Yuaningsih, Lilis; Febrianti, R. Adjeng Mariana

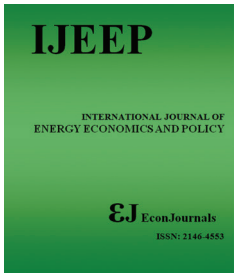
Article

Spotting the environmental effect of the economy and technology : how the development is causing a stringency with carbon emission?

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Yuaningsih, Lilis/Febrianti, R. Adjeng Mariana (2021). Spotting the environmental effect of the economy and technology : how the development is causing a stringency with carbon emission?. In: International Journal of Energy Economics and Policy 11 (6), S. 130 - 137. https://www.econjournals.com/index.php/ijeep/article/download/10938/6109. doi:10.32479/ijeep.10938.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2021, 11(6), 130-137.

Spotting the Environmental Effect of the Economy and Technology: How the Development is Causing a Stringency with Carbon Emission?

Lilis Yuaningsih, R. Adjeng Mariana Febrianti*

Widyatama University, Indonesia. *Email: adjeng.mariana@widyatama.ac.id

Received: 28 September 2020 **Accepted:** 29 January 2021 **DOI:** https://doi.org/10.32479/ijeep.10938

ABSTRACT

The increasing threat to natural climate has extended the focused on economic growth and technology. Thus, this research contribution has provided an empirical investigation for examining the impact of economic and science and technology indicators on carbon emission from five different sources namely; emission from transport industry, other sectors, residential building, electricity and heat production, and emission from manufacturing industries in Thailand. Different statistical analyses were done to analyze the individual and combine effect of both economic and science and technological indicators during 1990-2014 with yearly data trends. The results show that some economic factors are found to be positive determinants of carbon emission, while others have shown their adverse influence in increasing carbon threats to natural environment in Thailand. As per the research implications, present work is among the initial contribution while exploring the environmental effects of growth and technology in Thailand for which a specific research findings are presented earlier. For this reason, this work can provide a good understanding to policy-makers, reserachers, and students in the targeted fields like carbon emission, economy and science and technology. Moreover, some productive future directions are also provided in this paper. First, methodological context of the study can be revised for better findings through some time series models. Second, regional context of the study may spread to other economies like Indonesia, Malaysia and Singapore.

Keywords: Climate Change, Carbon Emission, Economic Growth, Thailand
JEL Classifications: O44, P18, Q56

1. INTRODUCTION

In current era, a range of economic and technological developments are experienced by the humans in the world. However, at the same time, such developments are causing a range of challenges because of their environmental effects in both developed and developing countries (Åström et al., 2012; Béguin et al., 2011; Kamran and Omran, 2018; Prowse et al., 2009; Santana Vilorta, 2020; Santos-Munguía and Perez, 2020). Since the deterioration of the natural environment, there is a growing concern about the climate change and global warming (Cox et al., 2000; McCright and Dunlap, 2011; Mori et al., 2010; Whitmarsh, 2009). The reason behind such threats to nature and the whole planet earth is observed in the form of increasing emission of carbon from different sources and sectors (Huang et al., 2018; Liu et al., 2019; Shao et al., 2018). Although, a range of financial and economical benefits are enjoyed by the world community due to advancement in technology, however, environmental degradation is also an outcome of such development (Kutz, 2018; Moreno-Brid et al., 2020; Ormaechea and Fernandez, 2020; Ortiz and Castillo Renteria, 2020). It is known as the deterioration of the natural climate due to depletion of range of sources like water air, and most importantly, the destruction of overall ecological system (Demirbas, 2005; Goudie, 2018; Peterson, 2019; Aleem, 2020; Batool et al., 2020; Hornung, 2020; Janssen, 2020). More consumptions of natural resources result in devastation of the environment. Various types

of environmental degradation are observed and some of them are in critical situation which needs immediate solution from the world leaders and departments like United Nations (UN).

