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The Effect of Financial Sector Development on Carbon Emission in Thailand

Altaf Hussain[1], Rashid Ahmad[2]

[1] Assistant Professor, Department of Economics, The Islamia University of Bahawalpur, Pakistan.
Email: altafhussain@iub.edu.pk
[2] Assistant Professor, School of Economics, Bahauddin Zakariya University Multan, Pakistan.
Email: rashidahmad@bzu.edu.pk

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ABSTRACT

Economic development typically faced many hurdles, like policymakers does not focused the potential factors which creating hurdles in economic development. One of the problems of economic development is climate change, which directly caused global warming. Climate change and global warming occurred due to human induced greenhouse gas production and use of fossil fuel (manufacturing and industrial process) which produce massive amount of carbon emission gas. Furthermore, climate change has many side-effects like rapid loss of glaciers, rising sea level, severe heatwaves and etc. Thailand is the land of tropical beaches but even the temperature increased to certain high level in summer due to effect of climate change. According to the intergovernmental panel report the sea level increased by time due to climate change which is almost the average of 1.8 mm per year. So, this situation is unpredictable and the arid zone of this country is now facing the severity of droughts with increased frequency. So, the objective of this study to examine the long run association between carbon emission, energy consumption, and financial development in Thailand. This study used the timer series data from 1980 to 2018 which is taken from (World Bank, 2020). Autoregressive distributed lag (ARDL) model used to examine that long run relationship and results indicates that there exits uni-directional and long run relationship among financial development and carbon dioxide. So, policy makers highlight the issue of global warming and serious action against the excessive use carbon emission because it is serious obstacle to human wellbeing which results in unproductive capacity of employee. Furthermore, the government needs to established policies which help companies to adopt environmentally friendly equipment's which produce less carbon emission.

Corresponding Author's Email: altafhussain@iub.edu.pk

1. Introduction

In growth empirics, number of researches were reported to establish a financial institution's role in economic growth. The relationship between economic growth and financial development can be explained with the help of the manufacturing and financial sector's fund allocation and mobilization of savings (Goldsmith, 1969; McKinnon, 1973; Schumpeter, 1911). According to other researches Goldsmith (1969); King and Levine (1993); McKinnon (1973), a sound financial system will increase the growth rate and its functionality. Mohammad Shahbaz (2009) investigated a sound and well-developed financial sector that can provide remarkable financial service access by reducing monitoring and

information cost. Furthermore, the investments should be encouraged by the financial sector by allocating resources, monitoring the workings of the firms, risks diversification, offer to hedge, enable trading, mobilizing savings, provide cheaper cost loans, and encouraging sectors that enhanced domestic output by using environmentally friendly technology.

Some studies also showed that a well-developed financial sector could reduce the energy pollutants along with the economic growth stimulation (Al-Mulali, Tang, & Ozturk, 2015; Alam et al., 2015; Muhammad Shahbaz, Mutascu, & Azim, 2013). In the modern age, environmental friendly technology can only be improved with financial development (Birdsall & Wheeler, 1993; Frankel & Rose, 2002). Researchers (Muhammad Atif Nawaz, Azam, & Bhatti, 2019; Sadorsky, 2010, 2011; Muhammad Shahbaz & Lean, 2012; Tamazian, Chousa, & Vadlamannati, 2009) also confirmed that the CO2 and energy are direct effect by financial development which table 1 and figure affirmed that (World Bank, 2020). The carbon dioxide emission can be reduced if the energy sector improves technology and uses renewable energy.

