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Analysis of Factors Affecting Renewable Energy Consumption Evidenced from Thailand

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ABSTRACT

In Thailand, renewable energy is an essential component in the choice of low-emissions economy growth. This study aims to investigate the factors of renewable energy consumption in Thailand. The data has been analyzed from 1980 to 2018 to identify the influencing factors for the overall energy use of renewable energy in Thailand using the Autoregressive Distributive Lag model (ARDL). The results demonstrate that renewable energy has a long-term relationship with fossil fuel consumption, financial expansion, foreign direct investment, trade openness, and GDP per capita. Further economic and financial development boosts renewables consumption of energy in Thailand. At the same time, trade and non-renewable energy (use of fossil fuel) detract from renewables consumption of energy. Hence the government of Thailand should elaborate on strategies that can increase the renewable energy amount because renewable energy plays a significant role in economic development without affecting the environment. It also increases the share of renewable energy in total energy consumption but less than renewable energy consumption.

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1. Introduction

In recent decades, Thailand's economy has seen a rise in carbon intensity and energy consumption. The Thailand economy has been increasing for the past few years, and the Gross Domestic Product of Thailand grew by 4.1% in 2018. Thailand's economic performance has also increased renewable energy sources and carbon emissions. According to the world development indicators (World Bank, 2020), there is an increase in Thailand's energy consumption increased from 464.428 kg per capita in 1980 to 1955.343 kilograms per capita in 2018. Carbon dioxide (CO2) emission is also increased significantly from 40135.32 kt in 1980 to 306764.6 kt in 2018 due to a rise in the energy intake in Table 1(World Bank, 2020).

Thailand has high CO2 emissions linked with the consumption and production of energy because coal is an essential part of energy production (Baloch et al., 2021). World Bank (2020), Thailand has the energy consumption related to carbon dioxide emission is 40135.32 kt with 464.4278 kilotons in 1980 compared with 232606.3 kt with 1502.28-kiloton in 2018, which makes it a very high CO2 emitter. The current trend among emissions of carbon dioxide and energy use is not sustainable, as fig. 1 reflects the fluctuation between both variables. This trend of emission level of Thailand will directly affect the climate and increase global warming.

Table 1
Consumption of Energy and CO2 emission in Thailand

Years	CO2 emissions	Energy Usage
1980	40135.32	464.4278
1981	38048.79	460.1977
1982	37909.45	456.5577
1983	42452.86	411.7712
1984	45973.18	446.4831
1985	48672.09	475.4924
2014	316212.7	1969.002
2015	182442.4	1222.247
2016	249327.6	1595.624
2017	215885	1408.936
2018	232606.3	1502.28

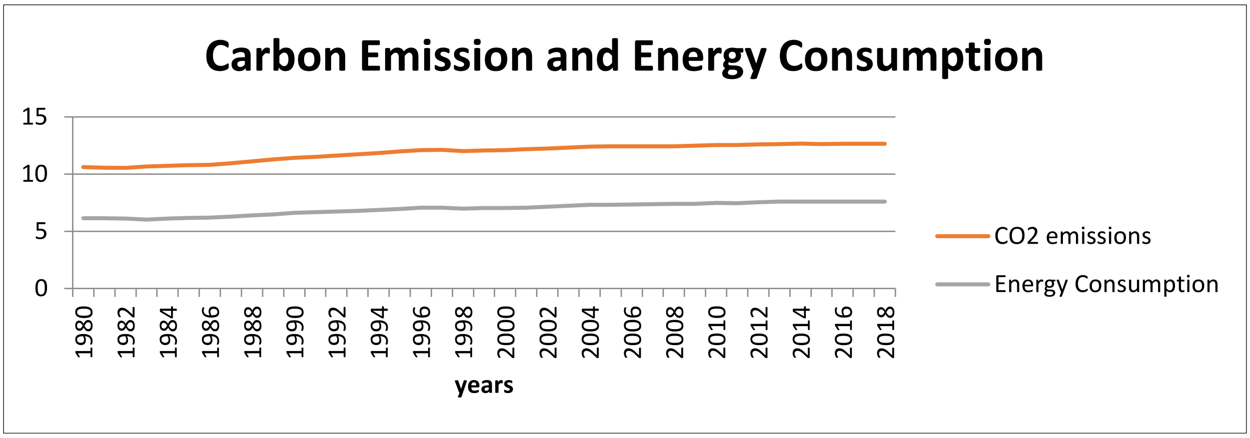

Figure 1: Time trend of Carbon emission and Energy consumption

Thailand's high level of carbon dioxide emission and energy intensity has attracted international and national markets; therefore, Thailand must change its energy policies and strategies (F. Chien, Kamran, et al., 2021). The government is taking some measures to solve the situation. The significant initiative to be taken by Thailand's Government is to raise the share of renewable energy in total electricity. Currently, renewable energy share in the total energy consumption in Thailand is not increasing with time, as shown in Fig 2. According to World Bank (2020), The highest level of renewable energy usage relative to overall energy consumption in 1990 (33.639%) was reduced to 23.195% in 2018.

