



ENHANCING SUSTAINABLE ECOLOGICAL FOOTPRINTS THROUGH CLIMATE FUNDS, GREEN TECHNOLOGY INVESTMENTS AND RESEARCH AND DEVELOPMENT EXPENDITURE: A PANEL DATA ANALYSIS OF ASEAN COUNTRIES

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Abstract. Ecological footprint (EF) measures the demand generated by people or the group of people towards the global natural resources. This paper is majorly based on exploring the number of major factors that enhanced sustainable ecological footprints, and these are climate fund, green technology investment and research & development expenditure, while population and education are act as controlling variables. In this paper, eight major ASEAN states i.e. Singapore, Cambodia, Philippines, Vietnam, Indonesia, Thailand, Malaysia, and Myanmar based information is considered for hypothesis testing. A panel data analysis based statistical outcomes are generated to conclude that there is a strong relationship among the tested variables. The unit root test-based outcomes show that there is no existence of the null hypothesis, and the panel cointegration test depicts that there is no cointegration (in both within-dimension and between-dimension) among the tested hypothesis. All the probability values are lower than 0.05, while the coefficient estimation test shows that all the tested variables having significant coefficient values. Last, but not the least, the Granger Casualty Test based statistics show that there is a strong correlation among the tested variables, so it becomes clear that if the government made an efficient green technology investment, climate funds and research & development & expenditure oriented strategies, then a sustainable ecological footprints will be developed. This paper will add value in efficient environment-oriented decision making for government, policymakers and environmentalists. However, the lack of renewable energy consumption and fertility rate affect the authenticity of this paper, which can be overcome by upcoming scholars.

Keyword: Ecological Footprints; Climate Funds; Green Technology Investments; Research and Development Expenditure; Population; Education

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Jel Codes: O1, O53

1 Introduction

The sustainable ecological footprints of ASEAN countries from the period of 1971 to 2017 were impacted with the help of financial development such as green practices, climate funds, and research expenditures (Kongbuamai, Bui, Yousaf, & Liu, 2020; Farooqi, 2020; Siddique, Masood, Javaria, Huy, 2020).

The environmental quality of a country can be improved by the reduction of an ecological footprint because according to Yilanci and Pata (2020) as environmental quality and ecological footprint are inversely proportional to each other. Environmental degradation has been increasing with the increase in the economic growth that result in releases of greenhouse gases. Deforestation also increases the level of environmental degradation by releasing carbon dioxide. The financial sector of a country plays a vital role in achieving and enhancing sustainable development. The table 1 below describe important goals in investing green technology.

Table 1: type of Goals

Short-term goals	Medium-term goals	Long-term goals
Enhanced foreign as well as domestic investment in green technology.	Enhanced production of green technology services and products.	ASEAN states become major producers of green technology in the global market.
Enhanced public awareness and commitment to the adoption of green technology	Expansion of green technology application to many sectors.	Induction of green technology in ASEAN nations.
Expansion of local research centers and institutes	Enhanced research development and innovation of green technology.	Significant minimization in energy consumption.

Environmental pollution has been increasing day by day because of the release of CO₂ and greenhouse gases and makes it difficult to achieve ecological sustainability (Bilgili, Koçak, & Bulut, 2016; BeltránPascual & Virseda, 2020). Urbanization is also a problem of ASEAN countries that results in a greater number of emission of harmful gases in the atmosphere (Wang, Chen, & Kubota, 2016; Farooq & ullah yousafzai, 2020). These countries are facing the issue of environmental degradation because of the rapid growth of industrialization. The green financing should concentrate on an innovative financial blueprint that helps in increasing sustainable ecological development. However, the investments in renewable energy remains up and down in different years. It has been given below in figure 1.