Table 1
CO2 emission, Energy usage, and Financial Development

Years	CO2	Financial Development	Energy Usage
2000	2.879479	4.655119	7.045994
2005	3.78297	4.541484	7.32216
2010	4.195642	4.751411	7.469485
2015	4.465458	5.006449	7.5706
2016	4.496517	4.987594	7.584248
2017	4.527451	4.976623	7.580066
2018	4.496475	4.973915	7.578321

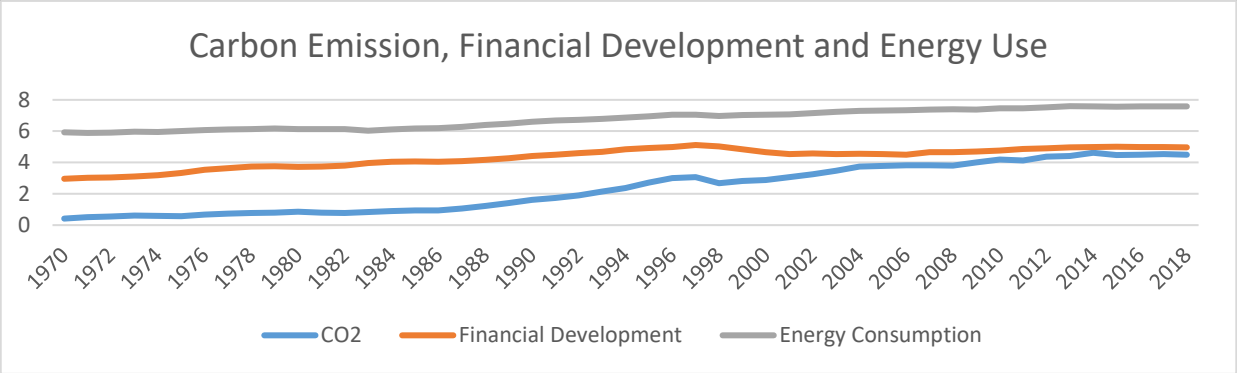

Figure 1: Relationship of CO2 emission, Energy use, and Financial Development in Thailand

Nowadays, the most controversial environmental challenge is climate change and global warming. IPCC (2007) reported that the atmosphere and ocean are warming because of the human-induced, greenhouse gas emissions and use of fossil fuels, which generates carbon dioxide and increases the temperature of the environment. Rising sea level, reversing ocean currents, increasing storm intensity, altering precipitation patterns, and extreme weather conditions are the ongoing outcomes of climate change. These changes are producing adverse effects on our wildlife, ecosystems, and human wellbeing (Bakhtyar, Kacemi, & Nawaz, 2017; Muhammad Shahbaz et al., 2013).

While fossil fuels and minerals are energy resources and used in manufacturing processes. It reflects that all the natural resources are significant for economic development and financial development and are necessary for growth. The environment pollutants can be reduced with financial development by using environmentally friendly business policies (Gupta & Goldar, 2005). The financial sector should also refrain the firms which are releasing pollutants in the environment to enhance the productivity of environmentally friendly technology (Capelle-Blancard & Laguna, 2010; Muhammad Shahbaz & Lean, 2012). The market value of the firm will be increased by making these policies and increases manufacturing (Klassen & McLaughlin, 1996). Therefore, the stock market and the shares of

specific firms will be dependent on their performance in the environment-friendly ecosystem. All these actions will source a reduction in carbon dioxide emissions and eradicate pollution from the environment.

The purpose of the study is to explore the impact of financial development on Co2 (carbon dioxide) emissions in Thailand. Furthermore, the study also reflects the impression of capital market development and banking sector effect on carbon dioxide emission while determining the causality among Co2 emission and financial sector variables in Thailand.

2. Literature Review

Many studies encountered the use of porous such as crude oil which is the world's most important source since made fifties. Crude oil as easy transportation, high energy density, and relative abundance was used for different manufacturing processes including chemical products, pharmaceuticals, plastics, pesticides, fertilizer, solvents, etc. It is a very demanding raw material of industry as its consumption is around 84 million barrels per day. The oil is found in the earth crust, and due to its high demand, scientists think that the oil supply will be vanished from the earth crust in about the next 120 years (Covert, Greenstone, & Knittel, 2016). Therefore, everyone must search for other alternatives not only for renewable energy but also for other relevant industries (Arutyunov & Lisichkin, 2017).

