Applying Vector Error Correction Model to analyze the bi-directional linkage between FDI and pillars of sustainable development in Vietnam

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Abstract

FDI and sustainable development are considered as two topics of interests of such developing countries as Vietnam. In the current circumstance, they are not independent but closely linked to each other. Despite this fact, there seems to be little researches, especially quantitative ones, which have clarried this bi-directional relationship between FDI and sustainable development as a system of three pillars (economic growth, society and environment). Applying Vector Error Correction Model (VECM), regarded as an efficient model to look into this linkage in both short and long-term, the paper provided the specific evidence to prove for the existence of the impact of FDI on particular pillars of sustainable development and vice versa.

JEL classification: F21, F63, F64

Keywords: Foreign direct investment, Sustainable development, Economic growth, Society, Environment.

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1. Introduction

Sustainable development was defined in the Law on Environmental Protection, Article 3, Title 4 in 2005 as follows: "Sustainable development means development that meets the needs of the present generation without harming the capability of meeting those of future generations on the basis of close and harmonious combination of **economic growth**, assurance of **social advancement** and **environmental protection**". Therefore, in order to reach the target of sustainable development, it is necessary for a country to achieve the three goals related to economic, social and environmental aspects. Especially for Vietnam, the Sustainable Development Strategy for the period of 2011-2020 clearly affirms the future development towards sustainability of the country in the coming years.

Foreign direct investment (FDI) is one of financial flows which plays a considerable role to countries worldwide, particularly for such developing countries as Vietnam. This private flow has made a great contribution to the addition to the total capital of the country as its domestic capital amount is still small, also to the facilitation for the country to get new technologies, the increase of the technology transfer activities, the improvement of management, production skills of labors, and the enhancement of social lives of citizens. Despite that fact, FDI has also had many negative effects on Vietnam' society and environment in the previous years. The issues of environmental pollution such as the serious water pollution caused by Vedan, Formosa and many other FDI invested enterprises have raised an urgent need to have a comprehensive study about the relationship between FDI and sustainable development in Vietnam.

Applying the Vector Error Correction Model, the great advantage of which is that there is no need to deal with the endogeneity problems in both short and long run, the author has found the evidence to clarify the bi-directional linkage between FDI and three pillars of sustainable development.

The next sections of the paper are as follows: Section 2 considers the literature review. Then, section 3 mentions database. Section 4 comes with the research model and ethodology. The final section is the conclusion.

2. Literature review

Sustainble development is usually considered as a comprehensive system of three pillars (economic growth, society and environment). As a result, at the beginning, researchers usually look into this topic from the perspective of each pillar. Therefore, for the purpose of clarifying the literature review, at first, the author looks into the relationship between FDI and each pillar of sustainable development, then between FDI and sustainable development in general.

2.1 FDI and economic growth

Researches about the impact of FDI on economic growth or vice versa (the effect of economic growth on FDI) have been done by many economists about countries in the world and Vietnam as well. In addition, there also exist a number of studies regarding the two-way linkage between these two variables, especially empirical ones with different results applying various research methodologies. Some of typical works could be the paper of Tsai (1994) *about "Determinants of FDI and its impact on economic growth"*, Berthelemy and De´murger (2000) about *"Foreign Direct Investment and Economic Growth: Theory and Application to China"* , Bende-Nabende et. Al. (2001) about *"FDI, regional economic integration and endogenous growth: some evidence from Southeast Asia"*, or Lee (2009) *"Foreign Direct Investment, Pollution and Economic Growth: Evidence from Malaysia"*. For Vietnam, the researches of Nguyen Phu Tu and Huynh Cong Minh (2010) about *"The relationship between foreign direct investment and economic growth in Vietnam"* and Nguyen Dinh Chien and Ho Tu Linh (2013) about *"Is There Strong Bidirectional Causality between FDI and Economic Growth? New Evidence on Vietnam"* are two of the outstanding researches about the bi-directional linkage between FDI and economic growth.

