Does Financial Development Reduce CO2 Emissions in Malaysian Economy? A Time Series Analysis

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1 August 2012

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Abstract: This study deals with the question whether financial development reduces CO_2 emissions or not in case of Malaysia. For this purpose, we apply the bounds testing approach to cointegration for long run relations between the variables. The study uses annual time series data over the period 1971-2008. Ng-Perron stationarity test is applied to test the unit root properties of the series.

Our results validate the presence of cointegration between CO_2 emissions, financial development, energy consumption and economic growth. The empirical evidence also indicates that financial development reduces CO_2 emissions. Energy consumption and economic growth add in CO_2 emissions. The Granger causality analysis reveals the feedback hypothesis between financial development and CO_2 emissions, energy consumption and CO_2 emissions and, between CO_2 emissions and economic growth. The present study provides new sights for policy making authorities to use financial sector as an instrument to decline energy emissions.

Keywords: Financial development, CO_2 emissions, Cointegration

Introduction

Since the 1960s, there has been upsurge in the awareness of environmental degradation and its increasingly harmful impacts on climate change among the environment activists, economists and policy makers at national and international levels. Many countries have subsequently proposed policies and regulations to address environmental degradation in the pursuit of economic development. In Malaysia, the Environmental Quality Act, 1974 was instituted to ensure that the environment is safe, healthy, clean and productive. The government further introduced Environmental Quality Order of 1987 to lessen the air degradation attributed to some specific industrial development projects in Malaysia. In addition to ratifying the Kyoto Protocol on 4 September, 2004, thirty five sets of regulations and orders have been introduced, and enforced by the authorities in charge of Malaysian environment, since 1974 (MNREM, 2007).

In spite of the government's efforts, air quality caused by emissions has deteriorated since 1970s in Malaysia. Records show CO_2 emissions per capita was 1.583 metric tons in 1974, when the Environmental Quality Act came into force. The figure skipped to 3.108 metric tons in 1990 and further increased to 7.572 metric tons in 2008, implying more than 470 percent rise since the inception of Act in 1974. Gaseous, liquid and solid fuel consumptions account for an average of over 80 percent in Malaysia. Within these periods, economic activity and the resulting energy usage grew drastically. For example, real gross domestic product (RGDP) per capita increased from USD839.846 in 1974 to USD5077.938 in 2008. Energy use in the economy rose from 6758.357 (kg of oil equivalent) in the year 1974 to 73023.528 (kg of oil equivalent) in 2008 (World Bank, 2012). Similar to the situation in other countries, this has led to the belief that economic activity and energy usage are the actual drivers of environmental pollution in

Malaysia. However, in reality, there may be several factors which if not taken into account may lead to policy failures.

Attempts have been made in the literature to determine the connection between economic activity and environmental quality. Some studies document that higher economic growth is associated with higher environmental pollution because growth leads to more consumption and production activities to fulfil societal needs, thus triggering more pollution waste and more burden on ecological resources (see Georgescu-Roegen, 1971; Daly, 1991, 1995). Conversely, other researchers have shown that distant from being a risk to the lasting environmental quality, economic activity seems as germane in maintaining and improving the environment (Meadows et al. 1992), which aligns with the World Bank emphasis on the "win-win" type situation where higher growth is achieved with clean environment. Still, works such as Panayotou, (1997) documented that level of economic growth does not matters for environmental degradation but instead what matters are policies and institutions.

Even though the impact of economic activity on emissions in a bivariate setting is still unresolved in the literature, the nexus took a new twist with the introduction of additional variable(s). In this regards, it is believed that additional variable(s) may help explain the complexities surrounding the relationship between economic activity and environment. Inclusion of energy consumption in the environmental pollution and economic growth is now commonplace in the literature (see Kolstad and Krautkraemer, 1993 and Ang, 2007). Particularly, Kolstad and Krautkraemer (1993) suggest a dynamic link among, resource usage, environment and economic growth in which energy consumption has immediate impact on the economic growth while its influence on environment can be recognised in long run. Researches, including Ang (2008) and Lean and Smyth (2010) controls for energy consumption in Malaysia.

Beyond the aforementioned factors, financial sector may also influence energy emissions as on one hand, it may stimulate technological progress in the energy sector aimed to reduce emissions and conversely, financial sector promotes CO_2 emissions through the aiding of manufacturing activities (Jensen, 1996). Financial development may generally boost research and development (R & D) activities and sequentially improve economic activities, and hence, influence environmental quality (Frankel and Romer, 1999). Such flows of causation probably exist in developing countries (Frankel and Rose, 2002) and specifically in Malaysia (Ang, 2008). Therefore, exclusion of financial development in growth-emissions nexus may lead to omission of an important variable in the regression. Hence, in the present study, we consider the financial development as another likely contributing factor to environmental performance for Malaysian case. Against this backdrop, the present study is intended to analyse the static and dynamic relationship among the CO_2 emissions, energy consumption, economic growth and financial development.