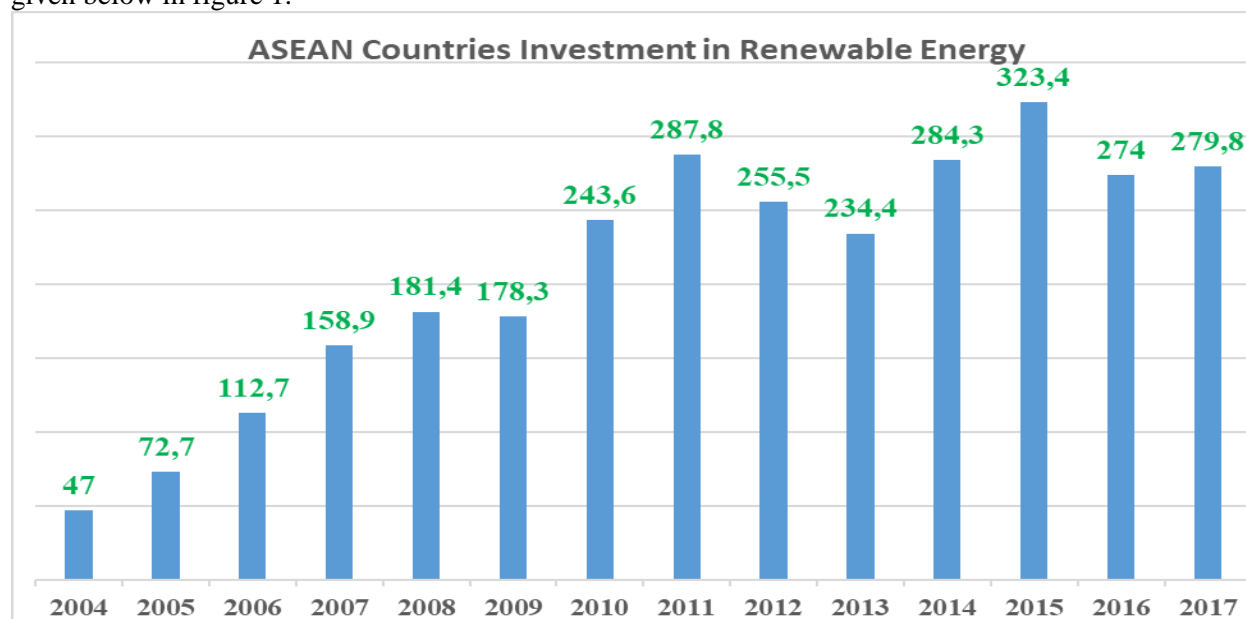


Figure 1: Investment in Renewable Energy

By exploring some previous researches, it comes to the knowledge that significant researches have been conducted in the previous year’s concerning ecological footprints (EFs). For example, research recently by Majeed and Mazhar (2019) has evaluated the overall impact of financial development on the ecological footprint through a panel data analysis method. However, the research has not been conducted regarding ASEAN states and its climate funds to enhance the sustainability level of EFs (Hussain et al., 2020). Hence, the current research paper is new and supportive to understand the role of climate funds in improving sustainable EFs. Moreover, in previous decades, several scholars such as Baloch, Zhang, Iqbal, and Iqbal (2019) have demonstrated the impact as well role of research development on the overall performance of EFs in different perspectives and regions. Nonetheless, the given paper is remarkable and justified mainly because no other scholar has explained the nexus

between green technology investments (GTI) and EFs from the perspective of all ASEAN countries. The current effort is new because no other study in the past has evaluated the direct impact of research and development expenditure (R&DE) on the sustainability of EFs concerning ASEAN regions. Based on the above justification, the study has the following objectives,

- The premier aim of the research is to evaluate the relationship between climate funds and sustainable ecological footprints (SEFs) in ASEAN states.
- The second objective of the paper is to analyze the impact of green technology investments on sustainable ecological footprints in ASEAN regions.
- The third and final objective of the study is to evaluate the overall impact of research and development expenditure on sustainable ecological footprints in ASEAN countries.

Several other types of research evaluate the nexus between economic development and ecological issues to give effective policy solutions to control economic growth and ecological challenges together (Charfeddine, 2017). The huge weakness of this researches is that they mainly rely on only CO₂ releases as a major indicator of ecological problems. The results of this paper are significant because this study takes other variables to understand the overall sustainability in EFs, hence the study has a significant scope in the ecological sector of ASEAN kingdoms to understand the role of GTI and climate funds.

The study consists of five chapters and background of the study, scope, significance, and problem statement has been discussed in the introduction chapter. The evidence related to different types of variables has been described in the literature review chapter. The information regarding population and sample size of research size has been described in the chapter of research methodology. The chapter of data analysis entails the data analysis tools and techniques. The last chapter of the study defines the conclusion, future recommendations, implications, and limitations.