2.2 FDI and society

The relationship between FDI and sustainable development from the social perspectives has been greatly concerned by the economists in the world in general and in Vietnam in particular. However, based on the author's knowledge, rarely is there any research on the two-way linkage between FDI and society (the impact of FDI on society and vice versa) in the world and Vietnam as well. The existing researches only cover the influence of FDI on specific aspects of society such as annual income, working condition,

poverty, inequality in income distribution, human development index or influence of some social factors on FDI inflows to host countries.

2.3 FDI and environment

There have been up to now some researches on the relationship between FDI and environment. The remarkable researches include *"FDI and Pollution: a Granger Causality Test Using Panel Data"* by Hoffman and colleagues (2005), *"Multivariate Granger Causuality Between CO2 Emmisions, Energy Consumption, FDI (Foreign Direct Investment) and GDP (Gross Domestic Product): Evidence Form a Panel of a BRIC (Brazil, Russian Federation, India and China) Countries"* by Pao and Tsai (2011) and so on. Depending on the selected samples and researching methods, these researches have found dispersed results. In specific, they have made different policy recommendations based on the characteristics of foreign investors and host countries. About Vietnam, the most famous and the only perceived by the author regarding this subject belonged to Dinh Hong Linh and Lin (2014) using data from 1980 to 2010 and applying different analyzing techniques.

2.4 FDI and sustainable development

Based on the author's knowledge, up until now, there has been no quantitative research on the bi-directional linkage of FDI and sustainable development as a system of three important pillars in the world and Vietnam. As a result, the author hopes to narrow this research gap.

2. Database

Given the concern of identifying relationship between FDI and sustainable development as a system of three pillars, the author collected secondary data from official sources. As it is impossible to consider all the elements contributing to each pillar, the author only relied on the variables which are available across the longest time-series (from 1970 to 2012). Data of each variable has been obtained from trustworthy sources, which are as follows:

Data of **Foreign direct investment (FDI) inflow in Vietnam** (**fdi**) was taken from World Developent Indicators provided by the World Bank. The value of FDI inflow is net

value calculated from the Balance of payment and measured in USD at the time of consideration.

Data of **Gross Domestic Product (GDP) of Vietnam** (**gdp**) was collected from the online database of the United Nations Conference on Trade and Development (UNCTAD). The value of GDP was measured by the price and exchange rate against US Dollars at the time of consideration. The unit measurement was million USD.

Data of **greenhouse gases (GHG) of Vietnam** (**ghg**) was taken from World Development Indicators introduced by the World Bank. The total amount of greenhouse gas was measured in the amount of CO2 emission equivalent (the unit of measurement was kilo tonne - kt). This was used as a variable to reflect the environmental condition in Vietnam.

Data of **life expectancy at birth in Vietnam** (**life**) was also collected from World Development Indicators. The unit of measurement was year. This variable was used as a proxy for living improvement of citizens, which is an aspect of society.

The summary of the data was included in table 1.

Table 1: Summary statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
fdi	46	2.23e+09	3.34e+09	-890000	1.18e+10
gdp	45	35317.9	48770.98	1884.65	186598.5
ghg	43	140673.6	70875.72	77395.27	310664.1
life	45	69.795	4.977727	59.02161	75.62912
year	46	1992.5	13.42262	1970	2015

Source: author's calculation

2. Research model and methodology

With the purpose of clarifying the relationship between FDI and sustainable development as a comprehensive system of three pillars proxied by three variables (Gross domestic products, Total greenhouse gas and Life expectancy at birth – three variables with the available data) across years, the author applied the Vector Error Correction Model (VECM). This is a popularly used model as the relationship among endogenous variables (those affecting each other) are of interest in short and long term. Moreover, the author did different tests to choose the suitable model for the analysis of the relationship. Those tests

