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DOES NATURAL RESOURCE RENT DEGRADE ENVIRONMENTAL QUALITY? A CASE STUDY IN VIETNAM

A renda por recursos naturais degrada a qualidade ambiental? um estudo de caso no Vietnã

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ABSTRACT

This study analyzes the relationship between economic growth, natural resource rent, industrial activity, and greenhouse gas emissions during the period 1986–2021. Annual time-series data were collected from the World Development Indicators, where CO_2-equivalent emissions were used to assess environmental quality, GDP per capita was used to measure economic growth, natural resource rent (% of GDP) was used to measure resource dependence, and the share of industrial value added in GDP was used to measure the level of industrialization. The study applies a nonlinear autoregressive distributed lag (NARDL) model to simultaneously examine short-term and long-term effects, as well as asymmetry among the variables. The results show that long-run cointegration exists in the model. Economic growth has a positive and statistically significant impact on emissions in both the short and long run, while natural resource rent has a negative effect in the long run. Furthermore, negative shocks to industrial activity have a more pronounced impact on emissions than positive shocks. These results imply the need to improve the quality of economic growth and promote industrial restructuring toward sustainability.
Keywords: Greenhouse gas emissions, Industrial asymmetry, NARDL model

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A RENDA POR RECURSOS NATURAIS DEGRADA A QUALIDADE AMBIENTAL? UM ESTUDO DE CASO NO VIETNÃ

Does natural resource rent degrade environmental quality? a case study in Vietnam

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RESUMO

Este estudo analisa a relação entre crescimento econômico, renda dos recursos naturais, atividade industrial e emissões de gases de efeito estufa no período de 1986 a 2021. Dados anuais de séries temporais foram obtidos a partir dos Indicadores de Desenvolvimento Mundial, em que as emissões equivalentes de CO_2 são utilizadas como proxy da qualidade ambiental, o PIB per capita representa o crescimento econômico, a renda dos recursos naturais (% do PIB) mede a dependência de recursos, e a participação do valor adicionado industrial no PIB capta o nível de industrialização. O estudo aplica o modelo autorregressivo não linear de defasagens distribuídas (NARDL) para examinar simultaneamente os efeitos de curto e longo prazo, bem como a existência de assimetrias entre as variáveis. Os resultados indicam a presença de Co-integração de longo prazo no modelo. O crescimento econômico exerce um impacto positivo e estatisticamente significativo sobre as emissões tanto no curto quanto no longo prazo, enquanto a renda dos recursos naturais apresenta um efeito negativo no longo prazo. Além disso, choques negativos na atividade industrial exercem um impacto mais pronunciado sobre as emissões do que choques positivos. Esses achados evidenciam a necessidade de aprimorar a qualidade do crescimento econômico e promover a reestruturação industrial em direção à sustentabilidade.

Palavras-chave: Emissões de gases de efeito estufa; Assimetria industrial; modelo NARDL

INTRODUCTION

The relationship between economic growth and environmental quality is becoming more important, because economic activity usually comes with substantial environmental costs (Tachega et al., 2024; World Bank, 2021). In Vietnam, economic growth has resulted to more demand for energy and more demand on natural ecosystems (Bui Thi Thu Thao & Cao Tan Huy, 2024). Trinh Thi Kim Thoa (2025) showed that growing GDP increase living standards but also pollution. Many emerging nations encounter a need to attain economic progress while simultaneously decreasing emissions to secure a sustainable future (Befeke et al., 2023; Jie & Rabnawaz, 2024; Qian & Chen, 2025).

Natural resource rent plays an important role for the quality of the environment because mining minerals and fossil fuels typically emits lots of carbon (Cai et al., 2023; Jie & Rabnawaz, 2024; Nguyen Thi Xuan Hoa et al., 2024). Extracting resources takes a lot of energy and often emits toxic substances into the air (Befeke et al., 2023; Cai et al., 2023). The effect of natural resource rent, on the other hand, is not the same in all nations and varies a lot on the quality of institutions. Countries with good governance can use resource revenues in ecological innovation and clean technologies (Almulhim et al., 2025; Asongu & Diop, 2022). In contrast, in resource-rich areas with weak legal frameworks, NRR often increases ecological pressure and raises CO_2 emissions (Befeke et al., 2023; Ganda, 2022).

