Available Online at www.e-iph.co.uk
Indexed in Clarivate Analytics WoS, and ScienceOPEN

E-B
Environment - Behaviour Proceedings Journal

AicQoL2024KotaKinabalu
https://www.amerabra.org

e-IPH
e-International Publishing House Ltd., United Kingdom

12th AMER International Conference on Quality of Life
The Magellan Sutera Resort, Kota Kinabalu, Malaysia, 26-28 Jan 2024

Carbon Conscious Consumption: Impact of expenditure and renewable energy in Malaysia

Norashida Othman[1*], Farah Raihana Ismail[2], Siti Norida Wahab[3], Safwan Kamal[4]
** Corresponding Author*

[1] Department of Economics and Financial Studies Faculty of Business and Management, Universiti Teknologi MARA (UiTM), Selangor, Malaysia.
[2] Department of Marketing and Management, School of Business and Economics (SPE), Universiti Putra Malaysia (UPM), Serdang, Malaysia.
[3] Department of Technology and Supply Chain Management Studies, Faculty of Business and Management, Universiti Teknologi MARA (UiTM), Selangor, Malaysia.
[4] Department of Zakat dan Waqf Management, Faculty of Islamic Economics and Business, IAIN Langsa, Langsa, Indonesia.

Email of All Authors: shidaothman@uitm.edu.my; fara.raihana@gmail.com; sitinorida23@uitm.edu.my; safwankamal@iainlangsa.ac.id
Tel: +6010 2451335

Abstract
This study aims to assess the impact of domestic consumption and renewable energy on environmental pollutants, with national income (GDP) included as a control variable. Employing the auto-regressive distributed lag (ARDL) econometric technique, the analysis spans time series data from 1990 to 2020. The bound F-test and Johansen cointegration tests validate that domestic consumption substantially contributes to environmental pollution. By addressing existing gaps in knowledge, this research provides valuable insights for shaping sustainable energy policies tailored to the unique circumstances of Malaysia.

Keywords: Carbon Emission; Consumption Expenditure; Renewable Energy Consumption; Auto-regressive Distribution Lag (ARDL)

DOI: https://doi.org/10.21834/e-bpj.v9i27.5374

1.0 Introduction

The issue of global climate change has become increasingly critical, primarily due to elevated concentrations of greenhouse gases (GHGs), with carbon dioxide (CO2) being the dominant contributor (Raihan et al., 2022). The increasing consumption spending in Malaysia gives rise to worries over its association with the upward trend in carbon emissions (Figure 1). As the country experiences economic expansion and urban development, the rise in consumer expenditure on products and services might significantly increase activities that produce high carbon emissions. This study is crucial for Malaysia due to its rapidly evolving economic landscape and the associated environmental challenges. As Malaysia experiences robust economic growth, the implications of carbon dioxide emissions on environmental degradation become increasingly pressing.

eISSN: 2398-4287 © 2024. The Authors. Published for AMER & cE-Bs by e-International Publishing House, Ltd., UK. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer–review under responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers), and cE-Bs (Centre for Environment-Behaviour Studies), College of Built Environment, Universiti Teknologi MARA, Malaysia.
DOI: https://doi.org/10.21834/e-bpj.v9i27.5374

