A Model for Determining the Effectiveness of Regulatory and Administrative Measures of Sustainability Policy in Thailand

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Abstract. *The objectives of this research are to 1) create a causal relationship model for political management in order to form sustainable policies under Thai environmental law. and 2) propose a strategic framework for national management to achieve sustainability. The study is designed as a mixed-methods study, which is called Path-Analysis based on an autoregressive Conditional Heteroscedasticity with observed variables (Path-ARCH-x_i Model). The study confirms a causal relationship between all three latent variables: economic growth, social growth, and environmental growth, with direct and indirect effects. Notably, each variable's indicator shows a different impact size of the relationship to changes in the variables. Economic growth is significantly influenced by industrial structures, while employment can greatly influence the changes in social growth. In terms of environmental growth, it is greatly influenced by energy consumption. Furthermore, economic growth, followed by social and environmental growth, has the greatest capacity for error correction. Consequently, proactive measures, particularly economic measures, are critical to ensure that environmental law enforcement is used to its full potential, as seen in European countries.*

Keywords:

Compulsory measures, Proactive measures, Economic measures, Sustainability policy, Causal model, Sustainability development

1. Introduction

Since 1992, when the National Economic and Social Development Plan was combined with the National Environmental Development Plan, Thailand's implementation of a strategy has been realized. The implementation of the national administrative policy seeks to encourage economic growth, social development, and environmental protection to achieve sustainable national development in all three areas. Thailand has experienced sustained economic growth, particularly in the industrial sector, because of active investment promotion by both domestic and foreign investors [1]. Tax exemptions and attractive interest rates incentivize entrepreneurs and producers to work to their full capacity. Additionally, Thailand's net export volume has increased due to a steady increase in exports and the right number of imports, which has helped the country earn a substantial amount of money [1]- [2].

In terms of tourism industry, the government has consistently accelerated local and international tourism promotion. According to a database, Thailand has welcomed a growing number of tourists since 2021, generating significant revenue [2]. Thailand has experienced higher economic growth because of the policy. Clearly, this expansion is beneficial to social development. The country's regions have equal income distribution, allowing a greater number of people to have access to better public utilities [1]-[2]. Education is now available to a greater number of people. In comparison to historical data, the unemployment rate and illiteracy rate have decreased in 2021. (1990). Furthermore, the unemployment rate has dropped significantly [3]. The preceding measures have resulted in continuous economic and social growth. However, the environmental sector is perceived differently, as CO_2 emissions have increased more rapidly since 1990. (2021). In terms of financial development, it affects the country's economic development, resulting in continuous growth and a continuously increasing growth rate. However, economic growth will affect the environment in the opposite direction. The greater the economic growth, the more the environmental impact will deteriorate [2]-[3].

This CO_2 emission exceeds its carrying capacity in every sector, with the greatest impact occurring in the industrial sector [4]-[5], primarily as a result of the rise

in energy consumption [6]-[9]. Both the country's capital cities and other provinces are experiencing an increase in CO_2 emissions, leading to an increase in greenhouse gas emissions. Obviously, this impact is becoming detrimental to the environment.

Consequently, this research on the relationship and impact of economic, social, and environmental growth is considered essential for the improvement of policies and the formulation of Thailand's future sustainable development. Based on a revision of relevant studies, the available literature with in-depth analysis is still limited. Most previous research, notably the Best Linear Unbiased Estimate (BLUE) [9]- [10], lacks falsifiability and validity assessments. This inefficiency in measuring instruments has led to inconsistencies and mistakes in the implementation of all three components of development policy: economic development, society, and the environment. Then, sustainability cannot be reached so long as there are disparities in policy implementation [9], [11]. The researcher analyzed quantitative and qualitative data through a comparative analysis of proactive measures in Thailand and European countries. The outcome will be used to capitalize on their advantages within the context of Thailand's sustainability strategy and environmental law, and to address present and future deficiencies. This research uncovered and highlighted the need for further study, which led to the creation of this work. Additionally, this research was conducted to support the design and planning of national policies in Thailand, but it is applicable to a variety of situations and industries. [10]- [11].

