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The Impact of Stocks Traded-Total Value, Foreign Direct Investment, Number of Students and Fossil Fuel Energy Consumption on NO2 Emissions in Iran

Abbas Ali Daryaei [a,*] , Ali Akbar Bajelan [b], Maryam Khodayeki [c]

[a] Imam Khomeini International University, Qazvin, Iran
[b] Mazandaran University, Babolsar, Iran
[c] Sohrevardi Higher Education Institution, Qazvin, Iran

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Abstract
The purpose of this paper is to examined the empirical effects of stocks traded-total value, foreign direct investment, number of students, and fossil fuel energy consumption on nitrogen dioxide (NO2) emissions in Iran using time series data for the period 1978–2012. To achieve this goal, we applied the autoregressive distributed lag (ARDL) bounds testing approach. Findings indicate that foreign direct investment, fossil fuel energy consumption, and number of students stimulate NO2 emissions in the long run. Based on these findings, the study recommends that Iran reduce emissions by expanding its existing Carbon Capture, Utilization, and Storage plants; capitalizing on its vast solar and wind energy; reducing high subsidies of the residential electricity scheme; and aggressively investing in energy research to build expertise for achieving electricity generation efficiency. It must be noted that greenhouse gas reduction policies cannot produce immediate results in changing wind and precipitation patterns and thus mitigating climate change effects.

Keywords: NO2 emissions, Energy consumption, Stocks traded-total value, Iran

Introduction

Unusual climate change due to greenhouse gas emissions is one of the consequences of population growth, changes in land use, degradation of forests, increase in agricultural and livestock production, production of solid and liquid waste. With the development of global economy, environmental pollution is becoming more and more serious (Jian et al., 2019). The largest source of greenhouse gases is the energy sector, which provides the necessary driving force for transportation, heat and cold production in various sectors, agricultural production and industrial products, etc. (Intergovernmental Panel on Climate Change, 2006). The global warming which is the result of fossil fuels combustion, has become one of the most important human concerns and

* Corresponding author E-mail: a.a.daryaei@soc.ikiu.ac.ir

there have been several worldwide meetings to discuss this issue (Yousefi et al., 2019). One of the richest energy sources in the world is Iran which always has been one of the main exporters of oil since 1913. Given the fact that it is located among the two major sources of energy in the world (the Caspian Sea in the north and the Gulf in the south), it is a special place at the international level (Farhadi, 2010). 10% of the world's oil exploration is owned by Iran. 15% of the world's total gas resources are owned by Iran, which has ranked it as the second largest natural gas resource holder. Household consumption is the major part of gas consumption. Nevertheless, in 2005, Iran payed about $ 4 billion to import fuel which lack of refinery, fuel smuggling and low household efficiency, as a result of paying fuel subsidies, are the main reasons. Iran as a rapidly developing country, whose economy is enriched by oil and gas exports, has to integrate green economy concept into its energy sector (Ardestani et al., 2017).

The value of stock exchanges in the market is one of the factors that have been considered in this study as a factor of energy consumption and consequently an increase in greenhouse gas emissions. The transfer of funds for economic growth is driven by the stock market. Thus, the volume and value of stock market exchanges enable governments and the industry to increase their long-term financing for development and modernization of existing industrial units or the implementation of new projects, hence, Stock market participation plays a role in economic growth through its specific services (Agrawala and Tatyja, 2007). The relationship between economic growth (and hence foreign direct investment) and the environmental quality in a long-term context can either be direct, inverted, or a combination of both (Hissaudin and Changmin, 2010). Another factor that contributes to environmental pollution is the human development index. In this study, the number of students as the most important human factor in development, is considered as human development proxies (such as Condensed, 2017). However, many factors have contributed to human development according to the United Nations reports (UN). Further to reports from this organization in 2016, Iran Has been ranked as 69 human development indicators. The most important factor for the consumption of fossil fuels is the high cost of transportation for the displacement of about four million students and snow consumption and etc.

Most previous studies have shown that economic growth would likely lead to changes in GHG emissions. It has also found that energy consumption is often a key determinant of GHG emissions. It is therefore worthwhile to examine the nexus between economic growths, energy and GHG emissions by considering them simultaneously in a modeling framework. In this strand, Lotfalipour et al (2007) and Atrkar Roshan (2007) initiated this combined strand of research. Recent works include Mojaver (2007) and Ahmad and Du (2017) and for a single country study.

