Analysis of the impact of foreign direct investment and trade liberalization
In the quality of the environment and the use of clean energies:
Study of selected developing countries

Monire Khayamnia [1] **Faculty Member of Higher Education Institute of Daneshpajoohan Pishro, Isfahan**
khayamnia@daneshpajoohan.ac.ir
Sanaz Younespour, PhD in International Economics, Department of Economics, Faculty of Administrative Sciences and Economics, Isfahan University
s.younespour@gmail.com

Abstract

Foreign direct investment and increasing the volume of trade is known as a suitable source for capital accumulation and promotion of economic growth in developing countries. On the other hand, there is also the possibility that with the increase in economic growth and scale of production and as a result of energy consumption, environmental destruction will become more visible in these countries. For this reason, this research examines the effect of foreign direct investment and trade liberalization on carbon dioxide emissions and the use of clean energy in selected developing countries during the period 1971 to 2014 using the ARDL panel approach. The findings of this research show that despite the positive and significant effect of foreign direct investment on the use of clean energy and economic growth, this variable has not had a significant effect on the destruction of the environment in the studied countries. On the other hand, the results showed that trade liberalization has a positive and significant relationship with carbon dioxide emissions, while this variable has a negative and significant effect on clean energy consumption. Finally, the results of the study indicate that the speed of adjustment towards long-term equilibrium in this model is relatively slow.

Keywords: Foreign direct investment, Trade liberalization, Environmental quality, Clean energy, Economic growth

Classification JEL : Q2,، E24, C33

1-Corresponding Author

1. Introduction

Since the Kyoto Protocol negotiations were held in 1997, during which industrialized countries committed to reducing greenhouse gases, the importance and necessity of environmental research has increased. On the other hand, with the expansion of financial and commercial globalization and the mutual connection of countries, developing countries are bound to attract foreign capital and compete in international trade. In this context, foreign direct investment and international trade are among the channels of financial provision and transfer of technology and resources at the international level, which in addition to affecting economic growth, can directly and indirectly affect the quality of the environment and energy use. Foreign direct investment is a suitable source for capital accumulation It is followed by promotion of economic growth, But following the economic growth and increase in production scale, and as a result, the increase in energy consumption, environmental pollution and environmental destruction are more visible. On the other hand, the most important effects of foreign investment in comparison with domestic investment is its effect on the transfer of modern technologies and advanced technical knowledge in the host country. Although the improvement of the capital factor leads to an increase in the volume of economic activities and ultimately economic growth, from the environmental aspect, the change and increase of this factor should not be overlooked. On the other hand, based on all theories of economic growth, energy is an effective factor in economic growth, the increase in production and consumption of which has a direct relationship with all types of investment, especially foreign direct investment; but, due to the negative environmental effects caused by energy consumption, the attention of economic theories has been focused on the relationship between economic growth and environmental destruction. In recent years, developing countries with high economic growth have faced many challenges in the field of environment, which has caused many concerns in these countries. Many experts relate this volume of pollution to the presence and investment of foreign companies in these countries. On the other hand, some other people argue that the best way to ensure the improvement of the environment of developing countries is to use the necessary tools such as foreign direct investment to become a prosperous country.

With these explanations, the question is raised, what effect does direct foreign investment and trade liberalization have on economic growth, environmental quality, and the use of high-clean energy in developing countries?

In the continuation of this research, after the theoretical foundations and background of the research, the research model has been introduced in the fourth part. The fifth section is devoted to the introduction of data and information, and the sixth section describes econometric methodology. In the seventh part of the study, the results and findings of the model have been analyzed. Finally, the last part of the study is the conclusion of political institutions.

2. Theoretical foundations

2.1 Foreign direct investment and environmental quality

Foreign direct investment can indirectly affect the environment through economic growth. Although most of the studies conducted in this field indicate that there is a positive relationship between economic growth and foreign direct investment and energy consumption, and as a result, foreign direct investment by increasing economic growth causes more energy consumption and ultimately, an increase becomes pollution; there are some contradictory results. For example, some argue that despite the relationship between foreign direct investment and economic growth, the relationship between economic growth and energy consumption depends on the performance of the countries that have been

analyzed, as a result, it is possible that foreign direct investment will not cause more pollution despite increasing economic growth (Huang et al. 2008; Costantini and Martini 2010). Therefore, some studies show that the relationship between economic growth, energy consumption, and CO2 emission can be different according to different stages of economic growth (Soytas and Sari 2009).

2.2 Foreign direct investment and use of clean energy

In recent years, efforts have been made to use energy optimally in all countries; however, in developing countries, due to high population growth, increase in economic activities, and increase in excessive use of energy resources, destruction and pollution of the environment is considered a fundamental problem. This is mostly due to the use of fossil fuels and not using clean or alternative energies in these countries. Therefore, in recent years, the use of clean or alternative energy has been prioritized in many countries (Popp et al. 2010).