2. Literature Reviews

This section identifies and investigates existing studies pertaining to the variables that are relevant to the research. Several streamline studies showing different relationship among the variables in different contexts across the globe are discussed.

Considering a relationship between energy consumption and economic growth in Pakistan, Ahmed et al. [12] found a unidirectional causality from economic growth to energy consumption, and this finding is also the case for Middle East countries, as per analysis of Ozcan Ozcan [13]. Accounting for additional carbon emissions aspect, Mohiuddin, Sarkodie and Obaidullah [14] examined the connection between carbon dioxide emissions, energy consumption, and GDP from Pakistani context. Their result indicates a long-term equilibrium relationship, implying a 1% increase in energy production will affect carbon dioxide emissions to rise by 13.7%. While carbon emissions are shown to grow per capita income in Saudi Arabia, as per analysis of Alkhathlan and Javid [15].

In China, Long et al. [16] investigated the relationship between energy consumption, carbon emissions, and economic growth from 1952 to 2012. They confirmed that China’s economic growth and carbon emissions are dominantly dependent on coal. Comparatively, Boutabba [17] examined the relationship between carbon emissions, financial development, economic growth, energy consumption, and trade openness for the Indian economy. As a result, it is concluded that financial development has a positive effect on carbon emissions, demonstrating that environmental improvement is possible due to financial development. In addition, Yusoff, Bekhet, and Mahrwarz [18] demonstrated that long-term variations in CO_2 emissions are influenced by both energy consumption and GDP. In the case of Afghanistan, it is believed that conservation and environmental policies have a negative impact on economic growth. In contrast, according to Minh's [19] research, Vietnam's energy usage has a significant impact on environmental degradation.

Putting population in studies, Sarkodie [20] examined the relationship between carbon dioxide emissions, energy use, GDP, and population in Ghana from 1971-2013. The same finding of long-run equilibrium running from GDP to carbon dioxide, and population to carbon dioxide emissions. Malaysia has also seen a growing trend in population and GDP, resulting in high rate of electricity generation and consumption. This rising has clearly contributed in the greater carbon emissions, found by Ali, Razman and Awang [21]. Under the context of Gulf Cooperation Council (GCC) countries, Bekhet, Matar and Yasmin [22] firmly suggest the integration of environmental aspects with the financial system into their current operations, as per their study’s conclusion.

As of South Asian economies, Nasreen, Anwar and Ozturk [23] investigated the nexus between financial stability, economic growth, energy consumption and carbon dioxide (CO_2) emissions. With their analysis, they prove that financial stability can lead to the improvement of environmental quality. Whereas the rise in economic growth, energy consumption and population density are found to negatively affect environmental quality in the long term. Having the same account for financial development, trade, economic growth, energy consumption and carbon emissions but in Turkey, Ozturk and Acaravci [24] affirm that an improved foreign trade to GDP ratio can increase per capita carbon emissions, yet financial development provides no relation to per capita carbon emissions in the long term. While Taher [25] proves that both financial development and

economic growth have a significant and positive impact on the carbon dioxide emissions in Lebanon. Further on adapting different testing tools, Farhani and Solarin [26] used combined co-integration and asymmetric causality techniques to explore the connection between financial development and energy demand. They find that financial development, foreign direct investment, and real GDP can decrease in energy demand, while trade and capital are found to positively affect that energy demand.

Nonetheless, energy consumption and natural resources might be investigated in greater depth to bolster this section. Sarkodie and Owusu [27] examined a wind farm project to determine its viability and economic feasibility in Ghana. This was accomplished by proposing a 10 MW model of VESTAS V90 wind turbine model. Their research demonstrates that the model can be utilized to enhance the efficiency of organizations and industries. Aeknarajindawat, Suteerachai, and Suksod [28] confirmed that natural resources and economic growth had a beneficial effect on CO_2 emissions, whereas renewable energy appears to have a negative effect on CO_2 emissions in Malaysia. According to the analysis by Sulub, Hamid, and Nazri [29], Malaysia's hydroelectric energy supply (HES) has also contributed to economic growth enhancement. Moreover, on a worldwide scale, Saboohi [30] has demonstrated evidence of oil production and trade in reaction to the rise in carbon emissions.

