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THE ROLE OF FINANCIAL DEVELOPMENT AND MANUFACTURING SECTOR EXPANSION ON EMISSION REDUCTION FOR SUSTAINABLE ECONOMIC DEVELOPMENT IN THE WORLD'S BIGGEST EMITTER ASIA

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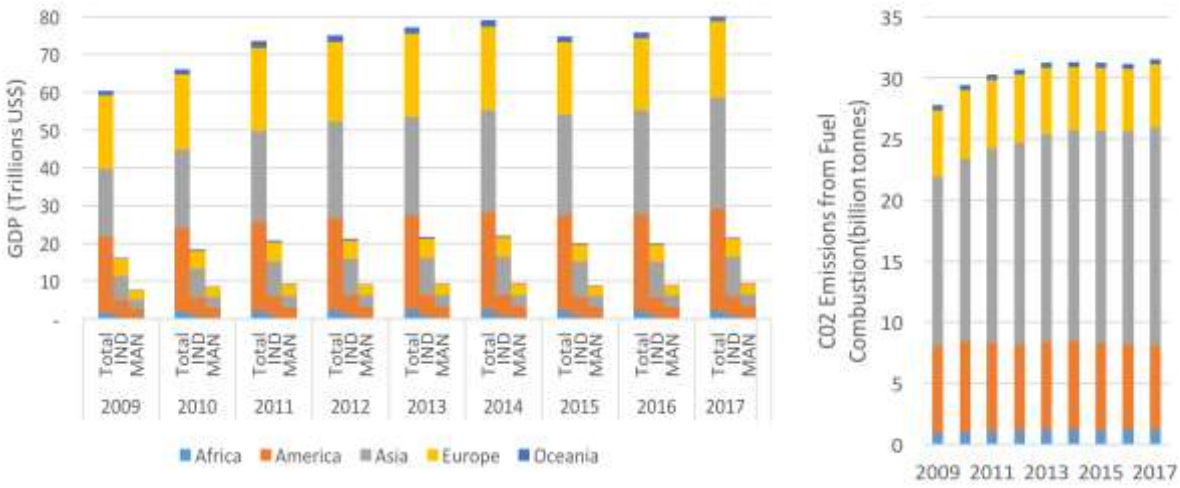
ABSTRACT: Manufacturing has played an imperative role on world's economic development even in Asia. Massive expansion of this industrialization impact, enforces Asia to be the world's biggest emitter because of the presumption as the major determinant of Carbon dioxide (Saidi & Mbarek) emissions. Instead of expected to accelerate high economic growth, it has left a harmful impact which threaten our environment sustainability. On the other side, the effect of globalization stimulates the evolution of financial development with debatable impact on the environment. Some argues that financial development supplies additional funding to boost production economic of scale particularly in manufacturing sector resulting CO2 emissions enhancement. On the contrary, the others assumes that environmentally friendly technology supported by adequate financial development can stimulate efficient production process which can protect the environment. Therefore, this study aims to analyze the effect of manufacturing sector expansion and financial development on CO2 emissions in Asia during 2009-2018 by using System Different Generalized Method of Moment (Sys-GMM) dynamic panel model. This study result shows that financial development negatively effects CO2 emissions, moreover it can minimize negative effect of manufacturing sector expansion on CO2 emissions reduction in line with the actualization of the 13th goal of Sustainable Development Goals (SDGs).

KEYWORDS: Financial development, CO2 Emissions, Manufacturing Sector, System Different Generalized Method of Moment (Sys-GMM), dynamic panel model

I. INTRODUCTION

Industrial sector, in this case represented by its primary subsector manufacturing, has played an imperative role on world's economic development because of its characteristics of having a great capacity for productivity growth, technical and financial externalities, and increasing return to scale so that it can accelerate high economic growth rate (Felipe, 2018). An economy dominated by manufacturing sector is expected to have rapid headway. Therefore, many countries compete each other to speed up structural transformation from agricultural sector. Asia itself, one of five world continents that has already been a principal contributor of World's Gross Domestic Product (GDP) since 2011 based on United Nations Conference on Trade and Development (UNCTAD) data as shown in Figure 1(a), realizes this condition very well. More over, Asia is acclaimed as the biggest contributor of world manufacturing sector output since 2016 as more than 30 percent of world manufacturing sector output has been supported it by Asian Countries (Figure 1(a)).