The remainder of the paper is prepared as follows. Section-II deals with prior literature. Section-III concentrates on econometric modeling and estimation techniques as well as data collection. Empirical findings are described in Section-IV, in while section-V contains conclusions and policy recommendations.

II. Literature review

There are numerous scholarships that have examined the "inverted-U shaped" link (popularly called Environmental Kuznets Curve (EKC)) between economic growth and environmental degradation. In the line of Grossman and Krueger (1995), Selden and Song (1994) show economic growth Granger causes environmental degradation in the early phase of development and, after a threshold level of development; economic activity triggers improvement of the environs, probably due to environmental awareness. The studies which have also tested the existence of EKC are Ekins (1997), Stern (2004), Heil and Selden (1999), Dinda (2004), Dinda and Coondoo (2006), Managi and Jena (2008), Coondoo and Dinda (2008) and Shahbaz et al. (2012) among others. However, there are no consensus in these studies in terms of sign, magnitude and significance of the coefficients. Further, there has been problem of country specific heterogeneity particularly in case of panel data studies. Therefore, some studies have focused on time series techniques to test the EKC in order to take care of country specific heterogeneity.

Following Grossman and Krueger, (1995) very recently some studies have analysed the role of financial development on environmental performance. For example, Claessens and Feijen (2007), Halicioglu (2009), Tamazian et al. (2009), Tamazian and Rao (2010) suggested that development of financial sector is likely to confer superior financial services for eco-friendly programs at decreased costs and hence reduces energy pollutants. Recently, Tamazian et al. (2009) opined that an effective financial sector is likely to offer greater funding at lesser charges (which is equally valid for environmental projects too) by establishing a link between financial development and environmental degradation. Besides, Tamazian and Rao (2010) documented that since environmental projects are considered to be the non-private sector responsibility, the ability of getting financing for such purposes have vital relevance for authorities at the national, state and local platforms. Hence, the financial services may be mobilized by financial institutions for investment in the eco-friendly related projects. Furthermore, it is documented that through good governance practices, financial development improves emission management (Claessens and Feijen, 2007). Further, Kumbaroglu et al. (2008) documented that financial assistance and its consequent technological investments are unavoidable for steady evolution of the energy sector. Similarly, Tadesse (2005) documented that improvement of the financial system prompts technological innovations (which acts propels productivity and hence economic growth) through risk sharing and easing capital mobilization.

Focusing on another dimension, Claessens and Feijen (2007) argued that involving in the practices of carbon trading activities, the presence of a well-functioning financial sector is essential as it is a device that offers the inducement to alleviate the emission of environmental harmful gases. Dasgupta et al. (2001) noted that the environmental regulators in emerging nations may initiate projects directly linked with capital markets and frequently published report on the environmental successes of the companies. Similarly, Lanoie et al. (1998) also argued that the policy makers impose the release of periodic bulletin of environmental achievements of companies to the financial systems and to the public at large, which will force firms to operate more environmental friendly. Hence a well-functioning financial system will help in mitigating CO_2 emissions (Tamazian et al. 2009). However, as pointed out by Rojas-Suarez and Weisbord (1995), the role of capital market in developing countries is relatively small vis-a-vis other financial sectors' segment like banking sector. Therefore, capital sector may not play vital role in developing economies.

III. Econometeric Modeling and Estimation Techniques

The aim of this study is to evaluate the relationship of financial development, energy consumption and economic growth with CO_2 emissions in case of Malaysia. In doing so, various approaches are applied to test the economic growth, CO_2 emissions and natural resources relationship, lined with previous literatures. For example, Jorgenson and Wilcoxen (1993) used aggregate growth model under equilibrium framework to inspect the links between environment pollutants, energy consumption and economic development. Recently, Ang (2007, 2008), Soytas et al. (2007), Halicioglu (2009), Jalil and Mahmud (2009), and latter on, Shahbaz et al. (2012) applied single equation model to explore the relationship between economic growth, energy consumption and CO_2 emissions.

