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Imperative Individual Effect of Resource Rents Towards Environmental Sustainability in Southeast Asian Economies

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ABSTRACT

The aim of existing research is to analyze both the overall and specific impressions of natural resource rents on ecological damage within Southeast Asian countries. The study intentions to assess the inverted U-shaped foundation within the context of economically developing nations in Southeast Asia. The experiential findings from FM-OLS and D-OLS indicate that the initial phase of U shape EKC is supported by economic growth and carbon gas releases positive relationship over the long term. Nonetheless, the opposing impression of squared form of growth on carbon gas releases illustrates the inverted U formed premise of EKC in unindustrialized Southeast Asian markets. Simultaneously, consumption of renewable energy paradoxically undermines environmental cleanliness due to its favorable bearing on carbon gas releases. At the level of individual natural resources, coal rent positively influences carbon gas releases. Further, forest plus oil rentals subsidize to the lessening of carbon gas releases. Nonetheless, forest resource rents represent the most significant environmentally sustainable indicator. This suggests that the growth rate of emerging economies is boosted by forest rentals, which also perform a starring role in mitigating damage to the environment. The overall level of natural resources, along with the aggregate of resource rentals, has a optimistic control on atmospheric carbon dioxide secretions and contributes to environmental degradation over time.

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1. Introduction

Global warming has emerged as the predominant environmental challenge globally in recent years. Developing nations are prioritizing growth generating strategies while neglecting environmental issues. This apathy has turned problematic for them, and the ecological risk is escalating in severity daily. As production escalates and growth accelerates, carbon gas releases in the atmosphere are amassed. The energy sector's contribution is significant during fast expansion. Energy is seen as the essential element for emerging countries, since it sustains their economic operations (World Economic Forum, 2012). Consider the development of Southeast Asia to achieve sustainable economic progress and an improved level of life. A significant increase in energy use has propelled economic expansion while failing to address an environmental threat. Since 2000, energy demand has surged by 80 percent, necessitating a doubling of non renewables usage and resulting in elevated carbon gas releases levels (World Economic Forum, 2019). Since the conclusion of 2000, advancements in knowledge and technology, together with admittance to universal markets, have transmuted the Southeast Asian area into a global commerce powerhouse. Consequently, it became one of the ecosphere's firmest rising economic zones (IRENA, 2018). The surplus desire for fossil fuels poses a risk to environmental efficiency. Southeast Asian nations want to implement renewable energy in their primary industries to achieve the 23% renewable energy goal for the continent (IRENA, 2018). The Southeast Asian region, while predominantly embracing renewable energy, also retains a prosperity of ordinary

resources and is generating significant revenue from these assets. The Southeast Asian region possesses significant coal reserves, accounting for approximately one third (World Energy Council, 2020). Malaysia is recognized as a prominent country in the adoption of natural resources, holding the 26th position in the index of World Energy(World Energy Council, 2019). Nonetheless, various Southeast Asian nations, including the country of lao PDR, Cambodia, Vietnam and Papua New Guinea, demonstrate notable efficiency in managing their forest resources. Additionally, Malaysia, Indonesia, and Vietnam are well-known for oil assets whereas Mongolian area is recognized for coal reserves (World Energy Council, 2020). The ordinary natural resources perform a crucial part in economic activities, and the importance of environmental protection is being evaluated in this region. Achieving this balance is feasible only through the justifiable utilization of ordinary resources and their associated rentals. Furthermore, the focus on environmental protection remains crucial and requires a commitment to sustainability. It will be intriguing to analyze the impacts of both individual and aggregate resource rentals on the conservational circumstances in Southeast Asian nations.

The developing economies of Southeast Asia are acutely cognizant of the inevitability to align themselves with over-all counterparts in contemporary times. Nevertheless, without progress in innovation and the sustainable use of resource revenues and energy, achieving eco-friendly sanitation remains unattainable. The primary aim of existing experimental research is to recognize how renewables and rental prices for natural resources affect the eco-friendly conditions in Southeast Asian nations. The aforementioned determination be beneficial to explore the results of implementing green energy initiatives in Southeast Asia. Furthermore, to determine which type of natural resource is most appropriate for the environmental conservation efforts in Asian nations. The subsequent ambition of this research is to advance the EKC thought at an early stage, examining whether there is positive association flanked by economic expansion and greenhouse gas pollutants. This necessitates the development of EKC pemise of inverted U-shape to ascertain the significance of environmental protection as a crucial endeavor for the growth of Southeast Asian economies. There is a concern that the positive economic growth driven by rents of resources and renewable energy may exacerbate deterioration of the environment in appearing Southeast Asian nations.