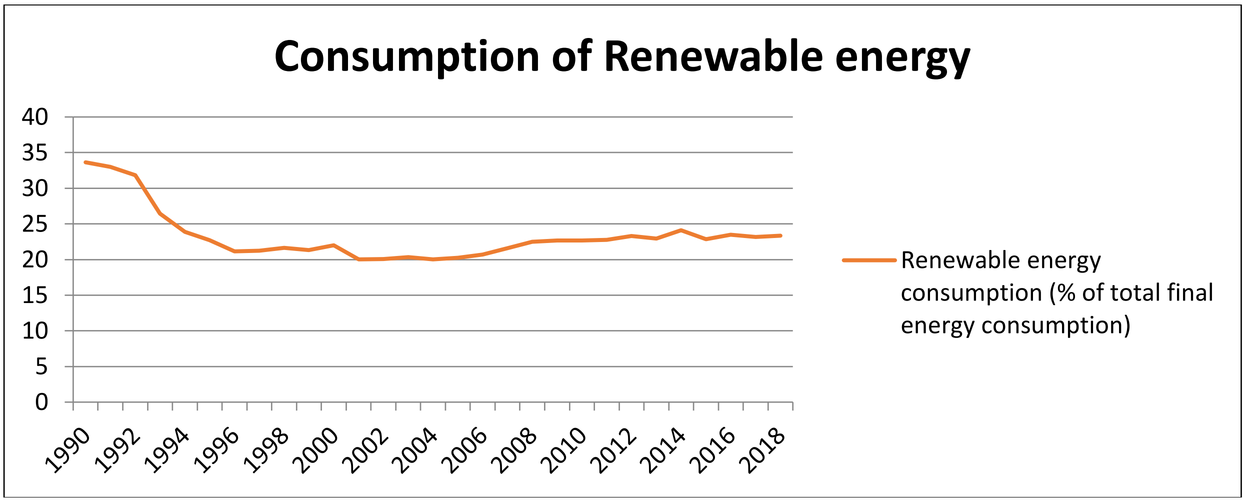

Figure 2: Renewable Energy in Thailand

As the proportion of sustainable energy usage decreased from 1990 to 2018; therefore, the government aimed to reverse the trend and try to promote different strategies for renewable energy in Thailand. The Government aims to minimize pollution and set more ambitious targets for achieving an outstanding share of clean energy use in Thailand's total energy consumption. However, the government should create more policies and strategies to deal with environmental pollution and energy-related carbon dioxide emissions because it affects Thailand and the whole world. The consumption of non-renewable energy or fossil fuel energy is very high in the country; therefore, the government should also follow policies to respond to non-removable energy demand by using renewable energy.

Several research papers have been researched, estimating the trend of renewable energy use. However, the current research does not reflect the sum of renewable energy but examines the amount of sustainable energy in total energy usage. According to Bakhtyar, Kacemi, and Nawaz (2017); F. Chien, Hsu, Zhang, Vu, and Nawaz (2021); Haq, Nawaz, Akram, and Natarajan (2020); Nawaz, Azam, and Bhatti (2019); Vachon and Menz (2006), examined the characteristics of individual countries and found that energy endowment, wealth, and culture are essential drivers for the consumption and production of renewable energy. The Pathways, along with some important characteristics such as development policies goals, adaptation and migration capabilities, energy market structure, carbon dioxide emission, the advancement of Technology, energy structure and consumption level, resource endowment, and income level, are the factors affecting the renewable energy. Hence, this study considered these factors and focused on a single country - Thailand - whose carbon dioxide emission reduction is a crucial path to follow to achieve climate change targets. Based on this analysis from the previous study, the contribution of renewable energy is considered a control variable in overall energy consumption. Therefore, this study aims to determine the experimental factors and obstacles to renewable energy use in Thailand.

2. Literature Review

Renewable energy has drawn the attention of many researchers in recent years. Researchers reported that there are many viable options through which access of energy can be enhanced as well as climate change can be less severe. The work on renewable energy determinants can be classified into the investigation of individual variables, developing and developed countries, time and panel series analysis, and different regenerative energy types.

Marques, Fuinhas, and Manso (2010) reported that the European Union (EU) renewable energy drivers used the fixed-effect vector decomposition (FEVD) method for data from 1990 to 2006. Research has been conducted on renewable energy's country-specific, socioeconomic, and political factors. The findings showed that traditional energy sources hinder sustainable energy usage while renewable energy sources are stimulating with the reduction of energy dependency. Rafiq and Alam (2010) analyzed renewable energy factors and their investors in emerging countries. The date of 6 developing countries was used for this study (Turkey, Indonesia, the Philippines, India, China, and Brazil). The methods used for this study was autoregressive distributed lag (ARDL) and employ panel methods (FMOLS and DOLS). The result reflects that the pollutant emission and income are the main factors of energy renewable in Indonesia, India, China, and Brazil. At the same time, Turkey and the Philippines are the only renewable energy driver: income. Omri and Nguyen (2014) considered the consumption of renewable energy aspects using a dynamic GMM panel model and collected data for 64 countries from 1990 to 2011. The subpanel has also been developed for the low, middle, and high-income countries. According to their analysis, the significant influencers of carbon dioxide emissions are trade openness (Zhuang et al., 2021). There is also a slight but negative effect of oil prices on the advancement of renewable energy(Nawaz, Ahmad, Hussain, & Bhatti, 2020).