Latter on, Talukdar and Meisner (2001), Tamazian et al. (2009) and Jalil and Feridun (2010) augmented single equation model by incorporating financial development as a potential determinant of CO_2 emissions. Following these studies, we use financial development, economic growth, energy consumption and CO_2 emissions within a multivariate framework in case of Malaysia. All the series are transform into natural logarithm to attain reliable and consistent results (Shahbaz et al. 2012). The estimable equation is modeled as following:

$$CO_{2t} = f(F_t, E_t, Y_t) \qquad (1)$$

$$\ln CO_{2t} = \beta_1 + \beta_F \ln F_t + \beta_E \ln E_t + \beta_Y \ln Y_t + \varepsilon_t \qquad (2)$$

Foreign direct investment (FI_t) is included in the model to capture the impact of foreign capital on CO_2 emissions. Malaysia is an attractive place for foreigners to make investment. With sound domestic financial sector, foreign direct investment may act as conduits against environmental degradation by adopting advanced, cleaner and environment friendly techniques (Talukdar and Meisner, 2001). The empirical equation is modeled as following:

$$\ln CO_{2t} = \delta_\circ + \delta_F \ln F_t + \delta_E \ln E_t + \delta_Y \ln Y_t + \delta_{FI} \ln FI_t + \varepsilon_t \qquad (3)$$

We have also included squared term of financial development i.e. $\ln F_t^2$ to check whether nonlinear reationship between financal development and CO_2 emissions is inverted U-shaped or not. The logic behind this argument is that financial sector cares less about environment at initial stages of growth, and once economy is matured then developed financial sector improves environmental quality by issuing loans to environmentally friendly projects to sustain domestic production and hence economic growth. The empirical equation is formulated as following:

$$\ln CO_{2t} = \alpha_\circ + \alpha_F \ln F_t + \alpha_{F^2} \ln F_t^2 + \alpha_E \ln E_t + \alpha_Y \ln Y_t + \alpha_{TR} \ln TR_t + \varepsilon_t \qquad (4)$$

Where, CO_{2t} is energy emission per capita, F_t is financial development proxies by domestic credit to private sector per capita, E_t is energy consumption per capita and Y_t is real GDP per capita, FI_t is foreign direct investment per capita and TR_t is for trade i.e. exports + imports per capita. It is expected that financial development reduces CO_2 emissions through research and development enhancing effect due to economic growth. It implies that the sign of $\alpha_F < 0$ if $\alpha_{F^2} = 0$. The inverted U-shaped relationship between financial development and CO_2 exists if $\alpha_F > 0$ while $\alpha_{F^2} < 0$. The economic activity is stimulated by energy consumption that resultantly increases CO_2 emissions. This leads us to expect $\alpha_E > 0$ and $\alpha_Y > 0$. Halicioglu (2009) claimed that $\alpha_{TR} < 0$ if industries of emerging economies are engaged in heavy production with less share of CO_2 emissions and vice versa. Foreign direct investment is environment friendly if $\delta_{FI} < 0$ and vice versa.

To establish long run link in the variables, we employ the ARDL bounds testing procedure (Pesaran et al. 2001). The bounds testing approach has several advantages. The major merit lies in the fact that, unlike other widely used cointegration techniques, it can be applied irrespective of the order of integration, I(0) or I(1). Besides, a dynamic error correction model (ECM) can be computed from the ARDL specification via a simple linear transformation. The unrestricted form of error correction model of ARDL method is given below:

$$\begin{aligned}\Delta \ln CO_{2t} &= \alpha_\circ + \alpha_1 T + \sum_{i=1}^{p} \beta_i \Delta \ln CO_{2,t-i} + \sum_{i=1}^{p} \delta_i \Delta \ln F_{t-i} + \sum_{i=1}^{p} \varepsilon_t \Delta \ln Y_{t-i} + \sum_{i=1}^{P} \sigma_i \Delta \ln E_{t-i} \\ &\quad + \lambda_{CO2t} \ln CO_{2,t-1} + \lambda_F \ln F_{t-1} + \lambda_Y \ln Y_{t-1} + \lambda_E \ln E_{t-1} + \mu_t\end{aligned} \tag{5}$$

In equation-5, $\beta, \delta, \varepsilon$ and σ refer to the short run parameters and $\lambda_{CO2}, \lambda_{FD}, \lambda_Y, \lambda_E$ to the long run relation. The null of no cointegration implies $H_0 : \lambda_{CO2} = \lambda_F = \lambda_Y = \lambda_E = 0$. The rejection of the null $H_a : \lambda_{CO2} \neq \lambda_F \neq \lambda_Y \neq \lambda_E \neq 0$ suggests existence of cointegration. The decision about cointegration is based on the calculated F-statistics. The critical bounds have been computed by Pesaran et al. (2001). The upper critical bound (UCB) assumes that all the variables are I(1). The lower critical bounds (LCB) assumes all the variables are I(0). If UCB is lower than the calculated F-statistic, the decision is in support of cointegration; i.e., the series relates in the long run. If the F-statistic is less than the LCB then there is no cointegration. The decision about cointegration is inconclusive if the F-statistic lies between LCB and UCB. In such situation, we will have to depend on on the lagged error correction term to examine long run connection. Finally, sensitivity analysis is also conducted to check problems associated with the short run model.