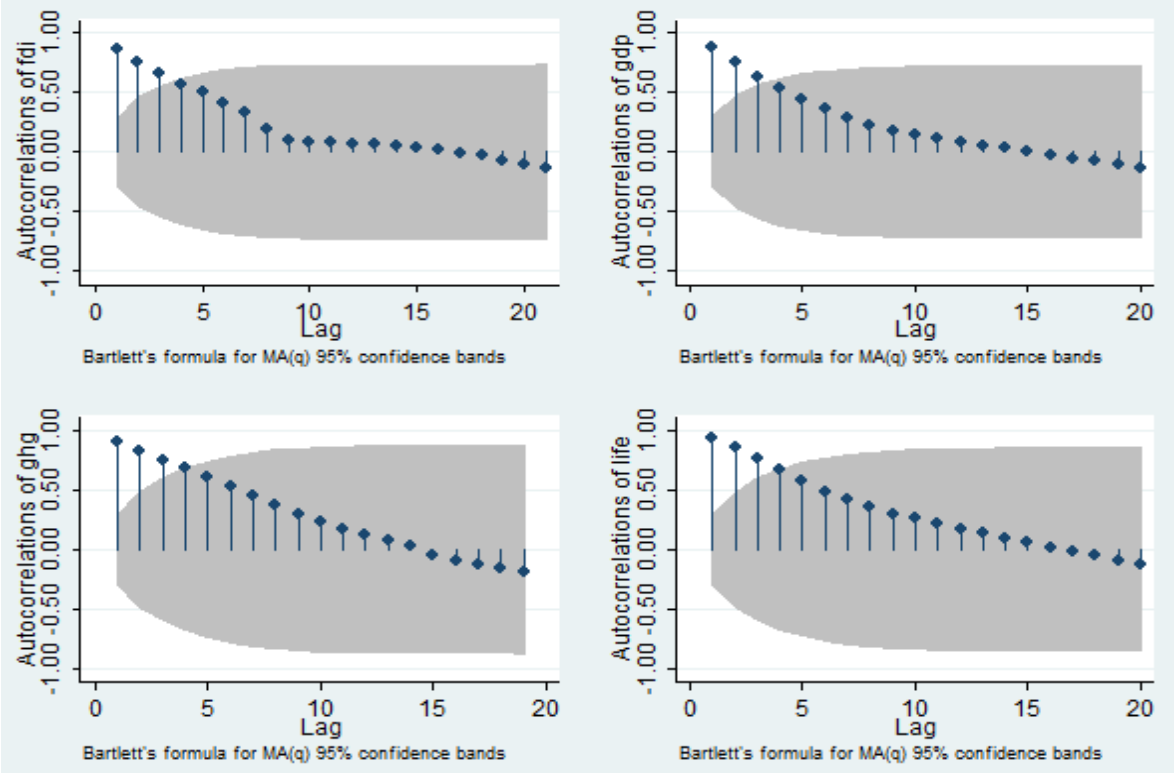
include *(1) Test of autocorrelation, (2) Unit root test, (3) Selection-order criteria and (4) Johansen cointegration test.*

2.1 Test of autocorrelation

One popular and serious problem ocurring with time-series data is autocorrelation. This happens when residual u_t has a significant correlation with residuals of previous years $u_{t-1}, u_{t-2}, \dots u_{t-p}$ (p is number of years before t) in the regression equation $Y_t = \beta_0 + \sum_{i=1}^{n}(\beta_i \times X_i) + u_t$. It leads to the bias in estimated value using Ordinary Least Squares (OLS).

Given the collected data, the author estimated the impact of three pillars of sustainable development on FDI using Ordinary Least Square (OLS) method. As presented in Appendix 1, it is apparent that the value of R^2 (R-squared) and adjusted R^2 (adjusted R-squared) are quite high (87%), signaling the existence of the autocorrelation of residuals u_t across time.

Figure 1 Correlation of residuals across time of FDI, GDP, GHG và LIFE



Source: The author's calculation

In addition, according to Figure 1 on the autocorrelation of residuals across time of different time-series, it can be observed that the autocorrelation occurs in all series. We could see that the longer the duration, the weaker the autocorrelation. The strongest autocorrelation happens in the period of 2 or 3 years before the time of consideration.

For further examining this phenomenon of autocorrelation, the author has used Breusch – Godfrey LM test (null hypothesis (H_0) means there is no autocorrelation among residuals). In table 1, with p-value = 0, the null hypothesis is rejected, meaning that the autocorrelation among residuals exists. Therefore, it is very important to deal with this problem before estimation.

