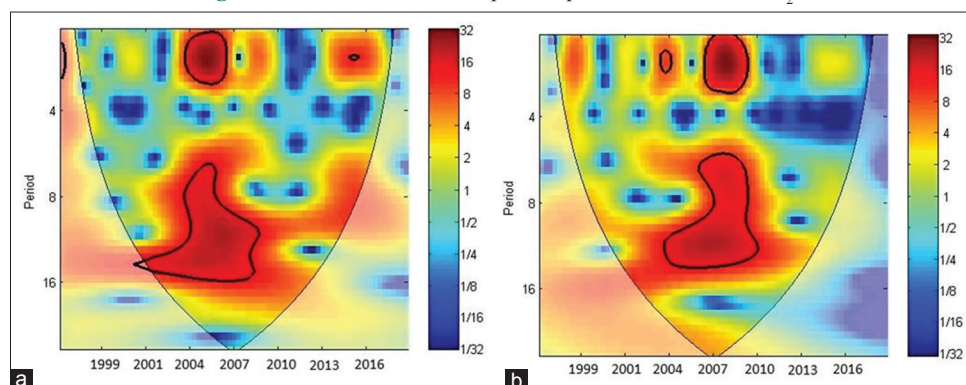


The thick black contour represents the 5% significance level against the red noise. The color code for power ranges from blue (low power) to red (high power)

**Figure 4:** Wavelet coherence power spectra of ENG-CO
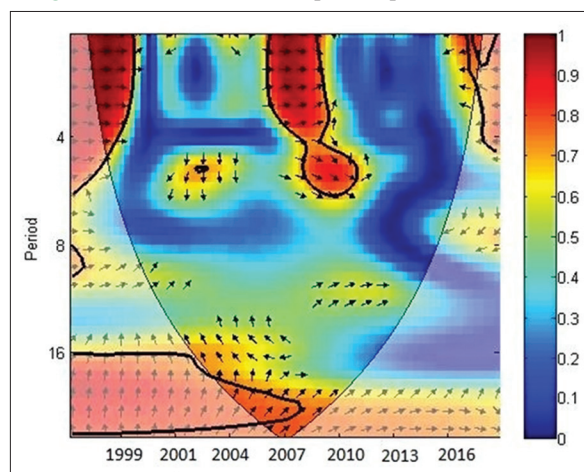


The thick black contour represents the 5% significance level against the red noise. The color code for power ranges from blue (low power) to red (high power)

## 5. CONCLUSION AND RECOMMENDATIONS

Regardless of the various existing literature with studies concentrating on the relationship among renewable energy consumption, energy consumption and environmental degradation, results are fairly blended. Additionally, past investigations have likewise utilized established examination methods, for example, autoregressive models, linear models or cointegration models which are inclined to the issues of non-stationary time arrangement. We have utilized the wave-like wavering transmute structure to explore the relationship among renewable energy consumption, non-renewable energy consumption and environmental degradation in Malaysia.

We have utilized continuous wavelet power range, and wavelet coherence power range estimations to analyze the relationship among renewable energy consumption, non-renewable energy consumption and environmental degradation by taking about quarterly data for the time of 1997(1) to 2017(4). Moreover, the consequences of wavelet coherence affirm that ENG and $CO_2$ emission have a bi-directional causal association with one another in the medium run and a uni-directional causal relationship where ENC is driving in a short run era. However, we found no proof of a causal relationship in a long and long run period. Finally, the aftereffects of wavelet coherence affirm that RENE and $CO_2$ emission have a bi-directional causal association with one another in short run and a uni-directional causal relationship where $CO_2$ emission is driving in medium run day and age. Nonetheless, we found a proof of a uni-directional causal relationship in a long and long run period where causality is running from renewable energy consumption to environmental degradation in Malaysia.

Despite the fact that this investigation distinguishes the confinement of bivariate procedure, in the further studies researchers may utilize a multivariate method to reevaluate the association. This examination should be possible later on with nexus of some other monetary variable for example, tourist arrivals, oil prices, exchange rate, stock price index exports of goods and services and

foreign portfolio investment which can be suitable on theoretical perspectives in the economic system.

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