The primary greenhouse gas is carbon dioxide, which content is becoming higher over time by human activities. It is a part of the earth's carbon cycle and presents in the atmosphere while the carbon cycle is altering by the human actions by adding carbon dioxide to the air as well as naturally. Many natural sources cause carbon dioxide emissions but humans are the cause of an increase in this emission and because of industrial and manufacturing revolution (National Research Council, 2010). The land-use for construction instead of agriculture, industrial processes, fossil fuel combination for transport and energy are the main reasons carbon dioxide emissions. The carbon dioxide emission can be reduced if we reduce the combustion of fossil fuel. Many interventions and policies can be made for the reduction of carbon dioxide emissions used, especially for the energy sector.

When we burn fossil fuel that will go into an atmosphere that will be observed by trees as a natural carbon cycle. The carbon dioxide is trapped in the atmosphere in the past million years, and we are rapidly increasing its percentage in the atmosphere by burning fuels for energy. Therefore, it is necessary to look for renewable energies rather than non-renewable. (Busse, Brümmer, & Ihle, 2010).

Shaw (1973) introduced a new terminology; financial deepening, this term was introduced to define the financial transactions expansion process in the market when the non-financial activity's growth is less than the market place. Stiglitz (1998) investigated that economic development was directly proportional to the financial system; therefore, it was directly affecting the renewable energy sector. The financial deepening concept used by different economists and financial researchers to recognize the different components of the financial system.

Omri and Nguyen (2014) investigated the renewable energy determinants 64 economies of period 1990-2011 with the help of the GMM panel model. The result showed that the carbon dioxide emission was decreased with financial development as well as the oil price had an inverse relationship with renewable energy development. Omri and Nguyen (2014) studied the strategies of the state for renewable energy and concluded that financial development was essential for the promotion and development of re-newable energy sector. Stadelmann and Castro (2014) accumulated the data of 12 developing nations between 1998 and 2009. According to their results, there were many domestic factors (e.g., finance) associated with renewable energy development. Martinot (2002) was reported that the renewable energy sector was behind, then nonrenewable energy because of the design of domestic policies, which was enhanced with the help of different interventions. Still, it is necessary to start right now because there will be worse climate change after some years. Millner and Dietz (2015) designed their model based on the Ramsey-CassKoopmans growth model for the areas taking an actual minor share in the

carbon emission globally. According to their results, the climate change is exogenous to the developmental choice of a specific area.

Tamazian et al. (2009) inspected the association of carbon dioxide emission, financial and economic development with the help of BRIC nations, and data time spam was 1992-2004. The result showed that the carbon dioxide emission determinants were financial and economic development. Environmental degradation had an opposite influence on financial and economic development. Furthermore, indicators such as openness and financial liberalization can reduce CO2 emissions. Zhang (2011) examined the financial growth role in China on Co2 emission. The long-run affiliation was started among the indicators of financial development and carbon dioxide emission. The scholar used the Granger causality test to confirm that the important carbon dioxide emission driver was financial intermediation scale. Muhammad Shahbaz et al. (2013) stated the character of environmental deprivation and financial instability over the period 1971-2009 in Pakistan. The researcher used the bound testing approach based on ARDL and find out the long association amid Co2 emission, trade openness, energy use, economic development, and financial stability in the case of Pakistan. Environmental degradation was increased by financial instability which directly harms the environment of Pakistan. Furthermore, the environmental Kuznets curve was also present according to their study. The trade openness had an indirect association with carbon dioxide emission while energy consumption was directly proportional to it.