In light of the above environmental adversity, this study investigates the long-run effects of stocks traded-total value, number of students, fossil fuel energy consumption, and foreign direct investment on NO2 emissions for Iran for the period 1978–2012. Although numerous time series and panel studies have examined such associations (e.g. Lotfalipour et al., 2007., Ahmad and Du, 2017., Kandananond, 2017), to the best of the authors' knowledge, no study has yet been undertaken to determine such causal relationships in the context of Iran, which is potentially a very important country for such investigation. The current study is an attempt to fill this gap.

Literature review

NO2 emissions, stocks traded-total value and foreign direct investment

There are many opportunities for companies developing their technical skills and organizational capabilities to prevent pollution and increase economic efficiency as result of minimizing waste

and reducing greenhouse gas emissions in the industrial process. Observing the principles of standards of air and environmental pollution can lead to an increase in the value of companies' stocks (Miroshnichenko, 2017). Commitment and obligation of companies to observe environmental considerations and notice the welfare of society are directly related to their performance, its consequences are fame, social status and society trust improvement. Identifying new opportunities, maintaining and expanding market share in competitive situation are the results of it.

The liquidity of these companies' shares lead to keep the environmental protection cycle and greenhouse gas-such as NO2- emissions reduction. Dinatti and Khodorkemi (1396) showed that the publication of positive environmental news in the capital market of Iran caused stock prices rising and also make a positive reaction of investors, while the publication of negative environmental news does not effect on stock prices and reaction of investors.

This confirms the theory posed by Sylwien and Goldson (2016). The theory states that the reaction of investors committed to social responsibility is positive toward the publication of valid corporate environmental performance. This could boost the company's economic prosperity and further invest in its development, which, of course, will increase the company's energy consumption and due to further greenhouse gases emissions. In general, capital markets are keenly interested in the effects of climate changes and greenhouse gas emissions. For example, Celc et al (2008) consider investors as a key factor in the development of carbon accounting and reporting. Moreover, institutional investors require companies which provide information related to risks and opportunities associated with climate change. The interest of capital markets in climate change consequences has attracted the attention of many researchers to the effects of market valuation of environmental activities. The focus of many previous studies was on the relationship between the company's market valuation and pollution levels, such as water pollution (Kurmer and Magnan, 1997), sulfur dioxide emissions (Hughes, 2002), other toxic gases emissions (Clarkson, 2004), and greenhouse gas emissions (Chapel, 2013) (Bobocardus, 2017). The relationship between the company’s development and economic growth which leads to an increase in the company valuation and, ultimately, more energy consumption-the beginnings of a greater emission of greenhouse gases, such as CO2 and NO2-is a vital point that many of these studies have not paid attention to. As a matter of fact, this is the primary basic element for illustrating the relationship between volume and value of stock exchanges and NO2 emissions.

As stated, foreign investment is one of economic growth factors, which also affects the environment, according to Kuznets' environmental hypothesis. It should be noticed that the relationship between economic growth and environmental quality in a long-term time frame can be direct, inverted, or a combination of both. The literature on this subject began and expanded in 1992 with an article by Grossman and Kröger. The relationship between some environmental degradation –such as carbon storage, carbon dioxide emissions per capita, airborne particles, poor healthy water availability, lack of urban sewage drainage, deforestation, etc.) and per capita income have been confirmed. Heussautine and Changming (2010) considered the long-term relationship and dynamic causality between carbon dioxide emissions, energy consumption, direct foreign investment and GDP in their study by using panel concurrency and Granger causality test for Brazil, Russia, India and China, for the period from 1980 to 2007. Meanwhile, the results of the Granger causality relationship indicate that long-term causality causing direct foreign investment and energy consumption, direct foreign investment and carbon dioxide emissions and short-run tow-sided causation, between GDP and energy consumption, GDP and dioxide emissions Carbon, direct foreign investment and energy consumption, direct foreign investment and carbon dioxide emissions.