2 Literature review

2.1 Theory of ecological footprint (EF)

A Canadian ecologist William Rees presented the theory of EF in 1996, and according to Liu, Zhang, Ren, Gu, and Yuan (2018) he demonstrates in his theory that EF is the estimation of the available biologically productive land as well as the water are required to provide the renewable assets that a country consumes and to absorb the wastes it produces (Zhang et al., 2020). According to LIANG et al. (2017) William Rees state that EF calculates the needs for productive areas mainly such as croplands, marine areas, forested land, and built uplands. William Rees also gave the concept of bio-capacity and according to him, footprint and bio-capacity can be compared mainly at the individual, regional, country, and world level. According to Steiner, Peschel, and Grebitus (2017) both bio-capacity, as well as footprint, modifies every year with the number of individuals, per individual consumption and the productivity of ecosystems. According to this theory, climate funds and eco-friendly investments are the one solution to deal with the challenge of modification in the footprint every year (Jorgenson, 2016). According to Naderi Mahdei, Bahrami, Aazami, and Sheklabadi (2018) during the past few years, the concept of EF analysis has been broadly used around the globe in support of sustainability through research and development. This is mainly because according to Yin, Han, and Wu (2017) research and development in the field of ecology enable individuals to analyze as well as manage the use of resources mainly throughout the economy and finds the sustainability of people's lifestyles and goods (Rudolph & Figge, 2017).

2.2 The relationship between Climate funds and sustainable ecological footprints

Climate funds play a dynamic role in achieving a sustainable ecological footprint by reducing the emission of harmful gases in the atmosphere, such as greenhouse gases and carbon dioxide. The execution of the study concerned with Luke (2019) has revealed that climate funds increase the resilience of and reduces the vulnerability of ecological systems and enhances the sinks of harmful gases. A financial blueprint known as green

credit helps in controlling the environmental pressure by climate funds. Boermans and Galema (2019) describes that environmental pollution can be controlled by providing loans to the industries implementing clean technology at a low-interest rate to enhance the sustainability of ecological footprints. It has been explained in the study by Cipler and Roberts (2019) that to emphasize the production of ecological agriculture, the financial sectors of ASEAN countries have promoted research and development in the new energy source. Climate funds attract more environmental-friendly projects with the help of R&D to improve the sustainability of ecological footprints. It has been concluded by Wirth (2018) that R&D helps in managing the use of the resources during the economy and to find the sustainability of goods and lifestyles of the people of a country. According to J. W. Lee (2019), the world's largest dedicated fund that helps the ASEAN countries in reducing the emission of carbon dioxide and greenhouse gas is known as the green climate fund. The researcher Scheffers et al. (2016) has elaborated the purpose of climate funds is to enrich the sustainability of ecological footprints and to help different countries to develop green growth. The investigation conducted by the Chu, Deng, Jin, Wang, and Li (2017) states that climate funds play an essential role in providing significant financial resources and allowing the economies and societies to condense the impact of climate change. The theory of ecological footprints supports the association among sustainable ecological footprints and the climate funds by explaining that the challenge of modification in the ecological footprint can only be solved with the help of eco-friendly investments and the climate funds. So, based on above arguments the study propose the following hypotheses,

H2: There is a favorable connection between climate funds and sustainable ecological footprints.