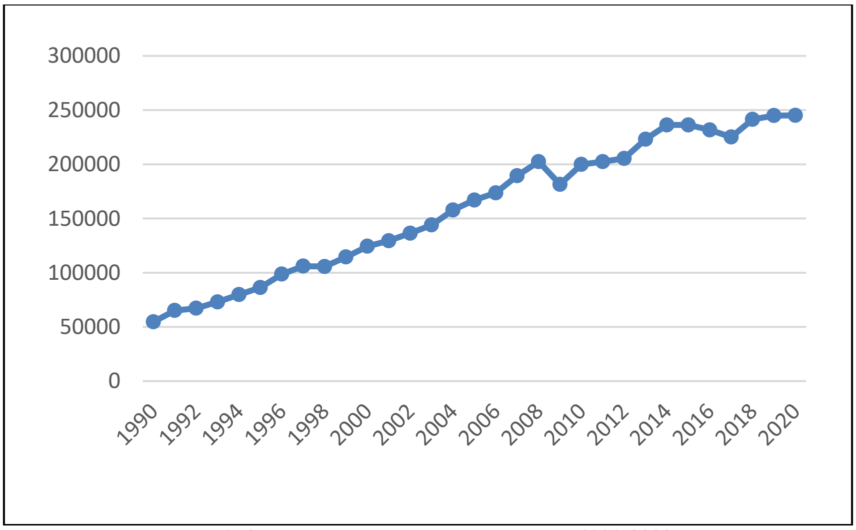

Fig. 1. Carbon dioxide emissions in Malaysia 1990-2020
Source: worldbank, 2023

The higher carbon emissions in Malaysia pose a multifaceted problem with serious environmental and public health implications. Elevated carbon emissions contribute significantly to climate change, resulting in adverse impacts such as extreme weather events, rising temperatures, and ecosystem disruptions. In Malaysia, a country vulnerable to climate-related risks, this exacerbates challenges like floods, droughts, and biodiversity loss. Furthermore, increased carbon emissions contribute to air pollution, affecting the respiratory health of the population. As Malaysia strives for sustainable development, higher carbon emissions also signify a dependence on fossil fuels, hindering the transition to a greener and more resilient economy.

As Malaysia strives to achieve its sustainability goals, it is critical to investigate the interplay between domestic expenditure, particularly in relation to energy consumption, and the adoption of renewable energy sources. Therefore, this research aims to explore this gap in knowledge by analyzing the intricate relationships between domestic expenditure, renewable energy utilization, and carbon emissions, providing valuable insights for policymakers, businesses, and the public to foster environmentally responsible economic development. The objective of the study is to identify the influence of domestic consumption expenditure and renewable energy consumption on carbon emissions. This research is vital for formulating specific policies and strategies that foster a future in Malaysia characterized by sustainability and reduced carbon footprint.

2.0 Literature Review

The theoretical impact of household consumption on carbon emissions is uncertain. Nevertheless, research has examined various viewpoints regarding the correlation between household consumption and carbon emissions. Various elements have been identified as the catalysts for environmental sustainability. The latest study conducted by Alola et al. (2021) and Sarkodie (2020) emphasizes that domestic consumption (DC) has been extensively analyzed from several angles, primarily focusing on its role as an environmental variable. There is a scarcity of research that has examined domestic consumption in terms of its contribution to environmental sustainability about greenhouse gas (GHG) emissions. Only a few studies have investigated the factors contributing to environmental contamination from the viewpoint of developing countries (Alola et al., 2021; Ahmad & Khattak, 2020). In their study, Ahmad and Khattak (2020) investigated the impact of aggregate domestic consumption spending per capita (ADCSP) on carbon dioxide (CO2) emissions in South Africa. More precisely, the study found that a 1% rise in ADCSP leads to a 0.31% increase in CO2 emissions in the long term and a 0.22% increase in the short term.

Furthermore, their research deduces from the non-linear Autoregressive Distributed Lag (NARDL) model that a positive disturbance in average daily carbon stock price (ADCSP) has a greater impact on long-term CO2 emissions than short-term emissions. Similarly, Alola et al. (2021) discovered that DC (domestic consumption) negatively impacts the environmental condition of the group of European Union member countries, both in the short and long term. They also observed that real income hurts the environment, while alternative energy sources are a potential solution to reduce greenhouse gas emissions.

