THE NEXUS BETWEEN MACROECONOMICS VARIABLES AND THE CO_2 EMISSIONS: EMPIRICAL EVIDENCE FROM MALAYSIAN ROAD TRANSPORT SECTOR

Nur Zaimah Ubaidillah
Universiti Malaysia Sarawak
Lecturer
E-mail: unzaimah@feb.unimas.my

Rossazana Ab. Rahim
Universiti Malaysia Sarawak
Senior Lecturer
E-mail: arrossazana@feb.unimas.my

Farhana Ismail
Universiti Malaysia Sarawak
Lecturer
E-mail: ifarhana@feb.unimas.my

Abstract

In the present paper, an attempt is made to examine the nexus between the macroeconomic variables and the CO_2 emissions from road transport sector in Malaysia. Using vector error correction model during 1980 to 2009 period, the empirical results show that there is an evidence of a long-run relationship among the variables. The findings of this research also indicate that a bi-directional relationship exist between the number of vehicles and CO_2 emission in the short-run.

Key Words: *Real GDP, Population, CO_2 emissions, Oil Price*

JEL Classification: Q53

1. INTRODUCTION

Over the past few decades, the debate on the relationship between environmental degradation with trade liberalization and economic growth has ignited significant studies (Condoo and Dinda, 2002; Frankel and Rose, 2002; Liu, 2006; Choi, Heshmati and Cho, 2010). Majority of previous studies tend to employ the country-based approach in their empirical research. For that reason, this study examines the macroeconomic factors affecting Carbon Dioxide (CO_2) emission in Malaysia road transport sector. As Malaysia is shifting from manufacturing to

service based economy, the process of globalization and rapid economic progress has led to increasing demand for transportation. Growing demand on transport encourages the combustion of fossil fuels emitting a range of greenhouse gases (GHG) which includes CO_2, methane (CH_4) and nitrous oxide (N_2O). According to Safaai, Noor, Hashim, Ujang and Talib (2010), among the six GHGs which causes global warming potential, CO_2 is the most important one as the atmospheric concentration increases due to human activities. This has led to 70 per cent contributed by CO_2, 24 per cent contributed by CH_4 while 6 per cent contributed by N_2O towards the GHG effects.

In a report by International Energy Agency (IEA) and Organization for Economic Co-operation and Development (OECD, 2009), transport accounts for about 19 per cent of global energy use and 23 per cent of energy related CO_2 emission and is more likely to increase 50 per cent by 2030 and more than 80 per cent by 2050. According to International Protocol for Climate Change (IPCC, 2005), the processes and feedbacks for climatic system could be affected as a result of the increment in GHG concentrations. A rise in atmospheric GHG concentrations would lead to average temperature increment for the surface-troposphere system. It is noted that as the most essential anthropogenic GHG, the ascend of CO_2 emissions due to fossil fuel burning could be the major contributor in affecting the atmospheric concentrations which would result in the rise of worldwide temperature and sea level. It is also interesting to note that Malaysia is one of the top thirty emitters with 73 per cent increment from 1994 to 2004 (World Bank, 2007); thus, it motivates this study to be undertaken.

1.1. Malaysia Motorization Trends and Challenges

Being a small open economy, Malaysia has been well endowed by tremendous macroeconomics performance for the past few decades. Amidst the 1997 economic crisis, Malaysia steadfastly survives the turbulence without resorting to aids by the International Monetary Fund (IMF). With over 27 million populations to date, along with the economic expansion of 46.46 per cent growth in real Gross Domestic Product (RGDP) from 2000 to 2009, Malaysia continue to prosper with rising standard of living with the increase in purchasing power parity of 107.45 per cent from 2000 to 2010. This has triggered Malaysia to a higher degree of urbanization and motorization leading to greater travel demand. According to the Ministry of Transport Malaysia (2012), the total number of registered road vehicles rises for 274.95 per cent from 1980 to 2009.

