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A Trade-off Between Economic Growth and Environment Sustainability

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Abstract
Climate change has been a troubling environmental issue for years. Environmental, which includes climate change, has been ranked top five global risk of 2017 in a recent report by World Economic Forum (WEF 2017). The incentive to resolve or reduce the deterioration process has been set out by many countries across the world. Environmentally speaking, reducing emissions plays a crucial role in slowing the deterioration process which in turn, improves the environment condition. However, by reducing emission and other means can negatively impact the economy in terms of production and output. Thus, this can limit countries' economic growth especially for emerging markets. To further understand the impacts, this paper seeks to answer the research question: how does fulfilling the Paris Agreement inversely impact emerging market's economic growth especially for top emission emitters in Asia? To answer the question, this paper would examine relation between emissions and economic growth in quantitative term. In addition to quantitative analysis, case studies of specific emerging market countries would be included as well.

Key words: Indonesia; Carbon emission; Economic growth; Palm oil industry

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INTRODUCTION
Climate change has been a troubling environmental issue for years. Environmental, which includes climate change, has been ranked top five global risk of 2017 in a recent report by World Economic Forum (WEF 2017). The incentive to resolve or reduce the deterioration process has been set out by many countries across the world. In 2016, over 110 countries ratified the Paris Agreement as a mean to curb climate change by remaining global temperature rise below 2 degrees Celsius (UNFCCC 2016). By agreeing to the Paris Agreement, countries are to reduce their emission level which varies across countries. Nonetheless, cooperation like Paris Agreement can contribute to a sustainable environment with the condition that, if and only if, countries kept their promises and do make the effort in reducing emissions. Environmentally speaking, reducing emissions plays a crucial role in slowing the deterioration process which in turn, improves the environment condition. However, by reducing emission and other means can negatively impact the economy in terms of production and output. Thus, this can limit countries' economic growth especially for emerging markets. To further understand the impacts, this paper seeks to answer the research question: how does fulfilling the Paris Agreement inversely impact emerging market's economic growth especially for top emission emitters in Asia? To answer the question, this paper would examine relation between emissions and economic growth in quantitative term. In addition to quantitative analysis, case studies of specific emerging market countries would be included as well.

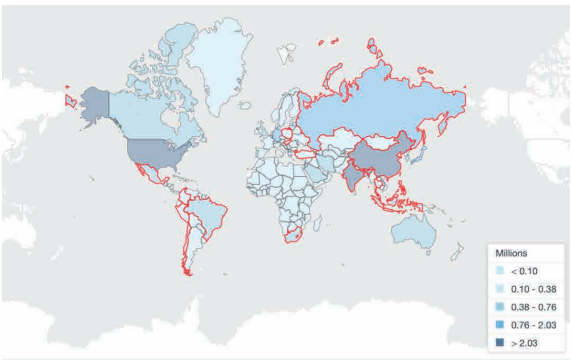

Figure 1
Overview of Carbon Emissions Across Countries[1]
Source: World Bank

1. BACKGROUND

1.1 What is Climate Change?

Human activities have significantly contributed to the rising problem of climate change. Here, human activities refer to the "burning of fossil fuels like coals and oil" as a primary method to generate energy (NASA 2017a). Throughout the burning process, greenhouse gases (GHGs) are released into the atmosphere. Overtime, these GHGs which includes water vapour (H_2O), nitrous oxide (N_2O), methane ($CH_{4)}$ and carbon dioxide (CO_2) form a thick layer in the atmosphere which traps the heat from the sun (NASA 2017a). Continuous trapping of heat has resulted in a rise in global temperature which in turn, altered the global climate. The increase in heat, also known as global warming, has led to significant consequences to the ecosystem in ways like rising sea-level temperature. Other consequences also include severe drought or flood in certain regions, rise in sea level by one to four feet, melting of Arctic's ice and many others (NASA 2017b). In addition to significant weather alteration and global warming, human activities have also damaged the ozone layer. On top of the mentioned GHGs, another gas that has been released was chlorofluorocarbons (CFCs). CFCs have continuously thinning the ozone layer which plays a key role in protecting humans and the ecosystem by limiting the entry ultraviolet radiation (UV-B) from the sun (EEA 2017). In general, climate change has significantly damage earth's environment which in turn, affect humans and the ecosystem.

1.2 Paris Agreement

Paris Agreement is an official and legal global effort to manage the acceleration effect of climate change. Specifically, as noted above, the aim of this agreement is to limit the rise of global temperature by 2 degrees Celsius by the end of 21st century (European Commission 2016; UNFCCC 2016). Even though Paris Agreement unites countries with a common aim however, contribution made significantly varies across participants. That said, the United Nations (UN) understands the variations in social and economic development between countries, particularly developed and developing ones. Thus, instead of enforcing a minimum threshold reduction for the level of emission, countries are to set its own emission target respective to their level of development (European Commission 2016). Nonetheless, to ensure that participating countries do make the effort to reduce their domestic emission, all participants have to regularly report on their process. Furthermore, there would "be a global stocktake every 5 years" as a mean of assessment and to achieve the purpose of the agreement (UNFCCC 2016).

1.3 Emerging Market

Emerging markets are a kind of concept that refers to countries, regions or economies that are currently under development, and not yet mature or developed. For example, Brazil, Russia, India, China and South Africa are known as the "BRICS", and later the rise of the "MINTs", including countries like Mexico, Indonesia, Nigeria and Turkey.

Emerging markets often have the characteristics of low labour costs and abundant natural resources. On the one hand, developed countries have incentives to move production lines to emerging markets, to reduce the production costs through the access of cheap labour and cheap raw materials, and thus to enhance competitiveness. On the other hand, emerging markets are mutually benefited as well in terms of technology transformation, job creation and economic growth.

2. DATA

2.1 The Sample

To examine the effect of carbon emissions on economy of emerging markets, we construct a dataset that covers the 16 emerging markets[2], which meet the conditions listed by the all following institutions, International Monetary Fund (IMF), Morgan Stanley Capital International (MSCI), Standard and Poor's (S&P), Russell and Dow Jones, see **Table 1**. All selected countries will be examined throughout the time frame from 1990 to 2013[3].