A thorough review of relevant research reveals that no other study has focused and emphasized the validity and spuriousness check. As a result, the purpose of this research is to develop a set of guidelines for future application and adaptation. Furthermore, it is made available to policymakers to assist them in developing policies and strategies for Thailand. The research procedure is as follows.

1) Establish a model structure by identifying latent variables and observed variables.

2) Process observed variables to be stationary using the concept of Augment Dickey and Fuller [31]

3) Test a co-integration at the same level by adapting the theory of Johansen Juselius [31]

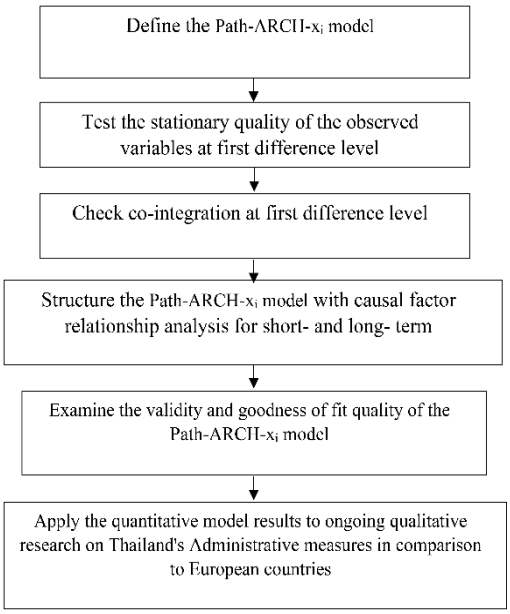
4) Analyze the relationship between causal factors in the short and long term [32]-[33].

5) Examine a spuriousness and validity

6) Analyze the impact size of the causal factor relationship and its direction

7) Apply the quantitative model results to ongoing qualitative research on Thailand's proactive measures in comparison to European countries, and

8) Conclude and make recommendations



3. The Material and Method

3.1 Path Analysis- Autoregressive Conditional Heteroscedasticity Model (Path-ARCH model)

As mentioned, the study examined the relationship between short- and long-term causal factors by using advanced statistical techniques to analyze correlation influences and the capacity to achieve equilibrium. The researcher implemented and developed the Path-ARCH-xi model to ensure the accuracy of the analysis results and the greatest possible outcome. The material and procedure are outlined as follows: [35]-[36]

3.2 An Application of Path-ARCH-xi with Time Series

The application of ARCH can be done in 4 different steps [37]-[40].

1. Formulate a mean equation of time series Y_t based on Box-Jenkins or regression analysis mode to obtain a no serial correlation variable. An example of mean equation in the form of a regression equation is presented below.

$$Y_t = \beta_1 X_{1t} + \beta_2 X_{2t} + \ldots + \beta_K X_{Kt} + \varepsilon_t \quad (1)$$

Where $X_{1t} + X_{2t}, \ldots, X_{Kt}$ is an independent variable at *t* time period, and $\beta_1, \beta_2, \ldots, \beta_K$ is a parameter. According to the case studies in this research, the dependent variable (Y) was set to represent economic, social, and environmental growth.

We can utilize the method of ordinary least squares to estimate the parameters in Equation (1), and that facilitates the calculation of Residual, e_t.

2. Use e_t of Y_t to test the Path-ARCH-xi model in terms of appropriateness in the application of Y_t, and that can be observed from two methods:

Method 1: Use a statistic of Ljung-Box Q or *Q(m)* of e_t^2 , if the hypothesis is found:

If $H_0 : p_1 = p_2 = \ldots = p_m = 0$ is rejected, the Path-ARCH model can be used with time series Y_t. If the hypothesis $H_0 : p_1 = p_2 = \ldots = p_m = 0$ is accepted, the Path-ARCH-xi model should not be integrated with time series Y_t .

