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Thi Ha, Pham
Graduate School of Economics, Kyushu University

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The impact of foreign direct investment and economic growth on carbon dioxide emissions in Vietnam

Pham Thi Ha[†]

Abstract

This paper examines the relationship between foreign direct investment (FDI), economic growth, and carbon dioxide (CO_2) emissions in Vietnam during the period 1988 – 2015 by applying the autoregressive distributed lag (ARDL) approach. The results reveal that pollution haven hypothesis does not exist in Vietnam since FDI is good for environment in the long-run, and it is not significant in the short-run. However, economic growth causes pollution in the long-run, and it is insignificant in the short-run.

Keywords: carbon dioxide emissions, foreign direct investment, economic growth, bounds test, Vietnam.

1. Introduction

Since the start of renovation (Doi Moi) in 1986, and especially since the global economic integration of the early 1990s, Vietnam has become an attractive destination for FDI; this resulting from the country's governmental policies encouraging FDI, as well as from its geographical position near global supply chains, political and economic stability, and abundant labor resources. According to the Vietnam General Statistics Office (GSO) 2013, during the period of 1988-2012, FDI inflow into Vietnam has followed a long-term upward trend and short-term fluctuations. The success of Vietnam in attracting FDI has had a positive impact on the country's economic performance; during the period of 2000-2012, the contribution of FDI to gross domestic product (GDP) has followed an increasing trend from 13.3% in 2000 to 18.1% in 2012. Regarding the contribution to investment, in accordance with GSO, over a ten year period of 1995-2004, despite an increase in absolute value, the share of FDI in total investment declined from

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30.4% in 1995 to the low percentage of 14.2% in 2004 mainly due to the vigorous expansion of public investment. Subsequently, it bounced back from 14.9% in 2005 with the most recent figure of 23.3% in 2012. Meanwhile, the share of the state sector decreased significantly after 2001 partly due to state owned enterprises reform in recent years which included streamlining of public investment. At the same time, FDI makes a particularly important contribution to export revenue. In 2011, export by the FDI sector was more than US$55 billion or a half (49.4%) of the country's total export and there was a rising trend of FDI exports over the period of 1995-2012, which rose faster than the export of the domestic invested sector. The exports fell temporarily in 2009 because of a global recession, but continued to rise subsequently, reaching the highest rate approximately 70% to Vietnam's export turnover of US$162.4 billion in 2015. This highlights the fact that the FDI activity is a crucial determinant of trade flows and structure in the Vietnamese economy. In addition, FDI also contributes to the state coffers. Despite the existence of many incentives in the forms of exemptions, tax reductions and import duties, the contribution of the FDI sector to fiscal revenue was on a rising trend, from 5.2% of the total state revenue in 2000 to 14.10 % in 2014.

Vietnam's economic growth in the nearest two decades was closely associated with the inflow and operation of FDI. The long-term rising trends in the contribution of FDI to a number of macroeconomic aspects including GDP, investment, export and fiscal revenue are the evidence of the critical importance of FDI sector in Vietnam's economic development. Due to the economic reforms in Vietnam in 1986, the annual growth rate is 8.5% over the decades before the year of 1997; and after the Asian financial crisis in 1997/1998, the growth rate of Vietnam fell from 9.3% in 1996 to 5.8% in 1998 and then 4.8% in 1999. After that it started to move up again in 2000 to 6.7% and went on to achieve 8.5% in the year of 2007. Due to the global financial crisis which started in 2008, it declined to 5.3% in 2009, and the recovery has been witnessed since 2012 with GDP growth gradually increasing and reaching 6% in 2014. Despite the global trade recession and China's economic growth slowing down, which impacted most parts of Southeast Asia, Vietnam proved to be resilient to the turbulences and still scored a growth rate of 6.7% in 2015. In a mere quarter century Vietnam has raced from the back of the third world economy to middle-income status; however, Vietnam's economic growth has had an outsized environmental impact; between 1991 and 2012, the country's GDP grew by 315%, while its greenhouse gas emissions rose by 937%; hence, there is potential to reduce Vietnam's greenhouse gas emissions relative to GDP[1).