2.3 The association between Green technology investments and sustainable ecological footprints

The world of green technology (GT) solutions with every sector are fast-moving, and countless concepts exist concerning what GT is for ecological concepts as well as its related advantages for ecological footprints (Saber, Cruz, Sarkis, & Nagurney, 2018). According to Cohen, Lobel, and Perakis (2016) GT in almost every sector involves producing things and products that incorporate one or more significant aspects of ecologically friendly solutions. Producing and using green technological processes and products has raised the importance of green for ecological issues and also for livability and sustainability (Song & Wang, 2018). According to Neoh, Noor, Mutamim, and Lim (2016) what is more, significant is that sectors with green investments have also enhanced financial as well as ecological efficiency, as when compared to traditional sectors that do not invest in green technologies (Sun, Miao, & Yang, 2017; Wang & Zhou, 2020). Ecological survival in the existing harsh environmental times calls for innovations and green investments. As a consequence, green investments, as well as green remodeling, are significantly becoming hallmarks of contemporary ecological efficiency (Baležentis, Štreimikienė, Melnikienė, & Zeng, 2019; Wang & Zheng, 2020). Green technology investments (GTI) generate a lot of benefits for sustainable ecological footprints this is mainly because according to Song, Zheng, and Wang (2017) green technologies directly influence the overall environmental process. Perhaps the single most positive advantage of GTI is the EF's impact. Traditional technologies like petroleum generators, cause critical and huge damage to the environment, hence making it necessary that businesses as well as all other sectors opt for green technologies. In general, according to Luke (2019) green technology helps business carbon footprint (CF), minimizes waste, minimized energy consumption, minimizes water, and conserve water which significantly affects the sustainability level of EFs. Moreover, investing in GT enables many industries and sectors to use renewable energy resources that never evacuated in nature which affects the sustainability level of ecological footprints significantly (Nguyen & Kostarakis, 2018). Furthermore, investment in GT also enables sectors to use technology that incorporates green chemistry as well as green engineering which significantly affects EFs and its sustainability. Hence, the given study suggests the following hypotheses;

H2: There is a significant relationship between green technology investments and SEFs.

2.4 The relationship between Research and development expenditure and sustainable ecological footprints

In terms of ecological concepts, research and development (R&D) include processes and practices that environmental centers and authorities undertake to enhance the sustainability level of the environment Hassan, Xia, Khan, and Shah (2019) and according to Sayegh et al. (2017), it is often the initial step in the development of

ecological strategy and development process. The objective is generally to take innovative steps and processes to make the environment friendly for humans. R&D expenditure is another related concept which refers to the amount of money spent on creative as well as innovative ecological ideas that generate huge benefits in terms of EFs. According to Yasin, Ahmad, and Chaudhary (2020), R&D expenditure is the money spent on creative efforts majorly undertaken on systematic concepts to enhance the stack of data and knowledge and the use of this data to devise new ecological-friendly applications. In particular, it has come to the knowledge that there is a direct nexus between the R&D expenditure and ecological sustainability across the globe, but this direct correlation is much significant in high-tech nations than in low-tech states and regions. In research done by Musikavong and Gheewala (2017) manifest that countries with high R&D expenditure were found to have a strong relationship between R&D and ecological benefits, while states with low R&D expenditure have experienced bad results in terms of ecological benefits. According to Khan et al. (2020), high R&D expenditure plays a very remarkable role in the success of EFs efforts this is because R&D contributes to the sustainability of ecological footprints. It is the high expenditure function that gives a platform for innovation as well as for creativity to flourish in an ecological concept. According to Zhang et al. (2020), innovative breakthroughs in the ecological field have occurred only because of high expenditure and significant efforts of the R&D function. Therefore, the above arguments lead to the establishment of the following hypotheses,

H3: There is a significant relationship between R&D expenditure and sustainable ecological footprints.

3 Methodology

Eight major ASEAN states are considered for the proposed hypothesis testing and data evaluation named as Singapore, Cambodia, Philippines, Vietnam, Indonesia, Thailand, Malaysia and Myanmar. In this study, Ecological footprints based statistics are considered as dependent variables, while climate fund, green technology, and research & development expenditure are studied as major independent variables. To critically inspect their interdependence, a population and education act as controlling variables within this panel data analysis, where all of these statistics are collected from their official state’s websites. This paper is a productive approach to overcome all the EKC literature gaps regarding the tested variables. The EKS literature is established that sustainable ecological footprints and the other industrial development factors directly enhanced the state’s environment. The following econometric model is considered to test the augmented EKC hypothesis;

$$LEFP2it = \beta_0 + \beta_1LCLFit + \beta_2LGTI2it + \beta_3LRADit + \beta_4LPOPit + \beta_5LEDUit + \varepsilon it \dots\dots\dots (1)$$

Where $LEFP2it$, $LCLFit$, $LGTI2it$, $LRADit$, $LPOPit$, and $LEDUit$, are the logarithm forms of ecological footprints, climate funds, green technology, investment, research & development expenditure, population and education, respectively.