Industrial production, particularly in mining and processing, harms the environment through the use of fossil fuels (Jie & Rabnawaz, 2024). Industrial value added is positively related to carbon emissions in developing economies due to outdated production technologies. Limited investment in modern treatment systems in small-scale enterprises and continued reliance on resource-intensive industries create environmental pressure (Almulhim et al., 2025; Asghar et al., 2025).

Studying the relationship between natural resource rent and emissions is important because natural resource rent is closely linked to carbon emissions in both developing and emerging economies due to their reliance on fossil fuels (Soni & Manogna, 2025). Previous studies show that, in the world's major emitters, natural resource rent reduces ecological quality and supports the "pollution paradise" hypothesis (Shang et al., 2025). Resource extraction not only increases greenhouse gas emissions but can also prevent long-term sustainable economic growth with no strict constraints (Manigandan et al., 2025; Safdar et al., 2022). Because empirical results are mostly focused on the regional level, policymakers need nation-specific studies to come up with resource management strategies that are efficient for each country.

1 METHODOLOGY

1.1 Data

The study uses annual time-series data from the World Bank's WDI database (1986–2021), with a total of 36 observations. The number of years is sufficient for regression analysis, as suggested by (Tabachnick & Fidell, 2013) and (Pham Manh Hong et al., 2022). The main variables in the study are: (i) CO_{2e}, which refers to total CO_2-equivalent emissions and is used to measure environmental quality; (ii) GDP per capita at constant 2015 prices, which indicates economic growth; (iii) NRR, which refers to natural resource rent (% of GDP); and (iv) IND, which stands for industrial value added as a share of GDP and reflects the level of industrial production (Table 1).

Table 1 - Descriptive statistics of variables

Indicator	$CO_{2}e$ (mt $CO_{2}e$)	GDPPC (GDP per capita, constant 2015 US$)	NRR (Total natural resources rents (% of GDP)	IND (Industry (including construction), value added, % of GDP)
Mean	115.05	1652.77	6.82	33.38
Median	84.79	1464.84	7.29	34.94
Standard Deviation	98.11	861.03	3.52	5.03
Kurtosis	0.29	-0.85	-0.84	-0.46
Skewness	1.08	0.57	0.12	-0.79
Minimum	20.33	607.59	1.16	22.67
Maximum	348.33	3358.22	13.92	40.21
Count	36	36	36	36

1.2 The nonlinear autoregressive distributed lag model

Base on the ARDL model of Pesaran et al. (2001), the NARDL model was developed by Shin et al. (2014) to capture nonlinear and asymmetric effects. The dependent variable is lnCO2e, which represents greenhouse gas (CO_{2e}) emissions. The independent variables are lnGDPPC (GDP per capita at constant 2015 prices), NRR (natural resource rent, as a percentage of GDP), and IND (industrial and construction value added, as a percentage of GDP).

The econometric equation of the NARDL model is defined as follows: Eq. 1:

$$\text{NARDL: } \Delta \text{lnCO2e}_t = \beta_0 + \underbrace{\sum_{j=1}^{p} \beta_j \text{lnCO2e}_{t-j} + \sum_{i=0}^{q} \delta_{1,i} \text{lnGDPPC}_{t-i} + \sum_{i=0}^{q} \delta_{2,i} \text{NRR}_{t-i} + \sum_{i=0}^{q} \delta_{3,i} \text{IND}^{+}_{t-i} + \sum_{i=0}^{q} \delta_{3,i} \text{IND}^{-}_{t-i}}_{\text{Short-run}} + \underbrace{\varphi_1 \text{lnGDPPC}_{t-1} + \varphi_2\, \text{NRR}_{t-1} + \varphi_3^{+} \text{IND}^{+}_{t-1} + \varphi_3^{-} \text{IND}^{-}_{t-1}}_{\text{Long-run}} + \varepsilon_t \quad (\text{Eq. } 1)$$