Vietnam's CO_2 emissions have grown by more than 10% in most years after 1990[2). While at the time before 1990 a clear singular driver of emissions cannot be identified, after 1990 the

1) World Resources Institute Climate Analysis Indicators Tool (WRI CAIT 2.0, 2016)
2) International Energy Agency 2012

economic growth and carbon intensity have driven the increase of emissions to approximately equal extents. In 2007, the country's CO_2 emissions per capita were 1.07 tons, nearly 20% of the world average, increasing to more than 100% to around 2.2 tons in 2015. The carbon growth rate was around 83.2% from 1990 to 2010, and the CO_2 emissions are expected to grow rapidly as Vietnam is likely to industrialize and economically utilizes more carbon intensive fuels, substituting traditional noncommercial fuels including biomass. Therefore, the purpose of this study is to investigate the impact of economic growth and FDI on CO_2 emissions in Vietnam since the time of innovation to date.

The rest of the paper is organized as follows: Section 2 discusses literature review, Section 3 describes data and methodology, Section 4 provides empirical findings and the final section concludes.

2. Literature review

Grossman and Krueger (1991) in their pioneering work on the North America Free Trade Agreement (NAFTA) showed that increased income is associated with an increase in pollution in poor countries, but a decline in pollution in rich countries. They initiated the research literature on trade, growth and pollution by proposing an environmental Kuznets curve (EKC) that hypothesizes an inverse U-shaped relationship between a country's per capita income and its pollution level. Following the paper in 1991, Grossman and Krueger (1995) used a cross country data set covering 58 countries in the 1980s and found the support of an inverse U-shape relationship between the income and pollution, i.e. pollution increases with income at low levels of income and decreases at high levels of income, with the turning point for most of the pollutants coming before a country reaches a per capita income of US$8,000 (Grossman and Kruger, 1995, p.370).

Since the appearance of EKC literature review, there are two different schools of thought: The first one, supporting the EKC implication that economic growth is ultimately good for environment (Beckerman, 1992; Shafik and Bandyopadhyay, 1992; Grossman and Krueger, 1995; Lomborg, 2001); and the second one, pointing a number of methodological flaws in deriving the EKC (Arrow et al, 1995; Stern et al 1996; Ekins, 1997; Stern, 1998; Suri and Chapman, 1998; Rothman, 1998; Stern and Common, 2001; Cole, 2003, 2004). Since the mid - 1990s, the EKC has been attacked on both empirical and methodological grounds, a trend that has continued in recent years, and the results have been far more ambiguous (Nahman and Antrobus, 2005; Shen, 2006; Beak and Koo, 2009; Mulali et al, 2015; etc). In order to explain for the mixed empirical results in EKC, Nahman and Antrobus (2005) stated that "*in some cases the data does give rise to an EKC-type relationship, in other cases it does not, while in many cases the emergence of an EKC-type relationship depends on the variables included in and the functional form attached to the* *statistical model, or on the type of model used*" (Nahman and Antrobus 2005, p.110). The critiques of EKC were divided into two groups: Methodology and interpretation of results (Cole, 2003). Due to the collinearity or multicollinearity problems that may arise between GDP and square of GDP in EKC hypothesis when the environmental degradation is a function of GDP and square of GDP, Narayan and Narayan (2010) proposed a new way of testing whether a country or group of countries has reduced CO_2 emissions over time with growth in real per capita GDP. They suggest comparing the short and long-run elasticities, if the long-run income elasticity is smaller than the short-run elasticity, then we can conclude that over time, income leads to less carbon dioxide emissions. The results of panel data of 43 developing countries during period 1980-2004 reveal that only in Middle Eastern and South Asian panels the income elasticity in the long-run is smaller than the short-run, denoting that CO_2 emissions has fallen with a rise in income. Simultaneously, Jaunky (2011) based on the methodology of Narayan and Narayan to test the CO_2 emissions-income nexus for 36 high-income countries for the period 1980-2005, and found that in the long-run, CO_2 emissions have fallen as income rises.