Causal link among the series is examined by applying the Granger procedure within the VECM. Existence of cointegration implies the existence of causal link in at least one direction. Engle-Granger (1987) cautioned against using the Granger causality test in first difference through vector auto regression (VAR) method due to the possibility of misleading results in the presence of cointegration. The inclusion of an error-correction term helps to capture the long run relationship. The Granger causality test is augmented by an error-correction term which is formulated as a bi-variate p^{th} order vector error-correction model (VECM) as follows:

$$\begin{bmatrix} \Delta \ln CO2_t \\ \Delta \ln F_t \\ \Delta \ln Y_t \\ \Delta \ln E_t \end{bmatrix} = \begin{bmatrix} k_1 \\ k_2 \\ k_3 \\ k_4 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} d_{11}(L) & d_{12}(L) & d_{13}(L) & d_{14}(L) \\ d_{21}(L) & d_{22}(L) & d_{23}(L) & d_{24}(L) \\ d_{31}(L) & d_{32}(L) & d_{33}(L) & d_{34}(L) \\ d_{41}(L) & d_{42}(L) & d_{43}(L) & d_{44}(L) \end{bmatrix} \begin{bmatrix} \Delta \ln CO2_{t-1} \\ \Delta \ln F_{t-1} \\ \Delta \ln Y_{t-1} \\ \Delta \ln E_{t-1} \end{bmatrix} + \begin{bmatrix} \delta_1 ECM_{t-1} \\ \delta_2 ECM_{t-1} \\ \delta_3 ECM_{t-1} \\ \delta_4 ECM_{t-1} \end{bmatrix} + \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \end{bmatrix} + \begin{bmatrix} \eta_1 \\ \eta_2 \\ \eta_3 \\ \eta_4 \end{bmatrix} \quad (6)$$

Where, Δ is a difference operator, ECM represents the error-correction term derived from long run cointegrating relationship via the ARDL model; C_i (i = 1….4) are constants; and η_i (i

=1…4) are serially uncorrelated random error terms with zero mean. The VECM provides directions for Granger causality. Long-run causality is captured by a significance of lagged *ECMs* using t test while F-statistic or Wald test captures short run causality.

The data of CO_2 is energy emissions (metric tons per capita); financial development proxied by domestic credit to private sector per capita (F); real GDP (Y) per capita for economic growth; energy consumption (E) per capita, foreign direct investment per capita (FI) and trade (TR) per capita has been obtained from world development indicators (CD-ROM, 2012). The study covers data period of 1971-2008.

IV. Empirical Results

The results of descriptive statistics and correlation matrix are reported in Table-1. The statistics of Jarque-Bera test state that all the series are normally distributed with zero mean and finite variance. The correlation analysis indicates negative correlation between financial development and CO_2 emissions. Energy consumption is positively correlated with energy emissions. Energy consumption and economic growth are positively correlated. Financial development and energy consumption are positively correlated. A negative correlation exists between financial development and economic growth.

Table-1 Descriptive Statistics and Correlation Matrix

Variables	$\ln CO_{2t}$	$\ln F_t$	$\ln E_t$	$\ln Y_t$
Mean	1.2242	4.5105	7.1709	9.2104
Median	1.0622	4.7018	7.1273	9.1720

Maximum	2.3930	5.3490	7.9522	9.8828
Minimum	0.3724	3.1680	6.2611	8.4092
Std. Dev.	0.6101	0.6258	0.5288	0.4336
Skewness	0.2900	-0.6748	-0.2436	-0.1283
Kurtosis	1.8380	2.3238	1.81361	1.7910
Jarque-Bera	2.6708	3.6082	2.6042	2.4184
Probability	0.2630	0.1646	0.2719	0.2984
$\ln CO2_t$	1.0000			
$\ln F_t$	-0.0879	1.0000		
$\ln E_t$	0.5988	0.1475	1.0000	
$\ln Y_t$	0.3323	-0.01038	0.2573	1.0000

The primary step is to find integrating properties of the variables before proceeding to the ARDL bounds testing approach to cointegration for long run relationship. Although, there is no need of pretesting the order of integration of the series for applying bounds testing approach to cointegration. The critical bounds developed by Pesaran et al. (2001) are premised on the assumption that the variables are stationary of order $I(0)$ or $I(1)$. But computation of the ARDL F-statistic becomes useless if any variable is found to be integrated at I(2). It is necessary to test the stationarity properties of the variables to ensure that none of the variable is stationary at I(2) or beyond that order of integration. In doing so, Ng-Perron (2001) unit root test is applied to examine the unit root properties of the variables. The results of Ng-Perron unit root test are presented in Table-2. The unit root analysis indicates that all the series are non-stationary at their level form with intercept and trend. At 1st differenced level, energy consumption, economic growth, financial development and CO_2 emissions are integrated. This implies that all the variables are integrated at I(1).