Marques et al. (2010) examined the individual variables, policies, and factors for renewable energy promotion in various countries (Vachon & Menz, 2006; Van Rooijen & Van Wees, 2006; Y. Wang, 2006). Johnstone, Haščič, and Popp (2010) analyzed the challenges and prospects of renewable energy promotion policies. T. Chien and Hu (2008); Gan, Eskeland, and Kolshus (2007) provided empirical evidence for renewable energy growth and resulted that the major promoter for sustainable power is energy security. Sadorsky (2009b) studied renewable energy deployment, and development is highly dependent on environmental concerns. Chang, Huang, and Lee (2009) identified the association between energy prices, gross domestic product, and clean energy and showed that renewable energy is directly proportional to higher GDP. Carley (2009); Menz and Vachon (2006) identified financial incentives and the state's policies for renewable energy use and promotion. Saibu, Omoju, and Nwosa (2012) investigated the portion of energy usage for fossil fuels in total energy consumption, a basic factor affecting renewable energy consumption deployment. The comprehensive discussion was provided in the literature (Huang, Alavalapati, Carter, & Langholtz, 2007; Nawaz et al., 2021; Sadorsky, 2009a) with investigated the effect of calculated GDP, as income impact, and renewable energy adaptation, with the majority of studies showing the positive influence of income on renewable energy. Pfeiffer and Mulder (2013) provided the empirical survey which identifies little evidence of greenhouse gas mitigation-related technology was enhanced significantly with financial mechanisms such as CDM, GEF, ODA, FDI, and trade. Popp, Hascic, and Medhi (2011) analysed the patenting activity impact in 26 OECD countries on renewables consumption over the period 1991-2004 and showed that renewable energy technology has the robust but small impact of knowledge. Likewise, (Brunnschweiler, 2010) examined the effect of the financial sector on renewable energy use in countries outside the OECD.

Numerous articles published on the explanation of renewables deployment. Bird et al. (2005); Menz and Vachon (2006) identified the different factors for wind renewables for American states. Beckman, Borchers, and Stenberg (2011) reported the solar and wind renewables determinants in America from 2009 survey data by using a binary-choice model for data compiling. The findings indicated that farmers who have been specialized in fresh crops and use high-end machinery are improbable to address renewable energy production. In contrast, those who adopt sustainable practices and have large farm sizes could tell more. Adelaja and Hailu (2007) investigated the outcome of Michigan's renewable energy, which depends on the wind production unit, and resulted in a strategy to accelerate wind energy production in the mentioned state. Pfeiffer and Mulder (2013) investigated non-hydro renewable drivers by compiling the data of 108 developing countries with the help of a two-stage estimation analysis. The results reflect that renewable energy can be improved with stable and democratic regimes, higher per capita income, regulatory instruments, higher schooling levels, and economic instruments. On the other hand, institutional policy support programs, high fossil fuel production, increase electricity consumption, aid, and openness undermine renewable energy adoption (Shafiq, ur Raheem, & Ahmed, 2020; Shair et al., 2021; Sun et al., 2021).

Studies describing the option of policies on renewable energy have also been numerous in the literature. Stadelmann and Castro (2014) analyzed 112 developing countries for international and domestic determinants for renewable energy policies from 1998 to 2009. The logit model was used for the identification of four types of policies, i.e., framework policies, miscellaneous payments, goals for sustainable energy, and other financial incentives. The results showed that renewable energy policies are positively associated with domestic factors such as wealth and population, which hydropower case weakens the target adoption. Renewable policy adoption is promoted by EU membership, colonial influence, and international factors, while climate finance mechanisms such as Clean Development Mechanism (CDM) and Global Environmental Facility (GEF) can only aid the target adoption. Martinot (2002) reported that domestic policy design could influence the deployment of renewable. Mitchell et al. (2011) investigated some domestic factors such as new industry development possibilities, affordable energy pursuit, and generation of employment are very important factors for creating/enhancing new policies for renewable energy conservation and developing countries. Carley (2009) studied clean energy programs and their efficiency in several states of America.

Numerous researchers examined the variables influencing the rate of renewable vitality advancement through which carbon emanation can be diminished (Xiang et al., 2021). Rafiq, Bloch, and Salim (2014) explored the association between clean energy generation, carbon dioxide emissions, income in India and China using a vector model, and they took the data for 1972-2011. As a short-run result, the interaction between carbon dioxide emissions and renewable energy is uni-directional. There is a one-way association from production to renewables besides bi-directional among renewable and carbon dioxide emissions in the long run. However, the amount of renewable energy formed and disbursed is taken by endogenous indicators in previous studies. Then according to SSDN and IDDRI, through increasing the share of renewables in overall energy consumption, global warming and carbon dioxide emissions can be reduced. Therefore, this analysis is somewhat different from the previous one since the share of renewable energy is assumed to be an exogenous indicator. The study's conclusion is very significant for refining the share of renewable energy in total energy consumption.

3. Data and Methodology

The controlled indicators in this study are renewable energy generation to the total consumption of power in Thailand. These data are considered by measuring the ratio between renewable energy development and total energy usage in Thailand. The explanatory variables are real per capita GDP, market liberalization, foreign direct investment, economic growth, and fossil fuel use. The economic growth measured in GDP per capita. Number of studies have demonstrated that financial development (in terms of GDP) directly impacts the production of renewable energy (Chang et al., 2009; Rafiq & Alam, 2010). So, the GDP needs to be included in the model. The share of tariffs in GDP calculates the degree of trade openness.