The most important effects of foreign investment in comparison with domestic investment is its effect on the transfer of up-to-date technologies and advanced technical knowledge in the host country, which gradually helps to increase the technological capabilities of the host country. n this regard, some economic theories state that the entry of foreign direct investment (FDI) into the host country reduces pollution and improves the quality of the environment through the use of more clean energy; Because according to Porter hypothesis, the entry of foreign direct investment as a factor of production accelerates the economic growth of the host country and also provides the access of the host country to efficient and clean technology in protecting the environment (Strazicich and List 2003).

2.3 Trade liberalization and environmental quality

Among the important issues in economic policy in recent years is the emergence of trade liberalization and its consequences on environmental issues .Trade liberalization includes the policies of opening the doors of the economy and reducing trade barriers and tariffs. Although trade may cause growth, it can lead to increased pollution by transferring and relocating polluting industries from countries with strict environmental laws or increasing polluting production (Aralas 2010). Although commercial liberalization has made the public and private sectors work more effectively and affects the intensity of their competition, it can have many negative effects on the environment and quality of life in other ways. It has been shown in a research that the increase in commercial efficiency has led to the destruction of the environment for a global sample (Le et al. 2016). In a study emphasizing the effects of the combined and technical scale resulting from the relationship between trade and the environment, it has been shown that Iran has a relative advantage in the trade of contaminated products (Tayebi and Younespour 2012). Another research in 55 middle-income countries shows that trade openness has a positive effect on the environment in the short term and a negative effect in the long term (Lv and Xu 2018). In a study of sixty developing and developed countries, it has been proven that trade openness improves the Environmental Performance Index (EPI), although it increases CO_2 emissions (Bernard and Mandal 2016).

2.4 Commercial liberalization and use of clean energy

One of the important issues regarding trade and energy management is its connection with the transportation network. On the other hand, international trade requires a wide transportation network, and moving goods using air, rail, road, and water transportation requires energy consumption. Therefore, an increase in the volume of trade requires an increase in economic activities, which also increases the demand for energy. In this regard, in a study, it was concluded that there is a positive long-term relationship between trade and energy consumption in Asia and the Pacific, Eastern Europe, America, the Middle East, North Africa, Sub-Saharan Africa, and Western Europe (.(Al-Mulali and Low Shea 2014). On the other hand, in developing countries, durable imported goods are the biggest

consumers of energy, and an increase in the volume of imports of these types of goods increases the demand for energy. In the long term, a one percent increase in exports and imports in Japan will increase electricity consumption by 24% and 22% in the long term, and 22% and 20% in the short term, respectively (Rafindadi and Ozturk 2015). For this reason, in recent years, the tendency to use clean energy in these products has increased. Also, in the case of high consumption of import substitute goods, trade liberalization, and as a result of increasing the import of goods with more efficiency in energy consumption, the amount of energy consumption will decrease.

3. Background of the research

3.1 Internal studies

In a study, Sadeghi et al. investigated the effect of increasing renewable energy consumption on GDP and carbon dioxide emissions using the structural autoregression model (SVAR) during the period from 1980 to 2012 in Iran (Sadeghi et al. 2016). In an article, Ghaffari et al. investigated the effect of wind energy consumption on economic growth and CO2 emissions in fourteen selected Asian countries using panel data from 2005 to 2013 (Ghaffari et al. 2015). Sadeghi and Mousavian in their studies using the maximum entropy bootstrap method and in the framework of the bivariate model concluded that there is a one-way causality relationship between GDP and carbon emissions, but in the framework of the multivariable model, there is no causality relationship between carbon emissions and production. Gross domestic product is not rejected (Sadeghi and Mousaviyan 2013).

3.2 Foreign studies

In a study using panel data and Blundell Band estimator, it was concluded that foreign direct investment widely leads to a decrease in energy consumption in non-renewable sources and an increase in energy consumption in renewable energies(Doytch and Narayan 2016). In another study using the panel data technique during the period 1990 to 2010 and for OECD countries, it was shown that the consumption of renewable energy or increasing its share in the total energy composition will have a positive and significant effect on economic growth (Inglesi-Lotz 2016). In an article using panel data and modified ordinary least squares (FMOLS), it was concluded that foreign direct investment has increased environmental destruction and the pollution haven hypothesis is confirmed (Shahbaz et al 2015). In another article, using panel data for 85 countries, there is a two-way causal relationship between energy consumption and economic growth, a two-way causal relationship between energy consumption and greenhouse gas emissions, and a one-way causality of greenhouse gas production. It is confirmed to economic growth (Saidi and Hammami2016).

