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The Determinants of CO_2 Emissions in Malaysia: A New Aspect

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ABSTRACT

In light of the deterioration of environmental quality, this study aims to identify the determinants of CO_2 emissions in Malaysia using the autoregressive distributed lag and the decomposition-type threshold methods. This study signifies that economic growth is the main contributor to CO_2 emissions which is in line with the theory of the Environmental Kuznets Curve curve. Meanwhile, this study also confirms that vertical intra-industry trade between Malaysia and China together with the bilateral FDI from China to Malaysia are the significant determinants of CO_2 emissions in Malaysia. As such, this study suggests that the Malaysian government should monitor the implementation of the green growth strategy to enhance the sustainability of the economic and trade growth without compromising environmental quality.

Keywords: CO_2 Emissions, Economic Growth, Vertical Intra-industry Trade
JEL Classifications: F18, F43, Q43

1. INTRODUCTION

Rocketing global economic growth has been accompanied by the simultaneous increase in the world's consumption of energy and this has resulted in a surge of CO_2 emissions. The CO_2 emissions level in developing countries will surge continuously if they continue the conventional patterns of economic growth (OECD, 2012).

Based on Quitzow et al. (2013), Asia has been transformed into the major manufacturing hub of the world. This transformation has led to significant economic growth in Asian countries and has given rise to emerging markets such as Malaysia. It is noted that Malaysia was one of 13 countries identified by the Commission on Growth and Development in their 2008 Growth Report to register an average economic growth rate of more than 7% annually for 25 years consecutively or more (The World Bank Group, 2016). The remarkable trade performance was one of the main contributors to Malaysia's growth rate. Malaysia's total trade has increased from RM988.2 billion in 2009 to RM1465.4 billion in 2015 (MITI, 2015). This was mainly contributed by the manufacturing sector. Meanwhile, China has emerged as the top trading partner of Malaysia since 2009 (MITI, 2015). As China has become the centre of global production in recent decades, the trade pattern between Malaysia and China has been focusing more on vertical intra-industry trade (VIIT). Arising from this, China's FDI outflow to Malaysia has surged from USD202.88 million in 2000 to USD294.33 million in 2010 (National Bureau of Statistics of China).

However, it is noticeable that the astonishing economic growth and trade performance of Malaysia was accompanied by a deterioration in environmental quality. CO_2 emissions have reached a worrisome level in which they have increased roughly two-fold from 129.5 metric tonnes in 2000–236.1 metric tonnes in 2014 (CEIC database). As such, this study aims to contribute to the literature on Malaysia's environment and trade by identifying the determinants of CO_2 emissions in Malaysia. This study examines whether economic growth, VIIT between Malaysia and China as well as China's FDI in Malaysia will affect CO_2 emissions in Malaysia as little attention has been paid to analyse the impact of VIIT and the bilateral FDI on CO_2 emissions in past studies. The outcome of this study will provide implications for Malaysian policy makers to enhance the sustainability of economic growth without compromising environmental quality.

2. THE DETERMINANTS OF C02 EMISSIONS

Owing to the seriousness of the global greenhouse effect and pollution, CO_2 emissions have become a hotly debated topic with many studies focusing on the determinants of CO_2 emissions (Aka, 2008; Galeotti et al., 2006; Jalil, 2014). In accordance with previous studies, one of the most prominent determinants of CO_2 is economic growth. This theory was introduced through the Environmental Kuznets Curve (EKC) which is an inverted U-shape, to demonstrate the relationship between economic growth and environmental quality. There have been many studies which support this theory; initial economic growth leads to an increase in environmental degradation until a particular turning point whereby an increase in economic growth improves the environment (Grossman and Kreuger, 1995; Kasman and Yavuz, 2015; Keho, 2015; Opoku et al., 2014; Peng et al., 2016; Saboori et al., 2012; Balogh and Jámbor, 2017). Income seems to be a significant factor in determining the effect of economic growth and pollution.

Besides that, trade also plays a pivotal role in determining CO_2 emissions. In a study on the environmental impacts of a North American Free Trade Agreement, Grossman and Kreuger (1991) put forward the argument that there are three mechanisms by which a change in trade can affect the level of pollution. Firstly, the scale effect; an increase in trade and investment liberalization increases economic growth, resulting in environmental degradation. Secondly, through the composition effect, countries are encouraged to produce goods according to their comparative advantage, which may damage the environment. Lastly, through the technique effect, an inflow of clean technology through FDI and a higher national income through trade liberalization would empower society to demand a better environment.

In addition to that, the relationship between FDI and environmental degradation can be summarised through the pollution haven hypothesis or the pollution halo hypothesis. According to the pollution haven hypothesis, differences in environmental regulation may determine the flow of FDI through the flight of pollution intensive industries and also the pull factor of more lax environmental regulations (OECD, 1999). On the other hand, the pollution halo hypothesis states that FDI inflow from developed countries which are seen to be more environmentally conscious would bring newer and cleaner technology (OECD, 1999). As such, the impact of FDI inflows on CO_2 emissions remains inconclusive.