Furthermore, the effect on foreign direct investment technology transfer in host nations has also been examined (Damijan, Knell, Majcen, & Rojec, 2003; Sinani & Meyer, 2004). Moreover, Thailand has become one of the fastest-growing recipients of foreign direct investment worldwide. Since commercial accessibility and foreign direct investment are critical drivers in China's economy. To test the hypothesis of technology transferred, the foreign direct investment will use in the present study and estimate the impact of technology on re-renewable energy production.

Most recent studies used financial development to develop the financial sector or use renewable energy have contradictory results (Brunnschweiler, 2010; Omojolaibi, 2016; Peterson, 2008). Theoretically, the existence of the financial sector is expected to make a significant contribution to renewable energy development projects. We, therefore, comprehend financial developments in the model to empirically test whether economic developments have a significant impact on Thailand's clean energy technologies or not. Aguirre and Ibikunle (2014) documented the "lobby effect" when using renewable energy.

Further, this indicates the effect of conventional energy sources on the disruption of the use of renewable power. The excessive use of fossil foil makes hurdles in clean source energy. Certain research has shown that the "lobby effect" has significantly affected the acceptance of renewable energy sources (Marques et al., 2010; Pfeiffer & Mulder, 2013; Sovacool, 2009). Considering that Thailand is amongst major primary energy users in the globe and one of prime energy producers, plus more than 50% of its energy intake comes from fossil fuels, the "lobby effect" is a significant factor. Therefore, the study of the complex relationship between renewable electricity use and its effects in Thailand is part of the model; the following models were specified in this study:

$$RENER_t = \alpha_O + \alpha_1 GDPPC_t + \alpha_2 TR_t + \alpha_3 FDI_t + \alpha_4 FINDV_t + \alpha_5 FFUEL_t + \epsilon_t \quad (1)$$

According to equation 1, RENER represents the consumption of renewable energy compared to the total usage of energy, per capita of GDP is proxied as the GDPPC, TR is measured by trade openness, and finally, the financial development proxied by domestic credit to private sector percentage of GDP. FDI has expressed the foreign direct investment in Thailand, and FFUEL is the fossil fuels share in energy consumption; α_O is a coefficient, $\alpha_1 \, to \, \alpha_5$ are the corresponding variables Coefficients; and ϵ_t are error terms. Variable selection is based on previous theories and publications. The expected logarithm (In) of the variables is used to keep away from heteroscedasticity. The equation is as follows:

$$\ln (RENER)_t = \alpha_O + \alpha_1 \ln (GDPPC)_t + \alpha_2 \ln (TR)_t + \alpha_3 \ln (FDI)_t + \alpha_4 \ln (FINDV)_t + \alpha_5 \ln (FFUEL)_t + \epsilon_t \quad (2)$$

The data used in the study was extracted from the World Development Indicator (WDI) of the World Bank.

3.1. Estimation Procedure

The study applies the ARDL cointegration method derived by (Pesaran, Shin, & Smith, 2001). This technique has many advantages as compared with Johansen and Juseliu's co-integration methods (Sinani & Meyer, 2004). To apply this evaluation process, limits the equations. Because (1) is converted into a vector error correction model (VECM):

$$\ln(RENER)_t = \pi_o + \sum_{i=1}^{p}\pi_1\Delta\log(RENER)_{t-1} + \sum_{i=0}^{p}\pi_2\Delta\log(GDPPC)_{t-1} + + \sum_{i=0}^{p}\pi_3\Delta\log(TR)_{t-1} + \sum_{i=0}^{p}\pi_4\Delta\log(FDI)_{t-1} + \sum_{i=0}^{p}\pi_5\Delta\log(FINDEV)_{t-1} + \sum_{i=0}^{p}\pi_6\Delta\log(FFUEL)_{t-1} + \pi_7\log(RENER)_{t-1} + \pi_8\log(GDPPC)_{t-1} + \pi_9\log(GTR)_{t-1} + \pi_{10}\log(FDI)_{t-1} + \pi_{11}\Delta\log(FINDEV)_{t-1} + \pi_{11}\Delta\log(FFUEL)_{t-1} + \varepsilon_t \quad (3)$$

According to equation 3, endogenous indicator is Renewable energy (RENER), and exogenous variables are lags of RENER, per capita GDP, trade, foreign direct investment, domestic credit to private sector, and fossil fuel energy.

3.2. Data Source

Thailand's annual data from 1990 to 2018 were taken from the World Development Indicators(World Bank, 2020).

4. Results & Discussion

4.1. Summary Statistics

Table 2
Summary Statistic

Variables	REN	FD	FDI	FFEN	GDP	TRADE
Mean	3.138374	4.767851	0.860599	4.355974	8.090631	4.71082
Median	3.120485	4.751411	0.964507	4.383248	7.970416	4.798249
Maximum	3.51569	5.11502	1.861721	4.407417	8.892002	4.944759
Minimum	2.996965	4.423277	-0.40483	4.156348	7.319165	4.327866
Std. Dev.	0.138	0.204854	0.578806	0.068014	0.487549	0.208231
Skewness	1.654856	-0.03515	-0.62079	-1.96888	0.174735	-0.71623
Kurtosis	5.090157	1.577269	2.687692	5.680918	1.588542	2.007829
Observations	29	29	29	29	29	29

At this stage, the study provides descriptive statistics in Table 2. The results of this analysis mean that each of the series is white noise, as confirmed by the Jarque Bera test statistic. Correlation analysis reveals a positive relationship that combines renewable energy sources, economic development, fossil fuel vitality, GDP, and trade.