2. Review of Previous Studies

Countries rich in natural resources often find themselves trapped in the resource-curse occurrence. The financial prudence experiencing the resource-curse encounter ecological challenges, including CO_2 secretions (Shao & Yang, 2014; Song, Wang, & Zhao, 2018). Wang et al. (2019) probed the impressions of the availability of ordinary natural resources going on the competence of carbon gas releases. The verdicts signpost that large quantity of ordinary resources deleteriously controls the efficacy of carbon emanation levels. Badeeb, Lean and Shahbaz (2020) scrutinized the effective impressions of resource rentals and the EKC within Malaysia's resource-driven economy, providing confirmation of the inverted U premise in the context of Malaysia. In G7 nations, the interplay between economic expansion and entirety instinctual resource rents has contributed to increased emissions of CO2 and environmental destruction. The improved economic advancement is concurrently effective in managing carbon emissions in the later stages, supporting the inverted U proposition of the EKC (Adedoyin, Alola, & Bekun, 2020). Wang et al. (2020) examined how aggregate rents of natural resources and globalization of economies have influenced carbon emissions in the seven nations of the G7. Solarin (2020) indicates that there is an optimistic correlation between ecological loss and resource rental in appearing financial markets. According to facts from the the Organization for Economic Cooper, the pillaging of earth's resources contributes to an upward trend in emissions of greenhouse gases (Ulucak, Danish, & Ozcan, 2020).

It is fascinating to examine previous studies concerning resource rents and renewables aimed at reducing greenhouse gases pollutants. One evidence is taken from a comprehensive study involving large sample of economies both emergent and emerging. It is inferred that the uptake of renewables contributed to predictable economic expansion while also reducing greenhouse gas pollutants (Bhattacharya, Awaworyi Churchill, & Paramati, 2017). In a study of large sample of countries that are emerging, it was found that renewables enhanced the sustainability of the atmosphere by decreasing the release of green-house vapors (Ito, 2017). In the BRICS group nations, the wealth of resources and their rents has led to a decrease in carbon releases in Russia, in contrast to South Africa. Nonetheless, the idea that EKC exists is

grounded in all economies included in BRICS (Danish et al., 2019). Evidence from the BRICS region shows an obvious adverse effect of rental prices for natural resources and renewables on the environmental footprint. The adversative belongings of accelerated economic expansion on the atmosphere have demonstrated the inverted U-shape premise within the member countries of the BRICS (Danish, Ulucak, & Khan, 2020). In an evidence of European nations, the environmental efficiency is originated by the consumption and implementation of renewables (Alola, Bekun, & Sarkodie, 2019), also evident by environmental researcher named with Acheampong, Adams and Boateng (2019) in an evidence of Saharan Africa. In these cases of Europe and Sub-Saharan Africa, the U and inverted U premises of EKC are fullfilled by the expansion of economic activities and environmental quality in these regions. Pata (2018) examined the cogency of the E-K-C premise by founding that the economic expansion and carbon gas emissions have proved the U shape premise. At the same time, the double effect of square term of economic expansion comprehensively reduced the secretions of greenhouse gas and proved the inverted U formed premise in Turkey, while intake of renewables devour a significant sway on eco-friendly quality and to fulfill this hypothesis. Chen et al. (2019) investigated the interaction across energy from renewable sources and squared or double effect of economic expansion, finding that both negatively impacted damage to the environment in China, supporting the readily apparent inverted U-shape premise.