Table-2 Unit Root Results

Ng-Perron Test at Level				
Variables	Mza	MZt	MSB	MPT
$\ln E_t$	-9.6708	-2.1531	0.2226	9.6161
$\ln Y_t$	-10.9080	-2.2980	0.2106	8.5367
$\ln F_t$	-4.2011	-1.1888	0.2829	19.2134
$\ln CO_{2t}$	-7.5482	-1.8382	0.2435	12.2865
Ng-Perron Test at 1st Difference				
$\Delta \ln E_t$	-20.4721**	-3.1991	0.1562	4.4523
$\Delta \ln Y_t$	-23.9098*	-3.4575	0.1446	3.8116
$\Delta \ln F_t$	-40.0756*	-4.4763	0.1117	2.2739
$\Delta \ln CO_{2t}$	-18.0119 **	-3.0009	0.1666	5.0594
Note: * and ** represent significance at 1% and 5% level.				

Table-3: The ARDL Cointegration Analysis

Estimated Equation	$CO_{2t} = f(F_t, E_t, Y_t)$
Optimal lag structure	(1, 1, 1, 1)
F-statistics	9.3610**

Significant level	Critical values (T = 34)#	
	Lower bounds, $I(0)$	Upper bounds, $I(1)$
1 per cent	10.265	11.395
5 per cent	7.210	8.055
10 per cent	5.950	6.680
Diagnostic tests	Statistics	
R^2	0.77982	
Adjusted- R^2	0.64352	
F-statistic (Prob-value)	5.7213 (0.0002)*	
$\chi^2 NORM$	0.6700 (0.7153)	
$\chi^2 SERIAL$	2.0148 (0.1270)	
$\chi^2 ARCH$	0.0028 (0.9575)	
$\chi^2 WHITE$	0.6128 (0.8359)	
$\chi^2 RAMSEY$	1.2139 (0.2836)	

Note: The asterisk *, ** denote the significant at 1, 5 per cent level. AIC is applied in determining the optimal lag structure. The probability values are provided in parenthesis. $\chi^2 NORM$ is for normality test, $\chi^2 SERIAL$ for LM serial correlation test, $\chi^2 ARCH$ for autoregressive conditional heteroskedasticity, $\chi^2 WHITE$ for white heteroskedasticity and $\chi^2 RAMSEY$ for Ramsey Reset test.

Before proceeding to the ARDL bounds testing, appropriate lag length of the variables should be selected by using AIC and SBC criterions. It is pointed out by Lütkepohl, (2006) that AIC lag length criteria provides efficient and consistent results to capture dynamic relation between the variables. So, using AIC criteria, optimal lag length of the variables is 1 which is reported in 2 row of Table-3 with the results of the cointegration test. Narayan (2005) pointed out that the critical bounds developed by Pesaran et al. (2001) are not suitable for small sample. Our sample consists of $T = 38$, we use critical bounds developed by Narayan (2005).

The results of the ARDL bounds testing approach to cointegration are reported in Table-3. Our computed F-statistic exceeds upper critical bound at 5 per cent significance level once CO_2 emissions is used as predicted variable. This confirms the presence of cointegration between the variables over the period of 1971-2008. This entails that financial development, energy consumption, economic growth and CO2 emissions are cointegrated for long run relationship in case of Malaysia.

Table-4: Long Run Results

Dependent Variable = $\ln CO_{2,t}$						
Variables	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Constant	-6.5182	-3.8334*	-6.7719	-3.5799*	-6.6748	-5.1309*
$\ln CO_{2,t-1}$	0.4234	4.1021*	0.4055	3.5270*	0.3013	3.3588*
$\ln F_t$	-0.1873	-4.2968*	-0.1860	-4.0594*	-0.8642	-1.4623
$\ln F_t^2$	…	…	…	…	0.0732	1.1557
$\ln Y_t$	0.5549	1.7739***	0.5843	1.7218***	0.9247	3.7994*