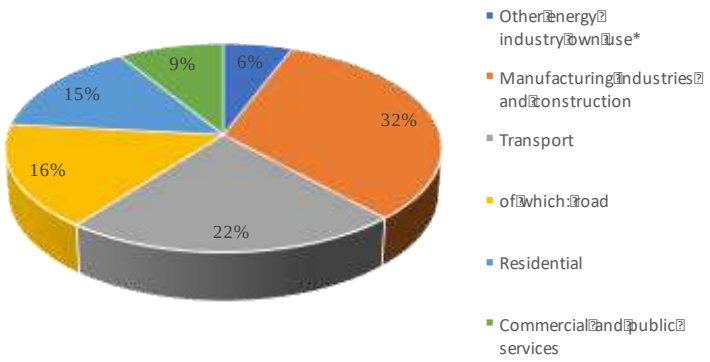


(a) (b)

Source: UNCTAD & IEA (2020)

Figure 1. GDP and CO2 Emissions from Fuel Combustion By Continent 2009-2017

Unfortunately, this manufacturing sector expansion has left a harmful impact which threaten our environment sustainability. This consequence of industrialization has been discovered as the major determinant of carbon dioxide emission that continuously going up day by day. The latest International Energy Agency (IEA) data as shown in Figure 2, reveals that in 2017, 32 percent of total CO2 emission by fuel combustion with electricity and heat is contributed by manufacturing industry and construction. Consequently, Asia can't avoid of getting a predicate as the world's biggest emitter. This is also strengthened by an overview of CO2 emissions escalation which is dominated by Asian countries as shown in Figure 1(b).



Source: IEA (2020)

Figure 2. CO2 Emissions from Fuel Combustion with Electricity and Heat

On the other hand, the 13th goal of 17s Sustainable Development Goals (SDGs) invokes us to take urgent action to combat climate change and its impacts. We can not ignore this crucial condition at all to ensure that our future generation will still can relish sustainable world. We have to find solution that we can use to minimize carbon dioxide emission without ignoring the manufacturing sector expansion spillover. The effect of globalization stimulates the evolution of financial development with debatable impact on the environment. Ozturk and Acaravci (2013) could not find the significant effect of financial development on CO2 emissions in Turkey. The same case had also been found in USA (Dogan & Turkekul, 2016). Some positive effects of financial development on CO2 emissions have been found in Pakistan (Shahzad, Kumar, Zakaria, & Hurr, 2017), Tunisia (Farhani & Ozturk, 2015), India (Boutabba, 2014), and China (Zhang, 2011). Positive effects of financial development on CO2 emissions had also been found in panel analysis of BRICS economies, the top ten CO2 emitter countries (Japan, USA, South Korea, Germany, Iran, Canada, Saudi Arabia, China, India and Russia), G7 countries (Raheem, Tiwari, & Balsalobre-Lorente, 2020), G8 and D8 countries ho(Shoaib, Rafique, Nadeem, & Huang, 2020), and 192 global world countries (Khan, Khan, & Binh, 2020),. Negative effect of financial development on CO2 emission had also much enough found like in Malaysia (Shahbaz, Solarin, Mahmood, & Arouri, 2013), Indonesia (Shahbaz, Hye, Tiwari, & Leitão, 2013), Pakistan (Godil, Sharif, Agha,

& Jermsittiparsert, 2020), and South Africa (Shahbaz, Tiwari, & Nasir, 2013). Some panel analysis which had also found the negative effect of financial development on CO2 emissions were in Gulf Cooperation Council (GCC) countries (Salahuddin, Gow, & Ozturk, 2015), 19 emerging countries (Saidi & Mbarek, 2017), top countries listed in Renewable Energy Country Attractiveness Index(Dogan & Seker, 2016), and 23 selected European Union (EU) countries (Park, Meng, & Baloch, 2018). This ambiguity effect of financial development on CO2 emission has encouraged us to investigate the case of Asian countries.

Therefore, based on the background and the problem above, this study aims to identify the existence of Environmental Kuznet Curve (EKC) among Asian countries; to analyze the effect of manufacturing sector and financial development on CO2 emission among Asian countries in order to give policy recommendation to keep enhancing industrialization without ignoring environment sustainability.

II. LITERATURE REVIEW

A principal foundation theory of this study is Environmental Kuznet Curve (EKC) hypothesis which associates the link between economic growth and environmental degradation as a consequence (Panayotou, 1993). EKC hypothesis is illustrated as an inverted U-shaped curved which describe a condition where at the early stages of economic growth, environmental degradation increases along with per capita income growth. Subsequently, after reaching a particular threshold value, it declines in line with the further enhancement of per capita income growth. In Asia, there are several studies which investigates the occurrence of EKC hypothesis. Taguchi (2013) couldn't proved the occurrence of EKC hypothesis in 19 Asian economies in 1950-2009 since he found that carbon emission tend to increase continuously. Apergis and Ozturk (2015) proved the presence of EKC hypothesis for 14 Asian countries in 1990-2011. But, there is no study that analyze EKC hypothesis occurrence in Asia as a whole continent.

Kaldor (2007) stated that manufacturing sector was a principal stimulus engine of economic growth. It was known as the first growth law of Kaldor. Manufacturing sector acted as a intermediary between primary sector and tertiary sector because it transformed raw materials from primary sector and then turned it into to a finished production through production process, hence forward to be transported and distributed by tertiary sector. The production process gave value added to increase the total output. The manufacturing sector involved less manpower than agricultural sector. It described higher degree of economic development. Then, the second growth law of Kaldor, which was also knowned as Verdoorn's Law, stated that manufacturing sector productivity growth was flexible, it was affected by manufacturing sector output growth. Manufacturing sector productivity could automatically increase more or less depend on the size of the market. Finally, the third growth law of Kaldor stated that manufacturing sector productivity growth affected productivity growth of the other sector.