Method 2: Use the following equation:

$$e_t^2 = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 e_{t-2}^2 + \ldots + \gamma_m e_{t-m}^2 - u_t \quad (2)$$

Later, we do a test on the hypothesis, $H_0 : \gamma_1 = \gamma_2 = \ldots = \gamma_m = 0$, where the statistic used is $LM = NxR^2 \sim X_m^2$. This is where ^ is the number of data points used in Equation (2) . While R^2 is the coefficient derived from Equation (2), or we can use F statistic to test that hypothesis. However, if the main hypothesis is rejected, the Path-ARCH-xi model can be applied to time series Y_t . If the main hypothesis is accepted, the Path-ARCH-xi model should not be used for the time series Y_t .

3. Estimate a Variance Equation of an unexpected event. If the main hypothesis in step 2 is rejected, then we will estimate the whole parameter of the average equation and variance equation simultaneously with the maximum likelihood method.

4. Check whether the Path-ARCH-xi model is properly built by using the following rule, which is that $\tilde{e}_t$ (standard value of e_t) must not have a relationship within, and $\tilde{e}_t^2$ (squared standard value of e_t) must not have a relationship within. [41]-[44]

The above test can be done via the use of the statistic of Ljung-Box Q of $\tilde{e}_t$ and $\tilde{e}_t^2$, respectively. The calculation formula for a standard value of $\tilde{e}_t$ is $\tilde{e}_t = \frac{e_t}{\sigma_t}$, while σ_t can be estimated from a squared value of the forecasting value obtained from the Equation $Y_t = \beta X_t$

3.3 A Short-term Variance Forecast Based on Path-ARCH-x$_1$

In the case of the Path-ARCH-x$_1$ model, the forecasting of such variance can be done through the application of the following equation [42]-[43]

$$Var(\varepsilon_t | I_{t-1}) = \sigma_t^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 \quad (3)$$

Upon a condition attached, the available information at *t-1* time period or denoted as I_{t-1} has to be known in all variables since time period 1, 2, ..., until *t*-1 , such as the calculation of forecasting value of the short-term variance at *t, t*+1, *t*+2 and *t*+3 time period is shown below. [46]

$$\begin{aligned} \hat{\sigma}_t^2 &= \hat{\gamma}_0 + \hat{\gamma}_t \varepsilon_{t-1}^2 \\ \hat{\sigma}_{t+1}^2 &= \hat{\gamma}_0 + \hat{\gamma}_t \hat{\sigma}_t^2 \\ \hat{\sigma}_{t+2}^2 &= \hat{\gamma}_0 + \hat{\gamma}_t \hat{\sigma}_{t+1}^2 \\ \hat{\sigma}_{t+3}^2 &= \hat{\gamma}_0 + \hat{\gamma}_t \hat{\sigma}_{t+2}^2 \end{aligned} \quad (4)$$

Here, ε_{t-1}^2 has to be the value used in the parameter estimation by maximum likelihood. Therefore, the forecasting value of the short-term variance in the general form can be expressed as below. [44]-[45]

$$\hat{\sigma}_{t+j}^2 = \hat{\gamma}_0 + \hat{\gamma}_t \hat{\sigma}_{t+j-1}^2 \quad (5)$$

Where $\hat{\sigma}_{t+j-1}^2 = \varepsilon_{t+j-1}^2$, when $j-1 < 0$ *and* $j \to \infty$

We can calculate such forecasting value by using the following equation. [44]

$$\hat{\sigma}_{t+j}^2 = \frac{\hat{\gamma}_0}{1 - \hat{\gamma}_1} \quad (6)$$

It should be noted that in this study, the researcher developed the Path-ARCH-x_i model, which must determine the size, autoregressive, integrate, and clear moving average to be the best model.

4. Empirical Analysis

4.1 Define a structure of latent variable and observed variables.

This research has determined the key three latent variables, comprising of economic growth, social growth, and environmental growth. Each latent variable has a number of observed variables totaling 12 indicators. They are rate of urbanization (Un), the structure of industries (In), trade balance $(E-m)$, indirect foreign investment (Fo), the government's expenditure rate (Ex), employment rate (Em), health and illness (He), the prevalence of social security (So), consumer protection (Co), energy consumption (En), oil consumption rate (Oi), and green technology (Gt). This research initially examines the white noise property of the indicators. As of result, all the indicators are found to be non-stationary at the level I(0), as illustrated in the table below.