Sharif et al. (2019) detailed that a spike in renewables has led to a slowdown in damage to the environment, indicating environmental sustainability, as well as identified the EKC premise of U and inverted U across large panel globally. In OECD nations, the adoption of renewables which is the sustainable form of energy devours a diminution in harm to the environment. At the same time, economic expansion implies both premises of EKC which are U and inverted U formed (Cheng, Ren, & Wang, 2019). Further evidence from Cheng et al. (2019) concerning the members of the BRICS indicated that the utilization of sustainble form of energy as renewables has a detrimental effect on atmospheric carbon gas secretions. Conferring to verdict of Destek and Sinha (2020), sustainable source of energy as renewables and secretions of carbon-gas are negatively associated in the economies of the OECD. In this evidence of Destek and Sinha (2020), economic expansion and its squared form has revealed the U and inverted U formed premise of EKC which leads attention towards environmental sustainability within OECD countries. Additionally, some aspects have identified the inconsequential upshot of renewables for environmental sustainability (Adams & Nsiah, 2019; Nathaniel & Iheonu, 2019). Upon assessing the literature, we ascertain that nations worldwide possess a plethora of natural resources and yield substantial rents. Nonetheless, the extensive natural resources have adversely affected the world ecosystem. Renewable energy is the only means to mitigate greenhouse gases releases and enhance the sustainability of the environment. Nonetheless, global economies have relied on fossil fuel-generated energy for decades, making it premature to anticipate significant advancements from renewables. Nonetheless, some studies has not shown a substantial impact of sustainable form of energy as renewables on the ecosystem. The literature about Southeast Asian nations lacks data to substantiate the possessions of the rental of ordinary resources and green energy sources on preservation of the environment. Despite the abundance of earth's resources and energy from renewable sources, is in Southeast Asian nations. This exploration evaluates the sway of renewable sources of energy, rentals from ordinary resources, and economic expansion on carbon gas secretions in the rising realms of Southeast Asia. Following these instances, the current examination will explore the contribution of sustainable energy source as renewables and rental prices of resources to economic progress in order to condense carbon gas excretions and authorize the inverted U and U formed premises of EKC.

3. Data & Methodology

3.1. Data & Variables Descriptions

Aimed at estimation purposes, the data is engaged from 1996 to 2020 of the Southeast Asian evolving countries. The fifteen evolving economies of Southeast Asian regions are China, Cambodia, Fiji, Indonesia, Mongolia, Malaysia, Myanmar, lao-PDR, Philippines, PNG, Solomon-Islands, Samoa, Thailand, Viet Nam, and Vanuatu. The data-source of these Southeast Asian markets is occupied through World Development Indicators of World Bank (2020).

Table 1: Variables with description

Variables Sign	Descriptions of Variables	Measurements
Dependent Indicator		
CO_2	Carbon dioxide emissions	Per capita metric tons
Independent Indicators		
GDPGR	Economic growth	Annual Percentage of GDP growth
$GDPGR^2$	Economic growth square	
TNR	Aggregate natural resource rents	
FR	Forest rents	GDP Percentage
OIR	Oil rents	
CR	Coal rents	
REC	Renewable energy consumption	Final energy consumption in percentage

Source: World Development Indicators (2020). https://databank.worldbank.org/source/world-development indicators#advancedDownloadOptions

3.2. Theoretical and Econometric Model

Kuznets (1955) proposed the EKC theory, elucidating the correlation between growth in economy and environmental deterioration. The theory comprises two principal stages: the U-shape and the inverted U-formed stages of EKC premise. During the first phases of prosperity, industrialization and urbanization result in heightened carbon dioxide (CO_2) emissions, since economic growth is favored above environmental considerations. This segment tallies with the U contour of EKC theory, whereby contamination levels escalate in tandem with economic progress. As economies advance, a transitional phase recognized as composite impression, ascends. At this juncture, environmental concerns spirals, prompting the adoption of regulations that merge economic expansion and ecological sustainability together at once. Rendering this, sustainable technology with efficient energy are becoming significant towards ecologically responsible progress. In the final phase which is referred as technical consequence, ordering of environmental superiority befalls with continued economic progress, portentous a central threshold (Adedoyin, Alola, & Bekun, 2020). By the side of this interval, insistent economic progress habitually revealed as squared term, facilitates the lessening of carbon gas releases, hence ratifying the inverted U form concept (Grossman & Krueger, 1991). This phase is well-defined by the practice of intellectual technology, regulatory structures, and focused sustainability. During this phase, administrations are admonished to embrace renewable sources to diminish emanations and mend eco-friendly quality. This analysis integrates renewables and rental prices for resources with economic expansion to evaluate their impact on reducing CO_2 secretions. The use of renewable energy solutions enables economies to maintain development while diminishing their environmental impact. The research also examines whether resource-dependent economies adhere to the Environmental Kuznets Curve theory, taking into account the paraphernalia of extracting resources on the state of environment. The E-K-C proposition elucidates the coexistence of economic improvement with conservational sustainability, accent the significance of governmental interventions, technical innovations, and the practice of renewables for enduring ecological equilibrium. On the bases of above theoretical model, the econometric model is developed initially as functional-form which is given below:

$$CO2 = f(GDPGR, GDPGR2, REC, CR, FR, OIR, TNR) \quad (1)$$

The above equation of functional form infers dependent variable as carbon dioxide emanations. At the same time, the independent variables are economic expansion and its square term, while individual resource rents as oil, coal and forest with aggregated resources. Further, the study engaged sustainable source of energy as renewables to influence environmental quality of Southeast Asian region. The econometric equation based on Danish, Ulucak and Khan (2020) and Adedoyin, Alola and Bekun (2020), and is specified underneath:

$$CO2it = \beta 0 + \beta 1 GDPGRit + \beta 2 GDPGR2it + \beta 3 RECit + \beta 4 CRit + \beta 5 FRit + \beta 6 OIRit + \beta 7 TNRit + \mu i \quad (2)$$

In econometric Equation (2) display above indicates β_0 as intercept, while the rest of β's as β_1 to β_7 are model's slope. At the same time, the econometric model has μ_i which is actually the error term to reduce the upshot of undetected errors. This above empirical model of Southeast Asian nations is figured out to estimate the inspiration of individual and aggregated resource rents, sustainable form of energy as renewables and economic growth with it's square term on environmental deprivation in Southeast Asian region. In the early steps, The econometric

test given Pesaran (2004) and named as cross-section dependency is established based on Badeeb *et al.* (2020). The CD method equations are as follow:

$$CD = \left(\frac{TN(N-1)}{2}\right)^{1/2} \acute{P} \tag{3}$$

$$\acute{P} = \left(\frac{2}{N(N-1)}\right) \sum_{i-1}^{N-1} \sum_{j=i+1}^{N} \acute{P}ij \tag{4}$$

After CD estimation, the existing study has gone through CIPS and IPS unit-root tests followed by their developers (Pesaran and Timmermann, 2009; Im, Pesaran and Shin, 2003). Rendering this, CIPS for empirical testing is prearranged underneath:

$$CIPS_{N\,\&T} = N^{-1} \sum_{i=1}^{N} t_i\,(N\ \&\ T) \tag{5}$$

Here, T & N specifies as time measurements and cross-sections. Nevertheless, t statistics for βi coefficients are denoted by *ti (N & T)*. Further, Pedroni and Kao validate the cointegration and long-term presence in the model (Kao, 1999; Pedroni, 1999, 2004) which are followed by past lessons of Adedoyin, Alola and Bekun (2020) & Chen et al. (2019), formulated down as follows:

$$CO2it = \beta i + \rho it + \beta 1iGDPGRit + \beta 2iGDPGR2it + \beta 3iRECit + \beta 4iCRit + \beta 5iFRit + \beta 6iOIRit + \beta 7iTNRit + \varepsilon it \tag{6}$$