Liu et al. (2021) investigated the impact of household consumption on carbon emissions across 30 Chinese provinces from 1995 to 2017, employing various estimators such as the pooled mean group, common correlated effects mean group, and recently developed cross-sectional augmented autoregressive distributed lag methods. Their findings suggest that household consumption contributes significantly to increased carbon emissions. Meanwhile, Khan et al. (2020) focused on consumption-based carbon emissions, considering trade adjustments for oil-exporting nations. Their empirical results, spanning both short-run and long-run analyses, indicate a detrimental impact of exports on consumption-based carbon emissions. Additionally, gross domestic product (GDP) and imports were found to exert a positive and statistically significant influence on consumption-based carbon emissions in both the short-run and long-run contexts.

Ehigiamusoe and Dogan (2022) explored the effects of real income, renewable energy consumption, and their interactive impact on carbon emissions in low-income countries. The findings indicate that while renewable energy mitigates emissions, the interaction effect remains positive, and the marginal effect of renewable energy on emissions varies with real income levels. Sun et al. (2022) investigated the interconnections among renewable energy consumption, urbanization, economic growth, and carbon emissions (CE) in the MENA region from 1991 to 2019. Their study revealed that economic growth contributed to increased CE, whereas renewable energy consumption emerged as an optimal solution for CE mitigation. Bekun (2019) scrutinized the determinants of CE in the EU, emphasizing the role of renewable energy, among other factors. The study highlighted that using renewable energy in the EU countries exhibited a carbon-mitigating effect. Furthermore, Usman (2020) employed the NARDL approach to elucidate the asymmetric role of clean energy utilization in carbon emissions from 1975-2018 in Pakistan. The study discerned that positive and negative shocks in alternative energy sources, encompassing cleaner, nuclear, and explosive waste energy, had varying effects on carbon emissions in Pakistan.

Moreover, previous researchers have exerted considerable effort to elucidate the impact of economic growth on the environment and to discern the true association between these variables and environmental degradation. While some scholars, as exemplified by Khan et al. (2021) and Zafar et al. (2019), assert that economic growth significantly contributes to enhancing environmental quality, another group of researchers has an opposing perspective. Scholars such as Uzair Ali et al. (2022), Abid et al. (2022), and Chishti et al. (2021) contend that economic growth and domestic savings pose challenges to the ecological system. Rooted in the demand-following hypothesis, proponents argue that robust economic development fosters sustainable financial development, facilitating funds transfer from the finance sector to the real sector and stimulating domestic savings. This, in turn, allows for investments in research and development, leading to human capital development. Encouraging green technology projects and allocating funds to promote eco-friendly innovations can reduce wastage, enhance productivity, and decrease the demand for raw materials (Murshed et al., 2021; Liu & Song, 2020). However, the Environmental Kuznets Curve (EKC) hypothesis posits that economic development contributes to environmental pollution. This occurs as many countries opt for low-cost but high carbon-emission energy sources to minimize costs and lower product prices, aiming to capture foreign markets. Although transitioning to renewable energy sources yields long-term benefits, the initial costs are substantial (Xu et al., 2021). Based on the aforementioned investigations, Table 1 summarizes the variables that influence carbon emissions in Malaysia.

Table 1. Summary of variable descriptions

Variable	Measurement
Carbon Emissions (CO2E)	Carbon dioxide emissions in (Kt)
Domestic Consumption (DC)	Final domestic consumption expenditure (constant 2015 US$)
Renewable Energy (Renew)	Renewable energy consumption (% of total final energy consumption)
Economic Growth (Y)	GDP per capita (constant 2015 US$)

(Source: World Development Indicators (WDI))

The limitations of prior research are twofold. Firstly, the majority of previous studies have concentrated solely on developed countries. Secondly, the proxy employed to measure environmental pollution has been confined to carbon emissions. This current study addresses the abovementioned gaps by evaluating the long-term association between domestic consumption and environmental pollution, utilizing carbon emissions as a proxy.