Table 1 Unit Root Test at Level I(0) and First Difference I(1)

Tau Test				MacKinnon Critical Value		
Variables	Level I(0) Value	Variables	First Difference I(1) Value	1%	5%	10%
$\ln(Un)$	−2.15	$\Delta\ln(Un)$	−5.01***	−4.25	−3.50	−2.45
$\ln(In)$	−3.50	$\Delta\ln(In)$	−6.99***	−4.25	−3.50	−2.45
$\ln(E-m)$	−2.12	$\Delta\ln(E-m)$	−4.75***	−4.25	−3.50	−2.45
$\ln(Fo)$	−4.10	$\Delta\ln(Fo)$	−6.50***	−4.25	−3.50	−2.45
$\ln(Ex)$	−3.05	$\Delta\ln(Ex)$	−5.08***	−4.25	−3.50	−2.45
$\ln(Em)$	−3.59	$\Delta\ln(Em)$	−5.65***	−4.25	−3.50	−2.45
$\ln(He)$	−3.45	$\Delta\ln(He)$	−4.59***	−4.25	−3.50	−2.45
$\ln(So)$	−3.69	$\Delta\ln(So)$	−4.61***	−4.25	−3.50	−2.45
$\ln(Co)$	−3.85	$\Delta\ln(Co)$	−4.75***	−4.25	−3.50	−2.45
$\ln(En)$	−3.97	$\Delta\ln(En)$	−5.41***	−4.25	−3.50	−2.45
$\ln(Oi)$	−3.99	$\Delta\ln(Oi)$	−5.39***	−4.25	−3.50	−2.45
$\ln(Gt)$	−4.05	$\Delta\ln(Gt)$	−5.01***	−4.25	−3.50	−2.45

Note: *** denotes a significance, α = 0.01, compared to the Tau test with the MacKinnon Critical Value, Δ is the first difference, and $\ln$ is the natural logarithm.

Table 1 explains that all the observed variables at the level I (0) are non-stationary, and that demonstrates the inability of the variables for a model construction. Therefore, this research further processes them for a first difference by applying a unit root technique. This is done by comparing a tau test value with a MacKinnon critical value. After doing a first difference, the tau test value of all the observed variables are found stationary at all levels of 1%, 5%, and 10%. This finding can conclude that all the observed variables are found suitable for further analysis, and they can be tested for a co-integration.

4.2. Analysis of Co-Integration

In conducting a co-integration analysis, all the observed variables at the first difference are analyzed for a long-term relationship, as shown in Table 2.

Table 2 Co-integration test by Johansen and Juselius.

Variables	Hypothesized No of CE(S)	Trace Statistic Test	Max-Eigen Statistic Test	MacKinnon Critical Value	
				1%	5%
$\Delta\ln(Un)$, $\Delta\ln(In)$, $\Delta\ln(E-m)$, $\Delta\ln(Fo)$, $\Delta\ln(Ex)$, $\Delta\ln(Em)$, $\Delta\ln(He)$, $\Delta\ln(So)$, $\Delta\ln(Co)$, $\Delta\ln(En)$, $\Delta\ln(Oi)$, $\Delta\ln(Gt)$	None***	255.15***	241.05***	17.75	12.25
	At Most 1***	99.25***	80.50***	15.05	9.25

*** denotes significance α = 0.01, ** denotes significance α = 0.05

Table 2 explains that all the observed variables have a long-term relationship at the first difference. The trace test values are estimated to be 255.15 and 99.25, which are greater than the MacKinnon value at a statistically significance level of 0.01.

4.3 Analysis of Causal Factor Relationship

In this stage of the analysis, the short- and long-term interactions of all latent variables are examined and analyzed. As depicted in Fig. 2, each latent variable consists of several indicators that reflect the impact of the correlation.