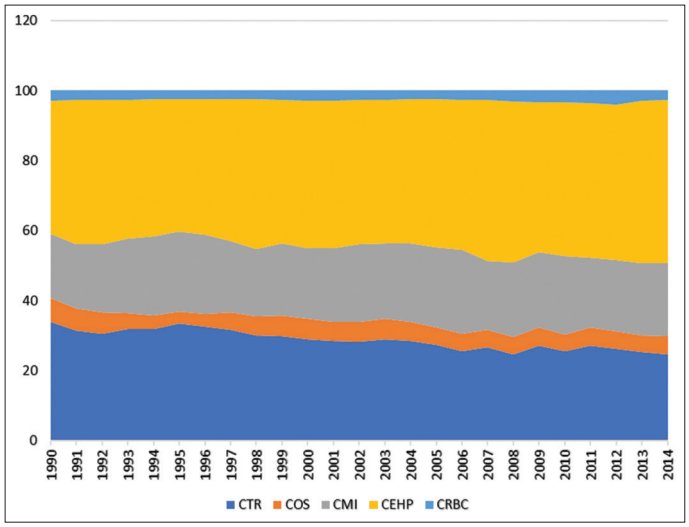
In any region of the world, the factor of economic development depends on variety of the indicators. Different mechanism are employed by diverse economies with the usage of natural sources. However, many aspects are highlighted in the literature, covering the fact that more development in any country results in adverse impact on the environment like pollution, more usage of the resources, creation of carbon emission in the climate, and similar other threats (Cumming and von Cramon-Taubadel, 2018; Danish and Wang, 2018; Longo and Baker, 2014; Perera, 2018; Singh et al., 2013; Li et al., 2020; Martínez-Martínez, 2020; Nguyen et al., 2020; Nurpeisova et al., 2020). For this reason, various economies are facing the issue of low quality of natural environment and bad living standards for its communities too. As inspired from this issue, present paper has highlighted the situation of carbon emission in the economy of Thailand while investigating its relationship with different economic indicators and science and technology factors. After the detailed investigation of Thai economy, it is found that many issues are presented in terms of natural environment like air pollution through carbon emission, soil erosion, water pollution, damage to eco-system and deforestation as well. As per Figure 1 below, it is found that carbon emission from heat and production (CEHP) is significantly greater than the rest of the indicators, showing a significant portion (yellow color). Whereas the carbon emission from transport (CTR) has also shown an alarming situation. Whereas, carbon emission from manufacturing industries (CMI) seems to cover the third ranking as observed in the Figure 1.

2. LITERATURE REVIEW

There are number of theoretical and empirical studies on the topic of carbon emission in different regions. This section covers some of the studies for the relationship between carbon emission, economic growth and technological factors too. For example, Aye and Edoja (2017) investigated the impact of economic growth on carbon emission while using the panel threshold framework, based on the data from 31 emerging economies. It is found that economic growth is negatively influencing the CO_2 emission in the low growth economies. More specifically, in high growth economies, the impact of economic growth on carbon emission is positively significant. Additionally, their findings have provided no evidence to support for the environmental Kuznets curve (EKC), rather they have found a u-shaped relationship between the selected variables. In addition, their study has found the causal relationship between carbon emission, economic growth and financial development. Schröder and Storm (2018) aims to investigate the restriction to stop the future global warming with the measurement of carbon emission. Expanding their discussion, authors claims that literature work is also arguing about radical de-carbonization with the increasing type of the economy. Mardani et al. (2019) has conducted a systematic review for the relationship between carbon emission and economic growth over the last two decades. A review from 175 articles have revealed the fact that there is bidirectional causality between the economic growth and emission of carbon in different economies.

In addition, Pandey and Rastogi (2019) empirically examined the impact of energy consumption in terms of electricity and its relationship with GDP under environmental degradation during 1971-2017. As per the trends of the data set, time series analyses like Dicky Fuller test has been applied to investigate the short term and long term relationship between GDP and carbon emission with co-integration and Granger Causality methods. As per the applied methods, authors found that there is a long-term relationship between the defined variables. However, short run causality exists between electricity consumption to economic growth and carbon emissions. Ismail (1996) has investigated the Malaysian economy in terms of economic evaluation of the carbon emission in the forestry sector. Galeotti et al. (2017) has measured the environmental policy stringency for the impact of environmental innovation and efficiency factor of the energy too. Authors claim for the contribution in the literature through computing the diversified indicators of environmental policy stringency with the testing of environmental innovation.

Figure 1: Carbon emission in Thailand during 1990-2014



3. RESEARCH METHODS AND VARIABLES

Based on the above literature, authors have investigated the causal effect of economy and science on carbon emission, considering the following variables of the study.

- Carbon emission: From transport as a percentage of total fuel combustion (CTR) as dependent variable I (Galeotti et al., 2017)
- Carbon emission: From other sectors, excluding residential buildings etc., (COS) as dependent variable II (Parikh et al., 2009)
- Carbon emission: From manufacturing industries as % of total fuel combustion as dependent variable III (Sheinbaum-Pardo et al., 2012)
- Carbon emission: From electricity and heat production as % of total fuel combustion (CEHP) as dependent variable IV (Gustavsson et al., 1995)
- Carbon emission: residential building and commercial as % of total fuel combustion (CRBC) as dependent variable V (Adom et al., 2018)

- Gross domestic product: measured through annual growth % (GDPCG) as independent variable I (Djankov et al., 2006)
- GDP per capita: measured through constant 2010 US dollars as independent variable II (Bank, 2017)
- GDP per capita: measured through current LCU as independent variable III (James et al., 2012)
- GDP per capita: measured through current US dollars as independent variable IV (Bank, 2016)
- Charges for the use of intellectual property payments as independent variable V (Fisman et al., 2004)
- Researchers in R&D: measured through million people as independent variable VI (Aristovnik, 2012)
- High technology exports measured through current US dollars as independent variable VII (Seyoum, 2004).

The data for the above explanatory and outcome variables is purely secondary in nature and collected from different sources during 1990-2014 with annual observations. This study has applied the multiple regression methods to investigate the causal relationship between economic factors, scient and technology indicators and carbon emission through five major sources. Equation 1 below provides the information about dependent and independent variables, regression coefficients, and error terms.