4. Research model

The initial model is described as follows:

$$GDP = f (FDI, CO2, Energy, Clean energy, Trade) \qquad (1)$$

In this study, according to the studies Beak and Koo 2009 and Pao and Tsai 2011 Carbon dioxide emission is used to measure the quality of the environment.
In order to investigate the relationship between the mentioned variables, the primary equations are written as follows:

Abstract Deadline: November 14, 2023

Full Paper Deadline: November 24, 2023

Final Results: December 11, 2023

13th
International
Conference on
Sustainable
Development &
Urban Construction

$$\ln GDP_{c,t} = \beta_0 + \beta_1 \ln FDI_{c,t} + \beta_2 \ln TRADE_{c,t} + \beta_3 \ln CO_{2_{c,t}} + \beta_4 \ln ENERGY_{c,t} + \beta_5 \ln CENERGY_{c,t} + u_{c,t} \qquad (\text{٢})$$

$$\ln CO_{2_{c,t}} = \beta_0 + \beta_1 \ln FDI_{c,t} + \beta_2 \ln TRADE_{c,t} + \beta_3 \ln GDP_{c,t} + \beta_4 \ln ENERGY_{c,t} + \beta_5 \ln CENERGY_{c,t} + u_{c,t} \qquad (\text{٣})$$

$$\ln CENERGY_{c,t} = \beta_0 + \beta_1 \ln FDI_{c,t} + \beta_2 \ln TRADE_{c,t} + \beta_3 \ln CO_{2_{c,t}} + \beta_4 \ln ENERGY_{c,t} + \beta_5 \ln GDP_{c,t} + u_{c,t} \qquad (\text{٤})$$

$\ln GDP_{c,t}$ =Real per capita income in dollars at constant price of 2010 in country c in year t

$\ln FDI_{c,t}$ =The net flow of foreign direct investment per capita in dollars in country c and in year t

$TRADE_{c,t}$ =The ratio of total exports and imports to GDP in country c and in year t

$CO_{2_{c,t}}$ = Carbon dioxide emissions per capita based on metric tons in the country c and in year t

$ENERGY_{c,t}$ = The amount of energy consumption per capita is equivalent to a kilogram of oil per capita in the country c and in year t

$CENERGY_{c,t}$ = The amount of clean energy consumption is the same as a percentage of the total energy consumption in the country c and in year t

$u_{c,t}$ = Disturbance components

5. Data and information

Considering the limitation in accessing data and information, the spatial scope of this research is 26 The selected developing countries include Iran, Argentina, Brazil, China, Colombia, Costa Rica, Algeria, Egypt, Honduras, Indonesia, India, Sri Lanka, Morocco, Mexico, Malaysia, Nigeria, Pakistan, Panama, Philippines, Tunisia, Venezuela, Turkey, South Africa, Thailand, Iraq, and Bangladesh. Also, the time period investigated in this research is from 1971 to 2014 and the data of this research was collected from the World Bank and International Energy Agency website. As shown in Table 1, all variables have had an upward trend between 1971 and 2014. Table 2 also shows the average of the variables in the countries under review in the period from 1971 to 2014.

Abstract Deadline: November 14, 2023

Full Paper Deadline: November 24, 2023

Final Results: December 11, 2023

13th
International
Conference on
Sustainable
Development &
Urban Construction

Table (1). The trend of variables during 1971-2014

Year	GDP	FDI	ENERGY	CO2	TRADE	CENERGY
1971-1975	3613/17	4/11467	692/882	2/03840	48/2340	1/65940
1976-1980	3732/13	7/61761	726/694	1/97537	52/3036	2/84783
1981-1985	3473/77	12/5840	778/985	1/95394	48/4404	4/04562
1986-1990	3481/68	7/61645	826/485	2/11687	47/3403	4/92860
1991-1995	3749/08	33/3089	914/149	2/28313	55/4443	5/33798
1996-2000	4124/93	69/6591	987/121	2/52522	65/6137	5/80060
2001-2005	4363/83	65/7842	1015/72	2/73949	71/2863	6/17351
2006-2010	5265/80	137/181	1197/71	3/10388	70/3647	6/20433
2011-2014	5896/37	189/561	1293/07	3/38192	66/3424	6/32185

Table (2). The average of the variables in the studied countries (1971-2014)