The past approach of empirical work on trade/FDI patterns and the EKC was to test the pollution haven hypothesis (Antweiler et al, 2001; Levinson, 1996a, 1996b; Xing and Kolstad, 2002; Eskeland and Harrison, 2003). These studies find little evidence that environmental stringency impacts on trade/investment flows. However, it does not mean that trade and FDI flows do not explain the EKC.

Grossman and Krueger (1991) described three possible sources of environmental impact from greater openness to trade and foreign investment: A scale effect, a technique effect, and composition effect. Specifically, the scale effect concerns to the impact on the environment as a result of an increase in economic output due to the expansion of investment; the technique effect expresses that investment either drives a more rapid rate of technology development, diffusion and transfer, or it increases income and hence the demand for a cleaner environment; and the composition effect refers to investment that will change the industrial structure of an economy. The relationship is expected to be negative, positive, and can also be ambiguous, respectively. Jha (1999), and Zarsky (1999) showed that the effects of FDI on receiving countries can be positive, negative, or neutral. In the case of China, Liang (2006) examined the relationship between the scale of FDI and local air pollution by using the data of more than 260 major cities from 1996 to 2003. He then found evidence that foreign investment has beneficial effect on local environment, controlling for industrial output and composition. On the other hand, theoretical literature pointed out that the economic success of the country has been achieved at the expense of their environmental degradation. However, identifying the net effect of FDI on the environment is complex. The OECD (2002) presented two limitations that might explain the difficulties in addressing the net environmental effect of FDI flows. First, it is difficult to separate clearly the environmental effects of domestic economic activity from the effects of foreign affiliate activity. Second, FDI does not occur in a vacuum so environmental effects cannot be analyzed in isolation from other related factors, for example, trade influences the potential market opportunities in a country. In a related study, Zhang (2013) used a panel of 112 Chinese cities over four years from 2001 to 2004 to examine the income-pollution nexus for several water and air pollution indicators. The majority of pollutant emissions confirmed that at current income levels in China, economic development will induce more industrial pollution emissions; whereas EKC was found to exist for wastewater and petroleum-like matter with the estimated turning point is US$ 3,605 and US$ 4,992 (at 1990 prices), respectively. At the same time, the study also expresses that domestic investments have the strongest positive effects on industrial pollution emissions, while foreign investments have an insignificant effect in almost pollutants (wastewater, COD, CrVI, waste gas, SO_2, soot and dust), except for positive significance for petroleum-like matter, waste gas and SO_2.

Basing on panel data of 66 less developed countries between 1980 and 1996, Grime and Kentor (2003) argued that heavy dependence on FDI contributes to the growth of CO_2 emission in less developed economies of the globe; however, the domestic investment has no significant effect on CO_2 emissions. Furthermore, the study also suggested that FDI is more concentrated on industries which require more energy; as a result, energy emissions are increased, and therefore, foreign investors prefer to invest in these industries in developing countries where environmental laws are relatively flexible. With the same conclusion, Beak et al (2009) examined dynamic relationship among the trade, income, and environment for 25 developed and 25 developing countries by using a time series dataset of sulfur emissions (SO_2), income and trade openness and adopt the vector autoregression model. Results suggested that trade and income growth tend to increase environmental quality in various developed countries, whereas they have detrimental effects on environmental quality in most developing countries. Muhammad et al (2011) examined the environmental consequences of economic growth and FDI, basing on data of 110 developing and developed nations in the world by applying pooled regression along with fixed and random effect models, and showed that a consistent rise in FDI is contributing to CO_2 emissions. Additionally, the case of FDI inflows of France, Kheder (2010) considered mutual relationship among the FDI, the environmental regulation and the pollution by using a consistent data set at a disaggregate sector-level, in a mix of developing, transition, emerging, and developed countries for the years from 1999 to 2003; this confirmed the pollution havens and determine their impact on pollution in host countries. The researcher detected a negative influence of the environmental regulation on FDI location, while it took into account the endogeneity of this environmental regulation. In other research, Beak and Koo (2009) investigated the interrelationship among FDI, economic growth and environment in China and India by analyzing the annual time-series data over the period 1980-2007, and the period 1978 to 2007 for China and India respectively by applying

ARDL methodology.　They found that for China, FDI tends to deteriorate environmental quality in both the short and long - run; and the result is the same for India in the short-run, but in the long-run, FDI is insignificant.　For economic growth, it tends to worsen the environment in both short and long run.