Carbon emission=b0+b1~.b4(economic factors)+b5~.b7(science and technology)+e

Where carbon emission is measured through CTR, COS, CMI, CEHP, and CRBC respectively under sperate regression models. Meanwhile, to analyze the effect from economic factors, key titles are: GDPCG, GDPPC, GDPPCC, and GDPPUSD respectively as presented through regression coefficients of b1-b4. Additionally, effect from the factors of science and technology key titles are: CUIP, R&D, and HTEXPUSD and their marginal impact on carbon emission is reflected through b5-b7. Besides, this study also observed those factors which are not included in the model but entitled as error terms (e).

4. EMPIRICAL FINDINGS

Table 1 showing the descriptive results of all the variables, along the trends in the values through box plot range. The total maximum number of observations are 25 while minimum are observed as 17 for RD. For measuring the trends of carbon emission, indicators like carbon emission from transport (CTR) has presented a mean score of 28.81, carbon emission from other sectors (COS), average trend is 5.17, for carbon emission from manufacturing industry (CMI) is 21.05%, and for carbon emission from electricity and heat production (CEHP) is 42.12%. However, the lowest mean score in all the factors of carbon emission in Thailand is found for carbon emission from residential building and commercials (RCBC) which is 2.85 respectively. This value would justify the a comparatively low value of Co2 Emission in the country. In terms of standard deviation, CTR is showing a highest score of 2.79 in all the carbon emission proxies. Whereas lowest deviation in the mean score is observed for CRBC; 0.39. Moving further, the development factor is divided into two major types; economics factors and science and technology industry. For Economic factors, GDP per capita growth rate is collected from different online sources, showing an average score of 3.72% during the period of this research, However, the deviation score for this mean value is 4.07 with the highest observation of 9.62, showing a good growth and development in the economy of Thailand. For the second factor of development, GDP per capita, taking the constant of 2010, which shows a mean score of 4024 and deviation of 917.78. Meanwhile, the third and fourth development factors are entitled

Table 1: Descriptive results with both plot trends of the variables

Variable	n	Mean	S.D.	Min.	0.25	Mdn	0.75	Max.
CTR								
CTR	25	28.81	2.79	24.65	26.55	28.36	31.48	33.8
COS								
COS	25	5.17	0.78	3.49	4.93	5.1	5.64	6.94
CMI								
CMI	25	21.05	1.48	18.22	20.23	21.04	22.31	24
CEHP								
CEHP	25	42.12	2.53	37.79	41.01	42.21	43.89	46.6
CRBC								
CRBC	25	2.85	0.39	2.45	2.59	2.71	3.02	3.97
GDPCG								
GDPCG	25	3.72	4.07	-8.74	2.22	4.49	6.99	9.62
GDPPC								
GDPPC	25	4024.14	917.78	2503.8	3345.59	3731.26	4745.3	5589.31
GDPPCC								
GDPPCC	25	1.10E+05	47393.89	38607.05	76342.47	90052.45	1.40E+05	1.90E+05
GDPPUSD								
GDPPUSD	25	3219.47	1482.58	1508.94	2033.26	2660.12	4213	6168.27
CUIP								
CUIP	25	1.60E+09	1.30E+09	1.70E+08	5.80E+08	1.10E+09	2.30E+09	4.60E+09
RD								
RD	17	329.74	245.72	72.44	167.21	280.6	390.21	964.16
HTEXPUSD								
HTEXPUSD	17	3.30E+10	4.60E+09	2.50E+10	2.90E+10	3.20E+10	3.70E+10	3.90E+10

GDP per capita (current LCU), and GDP per capita (current US$) with the average trends of 1.10E+05 and 3219.47 in US dollars and deviation of 47393 and 1482 respectively (Hussain et al., 2020; Li and Xu, 2020).

After discussing the descriptive framework of both carbon emission proxies and economic factors of development, present discussion is providing a review about science and technology factors. To address this objective, three factors entitled as Charges for the use of intellectual property, payments (BoP, current US$) or CUIP, Researchers in R&D (per million people) or R&D, and High-technology exports (current US$) or HTEXPUSD are added among other regressors of the study. It is found that for these set of the variables, R&D is showing a mean trend 329.74, whereas rest of the two factors have shown an average score of 1.60E+09 and 3.30E+10 during the period of study.

The descriptive findings have provided a good understanding to examine the layout of the data for selected variables over the period of study. Furthermore, robust coefficients through regression analyses show that for the First measure of carbon emission as observed through CTR, there is a significant and negative influence from GDPPC where the coefficients and standard error are providing a P < 1%, hence accepting the negative and significant impact of GDPPC on CTR during the study period. This would explain that with the more GDPPCC int eh economy of Thailand, lessor the carbon emission from transportation and similar other sources. This result providing an evidence for the policy-makers dealing with the climate change and economic growth factors. On the other hand, GDPPUSD shows an effect of 0.002211 on carbon emission from transportation, defending that more the GDP per capita in $, more the carbon emission from the transportation. This relationship is saying that attention is required to mitigate the increasing trends of CTR from GDP per capita ($). The rest of the economic factors are found to be insignificant indicators of CTR in Thailand.