To date, a significant volume of literature has evolved regarding the association between stocks traded-total value, foreign direct investment, and environmental pollution. Numerous time series and panel data studies have examined their relationship, and some have examined the validity of the environmental Kuznet curve (EKC) hypothesis. Degraeuwe (2016) analyzed the factors responsible for NO2 emissions in Belgium using cointegration analysis. Their findings indicated that Belgium differ significantly in terms of per capita NO2 emissions, energy structure, and energy intensity, although they experienced similar characteristics of stable growth during their urbanization process. The level of GHG emissions is negatively related to the firm value. The negative impact is more prominent for firms in a country with a GHG emissions trading scheme and with stringent environmental regulations (Choi and Lou, 2017). Stock markets have shown an increasing interest in the consequences of climate change in general and carbon emissions specifically (Kauffmann et al., 2012). For instance, Kolk et al (2008) identify investors as a key factor in the development of carbon accounting and reporting. Additionally, institutional investors require companies to provide them with information about climate-change-related risks and opportunities (Solomon, Solomon, Norton, & Joseph, 2011). Also, Shao (2018) shows that FDI has a significant negative impact on carbon intensity of the host country. After considering the other factors, including share of fossil fuels, industrial intensity, urbanization level and trade openness, the impact of FDI on carbon intensity is still significantly positive.

NO2 emissions, number of students and fossil fuel energy consumption

Sustainable development is a kind of transformation process that considers resource utilization, investment management, technological development orientation and organizational changes simultaneously with current and future needs. For this purpose, an important step in environmental policy is to identify and clarify the attitude of the students - as a conscious and influential group of society - towards the environment. The starting point for assessing the environmental consequences that comes into our life cycle is a sustainable lifestyle; therefore, this viewpoint should take into account the individuals actions and their outcomes. It is necessary to pay attention to planning and encouraging people to reform their lifestyle and consumption patterns. Plans to achieve sustainable development must change in consumption patterns of the community, especially young people, and particularly educated one.

As a pioneer of social change in each society, they are a symbol of the immediate future of the present society. Assessing the behavior and performance of young people in achieving the basics of sustainable living is the most effective step to protect the environment. That is, each person will evaluate his or her behavior in an environmentally-friendly way in order to achieve a stable and coherent behavior with nature. Because the proper utilization of resources leads to sustainability of life. training educated people who have the ability to help communities and governments to solve technical, managerial and policy problems in the areas of natural resources, environmental quality and social justice, are the primary aim of such environmental programs, (Clarke, 2010; Robinson et al., 2011). Hence, the source of the restructuring of structures, the creation of new and sustainable functions, and their institutionalization in structures towards stabilization, is the university.

In other words, designers of educational institutions can change structures in order to achieve sustainable consumption for energy consumption from water resources and heating and cooling systems. By setting up research and education units and communicating with companies, industries and government groups, they provide new and sustainable functions in the production, service and distribution sectors, and finally universities, such as private and public institutions, are responsible for solving community problems such as sustainability. Making recognition about the importance

of human interaction with the environment and its negative or positive effects on the environment is the main purpose in promoting the environmental culture of the community. Therefore, investing in the field of environmental protection culture promotes and develops it. Responsible and influential organizations in the field of education including the Ministry of Education, the Ministry of Science and Technology, and the Environmentalist NGOs and Agencies, should participate it, and each of them will implement rational and principled action.

The main pillar of Community education is to empower them to make the right decisions, change behavior and performance, and make optimal use of resources. Increasing the community awareness about the environment will lead to the implementation of laws and increase their satisfaction. The more empowerment of individuals in implementing environmental laws and creating a sense of responsibility will lead to more positive relationship with psychological empowerment and the creation of internal motivation in individuals. Certainly, regular planning based on priorities in the community is needed to educate the society towards preventing environmental degradation, and according to the responsible organizations and defined tasks, they are obliged to include priorities in their work plan. Meanwhile, more students are raising awareness of people about community issues. Knowledge about the correct way of energy sources is inversely proportional to the number of students. Modiriglo and Altonler (2010) investigated the lifestyle of 507 students in Turkey and found that there is a positive relationship between attitude and environmental knowledge and their sustainable lifestyle. Finale (2010) found that students had a positive attitude toward adapting their personal habits to a sustainable lifestyle in a study on the quality commitment of sustainable lifestyle students at Queen's University in Canada (Salehi & Pasokinejad, 1394).

Based on the environmental sociology, students' role in polluting emissions from greenhouse gases can be deliberated. The sociological studies about the role of nature in society background is as great as the sociology itself. From the perspective of many classical sociology thinkers, modern society has a dual relationship with nature; it means, not only society is considered part of the natural world, but also it is in opposition to this world. The study of the social thought of the nineteenth century shows that at that period, nature has often been regarded as determining the status of society. According to the social thought of that time, the environment and geographical factors create the structure of culture. The term "nature" in sociological writings, with the appearance of new environmental movements since the late 1960s, was synonymous with the ecosystem or in connection with the decline of ecosystems and only after the emergence of what the public environmental awareness in North America was called in the 1970s, an environmental sociology field was created. Based on the environmental sociology, the development of universities and, consequently, the increase of students, can lead to the proper use of technology in society to reduce greenhouse gas emissions, such as NO2.