In the case of FDI inflow in Vietnam, there are various studies evaluating the performance of the FDI and its impact on Vietnamese socio-economy (i.e. Freeman, 2002; Phuong Hoa, 2002, 2004; Nguyen et al, 2011; Anh Dao & Thanh Binh, 2013; Bhatt, 2013; Anwar & Nguyen 2010, 2011 and etc); however studies investigating the EKC hypothesis in Vietnam are still far and few in between.　To my knowledge, recently, there are two papers of Al-Mulali et al (2015) and Tang et al (2015) that investigate EKC hypothesis in Vietnam for time series data from 1981 to 2011 and 1976 to 2009, respectively.　The first research used ARDL methodology and following the new approach by Narayan and Narayan (2010) for variables including CO_2 emissions, capital, labor force, export, import and electricity consumption; whereas the last one applied the techniques of cointegration and Granger causality for CO_2 emissions, energy consumption, FDI and economic growth.　With different methodologies as well as time series data, the results of their studies are contrasting when Al-Mulali et al (2015) state that EKC hypothesis does not exist in Vietnam; while Tang et al (2015) confirmed the existence of EKC hypothesis and assume an inverted U-shaped relationship between CO_2 emissions and economic growth.　However, the conclusions of two researches are questionable due to the year of starting in time series data are from 1981 and 1976 respectively, this was not suitable for Vietnamese economy when Vietnam War ended in 1975, and it started innovation since 1986; and especially the law of FDI was enacted in the end of 1987. Therefore, FDI and export in Vietnam only can be significant after that few years.　Thus, the author believes that with the time series in this study starting from 1988, it will eliminate that limitation, and the conclusions of paper will probably make a contribution to the literature.

3. Methodology and data

The relationship between CO_2 emissions, FDI and economic growth is given below:

$$\ln CO_{2t} = \alpha_0 + \alpha_1 \ln FDI_t + \alpha_2 \ln GDP_t + \varepsilon_t \quad (1)$$

In this equation, ln denotes the natural logarithm and ε_t is the disturbance term; CO_2 is per capita carbon dioxide emissions measured in metric tons, GDP is per capita Gross Domestic Product, and FDI is per capita FDI measured in 2010 of constant US dollar.　This study will use time series data for the period 1988-2015, CO_2 emissions data is extracted from the World Bank, WDI (World Development Indicators), FDI data is collected from Ministry of Planning and Investment of Vietnam and GDP data is collected from General Statistic Office of Vietnam.

Equation (1) is then reformulated as the error - correction version of the ARDL model developed by Pesaran et al (2001).

$$\Delta(\ln CO_{2t}) = \alpha + \sum_{k=1}^{p} \varepsilon_k \Delta(\ln CO_{2t-k}) + \sum_{k=1}^{p} \varphi_k \Delta(\ln FDI_{t-k}) + \sum_{k=1}^{p} \phi_k \Delta(\ln GDP_{t-k}) + \delta_1 \ln CO_{2t-1} + \delta_2 \ln FDI_{t-1} + \delta_3 \ln GDP_{t-1} + \varepsilon_t \quad (2)$$

This methodology solved the non-stationary problem related to the time series data, the bounds test can be used irrespective of whether the variables are pure I(1), I(0) or mutually cointegrated. In addition, the properties of the ARDL approach are more effective in analyzing small samples than other approaches. Another advantage of this model is that the short-run and the long-run effects of the independent variables on the dependent variables are assessed simultaneously to distinguish between the short and long-run effects of the variables.