3.0 Methodology

Utilizing the auto-regressive distributed lag (ARDL) econometric technique, this study analyses time series data spanning from 1990 to 2020. The ARDL bounds testing technique is employed to scrutinize the long-term relationships among the variables, given the dataset's integration with a combination of I(0) and I(1) in a small sample size. Recognized as a flexible and widely adopted approach for cointegration testing in a multivariate context (Othman et al., 2023), ARDL is selected for its suitability. The investigation explores the association between domestic consumption and carbon emissions in Malaysia, where emissions proxy for environmental pollution variables. Following the model framework derived from prior literature, the selected variables are structured in the following form:

$$LnCo2E = \beta_0 + \beta_1 DC_t + \beta_2 LnRenew_t + \beta_3 LnY_t + e_t \tag{1}$$

Where $Co2E$ represents carbon dioxide emissions, DC is the final domestic consumption, Renew denotes renewable energy consumption, Y signifies national income, and e_t denotes the error term. To facilitate analysis, this study applies natural logarithmic transformations to all variables. The data utilized in the analysis were sourced from the World Development Index (WDI), covering annual data from 1990 to 2020. Ensuring stationarity is crucial, as nonstationarity would render all regression analysis results invalid. Therefore, the augmented Dickey–Fuller (ADF) and Phillip–Perron (PP) tests will be employed to verify the stationarity of each variable. The general specification of this study's ARDL bound test approach takes the form of an unrestricted error correction model to test for cointegration as follows:

$$\Delta lnCo2E_t = \propto_0 + \sum_{K=1}^{t} \propto_k \Delta lnDC_{t-K} + \sum_{l=0}^{u} \gamma_l \Delta lnRenew_{t-l} + \sum_{i=m}^{v} \tau_m \Delta lnY_{t-m} + \emptyset_1 lnCo2_{t-1} + \emptyset_2 lnDC_{t-1} + \emptyset_3 lnRenew_{t-1} + \delta_4 lnY_{t-1} + \varepsilon_t \tag{2}$$

Where ∆ denotes the first difference operator, and n represents the lag order. The term $\Delta lnCo2E_t = \alpha_0$ captures the changes in the lagged dependent variable, where α_0 signifies the drift term, and ε_t denotes the residuals. Subsequently, the study ascertains the optimal lag length for p, q, r, and s in Equation (2). The determination of maximum lags relies on the AIC information criteria. Additionally, a uniform lag length (p, p, p, p) is employed. Finally, the calculated F-statistics in this study are compared to critical values tabulated by Narayan (2005) given the relatively small sample size (ranging from 30 to 80 observations). If the computed F-statistic falls below the lower bound, the null hypothesis of no cointegration cannot be rejected. Conversely, if the computed F-statistic surpasses the upper threshold, the null hypothesis of no cointegration can be rejected, indicating a cointegrating long-run relationship. However, the test results are inconclusive when the calculated F-statistic falls between the two critical value limits. The optimal lag selection will be based on AIC, and diagnostic and stability tests will be conducted to evaluate the adequacy of the ARDL model's goodness of fit.

4.0 Findings

4.1 Unit Root Test

The outcomes from the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests in Table 2 reveal that the p-values for all variables are statistically significant, leading to the rejection of the null hypothesis of stationarity at both the level and first difference. Consequently, the study infers a mixed stationary result for the unit root test. With this observation, the subsequent step involves advancing to the ARDL bounds testing approach to assess cointegration.

Table 2. Stationary test

Variables	t - statistic				
	Level		First Difference		Order of Integration
	ADF	PP	ADF	PP	
lnCo2	-1.0701	-1.4474	-6.4503***	-6.9041***	I (1)
LnDC	2.6204	2.7725	-2.7558*	-2.6976*	I (1)
lnRenew	-1.6814	-1.7407	-3.1903**	-3.1242**	I (1)
lnY	-4.7731***	-4.7679***	-4.767942**	-24.954***	I (0)

*(Note: Symbols *** ,** and * indicates p < .01, p < .05, p < .10 respectively)*

4.2 Cointegration Bound Test

The first stage in the cointegration bound test approach involves estimating the ARDL model while employing a relevant criterion for lag length selection. This study utilised the Schwarz criterion (SIC) to identify the optimal lag order for the conditional ARDL model, with a maximum lag order set at 2. After this, the analysis focused on evaluating the combined significance of the coefficients using the Wald test, a statistical procedure involving the imposition of constraints on the estimated long-run coefficients of the variables. The outcomes of the bound test are succinctly presented in Table 3.