4.2. Augmented Unit root test

Before using equations for evaluating the effect of renewable energy determinants in Thailand, according to Beckman et al. (2011), the data on time series attributes is used to check the order of integration. This study also consists of the time series data required to check the stationarity of indicators. For this purpose, use the Augmented Dickey-Fuller (ADF) test to check the stationarity of indicators. And the result is presented in table 3;

Table 3
Unit root test

Variable	Level		First Difference		Result
FD	-2.36509	0.3879	-2.86756	0.0625	I(1)
FDI	-3.76577	0.0341			I(0)
FFEN	-5.58709	0.0001			I(0)
GDP	-2.68025	0.252	-3.31687	0.0849	I(1)
REN	-2.53868	0.3087	-4.45378	0.0077	I(1)
TRADE	-1.21177	0.8884	-5.45052	0.0008	I(1)

According to the Augmented Dickey-Fuller (ADF) test, some variables are stationary at the level and stationary at the first difference, shown in table 3. The results of the ADF test confirms that the Financial, economic development, trade, and consumption of renewable energy has the order of integration I(1), and foreign direct investment and non-renewable energy are stationary at level. It concludes that there exists a mixed integration order. So, we move to ARDL results for the long-run and short-run and after that confirmed the co-integration between the models is confirmed from the bound test. ARDL results are shown in table 4;

4.3. Autoregressive Distributive Lag (ARDL) results

Table 4
ARDL estimates

Variable	Coeff.	SE	t-ratio	Prob.
Short run Coefficients				
D (REN(-1))	0.435	0.271	1.604	0.137
D (REN(-2))	0.152	0.094	1.623	0.133
D (GDP)	0.001	0.037	0.032	0.975
D(TRADE)	0.063	0.045	1.416	0.185
D(TRADE(-1))	-0.167**	0.051	-3.284	0.007
D(FDI)	-0.010	0.007	-1.517	0.157
D(FD)	-0.082	0.060	-1.351	0.204
D(FFEN)	-2.733***	0.388	-7.038	0.000
D(FFEN(-1))	1.817**	0.789	2.304	0.042
CointEq(-1)	-0.987***	0.207	-4.764	0.001
Long run Coefficients				
C	13.007***	0.958	13.572	0.000
GDP	0.066**	0.022	2.948	0.013
TRADE	-0.215**	0.080	-2.686	0.021
FDI	-0.010	0.006	-1.652	0.127
FD	0.380*	0.194	1.957	0.069
FFEN	-2.631***	0.262	-10.060	0.000
Model Diagnostics				
R-square				0.988
Adj. R-square				0.973
LM-test				0.294
Heteroscedasticity				0.610
Ramsey RESET				0.222

Note: ***,** and * show 1%, 5% and 10% level of significance respectively.

The co-integration model results indicate that, except trade, the significance of all indicators reached a 10% significance level. According to the analysis, if GDP per capita rises by 1%, the renewable energy share in Thailand's overall electricity usage will rise by 0.066%. This is consistent with earlier studies(Rafiq et al., 2014) and (Marques et al., 2010) Apply to European Union member states(Pfeiffer & Mulder, 2013). Economic developments have increased the share of renewable energy in electricity consumption in multiple forms. First, the government should have enough capital to finance environmental protection. Considering that fundamental development requirements have been largely addressed, the government would be willing to make sacrifices to promote renewable energy while promoting increased energy efficiency. Second, as income levels increase and living standards improve, people can demand protection of the environment and have ability to pay for clean energy sources.

Trade liberalization has a significant impact, and foreign direct investment has an insignificant effect on the share of Thailand's overall electricity consumption in the form of renewable energy. The finding supports previous research (Popp et al., 2011), which came from a survey of 108 underdeveloped nations that increased openness by limiting the use of renewable energy. Peterson (2008) also found no evidence that trade and foreign direct investment positively affect clean technology. This finding contrasts with the previous study, which significantly impacts trade and foreign direct investment in renewable energy (Omri & Nguyen, 2014).

The findings indicate that a rise of 1% in trade openness and foreign direct investment has resulted in a 0.21% reduction within the share of sustainable energy in power consumption. However, the effects of foreign direct investment and the increase in the exchange rate have contributed significantly to overall energy demand compared with renewable energy utilization. This research distinguishes from the current perception that foreign direct investment and commercial openness are critical to raising the share of renewable sources' electricity generated in overall power consumption. Foreign direct investment and business liberalization may encourage renewable energy growth across talent gathering and technology transfer but may not increase renewable energy share in total electricity intake. Another aspect that can illustrate Thailand's inadequate attention to environmental problems in recent decades can also contribute to foreign direct investment and trade as companies depend heavily on cheap and subsidized fossil fuels and flourish on them. This argument lies on (Peterson, 2008; Unruh, 2000). Unruh (2000) argues that specific structural mechanisms can interfere with the proliferation of renewable energy technologies.