Panayotou (1993) stated that five main determinants of the state of natural resources and the environment in a country, incuding CO2 emissions, are the economic size; the sectoral economic structure; the level of technological progress; the demand for environmental convenience; and the environmental expenditures. The bigger the economic size of a country, which can be measured by per capita income, the higher level of emissions generated. As a country became industrialized, which was reflected by manufacturing sector share, the higher the energy consumption used, then the rate of emissions generated would also be higher. However, the structure of the manufacturing industry of a country would distinguish the effect on CO2 emissions. The higher industrialized level of a country, dominated by sophisticated technology with advanced information and communication technology, the production process activities woulf be more environmentally friendly.

Positive and negative effect of financial development on CO2 emissions had been resumed by Jiang and Ma (2019). There were three ways how financial development can increase carbon emission. First, financial support could overcome information asymmetric problem so that firm can expand their production scale which further can increase CO2 emissions. Second, financial support could provide service of consumption credit to expand social consumption especially in high consumed energy product, which further can increase CO2 emissions. Third, financial support could establish firm's good image on stock market which can enhances firm confidence to stimulate production and comsumption activity which further can increase CO2 emissions.

There were also three ways how financial development can reduce carbon emission. First, financial support could overcome firm financing constraints to increase firm investment to update production technology and equipment which can decrease production cost and increase product competitiveness, hence forward can decrease energy cost and reduce carbon emission. Second, financial support could provide fund to improve firm energy infrastructure with environmentally friendly project, which further can reduce carbon emission. Third, financial support could establish firm's good image on stock market especially about firm's social responsibility of environmental protection supervised by financial authorities and public which further can reduce carbon emission.

Raheem et al. (2020) found that financial development which is represented by as the credit provided by the private sector give positive impact on CO2 emissions in G7 countries in 1990-2014 but the interaction with ICT give negative effect. Those study had inspired us to investigate the effect of financial development on CO2 emissions to encounter other bad impact of manufacturing sector expansion in this case.

Financial development is a multidimensional process which was commonly observed from financial institutions and financial markets aspects in terms of their depth, access, and efficiency (Svirydzenka, 2016). This study focused on financial institutions depth, a crucial measure more concerned on the quantity aspect of financial development. Deepening financial institution needed a speed limit since it can trigger economic and financial instability without strict regulation and supervision. The weakening effect of bell-shaped relationship in term of financial development impact on economic growth stemed from financial deepening, rather than from greater access or higher efficiency (Sahay, Čihák, N'Diaye, & Barajas, 2015).

This study is expected to give contribution to the literature about CO2 emission as the first study to examine the role of financial development and manufacturing sector on CO2 emissions. Previous studies had found that those two factors mostly could enhance economic growth so did the carbon emission. Hence, this study tries to investigate whether the collaboration between them can give good impact for our expectancy of sustainable development. Then, this study focus to find a away to reduce CO2 emission in Asia as the biggest emitter continent of the world in order to solve world CO2 emissions problem rapidly.

Figure 3 has showed us the research framework of this study. As we mention earlier, this study aims to identify the existence of EKC hypothesis among Asian countries. Therefore, we use income per capita and income per capita square as independent variable with expected sign of positive to income per capita and negative to income per capita square to support the existence of EKC hypothesis. Another factors that we expected to give an effect on CO2 emission are manufacturing sector expansion with it positive effect and financial development with its ambiguity effect. We add the urban population factor and control variable that based on theory give positive effect on CO2 emission. Last, we try to investigate the effect of the interaction between manufacturing sector expansion and financial development.

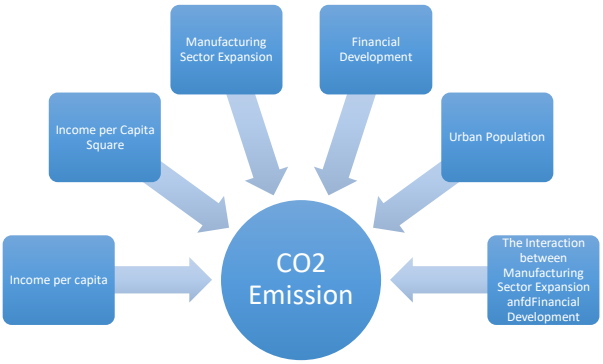


Figure 3. Study Framework

III. METHODOLOGY

3.1 Data Source and Variable Description

This study involves panel data of 41 Asian countries during 2009-2018. A latest decade is expected to give a comprehensive description of economic cycle dynamics in a Asia. Data of Armenia, Bahrain, Laos, North Korea, State of Palestine, Syria, Taiwan, Turkmenistan, Uzbekistan, and Yemen is not included in this study due to unavailibility of complete data. Nevertheless, in 2018, CO2 emissions from this 41 Asian countries has covered 82% of total CO2 emissions Asia so hopefully it can give a Asia's comprehensive overview as a whole. Majority data source of the economic model of this study has taken from World Development Indicator (WDI) by World Bank, while for CO2 Emissions, this study chooses Global Carbon Atlas data. Some data from International Energy Agency (IEA), International Monetary Fund (IMF), and United Nations Conference on Trade and Development (UNCTAD) are used to enrich the analysis of this study.