Equation (2) indicates that CO_2 emissions tend to be influenced and explained by its past values. The structural lags are established by using minimum Akaike's information criteria (AIC) and Schwarz information criterion (SIC). After regression of Equation (2), the Wald test (F-statistic) was computed to differentiate the long-run relationship between the concerned variables. The Wald test can be carried out by imposing restrictions on the estimated long-run coefficients of CO_2 emissions, FDI and GDP. The null and alternative hypotheses are as follows,

H_0 : $\delta_1 = \delta_2 = \delta_3 = 0$ (no long-run relationship)

Against the alternative hypothesis,

H_1 : $\delta_1 \neq 0$; $\delta_2 \neq 0$; $\delta_3 \neq 0$ (a long-run relationship exists)

The computed F-statistic value will be evaluated with the critical values tabulated in the Table CI (iii) of Pesaran et al. (2001). According to these authors, the lower bound critical values assumed that the explanatory variables x_t are integrated of order zero, or I(0), while the upper bound critical values assumed that x_t are integrated of order one, or I(1). Therefore, if the computed F-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we conclude that there is no long-run relationship between property and its determinants. Conversely, if the computed F-statistic is greater than the upper bound value, then x_t and its determinants share a long-run level relationship. On the other hand, if the computed F-statistic falls between the lower and upper bound values, then the results are inconclusive (Pesaran et al, 2001, p.301).

4. Empirical results

Unit root tests

The ARDL modeling starts with unit root tests to check the stationary status of all variables in the model and the order to its integration after differencing. This is to ensure that the variables are not I(2) or I(d) stationarity so as to avoid spurious results and ARDL approach could be applied to the model. The results of unit root tests (t-statistic) of 3 variables in the model under deterministic trend and intercept, and intercept only options are presented in Table 1. All variables in the model comprise a combination of cointegration I(0) and I(1), hence complied with the unit root test requirement to proceed for bounds testing procedure in the ARDL approach (Pesaran & Pesaran, 2009).

Table 1 Unit roots tests using ADF and AIC selection criteria

Var	With trend and intercept				With intercept only			
	level	1st Diff	2nd Diff	I(d)	level	1st Diff	2nd Diff	I(d)
lnco2	-3.85**	-4.88***		I(0)	0.45	-5.2***		I(1)
lngdp	-2.94	-4.81**		I(1)	-1.88	-3.57***		I(1)
lnfdi	-3.65**	-5.82***		I(0)	-5.93***	-5.16***		I(0)

Notes: the null hypothesis is that the time series is non-stationary, or contains a unit root. The asterisks ***, ** and * denote significance at 1, 5 and 10 per cent levels, respectively.

Cointegration results

Table 2 shows the determination of the lag length (p) of each variable in equation (2). To choose an optimal lag length, we use various system-wise methods such as AIC, SC, FBE, HQ and LR test. The results indicate that the lag length of one year is the best.

Table 2 Lag length selection criterions

Lag	LogL	LR	FPE	AIC	SC	HQ
0	37.15379	NA	0.003404	-2.846149	-2.698892	-2.807082
1	45.16671	13.35487*	0.001901*	-3.430559*	-3.234217*	-3.378469*
2	45.74609	0.917356	0.001975	-3.395508	-3.150080	-3.330396
3	46.01263	0.399801	0.002109	-3.334386	-3.039872	-3.256251
4	46.19425	0.257296	0.002273	-3.266187	-2.922588	-3.175030

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

With the selected lag lengths, we then test the existence of a long-run cointegrated relationship among the variables. Specifically, the null hypothesis of no long-run relationship ($H_0 : \delta_1 = \delta_2 = \delta_3 = 0$) in equation (2) is tested using an F-test with the critical value tabulated by Pesaran et al (2001). The result shows that with 1 lag (p =1), the calculated F - statistic is 5.02 that is higher than upper critical value of 4.85[3)] at 5% for unrestricted model with intercept and no trend;

3) With two regressors and unrestricted intercept and no trend, F-statistic for 5% critical value bounds is (3.79, 4.85), which is taken from Table CI (iii) in Pesaran et al. (2001) on p.300

therefore the null hypothesis of no cointegration can be rejected, indicating the existence of a stable long-run relationship among CO_2 emissions, GDP and FDI. At the same time, the diagnostics reveal that the ARDL model of equation (2) is stable (see Table 3, Panel C), supporting the choice of p=1 for this model.