In this model, the symbols p and q represent the optimal lag lengths for each variable in the model; the short-term coefficients are: β_0; β_j; $\delta_{1,i}$; the long-term coefficients are: φ_i; the error term is: ε_t; Δ denotes the first-order difference; $IND^{+} and\ IND^{-}$ show the cumulative positive and negative shocks of the explanatory variable IND. These shocks reflect how the level of industrialization has changed over time. The coefficients $\varphi^{+}$and φ^{-} show the long-term effects in each direction. This decomposition allows the NARDL model to capture the nonlinear and asymmetric relationship between industrial production and CO_{2e} emissions. This provides stronger evidence than conventional linear ARDL models, which assume symmetric effects between variables.

To use the NARDL model, the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are used to check whether the time-series data are stationary. This is done to ensure that no variable is integrated of order two, I(2). Next, the IND variable is decomposed into positive (IND^{+}) and negative (IND^{-}) shocks using the cumulative approach of Shin et al. (2014) to examine asymmetric effects. Lag selection can be based on criteria such as AIC or SIC. In this study, EViews is used to automatically select the optimal lag length for each variable, as suggested by Nsor-Ambala and Amewu (2023). The ε_t is an IID process with zero mean and constant variance, σ_{ε}^{2}. The Bounds test is then applied to identify the presence of long-run cointegration among the variables. Next, the Wald test is used to test for asymmetry. After estimating the NARDL model, the study conducts diagnostic tests, that are Breusch–Godfrey (autocorrelation), Breusch–Pagan/White (heteroskedasticity), Jarque–Bera (normality), and stability tests such as CUSUM and CUSUMSQ, to ensure that the model meets basic econometric assumptions and that the estimated coefficients remain stable over time.

2 RESULTS AND DISCUSSION

2.1 Unit root test

The ADF and PP test results in Table 2 show that all variables CO_{2e}, GDPPC, NRR, and IND are not stationary at the level but become stationary after first-order differencing, which indicates that all series are integrated of order one, I(1). No variable is integrated of order two, which meets the conditions for applying the ARDL and NARDL models. Dividing the industrial variable into increasing (IND^{+}) and decreasing (IND^{-}) components does not change the order of integration of the series, allowing a valid econometric analysis of the asymmetric effect of industrialization on CO_{2e}emissions.

Table 2 - Unit Root Test Results

Null hypothesis (H_0): The variable has a unit root (is non-stationary)

Variables	ADF		PP		Order of Integration (with intercept)
	Level	First Difference	Level	First Difference	
lnCO2e	0.4087^{ns}	-3.5539^{**}	0.2783^{ns}	-3.6370^{**}	I(1)
lnGDPPC	-1.2579^{ns}	-3.3216^{**}	-0.3043^{ns}	-3.1055^{**}	I(1)
NRR	-2.2612^{ns}	-6.0745^{***}	-2.2380^{ns}	-6.0745^{***}	I(1)
IND	-0.9728^{ns}	-4.5013^{***}	-1.1258^{ns}	-4.5013^{***}	I(1)

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively; ns indicates non-significance.
The Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests are employed.
The test equations include a constant (with intercept).

The Bounds test results in Table 3 show that the F-statistic reached 22.6772, which is much higher than the upper bound I(1) at all significance levels. As a result, the null hypothesis is rejected, confirming the existence of a long-term cointegration relationship between CO_{2e} emissions and the explanatory variables in the ARDL model.

Table 3 - Bounds Test Estimation in the ARDL Model

Null hypothesis (H_0): No cointegration relationship exists

F-statistic	Critical values for the Bounds test		
	Significance level	Significance level	Significance level
	10%	2.696	3.898
22.6772	5%	3.276	4.63
	1%	4.59	6.368

2.2 Short-term and long-term relationships

Short-term results show that ECM(-1) is negative and statistically significant, confirming the adjustment process that brings CO_{2e}emissions back to long-term equilibrium at a rate of about 69.7% per period. lnGDPPC has a positive and statistically significant effect on CO_{2e} emissions, while NRR shows a negative effect at the 10% significance level. For industrialization, short-term asymmetry is observed, where IND^{+} is not significant, while IND^{-} has a positive and statistically significant effect. At the same time, ΔIND shows a significant effect on CO_{2e} emissions in the short term.