Financial growth has had a significant positive effect on Thailand's renewable energy. However, the impact is limited. Financial development increased by 1%, and renewable energy generation increased by 0.38%. It establishes the research of (Brunnschweiler, 2010; Popp et al., 2011). The capability to supply credit services to fund large-scale projects such as clean energy technologies and many other forms of renewable energy sources continues to increase as the financial sector expands. Two factors may explain the tiny impact of economic development on Thai renewable energy. Firstly, Thailand's financial sector is still heavily regulated, undermining its ability to fund large projects adequately despite state guarantees. Secondly, due to the uncertainty of future climate policies, the risks involved in financing green energy initiatives have discouraged the financial services industry from assisting in financing sustainable energy initiatives. This view is based on the conclusions of previous research by the International Energy Agency (Emissions, 2005). Financial companies are reluctant to spend on sustainable energy innovations due to future global strategies and longer repayment terms. It thereby confirms the findings of (Liming, 2009; Q. Wang & Chen, 2010)that innovative frameworks, tools, and financing mechanisms are essential to finance renewable energy in Thailand.

The proportion of fossil fuels in overall energy utilization harms Thailand's use of renewable energy. In Thailand, a 1% rise in the share of fossil fuels in energy usage culminated in a 2.631% fall in clean energy. It refers to the findings of the (Aguirre & Ibikunle, 2014; Marques et al., 2010; Sovacool, 2009). Sovacool (2009) argued that the lobbying role of conventional vitality sources prevented recoverable energy sources, while (Pfeiffer & Mulder, 2013) argued that higher the production of fossil fuels seemed to hinder sustainable energy consumption. It demonstrates that conventional energy lobbying organizations are capable of disrupting renewable energy.

5. Conclusion and Policy Recommendations

This research analyzes Thailand's long-term renewable energy determinants by using data from 1990 to 2018. Several pieces of research on the use of renewable energy have been conducted, but the majority of those research used panel data analysis and concentrated on renewable energy. This research differs by focusing on an analysis of Thailand's historical sequence and the determinants of the overall usage of electricity by renewable energies. The auto regressive distributive lag (ARDL) and vector error correction model were applied to examine the long-run and short-term association among renewable energy in Thailand and the factors influencing it. Depending on the research findings, many results emerged. Firstly, actual per capita GDP has increased the proportion of renewable energy in overall electricity utilization in Thailand. Due to economic growth, the country has enough financial and human resources to spend in and exploit renewable energy. In addition, the public would be likely to use renewable energy sources which reduce air emissions correlated with producing fossil fuel power due to increasing incomes and living standards. Secondly, foreign direct investment and commercial liberalization have devastated the share of renewable energy in overall energy use. Foreign direct investment and trade have contributed to a rise in total electricity demand compared with renewable vitality consumption. Foreign direct investment and trade liberalization may increase renewable energy, but the share of sustainable energy in overall electricity consumption does not increase. Thirdly, financial growth has had a positive and significant impact on the proportion of renewable energy usage in electricity, but it has a minor effect. As the fiscal field expanded, it developed the ability to fund projects related to renewable energy technology.

Nonetheless, due to the uncertainty of future climate policy and the long investment recovery period, the uncertainties affiliated with the funding of renewable energy projects minimize the financial sector's impact on the growth of sustainable energy. Fourth, conventional nonrenewable fuel has a significant negative effect on renewable energy sources. The forecast error variance decomposition results indicate that fluctuation in Thailand's renewable electricity use is mainly due to the shock itself and by financial growth. In addition, although the influence of disruptions on all parameters has a transient effect, the impact of lobbying tends to have a permanent and destructive implications for sustainable energy.

The Government should intentionally assure that overseas investors and manufacturers of products exported to Thailand acquire and accept renewable electricity. Third, strengthening and supporting the financial sector to increase its capacity to finance investments in clean energy technologies. This can be achieved by providing national guarantees for projects promoting renewable energy development and decomposition. Fourth, the Chinese government will proactively lobby groups that control renewable energy production in the fossil fuel industry. Therefore, it is necessary to take deliberate steps to reduce the use of fossil fuels substantially. This could be accomplished by reducing incentives for the nonrenewable fuel industry and levying carbon taxes to collect economic and environmental costs of fossil fuel emissions.

This article explores the factors that drive renewable vitality advancement in Thailand. This explores variables that contribute to the share of renewable energy generation in Thailand's overall electricity use. The study findings have significant implications for strategy that encourage the share of renewable energy and the proportion of electricity produced by renewable sources in total electricity usage. However, the hindrance of the study is that it focuses on Thailand's renewable energy sector in general. Considering the discrepancies throughout supplying clean energy resources and the level of economic growth among Thai provinces, future research should investigate the factors that determine Thailand's provincial and sectoral renewable energy power generation shares. In addition, future research may also delve into the determinants of various kinds of renewable energy.

References

Adelaja, S., & Hailu, Y. (2007). Projected impacts of renewable portfolio standards on wind industry development in Michigan. *Lansing: The Land Policy Institute at Michigan State University*.

Aguirre, M., & Ibikunle, G. (2014). Determinants of renewable energy growth: A global sample analysis. *Energy Policy, 69*, 374-384. doi:10.1016/j.enpol.2014.02.036

Bakhtyar, B., Kacemi, T., & Nawaz, M. A. (2017). A review on carbon emissions in Malaysian cement industry. *International Journal of Energy Economics and Policy, 7*(3), 282-286.