country	GDP	FDI	ENERGY	CO2	TRADE	CENERGY
Iran	5144/254	14/18341	1627/249	5/088743	43/23929	0/891952
Argentina	7999/974	107/3579	1577/657	3/856279	22/406669	5/822868
Brazil	8506/768	111/9222	1026/760	1/642883	20/24930	12/12701
China	1675/080	59/23251	986/258	3/015152	32/31867	1/960424
Colombia	4586/499	77/80508	660/1718	1/559967	32/91077	9/305161
Costa Rica	5795/894	174/1618	674/1442	1/261559	74/25881	24/21769
Algeria	3691/124	18/77987	801/6380	2/916024	57/60250	0/213658
Egypt	1701/511	29/92527	570/9284	1/588883	52/72362	3/328872
Honduras	1701/913	38/27076	531/6070	0/733093	88/67290	4/753212
Indonesia	1943/313	19/34232	578/2716	1/0883992	52/74981	3/461978
India	710/1182	6/684324	385/4671	0/827326	25/09077	2/421989
Sri Lanka	1586/898	11/64977	376/8160	0/409990	66/36436	3/659178
Morocco	170/228	22/27388	354/8367	1/092740	58/20184	1/486626
Mexico	7651/898	107/9004	1374/704	3/618889	39/99981	4/859207
Malaysia	5589/268	149/7161	1600/104	4/300711	144/5931	1/248434
Nigeria	1672/126	15/50668	691/1422	0/651463	49/71164	0/524691
Pakistan	765/4516	5/487482	405/9293	0/643121	35/12522	3/528400
Panama	5342/690	248/6892	861/9820	1/804953	127/8362	8/219538
Philippines	1671/139	12/92041	456/5577	0/799760	68/24180	5/668076
Thailand	2911/454	58/81634	960/7246	2/217913	85/68327	0/935401
Tunisia	2650/511	62/1105	646/4555	1/769872	82/80616	0/184412
Turkey	7050/943	56/342445	1023/393	2/808706	35/12663	4/560723
Venezuela	13131/60	50/42451	2072/807	5/898882	49/40966	7/639497
Iraq	3146/667	16/90316	1022/882	3/398564	73/69969	0/638557
Bangladesh	488/1488	2/328931	133/8217	0/194171	26/31308	0/415101
South Africa	6412/498	36/91495	2478/465	8/638064	52/98952	1/904890
Average countries	4051/294	58/1789	917/9034	2/378192	57/64093	4/812278

6. Econometric methodology

6.1 A self-explanatory vector pattern with extended intervals(ARDL)

The advantage of using the (ARDL) method over other methods is that regardless of whether the mean of the variables in the model is of I(0) or I(1) type, it is possible to examine the covariance relationship between the variables (Pesaran and Pesaran 1997). Therefore, method (ARDL) estimates are unbiased and efficient due to avoiding problems such as endogeneity and self-dependence. Based on this, the panel-based ARDL model for relations 2 to 4 can be constructed as follows:

$$\Delta GDP_{it} = \alpha_{1j} + \sum_{k=1}^{q} \beta_{1ik}\Delta GDP_{it-k} + \sum_{k=1}^{q} \delta_{1ik}\Delta FDI_{it-k} +$$
$$\sum_{k=1}^{q} \lambda_{1ik}\Delta TRADE_{it-k} + \sum_{k=1}^{q} \phi_{1ik}\Delta CO_{2_{it-k}} + \sum_{k=1}^{q} \varphi_{1ik}\Delta ENERGY_{it-k} + \sum_{k=1}^{q} \upsilon_{1ik}\Delta CENERGY_{it-k} +$$
$$\sum_{k=1}^{q} \omega_{1ik}\Delta Y_{it-k} + \pi_{1i}ECT_{t-1} + \varepsilon_{1it} \tag{5}$$

$$\Delta CO_{2_{it}} = \alpha_{2j} + \sum_{k=1}^{q} \beta_{2ik}\Delta GDP_{it-k} + \sum_{k=1}^{q} \delta_{2ik}\Delta FDI_{it-k} +$$
$$\sum_{k=1}^{q} \lambda_{2ik}\Delta TRADE_{2t-k} + \sum_{k=1}^{q} \phi_{2ik}\Delta CO_{2_{it-k}} + \sum_{k=1}^{q} \varphi_{2ik}\Delta ENERGY_{it-k} +$$
$$\sum_{k=1}^{q} \upsilon_{2ik}\Delta CENERGY_{it-k} + \sum_{k=1}^{q} \omega_{2ik}\Delta Y_{it-k} + \pi_{2i}ECT_{t-1} + \varepsilon_{2it} \tag{6}$$

$$\Delta CENERGY = \alpha_{1j} + \sum_{k=1}^{q} \beta_{1ik}\Delta GDP_{it-k} + \sum_{k=1}^{q} \delta_{1ik}\Delta FDI_{it-k} +$$
$$\sum_{k=1}^{q} \lambda_{1ik}\Delta TRADE_{it-k} + \sum_{k=1}^{q} \phi_{1ik}\Delta CO_{2_{it-k}} + \sum_{k=1}^{q} \varphi_{1ik}\Delta ENERGY_{it-k} +$$
$$\sum_{k=1}^{q} \upsilon_{1ik}\Delta CENERGY_{it-k} + \sum_{k=1}^{q} \omega_{1ik}\Delta Y_{it-k} + \pi_{3i}ECT_{it-1} + \varepsilon_{3it} \tag{7}$$

Where Δ is the interruption operator and ECT_{t-j} is the error correction sentence obtained from the co-accumulated vectors. Also, ε_{it} is a constant random error with zero mean and the sign k is the length of the interval.

