Asian Journal of Economic Modelling
ISSN(e): 2312-3656
ISSN(p): 2313-2884
DOI: 10.18488/journal.8.2018.61.47.55
Vol. 6, No. 1, 47-55

URL: www.aessweb.com

CO2 EMISSIONS AND ECONOMIC GROWTH IN VIETNAM: AN ARDL BOUND TESTING APPROACH

Nhung Thi Kim NGUYEN[1+]
Minh Binh LE[2]

[1]*Faculty of Economics and Business Administration, Hatinh University, Vietnam*
Email: nhung.nguyenthikim@htu.edu.vn
[2]*College of Economics, Cantho Univerisity, Vietnam*
Email: lbminh@ctu.edu.vn

(+ Corresponding author)

Article History
Received: 14 November 2017
Revised: 22 December 2017
Accepted: 29 December 2017
Published: 5 January 2018

Keywords
Carbon dioxide emissions
Impacts
Economic growth
Environmental protection policy
Long run
Sustainable growth and Development
Vietnam.

JEL Classification:
F16, F43

ABSTRACT

This study examines the impacts of CO2 emissions on economic growth of Vietnam for the period 1986-2015 by using Autogressive Distributed Lag (ARDL) model. The results reveal that there is cointegration relationship between CO2 emissions and economic growth. In the long run carbon dioxide emissions have a significant negative impact on Vietnam economic growth. Therefore, in order to achieve a sustainable growth and development, it is advisable for the Vietnamese government to focus on environmental protection policy.

Contribution/ Originality: This is the very first study to examine the impacts of carbon dioxide emissions on Vietnam economic growth for the 1986-2015 period. The results show that carbon dioxide emissions have a significant negative impact on Vietnam economic growth.

1. INTRODUCTION

It is undeniable that economic growth is one of primary factors contributing to the prosperity of a country. Therefore, many countries have sought ways to boost economic growth even at the cost of environment. However, it is noteworthy that economic growth and environment have a reciprocal relationship. Economic growth can lead to environmental degradation and lower environmental quality is in return detrimental to economic growth. Theoretically, environmental degradation causes health problems, resource reduction and natural disaster which can slow down economic growth (Azam *et al.*, 2016). One of the most serious environmental problems is the global warming largely caused by CO2 emissions (Canadella and Raupacha, 2007; Friedlingstein *et al.*, 2010).

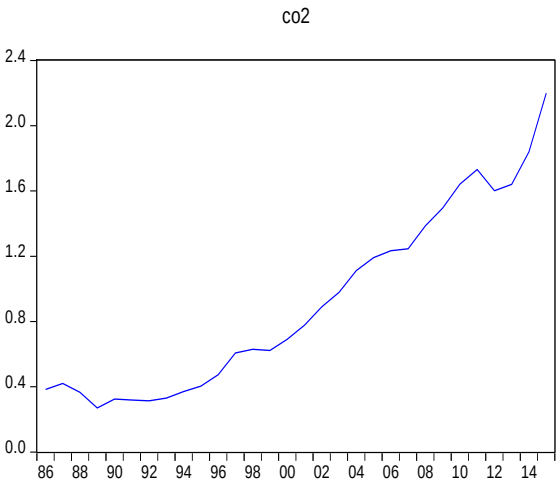

Figure-2. CO2 emissions in Vietnam for the 1986-2015 period (measured in metrics tons per capita)
Source: Drawn in Eviews 10 using data from WDI (2015)

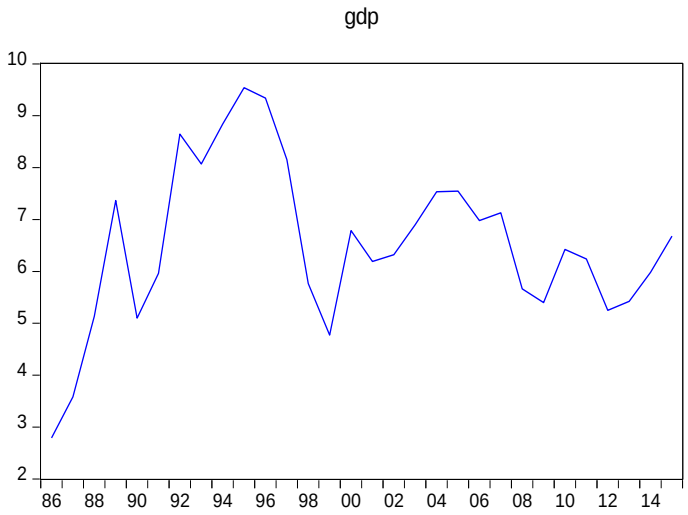

Figure-1. Vietnam annual real GDP growth
Source: Drawn in Eviews 10 using data from WDI (2015)