Boutabba (2014) considered the long-run connection among total energy use, trade openness, CO2 emission, financial development, and economic growth over the period 1970-2008 in India. They found strong evidence upon the casual and long-run affiliation among trade openness, financial development, per capita consumption of energy, per capita economic expansion and per capita carbon CO2 emission. Furthermore, it was unidirectional from financial development, consumption of energy, per capita real income to per capita carbon emissions. Gokmenoglu, Ozatac, and Eren (2015) investigate the financial development impact on environmental pollution especially air pollution in Turkey. They have originated that there exists a long-run affiliation among Co2 emission, financial development, and industrialization. Furthermore, here is a uni-directional affiliation to carbon dioxide production from financial expansion. Ekbom & Dahlberg (2008) inspected the association between environment, climate change, and economic development as well as challenges regarding the issues and resulted in the growth restrained by climate change. Okali (2004) studied that in Nigeria, climate change and concluded that geographical location is the main factor and there exists 6 major areas with variable weather in the mentioned country. Furthermore, there exists the less capability of technology, the lack of awareness, inadequate resources, serious social tensions, high population density, insecurity issues, higher population density, and high GDP concentration generating industries with very vulnerable changes in the climate.

Rennkamp, Haunss, Wongsa, Ortega, and Casamadrid (2017) investigated the 3 middle-income economies that are Mexico, South Africa, and Thailand for renewable energy and fossil fuel resources and their reliance on the economy. All three countries have an abundant amount of fossil fuels locally as well as renewable energy resources. According to their result, politics is another important factor in renewable energy because the private collection was supporting renewable energy policies. At the same time, the opposition wants to increase conventional methods for energy, such as fossil fuel. Furthermore, the association among economic considerations besides environmental consideration is powerful in all three countries.

Bößner et al. (2020) investigated the low carbon technologies in Peru, Thailand, and Uganda. They discussed the policy transfer, dynamics, processes, and the player's intricate in the policy transmission processes and renewable energy penetration. The result showed that the policy transfer is very complex because of the involvement of many stakeholders. Furthermore, policy transfer is a continuous process that required iterative learning. Renewable energy is vital to address climate change and enhance affordability, sustainability, and reliability.

3. Methodology and Data

The goal of this study assesses the affiliation among development in the financial sector and environmental degradation in Thailand. Numerous researches have been conducted to estimate the determinants of carbon emissions. So, different approaches are applied to examine financial development, natural resources and other factors such as the association among income and carbon productions. Jorgenson and Wilcoxen (1993) examined the stable cumulative growth model to review the relations among environmental pollutants, consumption of energy, and economic expansion. Also, (Ang, 2007, 2008; Halicioglu, 2009; Muhammad Shahbaz & Lean, 2012) among others, used a multivariate model to estimate the association among economic development, consumption of energy and carbon emission (CO2). Subsequently, Jalil and Feridun (2011); Muhammad A Nawaz and Hassan (2016); Talukdar and Meisner (2001); Tamazian et al. (2009) examined the multivariate equation model by including financial sector which is important determinant for carbon emissions. However, financial sector helps in environmental degradation levels by increasing the emission level of CO2 through the growth of the industrial sector.

As discussed in the literature, this paper examined the impression of financial & economic sectors development on the CO2 emission level with the help of controlled indicators. Controlled indicators consist of trade liberalization and total energy usage, and the model depends on multivariate methodology in the case of Thailand. For the unbiased estimates and avoid the spurious regression, variables are transformed in logarithms forms as given by (Muhammad Shahbaz & Lean, 2012). The estimated equation is modeled as follows:

$$ENVIOR=f(FIN, ECON, GDP, FDI) \quad (1)$$

Where ENIVOR= Carbon dioxide emission in kiloton used as a proxy of the environment is an endogenous variable. Exogenous variables are GDP measured by annual GDP growth rate, and FIN= financial development is proxied by "domestic credit to private sector % of GDP," and controlled indicators are ECON is energy consumption which is measured by "Energy use (kg of oil equivalent per capita)." This study used annual secondary data, so the prime objective of this data is checking the order of integration of the data before move to analysis.