3.1 Panel Unit Root Tests

Im, Persaran and Shin, Levin-Lin-Chu and ADF-chi-square test based authentic tested are implemented to inspect the existence of panel stationary. All such tests have null hypothesis based justification that there is a unit root against any alternative and a stationary variable (Khraief, Shahbaz, Heshmati, & Azam, 2020; J. Lee & Tieslau, 2019). Levin with other research-based test equation is given below;

$$yit = ai + \beta i yi,t-1 + pi \sum_{j=1}^p \alpha j yit-j + eit \dots\dots\dots (2)$$

According to the above equation, yit is considered as a difference of yit for the ith state in the period $t = 1, \dots, T$. This statistical outcome is the best homogeneity assumption so that $H0: \beta = \beta i = 0$. Equation 2 depicts the heterogeneity by allowing the βi to change across any cross-section, under the influence of an alternative hypothesis where the majority of individual services may show non-stationary outcomes. The heterogeneous and nonparametric Wu and Maddala test based p values show a final panel unit root test. Its statistical equation is mentioned below;

$$p = -2 N \sum_{i=1}^N \ln \beta i \dots\dots\dots (3)$$

3.2 Panel Cointegration Test

In this paper, the cointegration test of Pedroni and Kao are conducted in order to evaluate the existence of long-run relationship among variables, where the Kao test is a residual and parametric based test for the null hypothesis of no configuration. Its LSDV regression equation is given below;

$$y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it} \dots \dots \dots (4)$$

Well, the Dickey-Fuller test is majorly applied for the residuals that are estimated from the regression equation estimation (Zoundi, 2017). There is a cross-sectional invariant among the five variations of the Kao test slope efficient (β). In addition, the Pedroni is also a residual-based cointegration test for no cointegration based null hypothesis. The Pedroni regression equation is shown below;

$$y_{it} = \alpha_i + \delta_i t + \beta_i X_{it} + \epsilon_{it} \dots \dots \dots (5)$$

where β_i , δ_i and α_i are away from any cross-sections. After this, Pedroni test based pooling residuals tests are derived from equation 5, where the first one is obtained through residuals on “within dimension” which is based on homogeneous panel cointegration statistics. While the second one is based on obtained residuals along “between dimensions” which is based on heterogeneous group means statistics.

3.3 Estimating the Cointegration Relationship with Weighted FMOLS

This fully modified ordinary least square (FMOLS) is used to evaluate the cointegrated panel regression and considered as the best panel estimation technique. It is such a parametric approach which is helpful to generate optimal cointegrating regression outcomes and develop an endogeneity and serial correlation because of their cointegrating relationship (Abdullah, Siddiqua, & Huque, 2017). In this research, Chiang & Kao and Pedroni pooled FMOLS estimators are used for the cointegrated heterogeneous panels. This statistical approach allows deviation in the cross-section based long-run variance. The corresponding asymptotic covariance and estimator of the tested variables are given below;

$$\hat{\beta}^*_{fw} = (N \sum_{i=1} T \sum_{t=1} X^*_{it} X^*_{it})^{-1} N \sum_{i=1} T \sum_{t=1} (X^*_{it} y^*_{it} - \lambda^*_{12i}) \dots \dots \dots (6)$$

$$V_{fw} = (1/N N \sum_{i=1} (1/T \sum_{t=1} X^*_{it} X^*_{it}))^{-1} \dots \dots \dots (7)$$

3.4 Panel Granger Causality Tests

The cointegration existence is such a sign that a causal relationship exists among the variables. In this paper, Hurlin and Dumitrescu based Granger causality test is adopted to inspect the direction and existence of casual relationships (Saidi & Mbarek, 2016). In this panel Granger causality testing of the multivariate regression-based general form is given below;

$$y_{it} = \alpha_{0i} + \alpha_{1i} y_{it-1} + \dots + \alpha_{li} y_{it-l} + \beta_{1i} X_{it-1} + \dots + \beta_{li} X_{it-l} + \dots + \beta_{2i} Z_{it-1} + \dots + \beta_{2i} Z_{it-l} + \epsilon_{it} \dots \dots \dots (8)$$