Moving towards the factors for the science and technology, only the effect from R&D is positive, significant as t-value found to be above the threshold point of 1.96. This could say that one of the key reasons for increasing CTR in Thailand is more R&D. Whereas, no impact of CUIP and HTEXPUSD on CTR is found.

The third step under Table 2 provide the combine effect of economic factors and science and technology on carbon emission from transportation. Furthermore, the model findings showing negative effect from GDPCG, and GDPPCC, provided that higher such economic factors, the lower the CTR which is indeed a good sign. This relationship is a good indication in the Thailand economy as much growth for GDP per capita, and GDP per capita in the form of current LCU are helping to secure the natural environment with lowering the carbon emission of transport.

For second indicator of carbon emission as reflected through emission from other sectors in Thailand. For analyzing the relationship between economic factors and science and technology as determinants of carbon emission, similar steps are repeated as those which are considered for the carbon emission from transport. Column five, Table 2 shows that significant and negative impact from GDPPC and GDPPUSD is found. Their effect is highly significant at 1%, with lowest value of p-score. It would justify that higher the economic development like GDPPC and GDPPUSD, lower the carbon emission from other sectors in Thailand. While the influence from GDPPCC is found to be positive and significant at 1%. This means that higher the economic growth like GDPPCC, higher the carbon emission is experienced from other sector.

After the discussion for the influence of economic factors on carbon emission from other sector, column six shows a highly significant and negative influence from HTEXPUSD; -0.3674

Table 2: Examining the impact of economic development on carbon emission proxies

	Economic factors	Science and technology	Both economic factors and science and technology	Economic factors	Science and technology	Both economic factors and science and technology
	Carbon emission from transport			Carbon emission from other sectors		
GDPCG	−0.0672		−0.352***	0.0679*		0.0345
	(0.0456)		(0.0332)	(0.0332)		(0.0509)
GDPPC	0.00166		0.0173	−0.00476***		−0.0291***
	(0.00189)		(0.0119)	(0.000806)		(0.00260)
GDPPCC	−0.000148***		−0.00682**	0.000115***		−2.10e-05
	(3.59e-05)		(0.000406)	(1.83e-05)		(8.88e-05)
GDPPUSD	0.00211***		0.0760**	−0.000869***		0.000499
	(0.000362)		(0.00410)	(0.000195)		(0.000896)
CUIP		−5.26e-10	−1.11e-09		−1.95e-10	−8.32e-11
		(6.93e-10)	(1.42e-09)		(1.31e-10)	(3.11e-10)
R&D		0.2232***	0.863***		0.000393	0.000447
		(0.00211)	(0.00538)		(0.000305)	(0.00118)
HTEXPUSD		−2.23e-10	9.85e-11		−0.3674***	−0.6974***
		(1.63e-10)	(2.18e-10)		(00.0525)	(0.0157)
Constant	31.28***	35.52***	6.549	14.68***	6.303***	6.932
	(3.823)	(4.173)	(20.30)	(1.546)	(0.774)	(4.439)
Observations	25	15	15	25	15	15
R-squared	0.898	0.770	0.867	0.758	0.630	0.814

Robust standard errors in parentheses, ***P<0.01, **P<0.05, *P<0.1

(0.0525), accepting the fact that higher the HTEXPUSD, lowers the carbon emission as vice versa. Last column In Table 2 shows the combine effect from economic factors and science and technology indicators. As per the findings, only the GDPPC and HTEXPUSD are showing that they are causing a reduction in the carbon emission from other sectors. Besides, Figure 2 provides the general understanding for the regression outlier graphs as observed for each of the explanatory variables of the study.

For examining the carbon emission trends through manufacturing industries and impact from economic factors and science and technology, Table 3 is showing the regression results. As per the findings under column 2, significant and positive, and significant and negative impact on carbon emission through manufacturing industries is found. This would further justify through coefficients as per robust standard errors, significant at 1%. It means that higher GDPPC is causing more carbon emission from manufacturing in Thailand, While GDPPCC is causing a reduction in carbon emission from manufacturing sector. For the indicators of science and technology, CUIP is lowering the carbon trends from manufacturing sector, whereas HTEXPUSD is causing an increasing trend in such emission in Thailand. However, the combine effect from both economic and science and technology indicators, only the factor of HTEXPUSD is found a direct determinant for carbon emission from manufacturing sector.

For carbon emission from electricity and heat production, Column five (Table 3) presents the evidence for the significant and negative determinant effect from GDPPC and GDPPUSD respectively. These factors are justifying that with the more such growth trends, lower the carbon emission from electricity and heat production. Contrary to this, the impact from GDPPCC is positive and significant at 1%, saying that more the GDDPPCC higher the carbon emission with the consumption of electricity and heat productions.