The relationship between greenhouse gas emissions (CO2 and NO2), electricity consumption and economic growth was studied by using models of simultaneous equations with panel data of 14 Middle Eastern and North African countries during the period 2011-1990 by Omri (2013). Experimental results showed that there is a causal relationship between electricity consumption and economic growth. However, research findings confirm the existence of single-way (one-sided) causality from energy consumption to carbon dioxide emissions - without any feedback effect and in the whole region, there is a two-way causality relation between carbon dioxide emissions and economic growth. The research has shown that in order to maintain sustainable economic growth in the Middle East and North Africa, there must be differences in the relationship between energy consumption and economic growth through environmental and energy policies. Altiny and Caragol (2004) inspected the causal relationship between fossil energy consumption and real GDP in

Turkey over the period 1950-2000. They showed that there is strong evidence for single-sided causality of energy consumption to income. Meanwhile, it is clear that electricity power supply for more consumption is essential to sustaining economic growth in Turkey. Previous studies have shown that economic growth may lead to changes in NO2 emissions. It has also been clarified that energy consumption is often a decisive factor in the emission of CO2 and NO2. Also, Aye and Edoja (2017) indicate that economic growth has negative effect on CO2 emission in the low growth regime but positive effect in the high growth regime with the marginal effect being higher in the high growth regime.

Material and Method

An econometric model of the following form was estimated in the current study.

$$N_t = \beta_0 + \beta_1 FDI_t + \beta_2 FFEC_t + \beta_3 STTV_t + \beta_4 NS_t + \varepsilon_0 \quad (1)$$

The coefficients β_1, β_2, β_3, and β_4 represent the long-run elasticity estimates of Per capita NO2 emissions, Stocks Traded-Total Value as share of GDP, Per capita fossil fuel energy consumption, and Per capita Number of Students, respectively.
To investigate the relationships, data for the following variables were sourced:
• Per capita NO2 emissions (N)
• Foreign Direct Investment as share of GDP (FDI)
• Per capita fossil fuel energy consumption (FFEC)
• Stocks Traded-Total Value as share of GDP (STTV)
• Per capita Number of Students (NS)

The World Development Indicators database 2017 was the source of the data for all these variables (World Bank., 2017). Per capita fossil fuel energy consumption (TWh) and per capita NO2 emissions were estimated by dividing total energy consumption and NO2 emissions by the mid-year population. The variables were then transformed into natural logs. This transformation was intended to overcome the problem of heteroscedasticity between the variables.

Estimation procedures

Unit root tests

This study used the Autoregressive-Distributed Lag Bounds Test (ARDL hereafter), proposed by Im, Pesaran, and Shin (2001), to obtain unbiased and consistent estimations. The major advantages of this technique to other cointegration methods are that it can be applied regardless of the order of integration variables (0 or 1) and that it is adequately efficient for a small sample size. It is important because results from different unit root tests may produce different orders of integration; in addition, there is no test without a degree of uncertainty in determining integration order of variables. As a result, the ARDL can be used to resolve this uncertainty. In the Johansen's approach, all variables should have an equal length of the optimal lag and its results are sensitive to the selected lags; whereas, these conditions do not apply to the ARDL approach. On the other hand, many selections, such as the selection of exogenous and endogenous variables and the optimal lag length, should be made in the Johansen cointegration test and results are sensitive to these selections; whereas, the bounds test does not deal with such problems. Since the bounds test

cannot be applied to the second-order cointegration variables, the Augmented Dickey-Fuller test is initially used to ensure that none of the variables are integrated of order 2.