3. METHODOLOGY

This study employs the ordinary least squares-based autoregressive distributed lag (ARDL) method to identify the determinants of CO_2 emissions in Malaysia. The ARDL method is the most suitable method for this study as it can produce unbiased results for small sample sizes (Pesaran and Shin, 1999; Pesaran et al., 2001). In addition, a dynamic error correction model (ECM) can be derived from the ARDL method (Banerjee et al., 1993) to estimate the long-run coefficient.

The unrestricted ECM model is formulated as follows:

$$\begin{aligned}\Delta CO_2 = \; & C + \beta_1 RGDP_{t-1} + \beta_2 RGDP_{t-1} + \beta_3 FDI_{t-1} \\ & + \beta_4 VIIT_{t-1} \sum_{i=1}^{p} \alpha_{1i} \Delta CO_{2t-i} + \sum_{i=0}^{p} \alpha_{2i} \Delta RGDP_{t-i} \\ & + \sum_{i=0}^{p} \alpha_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{p} \alpha_{4i} \Delta VIIT_{t-i} + \varepsilon_t\end{aligned} \quad (1)$$

Where,
C = Constant
β = Coefficient
CO_2 = CO_2 emissions in Malaysia
RGDP = Real GDP in Malaysia
FDI = China's FDI outflow to Malaysia
VIIT = The value of vertical intra-industry trade in manufacturing sector
P = Optimum lag length
ε_t = Residual.

All of the variables in the above model are in real and logarithm terms. CO_2 emissions serve as the dependent variable while RGDP (the proxy for economic growth), FDI and VIIT serve as the independent variables. They were selected based on past empirical studies and economic theories, namely the theories of the EKC; the scale effect, the composition effect and the technique effect; and the pollution haven hypothesis and the pollution halo hypothesis. The empirical model was examined using a bounds test by comparing the outcome with Narayan's (2005) critical value to ensure the appropriateness of ARDL method. Thereafter, diagnostic tests were performed to ensure that the empirical model was well specified and fit for estimation. Subsequently, the long-run joint hypothesis was carried out to examine the existence of a long-run cointegration. The equation for the ARDL long-run cointegration model is as follows:

$$CO_{2t} = C + \beta_1 RGDP_t + \beta_2 FDI_t + \beta_3 VIIT_t \quad (2)$$

If a long-run cointegration exists, the long-run coefficients can be estimated based on equation (2).

3.1. Decomposition-type Threshold Method

The decomposition-type threshold method was adopted in this study to compute the VIIT value. This method was developed by Fontagne and Freudenberg (1997) to identify IIT products and to compute various types of IIT including VIIT. Based on the decomposition-type threshold method, the extent of trade overlap in each product of the manufacturing sector will first be identified between Malaysia and China based on the following equation:

$$[\text{Lower value } (Xjt, Mjt)]/[\text{Higher value}(Xjt, Mjt)] \geq 0.1 \quad (3)$$

Where,
Xjt = The exports of product j of the manufacturing sector from Malaysia to China, at period t.
Mjt = The imports of product j of the manufacturing sector from China to Malaysia, at period t.

The trade of the product j is considered as intra-industry if the equation above holds. This is because the existence of concurrent exports and imports is proven if the smaller value of trade (either exports or imports) of the product is 10% or more of its larger value of trade (either exports or imports).

The identified IIT products will be further decomposed into Horizontal IIT and VIIT. Since VIIT involves a substantial gap between the unit values of exports and imports (Fontagne and Freudenberg, 1997; Ito and Okubo, 2011), the unit values of exports and imports for each identified IIT product in the manufacturing sector will be computed by dividing the trade value by the corresponding trade quantity. Thereafter, the equation below is employed to identify the VIIT products.

$$UVXjt/UVMjt>1.25 \quad (4a)$$

$$UVXjt/UVMjt<1/1.25 \quad (4b)$$

Where,
UVXjt = Unit value of product j, which is involved in the IIT, exported from Malaysia to China, at time t.
UVMjt = Unit value of product j, which is involved in the IIT, imported from China to Malaysia, at time t.

The IIT is considered as VIIT if equation (4a) or (4b) holds. Thereafter, the aggregate of the VIIT value between Malaysia and China in the manufacturing sector can be calculated for each year from 1997 to 2014 by adding the export and import values of identified VIIT products. The computed VIIT value serves as one of the independent variables of the empirical model.

3.2. Sources of Data

All data used are annual statistics covering a period of 18 years from 1997 to 2014. The CO_2 emissions and FDI data are derived from the BP Statistical Review of World Energy and China's National Bureau of Statistics while the real GDP is derived from the CEIC database. With respect to the VIIT value, the manufactured goods data of Standard International Trade Classification Revision 3 with 4-digit code are derived from the United Nations Commodity Trade Statistics Database.