$$X_{it} = \alpha_{0i} + \alpha_{1i} X_{it-1} + \dots + \alpha_{li} X_{it-l} + \beta_{1i} y_{it-1} + \dots + \beta_{li} y_{it-l} + \dots + \beta_{2i} Z_{it-1} + \dots + \beta_{2i} Z_{it-l} + \epsilon_{it} \dots \dots \dots (9)$$

$$Z_{it} = \alpha_{0i} + \alpha_{1i} Z_{it-1} + \dots + \alpha_{li} Z_{it-l} + \beta_{1i} X_{it-1} + \dots + \beta_{li} X_{it-l} + \dots + \beta_{2i} y_{it-1} + \dots + \beta_{2i} y_{it-l} + \epsilon_{it} \dots \dots \dots (10)$$

Under the Hurlin and Dumitrescu panel causality test, the test statistics averages are developed where the Granger causality regressions are acted for each cross section (Younsi & Bechtini, 2018).

4 Analysis Interpretation

In order to justify the hypothesis testing, the Pesaran cross-sectional dependence (CD) test with the p-value is considered to inspect that either the data is suffered from cross-correlated root terms or not. This test is helpful to justify that the first generation model-based application is implemented in this analysis portion. After this, several unit root test-oriented productive outcomes generated to evaluate the order of integration variables which is a precondition for the panel cointegration outcome. All the tested variables are considered in with and without trend at both first difference and level. The following unit root test based statistical outcomes depict that unit root exists at the level and the absence of unit root occurs at the first difference (see table 2).

Table 2: Unit Root Test

Constructs	Level		1 st Difference	
	Constant	Constant+ Trend	Constant	Constant+ Trend
EFP	-2.0336	-2.6304	-6.6944*	-6.2394**
CLF	-3.2034	-3.3945	-5.3229***	-5.4095***
GTI	-3.2933*	-3.5044*	-7.7941**	-7.2309**
RAD	-5.2994*	-5.2444*	-6.3045*	-6.3944**
POP	-4.2994*	-3.2233*	-6.3040*	-6.2844***
EDU	-2.2904	-2.3994	-8.3955**	-8.6399***

After the unit root test, all the variables are integrated with order one, I(1) where the cointegration test is processed to evaluate the existence of a long-run relationship among the variables. According to the following Panel Cointegration test, four out of four Pedroni tests are within the dimension based tests means at their homogeneous panel cointegration form between panel ADF-statistic and panel PP-statistic. While, the Kao test shows that there is a long-run interdependence among the variables, where all three out of three variables are between the dimensions means at the realistic heterogeneous cointegrated form. After these statistical outcomes, it becomes concluded that on the group pp-statistics, all the variables are cointegrated in both nonparametric and heterogeneous forms. The table 3 depicts that there is no occurrence of any cointegration among the tested variables.

Table 3: Panel Cointegration Test

“Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-2.3884*	0.0103	12.0387	0.0003
Panel rho-Statistic	2.7334**	0.0003	3.63982	0.0298
Panel PP-Statistic	-3.3924**	0.0230	-4.13988	0.0000
Panel ADF-Statistic	2.2033**	0.0376	-2.42093	0.0004
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	Prob.		
Group rho-Statistic	4.3094**	.00001		
Group PP-Statistic	-7.1317**	0.0000		
Group ADF-Statistic	-2.1426**	0.0033		
Kao test.	Statistic	Prob.		
ADF	-4.6394*	0.0000		

In order to evaluate the coefficient of a long-run relationship among the FMOLS estimator, the following outcome is generated. This is a nonparametric estimation process and is quite valid that the normality assumption does not exist. In the following table, the *, ** and *** shows that there is a statistics relationship at the 5 and 10% and there is a significant impact of all the tested variables on the ecological footprints, as shown in the following table 4.

Table 4: Coefficient Estimation Test

Variable	Value	Pooled	Grouped
CLF	Beta	0.291**	0.233**
	SE.	0.588	0.677
GTI	Beta	0.293*	0.210**
	SE	0.293	0.455
RAD	Beta	0.122*	0.123*
	SE	0.994	0.498
POP	Beta	0.299**	0.322**
	SE	0.536	0.445
EDU	Beta	0.200	0.394**
	SE	0.378	0.384
Adj. R Square	Beta	0.793***	0.784***
	SE	0.888	0.848

The above table depicts the grouped and pooled form of coefficient estimation of all the tested influencing variables and their efficiency is shown in their significant outcomes. According to the above-mentioned test, the coefficient values of climate funds, green technology investments, research and development expenditure, population, and education are significant that means all the variables directly affects the ecological footprints within a developing state. In addition, its adjusted R square shows appropriate outcomes in this analysis. After this, the Granger Causality test based statistics are given below in table 5.