Table 3: Bounds Test for the presence of a relationship level.

Test Statistic	**Value**	**Significance level**	**I(0)**	**I(1)**
F-Statistic	4.1477*		K=3 N=30	
		1%	3.65	4.66
		2.5%	3.15	4.08
		5%	2.79	3.67
		10%	2.37	3.20

*(Note:*Denotes rejection of the null hypothesis of no cointegration at 10% significance level. #The critical values are obtained from Narayan (2005)*

The outcome from Table 3 reveals that when Co2E is considered the dependent variable, the null hypothesis of no cointegration is dismissed, given that the F-statistic value of 4.1477 surpasses the upper bound critical value at a 2.5% significance level. This result signifies the rejection of the null hypothesis, indicating evidence supporting a long-term relationship among the variables. Subsequently, Table 4 outlines each variable's long-term coefficients derived from the ARDL model. The findings highlighted in Table 4 show that only lnRenew exhibits negative coefficients in relation to lnCo2E, and these coefficients are statistically significant at a 1% significance level. Conversely, lnDC and lnY display positive coefficients but are not deemed statistically significant.

Table 4. Long-run estimation based on the selected ARDL model (1,1,0,0)

Variable	Coefficient	t-Statistic	Prob.
C	1.8468 (3.4533)	0.5348	0.5977
lnDC	0.0596 (0.3929)	-0.1517	0.8806
lnRenew	-0.2326 (0.0868) ***	-2.6792	0.0131
lnY	1.3429(0.0083)	1.6713	0.1076

*(Notes: Standard errors in ( ) and ***,**,* are significant at 1%, 5%, and 10%, respectively)*

Table 5 depicts the short-run interrelations among the variables using the error correction term model (ECT). As anticipated, the ECT coefficient exhibits a negative and statistically significant value at a 1% level, indicating that 32.34% of the disequilibrium corrects itself to reach long-term equilibrium within one year. This implies that any disequilibrium shock from the preceding year adjusts swiftly toward long-run equilibrium, converging at a rate of 32.34% annually, with full adjustment expected to take more than a year (3.09 years). Additionally, Table 5 indicates the absence of short-run relationships among the variables.

Table 5. Error correction term model and short-run estimation

Variable	Coefficient	t-Statistic	Prob.
C	-0.0007 (0.0170)	-0.0450	0.9645
D lnCo2E(-1)	-0.2293 (0.1334)*	-1.7182	0.0992
D lnDC	0.7522 (0.3947)*	1.9058	0.0692
D lnRenew	-0.0479 (0.0546)	-0.8771	0.3895
D lnY	-0.0424 (0.4008)	-0.1058	0.9166
ECT(-1)	--0.3234 (0.0909)	-3.5567	0.0017
Diagnostic test statistic			
R^2	0.5900	Prob(F-statistic)	0.0005
Adjusted R^2	0.5009	Durbin-Watson stat	2.0384
Log likelihood	59.558	S.E. of regression	0.03484
F-statistic	6.6222		

*(Notes: Dependent variable: lnCo2E. Standard error in ( ) and *, **, *** denotes significance at 10%, 5% and 1% respectively)*

The next phase involves performing diagnostic tests to identify potential issues after determining both long-run and short-run relationships among the variables. To guarantee the impartiality of the chosen model and results, tests for serial correlation, heteroscedasticity, and stability (CUSUM stability tests) are executed. The outcomes of these diagnostic tests are presented in Table 6.