[1]The darker the colour, the more carbon emissions have been emitted

[2] Emerging markets: Brazil, Chile, China, Colombia, Hungary, Indonesia, India, Malaysia, Mexico, Peru, Philippines, Poland, Russia, South Africa, Thailand and Turkey.

[3] Due to the limited data, available from IRdata and the World Bank, this paper could only use the year up to 2013.

Table 1
The List of Emerging Markets Measured by Different Institutions

Country	IMF	MSCI	S&P	Dow Jones	Russell	Overall
Argentina	✔					
Bangladesh	✔	✔	✔			
Brazil	✔	✔	✔	✔	✔	✔
Chile	✔	✔	✔	✔	✔	✔
China	✔	✔	✔	✔	✔	✔
Colombia	✔	✔	✔	✔	✔	✔
Czech Republic		✔	✔	✔	✔	
Egypt		✔	✔	✔		
Greece		✔	✔	✔	✔	
Hungary	✔	✔	✔	✔	✔	✔
India	✔	✔	✔	✔	✔	✔
Indonesia	✔	✔	✔	✔	✔	✔
Malaysia	✔	✔	✔	✔	✔	✔
Mexico	✔	✔	✔	✔	✔	✔
Pakistan	✔	✔				
Peru	✔	✔	✔	✔	✔	✔
Philippines	✔	✔	✔	✔	✔	✔
Poland	✔	✔	✔	✔	✔	✔
Qatar		✔			✔	
Romania	✔					
Russia	✔	✔	✔	✔	✔	✔
South Africa	✔	✔	✔	✔	✔	✔
South Korea		✔			✔	
Taiwan		✔	✔	✔	✔	
Thailand	✔	✔	✔	✔	✔	✔
Turkey	✔	✔	✔	✔	✔	✔
Ukraine	✔					
United Arab Emirates		✔		✔	✔	
Venezuela	✔					

Source: IMF, MSCI, S&P, Russell and Dow Jones

This paper has chosen emerging market as the area of focus because its characteristic coincides with carbon emissions. In other words, the development of emerging market primarily relies on industrial and manufacturing production which tends to release high level of emissions.

2.2 Changes in Carbon Emissions

By comparing the size of CO_2 emissions in the emerging markets and the rate of growth, we can draw the observation that for CO_2 emissions, they were relatively small between 1990 and 1991. The emissions have continued to increase since 1992, but with steady growth and little fluctuation up to the year of 2002 (see in **Figure 2**).

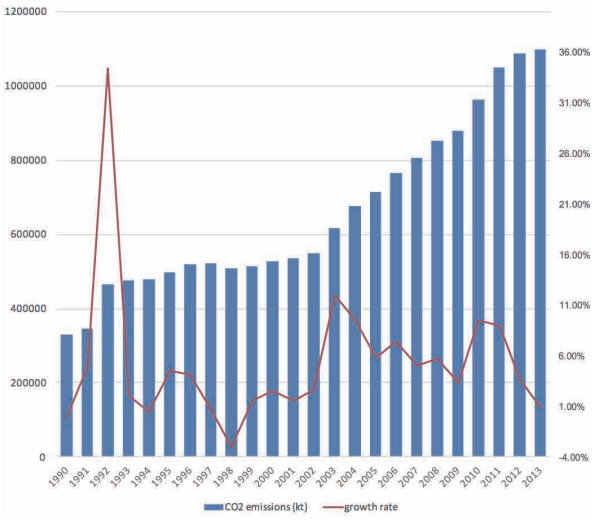

Figure 2
Changes in Carbon Emissions in Emerging Markets From 1990-2013 (Including Russia)
Source: World Bank Database

The emerging market began to show a significant increase in carbon emissions after the year of 2003, the amount has increased from 615713.59 kiloton to 1096950.96 kiloton during this decade. Please note that, in 2000, China joined WTO as a permanent member, this is also known as WTO effect, which may indirectly boost the productions in China, thus increasing the use of energy and resulting in a higher volume of carbon emission. From the perspective of CO_2 emissions growth rate, before 2003, the growth rate of CO_2 emissions has been fluctuating slightly above and below 5%. After 2003, the growth rate of CO_2 emissions in the emerging markets has been increasing, especially in the year of 2003, when the growth rate reached a staggering 12%. However, the growth rate in Figure 3 may not be accurate enough, because arithmetic mean is used in this case regardless of market size and population size in each selected emerging market, and there are missing emission data for Russia, which means there were no CO_2 emissions record for Russia in the year of 1991 and 1992. After adjustments, we came up with a revised **Figure 3**, arithmetic mean is still applied here but excluding Russia.

In **Figure 3**, we can see that, the overall trend of CO_2 emission growth in emerging markets (excluding Russia) shows a phenomenon of increasing first and then decreasing repeatedly. The growth curve is similar to the reverse "W" type. Moreover, there has been once negative growth in 1998, in which the Asian Financial Crisis broke out, many emerging markets have been suffering, mainly include Thailand, Indonesia, Malaysia and Mexico.