Long-term results show that lnGDPPC has a positive and highly significant coefficient, indicating that, in the long run, economic growth is linked to higher CO_{2e}emissions, reflecting environmental pressure from expanded production and consumption. The NRR variable is negative and significance at the 10% level, suggesting an negative relationship between natural resource rent and CO_{2e} emissions in the long run. For industrialization, long-term asymmetry is also found, where IND^{+} is not statistically significant, while IND^{-} has a positive and significant effect on CO_{2e}emissions (Table 4).

Table 4 - Estimation results for short-run and long-run relationships

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Short-run relationship				
ECM(-1) (= lnCO2(-1)*)	-0.6967^{***}	0.0739	-9.4246	0.000
lnGDPPC	1.4304^{***}	0.2065	6.9279	0.000
NRR	-0.0019^{*}	0.001	-1.8364	0.077
$IND^{+}(-1)$ (= @CUMDP(IND(-1)))	-0.0009^{ns}	0.0026	-0.3256	0.747
$IND^{-}(-1)$ (= @CUMDN(IND(-1)))	0.0104^{***}	0.0025	4.1391	0.000
ΔIND (= D(IND))	-0.0045^{**}	0.002	-2.2144	0.035
C	-3.0734^{***}	0.5043	-6.0942	0.000
Long-run relationship				
lnGDPPC	2.0530^{***}	0.1806	11.3672	0.0000
NRR	-0.0027^{*}	0.0015	-1.792	0.0832
IND^{+} (= @CUMDP(IND(-1)))	-0.0012^{ns}	0.0038	-0.3282	0.7450
IND^{-} (= @CUMDN(IND(-1)))	0.0149^{***}	0.0035	4.3136	0.0002

Model Diagnostic Tests

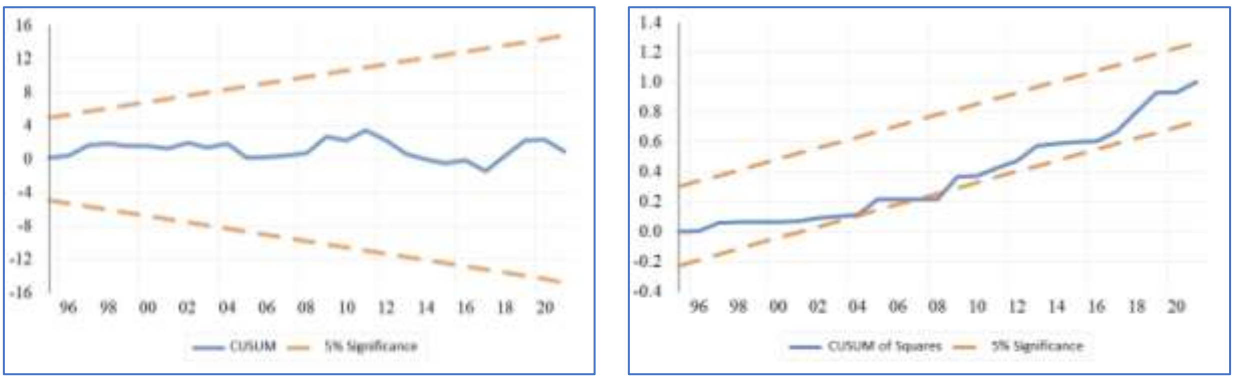
Test	F-Statistic	p-value (Prob.)
Breusch–Godfrey serial correlation test (LM test)	0.2232	0.8015
Breusch–Pagan–Godfrey heteroskedasticity test	2.1404	0.0812
Coefficient Symmetry Test (IND variable, Long-run)	5.4886	0.0268

Notes: ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively; ns indicates non-significance.