The impact from CUIP on CEHP is highly positive, causing more issue such carbon emission in natural environment. More importantly, the combine effect of both economic and science and technology indicators, positive impact from GDPCG, GDPPC, while negative from GDPPC, GDPPUSD, R&D, and HTEXPUSD. For the last factor of carbon emission from residential buildings and commercials, all economic factors are found as significant determinant when their separate effect is examined. However, HTEXPUSD as an indicator of science and technology is causing more such emission (Column 9, Table 3). In the end, when the combine effect is presented (Column 10), positive impact from GDPPUSD and HTEXPUSD, while negative from CUIP is expressed.

Figure 2: Outlier graph for explanatory variables

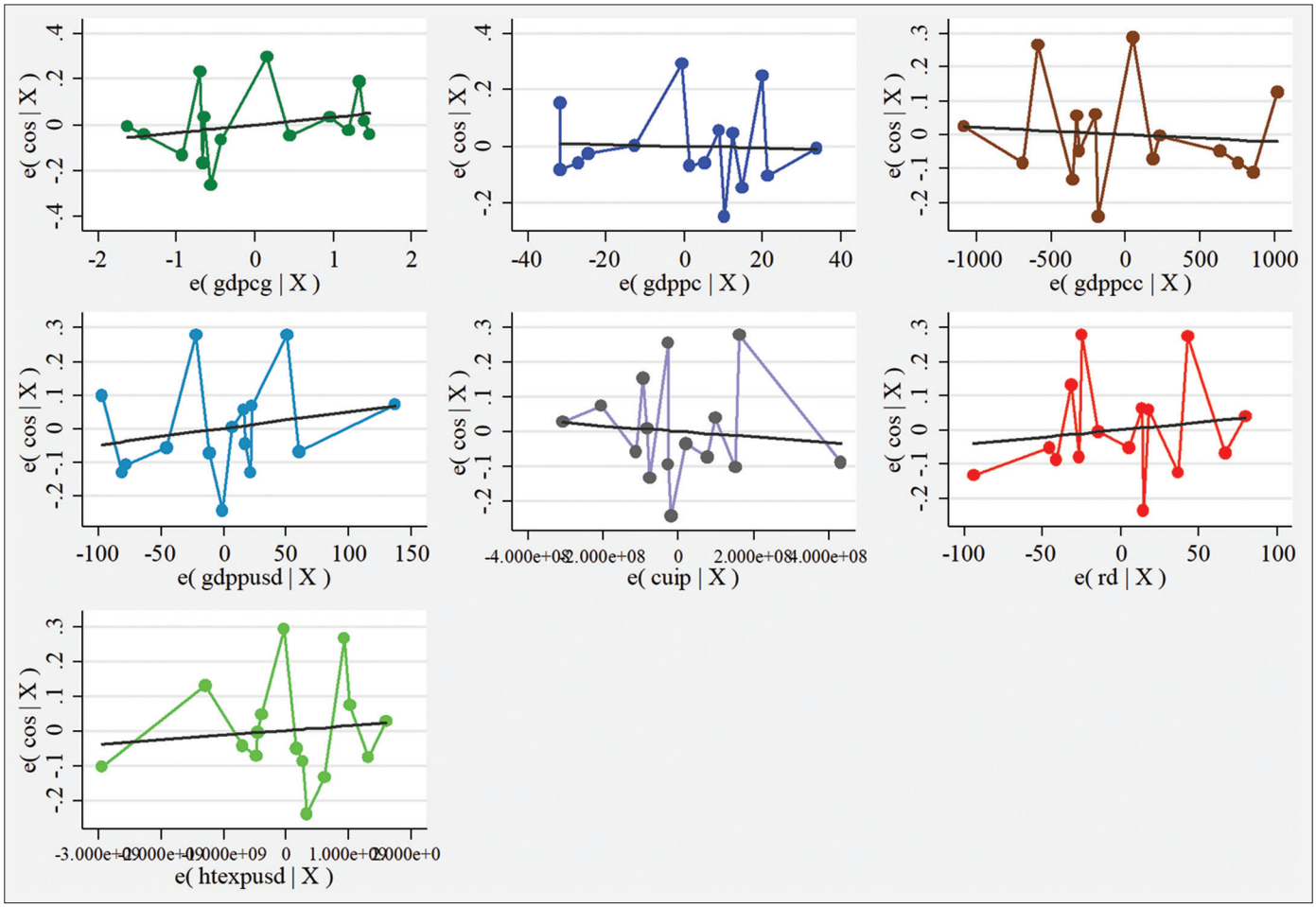


Table 3: Examining the impact of economic development on carbon emission proxies

	Economic factors	Science and technology	Both economic factors and science and technology	Economic factors	Science and technology	Both economic factors and science and technology	Economic factors	Science and technology	Both economic factors and science and technology
	CO_2 emissions from manufacturing industries			CO_2 emissions from electricity and heat production			CO_2 emissions from residential buildings and commercia		
GDPCG	0.0138		−0.126	−0.0411		0.478*	0.0263**		−0.0356
	(0.0429)		(0.149)	(0.0510)		(0.222)	(0.0104)		(0.0559)
GDPPC	0.00919***		0.0105	−0.00473*		−0.0300**	−0.00136***		0.00256
	(0.00158)		(0.00841)	(0.00239)		(0.0113)	(0.000333)		(0.00286)
GDPPCC	−0.000152***		−0.000284	0.000159***		0.00110**	2.64e-05***		−0.000116
	(2.91e-05)		(0.000264)	(4.30e-05)		(0.000386)	(6.47e-06)		(9.75e-05)
GDPPUSD	−0.000615		0.000221	−0.000802**		−0.0103**	0.000178*		0.00199*
	(0.000375)		(0.00235)	(0.000378)		(0.00390)	(8.75e-05)		(0.000983)
CUIP		−2.03e-09***	−2.52e-10		2.74e-09***	2.15e-09		0.9358	−7.09e-10*
		(6.24e-10)	(5.91e-10)		(8.41e-10)	(1.36e-09)		(1.14e-10)	(3.42e-10)
RD		0.00305	0.00550		−0.00330	−0.0158**		−0.000350	0.00126
		(0.00203)	(0.00367)		(0.00342)	(0.00512)		(0.000482)	(0.00129)
HTEXPUSD		4.33e-10***	4.90e-10***		−2.43e-10	−7.05e-10**		5.6611***	1.04e-10*
		(1.29e-10)	(1.25e-10)		(1.82e-10)	(2.07e-10)		(1.15247)	(5.23e-11)
Constant	2.167	10.11**	−7.023	47.03***	46.93***	96.67***	4.836***	1.119	−3.226
	(3.168)	(3.336)	(15.53)	(4.923)	(4.650)	(19.32)	(0.562)	(0.808)	(4.875)
Observations	25	15	15	25	15	15	25	15	15
R-squared	0.633	0.397	0.825	0.802	0.744	0.907	0.634	0.376	0.794

5. CONCLUSION AND RECOMMENDATIONS

Environmental outcomes of economic development and technology are reasonably influencing the decision makers in the field of climate change. A common notion is that higher economic growth and innovation in science and technology has a mixed trend on nature in the form of carbon emission through different sources. Increasing concerns about the environmental adverse impact through climate change and global warming are putting more pressure on the governments to take some serious steps. To avoid from such issues, world economies are implementing the environmental regulations, personal carbon trading, low carbon emission through travel schemes, and many other policies are highlighted in the literature. However, the relationship between economic factors, science and technology and carbon emission in the economy of Thailand is not well addressed. Therefore, this study has