$\ln E_t$	0.4149	2.0212**	0.4079	1.9513**	0.4605	2.1237**
$\ln FI_t$	...	...	0.0377	2.5262**	...	...
$\ln TR_t$	...	...	...	...	-0.2744	-2.0460**
Diagnostic Test	Statistics		Statistics		Statistics	
R-squared	0.9852		0.9862		0.9859	
F-statistic	477.1487*		401.8838*		315.1641*	
Durbin-Watson	1.9393		2.0299		1.8424	
χ^2 *NORM*	4.2694(0.1182)		3.2724(0.1947)		3.5399(0.1703)	
χ^2 *SERIAL*	0.0854 (0.9183)		0.0086(0.9914)		0.1663 (0.8907)	
χ^2 *ARCH*	0.7274 (0.4917)		1.8123 (0.1880)		1.5953(0.2160)	
χ^2 *WHITE*	0.3034 (0.9576)		0.2808 (0.9197)		0.4012 (0.8716)	
χ^2 *REMSAY*	1.9700 (0.1589)		2.1294 (0.1083)		1.3608 (0.2733)	
Note: *, ** and *** show signficnat at 1%, 5% and 10% levels respectively.						

Long run marginal effects of financial development, economic growth and energy consumption on CO_2 emissions are presented in Table-4. The results indicate that lagged dependent variable has positive impact on CO_2 emissions. This implies that current 0.4234 percent increase in CO_2 emissions is linked with 1 percent rise in CO_2 emissions in previous period, all else is same. The effect of financial development on energy emissions is negative and significant at 1 percent level. A percent development of financial sector lowers CO2 emissions by 0.1873 percent keeping other things constant. These findings are in consonance with Frankel and Rose (2002), Tamazian et al (2009, 2010) and, Jalil and Feridun (2010). Economic growth adds in CO_2 emissions significantly and its effect is dominant. All else is same, a 1 increase in economic growth raises CO_2 emissions by 0.5549 percent. The results support the findings of Song et al. (2008) for China, Halicioglu (2009) for Turkey, Fodha and Zaghdoud (2010) for Tunisia, Lean and Smyth (2010) for Malaysia, and Shahbaz et al. (2012) for Pakistan. The positive and significant relationship is found between energy consumption and CO_2 emissions in Malaysia. Keeping other things constant, a 1% increase in energy consumption is linked with 0.4149 percent in CO_2 emissions. This empirical evidence is in agreement with literatures such as Liu (2005), Ang and Liu (2005), Say and Yücel (2006), and, Ang (2008).

The relationship between foreign direct investment and energy emissions is positive and it is statistically significant. A 1 percent increase in foreign direct investment adds in CO_2 emissions by 0.038 percent by keeping other factors constant. These findings agree to pollution-haven hypothesis (PHH), which opines foreign direct investment (FDI) via multinationals are forced from their home countries to invest in host countries (especially developing economies) with weak environmental standards and deteriorates the environmental quality. Trade openness is inversely and significantly at 5 percent linked with CO_2 emissions. All else is same, a 1 percent rise in trade openness is linked with 0.2744 percent reductions in CO_2 emissions. This empirical view is consistent with Halicioglu (2009) for Turkey and Shahbaz (2012) for Pakistan.

The non-linear relationship between financial development and CO_2 emissions is U-shaped but it is statistically insignificant. This finding is surprising and suggests policy makers to redirect the financial sector to improve environment through issuing loans to environment friendly investment ventures which not only increases the efficiency of all sectors but also improves the quality of life by saving the environment from degradation.

Table-5: Short Run Analysis

Dependent Variable = $\Delta \ln CO_{2,t}$				
Variable	Coefficient	Std. Error	T-Statistic	Prob-Value
Constant	-0.0010	0.0111	-0.0939	0.9258
$\Delta \ln CO_{2,t-1}$	0.0091	0.1483	0.0613	0.9515
$\Delta \ln F_t$	-0.1006**	0.0495	-2.0327	0.0520
$\Delta \ln Y_t$	0.8827**	0.3961	2.2283	0.0344
$\Delta \ln E_t$	0.5752***	0.3033	1.8963	0.0687
ECM_{t-1}	-0.5097*	0.1417	-3.5954	0.0013
Diagnostic Tests				
R^2	0.5586			
$F-Statistic$	6.8339			
$D.W-Test$	1.8214			
Test	F-statistic	Prob. value		
$\chi^2 NORM$	0.2847	0.8672		
$\chi^2 SERIAL$	0.0321	0.9683		
$\chi^2 ARCH$	1.2396	0.3048		
$\chi^2 WHITE$	1.4759	0.1366		
$\chi^2 RAMSEY$	0.1976	0.6602		
Note: *, ** and *** show signficnat at 1%, 5% and 10% levels				

respectively.