To consider the significance of the lagged level variables in the error correction model in equation (2) explaining $\Delta lngdp_t$ and $\Delta lnfdi_t$ as long run forcing variables for $\Delta lnco_2$, we backtrack the dependent variable in the model as per ARDL functions and test for joint significance using F-statistic. Specifically, we change $\Delta lnco_2$ in equation (2) to $\Delta lngdp_t$ and $\Delta lnfdi_t$ respectively; the results show that the null of no conintegration cannot be rejected. Hence, the results suggest that the variables GDP_t and FDI_t can be treated as the "long-run forcing" variables for the explanation of CO_2.

The results have confirmed the cointegration among variables in the long-run, therefore the author will estimate the reduced-form solution of equation (2) in which first-differenced variables jointly equal zero. In the long run, all variables are statistically significant at the 1% level (Table 3, panel A). The long-run elasticity of CO_2 emissions with reference to GDP is 1.59, meaning that a 1% increase in per capita GDP is associated with a 1.59% increase in per capita CO_2; then the rapid economic growth in Vietnam has a detrimental effect on environmental quality. This suggests that Vietnam has not reached income level high enough to be able to reach the EKC turning points in a development trajectory; therefore the economic growth leads to an increase in the scale of economic activity and consequently, worse environmental quality. This outcome is consistent with Tang et al (2015) and Al-Mulali et al (2015). On the other hand, FDI has a slight negative impact on CO_2 emission (the coefficient is, -0.078); the increase in FDI inflows will result in decreasing slightly in per capita CO_2 emissions (about 7.8%) in the long run. Our result supports the neo-liberal argument that the influx of FDI is good for the environment and reduces pollution by transferring environment friendly technologies and production techniques from developed countries to Vietnam. Thus, the pollution haven hypothesis in Vietnam is rejected; this is in line with the findings of Tang et al (2015).

The error-correction model is estimated by the ARDL approach to capture the short run dynamic that may exist between the CO_2 emissions and its main determinants in Vietnam. The results in Panel B reveal that we fail to find any significant evidence about the effect of FDI on CO_2 in the short run; this result is supported by Tang et al (2015) when they could not find any relationship between FDI and CO_2 in the short-run in Vietnam. One of possible explanations for this insignificance is that it takes time for Vietnam to learn and adapt to the advanced technology and production techniques. Although the result of relationship between GDP and CO_2 of this paper is contrasting with Tang et al (2015) when they confirmed the existence of an inverted U-shaped relationship between CO_2 emissions and economic growth; however it is consistent with

Table 3 The long-run and short-run elasticities

Panel A: Normalized cointegrating vector - Long-run elasticities			
Variables	Coefficients	t-statistics	p-values
Constant	-10.5937	-47.90215***	0.0000
lngdp	1.5932	40.3849***	0.0000
lnfdi	-0.0781	-2.8899***	0.008
Panel B: Vector error correction model- Short-run elasticities			
Variables	Coefficients	t-statistics	p-values
Constant	-0.0149	-0.3772	0.7097
Δlnco2	0.3838	2.4465**	0.0233
Δlngdp	1.2205	1.4858	0.1522
Δlnfdi	-0.0094	-0.4161	0.6815
ε_{t-1}	-0.382	-2.2275**	0.037
Panel C: Diagnostic tests			
Serial correlation	[1] 0.1752 (0.6166) [2] 1.3879 (0.1940)		
Heteroskedasticity	[1] 0.5249 (0.7176) [2] 1.1036 (0.3406)		
Normality	[1] 1.6342 (0.4416) [2] 1.3412 (0.5114)		
RESET	[1] 0.3779 (0.7099) [2] 0.3252 (0.8071)		
CUSUM	[1] stable [2] stable		
CUSUMSQ	[1] stable [2] stable		

Note: The asterisks ***, ** and * denote significance at 1, 5 and 10% levels, respectively. [1] Long-run model, [2] Error correction model

Al-Mulali et al (2015).