Baloch, Z. A., Tan, Q., Kamran, H. W., Nawaz, M. A., Albashar, G., & Hameed, J. (2021). A multi-perspective assessment approach of renewable energy production: policy perspective analysis. *Environment, Development and Sustainability*, 1-29.

Beckman, J. F., Borchers, A., & Stenberg, P. L. (2011). *The determinants of on-farm renewable energy adoption*. Retrieved from

Bird, L., Bolinger, M., Gagliano, T., Wiser, R., Brown, M., & Parsons, B. (2005). Policies and market factors driving wind power development in the United States. *Energy Policy, 33*(11), 1397-1407. doi:10.1016/j.enpol.2003.12.018

Brunnschweiler, C. N. (2010). Finance for renewable energy: an empirical analysis of developing and transition economies. *Environment and development economics, 15*(3), 241-274. doi:10.1017/S1355770X1000001X

Carley, S. (2009). State renewable energy electricity policies: An empirical evaluation of effectiveness. *Energy policy, 37*(8), 3071-3081. doi:10.1016/j.enpol.2009.03.062

Chang, T.-H., Huang, C.-M., & Lee, M.-C. (2009). Threshold effect of the economic growth rate on the renewable energy development from a change in energy price: evidence from OECD countries. *Energy Policy, 37*(12), 5796-5802. doi:10.1016/j.enpol.2009.08.049

Chien, F., Hsu, C.-C., Zhang, Y., Vu, H. M., & Nawaz, M. A. (2021). Unlocking the role of energy poverty and its impacts on financial growth of household: is there any economic concern. *Environmental Science and Pollution Research*, 1-14.

Chien, F., Kamran, H. W., Nawaz, M. A., Thach, N. N., Long, P. D., & Baloch, Z. A. (2021). Assessing the prioritization of barriers toward green innovation: small and medium enterprises Nexus. *Environment, Development and Sustainability*, 1-31.

Chien, T., & Hu, J.-L. (2008). Renewable energy: An efficient mechanism to improve GDP. *Energy policy, 36*(8), 3045-3052. doi:10.1016/j.enpol.2008.04.012

Damijan, J. P., Knell, M., Majcen, B., & Rojec, M. (2003). The role of FDI, R&D accumulation and trade in transferring technology to transition countries: evidence from firm panel data for eight transition countries. *Economic systems, 27*(2), 189-204. doi:10.1016/S0939-3625(03)00039-6

Emissions, R. G. G. (2005). The Potential of Coal. *International Energy Agency*.

Gan, L., Eskeland, G. S., & Kolshus, H. H. (2007). Green electricity market development: Lessons from Europe and the US. *Energy Policy, 35*(1), 144-155. doi:10.1016/j.enpol.2005.10.008

Haq, M. A. U., Nawaz, M. A., Akram, F., & Natarajan, V. K. (2020). Theoretical Implications of Renewable Energy using Improved Cooking Stoves for Rural Households. *International Journal of Energy Economics and Policy, 10*(5), 546-554.

Huang, M.-Y., Alavalapati, J. R., Carter, D. R., & Langholtz, M. H. (2007). Is the choice of renewable portfolio standards random? *Energy Policy, 35*(11), 5571-5575. doi:10.1016/j.enpol.2007.06.010

Johnstone, N., Haščič, I., & Popp, D. (2010). Renewable energy policies and technological innovation: evidence based on patent counts. *Environmental and resource economics, 45*(1), 133-155. doi:10.1007/s10640-009-9309-1

Liming, H. (2009). Financing rural renewable energy: a comparison between China and India. *Renewable and Sustainable Energy Reviews, 13*(5), 1096-1103. doi:10.1016/j.rser.2010.03.023

Marques, A. C., Fuinhas, J. A., & Manso, J. P. (2010). Motivations driving renewable energy in European countries: A panel data approach. *Energy policy, 38*(11), 6877-6885.

Martinot, E. (2002). Power sector restructuring and environment: Trends, policies and GEF experience. *Washington, DC: Global Environment Facility*.

Menz, F. C., & Vachon, S. (2006). The effectiveness of different policy regimes for promoting wind power: Experiences from the states. *Energy policy, 34*(14), 1786-1796. doi:10.1016/j.enpol.2004.12.018

Mitchell, C., Sawin, J., Pokharel, G. R., Kammen, D., Wang, Z., Fifita, S., . . . Nadai, A. (2011). Policy, financing and implementation. In: Cambridge University Press, Cambridge, UK and New York, NY, USA.

Nawaz, M. A., Ahmad, T. I., Hussain, M. S., & Bhatti, M. A. (2020). How Energy Use, Financial Development and Economic Growth Affect Carbon Dioxide Emissions in Selected Association of South East Asian Nations? *Paradigms*(SI), 159-165.

Nawaz, M. A., Azam, M. A., & Bhatti, M. A. (2019). Are Natural Resources, Mineral and Energy Depletions Damaging Economic Growth? Evidence from ASEAN Countries. *Pakistan Journal of Economic Studies, 2*(2).

Nawaz, M. A., Seshadri, U., Kumar, P., Aqdas, R., Patwary, A. K., & Riaz, M. (2021). Nexus between green finance and climate change mitigation in N-11 and BRICS countries: empirical estimation through difference in differences (DID) approach. *Environmental Science and Pollution Research, 28*(6), 6504-6519.