Table 1 Breusch-Godfrey LM test result about autocorrelation

lags(p)	chi2	df	Prob > chi2
1	17.258	1	0.0000

Source: The author's calculation

2.2 Unit root test

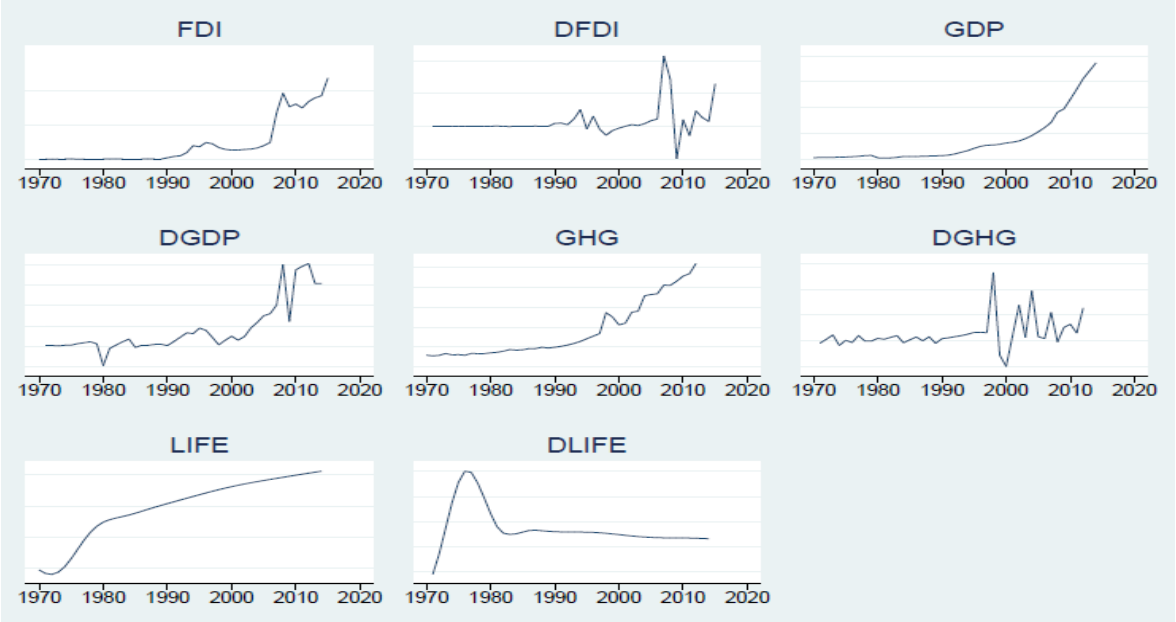
Unit root test is also important test to check the stationarity of time series data in the research. This kind of unit root test will help determine if the regression result (especially when the value of R^2 is high) is real or just created by trend (leading to the unreal estimates).

The idea of unit root test is to figure out if the coefficients of estimated variables are equal to 1. For example, we assume the estimated model to be $Y_t = \rho Y_{t-1} + u_t$ (meaning that the value of Y_t depends on that of Y in the previous period of Y_{t-1}). With the assumption of the random residual of u_t, if the obtained coefficient is that $\rho = 1$ (existence of unit root), our time series is non-stationary, then the estimated equation will be $Y_t - Y_{t-1} = (\rho - 1)Y_{t-1} + u_t \leftrightarrow \Delta Y_t = DY_t = \delta Y_{t-1} + u_t$. In this case, the null hypothesis (H0) is $\delta = 0$. If $\delta = 0$ is supported, then $\Delta Y_t = DY_t = u_t$. That is regarded as the case that the first difference $(\Delta Y_t / DY_t)$ of a non-stationary Y_t will be a stationary time series. That means the time series of Y_t is considered to be integrated of order 1, or I(1).

In the case that we need to take differences twice or more times (i.e p times) to achieve a stationary time series, that kind of series is intergrated of order p, or I(p).

According to Figure 2 presenting the change across time of the initial time series, it could be seen that there seems to be deterministic trends. However, for the first-difference series, their values do not follow specific trend. This signals the existence of the time series with the integration order of 1.