Interestingly, in the case of Malaysia, the major share of fleet is contributed by passenger cars and motorcycles with a share of 44.73 per cent and 47.01 per cent

respectively. Public transport in Malaysia however does not indicate any significant share in the total number of vehicles registered. The growing number of private transport predominantly passenger cars has shown growing concern on its impact on transportation issues in particular road congestion, demand for fuel and air pollution. As a highly subsidized country, Malaysian total subsidy of petroleum product substantially increases by 133.24 per cent from 2001 to 2009 with its highest peak value of USD 4,618 million in 2008 alone. (Ministry of Finance Malaysia, 2010) The transport fuel types in Malaysia initially consist of RON97, RON92 and diesel. However, in 2009 the usage of RON92 is replaced with unleaded RON95. Based on a gradual subsidy rationalization programme, effective from 2010, subsidies for fuel in particular petrol, diesel and liquefied petroleum gas (LPG) is reduced in which RON97 is no longer subsidized and determined by the automatic pricing mechanism. Nonetheless, aside from reducing government expenditure, this could also increase the awareness for better fuel efficient vehicles and greener technology which can assist in reducing the anthropogenic pollution.

Table 1 shows the CO_2 emissions from fuel combustion in Malaysia based on total final use in 1994 and 2000. The total of CO_2 emissions increase tremendously from 1990 to 2000 with over 198.73 per cent. In 1994, the main contributors for CO_2 emissions are Transportation and Industrial sector. However, in 2000, the percentage shares shifted to Energy Industries, Transportation and Industrial sector. Apparently, although a decline in percentage shares in total CO_2 emissions occur in transportation sector, the CO_2 emissions increase from 1994 to 2000 for 48 per cent. This indicates that despite the drop in total shares, transportation sector CO_2 emissions continuously increase within the six-year period of time. From this perspective, it is essential to gauge the factors affecting CO_2 emission from transport sector in order to construct a mitigating policy framework due to the anthropogenic sources of environmental degradation. As a country that experience substantial growth in its development, proper management of environment is crucial to ensure environmental sustainability persist in the long run.

Table 1: CO_2 Emissions from Fuel Combustion in Malaysia Based on Total Final Use

Source of Data	INC		NC2		
Year	1994		2000		Changes
Sectors	CO_2 emissions (Gg)	Shares	CO_2 emissions (Gg)	Shares	
Residential	&3,014	7%	3,947	3%	933(24%)
Commercial					
Industrial	18,083	41%	28,855	22%	10,722 (37%)
Transportation	21,375	49%	41,008	31%	19,633 (48%)
Agriculture	1,296	3%	917	1%	-379 (-41%)
Energy Industries and Others	n/a	-	56,019	43%	-
Total	43,768	100%	130,746	100%	86,978 (199%)

Note: Source: INC (Initial National Communication): MOSTE, 2000; NC2 (Second National Communication): Azman *et. al*., (2000). *n/a: not available. In the INC, energy industries were excluded from the CO_2 emission calculation.

In this sense, Malaysia is still facing difficulties as the current transport is heavily biased towards private motor transport with insufficient alternatives to public transport. According to the Ministry of Housing and Local Government (2006), the inefficient public transportation leads to the tendency for the urban population to opt for private vehicles instead of the public transport. Furthermore, the car-based transport system consumes more non-renewable energy and emits more compared to public transportation.[1] To date, the ratification of Kyoto Protocol in 2002 has provided a platform for Malaysia in dealing closely with issues pertain to climate change. As a non-Annex 1 country, Malaysia is only involved in the Clean Mechanism Development (CMD) under Article 12 of Kyoto Protocol which purposes include helping Annex 1 countries to achieve their emission reduction targets and assisting non-Annex 1 countries to promote sustainable development in their economies. At present, Malaysia is implementing the Euro 2 equivalent vehicle emission standards in which the level of sulphur content is reduced from 3,000 parts per meter (ppm) to 500 ppm. The implementation of sulphur reductions in fuel will gradually assist in ensuring significant reductions of CO_2 emissions can be made as at high level, sulphur can reduce the effectiveness of advanced catalytic converter for gasoline vehicles and clog particulate filters in diesel vehicles. The rest of the paper is organized as follows: Section 2 describes the literature reviews. Section 3 describes the data and methodology for Malaysia

[1] Refer to National Economic Advisory Council (2010) on Malaysia's New Economic Model (NEM).

CO_2 emission from transport sector. Section 4 presents the empirical results for this research. Finally, Section 5 presents some concluding remarks.