2.3 Model tests

The model test results show that it is no autocorrelation, based on the Breusch–Godfrey test (p = 0.8015), while the Breusch–Pagan–Godfrey test does not reject the homoskedasticity hypothesis at the 5% significance level (p = 0.0812). The coefficient symmetry test is rejected at the 5% level, indicating long-term asymmetry in the effect of industrialization, which is consistent with the NARDL model specification (Table 4). In addition, the CUSUM and CUSUM of Squares plots remain within the 5% confidence bounds, confirming parameter stability over the entire study period (Figure 1).

Figure 1 - CUSUM and CUSUMSQ Stability Tests for the NARDL Model



2.4 Discussion

The study results show that natural resource rent has a negative effect on greenhouse gas emissions, a finding that differs from most studies in the MENA region (Mabrouki, 2025), developing economies (Nwani et al., 2023), and BRI countries (Zuo et al., 2022), where natural resources often increase environmental pollution (Mabrouki, 2025; Sarosh & Yen, 2024). However, this negative effect can be explained by institutional quality. Strong institutions help countries apply environmental rules more effectively and manage natural resources in a more sustainable way, which reduces emissions (Mabrouki, 2025). Moreover, technological innovation and R&D spending are key factors in decoupling NRR from pollution, especially when resource revenues are reinvested in clean technologies to improve energy efficiency (Kisswani et al., 2025; Sarosh & Yen, 2024; Zuo et al., 2022). The interaction between resource rent and technological innovation has been shown to have a negative effect on the ecological footprint, which suggests that green technologies help reduce the negative impacts of resource extraction (Zuo et al., 2022). Finally, using resource rent to support the shift to renewable energy (REC), instead of fossil fuel–intensive consumption, also plays an important role in improving environmental quality, similar to sustainable development strategies in the United States and Vietnam (Kisswani et al., 2025; Nguyen Manh Hieu & Tran Thi Hoang Yen, 2023; Sarosh & Yen, 2024)

This analysis shows that economic growth leads to higher greenhouse gas emissions, which is in line with the findings of (Ho Thi Lam et al., 2024; Lenaerts et al., 2022), in the early stages of development, countries often focus on industrial production and capital accumulation, which results in higher pollution. This study also shows an asymmetric relationship: higher industrial production does not raise emissions, while lower production helps reduce emissions. This asymmetric result can be explained by three simple mechanisms: (1) Threshold effects, where cleaner technologies or scale effects may offset emissions as production increases; (2) Technological improvements, where production growth comes with investment in emission-reducing technologies; and (3) Structural changes, where growth is concentrated in industries with lower emissions.

CONCLUSION AND POLICY IMPLICATIONS

The results show a long-term relationship between economic growth, natural resource rent, industrial production, and emissions in Vietnam. Economic growth increases emissions in the long run, which reflects a growth model that still depends heavily on energy- and resource-intensive industries. For industrial production, the results show an asymmetric effect, where downturn shocks reduce emissions more strongly than upward shocks, suggesting that industrial restructuring is not yet aligned with environmental protection goals. Natural resource rent is also closely linked to emissions, which shows that resource extraction and use are still associated with polluting activities. Vietnam should shift economic growth strategy from expanding scale to improving quality. The government should reduce reliance on resource-intensive and highly polluting industries. To link economic growth with sustainable development, resource profits should be used more effectively to support renewable energy, cleaner production, and technological innovation.