3.2 Econometric Model

The estimation model of CO2 emission is calculated using a dynamic panel data analysis with System-Generalized Method of Moment (Sys-GMM) approach. Because lag variables become regressors in the model, Ordinary Least Square (OLS) estimators result biases and inconsistencies in parameter estimation (Blundell & Bond, 1998). This is due to the existence of dependent variable lag as an independent variable in the specification model. Dynamic relationship leads to the emergence of endogeneity problem. If the model is estimated by static panel data analysis, the estimators will be biased and inconsistent (Verbeek, 2008) Evaluation is done to determine the exact model that should meet the criteria of unbiased, consistent, and valid.

An alternative approach is to use Generalized Methods of Monents (GMM) to overcome the problem of endogeneity. There are two types of estimates that can be used through the GMM method, namely First Difference GMM (FD-GMM) and System GMM (Sys-GMM).

Because FD-GMM is a biased and weak estimator of precision when the number of samples is small, (Blundell & Bond, 1998) developed the GMM System. The reason for this is the instrument used in the weak first-difference equation. (Baltagi, 2005) suggested the Sys-GMM method to be an alternative when FD-GMM does not meet the assumptions.

3.2.1. Test Specifications for Dynamic Panel Models

3.2.1.1. Simultaneous Test

Simultaneous test tests the parameters of the dependent variable simultaneously related to the independent variable. Mathematically, the hypothesis can be written as follows.

$H_0: \beta_1 = \beta_2 = \cdots = \beta_k = 0$

$H_1: minimum\ one\ \beta_p = 0$

Where β is the parameter coefficient of the independent variable, k is the number of the independent variable, and p is the pth parameter; p = 1,2, ..., k. Statistics calculated through the Wald test are stated as follows.

$$W_{score} = n\widehat{\beta}'\widehat{V}_N^{-1}\widehat{\beta} \sim \chi_k^2 \quad (1)$$

The $\widehat{\beta}$ is the parameter estimation value of one-step efficient estimator or two-step efficient estimator. The critical region rejects H_0 from the calculated statistics which is when $W_{score} > \chi_\alpha^2$ or $p - value < \alpha$.

3.2.3.2. Arellano-Bond Test

This test consists of two hypotheses that test Arellano-Bond components m1 and m2. Arellano-Bond m1 expresses the relationship between first order and error, while Arellano-Bond m1 expresses the relationship between second order and error in each equation. The two of them tested the hypothesis that there is no relationship between error with first order and second order. (Baltagi, 2005) formulated his hypothesis mathematically, namely:

$H_0: E\left(\Delta v_{it} \Delta v_{i(t-j)}\right) = 0$

$H_1: E\left(\Delta v_{it} \Delta v_{i(t-j)}\right) \neq 0$

Where $j = 1,2$

The statistics proposed by (Arellano & Bond, 1991)are as follows.

$$m_j = \frac{\hat{r_j}}{s.e.(\hat{r_j})} \sim N(0,1) \quad (2)$$

$$r_j = \frac{1}{\mathrm{T}-3-j} \sum_{t=4+j}^{T} r_{tj} \quad (3)$$

$$r_{tj} = E\left(\Delta v_{it} \Delta v_{i(t-j)}\right) \quad (4)$$

The critical region rejects H_0 from the calculated statistic, namely when $m_j < -Z_{\frac{\alpha}{2}}$ or $m_j > Z_{\alpha/2}$, when $p - value < \alpha$. The consistency of the model with the GMM method is said to be consistent if the null hypothesis on Arellano-Bond m1 is rejected, while the null hypothesis on Arellano-Bond m2 fails to be rejected.

3.2.3.3. Sargan Test

The validity of the instrument was tested through the Sargan test (Baltagi, 2005). The hypothesis that is tested statistically can be stated mathematically as follows.

$H_0: E(W'\Delta v_i) = 0$

$H_1: E(W'\Delta v_i) \neq 0$

Statistics that used in Sargan test as follows.

$$S = \Delta v' W \left(\sum_{i=1}^{N} W_i' \Delta v_i \Delta v_i' W_i\right)^{-1} W' \Delta v \sim \chi_{(g-k)}^2 \quad (5)$$

Where g is the number of instruments and k is the number of parameters. The critical region of reject H_0 from the calculated statistics is when $S > \chi_\alpha^2$ or $p - value < \alpha$. A dynamic panel model with a valid GMM method when there is no relationship between the instrument variable with error or H_0 fails to be rejected.

3.2.3.4. Partial Test

Partial test examines each parameter of the dependent variable related to the independent variable in the model. Mathematically, the hypothesis can be written as follows.