observed the environmental outcomes of economic and science and technology indicators. For examining the economy, overall four factors; GDP per capita growth as annual percentage, GDP per capita constant in USD, GDP per capita in current LCU, and GDP per capita current USD were added in the regression models. Whereas science and technology head is further explained through charges for the use of intellectual property, research and development, and high technology exports in current USD are added in the models. To represent the natural impact, carbon emission from transport, other sector, manufacturing industries, electricity, heat production, and carbon emission from residential buildings were considered as main dependent variables of the study.

A descriptive look has provided a good understanding for all the variables along with standard deviation. As per empirical findings, economic factors like GDPPCC and GDPUSD are found to be negative and positive determinant for the carbon emission through transport when their effect is observed without considering the science and technology. This effect shows that GDPPCC is causing a reduction in carbon emission from transport, whereas GDPUSD is causing more emission from transport. From science and technology, R&D is found to be a direct indicator of carbon emission in Thailand from overall transport industry. When the combine effect from economic and science and technology factor is observed. GDPCG, GDPPC, and GDPUSD are showing that they are causing a reduction during the study period. In the second, step, significant determinant for the carbon emission from other sectors are; GDPCG, GDPPCC, and GDPUSD. In case of science and technology, HTEXPUSD has its adverse influence on the carbon emission from other sectors. However, under combine effect model, key indicators for the carbon emission are GDPPC, and HTEXPUSD only, showing the declining trend. For the remaining factors of carbon emission (from manufacturing industries, electricity and heat production, residential building and commercials) it is observed that GDPPCC is showing both positive and negative influence, whereas CUIP is found to be a direct determinant for carbon emission from manufacturing industries and carbon emission from electricity heat and production etc. In the last, HTEXPUSD has demonstrated the evidence that more emission from manufacturing industries, and residential building due to such high-tech exports in Thailand.

Besides, this paper is observed as a good contribution specifically in the economy of Thailand for exploring the effect of economic development and science and technology factors in determining the carbon emission. The presented analysis has provided enough evidence, showing that which economic and science and technology factors need to investigate as an opportunity or threat for the changing climate change in terms of increasing carbon emission. Additionally, some fruitful future directions are also provided in this paper. First, methodological context of the study can be revised for better findings through some time series models. Second, regional context of the study may spread to other economies like Indonesia, Malaysia and Singapore.

REFERENCES

Adom, P.K., Kwakwa, P.A., Amankwaa, A. (2018), The long-run effects of economic, demographic, and political indices on actual and potential CO_2 emissions. Journal of Environmental Management, 218, 516-526.