The negative coefficient and significance of ε_{t-1} error-correction term (ECT) ensure that the long-run equilibrium can be achieved; the absolute value of ECT indicates the speed of adjustment to equilibrium. The result indicates that ECT is negative and it is significant; hence the speed of adjustment of variables in order to achieve the long-run equilibrium is approximately 38% in a year. One explanation for this remarkable number is that Vietnamese economy is still in the initial stages of development; therefore so as to achieve the long-run equilibrium, the variables need to maintain high speed to adjust the equilibrium.

Ultimately, the diagnostic tests on the short-run model has applied, and the model is serially uncorrelated, heteroskedasticity, and normality. Furthermore, the Ramsey Reset test expresses that the model is correctly specified, and the CUSUM and CUSUMSQ tests to the residuals of the ECM model are stable over the sample period.

5. Conclusion

This paper has estimated the impact of FDI and GDP on CO_2 emissions in Vietnam by using time series data from 1988 to 2015 and employing Bounds Test approach. The analysis demon-

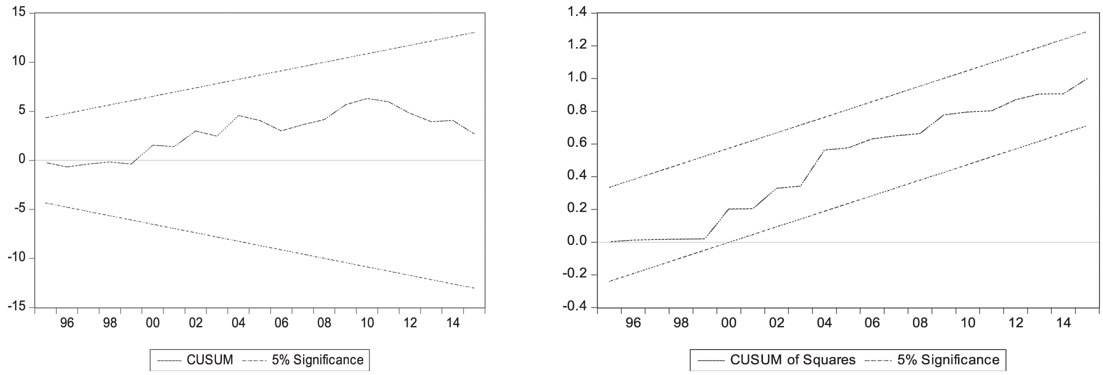

Fig.1. The plots of CUSUM and CUSUMSQ statistics

strates that in the long-run, the causality relationship is found among variables; GDP has a significantly positive impact on CO_2 emission while FDI has a slightly negative effect. However, in the short-run, the causality relationship cannot be found for all variables. In addition, the empirical result points out that the variables can achieve the long-run equilibrium, if the adjustment speed of them is approximately 38%. The results indicate that Vietnam economic development level has not reached the point where pollution can be reduced by the increase in GDP; at the same time, in the long run foreign investors in Vietnam, they are supported to enhance the quality of environment in Vietnam. Thus, the Vietnamese government while offering an inductive business environment to attract FDI should set proper policies on environmental planning and transfer of green technologies to ascertain the commitment of investors to environmental responsibility, energy, and wider sustainability in the country.

However, this study has quite a few limitations which should influence the outcomes, such as small number of observations, even the ARDL methodology is applied so as to avoid this disadvantage; real per capita FDI is an independent variable whereas it is considered less reliable in the most real economic analysis, and likely the omitted of other variables such as energy consumption (Tang et el. 2016, Al-Mulali et al 2015), factor demand, and technology intensity (Ramstetter et el. 2013). For further research, it should be possible to explore panel estimates across regions in Vietnam by adding such data as well as other waste emissions and ownership data to gain more understanding of the issues.

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