$H_0: \beta_p = 0$

$H_1: \beta_p \neq 0$

Where β is the dependent variable parameter and p is the pth parameter. The partial test statistic is stated as follows.

$$Z_{score} = \frac{\widehat{\beta_p}}{s.e.(\widehat{\beta_p})} \sim N(0,1) \quad (6)$$

There are three econometric specification modes of CO2 emission in this study based on Saidi and Mbarek (2017) as follows:

Model 1:

$$CO2_{i,t} = \beta_1 CO2_{i,t-1} + \beta_2 GDPC_{i,t} + \beta_3 GDPC^2{}_{i,t} + \mu_i + \varepsilon_{it}$$

$$CO2_{i,t} = \beta_1 CO2_{i,t-1} + \beta_2 GDPC_{i,t} + \beta_3 GDPC^2{}_{i,t} + \beta_4 MAN_{i,t} + \beta_5 FD_{i,t} + \beta_6 URBAN_{i,t} + \mu_i + \varepsilon_{it}$$

$$CO2_{i,t} = \beta_1 CO2_{i,t-1} + \beta_2 GDPC_{i,t} + \beta_3 GDPC^2{}_{i,t} + \beta_4 \mathrm{MAN}_{i,t} + \beta_5 \mathrm{FD}_{i,t} + \beta_6 \mathrm{URBAN}_{i,t} + \beta_7 \mathrm{MANFD}_{i,t} + \mu_i + \varepsilon_{it}$$

Table1: Variables Description

Variables	Abbreviation	Description and Measurement
Carbon Dioxide Emissions	CO2	Territorial emissions in tCO_2 per capita
Gross Domestic Product per Capita	GDPC	GDP per capita (constant 2010 US$)
Financial Development Indicator	FD	Domestic credit to private sector (% of GDP)
Manufacturing Sector Expansion	MAN	Manufacturing, value added (% of GDP)
Urban Population	URBAN	Urban population (% of total population)

IV. RESULTS AND FINDINGS

4.1 General Overview of Financial Development, Manufacturing Sector Expansion, and CO2 Emissions in Asia in 2009-2018

CO2 emissions escalation was a phenomenon experienced by Asian countries, the world biggest emitter, even in the latest decade 2009-2018. Territorial carbon dioxide emissions in Asia was increased 24.31 percent from 14,765.88 MtCO2 in 2009 to 19,507.99 MtCO2 in 2018. On average, China was the biggest emitter country in Asia, while the smallest emitter country in Asia was Timor Leste. Singapore was successful to be a country in Asia with the biggest territorial carbon dioxide emission reduction with 30.26 percents lowering. While, a country in Asia with horrible performance in territorial carbon dioxide emissions reduction was Bhutan with more than doubled increase, precisely 230.07 percent. But, if we see per person measurement, territorial carbon dioxide emission per person in Qatar was the highest in Asia while in Nepal was the lowest in Asia. Singapore and Bhutan was still be the best and the worst country in term of performance in territorial carbon dioxide per person reduction.

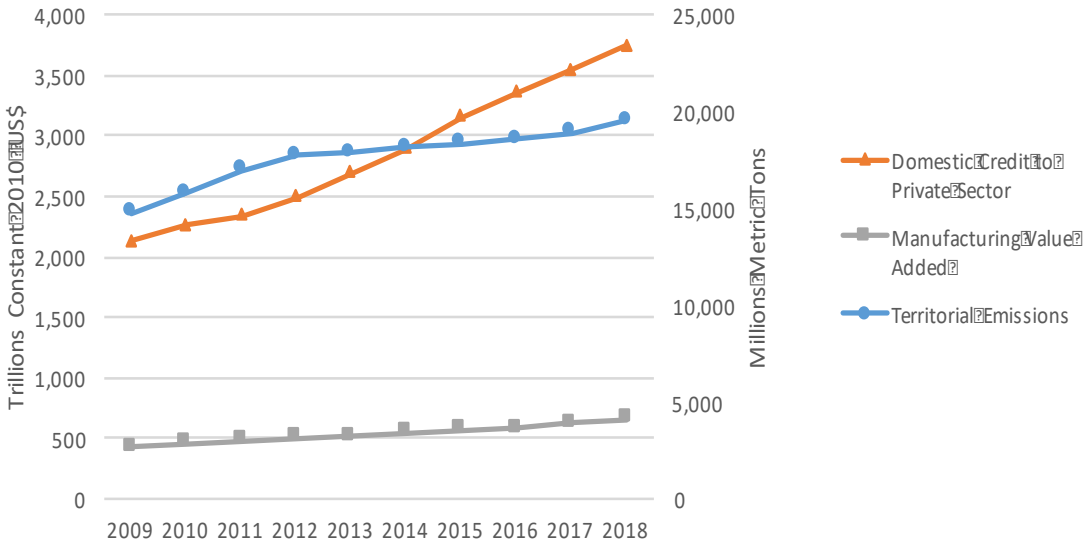


Figure 4. Evolution of Domestic Credit to Private Sector, Manufacturing Value Added, and Territorial CO2 Emissions in Asia 2009-2019

Manufacturing sector expansion in Asia was achieved excellent growth of 35.80 percent from 2009 to 2018. The predicate as the Asia biggest emitter for China and the Asia lowest emitter for Timor Leste was in line with their

performance in term of manufacturing sector expansion. 48.57 percent or almost a half of Asian country manufacturing value added was contributed by China. Timor Leste had just only a very slight contribution of Asian country manufacturing value added with only 0.0006 percent. However, manufacturing sector growth in Timor Leste had showed quite sharp increase with 234.23 percent growth from 2009 to 2018 which was the highest growth during the period. Hongkong was a country with the lowest manufacturing sector growth in Asia during the period. Manufacturing value added of Hongkong decreased for 23.89 percent from 2009 to 2018. In 2017, manufacturing industry and construction contributed 46 percent of CO2 emission from fuel combustion with electricity and heat.