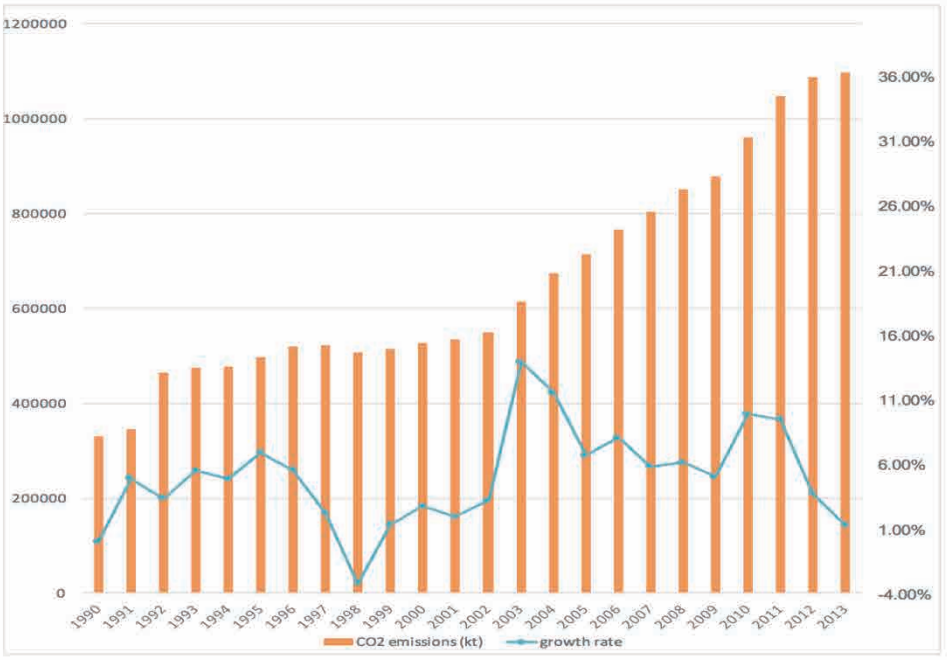

Figure 3
Changes in Carbon Emissions in Emerging Markets From 1990-2013(Excluding Russia)
Source: World Bank Database

The **Figure 4** shows the changes on carbon emission intensity. Generally, on a downward trend. The intensity of carbon emission in emerging markets (red line) has declined dramatically from over 70 percent to slightly below 30 percent over less the past two decades. Up to the year of 2013, the difference of carbon emission intensity between merging markets and developed markets (blue line) (in this case we use OECD members represent developed markets) is insignificant.

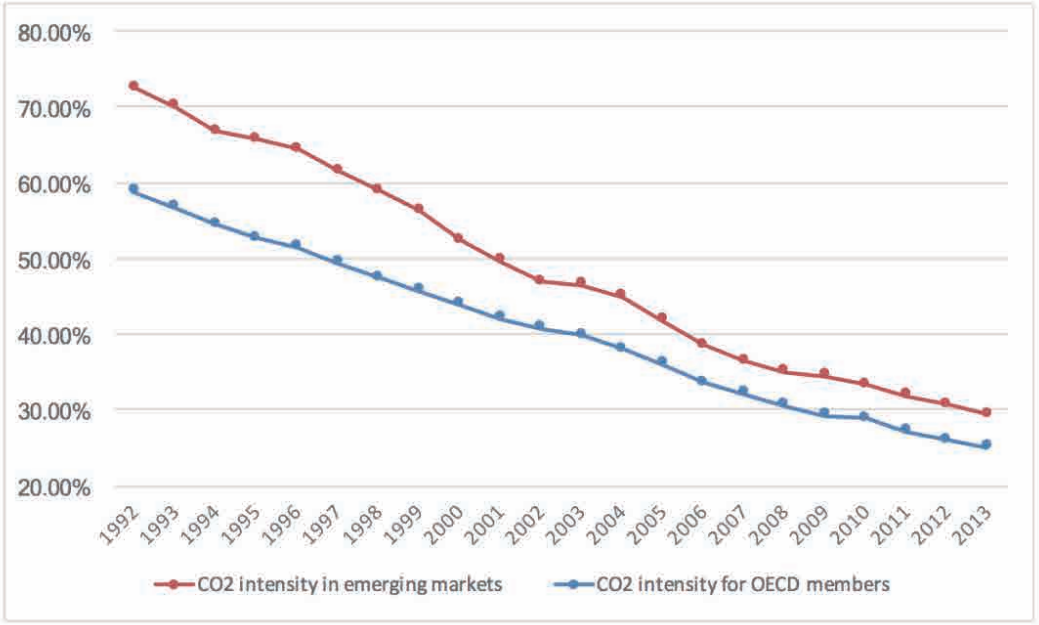

Figure 4
Carbon Emission Intensity From 1992-2013(kg per PPP $ of GDP)
Source: World Bank Database

Form the empirical data, the relationship between carbon emissions and economic growth is as follows:

(a) Economic growth has positive effect on carbon emissions

Since carbon emissions are mainly derived from the burning of fossil fuels, and fossil fuels is the major energy source, which is an important production factor, to boost economic growth. According to the theory of production, the increase in factor inputs usually leads to an increase in production and an increase in the size of the economy. On the contrary, the lack of factors of production will become the bottleneck of economic growth, restricting economic development.

(b) The double impact of economic growth on carbon emissions

There are two possible effects of economic growth on carbon emissions. On the one hand, according to the economics of scale, the larger and bigger the economy, the more energy input is required. Economic growth will lead to energy consumption through the marginal demand for energy consumption, driven by rising carbon emissions. On the other hand, economic growth can reduce carbon emissions through technical and structural effects. According to the technical effect, in the process of development in a country, technological progress is a result of R&D expenditure increases, and thus improve productivity, improve the efficiency of resource use, reduce the carbon emissions. So that energy can be recycling more efficiently. According to the structural effect, with the economic development, the output structure and investment structure have changed, the optimization of economic structure can help carbon emissions to be reduced. The impact of economic growth on carbon emissions depends on the relative weight on the technical effect and the structural effect.

After adjusting the scales of each indicator, namely CO_2 emissions, GDP and energy use, since each of them has a different counting unit, we put them into a same line chart. All have increased but the growth of energy use is not very obvious. The carbon emission in emerging markets is basically follow the same trend as GDP, or vice versa. To elaborate, between the year of 1995 and 2002, the gradient of change of carbon emission is similar to its of GDP, likewise the year from 2002 to 2008, as well as after 2008 (see in **Figure 5**).