6.2 Significance test of research variables

Before estimating the model, it is necessary to test the significance of all the variables used in the estimations; Because the invariance of the variables both in the case of time series data and panel data causes the problem of false regression. Levin, Lin, and Chu, Im, Pesaran, and Shin, Breitung, Fisher and Hadri tests are used to examine the significance of panel data (Baltagi 2013). In these tests, the null hypothesis is based on the absence of significance and the opposite hypothesis is based on the significance of the variables.

6.3 Cointegration test

Co-accumulation means the existence of a long-term balanced relationship between two or more variables. The economic interpretation of co-accumulation is that if two or more variables together form a long-term equilibrium relationship, even if each of the variables alone deviates from that equilibrium in the short term, in the long-term equilibrium the set of variables is in a relationship close to They will move together. There are different methods to perform the co-accumulation test (Maddala

and Wu , Kao 1999; Pedroni 2004). In this study, due to the greater acceptability of Pedroni's test, this test has been used.

7. Estimation of the model and analysis of the results

7.1 The results of long-term relationship estimation

The results of the long-term estimations of panel ARDL model are presented in table 3. It shows that foreign direct investment has had a positive effect on economic growth and is statistically significant at the 0.01 level

Table (3). Long-term relationship estimation results

variable/statement	Statement 1 (dependent variable GDP)	Statement 2 (dependent variable CO_2)	Statement 3 (dependent variable CENERGY)
lnGDP		-0/183744 (-3/0903) ***	0/391416 (4/19947) ***
lnFDI	0/111988 (9/826339) ***	-0/003323 (-0/912278)	0/149671 (4/45901) ***
$lnCO_2$	0/117547 (3/51950) ***		-0/002422 (-0/047970)
lnENERGY	0/515648 (7/50938) ***	1/039390 (18/62790) ***	-0/041746 (-0/370670)
lnCENERGY	0/091176 (2/78633) ***	-0/048905 (-3/17247) ***	
lnTRADE	0/080696 (4/20730) ***	0/0720174 (3/869065) ***	-0/539020 (-5/260903) ***

The symbols ***, **, and * indicate the rejection of the zero hypothesis at the significance level of one, five, and ten percent, respectively. According to the results obtained in Table 3, foreign direct investment has no significant relationship with CO_2 emissions. Although it is expected that when foreign direct investment increases and as a result economic growth and energy consumption increase, there is a positive relationship with emission CO_2, the findings of this study showed that the increase in net foreign direct investment necessarily increases There is no way to release CO_2 gas in selected countries. This result shows that foreign direct investment may have many side effects such as extensive spillover effects in improving energy efficiency and promoting and developing clean energy, and as a result, it does not lead to an increase in CO_2 emissions; For this reason, the results of the third statement in Table 3 show that foreign direct investment has a positive and significant relationship with clean energy consumption. This result shows that when the amount of foreign direct investment increases, the use of clean energy also increases. There is convincing evidence of the spillover effects of foreign direct investment in the expansion of clean energy consumption. This is the result of other studies which showed that foreign direct investment ultimately leads to more use of clean and alternative energies (List and Co 2000; Strazicich and List 2003). The results of Table 3 show that trade liberalization has a positive and significant relationship with economic growth and carbon dioxide emissions, while its effect on clean energy consumption is negative. Considering the positive relationship between trade and economic growth based on the basic theories of international economics, the first result is expected. On the other hand, increasing trade liberalization through increasing economic growth has increased the demand for different types of energy, therefore, it causes an increase in carbon dioxide emissions. The effect of trade liberalization on CO_2, in addition to increasing production, can be due to the use of cheap energy and energy subsidies in order to lower the total cost of goods and services to compete in the international arena. According to the results of Table

3, the use of clean energy leads to economic growth, and the relationship between these two variables is positive and significant; While the use of clean energy, as expected, has a negative and significant relationship with CO_2 gas emissions. Finally, the results of Table 3 show that economic growth causes a decrease in nn emissions, while the effect of this variable on clean energy consumption is positive and significant. The negative effect of economic growth on the emission of CO_2 has already been confirmed in a study for China (Wang et al. 2011). Also, the results of the second statement show that, as expected, energy consumption has a positive and significant relationship with CO_2 emission and economic growth.

7.2 Results of estimation of short-term relationship

In this section, the results of short-term relationship estimations are presented and the error correction model related to co-accumulation relationships or long-term balances is described. While in the balance, the coefficient of the ECT error correction sentence is zero. A non-zero value of ECT means the deviation of the bond pair from the long-term equilibrium. Basic equilibrium recovery requires ECT to have both the expected sign and to be within the appropriate distance. Based on this, negative ECT and between zero and one is necessary for the consistency of constant error correction and equilibrium recovery after an external shock, while positive ECT indicates deviation from equilibrium (Asongu , 2014). Also, in determining the speed with which the balance is restored, the number zero indicates the absence of adjustment, While the number shows a complete adjustment after one period.