2. LITERATURE REVIEW

An array of studies embodies the research on CO_2 emission and macroeconomic variables whereby majority of it concentrates on the relationship between pollutant emission and economic growth and trade openness. For example, Puzon (2012) conducted the Granger causality test to access the direction of causal relationship between sulphur emissions and economic growth using the data from 1950-2000. Their work proved that there is unidirectional causality running from sulphur emissions to Gross Domestic Product (GDP) in the Philippines. Zhao and Zhan (2012) studied on the cointegrating analysis of GDP, energy consumption and CO_2 emission in Shanghai from 1993 to 2009. Using Vector Error Correction Model (VECM), they found that a unidirectional relationship exist between economic growth and CO_2 emission in the long run. However, they also found no significant causal relationship from CO_2 to economic growth in both short run and long run.

Farhani and Rejeb (2012) considered fifteen MENA countries to examine the relationship between energy economics (EC), GDP and CO_2 emissions, covering annual period 1973 to 2008. Using panel causality test, panel fully modified ordinary least square (FMOLS) and panel dynamic ordinary least square (DOL), the finding of their study reveals that there is no causal relationship in the short run between GDP and EC and CO_2 and EC. They found that a unidirectional causality runs from GDP and CO_2 to EC in the long run. Granados, Ionides and Corpintero (2011), using annual time series data from 1958 to 2009, investigated the causal relationship between atmospheric CO_2, population and world economic output. They found that there was a causality running from population and world economic output to CO_2. Their results suggest that in a business-as-usual scenario, at a present world population of 7 billion, a 24.5 per cent contraction of global economy could reduce the CO_2 atmospheric levels.

Shahbaz (2012) used Zivot-Andrews unit root test, ARDL bounds and VECM granger causality approach to investigate the relationship between economic growth, energy intensity, financial development and CO_2 emissions. Using annual time-series data from 1971-2009, he found that while economic growth and energy intensity increase the CO_2 emissions, financial development has proven to condense it. Bengochea-Morancho, Higon-Tamarit and Martinez-Zarzoso (2001) examined the relationship between the CO_2 emissions and economic growth in the European Union. Using a panel data analysis for the period 1981 to 1995 in ten

selected European countries. Bengochea-Morancho et. al found different behaviour between countries with a level of income above EU average and those with a below average level of income. They indicated that the emissions in above-average income countries are higher than emissions in below-average income countries, independent of their income level.

While previous researches tend to identify the relationship between CO_2 emissions and growth or trade liberalization, this research on the other hand, tend to focus on the relationship between the macroeconomic variables and CO_2 emissions. This research departs from existing studies by concentrating on the sectoral approach in which transportation sector is taken as the main idea of the study.

3. Data and Methodology

3.1. Data Description

Annual time series data on Malaysia CO_2 emissions from transport, Real GDP (RGDP), population (PO), number of vehicles (VEH) and oil price (OILP) over the period 1980-2009 are utilized to identify the determinants. RGDP, PO, VEH and OILP are used in this research as these are the standard macroeconomic variables that reflect the emission in the road transport sector. The data on Malaysia CO_2 emissions from transport is acquired from OECD (Organization for Economic Co-operation and Development, 2009) and is in million metric tons. The data on Real GDP for Malaysia is acquired from the IMF's International Financial System 2011 (IFS) and is in US million dollars. The population and number of registered vehicles data are obtained from Department of Statistics, Malaysia (2011). The Malaysia petrol price is obtained from the Ministry of Domestic Trade, Co-Operatives and Consumerism (2012) based on the RON97 values in US dollars.[2] Each of these data will be transformed to natural logarithm.

3.2. Methodology

Based on the concept of cointegration, it is stated that in the existence of long-run relationship between two variables, the deviations from the long-run equilibrium path is bounded. In this research, Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests are utilized in order to determine unit root in the series. Johansen-Juselius multivariate test (1990) is applied to test for the cointegration whereas for a cointegrated model, Vector Error Correction Model (VECM) is applied to test Granger Causality.

[2] Oil price is represented by RON97 as it reflects the price of oil for end user in transportation sector.