Figure 2 The changes across time of FDI, GDP, GHG, LIFE and their first differences of DFDI, DGDP, DGHG, DLIFE



Source: The author's calculation

The Augmented Dickey Fuller is the popularly used test for stationarity. The null hypothesis (H0) of this test is that there exists no unit root. The ADF test results in Appendix 2 show that for all initial series, these null hypotheses are not rejected, meaning that all of them are non-stationary. Nevertheless, for all first-difference time series, the null hypotheses are stationary. Therefore, all of the considered time series are integrated of order 1. Then, as they are put into the research model, the final model is integrated of order 1 (I(1)).

2.3 Selection-order criteria

After the structure of the final model is determined to be integrated of order 1, the selection-order is also necessary to be clarify based on specific criteria. The possible criteria are Likelihood-ratio (LR), Akaike information criterion (AIC), Hannan and Quinn Information Criterion (HQIC), and Schwarz' Bayesian Information Criterion (SBIC). With a not-too-long time series, Schwarz' Bayesian Information Criterion (SBIC) is considered

to be the best choice. Based on this criterium, the suitable number of lags is 3 (years) (see Appendix 3).

2.4 Johansen cointegration test

Johansen test for the cointegration of different time-series is one of the most widely applied tests due to the fact that the test results will show if the short and long-term relationships of these series exist or not. According to Johansen method, the results of Trace statistics are also the most frequently considered. The null hypothesis of this test (H)) is that there is at most r cointegrations (r takes the value of 0, 1, 2…).

From the Johansen test results of cointegration in Appendix 4, it is clear that as r=0 (H0: there exits no cointegration), the value of trace statistics is 79.4093, higher than the critical value at 5%, meaning that H0 is rejected. Similarly, the null hypothesis of r=1 (existence of 1 cointegration) is also rejected. Nevertheless, as r=2, the value of trace statisics is smaller than the critical value, showing that there are two cointegrations in long-term. This test result proves for the neccessity of a suitable method to be able to consider the possible cointegrations in long-run. The most appropriate one is Vector Error Correction Model (VECM).

2.5 Contruction of the research model on the basis of Vector Error Correction Model (VECM)

Theoretically, Vector Error Correction Model (VECM) for multi-variables is constructed on the basis of Vector Autoregressive Model (VAR). The VAR with p lags is as follows:

$$\boldsymbol{y}_t = \boldsymbol{v} + \boldsymbol{A}_1\boldsymbol{y}_{t-1} + \boldsymbol{A}_2\boldsymbol{y}_{t-2} + \cdots + \boldsymbol{A}_p\boldsymbol{y}_{t-p} + \varepsilon_t$$

In which $\boldsymbol{y}_t$ is a vector of considered variables (Kx1), $\boldsymbol{v}$ is a vector of parameters (Kx1), $\boldsymbol{A}_1 - \boldsymbol{A}_p$ are matrixes of parameters (KxK) and ε_t is a vector of error/noise. From this above VAR, a VECM with the deterministic trend could be constructed as:

$$\Delta\boldsymbol{y}_t = \boldsymbol{v} + \Pi\boldsymbol{y}_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \, \Delta\boldsymbol{y}_{t-i} + \delta t + \varepsilon_t$$

In which $\Pi = \sum_{j=1}^{j=p} \boldsymbol{A}_j - I_k$, $\Gamma_i = -\sum_{j=i+1}^{j=p} \boldsymbol{A}_j$, δ is a vector of parameters (Kx1) reflecting the trends of variables across time.

From this general equation, the model to look into the bi-directional linkage between FDI and 3 pillars of sustainable development proxied by three variables is as follows:

$$\begin{pmatrix} \Delta fdi_t \\ \Delta gdp_t \\ \Delta ghg_t \\ \Delta life_t \end{pmatrix} = \boldsymbol{v} + \Pi \begin{pmatrix} fdi_{t-1} \\ gdp_{t-1} \\ ghg_{t-1} \\ life_{t-1} \end{pmatrix} + \sum_{i=1}^{p-1} \Gamma_i \begin{pmatrix} \Delta fdi_{t-1} \\ \Delta gdp_{t-1} \\ \Delta ghg_{t-1} \\ \Delta life_{t-1} \end{pmatrix} + \delta t + \varepsilon_t$$

(From the test results of the previous section, the value of p is 3).