3.1. Unit Root Test

According to the above secondary data its necessary to perceive the problem of a unit root in the series. Because it affects the estimation results, so if there exits the problem of unit root then the results are biased which further violate the assumption of CLRM. If the results are not unbiased then the estimates are just the piece of paper and not used for policy implementations. Hence it is necessary to check the stationary problem, and there are multiple tests to check the stationary of the data. This study uses the Augmented Dickey-Fuller (ADF) unit root test to check the stationary of data, then select the appropriate technique.

3.2. Co-integration Test

Several weighted statistical techniques have been proposed to estimate the long-term cointegration association between indicators. Engel and Granger (1987) initially purposed the cointegration model and later it is modified by (Hansen & Phillips, 1990). Later Johansen (1988); Johansen and Juselius (1990) gave complete information on the most likely methods has been widely used in empirical research. Johansen cointegration technique is not only a multivariate technique but also preferred over other techniques because it overcomes small sampling errors and provides more than one cointegration relationship. However, what is needed for these methods is that they all need to be integrated in the same order, that is I (1). If the level of cointegration of the variables is not the same, then the autoregressive distribution lag (ARDL) model best processed the single cointegration analysis and determined by (Pesaran, Shin, & Smith, 2001). However, ECMs are best suited if the order of integration of the indicators is not the same. Because ARDL has the advantage to estimate the short and long-run effect between exogenous indicators to the exogenous indicators at the same time, then in this study applied the

ARDL methodology. First of all, check the order of integration of the variable and then apply ARDL if the variable integrated order is mixed.

3.3. Econometric Model

$$\log(ENVIOR)_t = \alpha_o + \sum_{i=1}^{p} \alpha_1 \Delta\log(ENVIOR)_{t-1} + \sum_{i=0}^{p} \alpha_2 \Delta\log(FIN)_{t-1} + \sum_{i=0}^{p} \alpha_3 \Delta\log(ECON)_{t-1} + \sum_{i=0}^{p} \alpha_4 \Delta\log(GDP)_{t-1} + \sum_{i=0}^{p} \alpha_5 \Delta\log(FDI)_{t-1} + \alpha_7 \log(ENIVOR)_{t-1} + \alpha_8 \log(FIN)_{t-1} + \alpha_9 \log(ECON)_{t-1} + \alpha_9 \log(GDP)_{t-1} + \alpha_{10} \Delta \log(FDI)_{t-1} + \varepsilon_t \quad (2)$$

According to the equation 1, carbon dioxide emission (CO2) is an endogenous variable which is proxy of environment, and independent variables are lag of CO2, financial development, ECON use of energy as compared to the total, GDP (GDP growth rate annual) and FDI (Foreign direct investment).

We have two proxied for the development of the financial sector. The first one is the domestic credit to the private sector, and another one is liquid liabilities/ money supply M2 or M3. Most of the studies determined that the local credit to the private sector in the best measurement for financial development (Demirguc-Kunt & Levine, 2008; Levine, 1992; Mohammad Shahbaz, 2009; Muhammad Shahbaz, Ahmad, & Chaudhary, 2008). So, this study also used domestic credit to the private sector as an instrument for financial development.

3.4. Data Source

Annual time series data for Thailand of the time span of 1970 to 2018 has been taken from (World Bank, 2020) the World Development Indicators.