In Equation (6), ρ_i indicates the trends of deterministic trends. However, the null hypothesis $\rho_i = 1$ indicates no cointegration. Further, residual term ε_{it} is tested to verify the cointegration and long run correspondence, which is given below:

$$\varepsilon it = \rho i\, \varepsilon it - 1 + \mu it \tag{7}$$

After applying Pedroni and Kao cointegration tests FMOLS and DOLS methods covers long run outcomes (Pedroni, 2000; Pedroni, 2001). FMOLS stands for fully OLS which covers accurate, specific and well-organized estimators in the long-term. Rendering this purpose of investigation, the equation of FMOLS is equated down which is followed by past evidence of Chen *et al.* (2019):

$$\hat{\beta}_{FMOLS} = \left[\sum_{i-1}^{N} \sum_{t-1}^{T} (X_{it} - \bar{X}_\iota)(X_{it} - \bar{X}_\iota)'\right]^{-1} \left[\sum_{i-1}^{N} \left(\sum_{t-1}^{T} (X_{it} - \bar{X}_\iota)\, \hat{y}_{\mathrm{it}}^{+} - \mathrm{T}\hat{\Delta}_{\varepsilon u}^{+}\right)\right] \tag{8}$$

Equation (8) of FM-OLS indicate the specific mean of individual by $\bar{X}_\iota$. Nevertheless, $\hat{y}_{\mathrm{it}}^{+}$ and $\hat{\Delta}_{\varepsilon u}^{+}$ indicative of endogeneity rectification. At the same time, for robustness check and to approve the outcomes of FMOLS, Dynamic OLS (D-OLS) is applied which is introduced by Kao and Chiang (2000). This DOLS equation includes lags of cross sections to dismiss the serial correlation issue as well as it entertained the estimates of endogeneity corrected variables. Rendering this panel DOLS for robustness check is written as follow:

$$\hat{\beta}_{DOLS}\, \hat{y}_{DOLS} = \left(\sum_{i-1}^{N} \sum_{t-1}^{T} \widetilde{W}_{it} \widetilde{W}_{it\prime}\right)^{-1} \left(\sum_{i-1}^{N} \sum_{t-1}^{T} \widetilde{W}_{it} \widetilde{W} \widetilde{y_{it\prime}}\right) \tag{9}$$

Equation (9) of DOLS, regressors are reffered by $\widetilde{W}_{it\prime}$ vector. However, DOLS will provide the endogeneity adjusted unbiased approximation and also checked the FMOLS robustness.

4. Empirical Outcomes, Interpretation, & Discussion

The discussion of experimental assessment starts with cross-sectional which is anticipated by Pesaran (2004). In table 4.1, CD value is 0.0007, indicating an insignificant estimation at the rate of 0.998 probability. This infers that alternative hypothesis is rejected, whiule null is accepted refers to issue of cross-sectional dependence. After this, Table 4.2 has revealed the outcomes of CIPS test. The findings have contingent that CO_2, GDPGR, CR, REC, FR, TNR, and OIR are outbreak at first order of integration and suggests to cointegration and FMOLS, and DOLS long term estimation.

Table 2: CD Test

Test	Statistic	Prob.
Pesaran CD	0.0007	0.998

Table 3: Panel CIPS Unit-Root Test

		Level		First Difference		
Variables		**Const.**	**T & Const.**	**Const.**	**T & Const.**	**Decision**
CO_2	CIPS	-0.467	-1.315	-3.582***	-4.306***	
GDPGR	CIPS	-2.018	-2.417	-5.196***	-5.203***	
REC	CIPS	-1.700	-2.007	-4.088***	-4.307***	I(1) for all variables
CR	CIPS	-0.566	-0.994	-2.570***	-2.873**	
FR	CIPS	-1.540	-1.844	-4.645***	-4.790***	
OIR	CIPS	-0.043	-0.375	-2.694***	-2.750*	
TNR	CIPS	-1.221	-1.646	-4.192***	-4.274***	

Note: *** at 1 percent, ** at 5 percent, and * at 10 percent significance.

Table 4: Pedroni and Kao Cointegration

Pedroni Cointegration with-in dimension		
	Statistic	**p-value**
Modified D-F t	-1.715**	0.034
D-F t	-4.903***	0.000
Unadjust. modified D-F t	-15.009***	0.000
Unadjust. D-F t	-10.987***	0.000
Augmented D-F t	-9.998***	0.000
between dimension		
Modified PP t	3.902***	0.000
PP t	-4.399***	0.000
Augmented D-F t	-5.980***	0.000
	Kao Test	
ADF	-1.890	0.031
RV	0.247	
HAC	0.194	

Note: Ho: No cointegration

Table 4 above has presented cointegration findings. The outcomes primarily frights with Pedroni technique, grounded on collective AR co-efficients which are eight in counting. This infers that the common coefficients are significantly signifying cointegration among variables. This further has revealed the long-term survival among indicators of interest. Further, the ADF value of -1.890 from Kao technique is significant at 0.031, substantiating Pedroni cointegration concerns. However, the Pedroni and Kao cointegration further proceed to FM-OLS and D-OLS for further estimation.