Table 6. Statistical output for sensitivity analysis

Test Statistic	F-Statistic	Prob. Values
Serial Correlation (lag2)	0.5036	0.6126
Serial Correlation (lag4)	1.8191	0.1745
Normality	3.3642	0.3371
Heteroscedasticity	1.5481	0.2031
CUSUM	Stable (refer to fig. 2)	
CUSUMSQR	Stable (refer to fig.3)	

(Source: Output from E-views)

The diagnostic assessments involved scrutinizing serial correlation, normality, heteroscedasticity, and the CUSUM Test and CUSUM Square. Critical boundaries were established at a significance level of 5%. The model is considered stable when the blue line remains within these critical bounds, as demonstrated in Figures 2 and 3. However, if the blue line deviates beyond these critical thresholds, it suggests potential inconsistencies or unpredictability in the model's efficacy. The results affirm that the model is unbiased and stable, as detailed in Table 6.

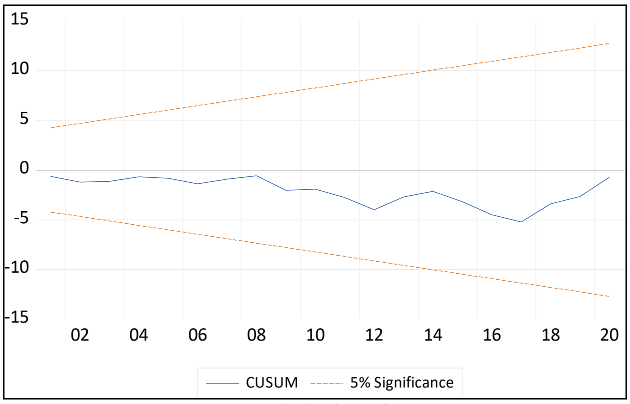

Fig. 2: CUSUM Stability Tests
(Source: Output from E-views)

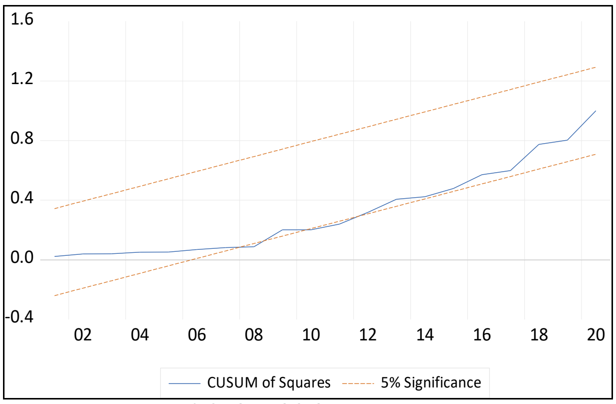

Fig. 3 CUSUMSQ Stability Tests
(Source: Output from E-views)

5.0 Discussion

The impact of domestic consumption on carbon dioxide emissions was found to be significant at a 10% level of significance. The coefficient (0.7522) for lnDC suggests that a one percent increase in domestic consumption correlates with a 0.75% increase in carbon dioxide emissions in the short term. These findings align with previous studies by Liu et al. (2021), Ahmad and Khattak (2020), and Alola et al. (2021). The observed increase in carbon emissions from domestic consumption in Malaysia during the short run can be attributed to a various factors. Firstly, the prevailing dependence on traditional fossil fuels exacerbates the carbon footprint associated with heightened consumption, as the transition to cleaner energy alternatives may not occur swiftly in the short term. Moreover, the consumption patterns, often characterized by the purchase and utilization of carbon-intensive products and appliances, contribute significantly to the observed spike in emissions. In the absence of widespread adoption of green technologies and sustainable practices, the carbon intensity of economic activities linked to domestic consumption remains high.