4. Results and Discussion

First of all, we discuss the descriptive summary of indicators which are used in this study in table 2;

Table 2
Description Summary of variables

Variables	ENVIOR	ECON	FDI	FIN	GDP
Mean	147439	1027.51	1.9079	88.2195	4.23126
Maximum	316213	1991.59	6.4348	166.504	11.3365
Minimum	15375.7	360.594	0.20196	19.3227	-8.7414
Std. Dev.	106513	574.475	1.48184	44.1428	3.50958
Observations	49	49	49	49	49

The descriptive statistics were carried out among financial development and CO2 emission in Thailand from 1970 to 2018. The table displays that the mean value of carbon emission per capita (ENVIOR) is 177439 kilotons, financial development instrumented by domestic credit to the private sector (FIN) is 88.21 $ of GDP per capita, per capita consumption of energy (ECON) is 1027 per capita, per capita gross domestic product (GDP) is 4.23 annual percentage and % of GDP of foreign direct investment (FDI) is $ 1.90 % of GDP. Before going to the analysis, we check the order of integration of variables by the ADF (Augmented Dickey-Fuller) test, and the results are given in Table 3.

Table 3
Augmented Dickey-Fuller Unit Root test

	Level		First Difference	
Variable	t-Statistic	Prob.	t-Statistic	Prob.
ENVIOR	-3.506	0.669	-3.509***	0.000
FIN	-3.509	0.280	-3.509**	0.033
ECON	-3.506	0.401	-3.509***	0.000
GDP	-3.506**	0.006		
FDI	-3.506**	0.014		

According to table 3, results confirmed that two indictors are stationary at a level, which are economic growth and FDI and others are stationary at I (1), which are

consumption of energy, emission of CO2 and domestic credit to the private sector. Unit root results confirmed that the model would move to ARDL, short-run effects are specified in 4 and long-run estimates are given in Table 4.

Table 4
Short-run ARDL results

Dependent variable: Environment				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D ENVIOR(-1)	-0.140	0.148	-0.950	0.350
D ENVIOR(-2)	-0.384**	0.143	-2.682	0.012
D ECON	0.087	0.187	0.465	0.645
D ECON(-1)	0.490**	0.175	2.808	0.009
DFDI	0.000	0.013	-0.023	0.981
DFDI(-1)	0.010	0.011	0.871	0.391
DFDI(-2)	-0.020*	0.011	-1.818	0.080
DFDI(-3)	-0.018	0.013	-1.329	0.195
D FIN	0.138**	0.036	3.795	0.001
D (GDP)	0.010***	0.002	4.221	0.000
D (GDP(-1))	-0.008**	0.003	-2.724	0.011
D (GDP(-2))	0.004**	0.002	2.144	0.041
ecm(-1)	-0.148*	0.076	-1.942	0.062

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

According to table 4, represents short-run ARDL results, and they indicate that the use of energy consumption, financial and economic development, have a positive impact on the environment. In contrast, FDI hurts environmental degradation. While according to the ECM term, which is statistically significant, and its coefficient is negative, which ensures the model takes a long-run association with the speed of adjustment of almost 14 % annually. After securing the error correction term of a long-term relationship of variables within the model will also confirm from the bond test and result of the bond test is given in table 5.

Table 5
Bond test

Critical Value	7.62532	
Significance	**I_0 Bound**	**I_1 Bound**
5%	2.86	4.01
1%	3.74	5.06

The bound test confirms that the estimated value is above, then the 1% significance level, which confirms the cointegration within the model. This further confirms the long-run association among environmental degradation with controlled variables. Lon run estimates are represented in table 6.

Table 6
Long run ARDL Results

Dependent variable: Environment				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	6.397**	1.950	3.280	0.003
FIN	0.934**	0.331	2.825	0.009
ECON	0.166	0.474	0.351	0.729
FDI	0.304**	0.116	2.619	0.014
GDP	0.074*	0.045	1.657	0.105
Model Diagnostics				
R^2				0.999
Adj. R^2				0.999
Durbin-Watson stat				2.291
LM test				0.125
ARCH test				0.529
Ramsey RESET Test				0.638

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

According to table 5, financial development, energy consumption, FDI, and economic development plays vital determinant towards unhealthy environment of Thailand. According to model diagnostics model is a best fit because its R square values are 99% which indicates that the controlled indicators almost clarify the endogenous variable and DW value

also indicates the model is a good fit, LM test indicates there does not exist the problem of autocorrelation in the model and ARCH test indicates that there does not exist the heteroscedasticity problem in the model and Ramsey reset test also specifies the model is a good fit.