After finding long run impact of financial development, economic growth and energy consumption on CO2 emissions, next step is to investigate their short run dynamics. For this purpose, we have applied error correction model (ECM). The results are reported in Table-5. We find that impact of lagged dependent variable (CO2) is positive on current CO_2 emissions but insignificant. Financial development declines energy emissions. We find that 0.10 percent decline in energy emissions is due to a 1 percent increase in financial development, on average, other things are equal. The positive and significant relationship is found between economic growth and CO_2 emissions. A 1 percent rise in economic growth causes 0.88 percent rise in CO_2 emissions. The impact of energy consumption on CO_2 emissions is positive and statistically significant.

The estimate of ECM_{t-1} term is negative and it is statistically significant at 1% level corroborating our proven long run association between energy consumption, economic growth, financial development and CO_2 emissions. The estimate of ECM_{t-1} term is -0.5097 suggesting that variations in energy emissions from short run to long span of time is corrected by 50.97 percent each year. It is an indication of very fast and significant adjustment process for Malaysian economy in any shock to CO_2 emissions model.

The results of diagnostic tests such as normality of residual term, LM for serial correlation, ARCH test, white heteroskedasticity and specification showed that short run model has passed all diagnostic tests successfully. There is no problem of serial correlation and, autoregressive conditional heteroskedasticity and same inference is drawn for white heteroskedasticity. The residual term is normally distributed and short run model is well l articulated.

The VECM Granger Causality Analysis

The results of the VECM Granger causlaity are reported in Table-6. In long run, bidirectional relationship is found between financial development and energy emissions. The feedback hypothe also exists between finnacial development and energy consumption. This finding is consistent with Islam et al. (2011) who reported that financial development and energy consumption are complementary in case of Malaysia but contrary with Shahbaz and Lean (2012) who reported unidirectional causlaity running from financial developmet to energy consumption in Tunisian economy. Bidierctional causal relationship is found between economic growth and energy consumption. This results is contrary to Ang (2007, 2008) who unidirectional causlaity runing from economic growth to energy consumption in France and Malaysia respectively. We found that energy consumption and ecnomic growth Granger cause each other but Ang (2008) reported nuetral hypothesis between both variables. The bidirectional cuusality between finnacial developement and economic growth is validating the existence of both supply-side and demand-side hypotheses, a finding consistent with Ndako (2010), who observe same for South Africa.

Table-7: VECM Granger Causality Results

Dependent variable	Type of Granger causality								
	Short-run				Long-run	Joint (short- and long-run)			
	$\Delta \ln CO_{2,t}$	$\Delta \ln F_t$	$\Delta \ln Y_t$	$\Delta \ln E_t$	ECM_{t-1}	$\Delta \ln CO_{2,t}, ECM_{t-1}$	$\Delta \ln F_t, ECM_{t-1}$	$\Delta \ln Y_t, ECM_{t-1}$	$\Delta \ln E_t, ECM_{t-1}$
	F-statistics [p-values]				[t-statistics]	F-statistics [p-values]			
$\Delta \ln CO_{2,t}$	–	2.8370*** [0.0783]	3.0801*** [0.0645]	2.5027*** [0.1030]	-0.6098* [-3.7587]	–	4.8998* [0.0085]	7.5106* [0.0010]	19.3750* [0.0000]
$\Delta \ln F_t$	1.7753 [0.1910]	–	0.1995 [0.8205]	1.0871 [0.3532]	-0.4350** [-2.2471]	2.0832 [0.1291]	–	1.9196 [0.1534]	2.3756*** [0.0951]
$\Delta \ln Y_t$	4.1571** [0.0282]	2.1212 [0.1418]	–	4.0227** [0.0311]	-0.9113* [-4.4034]	7.5128* [0.0010]	7.5732* [0.0010]	–	10.5057* [0.0001]
$\Delta \ln E_t$	10.9451* [0.0004]	3.3097*** [0.0538]	5.6006** [0.0101]	–	-0.9018* [-4.5792]	12.7199* [0.0000]	7.6916** [0.0009]	8.4048* [0.0007]	–
Note: The asterisks *, ** and *** denote the significant at the 1, 5 and 10 per cent levels, respectively.									

In short run, feedback hypothesis exists between economic growth and CO_2 emissions, energy consumption and CO_2 emissions and, energy consumption and economic growth. Financial development Granger causes CO_2 emissions and energy consumption.

These findings are in consonance with the observations of Al-Mulali and Sab (2012) for Sub Saharan African countries. Generally, these results imply that concerted effort to curb short and long term energy emissions, should not only include growth and energy usage initiatives, but also financial development in Malaysia. As these three variables also indicate bidirectional causalities among themselves, an integrated approach may be needed in such a way that financial development policies are interwoven with redesigning of energy policies (as the long run elasticities have earlier revealed) and reformulating economic policies in Malaysia.