4. EMPIRICAL RESULTS AND DISCUSSION

Table 1 exhibits the Bounds test result for long-run cointegration analysis. It is noticeable that the F-statistic is larger than the upper bound of the critical value at the 1% significance level. As a result, it indicates that the ARDL method is appropriate to treat the data and there is a long-run cointegration relationship between the dependent variable (CO_2 emission) and the independent variables (China's FDI outflow to Malaysia and the VIIT between Malaysia and China). To further enhance the reliability of the ARDL estimation, the empirical model was subjected to comprehensive diagnostic tests. The results of the tests are presented in Table 2.

The results from Table 2 confirm that the empirical model is free of serial correlation, heteroskedasticity, normality and stability problems. Furthermore, the result of the Ramsey RESET test indicates that the model is well-specified and therefore is reliable to estimate the long-run coefficient.

From Table 3, the coefficient of the error-correction term, ECT (−1) with −0.7776 and significance at the 5% level indicates that it takes about 1.3 years to correct any disequilibrium between the dependent variable and independent variables. Besides, the results signify that all independent variables, i.e., economic growth, VIIT between Malaysia and China and China's FDI outflow to Malaysia are the determinants of CO_2 emissions in Malaysia.

Consistent with the theory of EKC, and in line with the previous studies such as Mert and Bozdağ (2014); Jalil (2014); Akbostancı et al. (2009); Ang (2008); Aka (2008), the empirical result shows that economic growth plays the most prominent role in CO_2 emissions in Malaysia as the estimated coefficient is positive and the magnitude is the largest among all of the independent variables. The result implies that Malaysia, a developing country, has yet to achieve the turning point of economic growth that results in a positive relationship between economic growth and CO_2 emissions.

Nonetheless, the estimated coefficient for VIIT is also positive and statistically significant at the 5% level. As the nature of VIIT

Table 1: Bounds test for long-run cointegration analysis

Model	F-statistics	
Model 1: CO_2=f (RGDP, FDI, VIIT)	6.5212***	
Nayaran (2005)	K=3, n=16	
Critical value	**Lower bound**	**Upper bound**
1%	3.65	4.66
5%	2.79	3.67

***Denote significance at 5 1% levels. Critical values are obtained from Narayan (2005).

Table 2: Diagnostic tests

Diagnostic tests	F-statistics (P value)
JB	0.3478 (0.8404)
AR[2]	1.1871 (0.2759)
ARCH[1]	1.0041 (0.3163)
RESET[1]	0.3293 (0.6063)
CUSUM	Stable
$CUSUM^2$	Stable

JB is the Jarque-Bera statistic for residuals normality test. AR is the Lagrange Multiplier test of serial correlation. ARCH and RESET refer to ARCH Heteroskedasticity test and Ramsey RESET specification test. Figures in parentheses are the P values. Asterisks (**) indicate statistically significant at the 5% level

Table 3: Estimated long-run elasticities using the ARDL approach

ARDL (2,2,2,1)				
Variable	**Coefficient**	**Standard error**	**t-statistic**	**P value**
LRGDP	0.2073**	0.0467	4.4377	0.0114
LFDI	0.1212**	0.0354	3.4287	0.0266
LVIIT	0.1752**	0.0222	7.8891	0.0014
C	3.6657	0.5007	7.3206	0.0019
ECT (−1)	−0.7776**	0.1042	−7.4593	0.0017

Asterisks **indicate statistically significant at 5% level. A dummy variable was added to capture the structural break for the year 2007 due to the oil price shock effect, ARDL: Autoregressive distributed lag involves production fragmentation, it is involved in the industrial sector and results in higher CO_2 emissions (Keho, 2015; Mahmood and Chaudhary, 2012). Also, the positive coefficient implies that VIIT between the two nations brings the scale effect and the composition effect to Malaysia but not the technique effect.

Lastly, the positive and significant coefficient of FDI at the 5% level indicates that the home country has not brought newer and cleaner technology to the host country at this point in time which supports the pollution haven hypothesis (OECD, 1999) and is consistent with the findings of Peng et al. (2016), Gökmenoğlu and Taspinar (2015), Mahmood and Chaudhary (2012), Ren et al. (2014) and Acharyya (2009).

5. CONCLUSION

This study aims to identify the determinants of CO_2 emissions in Malaysia to enhance sustainable economic growth without a deterioration in environmental quality. Given that economic growth has emerged as the most influential determinant of CO_2 emissions, the policy makers of Malaysia should adopt new strategies to promote economic growth. Based on OECD (2011), green growth which fosters economic growth while preserving the resources and environment should be highly encouraged.

In fact, many efforts have been put in place by the Malaysian government to achieve the objectives of the green growth strategy. Green technology in Malaysia has been identified as a driver to improve the national economy and to promote sustainable development (Ministry of Energy, Green Technology and Water, 2012). If the green growth strategy is implemented successfully, it is believed that the economic growth of Malaysia will be further uplifted and the impact of economic growth, VIIT and FDI on CO_2 emissions will be reversed and therefore, Malaysia would be able to enjoy high income and the benefits of the technique effect from VIIT and FDI. In light of the importance of the green growth strategy, the Malaysian government should monitor its implementation closely.

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