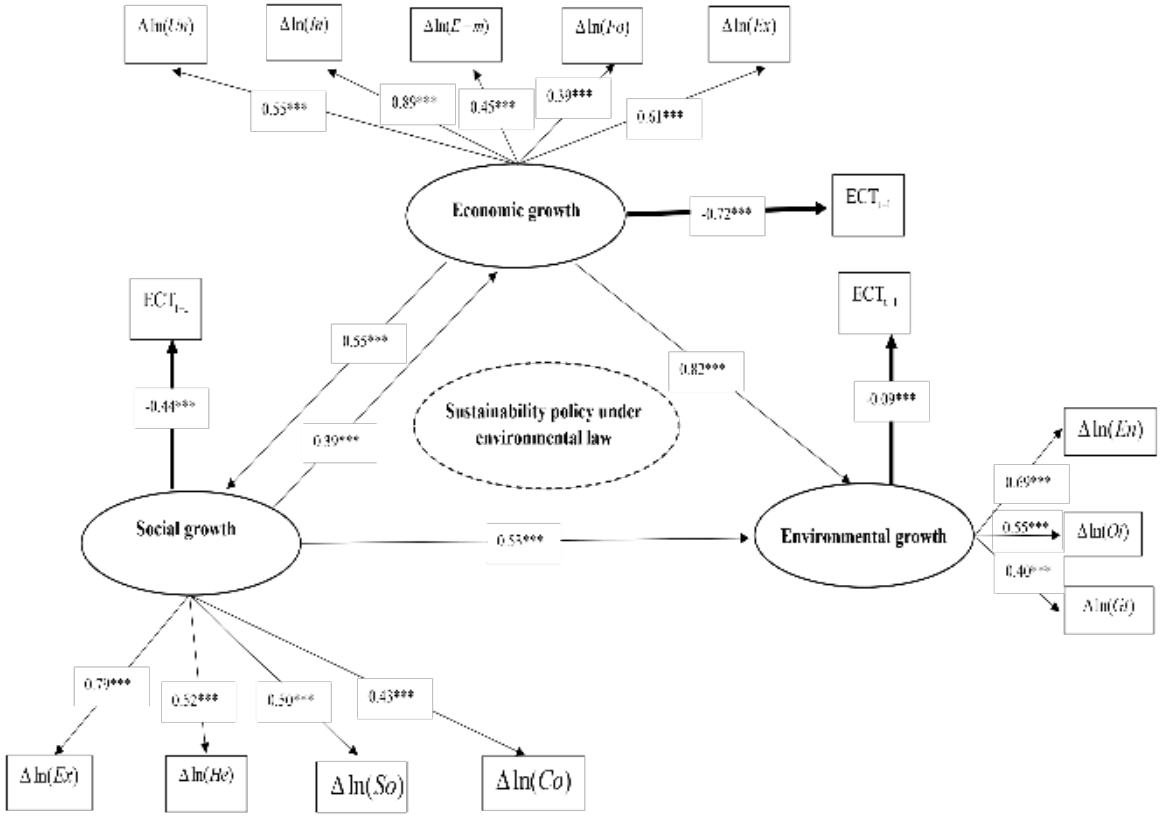


Fig. 2 The analysis result of the short-and-long term causal factor relationship

Fig. 2 illustrates the result of a long-term analysis. All three latent variables are demonstrated to be causal at the 0.05 and 0.01 level of statistical significance. In addition, economic growth is seen to have both direct and indirect effects on social growth and environmental growth. The indicators of each latent variable have shown the influential size of the relationship over the changes in the latent variables at a different magnitude. This study found that industrial structure has the greatest impact on economic growth. Employment is found to be the most influential on social growth, while energy consumption is found to be the most influential on environmental growth. Furthermore, economic growth is found to have the strongest error correction ability, followed by social growth and environmental growth, respectively. Upon validating the model, the causal factor relationship is shown to be white noise and free of spuriousness. This finding simply means that the model has eliminated the issues of autocorrelation, multicollinearity, and heteroskedasticity. As a result, the preceding relationship is defined as the "BLUE relationship."