ARDL bounds testing approach

Uddin et al (2013) suggested that conventional cointegration techniques do not provide reliable results when data are plagued with structural breaks. Therefore, this study employed the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran (1997) and Pesaran et al (2001) to estimate the co integrating or long-run relationship between the variables. The ARDL technique has already proved to be efficient in cases of small sample size and potentially removes the problems of omission bias and autocorrelation. In addition, the technique generally provides unbiased estimates of the long run model and valid t-statistics, even in the presence of the problem of endogeneity. The empirical formulation of the ARDL equation for our study was specified as follows:

$$N_t = \alpha + \beta t + \varphi D + \sum_{i=1}^{p} \lambda_i N_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} FFCE_{t-j} + \sum_{k=0}^{q_2} \beta_{2k} NS_{t-k} + \sum_{l=0}^{q_3} \beta_{3l} NET_{t-l}$$

$$+ \sum_{m=0}^{q_4} \beta_{4m} FDI_{t-m} + \sum_{n=0}^{q_5} \beta_{5n} STTV_{t-n} + \varepsilon_t \quad \text{.....(2)}$$

The long-run coefficients in ARDL model are estimated by:

$$\theta_r = \frac{\sum_{s=0}^{q_r} \beta_{rs}}{1 - \sum_{i=1}^{p} \lambda_i} \qquad \text{where that} \qquad r = 1,2,3,4,5 \quad \text{.....(3)}$$

The error correction model that links short-run and long-run relationships as defined by:

$$\Delta N_t = \beta_0 + \beta_1 t + \beta_2 D - \lambda . EC_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta N_{t-i} + \sum_{j=0}^{q_1-1} \phi'_{1j} \Delta FFCE_{t-j} + \sum_{k=0}^{q_2-1} \phi'_{2j} \Delta NS_{t-k}$$

$$+ \sum_{l=0}^{q_3-1} \phi'_{3j} \Delta NET_{t-l} + \sum_{m=0}^{q_4-1} \phi'_{4j} \Delta FDI_{t-m} + \sum_{n=0}^{q_5-1} \phi'_{5n} \Delta STTV_{t-n} + \varepsilon_t \quad \text{.....(4)}$$

In equation (4) EC_{t-1} is the error correction term defined by:

$$EC_{t-1} = \left(N_{t-1} - \theta_1 NS_{t-1} - \theta_2 NET_{t-1} - \theta_3 FDI_{t-1} - \theta_4 FFCE_{t-1} - \theta_5 STTV_{t-1} \right) \quad \text{.....(5)}$$

The term EC_{t-1} as the speed of adjustment parameter and shows how much of the disequilibrium is being corrected, that is, the extent to which any disequilibrium in the previous period is being adjusted. A positive coefficient indicates a divergence, while a negative coefficient indicates convergence.

Diagnostic tests

A number of diagnostic tests such as the Lagrange Multiplier (LM) test for serial correlation, the normality test, the ARCH test for heteroscedasticity, and model stability graphical plot tests (e.g. CUSUM and CUSUMS) were conducted.

Empirical results and analysis

Table 1 reports summary statistics for all the variables in order to determine the nature of the data distribution. The data of all the series are normally distributed, as the values of the standard deviations of these distributions are within a reasonable range, which imply that application of standard estimation techniques is not likely to provide spurious findings. Nevertheless, the data are free from the threat of multicollinearity, as evidenced from the Variance Inflation Factor (VIF) results depicted in Table 2. Fig. 1 depicts the logarithmic trend of all the variables for the sample period, which is more or less stable for all the variables.

Table 1. Summary statistics.

Variables	LN	LLFDI	LFFEC	LSTTV	LNS
Mean	0.361463	0.429904	6.971127	6.627068	23.24138
Median	0.369277	0.176633	7.031741	8.044530	21.00000
Maximum	0.410343	2.736115	7.433667	12.45711	59.00000
Minimum	0.322909	-0.289993	6.258625	-4.605170	3.000000
Std. Dev.	0.028306	0.657341	0.303739	5.046849	18.56005
Skewness	0.046588	1.768292	-0.587308	-0.657992	0.612301
Kurtosis	1.569057	6.418560	2.823939	2.301386	2.123734

Table 2. Variance inflation factors.

	Coefficient	Centered
Variable	Variance	VIF
LFDI	0.0935	1.070
LFFEC	0.0925	1.081
LNS	0.0893	1.092
LSTTV	0.0899	1.101