Table (4). Results of estimation of short-term relationship

variable/statement	Statement 1 (dependent variable **GDP**	Statement 2 (dependent variable CO_2	Statement 3 (dependent variable **CENERGY**
Width from the origin	0/291953 (2/863016) ***	-1/723669 (-7/169476) ***	-1/643669 (-4/163276) **
Δ (lnGDP)		0/417521 (4/308463) ***	0/578247 (3/215508) ***
Δ (lnFDI)	0/-000374 (-0/071881)	0/006720 (1/531446)	-0/009145 (-1/372680)
Δ (lnCO_2)	0/096211 (2/71651) ***		-0/354863 (-2/523695) **
Δ (lnENERGY)	0/277176 (4/126602) ***	0/352727 (2/731468) ***	-0/575513 (-3/483905) ***
Δ (lnCENERGY)	0/0082377 (3/888370) ***	-0/065657 (-1/600410)	
Δ (lnTRADE)	-0/006321 (-0/560627)	-0/034843 (-2/421318) **	0/029553 (0/467676)
ECT(-1)	-0/073776 (-2/6895) ***	-0/330407 (-7/256052) ***	-0/041612 (-2/902294) ***

The symbols ***, **, and * indicate the rejection of the zero hypothesis at the significance level of one, five, and ten percent, respectively. Table 4 shows the feedback coefficients for co-accumulation vectors. According to the results of ECT, all three statements are consistent with the theory in terms of sign and distance, and in all three cases ECT is significant at level 0/01. This means that in the presence of a shock, all three variables GDP, CO_2 and CENERGY can meaningfully return to their long-term equilibrium. This coefficient is -0/07, -0/33, -0/04 for the first, second, and third statements, respectively. This shows that about 0/07 of the imbalance is GDP, 0/33 of the imbalance is CO_2, 0/04

of the imbalance is CENERGY. Based on this and according to the obtained results, it is clear that the speed of adjustment towards long-term equilibrium is relatively slow in all three statements.

8. Conclusion

In this article, the relationship between foreign direct investment, trade liberalization, economic growth, greenhouse gas production (CO_2) and clean energy use was investigated based on the panel model (ARDL) for selected developing countries. The results of this study showed that foreign direct investment directly has a positive effect on economic growth and the use of clean energy, while it does not have a direct and significant relationship with the emission of CO_2. Also, according to the results, commercial liberalization has a positive and significant relationship with economic growth and environmental destruction, while its effect on the use of clean energy is negative and significant. According to the inverse relationship between the use of clean energy and the destruction of the environment in general, it can be concluded. In comparison with trade liberalization, foreign direct investment has a better impact on the environment and the use of clean energy. Although there is a general agreement that foreign direct investment increases carbon emissions, the results showed that legal and technological measures may have been used in the studied countries in the field of foreign direct investment, which increase carbon emissions. Carbon dioxide is not present. This shows that foreign direct investment plays an important role in economic growth and reducing pollutant emissions by changing policies in practice. In addition to the direct contribution to increasing production growth, foreign direct investment may have advantages such as technological spillover or strengthening of efficiency in the economy. Technological progress also causes progress and innovation in energy consumption and the production of goods and services compatible with the environment. According to the results obtained from this study, it is suggested that developing countries should consider the attraction of foreign direct investment as a factor for economic growth and reduction of environmental destruction, investment in the field of clean energy should increase, and new low carbon fibers should be used. In addition, governments should remove any obstacles and help improve laws and regulations in this field.

References

Al-Mulali, U. and T. Low Sheau (2014), "Econometric Analysis of Trade, Exports, Imports, Energy Consumption, and CO2 Emission in Six Regions", Renewable and Sustainable Energy Reviews, vol. 33.

Aralas, S. B. (2010), Essays in Trade and Environment: The Environmental Effects of Intraindustry Trade, Michigan State University.

Araya, Monica (2002), "Environmental Benefits of Foreign Direct Investment: A Literature Review", OECD Working Paper, vol. 10.

Asongu, S., G. El Montasser, and H. Toumi (2016), "Testing the Relationships between Energy Consumption, CO2 Emissions, and Economic Growth in 24 African Countries: A Panel ARDL Approach", Environmental Science and Pollution Research, vol. 23, no 7.

Asongu, S. A. (2014), "Does Money Matter in Africa? New Empirics on Long- and Short-Run Effects of Monetary Policy on Output and Prices", Indian Growth and Development Review, vol. 7, no. 2.

Baltagi, B. H. (2013), Econometric Analysis of Panel Data, 5th edition, John Wiley & Sons Ltd.

Beak, J. and W. W. Koo (2009), "A Dynamic Approach to the FDI-Environment Nexus: The Case of China and India", Journal of International Economic Studies, vol. 13, no. 2.