According to the results of this research, the researchers created the Path-ARCH-x1 model, which has complete features and is suitable for short-, medium-, and long-term forecasting. The researchers compared the accuracy of this model with previous models, including the ANN model, Fuzzy model, BP model, and GM-ARIMA model, and found that Path-ARCH-x1 provided the lowest MAPE and RMSE values. This demonstrated that this model is more appropriate than the previous models. The Path-ARCH-x_i model is a highly suitable model for analyzing the effectiveness of environmental law enforcement in Thailand considering sustainable development goals. The analysis shows that the economic with an error correction mechanism is at -0.72, followed by the social with an error correction mechanism at -0.44, and the environmental with an error correction mechanism at -0.09, with a significance of 0.01. The above development policy shows that Thailand

has developed its economy to grow continuously, which has also affected social growth. However, it found that the environmental aspect is continuously deteriorating and tends to deteriorate due to the influence of the growth of the economy and society. As a result of the findings, Thailand's environmental law enforcement measures are ineffective, as the economic aspect is rapidly growing alongside the continuous growth of the social aspect, the environmental aspect has deteriorated, and the ability to adjust to equilibrium is very limited. This makes it impossible to use environmental law enforcement measures as previously. As a result, qualitative research is required to analyze proactive measures to plan the most efficient and appropriate environmental law enforcement. This model demonstrates that economic measures should be taken as proactive measures. Thus, the researcher conducted a comparative study of economic measures in Thailand and Europe to develop a sustainable development goal with qualitative research analysis details. The details can be summarized as follows:

4.4 The Analysis of the Use of Administrative measures in European Union Environmental Law as a Guideline for Thailand's Environmental Management

According to the European Community's founding documents, the primary goal of the European Union is the establishment of a European single market and the removal of barriers that could harm the EU market. When global environmental trends and concerns have an impact on EU Member States and become an impediment to the EU market, they take environmental issues seriously, allowing them to evaluate policies and guiding principles of laws and policies. The following is a list of the European Union's most important environmental principles.

1.The precautionary and prevention principles

2. The environmental damage management principles, and

3. The polluter pays principle

Undoubtedly, the law is a major tool for the European Union to comply with its environmental law's principles, objectives, and enforcement. To ensure that laws are implemented and enforced efficiently, command and control measures are mostly utilized. Licensing systems, for instance, are employed to regulate commercial operations, but their shortcomings result in inadequate environmental preservation and restoration. Consequently, the enforcement of environmental law in the European Union has shifted towards the use of economic measures in addition to command-and-control measures, resulting in an increase in protection, as shown below.

1. The European Union's Directive 2002/96/EC on the Management and Disposal of Waste from Electrical and Electronic Equipment attempts to limit the amount of hazardous waste. This regulation's economic methods enhance the effectiveness of hazardous waste disposal. The following components are required for this statement.

(1) Requiring manufacturers to retrieve the carcasses of electric and electronic products for proper disposal, implying that they are aware of their responsibility for the environmental harm they cause.

(2) Requiring manufacturers to retrieve the carcasses of electric and electronic products for proper disposal, raising disposal costs and encouraging manufacturers to improve their manufacturing processes.

2. The European Union's Directive 2003/96/EC on Restructuring the Community Framework for the Taxation of Energy Products and Electricity aims to promote and support clean energy, thereby facilitating the reduction of greenhouse gas emissions in accordance with the Kyoto Protocol. This restriction can be used to combat global warming in the following ways:

(1) Defining the application of tax breaks and exemptions for businesses that use renewable energy. This may motivate the business units to enhance their energy efficiency and reduce their environmental impact.

(2) Providing financial incentives to encourage the use of renewable energy in industry. This program will encourage businesses to join the government in reducing energy use in production.

Note that the tax measure, according to the study, is being implemented in European Union environmental management. For example, England enacted the Climate Change Levy in the Finance Act of 2000; Northern Ireland exempts factories that use natural gas-based energy from taxes; and France enacted taxation for factory energy use in the Finance Act of 2000. All of these tax measures are in place to encourage the use of renewable energy and to aid in the taxation adjustment for those energy-intensive factories that are subject to governmental conditions.