3. Research results

From the Vector Error Correction Model (VECM) applied as above mentioned with 3 lags and 2 cointegrations for 4 time series), the research results regarding the relationship of interested variables are made clear in the following subsections:

3.1 Results for the long-term relationship

Table 2 illustates the long-term relationship of variables as follows:

From the *first cointegration equation* (_ce1), it could be shown that FDI and life have significantly positive correlation. In particular, as the life expectancy of citizens increase, FDI into Vietnam will also rise up. In other words, in long-term, foreign investors pay high attention to social life of people living in host countries.

The *second cointegration equation* (_ce2) presents the long-term relationships among pillars of sustainable development which are statistically significant. However, under the coverage of this paper, the author does not analyze in details these types of linkages.

Table 2 Results of long-term cointegratioins among variables

Cointegrating equations

Equation	Parms	chi2	P>chi2
_ce1	2	3.300834	0.1920
_ce2	2	128.0598	0.0000

Identification: beta is exactly identified

Johansen normalization restrictions imposed

beta	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_ce1						
fdi	1	.	.	.	.	.
gdp	0	(omitted)				
ghg	-8095.57	7509.828	-1.08	0.281	-22814.56	6623.422
life	1.52e+08	8.42e+07	1.81	0.071	-1.27e+07	3.17e+08
_cons	0	(omitted)				
_ce2						
fdi	1.27e-21	.	.	.	.	.
gdp	1	.	.	.	.	.
ghg	-.2678955	.0524319	-5.11	0.000	-.3706602	-.1651308
life	-3548.273	587.6246	-6.04	0.000	-4699.996	-2396.55
_cons	32524.33	.	.	.	.	.

Source: The author's calculation

3.2 Results for the short-term relationship

For the purpose of better clarifying the short-term relationship, the author will setting contraints for coefficients with the application Johansen normalization method. The base for normalization is determined from the long-term results in Table 3.

From the values of coefficients according to two equations of _ce1 và _ce2 (showing the long-term cointegrations), *for the first equation*, the coefficient of fdi is restricted to be 1, gdp to be 0, ghg to be statistically insignificant. *For the second equation*, that of gdp is restricted to be 1, fdi to be statistically insignificant (equal to 0). From these points, we will have the following configuration: (i) constraint 1 [_ce1]fdi= 1; (ii) constraint 2 [_ce1]gdp = 0; (iii) constraint 3 [_ce1]ghg = 0; (iv) constraint 4 [_ce2]fdi = 0; (v) constraint 5 [_ce2]gdp = 1

The result of LR test for overidentifying restrictions points out that the value of chi2(5) is equal to -49.87 (Prob > chi2 = 1.000), meaning that the null hypothesis of the suitability of contraints could not be rejected. Hence, the setting up different constraints in accordance with Johansen normalization method is appropriate.

For the aim of considering the bi-directional linkage between FDI and pillars of sustainable development, the author focuses on the impact of FDI on each pillar and vice versa. Table 3 gives evidence for the short-term relationship.

Table 3 The result of short-term relationship among variables

	D_fdi	**D_gdp**	**D_ghg**	**D_life**
	(1)	(2)	(3)	(4)
LD.fdi	**0.618*** **	**1.05e-06***	-2.56e-06	0
	(0.177)	(6.16e-07)	(3.09e-06)	(0)
L2D.fdi	-0.477***	**-2.64e-06*** **	1.07e-06	**0****
	(0.171)	(5.95e-07)	(2.98e-06)	(0)
LD.gdp	27,477	0.00131	1.150	-3.89e-06**
	(60,171)	(0.209)	(1.048)	(1.53e-06)
L2D.gdp	**297,681*** **	0.888***	0.759	-4.06e-06***
	(58,404)	(0.203)	(1.017)	(1.48e-06)
LD.ghg	-8,709	0.0328	-0.215	5.15e-07*
	(10,959)	(0.0381)	(0.191)	(2.79e-07)
L2D.ghg	-12,315	0.00843	-0.296	4.02e-07
	(11,160)	(0.0388)	(0.194)	(2.84e-07)
LD.life	-3.998e+08	1,483	-2,826	1.549***
	(1.086e+09)	(3,771)	(18,913)	(0.0276)
L2D.life	2.533e+08	-1,918	408.8	-0.759***
	(8.820e+08)	(3,063)	(15,362)	(0.0224)
Observations	40	40	40	40

(Vector Error Correction Model is considered. ***/**/* denote the significant level of 1%/5%/10% of t-statistics)

Source: The author's calculation

About the impact of pillars of sustainable development on FDI, the only variable having a positive and significant effect is L2D.gdp – 2 years difference in GDP. This makes sense as foreign investors do care about Vietnam's economic growth in previous years.