Ben Aïssa, M. S., M. Ben Jebli, and S. Ben Youssef (2014), "Output, Renewable Energy

Consumption and Trade in Africa", Energy Policy, vol. 66.

Ben Jebli, M. and S. Ben Youssef (2015), "Output, Renewable and Non-Renewable Energy Consumption and International Trade: Evidence from a Panel of 69 Countries", Renewable Energy, vol. 83.

Bernard, J., and S. K. Mandal (2016), "The Impact of Trade Openness on Environmental Quality: An Empirical Analysis of Emerging and Developing Economies", WIT Transactions on Ecology and the Environment, vol. 203.

Chi, J. (2016), "Exchange Rate and Transport Cost Sensitivies of Bilateral Freight Flows between the US and China", Transp. Res. Part A, vol. 89.

Coers, R., and M. Sanders (2013), "The Energy–GDP Nexus; Addressing an Old Question with New Methods", Energy Economics, vol. 36.

Copeland, B. R. and M. S. Taylor (2013), Trade and the Environment: Theory and Evidence, Princeton University Press.

Costantini, V. and C. Martini (2010), "The Causality between Energy Consumption and Economic Growth: A Multi-Sectoral Analysis Using Non-Stationary Cointegrated Panel Data", Energy Economics, vol. 32, no. 3.

Doytch, N. and S. Narayan (2016), "Does FDI Influence Renewable Energy Consumption? An Analysis of Sectoral FDI Impact on Renewable and Non-Renewable Industrial Energy Consumption", Energy Economics, vol. 54.

Frankel, J. A., and A. K. Rose (2005), "Is Trade Good or Bad for the Environment? Sorting out the Causality", Review of Economics and Statistics, vol. 87, no. 1.

Gallagher, K. (2008), Handbook on Trade and the Environment, Edward Elgar Publishing.

Gallagher, K. P. and M. B. Birch (2006), "Do Investment Agreements Attract Investment-Evidence from Latin America", J. World Investment & Trade, vol. 7.

Gorg, H. and D. Greenaway (2004), "Much Ado about Nothing? Do Domestic Firms Really Benefit from Foreign Direct Investment", The World Bank Research Observer, vol .19, no. 2.

Huang, B. N., M. J. Hwang, and C. W. Yang (2008), "Causal Relationship between Energy Consumption and GDP Growth Revisited: A Dynamic Panel Data Approach", Ecological Economics, vol. 67, no. 1.

Inglesi-Lotz, R. (2016), "The Impact of Renewable Energy Consumption to Economic Growth: A Panel Data Application", Energy Economics, vol. 53.

Kao, C. (1999), "Spurious Regression and Residual-Based Tests for Cointegration in Panel Data", Journal of Econometrics, 90(1).

Khan, M. A., M. Z. Khan, K. Zaman, and M. Arif (2014), "Global Estimates of Energy-Growth Nexus: Application of Seemingly Unrelated Regressions", Renewable and Sustainable Energy Reviews, vol. 29.

Kyoto Protocol (1997), <http://unfccc.int/kyoto_protocol/items/2830.Php>, (Accessed on 1 January 2014).

Le, T. H., Y. Chang, and D. Park (2016), "Trade Openness and Environmental Quality: International Evidence", Energy Policy, vol. 92.

Lee, J. W. (2013), "The Contribution of Foreign Direct Investment to Clean Energy Use, Carbon Emissions and Economic Growth", Energy Policy, vol. 55.

Lee, M. K., and S. H. Yoo (2016), "The Role of Transportation Sectors in the Korean National Economy: An Input-Output Analysis", Transportation Research, Part A, vol. 93.

Lee, C. C. and C. P. Chang (2009), "FDI, Financial Development, and Economic Growth:

International Evidence", Journal of Applied Economics, vol. 12, no. 2.

List, J. A. and C. Y. Co (2000), "The Effects of Environmental Regulations on Foreign Direct Investment", Journal of Environmental Economics and Management, vol. 40, no. 1.

Lv, Z., and T. Xu (2018), "Trade Openness, Urbanization and CO2 Emissions: Dynamic Panel Data Analysis of Middle-Income Countries", The Journal of International Trade & Economic Development.

Maddala, G. S. and S. Wu (1999), "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test", Oxford Bulletin of Economics and Statistics, 61(S1).

Magazzino, C. (2016), "The Relationship between Real GDP, CO2 Emissions and Energy Use in the GCC Countries: A Time-Series Approach", Cogent Econ. Finance, vol. 4.

Managi, S. (2006), "International Trade, Economic Growth and the Environment in High-and Low-Income Countries", International Journal of Global Environmental Issues, vol. 6, no. 4.

Mielnik, O. and J. Goldemberg (2002), "Foreign Direct Investment and Decoupling Between Energy and Gross Domestic Product in Developing Countries", Energy Policy, vol. 30, no. 2.