There are several arguments regarding reasons for the trade-off between economic growth and environmental degradation. Bozkurt and Akan (2014) argue that the upsurge in the global trade, travel and industrialization has caused the amount of CO2 emissions to increase overtime. Awan (2013) states that the adverse association between economic growth and environmental degradation is due to the overuse of natural resources for high growth desire. In the developing countries which have very few asset and low income, only by overusing natural resources can they secure economic growth. This results in environmental deterioration. Particularly, with the transformation of the economy from the stagnation stage to the development stage triggered by the modernization and industrialisation, the environmental has been heavily damaged in the developing world. The lack of experience and financial resources for the environmental protection has made the situation more alarming. As there is a negative association between environmental degradation and economic growth, appropriate and timely environmental policies on a local, national, regional and global scale are required for sustainable development (Auci and Trovato, 2011).

Vietnam is a developing country in Southeast Asian, which is on its path of industrialization and modernization. In the 1980s, Vietnam was a poor country with low economic growth and high inflation rate. However, since the introduction of Doi Moi (Innovation) policy in 1986 which transferred Vietnam from a centrally planned economy to a market oriented one, Vietnam has achieved outstanding economic growth. The country's average annual growth rate is 7.1% for the 1988-2000 period and 6,4% for the 2000- 2015 period. In the 2000-2015 period, the growth rate slows down due to the effect of global financial crisis in 2008 and the European debt crisis in the 2010 but the recorded growth rate is still higher most other countries in the world (Figure 1). The country's GDP per capita rose from 398 USD in 1986 to 1685 USD in 2016 (measured in constant 2010 dollar) (WDI, 2015) Vietnam became the third largest exporter of rice in the early 1990s, and the second largest exporter of coffee in the late 1990s (Nhiem *et al.*, 2006). In 2009 the country became a middle income country and is now targeting to become an industrialize country by 2020 (Welle-Strand *et al.*, 2013).

Despite outstanding economic achievements, Vietnam is now coping with serious environmental problems, particularly global warming. Figure 2 shows an upward trend in the CO2 emissions per capita in Vietnam from 1986 to 2015. Over 30 years, the amount of CO2 emissions has increased almost six times. CO2 emission in Vietnam is increasing at an alarming rate. Coal fired electric power plants are the primary contributor to the CO2 emissions. The enery sector in Vietnam is estimated to produce 224 million tonnes of CO2 by 2020 each year while other primary industries will produce approximately 10 million tonnes (Asia News Monitor, 2011).

Meanwhile, like other countries Vietnam is aiming to achieve sustainable economic growth and development, which causes no environemntal degradation and incurs no cost for the future generation. Therefore, in order to

fulfill this objective, environmental quality must be maintained. The literature on CO2 emission and economic growth has included various studies on the effect of economic growth on CO2 emissions but there are still very little research on the impacts of CO2 emissions on economic growth. This paper contributes to the existing literature by examining the effect of environmental degradation, proxied by carbon dioxide emissions, on economic growth of Vietnam for the 1986-2015 period using ARDL apporach to cointegration. To the best of our knowledge, this is the first study on the influence of CO2 emissions on Vietnam economic growth.

The paper is organized as follows. Section 1 deals with introduction; Section 2 provides a brief literature review; Section 3 set out data description and methodology; Section 4 is empirical results; The final section presents conclusion and discussions.

2. LITERATURE REVIEW

The available literature on the effect of environmental degradation on economic growth is still scanty.