REFERENCES

Almulhim, A. A., Qamruzzaman, M., & Aljughaiman, A. A. (2025). The influence of green trade openness, natural resources rent, institutional quality, and R&D investment on environmental sustainability in the OECD: testing the EKC and LCC hypotheses [Original Research]. *Frontiers in Environmental Science*, Volume 13 - 2025. https://doi.org/10.3389/fenvs.2025.1572439

Asghar, M. M., Imtiaz, I., Tariq, S., Fatima, M., & Nazir, M. (2025). Effect of Natural Resources, ICT Expenditures and Energy Intensity on Environmental Degradation in ASEAN Countries. *Contemporary Journal of Social Science Review,* 3(4), 992-1005. https://doi.org/10.63878/cjssr.v3i4.1448

Asongu, S. A., & Diop, S. (2022). *Resource Rents and Economic Growth:* Governance and Infrastructure Thresholds (European Xtramile Centre of African Studies Working Paper, Issue. https://ssrn.com/abstract=4242086

Befeke, C. L., Huang, D., Bosah, C. P., & Shaw, W. (2023). The impact of natural resource consumption on carbon emissions: evidence of a symmetric and asymmetric effect from Sub-Saharan Africa. *Environmental Science and Pollution Research*, 30(33), 80963-80977. https://doi.org/10.1007/s11356-023-28174-9

Bui Thi Thu Thao, & Cao Tan Huy. (2024). Effects of economic growth, foreign direct investment, energy consumption, and urbanization on the ecological footprint in Vietnam. *Tạp chí Nghiên cứu Tài chính - Marketing,* 15-31. https://doi.org/10.52932/jfm.v15i8.602

Cai, X., Li, K., Wang, W., Lu, Y., & Wang, R. (2023). The role of resource rent in shaping CO2 emissions in BRICS countries: A panel data approach. *Resources Policy,* 85, 103857. https://doi.org/https://doi.org/10.1016/j.resourpol.2023.103857

Ganda, F. (2022). The nexus of financial development, natural resource rents, technological innovation, foreign direct investment, energy consumption, human capital, and trade on environmental degradation in the new BRICS economies. *Environmental Science and Pollution Research,* 29(49), 74442-74457. https://doi.org/10.1007/s11356-022-20976-7

Ho Thi Lam, Le Hong Ngoc, & Nguyen Minh Hue Tran. (2024). Environmental Impacts of Economic Growth: A Dynamic Threshold Model Approach. *Tạp chí Khoa học & Đào tạo Ngân hàng*, 260-261(1-2). https://doi.org/10.59276/TCKHDT.2024.1.2.2571

Jie, W., & Rabnawaz, K. (2024). Renewable energy and CO2 emissions in developing and developed nations: a panel estimate approach [Original Research]. *Frontiers in Environmental Science,* Volume 12 - 2024. https://doi.org/10.3389/fenvs.2024.1405001

Kisswani, K. M., Al-Khasawneh, J. A., & Alam, M. S. (2025). The Role of Natural Resources, Electricity Production, Economic Globalization, and R&D in CO2 Neutrality: An Empirical Investigation for Kuwait. *International Journal of Energy Economics and Policy,* 15(6), 755-766. https://doi.org/10.32479/ijeep.21601

Lenaerts, K., Tagliapietra, S., & Wolff, G. B. (2022). The Global Quest for Green Growth: An Economic Policy Perspective. *Sustainability,* 14(9), 5555. https://www.mdpi.com/2071-1050/14/9/5555

Mabrouki, M. (2025). Institutional Quality as an Antidote to the Environmental Resource Curse: Evidence from CO Emissions in *MENA Economies* (MPRA Paper, Issue. https://mpra.ub.uni-muenchen.de/126563/

Manigandan, P., Alam, M. S., Alam, N., & Ozturk, I. (2025). The impact of green finance, green innovations, natural resources, and environmental innovations on sustainable economic growth in India: Fresh evidence from novel fourier-based approach. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-025-06349-3

Nguyen Manh Hieu, & Tran Thi Hoang Yen. (2023). Investigating the Relationship between Renewable Energy Consumption and Greenhouse Gas Emissions in Vietnam. Nghiên cứu mối quan hệ giữa tiêu thụ năng lượng tái tạo và phát thải khí nhà kính tại Việt Nam.