Omojolaibi, J. A. (2016). Financing the alternative: Renewable energy in the Nigerian economy. *International Journal of Environment and Sustainable Development, 15*(2), 183-200.

Omri, A., & Nguyen, D. K. (2014). On the determinants of renewable energy consumption: International evidence. *Energy, 72*, 554-560. doi:10.1016/j.energy.2014.05.081

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics, 16*(3), 289-326. doi:10.1002/jae.616

Peterson, S. (2008). Greenhouse gas mitigation in developing countries through technology transfer?: a survey of empirical evidence. *Mitigation and Adaptation Strategies for Global Change, 13*(3), 283-305. doi:10.1007/s11027-007-9111-8

Pfeiffer, B., & Mulder, P. (2013). Explaining the diffusion of renewable energy technology in developing countries. *Energy Economics, 40*, 285-296. doi:10.1016/j.eneco.2013.07.005

Popp, D., Hascic, I., & Medhi, N. (2011). Technology and the diffusion of renewable energy. *Energy Economics, 33*(4), 648-662. doi:10.1016/j.eneco.2010.08.007

Rafiq, S., & Alam, K. (2010). *Identifying the determinants of renewable energy consumption in leading renewable energy investor emerging countries.* Paper presented at the 39th Australian Conference of Economists, held.

Rafiq, S., Bloch, H., & Salim, R. (2014). Determinants of renewable energy adoption in China and India: a comparative analysis. *Applied Economics, 46*(22), 2700-2710. doi:10.1080/00036846.2014.909577

Sadorsky, P. (2009a). Renewable energy consumption and income in emerging economies. *Energy policy, 37*(10), 4021-4028. doi:10.1016/j.enpol.2009.05.003

Sadorsky, P. (2009b). Renewable energy consumption, CO2 emissions and oil prices in the G7 countries. *Energy Economics, 31*(3), 456-462. doi:10.1016/j.eneco.2008.12.010

Saibu, O., Omoju, O., & Nwosa, P. (2012). Trade openness and the dynamics of unemployment and poverty incidence in Nigeria: A multivariate cointegration analysis. *Nigerian Journal of Economic and Social Studies, 54*(3), 367-388.

Shafiq, M. N., ur Raheem, F., & Ahmed, A. (2020). Does Adaptation of Renewable Energy and Use of Service Industry Growth Diminution CO2 Emissions: Evidence of ASEAN Economies. *iRASD Journal of Energy & Environment, 1*(2), 61-71.

Shair, F., Shaorong, S., Kamran, H. W., Hussain, M. S., Nawaz, M. A., & Nguyen, V. C. (2021). Assessing the efficiency and total factor productivity growth of the banking industry: do environmental concerns matters? *Environmental Science and Pollution Research, 28*(16), 20822-20838.

Sinani, E., & Meyer, K. E. (2004). Spillovers of technology transfer from FDI: the case of Estonia. *Journal of comparative economics, 32*(3), 445-466. doi:10.1016/j.jce.2004.03.002

Sovacool, B. K. (2009). Rejecting renewables: The socio-technical impediments to renewable electricity in the United States. *Energy Policy, 37*(11), 4500-4513. doi:10.1016/j.enpol.2009.05.073

Stadelmann, M., & Castro, P. (2014). Climate policy innovation in the South–Domestic and international determinants of renewable energy policies in developing and emerging countries. *Global Environmental Change, 29*, 413-423. doi:10.1016/j.gloenvcha.2014.04.011

Sun, H., Awan, R. U., Nawaz, M. A., Mohsin, M., Rasheed, A. K., & Iqbal, N. (2021). Assessing the socio-economic viability of solar commercialization and electrification in south Asian countries. *Environment, Development and Sustainability, 23*(7), 9875-9897.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy policy, 28*(12), 817-830. doi:10.1016/S0301-4215(00)00070-7

Vachon, S., & Menz, F. C. (2006). The role of social, political, and economic interests in promoting state green electricity policies. *Environmental Science & Policy, 9*(7-8), 652-662. doi:10.1016/j.envsci.2006.07.005

Van Rooijen, S. N., & Van Wees, M. T. (2006). Green electricity policies in the Netherlands: an analysis of policy decisions. *Energy Policy, 34*(1), 60-71. doi:10.1016/j.enpol.2004.06.002

Wang, Q., & Chen, Y. (2010). Barriers and opportunities of using the clean development mechanism to advance renewable energy development in China. *Renewable and Sustainable Energy Reviews, 14*(7), 1989-1998. doi:10.1016/j.rser.2010.03.023

Wang, Y. (2006). Renewable electricity in Sweden: an analysis of policy and regulations. *Energy policy, 34*(10), 1209-1220. doi:10.1016/j.enpol.2004.10.018

World Bank, W. (2020). The World Bank. Retrieved from https://databank.worldbank.org/source/world-development-indicators

Xiang, H., Ch, P., Nawaz, M. A., Chupradit, S., Fatima, A., & Sadiq, M. (2021). Integration and economic viability of fueling the future with green hydrogen: An integration of its determinants from renewable economics. *International Journal of Hydrogen Energy, 46*(77), 38145-38162.

Zhuang, Y., Yang, S., Chupradit, S., Nawaz, M. A., Xiong, R., & Koksal, C. (2021). A nexus between macroeconomic dynamics and trade openness: moderating role of institutional quality. *Business Process Management Journal, 27*(6), 1703-1719.