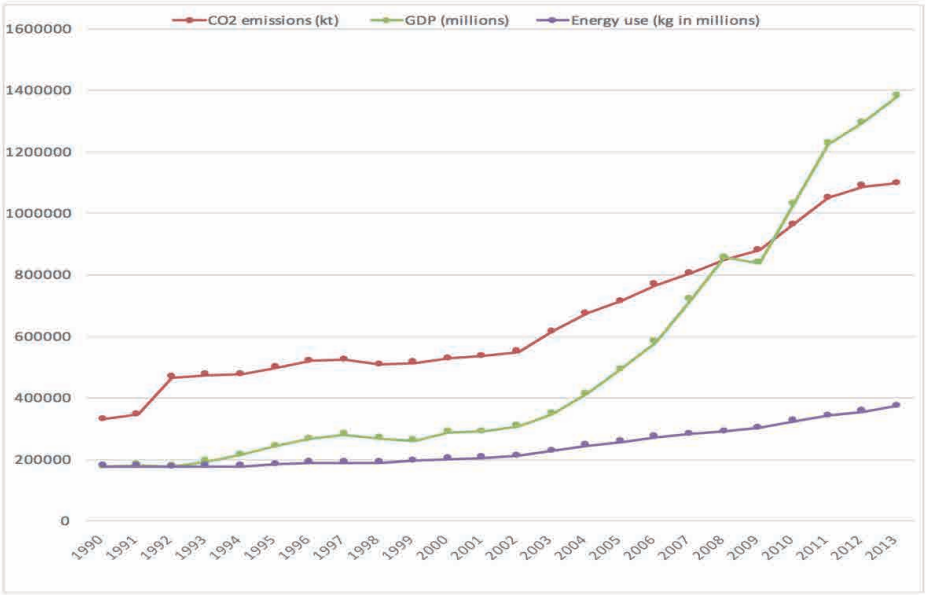

Figure 5
Overview of Emerging Markets From 1990-2013
Source: World Bank Database

3. EMPIRICAL RESULTS

As we know from the empirical data, there is the causal relationship between carbon emission and economic growth, however the causality is ambiguous, which means, we don't know whether (1) carbon emission is the cause of the economic growth change, that is, there is a one-way causal relationship from carbon emission to economic growth. (2) economic growth is the cause of carbon emission change, that is, there is a one-way causal relationship from economic growth to carbon emission. (3) carbon emission and economic growth are causal relations, that is, there is a two-way causal relationship between carbon emission and economic growth. Or (4) carbon emission and economic growth are independent, or there is no causal relationship between them.

To study the relationship between the two variables, a detailed and comprehensive analysis will be drawn using econometric software Eviews 9.0. First, the Vector Autoregression Model, VAR, is established and the optimal hysteresis order is obtained. Then, Granger Causality Test is used to judge whether the causal relationship between economic growth and carbon emission can be established.

3.1 Unit Root Test

In order to avoid the occurrence of pseudo-regression in the measurement analysis, it is necessary to test the unit root stability of economic growth and carbon emission over time in the emerging market, and the test results shown in the **Table 2**.

Table 2
ADF Stationary Test Results

Variables	(c,t,k)	ADF	1% Confidence level	5% Confidence level	10% Confidence level	P-value	Conclusion
GDP growth	(c,t,0)	-3.980776	-4.416345	-3.622033	-3.248592	0.0246	Stationary
CO_2	(c,t,0)	-1.057654	-4.440739	-3.632896	-3.254671	0.9138	Non-stationary
△GDP growth	(c,t,1)	-5.320760	-4.467895	-3.644963	-3.261452	0.0018	Stationary
$\triangle CO_2$	(c,t,1)	-4.713738	-4.467895	-3.644963	-3.261452	0.0061	Stationary

(c,t,k) c: intercept, t: trend, k: lag

Test critical values: at 1% level, 5% level, 10% level

△: first difference

The results show that, the original data of CO_2 is non-stationary at the level of neither 1%, 5% nor 10%, but becomes stationary at 1% confidence level after first-order difference. And the GDP growth remains stable all through. Therefore, it can be considered that there is a long-term relationship between GDP growth and CO_2.

Furthermore, it can be seen from **Table 3**, the unit root test results residual series, the residual sequence of the ADF test value is stable at 5% confidence level, from this, we can draw the conclusion that there is a long-term stationary correlation between economic growth and carbon emissions. Based on the unit root test results, now we can proceed to the next section to test the causal relationship between carbon emission and economic growth by using Granger Causality Test.

Table 3
Unit Root Test Results Residual Series

Variables	(c,t,k)	ADF	5% Confidence level	10% Confidence level	P-value	Conclusion
Resid	(c,t,0)	-4.061845	-3.673616	-3.277364	0.0244	Stationary

3.2 Granger Causality Test

By using Granger Causality Test, the causal relationship between carbon emission and economic growth can be determined. Whether is there a one-way causal relationship from carbon emission to economic growth, or a one-way causal relationship from economic growth to carbon emission, or a two-way causal relationship between carbon emission and economic growth, or even no causal relationship between them. Due to the large scale of figure, logarithm is taken in this case. The Granger Causality test results are shown in **Table 4**, via using econometric software Eviews 9.0

Table 4
Granger Causality Test Results

Null hypothesis (H_0)	Lag Length	F-value	P-value	Conclusion
GDP growth $\overset{\times}{\rightarrow}$ CO_2	1	5.768026	0.0163	**Reject H_0**
CO_2 $\overset{\times}{\rightarrow}$ GDP growth	1	4.688928	0.0304	**Reject H_0**

Note: $\overset{\times}{\rightarrow}$ The variable before the arrow is not the Granger cause of the variable after the arrow.

The test results show that, when the lag length is 1[4], GDP growth is the Granger cause of carbon emissions, as well as the carbon emissions are the Granger cause of GDP growth at 5% confidence level. To sum up, the economic growth causes the higher carbon emissions, and vice versa, there is a two-way Granger causality.

3.3 OSL Estimation

Since economic growth and carbon emissions are affected to each other, we now focus on the effect of carbon emission on economic growth.

The independent variable, carbon emissions, is measured by the carbon dioxide (CO_2) emissions (kt) that occurred in a country on a yearly basis and carbon. And the dependent variable is economic growth, which is based on GDP growth annually.