Nguyen Thi Xuan Hoa, Nguyen Duc Anh, Ngo Huu Quang, & Nguyen Thi Huyen Trang. (2024). Analysis of multi-factors affecting resource consumption efficiency in Vietnam. *The VMOST Journal of Social Sciences and Humanities*, 66(2), 50-59. https://doi.org/10.31276/VMOSTJOSSH.2024.0023

Nsor-Ambala, R., & Amewu, G. (2023). Linear and non-linear ARDL estimation of financial innovation and economic growth in Ghana. *Journal of Business and Socio-economic Development,* 3(1), 36-49. https://doi.org/10.1108/JBSED-09-2021-0128

Nwani, C., Bekun, F. V., Gyamfi, B. A., Effiong, E. L., & Alola, A. A. (2023). Toward sustainable use of natural resources: Nexus between resource rents, affluence, energy intensity and carbon emissions in developing and transition economies. *Natural Resources Forum*, 47(2), 155-176. https://doi.org/https://doi.org/10.1111/1477-8947.12275

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 1*6(3), 289-326. https://doi.org/https://doi.org/10.1002/jae.616

Pham Manh Hong, Nguyen Anh Tuan, & Le Phuong Thanh. (2022). The relationship between ghg emissions and economic growth in Vietnam. Science & *Technology Development Journal - Economics - Law and Management.* https://doi.org/10.32508/stdjelm.v6i1.802

Qian, J., & Chen, L. (2025). *Impact of natural resources rents on green growth:* evidence from G7 countries [Original Research]. Frontiers in Environmental Science, Volume 13 - 2025. https://doi.org/10.3389/fenvs.2025.1482812

Safdar, S., Khan, A., & Andlib, Z. (2022). I*mpact of good governance and natural resource rent on economic and environmental sustainability:* an empirical analysis for South Asian economies. Environmental Science and Pollution Research, 29(55), 82948-82965. https://doi.org/10.1007/s11356-022-21401-9

Sarosh, S., & Yen, C. M. (2024). The impact of natural resource rents on environmental degradation in case of USA: The role of technological innovation and renewable energy consumption. *Asian Journal of Economics and Empirical Research*, 11(2), 149-158. https://doi.org/10.20448/ajeer.v11i2.6390

Shang, T., Samour, A., Abbas, J., Ali, M., & Tursoy, T. (2025). Impact of financial inclusion, economic growth, natural resource rents, and natural energy use on carbon emissions: the MMQR approach. *Environment, Development and Sustainability,* 27(6), 14143-14173. https://doi.org/10.1007/s10668-024-04513-9

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). *Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework.* In R. C. Sickles & W. C. Horrace (Eds.), Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications (pp. 281-314). Springer New York. https://doi.org/https://doi.org/10.1007/978-1-4899-8008-3_9

Soni, S., & Manogna, R. L. (2025). Does natural resource rent and financial inclusion curb carbon emissions? Empirical evidence from E7 and G7 economies. *Humanities and Social Sciences Communications,* 12(1), 459. https://doi.org/10.1057/s41599-025-04786-z

Tabachnick, B., & Fidell, L. (2013). *Using Multivariate Statistics. Pearson Deutschland.* https://doi.org/DOI

Tachega, M. A., Chen, Y., Agbanyo, G. K., Ahmed, R., Appiah, A., & Mintah, C. (2024). *Energy efficiency, economic growth, and natural resource rent:* A trilemma analysis of environmental sustainability in Africa. Energy, 307, 132693. https://doi.org/https://doi.org/10.1016/j.energy.2024.132693

Trinh Thi Kim Thoa. (2025). *Environmental Protection in Economic Development in the Northern Midlands and Mountainous Provinces of Vietnam Today* [Doctoral dissertation, Ho Chi Minh National Academy of Politics]. Ha Noi.

World Bank. (2021). *The Changing Wealth of Nations 2021:* Managing Assets for the Future. World Bank. http://hdl.handle.net/10986/36400

Zuo, S., Zhu, M., Xu, Z., Oláh, J., & Lakner, Z. (2022). The Dynamic Impact of Natural Resource Rents, Financial Development, and Technological Innovations on Environmental Quality: Empirical Evidence from BRI Economies. *International Journal of Environmental Research and Public Health*, 19(1), 130. https://www.mdpi.com/1660-4601/19/1/130