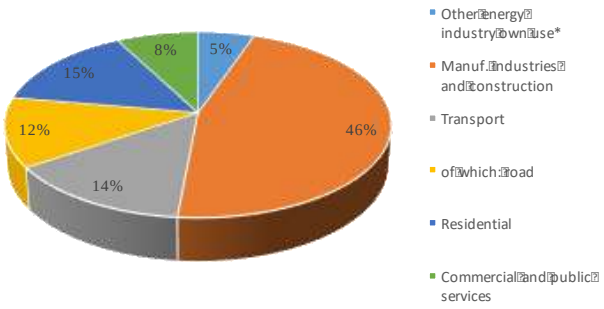


Figure 5. CO2 Emissions from Fuel Combustion with electricity and heat by Sector of Asia in 2017

Incredible achievement of 42.96 growth also occurred in term of Asia's financial development from 2009 to 2018, in this case represented by domestic credit to private sector. Interestingly, financial development performance in China and Timor Leste was also in line with their performance in carbon dioxide emission and manufacturing sector expansion. Myanmar was a country with the highest growth of financial development. Domestic credit to private sector in Myanmar increased more than 6 times. Growth of financial development in Afghanistan was the lowest in Asia, domestic credit to private sector in Afghanistan decreased more than a half from 2009 to 2018. 95 percent of domestic credit to private sector dominantly was served by bank.

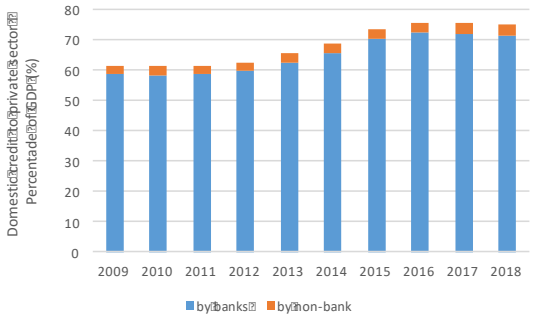


Figure 6. Share of Domestic Credit to Private Sector by bank and non-bank on GDP of Asian Countries in 2009-2018

4.2. CO2 emission estimation model

Estimation models of carbon dioxide emissions in Asia in 2009-2018 with Sys-GMM dynamic panel approach can be seen in Table 1. Statistically, all models meet the appropriate Sys-GMM dynamic panel data model's criteria. First, the full model criteria simultaneously tested through the Wald test rejects null hypothesis at the 1 percent significance level, which shows at least one significant variable in the model which affected carbon dioxide emissions. Second, the Arellano-Bond test of m1 and m2 with the hypothesis that there is a relationship between first-order and second-order with errors in the first difference equation, all three models are required to meet the desired Arellano Bond test criteria, i.e. first order is related to the first difference equation error (m1 significance test reject H0). All three models' m1 significance test gave significant result at 10 percent significance level. Meanwhile, the second order is not related to the first difference equation error (m2 significance test failed to reject H0). All three models' m2 significance test show the same results, gave insignificant results or failing to reject the null hypothesis at the 1 percent significance level. This Arellano Bond test results stated that estimators with Sys-GMM approach are consistent. Third, the Sargan test hypothesizes that there is no relationship between instrument and error. The instrument is said to be valid if the null hypothesis fails to be rejected. Sargan test results of this three models that provides insignificant results at 1 percent significance level state that the estimators with Sys-GMM approach use valid instruments. Finally, Forth, partial test of all three models showed that at 1 percent significance level all independent variables

affected carbon dioxide emissions. This forth results above state that models with Sys-GMM approach met the appropriate dynamic panel data model's criteria.