V. Conclusions and Policy Implications

This study examines the impact of financial development with economic growth and energy consumption on CO_2 emissions in the period of 1971-2008 for Malaysia. The ARDL bounds testing approach to cointegration is used to investigate long run relationship among the variables and short run dynamics are checked by applying error correction method. The direction of causality in economic growth, energy consumption, financial development and energy pollutants is examined through the VECM Granger causality approach within multivariate framework.

Our findings confirm long run relationship between the variables. The results also reveal that financial development reduces CO_2 emissions for Malaysian economy. Economic growth, energy consumption and foreign direct investment retard environmental quality. Increase in international trade reduces energy emissions. Further, the VECM Granger causality analysis indicates bidirectional causal relationship between financial development and economic growth, economic growth and energy consumption, financial development and energy emissions, energy emissions and economic growth, energy consumption and CO_2 emissions etc.

As economic growth and energy consumption are shown to be negatively related with environmental quality, this may tend to suggest cutbacks in economic activities especially by reducing energy–prone activities. In reality, however, the fact is that fossil fuel energy consumption, which is responsible for most pollution in the country, does not only enjoy government subsidies in Malaysia but also the dominant form of energy use. For instance, non-fossil fuel energy consumption fell from 22.60 percent in 1971 to 4.897 percent in 2008 (World Bank, 2012). Gradual reduction of government subsidy should be introduced in order to lessen intensity of fuel consumption.

Further, promotion of alternative forms of energy should be encouraged as against energy conservation policies. Fortunately, the financial system, which its development is shown to be positively related with environment safety, is handy in this regards. Financial institutions can approach the challenges of environment degradation with direct and indirect methods. Direct methods involve financial system investing in research and development on innovative technologies relating to cleaner energy (such as biogas, biomass, mini-hydro, solar and solid waste) and promoting awareness of the dangers of emissions for case of Malaysia. Although alternative sources have been promoted in the past, lack of finance has been one of the problems in realizing the projects. In 2007, CIMB (a leading financial institution in Malaysia) launch a

"Climate Change Equity Fund", which provides investors different investment access to international companies concentrating on environmentally-friendly expertise and alternate energies (CIMB, 2007). However, launching of Small Renewable Energy Power Programme (SREP) to provide small renewable energy power generation plants with a capability of 30 megawatts of electricity has not materialized as only two SREP projects were in operation with a total generation capacity of 12 megawatts. Inadequate participation of banking sector (which perceived that the projects as risky) in the scheme is a major obstacle to the project's realisation (MNREM, 2011).

In order to promote awareness on the perils of emissions, Hong Kong and Shanghai Banking Corporation Limited (HSBC) bank organized road show against pollution in selected countries inclusive of Malaysia and Singapore to educate employees on carbon finance and other issues in 2006 (Cogan, 2008). These efforts are however, insignificant compared with what is obtainable in a developed country like US, where Bank of America (a private financial institution) ventured on a 10-year, USD20 billion business plan to address climate change through philanthropy, capital markets activity, investments, lending, and its own operations in 2007. Earlier, the same bank budgeted around USD15 million for the installation of energy-efficient heating and of energy-efficient lighting and cooling apparatus, the application of control systems and the usage of solar energy (Pols, 2006). For more effective campaign, efforts should be extended to the larger public and moreover, other Malaysian banks may complement this effort by replicating the same programme in broader terms.

Indirect approach encompasses efforts to curtail emissions of clients that receive funding and other services from the financial sector. In doing this, banking system may give priority or incentives to loan that are related with less emissions business endeavours in the form of interest discounts. Financial system may as well add CO_2 related conditions to their existing financial product or impute CO_2 emissions related costs in their financial products. Simmarily, in future consideration of environmental quality in Malaysia, the role of financial sector must be accorded credence.

The present is not without its limitations. One, the usage of CO_2 emissions is not exhaustive as a proxy for environmental degradation, which is inclusive of halogenated fluorocarbons (HFC), nitrous oxide (N2O), per fluorocarbons (PFC) and sulphur hexafluoride (SF6) and even deforestation. Roles of important factors including urbanization, land use and government spending (especially government subsidy) on emissions are not considered in this research. In the case of Malaysia, urbanization is particularly essential because on one hand, most emissions in the country stem from the urban centres and on other hand, urbanization has nearly double from being 34.34 percent in 1971 to reach 70.36 percent in 2008 (World Bank, 2012). Effect of emissions on health indicators such as death rate, infant mortality, health expenditures have been ignored in this exercise. These are gaps left for future scholarships to fill in case of Malaysia.

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