Some studies find a negative impact of CO2 emissions on economic growth. Borhan *et al.* (2012) apply two stage least square method to examine the effect of CO2 emissions on economic growth of 8 ASEAN countries from 1965 to 2010. Their results confirm the EKC hypothesis. As the level of CO2 emissions increases, this directly decreases man made capital and labour, then causing economic growth to slow down. In another panel data set for China, USA, Japan and India with fully modified ordinary least squares Azam *et al.* (2016) analyses the impacts of CO2 emissions on economic growth controlled by explanatory variables such as human capital, energy and trade. The results reveal that while CO2 emissions and energy consumption have a significant negative impact on growth, trade and human capital tend to influence economic growth positively. However, the results for the individual countries are different. The negative impacts are only found in India. In contrast, CO2 emissions have a significant positive impact on economic growth in China, USA and Japan. Bozkurt and Akan (2014) examine the long run relationship between CO2 emissions, economic growth and energy consumption in Turkey for the 1960-2010 period by using Johansen and Juselius (1990) technique. It is found that while energy consumption positively influences economic growth, CO2 emissions have a negative impact on economic growth. Therefore, the sustainable development in Turkey requires the implementation of clean and renewable source of energy such ash solar power, natural gas. Using Ordinary Least Squares method, Ejuvbekpokpo (2014) finds an adverse impact of CO2 emissions on economic growth of Nigeria in the 1980-2010 period. Hence, the combined efforts from both the government and the enterprises in Nigeria are required for mitigating carbon dioxide emissions. In another research, Ghosh *et al.* (2014) explore the relationship between economic growth, CO2 emissions and energy in Bangladesh consumption from 1972 to 2011 by using cointegration technique. Ghosh *et al.* (2014) find that energy consumption has a significant positive impact on Bangladesh economic growth while carbon dioxide emissions have an insignificant negative impact.

On the contrary, some studies find a positive impact of CO2 emissions on economic growth. Shiyan and Genxin (2013) examine the causal relationship among energy structure, CO2 emission, R&D investment and economic growth in China in the 1990-2011 period by applying ARDL bound test in combination with Johansen and Juselius (1990) method. The results indicate that both in the short run and long run, CO2 emissions have a positive impact on economic growth of China. Meanwhile, energy structure negatively influences economic growth. The China government, therefore, should adopt energy saving policy and optimize the energy structure. Although Ghosh (2010) fails to find a cointegration between CO2 emissions and economic growth in India for the 1971-2006 period by using ARDL bounds testing approach, the study finds a bidirectional causality in the short run and that any reduction in CO2 emissions will reduce economic growth in India. The positive impact of CO2 emissions on economic growth is also found in Bozkurt and Akan (2014); Zeshan and Ahmed (2013) and Srinivasan *et al.* (2015).

However, to our best knowledge there has been no research on the impacts of CO2 emissions on economic growth in Vietnam. Most of the literature in Vietnam focus on the effect of economic growth on CO2 emissions.

This study fills in this gap by examining the impacts of CO2 emissions on Vietnam economic growth for the 1986-2015 period.

3. DATA DESCRIPTION AND METHODOLODY

3.1. Data Description

For empirical analysis, annual time series for the 1986-2015 period is used. The data are taken from worldbank database WDI (2015). There are three variables as follows:

CO2: carbon dioxide emissions, a proxy for environmental degradation, measured in metrics tons per capita. Carbon dioxide emissons are those stemming from the burning of fossil fuels and the manufacture of cement.

GDP: annual gross domestic product per capita growth (%). Annual percentage growth rate of GDP per capita based on constant local currency.

ODA: Net official development assistance received (constant 2014 US$), consisting of disbursement of loans mades on concessional terms (net of repayments of principal) and grants by official agencies.

With the aim of getting a linear model without heteroskedatisicty problem, data are transformed to the log form (Shawa and Shen, 2013). The following equation is estimated

$$lgdp_t = \beta_o + \beta_1 lco2_t + \beta_2 loda_t + \varepsilon_t$$

3.2. Methodology

This research uses the ARDL testing approach to cointegration to test the effect of CO2 emissions on Vietnam economic growth. ARDL technique has some advantages over other cointegration techniques: (1) The test is applied irrespective of whether the variable is integrated of order 0 or 1 given that no series is integrated of order 2; (2) The long run and short run impact can be estimated simultaneously without losing information; (3) For small sample size as the present study, ARDL approach is superior to Johansen and Juselius (1990) cointegration technique as the result is more valid; (4) Serial correlation and endogeneity problems can be corrected by the sufficient number of lags in the ARDL model Pesaran and Shin (1999).