The long-run estimations proposed that development in financial sectors measured by credit to the private sector by banks (FIN), per capita consumption of energy (ECON), foreign direct investment and gross domestic product per capita (GDP) have a positive influence on carbon release per capita (CAEM) in Thailand, all these confirm with theoretical expectation. As by theoretical literature the expected effect of financial development is negative because its attracts to those environmental projects which helps to reduction in the emission of carbon dioxide. But this study contradicts with the theoretical results and found that it boosts the emission level in Thailand which is confirmed by Bello and Abimbola (2010). So, its means that growth in level of financial expansion boosts the environmental degradation level.

Energy consumption has increased carbon dioxide emissions in Thailand, as confirmed also by (Gbadebo & Okonkwo, 2009). Furthermore, if an increase in consumption of electricity that results to an upsurge in carbon emissions. According to the growth, the process is intense in pollution, According to Akpan and Akpan (2012) confirmed that there exists the positive association among the economic development and carbon emission level, which means that it there increase in the level of consumption of electricity which ultimately boost the economic growth. So, it is cleared that consumption of energy boosts both the economic development in the occurrence of enviormental degradation.

In the presence of comparative advantage, if the good quality products is manufactured in the country which ultimately leads to contribute in part the enviormental degradation of that country. so, this results to designates that growth in the FDI level leads to boosts the production of CO2 which bring the environment to unhygienic conditions. In general, according to trade liberalization, then the consequence of technology controls the effects of scale and arrangement with in the presence of a comparative advantage in polluting (industries) or if the impact of technology and composition in a state with a comparative advantage in cleaning (industries) dominates the outcome of the scale, so the liberalization of trade will terminate in a positive effect from foreign direct investments which will finally boost carbon dioxide emissions (Grossman & Krueger, 1991). Tamazian and Rao (2010) also confirmed that trade opening (FDI) caused an increase in pollution, and also confirmed by (Ozturk & Acaravci, 2013).

Economic development boosts the enviormental degradation level outcomes of this study also confirmed that economic development increase the level of emission of CO2. Muhammad Shahbaz et al. (2013) also confirmed to increase in the expansion of economy rise the in level of carbon emission which create environment unhealthy and bad. Furthermore the usage of energy boosts the economic development level which ultimately create the environment bad in case for Indonesia, these studies also confirmed that consumption of energy rise in economic development an also increased CO2 emissions (Ozturk & Acaravci, 2013; Muhammad Shahbaz et al., 2013).

5. Conclusion

This study inspected the impression of financial developments with other controlled variables on carbon emissions in the Thai economy between 1970 and 2018. Controlled variables consist of financial development, consumption of energy, FDI in the presence of economic development, results revealed that these all controlled indicators have significant effect of emission level of carbon. The study concludes that financial development increases the carbon emission level in Thailand from the selected sample period.

Taking into account the observed nature of the role of development of financial on carbon emissions in Thailand during sample periods starts 1970 to 2018, the following strategic options are offered: Financial sector reforms by the monetary authority must be applied with great care to reduce instability in financial institutions and its impression on environmental degradation.

Central authority of Thailand's allows the financial sector to work independently, no political power ruled over these financial institutions. For example, issues of loan and schemes due to political trap should be dejected because that's only the waste of nations income. More importantly these investments should be projected to boost the environment neat and clean. And if some of some of financial sector faced loss or to be default then the other financial intuitions play a significant role to recover them by giving them loans which are participating for healthy environment. The government still needs to take urgent action against increasing the carbon footprint because it is a serious obstacle to human well-being that can result in the unproductive capacity of employees and the government needs to establish policies that help companies to adopt environmentally-friendly equipment that produces fewer carbon emissions.

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