Table2: Regression Result

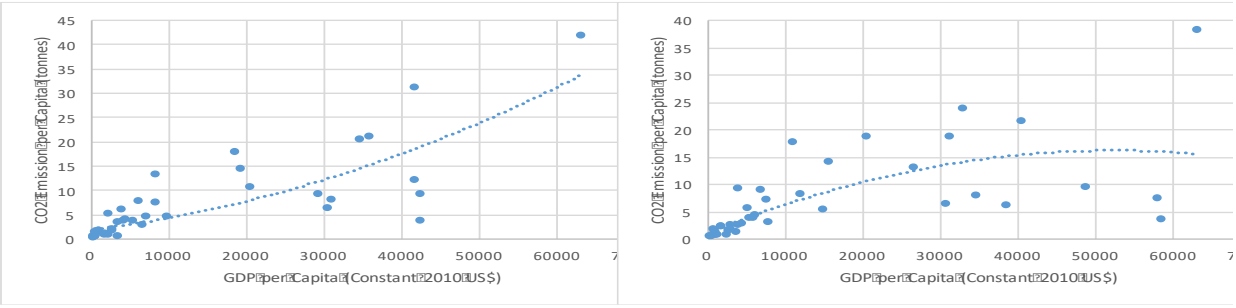
Variables	Model 1	Model 2	Model 3
CO2(-1)	0.6184532	0.5165705	0.4826839
	(0.000)	(0.000)	(0.000)
GDPC	0.0004942	0.0004797	0.0004434
	(0.000)	(0.000)	(0.000)
GDPC2	-4.88e-09	-4.58e-09	-4.10e-09
	(0.000)	(0.000)	(0.000)
MAN		0.0698614	0.1354758
		(0.000)	(0.000)
FD		-0.023728	-0.0071684
		(0.000)	(0.000)
URBAN		0.0360705	0.041315
		(0.000)	(0.000)
MANFD			-0.0013098
			(0.000)
Wald Test	2.25e+07	1.47e+07	2.52e+07
	(0.000)	(0.000)	(0.000)
Abond Test			
m1	-1.7705	-1.7613	-1.7577
	(0.0766)	(0.0782)	(0.0788)
m2	0.96906	0.86806	0.81657
	(0.3325)	(0.3854)	(0.4142)
Sargan Test	37.15175	38.60525	38.85646
	(0.7220)	(0.6622)	(0.6515)

$$\widehat{CO2}_{i,t} = 0.6184532\ CO2_{i,t-1} + 0.0004942\ GDPC_{i,t} - 4.88e-09\ GDPC^2{}_{i,t}$$

$$\widehat{CO2}_{i,t} = 0.5165705\ CO2_{i,t-1} + 0.0004797\ GDPC_{i,t} - 4.58e-09\ GDPC^2{}_{i,t} + 0.0698614\ MAN_{i,t} - 0.023728\ FD_{i,t} + 0.0360705\ URBAN_{i,t}$$

$$\widehat{CO2}_{i,t} = 0.4826839\ CO2_{i,t-1} + 0.0004434\ GDPC_{i,t} - 4.10e-09\ GDPC^2{}_{i,t} + 0.1354758\ MAN_{i,t} - 0.0071684\ FD_{i,t} + 0.041315\ URBAN_{i,t} - 0.0013098\ MANFD_{i,t}$$

Model 1 is the simplest carbon dioxide emission estimation model based on environmental kuznet Curve without any additional control variable. Model 2 added manufacturing sector expansion, financial development, urban population as independent variable. Then, Model 3 added the interaction term of manufacturing sector expansion and financial development as an additional independent variable.



a. 2009 b. 2018

Figure 7. Scatter plot of Asian Countries GDP per Capita and CO2 Emissions per capita in a. 2009 and b. 2018

Figure 7 shows the relationship of GDP per capita and CO2 emission per capita in 2009 and 2018 Figure 7a shows that positive trend which was not forming an inverted U shape Curve. While in Figure 7b, an inverted U

shape was formed. The existence of inverted U shaped EKC in 2018 stated that Asian Countries start entering the latter stage of economic development where the enhancement of economic growth will followed by emission reduction.