The ARDL approach to cointegration includes five steps. In the first step, the stationarity of the variables are checked to ensure that the variables are either I (0) or I(1). Next, the lags of the ARDL model are automatically chosen in Eviews based on AIC. Afterwards, the ARDL bound test is conducted to examine the cointegration relationship among the variables. The long run and short run models are then estimated to test the effect of CO2 emissions on economic growth. Finally, the diagnostic tests are conducted to test heteroskedasticity, misspecification, serial correlation and normality. CUSUM and CUSUMSQ statistics are utilized to test the stability of the model.

3.2.1. ARDL Bound Test

The ARDL bound test is conducted by utilizing Unrestricted Error Correction Model (UECM) to examine the cointegration relationship of the production function:

$$\Delta lgdp_t = \propto_o + \sum_{i=1}^{n} \propto_1 \Delta lgdp_{t-i} + \sum_{i=1}^{m} \propto_2 \Delta lco2_{t-i} + \sum_{i=1}^{k} \propto_3 \Delta loda_{t-i} + \propto_4 lgdp_{t-1} + \propto_5 lco2_{t-1} + \propto_6 loda_{t-1} + \varepsilon_t$$

where $\Delta lgdp$, $\Delta lco2$, $\Delta loda$ are the the first difference of the natural logarithm of gdp, co2 and oda respectively.

In order to examine the cointegration relationship of the variable, the F statistics is utilized to test the significance of the joint one lagged level variables (Pesaran *et al.*, 2001). The null hypothesis in the bound test is shown as: $\propto_4 = \propto_5 = \propto_6 = 0$. As Narayan (2005) argues that the critical values in Pesaran *et al.* (2001) are only appropriate for large sample sizes, this study compares the F statistics with the critical values from in the Narayan (2005) which is for small sample size (30-80). There are lower bound (F_L) and upper bound (F_U) critical values. If the $\hat{F} > F_U$, there is cointegration among the variables but if $\hat{F} < F_L$ no cointegration exists. When $\hat{F}$ falls between the lower bound and upper bound, the cointegration relationship is inconclusive without testing the order of integration of the underlying variables (Narayan, 2005).

3.2.2. The Long Run Relationsip

The following equation is estimated to examine the long run effect of CO2 emissions on economic growth:

$$lgdp_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 lgdp_{t-i} + \sum_{i=1}^{q} \alpha_2 lco2_{t-i} + \sum_{i=1}^{l} \alpha_3 loda_{t-i} + \varepsilon_t$$

3.2.3. The Short Run Relationship

In order to study the short run effect of CO2 emissions on economic growth, the ARDL error correction model is estimated:

$$lgdp_t = \lambda_0 + \sum_{i=1}^{g} \lambda_1 \Delta lgdp_{t-i} + \sum_{i=1}^{k} \lambda_2 \Delta lco2_{t-i} + \sum_{i=1}^{h} \lambda_3 \Delta loda_{t-i} + \lambda_4 ect_{t-1} + \varepsilon_t$$

where

ect_{t-1} is one period lagged error correction term

λ_4 is the coefficient measuring the speed of adjustment to stabilize disequilibrium in the model. A higher magnitude of the λ_4 indicates a higher speed of adjustment (Coakley *et al.*, 2004).