Table 5: FM-OLS and D-OLS

Dept Var.: CO_2			
Panel-FM-OLS			
Var.	**Coef.**	**Std. Err**	**t.stat**
GDPGR	0.411***	0.021	19.264
$GDPGR^2$	-0.020***	0.001	-10.755
REC	0.076***	0.019	3.859
CR	3.505***	0.936	3.744
FR	-0.717***	0.202	-3.547
OIR	-0.312***	0.093	-3.341
TNR	0.566***	0.063	8.989
Panel-D-OLS			
Var.	**Coef.**	**Std. Err**	**t.stat**
GDPGR	0.393***	0.040	9.813
$GDPGR^2$	-0.019***	0.003	-5.703
REC	0.079**	0.034	2.284
CR	3.681**	1.545	2.381
FR	-0.482	0.314	-1.535
OIR	-0.262	0.177	-1.474
TNR	0.525***	0.109	4.801

Note: *** at 1 percent, ** at 5 percent, and * at 10 percent significance.

Table 5 displays the long-term estimate outcomes using FM-OLS and D-OLS methodologies to evaluate the impact of economic development, its squared term, renewables, individual & aggregated resource rentals on carbon gas releases in South-East Asian nations. The results validate the EKC theory, indicating a U-formed correlation between economic development and carbon emissions in targeted area. The findings demonstrate that economic growth (GDPGR) positively stimuluses carbon gas releases (CO_2). The coefficients for GDPGR are 0.411 and 0.393 in FM-OLS and D-OLS at the 1% level, indicating that heightened economic activity intensify environmental deterioration in both emerging nations. Previous research has corroborated the first manifestation of the EKC theory (Adedoyin, Alola, & Bekun, 2020; Badeeb, Lean, & Shahbaz, 2020; Danish, Ulucak, & Khan, 2020). During the first stage of economic growth, dependence on non-renewables often intensificates CO2 emanations. Nonetheless, when economies advance and per capita income attains a certain threshold, the EKC hypothesis posits a shift towards decreased emissions. The transition is apparent from the negative squared economic growth (GDPGR2) coefficients of -0.020 & -0.019 in FM-OLS & D-OLS at the 1% level, substantiating the idea that economic maturity promotes environmental enhancement (Chen et al., 2019; Cheng, Ren, & Wang, 2019). Renewable energy is essential for fostering environmental sustainability; nevertheless, its efficient implementation poses a difficulty. The FM-OLS data reveal a positive coefficient of 0.076, significant at 1%, but the D-OLS results show a coefficient of 0.079, substantial at 5%, indicating that renewables intake has not yet significantly reduced emissions in Southeast Asia. The region's enduring confidence on fossils may account for this, since renewable energy has yet to be adequately incorporated to mitigate environmental deterioration (Adams & Nsiah, 2019; Nathaniel & Iheonu, 2019; Pata, 2018). Nevertheless, forthcoming renewable energy initiatives may substantially improve environmental sustainability in the next years (IRENA, 2018).