About the impact of FDI on pillars of sustainable development, FDI has a statistical significant effect on GDP (as a proxy for the economic pillar of sustainable development) and Life (as a proxy for the social pillar of sustainable development). In particular, *from the economic perspectives*, the increase in FDI leads to the higher economic growth (the variable of LD.fdi in equation (2)). On the contrary, the rise in FDI in the previous years makes economic growth reduce (the variable of L2D.fdi). This could be a signal indicating that FDI could cause negative effects on economic growth as longer time is taken into consideration. *From the social perspectives,* the boost in FDI leads to the going up of Life expectancy at birth (the variable of L2D.fdi in equation (4)). Despite the fact that the magnitude of the coefficent is quite small and nearly equatl to 0, the significant sign still proves for the possible existence of positive effect in a longer duration.

5. Conclusion

Foreign direct investment and sustainable development are two among hot topics attracting much attention of countries worldwide and Vietnam as well. Particularly for Vietnam, the orientation of the FDI attraction and sustainable development achivement are clearly mentioned under Vietnam's key legal regulations such as the ones provided in Resolution No.103/NQ-CP issued on 29/8/2013 regarding the orientation to improve efficiency of attracting, using and managing foreign direct investment (FDI) in the coming time and under the Decision 432/QĐ-TTg of Prime Minister on approving the Viet Nam Sustainable Development Strategy for the 2011-2020 affirmed the opinions and orientations to put a priority on sustainable development. Therefore, it could be estimated that FDI attraction and sustainable development enhancement are continued being maintained.

However, foreign direct investment (FDI) and sustainable development are not usually considered separately because there could exist a close linkage among them. FDI could itself have either positive or negative effect on three pillars of sustainable development (economic growth, society and environment). In their turns, the three pillars could either such kind of effect on FDI.

The author applied Vector Error Correction Model (VECM) in order to have a good base for the assessment of the relationship between FDI and all three pillars of sustainable development. The quantitative results indicated the existence of the short and long-run impacts of FDI on each pillar and vice versa. In accordance with the above descriptive analysis, the author made overall assessment on the relationship between FDI and sustainable development via each pillar. Particularly, *about the impacts of foreign direct investment on sustainable development*, FDI really helps to raise economic growth in short run, improve the life quality of people, and have a balanced impact (between positive and negative) on environment. However, FDI in previous years could negatively affect economic growth. Besides, the effect of FDI on society is still small (despite being statistical significance). Moreover, the impact of FDI on environment, although still unclear, makes a warning about the negative effect in the future. *About the impacts of sustainable development on foreign direct investment in Vietnam*, economic growth and the improvement of social life help Vietnam to get more FDI. Nevertheless, economic growth growth has insignficant effect on FDI in long run, despite having significant one in short run. Moreover, determinants relating to society and environment does not positively affect FDI inflows in Vietnam.

REFERENCE

1. Nguyễn Phú Tụ và Huỳnh Công Minh (2010), *Mối quan hệ giữa đầu tư trực tiếp nước ngoài với tăng trưởng kinh tế của Việt Nam*, Kỷ yếu Hội nghị Khoa học và Công nghệ lần thứ 1, Trường Đại học kỹ Thuật và Công nghệ TP. Hồ Chí Minh.
2. Viện Nghiên cứu Quản lý Kinh tế Trung ương (CIEM) và các cộng sự. (2014), "Năng lực cạnh tranh và công nghệ ở cấp độ doanh nghiệp tại Việt Nam năm 2013".
3. Bende-Nabende Anthony và các cộng sự. (2001), "FDI, regional economic integration and endogenous growth: Some evidence from Southeast Asia", *Pacific economic review*. 6(3), tr. 383-399.
4. Berthélemy Jean-Claude và Demurger Sylvie (2000), "Foreign direct investment and economic growth: theory and application to China", *Review of development economics*. 4(2), tr. 140-155.