The correlation between economic growth and carbon emission is examined by using the following OLS specification:

$$Economic\ growth_{it} = \beta_1 CO_2\ emission_{it} + \beta_2 population_{it} + \beta_3 trade_{it} + \beta_4 FDI.inflows_{it} + \beta_5 urbanization_{it} + \beta_6 land_i + \varepsilon_{it}$$

Firstly, we tested the correlation between economic growth and carbon emission merely by using GDP growth and CO_2 emissions respectively as proxies. All data are collected from World Bank database from 1990 to 2013 across 16 emerging markets. By using R, it is found that there is a positive correlation between economic growth and carbon emission, if there is one unit increase in CO_2 emission, there is about 0.606 unit (in percentage) increase in economic growth as shown in **Figure 6** below.

[4] The lag length of 1 is suggested by Eviews 9.0, when I use 2 and 3, the results are the same. All show rejection.

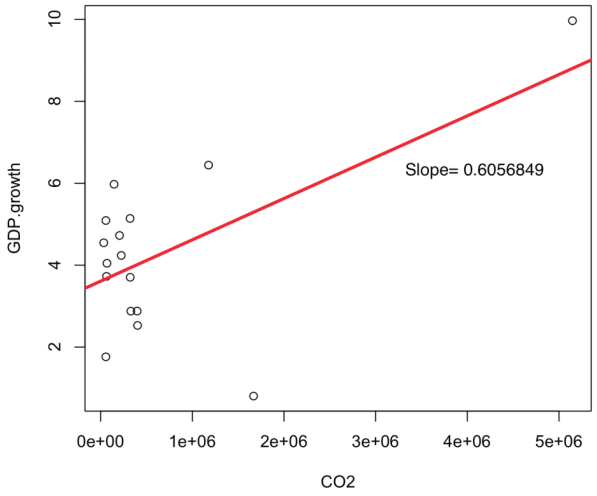

Figure 6
Source: IRdata

Moreover, we use Time Fixed Effect Regression Model to assume that each independent variable only changes over time, but does not change within itself. And 16 emerging markets are involved, each variable is collected during the year from 1990 to 2013, in total 384 observations are examined (see in **Table 5**).

Column 1 and 3, all variables are tested in 16 emerging markets over the year from 1990 to 2013. Column 2 and 4 include the year-fixed effect, in order to avoid spurious regression so that the preceding conclusion is under the ground. In this case, arithmetic mean is used by examining the effect of carbon emission on economic growth in emerging markets.

In column 1 and 2, the results show that carbon emissions have a significant and positive effect on economic growth. However, the results are rather unreliable because of the low R-squared. In column 3, more variables are put here, the result shows CO_2 has a negative but insignificant effect on GDP growth, whereas, population has a positive and significant effect, land has a negative and significant effect on economic growth. In column 4, all variables show a positive but insignificant effect on economic growth except for land.

Table 5

Dependent variable is economic growth				
	(1)	(2)	(3)	(4)
CO2	8.127e-07 ***	1.009e-06 *	-6.860e-09	2.713e-07
	(1.388e-07)	(3.544e-07)	(4.506e-07)	(1.349e-06)
Trade			5.389e-03	7.206e-03
			(4.893e-03)	(1.005e-02)
FDI inflows			1.069e-11	2.903e-11
			(1.215e-11)	(5.627e-11)
Population			4.233e-09***	3.277e-09
			(1.048e-09)	(2.170e-09)
Land			-1.712e-07**	-2.587e-07 .
			(5.906e-08)	(1.150e-07)
Urbanization			-4.633e-03	2.203e-03
			(1.543e-02)	(3.366e-02)
Year fixed-effect	No	Yes	No	Yes
Country fixed-effect	No	No	No	No
R-squared	0.08028	0.3669	0.7661	0.3669
Number of observations	384	384	384	384

Notes: OLS results. Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

4. EMERGING MARKET CASE STUDY: *INDONESIA*

Like many other emerging markets that are natural resource abundant, Indonesia is no exception when it comes to the trade-off between rapid GDP growth and environment degradation. For decades, Indonesia has significantly outperformed its neighbours in terms of GDP as the leading economy in the region (see Figure 5.1). Needless to say, Indonesia experienced its all-time high GDP and GDP growth in 2012 that accounted for US$917.87 billion but was followed by a slow decline afterwards (see Figure 5.2 and 5.3). Regardless of the drop in GDP over the next few years, Indonesia still

spared well at the international level with a GDP value that represented 1.39% of world economy (World Bank 2016; Trading Economics 2017).