Aleem, U. (2020), Perceptions of teachers regarding literacy drive policy for teaching and learning of English language skills and its implementational effectiveness. Hamdard Islamicus, 43(2), 276-295.

Aristovnik, A. (2012), The relative efficiency of education and R&D expenditures in the new EU member states. Journal of Business Economics and Management, 13(5), 832-848.

Åström, C., Rocklöv, J., Hales, S., Béguin, A., Louis, V., Sauerborn, R. (2012), Potential distribution of dengue fever under scenarios of climate change and economic development. Ecohealth, 9(4), 448-454.

Aye, G.C., Edoja, P.E. (2017), Effect of economic growth on CO_2 emission in developing countries: Evidence from a dynamic panel threshold model. Cogent Economics and Finance, 5(1), 1379239.

Batool, A., Bashir, M., Ch, S.A. (2020), Perceptions of university teaching faculty about professional growth: Structural modeling of professional development. Hamdard Islamicus, 43(3), 30-41.

Béguin, A., Hales, S., Rocklöv, J., Åström, C., Louis, V.R., Sauerborn, R. (2011), The opposing effects of climate change and socio-economic development on the global distribution of malaria. Global Environmental Change, 21(4), 1209-1214.

Cox, P.M., Betts, R.A., Jones, C.D., Spall, S.A., Totterdell, I.J. (2000), Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. Nature, 408(6809), 184.

Cumming, G.S., von Cramon-Taubadel, S. (2018), Linking economic growth pathways and environmental sustainability by understanding development as alternate social-ecological regimes. Proceedings of the National Academy of Sciences, 115(38), 9533-9538.

Danish, Wang, Z. (2018), Dynamic relationship between tourism, economic growth, and environmental quality. Journal of Sustainable Tourism, 26(11), 1928-1943.

Demirbas, A. (2005), Potential applications of renewable energy sources, biomass combustion problems in boiler power systems and combustion related environmental issues. Progress in Energy and Combustion Science, 31(2), 171-192.

Djankov, S., McLiesh, C., Ramalho, R.M. (2006), Regulation and growth. Economics Letters, 92(3), 395-401.

Fisman, R., Branstetter, L.G., Foley, C.F. (2004), Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-level Panel Data. United States: The World Bank.

Galeotti, M., Salini, S., Verdolini, E. (2017), Measuring Environmental Policy Stringency: Approaches, Validity, and Impact on Energy Efficiency. Italy: Centro Studi Luca d'Agliano Development Studies Working Paper 412.

Goudie, A.S. (2018), Human Impact on the Natural Environment. United States: John Wiley & Sons.

Gustavsson, L., Börjesson, P., Johansson, B., Svenningsson, P. (1995), Reducing CO_2 emissions by substituting biomass for fossil fuels. Energy, 20(11), 1097-1113.

Hornung, J.J. (2020), Comments on Ornitocheirus hilsensis Koken, 1883-one of the earliest dinosaur discoveries in germany. Palarchs Journal of Vertebrate Palaeontology, 17(1), 1-12.

Huang, L., Krigsvoll, G., Johansen, F., Liu, Y., Zhang, X. (2018), Carbon emission of global construction sector. Renewable and Sustainable Energy Reviews, 81, 1906-1916.

Hussain, H.I., Haseeb, M., Tvaronavičienė, M., Mihardjo, L.W., Jermsittiparsert, K. (2020), The causal connection of natural resources and globalization with energy consumption in top Asian countries: Evidence from a nonparametric causality-in-quantile approach. Energies, 13(9), 2273.

Ismail, R. (1996), An Economic Evaluation of Carbon Emisson and Carbon Sequestration for the Forestry Sector in Malaysia. Paper Presented at the Fuel and Energy Abstracts. Berlin, Germany: ResearchGate.

James, S.L., Gubbins, P., Murray, C.J., Gakidou, E. (2012), Developing a comprehensive time series of GDP per capita for 210 countries from 1950 to 2015. Population Health Metrics, 10(1), 12.

Janssen, R. (2020), The pleated dress of nywty. Palarchs Journal of Archaeology of Egypt Egyptology, 17(1), 1-11.

Kamran, H.W., Omran, A. (2018), Impact of Environmental Factors on Tourism Industry in Pakistan: A Study from the Last Three Decades The Impact of Climate Change on Our Life. Berlin, Germany: Springer. p197-212.

Kutz, M. (2018), Handbook of Environmental Degradation of Materials. Netherlands: William Andrew.

Li, H., Xu, C. (2020), Visualizing the knowledge domain of psychological contract research through bibliometric analysis. Revista Argentina de Clinica Psicologica, 29(1), 268-278.

Li, X., Lin, C., Xu, X. (2020), Influence of psychological bias of financial investors on the investment returns. Revista Argentina de Clinica Psicologica, 29(1), 249-254.

Liu, K.H., Chang, S.F., Huang, W.H., Lu, I.C. (2019), The Framework of the Integration of Carbon Footprint and Blockchain: Using Blockchain as a Carbon Emission Management Tool Technologies and Eco-innovation Towards Sustainability I. Berlin, Germany: Springer. p15-22.