Coal rents (CR) exhibit a robust positive correlation with carbon emissions. The FMOLS and DOLS coefficients for coal rents are 3.505 (significant at 1%) and 3.681 (significant at 5%), respectively, demonstrating that addiction on coal intensifies environmental degradation in Southeast Asia. The substantial need for coal-based income production has resulted in heightened carbon emissions, with coal reserves in the area constituting around 25% of total resources (World Energy Council, 2020). This over reliance has compromised environmental conservation initiatives. In distinction, oil, as well as forest rentals have opposing consequences. FMOLS data indicate that forest rents (FR) and oil rents (OIR) exhibit negative coefficients of -0.717 and -0.312, respectively, both significant at the 1% level. This signposts that the effective practice of these resources aids in environmentally friendly preservation. FM-OLS consequences corroborate this tendency, on the other hand D-OLS results reveal an trivial conclusion of oil and forest rentals on carbon gas releases. Evidence point out that viable forest resource super vision may expedite economic progress and reduce emanations, evident by World Energy Council (2019), as well as Danish et al. (2019); Danish, Ulucak and Khan (2020). In the enquiry of the collective or aggregated bearing of ordinary resource rentals, coal resources substantially escalate pollutant discharges, whereas forest and oil rentals mitigate this effect. The aggregated natural resource rents (TNR) coefficients, 0.566 & 0.525 in FM-OLS and D-OLS accentuate their inclusive favorable bearing on carbon gas emanations. The escalation of resource extraction, along with futile administration, has occasioned in intensified conservational corrosion (Adedoyin, Alola, & Bekun, 2020; Ulucak, Danish, & Ozcan, 2020). Previous inquiries substantiates these fallouts, underlining the ecological significances of resource rentals (Danish et al., 2019; Wang et al., 2020).

5. Conclusion with Policy Inferences

This research examines the impression of economic progress, renewables and individual and collective resource rentals on reducing carbon gas releases in growing nations of South-East Asia. It aims to verify both the U as well as inverted U formed premises of EKC theories. Rendering this, CIPS assessment is cast-off to look at the data for unit roots, indicating that altogether variables are assimilated at I(1). The research further operates Cross-section Dependency (CD), as well as Pedroni-Kao cointegration techniques to scrutinize long-term connotations, and incorporates FM-OLS and D-OLS methodologies for reckoning long-term possessions. The empirical results demonstrate that the CD test does not reveal cross-section dependency problems, hence permitting the use of FM-OLS and D-OLS with unit root verification at I(1). The cointegration studies further validate the long-term link between indicators of empirical interest. Results from FM-OLS and D-OLS indicate that, in the first phases, economic expansion positively influences carbon gas discharges, corroborating the U-shaped E-K-C

concept. Even so, at cutting-edge economic junctures, carbon gas diminution corroborating the inverted-U E-K-C concept for emerging nations. Unexpectedly, the use of renewables seems to elevate carbon gas radiations, perhaps attributable to inefficiencies in the energy transition process. Individual resources as Coal rentals noticeably contribute to carbon secretions, on the other hand, forest and oil rentals have a moderating influence. Forest rentals are expressively the most ecologically advantageous constituent, indispensable for nurturing economic spreading out while mitigating conservational damage. At the same time, D-OLS outcomes indicate a trifling correspondence between forest and oil rentals towards carbon radiations. Furthermore, collective or aggregated resources devour a positive tie with carbon gas secretions, intensifying ecological concerns.

The exploration point out that FM-OLS yields more steadfast estimates than D-OLS, functioning as a robustness check by vindicating endogeneity concerns. This study's policy inferences emphasize the necessity for sustainable eco-environmental strategies in targeted countries of South-East Asian region. Rendering this, policymakers must prioritize the operative integration of renewables to moderate carbon gas releases and abate dependence on non-renewables, especially coal source. However, enhancing forest protection legislature and sponsoring for viable resource management may markedly condense environmental worsening. Furthermore, administrations devour to provide legislative agendas that endorse green reserves, foster clean energy innovation, and enable the espousal of sustainable industrial practices. Additionally, policy inferences must be technologically advanced to merge economic evolution with eco-friendly sustainability.

5.1. Limitations and Future Directions

This empirical investigation contains limitations that need valuation in spite of its virtues. The research is centered on panel data from a specific set of Southeast Asian nations, theoretically restraining the applicability of the results to other areas with divergent economic and environmental surroundings. The exploration also restricted to take account of any structural breakages or country-specific strategy activities that may distress the linkage in the middle of economic progress and carbon emanations. Future study may use a more extensive dataset and apply sophisticated econometric methods to investigate the causality and dynamic impacts of environmental policy on sustainable economic development. Rendering these aspects, the furure research can cover these aspects.

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