3. The European Union Directive 2003/96/EC on the Establishment of a Scheme for the Trading of Greenhouse Gas Emission Allowances with the Community of the European Union aims to reduce greenhouse gas emissions. This provision clarifies the following points.

(1) A pollution disposal licensing system (permit) can be used to solve the problem of emissions by establishing environmental quality standards through Command-and-Control measures and imposing liability when disposal or release exceeds the allocated limit.

(2) The ability to trade the permit will encourage the use of an emission permit system, which will effectively reduce pollution in the environment.

(3) The ability to trade the permit will provide incentives for license holders to improve pollution control systems so that they do not need to obtain a new permit if they can reduce pollution emissions below the amount specified in the license.

4. The European Union's Directive 2004/35/EC on Environmental Liability in relation to the prevention and remediation of environmental damage aims to support Polluter Pays by transferring risk through financial security or guarantees. The use of this economic measure in this specific provision can give the European Union confidence that those operators have measures in place to prevent and repair environmental damage.

In this study, proactive measures in Europe were chosen because they have been very successful in achieving sustainable development in Europe. In addition to the quantitative research results, this research found that the proactive measure that must be urgently implemented is an economic measure with a standard equivalent to the European standard. Therefore, Thailand can apply economic measures to develop the country for long-term sustainability.

Furthermore, the advantages of each economic measure in these provisions are that economic measures are used to determine targets for the prevention and resolution of environmental issues better than command and control measures prescribed by law, implying a prescription for general use without discrimination.

5. Concussion and Discussion

This research initially analyzed the causal factor relationship of the three latent variables, resulting that economic growth, social growth, and environmental growth are both short-term and long-term related. The relationship is found at the first difference, where all the observed variables are stationary and interconnected. This type of relationship also shows that all the indicators are the right variables for the analysis, including a co-integration analysis. As of the co-integration analysis, it is estimated that the co-integration value is higher than the critical value at both significance levels of 0.05 and 0.01. This research further checks a model validity, showing that the model has a white noise relationship and is reliable. The model is also not spurious, making it suitable for future application and implementation of policies.

According to the research findings, the enforcement of environmental laws in Thailand should include economic measures to improve law enforcement efficiency. This viewpoint is based on research into the enforcement of EU environmental law, which has been developed and revised through the promotion of economic measures in conjunction with the use of command-and-control and civil measures. These measures make it possible to effectively enforce environmental management laws. The following are some examples of economic measures used in EU environmental law:

1. Implementing a product life cycle system or a deposit-refund system in conjunction with waste management and disposal of electrical and electronic products aims to reduce the amount of hazardous waste, which is pollution, by requiring manufacturers to collect and dispose of expired products. The advantage is that manufacturers must develop recyclable manufacturing processes while also lowering waste disposal costs.

2. Imposing taxes on energy or electricity products aims to encourage and promote entrepreneurs to use clean energy and develop clean energy use, which has the advantage of reducing carbon dioxide emissions into the environment, which is one of the causes of global warming.

3. Using the emissions permit system aims to reduce greenhouse gas emissions into the environment. The incentive is the benefit to be gained from the sale of emissions licenses. The advantage is that it incentivizes manufacturers to try to reduce emissions below the amount allowed.

4. Environmental liability is intended to be paid by the polluter by requiring that entrepreneurs who are at risk of causing damage to the environment must have financial collateral to incentivize operators to have preventive measures and remedial measures for damage. The advantage is that the state has a guarantee that the polluter will pay the cost of measures to prevent and repair damage to the environment and create incentives for entrepreneurs to be attentive to their business operations.

Recommendation: In the context of this research, findings have emerged from studies related to the essential nature of formulating effective national management policies. It is imperative to establish clear guidelines and accurate models, as the development of an inappropriate model can lead to significant adverse consequences when applied, ultimately resulting in erroneous policy formulation. Therefore, the creation of models and the development of corresponding strategies are vital tasks that the government must execute with the utmost care. Furthermore, both proactive and reactive measures should be implemented and compared with those employed by other countries that have achieved successful outcomes. Thailand can adapt these approaches as deemed suitable to its specific circumstances. This strategic adaptation will significantly contribute to long-term sustainability.

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