Longo, S.B., Baker, J.O. (2014), Economy versus environment: The influence of economic ideology and political identity on perceived threat of eco-catastrophe. The Sociological Quarterly, 55(2), 341-365.

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., Khoshnoudi, M. (2019), Carbon dioxide (CO_2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. Science of the Total Environment, 649, 31-49.

Martínez-Martínez, J.G.F. (2020), Prosocialidad y dificultades de socialización en la adolescencia. Influencias Según Sexo y Práctica Deportiva Método, 29, 117-124.

McCright, A.M., Dunlap, R.E. (2011), The politicization of climate change and polarization in the American public's views of global warming, 2001-2010. The Sociological Quarterly, 52(2), 155-194.

Moreno-Brid, J.C., Gómez, J.S., Franco, L.Á.M. (2020), Mexico's latest-and probably last-package of market reforms (2012-18): The remains of the day. Cuadernos de Economía, 39(80), 425-443.

Mori, N., Yasuda, T., Mase, H., Tom, T., Oku, Y. (2010), Projection of extreme wave climate change under global warming. Hydrological Research Letters, 4, 15-19.

Nguyen, T.M., Nguyen, H.T., Ngo, M.N.Q., Le, L.B., van Pham, Q.,

Le, N.N.T., van Nguyen, K., Bui, H.V., Dang, T.T., van Le, D. (2020), Epidemiological characteristics of dengue among Vietnamese children in the 2017 dengue outbreak. Systematic Reviews in Pharmacy, 11(12), 113-118.

Nurpeisova, A.A., Karabayeva, R., Benberin, V.V., Makalkina, L.G. (2020), Statin therapy improvement is a vital necessity for Kazakhstan healthcare. Systematic Reviews in Pharmacy, 11(12), 94-98.

Ormaechea, E., Fernández, V.R. (2020), Discontinuous continuity: Structural change and its (divergent) meanings in Latin American structuralism and neo-structuralism. Cuadernos de Economía, 39(80), 445-469.

Ortiz, C.H., Castillo Rentería, R. (2020), Breaking say's law in a simple market economy model. Cuadernos de Economía, 39(81), 897-918.

Pandey, K.K., Rastogi, H. (2019), Effect of energy consumption and economic growth on environmental degradation in India: A time series modelling. Energy Procedia, 158, 4232-4237.

Parikh, J., Panda, M., Ganesh-Kumar, A., Singh, V. (2009), CO_2 emissions structure of Indian economy. Energy, 34(8), 1024-1031.

Perera, F. (2018), Pollution from fossil-fuel combustion is the leading environmental threat to global pediatric health and equity: Solutions exist. International Journal of Environmental Research and Public Health, 15(1), 16.

Peterson, D.J. (2019), Troubled Lands: The Legacy of Soviet Environmental Destruction. United Kingdom: Routledge.

Prowse, T.D., Furgal, C., Chouinard, R., Melling, H., Milburn, D., Smith, S.L. (2009), Implications of climate change for economic development in Northern Canada: Energy, resource, and transportation sectors. AMBIO: A Journal of the Human Environment, 38(5), 272-282.

Santana Vilorta, L. (2020), Art as investment: Construction of a hedonic index to measure the valuation of Colombian art in the 1989-2015 period. Cuadernos de Economía, 39(79), 167-190.

Santos-Munguía, R.J., Pérez, J.M. (2020), Effect of workers' remittances on international reserves, economic growth and the real exchange rate index in Honduras. Cuadernos de Economía, 39(81), 703-729.

Schröder, E., Storm, S. (2018), Economic Growth and Carbon Emissions: The Road to Hothouse Earth is Paved with Good Intentions. United States: Institute for New Economic Thinking.

Seyoum, B. (2004), The role of factor conditions in high-technology exports: An empirical examination. The Journal of High Technology Management Research, 15(1), 145-162.

Shao, L., Li, Y., Feng, K., Meng, J., Shan, Y., Guan, D. (2018), Carbon emission imbalances and the structural paths of Chinese regions. Applied Energy, 215, 396-404.

Sheinbaum-Pardo, C., Mora-Pérez, S., Robles-Morales, G. (2012), Decomposition of energy consumption and CO_2 emissions in Mexican manufacturing industries: Trends between 1990 and 2008. Energy for Sustainable Development, 16(1), 57-67.

Singh, P., Sulaiman, O., Hashim, R., Peng, L.C., Singh, R.P. (2013), Using biomass residues from oil palm industry as a raw material for pulp and paper industry: Potential benefits and threat to the environment. Environment, Development and Sustainability, 15(2), 367-383.

Whitmarsh, L. (2009), What's in a name? Commonalities and differences in public understanding of climate change and global warming. Public Understanding of Science, 18(4), 401-420.

World Bank. (2016), GDP Per Capita (Current US $). Data; 2016. Available from: https://www.data.worldbank.org/indicator/NY.GDP.PCAP.CD.

World Bank. (2017), GDP Per Capita (Constant 2010 US $). Available from: https://www.data.worldbank.org/indicator/NY.GDP.PCAP.KD.