4. EMPIRICAL RESULTS

Before conducting the ARDL bound test, it is important to test for the stationarity of the variables to ensure that variables are either I (0) or I (2). The Augmented Dickey Fuller (ADF) test shows that all the variables are integrated of order 1. The result is shown as below:

Table-1. The Augmented Dicker Fuller test for the stationarity

Variables	Constant without trend		Constant with trend		Order of integration
	Level	First Difference	Level	First Difference	
Lco2	-4.314953**	-3.778359***	0.438299	-2.511518**	I (1)
lgdp	-3.835808	-4.861257***	-3.104610	-4.898222***	I (1)
loda	-0.937969	-10.36982***	-1.423317	-8.900507***	I (1)

Note: *: significant at 10%; **: significant at 5%; ***: significant at 1%
Souces: Author's calculation in Eviews 10

As all variables are I (1), the ARDL bound test can be applied to examine the cointegration relationship among the variables. Based on AIC, the ARDL (2,0,0) is chosen. From table 2, the F statistic is greater than the critical values from Narayan (2005) at 10% and 5 % level of significance, this confirms the existence of a long run relationship among the variables.

Table-2. ARDL bound test

Null hypothesis: No long run relationship exists		
Test statistic	**Value**	**k**
F statistic	6.986622	2
Critical values	Lower Bound	Upper Bound
10% (T = 30)	3.437	4.470
5% (T = 30)	4.267	5.473
1% (T = 30)	6.183	7.873

Notes: The critical values are taken from Narayan (2005)
Souces: Author's calculation in Eviews 10

The results of the long run relationship is shown in table 3. The coeffcient on the lco2 variable is negative and significant at 5% level, indicating carbon dioxide emissions have a negative impact on the economic growth in the long run. A 1% increase in carbon dioxide emissions is associated with 0,37% decrease in economic growth. Meanwhile, official development assistance has a positive impact on economic growth in the long run. As official development assistance increases by 1%, economic growth increases by 0,23%.

Table-3. Results of long run relationship

Levels Equation				
Case 3: Unrestricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LCO2	-0.370076	0.160978	-2.298926	0.0309
LODA	0.230849	0.129738	1.779350	0.0884

Souces: Author's calculation in Eviews 10

The results of short run relationship are shown in table 4. GDP growth one period lagged has a significant positive impact on economic growth. The ECT (-1) is significant and negative, confirming the results of the bound test. The disequilibrium in the short run is corrected in the long run at the adjustment speed of 67%.

Table-4. Results of Error Correction Model

ECM Regression				
Case 3: Unrestricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-2.080081	0.440948	-4.717299	0.0001
D(LGDP(-1))	0.258523	0.146843	1.760538	0.0916
CointEq(-1)*	-0.675975	0.141622	-4.773098	0.0001

Note: Dependent variable is D(LGDP)
CointEq (ECT) = LGDP - (-0.3701*LCO2 + 0.2308*LODA)
Souces: Author's calculation in Eviews 10

Diagnostic tests were conducted which then shows that the model is free from serial correlation, functional misspecification and heteroskedasticity and has normal distribution.

Table-5. Diagnostic tests

Test statistics	**LM Test statistic**	**F_version**
Serial correlation	CHSQ (2)= 0.489639 (0.7828)	F(2,21) = 0.186883 (0.8309)
Functional form	CHSQ (2) = 4.077762 (0.1302)	F (2,21) = 1.646118 (0.2167)
Normality	CHSQ (2)= 4.370538 (0.112448)	Not applicable
Heteroskedasticity	CHSQ (4) = 2.258002 (0.6884)	F (4,23) =0.504371 (0.7329)

Souces: Author's calculation in Eviews 10

The plot of CUSUM and CUSUMSQ to the residuals confirms the suitability of the short run and long run coefficients because the plot is within the critical bounds.