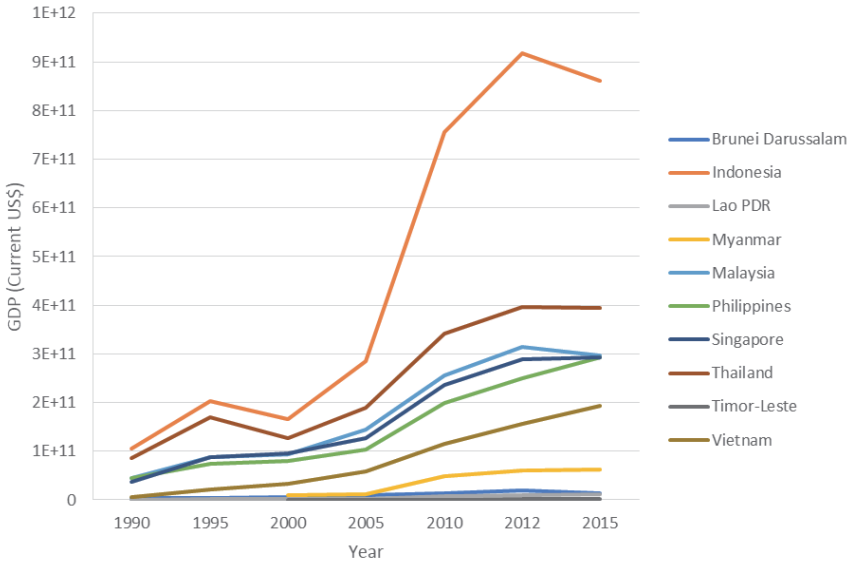

Figure 7
Southeast Asia GDP (by Country)
Source: World Bank Databas

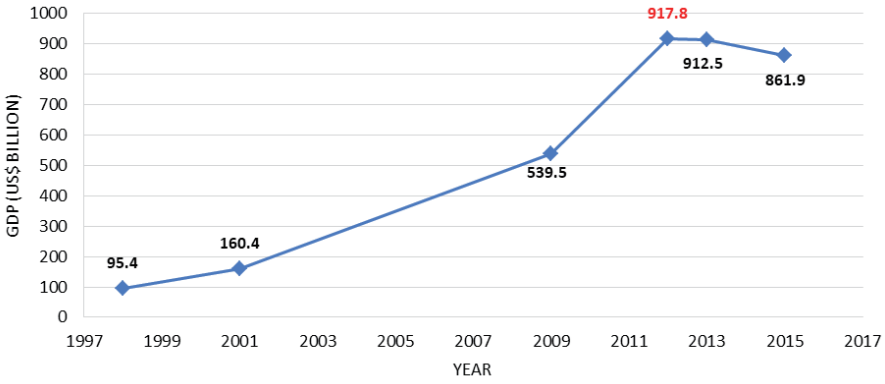

Figure 8
Indonesia GDP (US$ Billion)
Source: World Bank Database

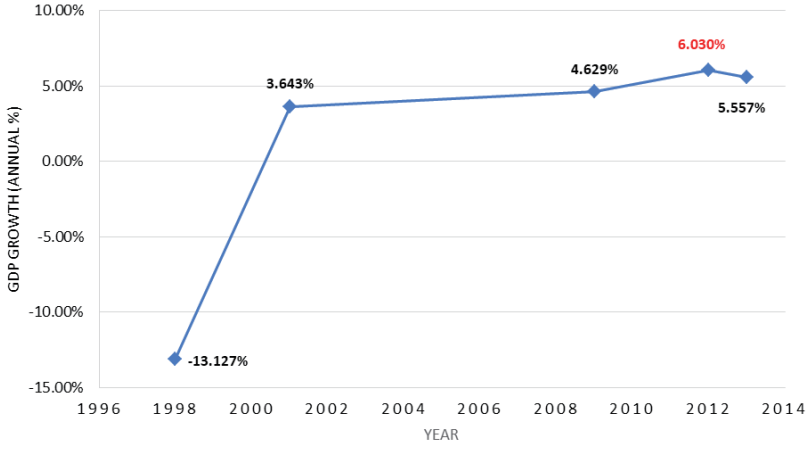

Figure 9
Indonesia GDP Growth (Annual %)
Source: World Bank Database

Of course, Indonesia's outstanding performance would not have happened without top three sectors, namely agriculture, service and industrial with the highest contribution to nation GDP. Here, industrial sector mainly consists of mining and manufacturing of natural resources. As noted above, Indonesia has been one of many natural resource rich country particularly in fossil fuels. As a member of OPEC[5] since 1962[6], Indonesia has been one of the major non-renewable energy exporters in the world. Indeed, natural resource abundancy resulted in an astonishing GDP growth is noteworthy but one must not neglect the cost of such performance. Throughout the process of abstraction through drilling, carbon emissions were released into the atmosphere. As mentioned, carbon emission is the key fueling element in climate change which thickens the sphere, causing the heat to be trap within the atmosphere and eventually warms the earth's temperature. The abstraction process worsens the issue of climate change and damaged the environment. Not only did Indonesia's industrial activity contributed to climate change but agriculture sector as well. Agriculture sector has also contributed a fair amount towards nation GDP. Even though, amongst the three sectors, agriculture's contribution has declined rapidly over the years due to industrialization however, their carbon emission inclined steadily. The process of deforestation in Kalimantan and Suliwesi for palm oil production over the years have severely damaged Indonesian forestry but also worsen climate change problem. Both economic activities had contributed positively to Indonesia's GDP but also negatively contribute to CO_2 emissions over the years. Specifically, the intensive carbon emission activities made Indonesia the top carbon emitter in the region (see Figure 10).

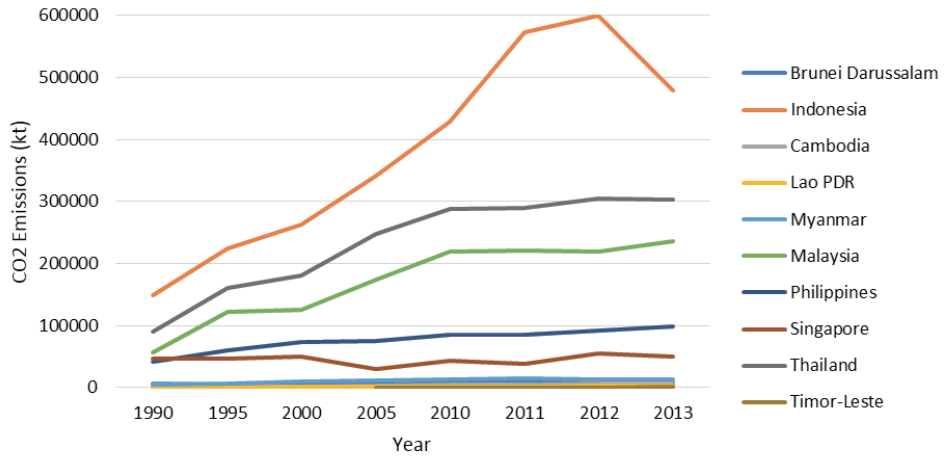

Figure 10
Southeast Asia CO2 Emissions (by Country)
Source: World Bank Database

Consequently, economic activities have positively contributed to Indonesia's economy and growth. Yet, the cost of rapid economic growth was environmental degradation and mass release of GHGs. Comparing Figure 7 and Figure 10, it is graphically evident that there is a positive relation between GDP growth and CO_2 emissions[7]. In the following, this paper would be looking at Indonesia's top two exporting industries that benefits the GDP and releases large portion of CO_2. More importantly, the paper further examine the impact on reducing carbon emission on these two Particularly, the two industries are fossil fuel (natural gas and oil) and palm oil (Dutu 2016).