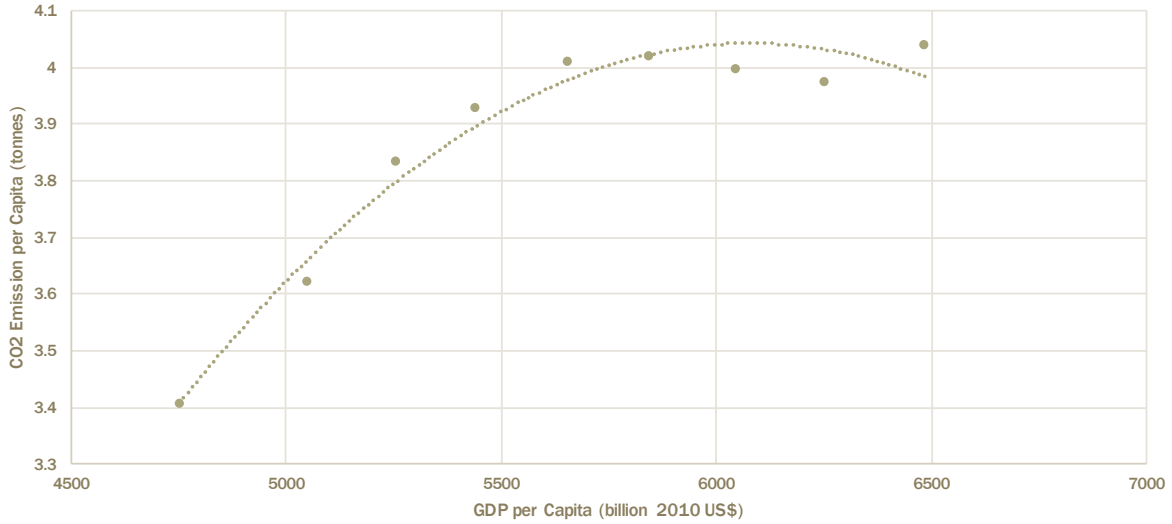


Figure 8. EKC Asian Countries 2009-2017

Manufacturing sector expansion have a positive effect on carbon dioxide emission. Sectoral economic structure is one of the five determinant of carbon dioxide emission (Panayotou, 1993). A country with higher level of manufacturing sector will consume more energy then increase CO2 emission. WDI data shows that in 2017, as an average only 26.19 percent of Asian countries manufacturing value added are from medium-high technology industry, the rest of it still use low technology that consume more energy and minim pollution waste handling. Singapore was a country with the most amount in composition of medium-high technology industry, Up to 80 percent of Singaporean's manufacturing value added was contributed by medium-high technology while Cambodia was a country with the least amount in composition of medium-high technology industry (0.25 percent). Therefore to enhance the emission reduction we need to increase medium-high technology industry particularly in countries with high CO2 emission and low proportion of medium-high technology industry like in Brunei Darussalam, Mongolia, Kazakhstan, and Oman.

Financial development have a negative impact on carbon dioxide emission. There were three ways how financial development can reduce carbon emission. First, financial support could overcome firm financing constraints to increase firm investment to update production technology and equipment which can decrease production cost and increase product competitiveness, hence forward can decrease energy cost and reduce carbon emission. Second, financial support could provide fund to improve firm energy infrastructure with environmentally friendly project, which further can reduce carbon emission. Third, financial support could establish firm's good image on stock market especially about firm's social responsibility of environmental protection supervised by financial authorities and public which further can reduce carbon emission. Condition of financial development in Asian country was primely fine. As an average, depth credit information index(0=low, 8=high) in 2018 of Asian countries was in moderate level with 6.075. Only 12.5 percent of Asian countries has a low level of credit information depth and 65 percent of Asian countries has a high level of credit information depth. Eleven countries has a perfect score of credit information are Azerbaijan, Brunei Darussalam, China, Georgia, Indonesia, Iran, Malaysia, Saudi Arabia, South Korea, Turkey, and United Arab Emirates. It shows that financial literacy in Asian country was brilliant. Afghanistan, Iran, Myanmar, Bangladesh and Nepal was five countries with lowest level of credit information depth so we need to focus to increase level of credit information depth in those five countries. This result is consistent with those which found in Malaysia (Shahbaz, Solarin, Mahmood, & Arouri, 2013), Indonesia (Shahbaz, Hye, Tiwari, & Leitão, 2013), Pakistan (Godil, Sharif, Agha, & Jermsittiparsert, 2020), South Africa (Shahbaz, Tiwari, & Nasir, 2013), Gulf Cooperation Council (GCC) countries (Salahuddin, Gow, & Ozturk, 2015), 19 emerging countries (Saidi & Mbarek, 2017), top countries listed in Renewable Energy Country Attractiveness Index(Dogan & Seker, 2016), and 23 selected European Union (EU) countries (Park, Meng, & Baloch, 2018).

Manufacturing sector is known as engine of growth, but in other side increase CO2 emission. It was a dillematic problems. Boosting manufacturing sector to enhance rapid economic growth will give bad impact on environment. Therefore, model 3 tries to find out the impact of the interaction between manufacturing sector expansion and financial development on CO2 emission. The negative coefficient sign show that the interaction between manufacturing sector and financial development can counter the impact of manufacturing sector that

can enhance C02 emission. This means that with the financial support, manufacturing firm can adopt new technology which can make the production process more efficient, reduce energy consumption, equipped by appropriate pollution waste handling so that finally can reduce CO2 emisssion. In order to fasten the emission reduction process, we can focus on enhancing financial development in countries with low financial development level but high CO2 emission such as Israel, Iran, Mongolia, Oman, Kazakhstan, Saudi Arabia, and Brunei Darussalam.

V. CONCLUSION

CO2 emissions escalation was a phenomenon experienced by Asian countries, the world biggest emitter, even in the latest decade 2009-2018 in line with the growth of manufacturing sector expansion and financial development. The existence of inverted U shaped EKC stated that Asian Countries start entering the latter stage of economic development where the enhancement of economic growth will followed by emission reduction. This study result shows that manufacturing sector expansion positively affects CO2 emissions while financial development gives negative effect on CO2 emissions. Moreover, financial development can minimize negative effect of manufacturing sector expansion on CO2 emissions reduction in line with the actualization of the 13th goal of Sustainable Development Goals (SDGs).

Therefore to enhance the emission reduction we need to increase medium-high technology industry particularly in countries with high CO2 emission and low proportion of medium-high technology industry like in Brunei Darussalam, Mongolia, Kazakhstan, and Oman. Afghanistan, Iran, Myanmar, Bangladesh and Nepal was five countries with lowest level of credit information depth so we need to focus to increase level of credit information depth in those five countries. In order to fasten the emission reduction process, we can focus on enhancing financial development in countries with low financial development level but high CO2 emission such as Israel, Iran, Mongolia, Oman, Kazakhstan, Saudi Arabia, and Brunei Darussalam. Further research can use another proxies of financial development from different dimensions or comparing effects from those different dimensions on CO2 emissions.

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