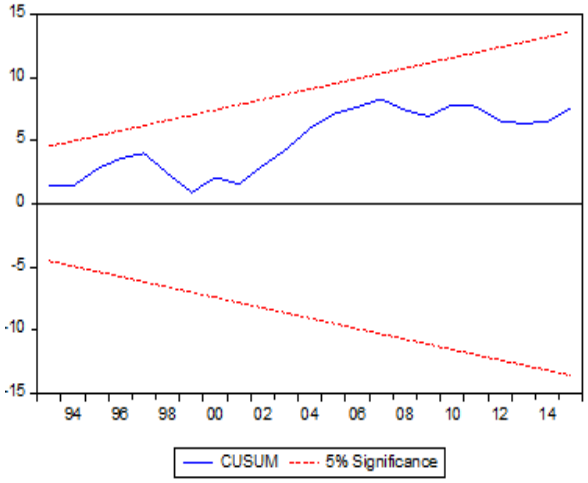

Figure-3. Plot of CUSUM statistics
Souces: Author's calculation in Eviews 10

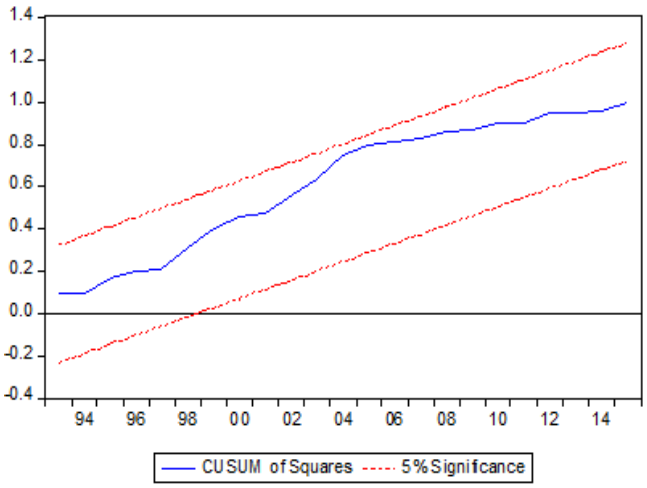

Figure-4. Plot of CUSUMSQ statistics
Souces: Author's calculation in Eviews 10

5. CONCLUSION AND DISCUSSIONS

This study aims to study the effect of CO2 emission on Vietnam economic growth for the 1986-2015 period by utilizing ARDL bound test approach to cointegration. The results show that CO2 emissions and economic growth in Vietnam has a cointegration relationship. Official development assistance, proxied by net official development assistance received, has a positive impact on Vietnam economic growth. This result is consistent with the argument that aid is crucial for facilitating economic growth in low income countries by providing technical and financial resources (Oecd Publishing, 2005). This is therefore important to attract this important source of capital. However, it is noteworthy that aid does not automatically boost growth and that aid must be spent wisely to boost economic growth. In addition, policy reforms, including corruption control are required to make sure that Vietnam can gain the donators' trust.

Meanwhile, CO2 emissions have a negative impact on growth. The result is similar to Ejuvbekpokpo (2014); Borhan *et al.* (2012); Bozkurt and Akan (2014). This implies that appropriate policies are required to reduce pollution in the country to ensure a sustainable growth path. More efficient uses of energy resource and the development renewable energy sources will contribute to lessen greenhouse gas emissions. At present, the Vietnam government has implemented several policies for reducing greenhouse gas emissions such as "National strategy on green growth in the 2011-2020 period with vision until 2050", "National Climate Changes Strategy", "National Target Programme on Energy Efficiency" ... In addition, the country has actively participated in international organizations and forums to cooperate with other countries in dealing this global issue. However, there are still some challenges facing the greenhouse gas emission mitigation program in Vietnam such as limited financial supports and investment, few application of advanced technologies, the lack of coordinate mechanism among agencies. In order to ensure a sustainable growth and development in Vietnam, these challenges must be overcome.

Funding: This study received no specific financial support.
Competing Interests: The authors declare that they have no competing interests.
Contributors/Acknowledgement: Both authors contributed equally to the conception and design of the study.

REFERENCES

Asia News Monitor, 2011. Vietnam: CO2 emissions in Vietnam at alarming rate. Bangkok.

Auci, S. and G. Trovato, 2011. The environmental Kuznets curve within European countries and sectors: Greenhouse emission, production function and technology. IDEAS Working Paper Series from RePEc.