4.1 Fossil Fuel (Natural Gas and Oil) Industry

Industrial sector has the largest contribution with a 40% value-add towards Indonesia's annual GDP. Within the industrial sector, fossil fuels such as coal and gas are Indonesia's top exporting products and contribute to over 10% of the overall GDP (World Growth 2011). As one of the core oil supplier in the world and a high domestic electricity consumptions, Indonesia has tried to burn massive quantity to support its demand. In addition to oil, Indonesia also supply coal (main component for electricity consumption) and gas (Hasan, Mahlia, and Nur 2012; Dutu 2016). Thus, it is obvious that fossil fuel plays an important role in foster economic growth for Indonesia. It is important to note to benefits provided

[5] Organization of the Petroleum Exporting Countries
[6] Indonesia became a member of OPEC since 1962 but withdrew its membership in 2009 due to its inability to support domestic oil consumption (net importer of oil). In January 2016, Indonesia re-joined OPEC (Hasan, Mahlia, and Nur 2012; OPEC 2017).

[7] The positive relation demonstrated in Figure 7 and Figure 10 coincides with the statistical results in section 4.

by the production of fossil fuels however, it is equally important to keep in mind about its disadvantages in terms of environment well-being. Throughout the burning process and utilization, large amount of GHGs were released into the atmosphere. For example, when burning fossil fuels, nitrous oxide (N_2O) and CO_2 would be created and released (NASA 2017).

Promoting and enforcing GHGs reduction through minimising fossil fuel industry production activity would in turn impose a downward pressure on Indonesia's GDP and growth. Noted before, over 10% of Indonesia's GDP was the product of fossil fuel industry. So, capping emission would represent a cut in fossil fuel production or Indonesia's GDP directly. This relation is statistically and empirical valid as shown in the case of Soviet Union's oil crisis. Reynolds and Kolodziej (2008) argued that the fall of Soviet Union's oil production did led to a decline in Soviet's GDP and not the other way round. Of course, lower fossil fuel production does have an indirectly effect on GDP as well. As a core industrial sector activity, the sales of fossil fuel have generated large revenue for Indonesian government and foreign exchange over the years (Sasmojo and Tasrif 1991). Thus, lower production would decrease government's revenue which in turn decrease their consumption. When there is a drop-in government's consumption, this would impact GDP negatively at a wide range of intensity[8]. In sum, when minimising the quantity of carbon emissions, this would limit fossil fuel output which results in a chain of effect. In turn, in combination of various effect, Indonesia would experience a decline in GDP and GDP growth.

4.2 Palm Oil Industry

Palm oil industry has been one of several growing industries in Indonesia. Currently, palm oil is the second largest agriculture industry[9] in Indonesia and a major supplier in the world, accounting to 47% of world production (Koh, Ghazoul, and Polasky 2010; World Growth 2011). Palm oil industry's rapid growth has benefited small-land owners and specific areas development, namely Kalimantan and Suliwesi. On average, Kalimantan and Suliwesi experience an annual growth rate of 13% and 8% respectively (World Growth 2011). In addition to development, palm oil industry has generated greater employment rate. Nonetheless, palm oil industry has greatly benefited Indonesia's sub-regional developments and GDP growth in general. Palm oil industry rapid growth and benefits are noteworthy however, the process in obtaining the land needed for plantation should be kept in mind as well. As briefly discussed earlier, massive deforestation in areas of Kalimantan and Suliwesi generated large amount of GHGs, particularly CO_2. By 2008, palm oil led to 27% out of a total of 40% deforestation in Indonesia or 70% of total forest (Hunt 2010; Carlson et al. 2012).

Similarly, reducing the total GHG emissions would negatively impact palm oil industry expansion and growth. Since deforestation (land use change and forestry) is the largest GHGs emitter in Indonesia amongst others, thus capping emission target would directly impact on rate of deforestation (Ministry of Environment 2010; Hunt, 2010). Indeed, lowering the rate of deforestation or preserving more forest would result in a lower CO_2 emission but this would limit palm oil production output. As argued by scholars (Koh, Ghazoul, and Polasky 2010), the quantity of palm oil production depends on a minimum amount of land needed for plantation. Therefore, to increase production output, more land (which means more deforestation) is needed for palm oil plantation. Conversely, limiting emission quantity would represent lesser deforestation. As a result, fewer lands would be available for plantation and in turn, lower production output. In sum, forest protection (or fewer deforestation) is in fact a trade-off against palm oil production in Indonesia.

Upfront, reducing carbon emissions, as shown, would limit oil palm production output. Yet, the consequent impact of lower output would also result a lower GDP and growth. Since GDP is "the market value of all final goods and services produced within a country in a given period of time", therefore lower production would adversely impact nation GDP (Mankiw 2011, 494). In the case of Indonesian palm oil industry, lower production does not only lower total output but also lowers profit, employment and social development. As mentioned, the rapid expansion of palm oil industry has created many job opportunities for local people. Furthermore, increasing palm oil sales have increase company profits and government tax collection (Koh, Ghazoul, and Polasky 2010; Schwarz 2010; Hunt 2010; World Growth 2011). Thus, lowering carbon emissions would tighten the amount of deforestation in Indonesia. This would result a lower production output, employment, company's profit and government revenue which are key components that composes nation annual GDP. In other words, lesser deforestation would negatively impact palm oil productions which in turn impose a downwards pressure on nation GDP. Therefore, referring to Paris Agreement, full commitment to reduce GHGs would inversely affect Indonesia's future GDP growth.