Table 5: Granger Casualty Test

Variables	EEP	CLF	GTI	RAD	POP	EDU
EEP	0.885					
CLF	0.398*	0.875				
GTI	0.399*	0.398*	0.889			
RAD	0.298	0.262*	0.332*	0.788		
POP	0.387*	0.398	0.309**	0.478*	0.711	
EDU	0.394*	0.409**	0.384*	0.298	0.554*	0.889

The above table shows that the ecological footprints based dependent variable has a strong relationship with climate funds, green technology investments, population and education. While, climate fund is highly correlated with green technology investments, research and development expenditure and education, and the green technology investment is directly dependent on the population level within the state. Well, the population is highly dependent on the advanced education level in the development of ecological footprints.

5 Discussion and Conclusion

Thus after critically interpreted the panel data analysis based statistics, it becomes clear that there is a significant impact of climate funds, green technology investments, and research and development expenditure on the favorable ecological footprints within the ASEAN states. In the Journal of Cleaner Production, Abdullah Mohammad Aldakhil with others stated that if advanced educational development occurred within a developing state which has an excessive number of inhabitants, then more productive outcomes will be generated to improve the ecological footprints within a state. They majorly explored the influence of green research and development to utilize and enhance the natural resources within the state (Aldakhil et al., 2019). According to them, high

technology export enhanced the emission of fossils, and the agricultural machinery substantially enhanced the emission of carbon-fossil, which should be minimized by making some effective steps. According to Lanouar Charfeddine and Zouhair Mrabet in their renewable and sustainable energy review, socio-demographics items like life expectancy at birth, urbanization, and the fertility rate enhanced the environment efficiency for the long run. This only occurs when the political institution's improvement of the state has never be accomplished by overcoming the external environment stress (Charfeddine & Mrabet, 2017).

In order to explore a similar concept in the Malaysian market perspective, Zahoor, Zhaohua and others conducted a research in their environmental science and pollution research-based journals. In their research, they concluded that globalization has a direct impact on the ecological carbon footprint in the existence of population density, energy consumption, financial development, and economic growth for the short and long run (Ahmed, Wang, Mahmood, Hafeez, & Ali, 2019). The similar research was conducted by Andrew, Festus and Samuel (2019) where they majorly worked on exploring the number of factors that caused a significant direct impact on the ecological footprints within a state like they majorly considered the country's trade policy, renewable and renewable energy consumption and the fertility rate that cause a major influence on the sustainable environment. According to these scholars, a 1% increase in the real GDP causes boosting environmental quality by 0.81% in a long run (Alola, Bekun, & Sarkodie, 2019). They considered renewable energy consumption as a major factor to improve the environmental sustainability and energy mix based diversification necessary for reducing pollution. This shows if the authority made efficient policies towards reducing their environmental pollution then sustainable ecological footprints will be developed.

Thus, it becomes concluded that the climate fund, green technology investments, research and development expenditure cause a significant positive impact on enhancing the sustainable ecological footprints within Singapore, Cambodia, Philippines, Vietnam, Indonesia, Thailand, Malaysia and Myanmar. Well, the above unit root test and panel cointegration test based statistics show that there is no existence of null hypothesis and no cointegration has existed among the tested variables. In addition, all the coefficient values of the tested variables depict that there is a direct influence of independent variables on the dependent ones because they all act as a game-changer in the current technological era.

5.1 Future Implications

This paper is an informative approach in front of their state's authorities and policymakers to make some efficient decisions regarding these ecological footprints provoking variables. In addition, the upcoming researchers can utilize this valid databased research in their discussion portion.

5.2 Limitations and Future Researches

In addition, there are some limitations of this challenging research that renewable energy consumption and fertility rate based major variables are ignored in the hypothesis testing, which can be overcome by upcoming researchers.

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