On the contrary, the effect of renewable energy consumption on carbon dioxide emissions exhibited statistical significance at a 1% level. The coefficient (-0.23) associated with *lnRenew* illustrates that a one percent increase in renewable energy consumption leads to a 0.23% decline in carbon dioxide emissions in the long run. One pivotal cause is the strategic governmental emphasis on sustainable development and environmental conservation. Malaysia has implemented progressive policies and incentives to promote the adoption of renewable energy sources, such as solar, wind, and hydroelectric power. One pivotal cause is the strategic governmental emphasis on sustainable development and environmental conservation. Malaysia has implemented progressive policies and incentives to promote the adoption of renewable energy sources, such as solar, wind, and hydroelectric power. These initiatives aim to diversify the energy mix, reduce dependency on fossil fuels, and create a more resilient and eco-friendly energy infrastructure. Technological advancements and innovation within the renewable energy sector have played a pivotal role in enhancing efficiency and output. These technologies' continuous improvement and optimization contribute to their effectiveness in reducing carbon emissions over the long term.

6.0 Conclusion and Recommendations

The impact of domestic consumption on carbon dioxide emissions was significant at a 10% significance level. The coefficient (0.7522) for lnDC suggests that a one per cent increase in domestic consumption correlates with a 0.75% increase in carbon dioxide emissions in the short term. These findings align with previous studies by Liu et al. (2021), Ahmad and Khattak (2020), and Alola et al. (2021). The observed increase in carbon emissions from domestic consumption in Malaysia during the short run can be attributed to various factors. Firstly, the prevailing dependence on traditional fossil fuels exacerbates the carbon footprint associated with heightened consumption, as the transition to cleaner energy alternatives may occur slowly in the short term. Moreover, consumption patterns, often characterized by the purchase and utilization of carbon-intensive products and appliances, contribute significantly to the observed spike in emissions. Without widespread adoption of green technologies and sustainable practices, the carbon intensity of economic activities linked to domestic consumption remains high.

Moreover, aligning with international sustainability goals has prompted the country to prioritize renewable energy adoption as part of its climate change mitigation strategy. The collaborative exchange of knowledge, technologies, and best practices with the global community further supports Malaysia's transition to a low-carbon energy landscape. As Malaysia positions itself as a proactive player in the global effort to combat climate change, these causes underscore the importance of a comprehensive and synergistic approach to achieve lasting reductions in environmental degradation by promoting renewable energy.

7.0 Limitations of the Study

The limitation of this study lies in the assumption of a linear relationship between domestic expenditure, renewable energy adoption, and carbon emissions. Complexities such as technological advancements, policy shifts, and unforeseen economic factors may introduce non-linear dynamics, influencing the accuracy of predictions. Another possible limitation is the exclusive focus on Malaysia, limiting the generalizability of findings. Future studies should conduct a comparative analysis across diverse ASEAN countries, including Indonesia, Thailand, Philippines, and Singapore, to offer a broader understanding of environmental pollution's nuances. Expanding the scope will provide policymakers with insights into tailoring effective and context-specific strategies for mitigating the impact of environmental pollution across the region.

Paper Contribution to Related Field of Study

This study advances environmental economics by unravelling the complex relationship between domestic expenditure, renewable energy integration, and carbon emissions in Malaysia. The findings provide actionable insights for policymakers, facilitating informed decisions towards sustainable development and emissions reduction strategies.

References

Abid, A., Mehmood, U., Tariq, S., & Haq, Z. U. (2022). The effect of technological innovation, FDI, and financial development on CO2 emission: evidence from the G8 countries. *Environmental Science and Pollution Research*, 29(8), 11654-11662.

Ahmad, M., & Khattak, S. I. (2020). Is aggregate domestic consumption spending (ADCS) per capita determining CO2 emissions in South Africa? A new perspective. *Environmental and Resource Economics*, 75(3), 529-552.

Akadiri, S. S., & Akadiri, A. C. (2020). Interaction between CO2 emissions, energy consumption and economic growth in the Middle East: panel causality evidence. *International Journal of Energy Technology and Policy*, 16(2), 105-118.

Alola, A. A., Akadiri, S. S., & Usman, O. (2021). Domestic material consumption and greenhouse gas emissions in the EU-28 countries: Implications for environmental sustainability targets. *Sustainable Development*, 29(2), 388-397.