5. Dinh Hong Linh và Shih-Mo Lin (2014), "CO2 emissions, energy consumption, economic growth and FDI in Vietnam", *Managing Global Transitions*. 12(3), tr. 219-232.
6. Hoffmann Robert và các cộng sự. (2005), "FDI and pollution: a granger causality test using panel data", *Journal of international development*. 17(3), tr. 311-317.
7. Lee Chew Ging (2009), "Foreign direct investment, pollution and economic growth: evidence from Malaysia", *Applied Economics*. 41(13), tr. 1709-1716.
8. Nguyen Dinh Chien và Ho Tu Linh (2013), "Is There Strong Bidirectional Causality between FDI and Economic Growth? New Evidence on Vietnam", *Journal of Transformative Entrepreneurship*. 1(1), tr. 25-38.
9. Pao Hsiao-Tien và Tsai Chung-Ming (2011), "Multivariate Granger causality between CO 2 emissions, energy consumption, FDI (foreign direct investment) and GDP (gross domestic product): evidence from a panel of BRIC (Brazil, Russian Federation, India, and China) countries", *Energy*. 36(1), tr. 685-693.
10. Tsai Pan-Long (1994), "Determinants of foreign direct investment and its impact on economic growth", *Journal of economic development*. 19(1), tr. 137-163.

APPENDIX

Appendix 1 The estimation results of the impact of pillars of sustainable development on FDI using OLS

Source	SS	df	MS
Model	2.6789e+20	3	8.9297e+19
Residual	3.6668e+19	39	9.4021e+17
Total	3.0456e+20	42	7.2514e+18

Number of obs	43
F(3, 39)	94.98
Prob > F	0.0000
R-squared	0.8796
Adj R-squared	0.8703
Root MSE	9.7e+08

fdi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
gdp	67620.09	12408.05	5.45	0.000	42522.44	92717.74
ghg	-1538.471	7842.032	-0.20	0.845	-17400.48	14323.54
life	1.36e+07	4.90e+07	0.28	0.783	-8.55e+07	1.13e+08
_cons	-9.78e+08	2.93e+09	-0.33	0.740	-6.91e+09	4.95e+09

(The estimation is done using Ordinary Least Squares - OLS)
Source: The author's calculation

Appendix 2 Unit root test results of Augmented Dickey-Fullerg

No.	Series	Z(t) value	p-value for Z(t) with regard to MacKinnon
1	FDI	-0.566	0.9806
2	**DFDI**	**-5.313**	**0.0001**
3	GDP	6.103	1.0000
4	**DGDP**	**-3.300**	**0.0663**
5	GHG	-0.775	0.9677
6	**DGHG**	**-7.467**	**0.0000**
7	LIFE	-0.790	0.9666
8	**DLIFE**	**-4.183**	**0.0077**

(Constant and trends are controlled for.)

Source: The author's calculation

Appendix 3 Selection criteria

Lag	LR	df	p	AIC	HQIC	SBIC
0				95.7755	95.8367	95.9461
1	503.35	16	0.000	83.6897	83.9958	84.5428
2	83.873	16	0.000	82.3596	82.9106	83.8952
3	170.08	16	0.000	78.8192	79.615	81.0373*
4	48.074*	16	0.000	78.4071*	79.4478*	81.376

(LR: Likelihood-ratio, AIC: Akaike information criterion, HQIC: Hannan and Quinn Information Criterion, SBIC: Schwarz' Bayesian Information Criterion. Các biến nội sinh: fdi, gdp, ghg, life)

Source: The author's calculation

Appendix 4 Johansen cointegration test results

Trend: constant — Number of obs = 40
Sample: 1973 - 2012 — Lags = 3

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	36	-1578.5459	.	79.4093	47.21
1	43	-1557.4189	0.65228	37.1553	29.68
2	48	-1545.1821	0.45765	12.6817*	15.41
3	51	-1541.262	0.17799	4.8415	3.76
4	52	-1538.8413	0.11400		

Source: The author's calculation