4. Results and Discussion

4.1. Unit Root and Cointegration test

Table 2 presents the ADF and PP test at level and first differences. The two tests show that all the series contain a unit root at level 5 per cent significance level. As may be observed, at 5 per cent significance level at first difference, all series are found to be stationary for ADF. However, for PP test, all series are found to be stationary at first difference and 5 per cent significance level except for PO. The Johansen-Juselius cointegration test is conducted to evaluate whether the series are cointegrated. Engle and Granger (1987) pointed out that the presence of cointegration rules out non causality among the variables. Based on the results from table 3, the trace statistics suggest the presence of two cointegrating vector while max-eigen statistics indicates a presence of one cointegrating vector in the system. This results show that long run relationship exist between CO_2 emission and the macroeconomics variables.

Table 2: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test Results For Series In First Difference

	Augmented Dickey-Fuller		Phillips-Perron	
Variables	Level	First Difference	Level	First Difference
CO_2	-0.2586 (1)	-8.0431 (0)*	-1.3953 (3)	-8.0431 (0)*
RGDP	-0.9660 (0)	-3.8419 (0)*	-1.2266 (2)	-3.8654 (1)*
PO	0.0259 (8)	-4.6259 (1)*	3.5011 (3)	-2.2690 (2)
VEH	-2.0949 (0)	-5.0797 (0)*	-2.3604 (2)	-5.1221 (3)*
OILP	-2.1680 (0)	-7.3884 (0)*	-2.0337 (1)	-7.3195 (2)*

*Notes: Significance at the 5% level.

Table 3: Johansen-Juselius Multivariate Cointegration Test Results

H_0:	H_1:	Trace Statistic	Critical Value (1%)	Max-Eigen Statistic	Critical Value (1%)
r=0	r=1	116.3640*	76.07	61.5402*	38.77
r≤1	r=2	54.8238*	54.46	23.7175	32.24
r≤2	r=3	31.1063	35.65	17.5893	25.52
r≤3	r=4	13.5170	20.04	9.7434	18.63
r≤4	r=5	3.7736	6.65	3.7736	6.65

Notes: (*) denotes rejection of the hypothesis at the 1%. The letter "r" represents the number of co-integrating equations. The 1% critical values are based on Osterwald-Lenum (1992).

4.2. Vector Error Correction Model Estimates

The direction of causality can be further explained by the VECM test. From the results, it is found that VEH is endogenous in the equilibrium system. Hence, this implies that VEH solely bear the brunt of short run adjustment to bring about the long run equilibrium. The speed of adjustment as measured by the Error Correction Term (ECT) coefficient of 67.83 per cent that requires approximately one year to adjust to the long run equilibrium. However, it appears that in the short run, bi-directional causality exists between VEH to CO_2. Thus this indicates that CO_2 emissions are impacted by the number of vehicles in the short run.

Table 4: Vector Error-Correction Model (VECM)

Note: The values in parentheses are chi-square. In the table, *shows that coefficients are significant at 5% level.

Independent Variable						
Dependent variable	ΔCO_2	ΔRGDP	ΔPO	ΔVEH	ΔOILP	ECT
ΔCO_2	-	-0.0659	-19.6756	0.4625*	0.1244	-1.1626
		(-0.1911)	(-0.7712)	(2.6740)	(0.5225)	(-3.3761)
ΔRGDP	-0.1195	-	23.3237	-0.0201	0.0484	-0.3385
	(0.6996)		(1.2651)	(-0.1606)	(0.2840)	(-1.3601)
ΔPO	-0.0011	0.0012	-	0.0010	-0.0002	-0.0022
	(-1.1103)	(0.8253)		(1.4154)	(-0.2134)	(1.5313)
ΔVEH	0.7760*	-0.0887	16.6053	-	0.1059	-0.6783*
	(3.3322)	(-0.2608)	(0.6608)		(0.4516)	(-1.9995)
ΔOILP	0.6597	0.1262	34.0794	-0.2731	-	-1.3267
	(1.6909)	(0.2216)	(0.8096)	(-0.9569)		(-2.3348)

5. Conclusions

This paper provides insights on the relationship between the macroeconomic variables and the CO_2 emission from the transport sector in Malaysia. It is noted that this study is crucial as it proves the existence of the long run relationship between the macroeconomic variables and the CO_2 emissions in which VEH is found to be the endogenous variable in the model. Moreover, the short-run dynamics indicate that the causality runs in both directions between VEH and CO_2. In order to transform and facilitate Malaysia in becoming a high income country, it is important to deal with the increasing threat of global climate change particularly in transport sector. A sustainable transport is fundamental whereby the transport policy in Malaysia should integrate with the environmental policy in which the negative externalities can be more properly regulated through some sets of accepted standards. Under the revised National Policy (2009), the Malaysian government has imposed a 100 per cent exemption on import duties and 50 per

cent on excise duties for new hybrid cars with engine capacity below 2,000 c.c. Indeed, this action could assist in providing an incentive for the society to purchase vehicles which is more environmentally efficient. In addition, government should implement better public transportation infrastructure to reduce the dependency on private based vehicles in the long run.