Aydemir, O., & Zeren, F. (2017). The impact of foreign direct investment on CO2 emission: evidence from selected G-20 countries. In Handbook of research on global enterprise operations and opportunities. *IGI Global.* (pp. 81-92). Access on 10th June 2023

Bekun, F. V., Alola, A. A., & Sarkodie, S. A. (2019). Toward a sustainable environment: Nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. *Science of the total Environment*, 657, 1023-1029.

Chishti, M. Z., Ahmed, Z., Murshed, M., Namkambe, H. H., & Ulucak, R. (2021). The asymmetric associations between foreign direct investment inflows, terrorism, CO2 emissions, and economic growth: a tale of two shocks. *Environmental Science and Pollution Research*, 28(48), 69253-69271.

Ehigiamusoe, K. U., & Dogan, E. (2022). The role of interaction effect between renewable energy consumption and real income in carbon emissions: evidence from low-income countries. *Renewable and Sustainable Energy Reviews*, 154, 111883.

Khan, A., Chenggang, Y., Hussain, J. & Kui, Z. (2021). Impact of technological innovation, financial development and foreign direct investment on renewable energy, non-renewable energy and the environment in belt & Road Initiative countries. *Renewable Energy*, 171, 479-491

Khan, Z., Ali, M., Jinyu, L., Shahbaz, M., & Siqun, Y. (2020). Consumption-based carbon emissions and trade nexus: evidence from nine oil exporting countries. *Energy Economics*, 89, 104806.

Liu, H., & Song, Y. (2020). Financial development and carbon emissions in China since the recent world financial crisis: Evidence from a spatial-temporal analysis and a spatial Durbin model. *Science of the Total Environment*, 715, 136771.

Liu, J., Murshed, M., Chen, F., Shahbaz, M., Kirikkaleli, D., & Khan, Z. (2021). An empirical analysis of the household consumption-induced carbon emissions in China. *Sustainable Production and Consumption*, 26, 943-957.

Murshed, M., Rahman, M., Alam, M. S., Ahmad, P., & Dagar, V. (2021). The nexus between environmental regulations, economic growth, and environmental sustainability: linking environmental patents to ecological footprint reduction in South Asia. *Environmental Science and Pollution Research*, 28(36), 49967-49988

Raihan, A., Begum, R. A., Said, M. N. M., & Pereira, J. J. (2022). Relationship between economic growth, renewable energy use, technological innovation, and carbon emission toward achieving Malaysia's Paris agreement. *Environment Systems and Decisions*, 42(4), 586-607.

Sarkodie, S. A. (2020). Causal effect of environmental factors, economic indicators and domestic material consumption using frequency domain causality test. *Science of the Total Environment*, 736, 139602.

Sun, Y., Li, H., Andlib, Z., & Genie, M. G. (2022). How do renewable energy and urbanization cause carbon emissions? Evidence from advanced panel estimation techniques. *Renewable Energy*, 185, 996-1005.

Usman, A., Ullah, S., Ozturk, I., Chishti, M. Z., & Zafar, S. M. (2020). Analysis of asymmetries in the nexus among clean energy and environmental quality in Pakistan. *Environmental Science and Pollution Research*, 27, 20736-20747.

Uzair Ali, M., Gong, Z., Ali, M. U., Asmi, F., & Muhammad, R. (2022). CO2 emission, economic development, fossil fuel consumption and population density in India, Pakistan and Bangladesh: a panel investigation. *International Journal of Finance & Economics*, 27(1), 18-31.

Xu, X., Huang, S., An, H., Vigne, S., & Lucey, B. (2021). The influence pathways of financial development on environmental quality: New evidence from smooth transition regression models. *Renewable and Sustainable Energy Reviews*, 151, 111576.

Zafar, M. W., Shahbaz, M., Hou, F., & Sinha, A. (2019). From nonrenewable to renewable energy and its impact on economic growth: the role of research & development expenditures in Asia-Pacific Economic Cooperation countries. *Journal of Cleaner Production*, 212, 1166-1178.