5. ALTERNATIVES AND POLICY SUGGESTIONS

Throughout the paper, we have shown that emerging market economic activities promotes growth but at the

[8] Changes in GDP (increase or decrease) is partly depended on the size of government's consumption.
[9] Agriculture sector (including palm oil industry) value-added represents 13.5% of total Indonesia's GDP.

expenses of environment degradation. In other words, emission reduction would impede the economic growth of emerging markets. That said, rising global efforts to curb climate change has put emerging markets under the lights. The current concern at hand for emerging markets is to actively fight against climate change by cutting down their emissions without hindering their growth. Therefore, the primary aim of this section is to provide alternative and policy suggestion for emerging market from both traditional approaches and new innovations.

5.1 Traditional Approaches

There are many traditional approaches that deals with carbon emissions. One of the approaches is transferable emission permits (TEP) also known as cap-and-trade. Instead of having centralized agency to deal and manage the quantity of emissions, TEP handles it at a decentralized level (Field and Olewiler 2011). In other words, a certain amount of emission permits is given to companies and they are allowed to trade or transfer their permits amongst themselves freely. On one hand, TEP ensures that a capped emission amount are permitted by the centralized agency. On the other hand, companies can transfer their permits to a certain amount which allows them to continue conducting their emission activities as usual. For example, 100 TEP are distributed by the agency and each TEP allows a company to release a maximum of 10,000 tonnes of CO_2. In total, one million tonnes of CO_2 would be emitted. Of course, not all companies would pollute the exact amount. Some may pollute less while other would require more than 10,000 tonnes. When such situation occurs, TEP provides the polluters the opportunity to sell, buy or transfer their permits to others who may need it more. Nevertheless, TEP would at least ensure a maximum amount of emission released within a given period while ensuring usual business operation for emerging markets.

Another typical approach is carbon tax. Carbon tax is "a direct levy on emissions for covered entities, it can take the form of special taxes on specific goods and fuels, or it may be economy wide" (Thomson Reuters 2013). This method is less effective in contrast to TEP because it does not limit the amount of emission being released. Furthermore, carbon tax would result in a deadweight loss or allocation inefficiency. Other than the listed disadvantages, carbon tax is still a good choice for managing carbon emissions. One of the advantages is that the tax would increase government revenue and be use as a source for future developments. Another advantage is that it would indirectly encourage companies to invest and use alternative technologies that would produce similar production output with a lesser emission rate (Asia-Pacific Economics Blog 2014). Emerging markets with lower capitals (government revenue) can adapt carbon tax first. While generating sufficient revenue, emerging market should shift to a less-emission method through investments and innovations such as renewable energy. In general, carbon tax should be used as an initial step to manage GHGs with a later shift to a more environmental-friendly method.

5.2 New Innovations

Unlike the traditional approaches which manage existing emissions through taxation or direct capping, new innovations change the sources of material. There are many technological innovations such as solar energy and wind energy. As discussed, the primary objective in burning fossil fuel was to generate and satisfy electricity consumption demands. The issue at hand was the combustion process which resulted high GHG emission. Solar and wind energy directly solve this issue and at the same time, produce more electricity quantity than combustion. For example, solar panels transfer sunlight into electricity that are used for housing, commercial and industrial use. Similarly, wind turbines generate electricity from wind power and can be used for various purposes (National Renewable Energy Laboratory 2017). In addition to the two most common renewable energy, hydroelectric power is another relative growing source for future electricity generators as well. Hydroelectric power generates electricity from the flowing water (National Renewable Energy Laboratory 2017).

Specifically, Indonesia's case and other emerging markets with similar environment and geography, solar energy would the best choice of substitute for fossil fuel. This is because, Indonesia and other emerging markets with large amount of sunlight exposure which makes it a perfect condition for generating electricity (Rozali, Mostavan, and Albright 1993; Hasan, Mahlia, and Nur 2012). Not only does emerging markets with similar geographic advantages for solar energy but hydroelectric power as well. Indonesia, Brazil, Russia and many other emerging markets have sufficient rivers to conduct hydroelectric power which generates electricity. For example, half of Indonesian rivers have the potential to create over 100 megawatt (MW) of electricity (Rozali, Mostavan, and Albright 1993). By utilizing renewable energy, emerging markets can avoid the negative impact of reducing emission which in turns decline its GDP growth.

CONCLUSION

Based on the combination of empirical data and case study of Indonesia, which is a representative for emerging market experienced both remarkably development and economic shocks. This paper tries to analyze the relationship between economic growth and carbon emissions in emerging markets, which shows that economic growth has positive effect on carbon emissions. Therefore, our main findings are as following:

First, the CO_2 emissions in the emerging markets have been stable with little fluctuation before the year of

2002. After 2003, the growth rate of CO_2 emissions in the emerging markets has been increasing, especially in the year of 2003, when the growth rate reached a staggering 12%. However, in general, the carbon emissions' growth curve is similar to the reverse "W" type.

Second, the intensity of carbon emissions in emerging markets has been declining dramatically over the past two decades. Up to the year of 2013, the difference of carbon emission intensity between merging markets and developed markets is narrowed gradually.

Third, the Granger causality test shows that the economic growth causes the higher carbon emissions, but not vice versa, there is a one-way Granger causality.

Forth, we chose Indonesia as a representative for emerging markets to further analyze. After suffering from Asian financial crisis, it took years for Indonesia to recovery. We looked at the most important two exporting industries in Indonesia, which are fossil fuel industry and palm oil industry, and tried to examine the relationship between the gain from economic growth and the cost from environmental damage. In fossil fuel industry, when minimizing the quantity of carbon emissions, this would limit fossil fuel output which results in a decline in GDP and GDP growth. Similarly, in palm oil industry, lowering carbon emissions would tighten the amount of deforestation in Indonesia. This would result a lower production output, employment, company's profit and government revenue which are key components that composes nation annual GDP.

Finally, alternative and policy suggestion for emerging market are provided in this paper. From the traditional approach perspective, transferable emission permits and carbon tax might be the feasible options to manage emissions. Moreover, from new innovations point of view, by using renewable energy, such as solar and wind energy, instead of using fossil fuel. Aiming not only to achieve economic development, but also to be environmental friendly.

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