Acknowledgement:

Financial support from Universiti Malaysia Sarawak (UNIMAS) through Research Grant [UNIMAS/TNC (PI)-04/09-01/05/01 Jld 3] is gratefully acknowledged. All remaining flaws are the responsibilities of the authors.

References

Azman Zainal Abidin, Siti Indati Mustapa, Radin Diana Radinahmad and Komathi Mariyappan. 2006. Development of the Greenhouse Gas (GHG) Inventory for the Energy Sector in Malaysia. G*reenhouse Gas Inventory Development in Asia – Experience from workshops on greenhouse gas inventories in Asia*, 48-53.

Bengochea-Morancho, A., Higon-Tamarit, F., and Martinez-Zarzoso, I. (2001). Economic Growth and CO2 Emissions in the European Union. *Environmental & Resource Economics* 19 (2), 165-172.

Choi, E., Heshmati, A., and Cho, Y. (2010). An Empirical Study of the Relationships between CO2 Emissions, Economic Growth and Openness. IZA Discussion Papers 5304, Institute for the Study of Labor (IZA).

Coondoo, D. and Dinda, S. (2006). Causality between Income and Emission: A Country Group-Specific Econometric Analysis, *Ecological Economics*, 40, 351-367.

Department of Statistics (2012). Malaysia.

Farhani, S. and Rejeb, J. B. (2012). Energy Consumption, Economic Growth and CO2 Emissions: Evidence from Panel Data for MENA Region, International Journal of Energy Economics and Policy*, Econjournals*, 2(2), 71-81.

Frankel, J.A., and Rose, A. K. (2002). Is Trade Good or Bad for the Environment? Sorting Out the Causality. NBER Working Paper No. 9201, Cambridge.

Granados, J., Ionides, E., and Corpintero, O. (2011). Long-run determinants of atmospheric CO2: Granger-causality and cointegration analysis. Institute for Social Research. http://hdl.handle.net/2027.42/8862 [Accessed 1 May 2012]

IEA and OECD (2009). Transport, Energy and CO_2. France.

International Monetary Fund. International Financial System (2011)

International Protocol on Climate Change (2005).

Kyoto Protocol (2002). Clean Design Mechanism (CDM).

Liu, G. (2006). A Causality Analysis on GDP and Air Emissions in Norway, Discussion Paper No. 447, Statistics Norway, Research Department.
Ministry of Transport (2012). Malaysia.
Ministry of Finance (2012). Malaysia.
Ministry of Domestic Trade, Co-operatives and Consumerism (2012). Malaysia.
MOSTE. (2000). Malaysia Initial National Communication. Kuala Lumpur: Ministry of Science, Technology and the Environment, Malaysia.

National Economic Advisory Council (2010). Malaysia's New Economic Model (NEM).

Puzon, K. (2012). Sulfur Emissions and Economic Growth in the Philippines: A Bivariate Cusality and Cointegration Analysis. Asian Journal of Business and Governance, 2, 112-124.
National Policy (2009). Malaysia.
Organization for Economic Co-operation and Development (2009).
Safaai, N. S. M., Noor, Z. Z., Hashim, H., Ujang, Z. And Talib, J. (2011). Projections of CO2 Emissions in Malaysia. Environmental Progress and Sustainable Energy, 30 (4), 658-665.
Shahbaz, M. (2012). Multivariate granger causality between CO2 Emissions, energy intensity, financial development and economic growth: evidence from Portugal. MPRA Paper 37774, University Library of Munich, Germany, revised 31 Mar 2012.
World Bank (2007 & 2012).
Zhao, W., and Zhan, Z. (2012). An Empirical Study of Relationship between Economic Growth and CO_2 Emission of Shanghai. *Advanced of Materials Research*, 347-357, 329-333