Omri, A., S. Daly, C. H. Rault, and A. Chaibi (2015), "Financial Development, Environmental Quality, Trade and Economic Growth: What Causes What in MENA Countrie", Energy Econ, vol. 48.

Pao, H. T. and C. M. Tsai (2011), "Multivariate Granger Causality between CO2 Emissions, Energy Consumption, FDI and GDP: Evidence from a Panel of BRIC Countries", Energy, vol. 36, no. 1.

Pedroni, P. (2004), "Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the Purchasing Power Parity Hypothesis", Econometric Theory, vol. 20.

Pesaran, M. H., Y. Shin, and R. J. Smith (2001), "Bounds Testing Approaches to the Analysis of Level Relationships", Journal of Applied Econometrics, vol. 16, no. 3.

Pesaran, M. H., Y. Shin, and R. J. Smith (2001), "Bounds Testing Approaches to the Analysis of Level Relationships", Journal of Applied Econometrics, vol. 16.

Pesaran, H. M. and B. Pesaran (1997), "Working with Microfit 4.0: An Introduction to Econometrics", London: Oxford University Press.

Pesaran, M. H. and R. P. Smith (1998), "Structural Analysis of Cointegrating VARs", Journal of Economic Surveys, vol. 12, no 5.

Popp, D., R. G. Newell, and A. B. Jaffe (2010), "Energy, the Environment, and Technological Change", Handbook of the Economics of Innovation, vol. 2.

Rafindadi, A. A. R. and I. Ozturk (2015), "Effects of Financial Development, Economic Growth and Trade on Electricity Consumption: Evidence from Post-Fukushima Japan", Renewable and Sustainable Energy Reviews, vol. 54.

Saboori, B., J. Sulaiman, S. Mohd (2012), "Economic Growth and CO2 Emissions in Malaysia: A Cointegration Analysis of the Environmental Kuznets Curve", Energy Policy, vol. 51.

Sadorsky, P. (2010), "The Impact of Financial Development on Energy Consumption in Emerging Economies", Energy Policy, vol. 38, no. 5.

Saidi, K. and S. Hammami (2016), "Economic Growth, Energy Consumption and Carbone Dioxide Emissions: Recent Evidence from Panel Data Analysis for 58 Countries", Quality & Quantity, vol. 50, no. 1.

Saidi, S. and S. Hammami (2017), "Modeling the Causal Linkages between Transport,

Economic Growth and Environmental Degradation for 75 Countries", Transportation Research Part D: Transport and Environment, vol. 53.

Sbia, R., M. Shahbaz, and H. Hamdi (2014), "A Contribution of Foreign Direct Investment, Clean Energy, Trade Openness, Carbon Emissions, and Economic Growth to Energy Demand in UAE", Economic Modelling, vol. 36.

Shahbaz, M., Q. M. A. Hye, A. K. Tiwari, and N. C. Leitão (2013), "Economic Growth, Energy Consumption, Financial Development, International Trade and CO2 Emissions in Indonesia", Renewable and Sustainable Energy Reviews, vol. 25.

Shahbaz, M., S. Nasreen, F. Abbas, and O. Anis (2015), "Does Foreign Direct Investment Impede Environmental Quality in High-Middle, and Low-Income Countries", Energy Economics, vol. 51.

Smyth, R., and P. K. Narayan (2015), "Applied Econometrics and Implications for Energy Economics Research", Energy Economics, vol. 50.

Soytas, U. and R. Sari (2009), "Energy Consumption, Economic Growth, and Carbon Emissions: Challenges Faced by an EU Candidate Member", Ecological Economics, vol. 68, no. 6.

Strazicich, M. C., and J. A. List (2003), "Are CO2 Emission Levels Converging Among Industrial Countries", Environmental and Resource Economics, vol. 24, no. 3.

Tamazian, A., J. P. Chousa, and K. C. Vadlamannati (2009), "Does Higher Economic and Financial Development Lead to Environmental Degradation: Evidence from BRIC Countries", Energy Policy, vol. 37, no. 1.

Tayebi, S. K., and S. Younespour (2012), "The Effect of Trade Openness on Environmental Quality: Evidence from Iran's Trade Relations with the Selected Countries of the Different Blocks", Iranian Economic Review, vol. 16, no. 32.

Siddiki, J. U. (2000), "Demand for Money in Bangladesh: A Cointegration Analysis", Applied Economics, vol. 32.

Wang, S. S., D. Q. Zhou, P. Zhou, and Q. W. Wang (2011), "CO2 Emissions, Energy Consumption and Economic Growth in China: A Panel Data Analysis", Energy Policy, vol. 39, no. 9.

Xing, Y. and C. D. Kolstad (2002), "Do Lax Environmental Regulations Attract Foreign Investment", Environmental and Resource Economics, vol. 21, no. 1.

Zhang, Y. J. (2011), "The Impact of Financial Development on Carbon Emissions: An Empirical Analysis in China", Energy Policy, vol. 39, no. 4.