Awan, A.G., 2013. Relationship between environment and sustainable economic development: A theoretical approach to environmental problems. International Journal of Asian Social Science, 3(3): 741-761. *View at Google Scholar*

Azam, M., A. Khan, H. Abdullah and M. Qureshi, 2016. The impact of CO 2 emissions on economic growth: Evidence from selected higher CO 2 emissions economies. Environmental Science and Pollution Research, 23(7): 6376-6389. *View at Google Scholar | View at Publisher*

Borhan, H., E.M. Ahmed and M. Hitam, 2012. The impact of CO2 on economic growth in ASEAN 8. Procedia - Social and Behavioral Sciences, 35: 389-397. *View at Google Scholar | View at Publisher*

Bozkurt, C. and Y. Akan, 2014. Economic growth, CO2 emissions and energy consumption: The Turkish case. International Journal of Energy Economics and Policy, 4(3): 484-494. *View at Google Scholar*

Canadella, J.G. and M.R. Raupacha, 2007. Contributions to accelerating atmospheric CO2 growth from economic activity, carbon intensity, and efficiency of natural sinks. Proceedings of the National Academy of Sciences of the United States of America, 104: 47.

Coakley, J., A.M. Fuertes and F. Spagnolo, 2004. Is the Feldstein–Horioka puzzle history? Manchester School, 72(5): 569-590. *View at Google Scholar | View at Publisher*

Ejuvbekpokpo, S., 2014. Impact of carbon emissions on economic growth in Nigeria. Asian Journal of Basic and Applied Sciences, 1(1): 15-25. *View at Google Scholar*

Friedlingstein, P., R.A. Houghton, G. Marland, J. Hackler, T.A. Boden, T.J. Conway and C.L. Quéré, 2010. Update on CO2 emissions. Nature Geoscience, 3(12): 811-812. *View at Google Scholar | View at Publisher*

Ghosh, B., K. Alam and A. Osmani, 2014. Economic growth, CO2 emissions and energy consumption: The case of Bangladesh. International Journal of Business and Economics Research, 3(6): 220–227. *View at Google Scholar | View at Publisher*

Ghosh, S., 2010. Examining carbon emissions economic growth nexus for India: A multivariate cointegration approach. Energy Policy, 38(6): 3008-3014. *View at Google Scholar | View at Publisher*

Johansen, S. and K. Juselius, 1990. The maximum likelihood estimation and inference on cointegration - with application to the demand for money. Oxford Bulletin of Economics and Statistics, 52(2): 169-210. *View at Google Scholar | View at Publisher*

Narayan, P.K., 2005. The saving and investment nexus for China: Evidence from cointegration tests. Applied Economics, 37(17): 1979-1990. *View at Google Scholar | View at Publisher*

Nhiem, P., C. Harvie and T.V. Hoa, 2006. Vietnam's economic transition: Policies, issues and prospects. Hyderabad, India: ICFAI University Press.

Oecd Publishing, 2005. Development centre studies: Policy coherence towards East Asia: Development challenges for OECD countries. Paris, FR: Organisation for Economic Co-operation and Development.

Pesaran, H.M. and Y. Shin, 1999. Autoregressive distributed lag modelling approach to cointegration analysis, chapter 11. In Storm, S., (Eds)., Econometrics and economic theory in the 20th century: The Ragnar Frisch centennial symposium. Cambridge: Cambridge University Press.

Pesaran, M.H., Y. Shin and R.J. Smith, 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3): 289-326. *View at Google Scholar | View at Publisher*

Shawa, M.J. and Y. Shen, 2013. Causality Relationship between foreign direct investment, GDP growth and export for Tanzania. International Journal of Economics and Finance, 5(9): 13. *View at Google Scholar | View at Publisher*

Shiyan, Z. and S. Genxin, 2013. Exploring carbon emissions, economic growth, energy and R &amp, D investment in China by ARDL approach 1-6.

Srinivasan, P., S.R. Inder and P. Karthigai, 2015. Relationship between energy consumption, CO2 emissions, economic growth and trade in India. Journal of Economic & Financial Studies, 3(2): 1-17. *View at Google Scholar | View at Publisher*

WDI, 2015. World development indicators. Retrieved from http://data.worldbank.org/products/wdi.

Welle-Strand, A., M. Vlaicu and A. Tjeldvoll, 2013. Vietnam – a new economic dragon in Southeast Asia? Journal of Developing Societies, 29(2): 155-187. *View at Google Scholar | View at Publisher*

Zeshan, M. and V. Ahmed, 2013. Energy, environment and growth nexus in South Asia. A Multidisciplinary Approach to the Theory and Practice of Sustainable Development, 15(6): 1465-1475. *View at Google Scholar | View at Publisher*