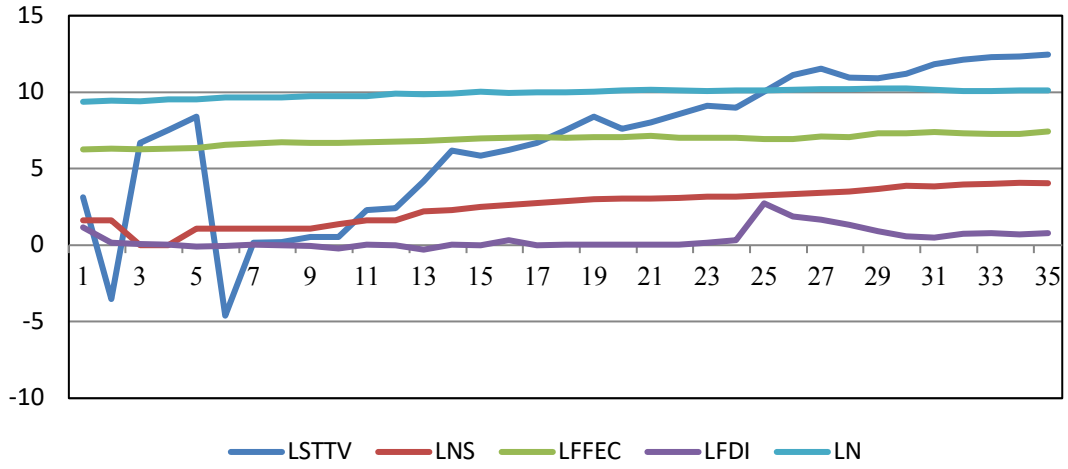

Figure 1. Logarithmic trends in NO2 emissions, foreign direct investment, fossil fuel energy consumption, stocks traded-total value, and number of students in Iran for the period 1978–2012.

Reliability assessment of the model's variables, considering structural failure (Table 3), shows that the time series of LFDI and LSTTV are integrated of order 0. In contrast, the time series of LNS, LN, and LFFEC are integrated of order 1. Since none of the model's variables are not

integrated of order 2, the F-statistics for the bounds tests can be applied. Results from the short-run dynamic model estimation are presented in Table 4. The model's coefficient of determination was 0.96, indicating its high explanatory power. Moreover, the model's F-statistics was obtained as 25.1, indicating the general significance of the regression equation. The Jarque–Bera test was obtained as 0.465, indicating normal distribution of error components. The value pertinent to the hypothesized heterogeneity of variance (ARCH effects) on the error terms was 1.422 and insignificant (p=0.233), indicating the lack of heterogeneity of variance in the model's error terms. Moreover, results from applying the Breusch-Godfrey test of first- and second-order serial correlation on the error components were insignificant and obtained, respectively, as 0.039 and 0.137, indicating no serial correlation between the error components.

Table 3. Zivot-Andrew structural break unit root test.

	Level	1st Difference	Break Point
LN	-4.2921	-7.6020	2008
LFDI	-12.1248	-	1990
LFFEC	-3.2494	-12.3362	1993
LNS	-4.5141	-6.0496	2005
LSTTV	-13.5780	-	1993

Table 4. Short-term dynamic relationship

	Coefficient	standard deviation	t-statistics	p-value
Intercept	-1.1120	0.2867	-3.8786	0.0026
LN (-1)	0.3635	0.1391	2.6125	0.0242
LN (-2)	-0.2156	0.1045	-2.0638	0.0635
LFDI	-0.0008	0.0020	-0.3883	0.7052
LFDI(-1)	0.0586	0.0142	4.1154	0.0017
LFDI(-2)	-0.0427	0.0096	-4.4542	0.0010
LFFEC	0.1316	0.0262	5.0270	0.0004
LFFEC(-1)	0.0787	0.0270	2.9169	0.0140
LSTTV	-0.0003	0.0022	-0.1528	0.8813
LSTTV(-1)	0.0005	0.0017	0.2891	0.7779
NS	-0.0019	0.0005	-3.6500	0.0038
DUM2007	-0.0543	0.0055	-9.9084	0.0000
$R^2 = 0.9617$	F=25.1001			

This study used the F-statistics for the bounds tests to investigate the presence of the cointegration vector. To investigate the long-run relationship between the variables, the dynamic relationship between variables is first estimated using the ordinary least squares. Then, the lack of a long-run relationship, meaning that the coefficients of the first-lagged variables are zero, is investigated using the Wald test. The rejection of the null hypothesis confirms the presence of a long-run relationship between the variables. The F-statistics in this test is not standard. Therefore, results of F-statistics in this test are compared to the critical values presented by Narayan (2005) for a small sample size (containing less than 80 data units). To this end, two critical values were considered: (i) the upper critical value assuming that all independent variables are integrated of order 1 and (ii) the lower critical value assuming that all independent variables are integrated of order 0. If the F-statistics is larger than the upper bound, the null hypothesis maintaining the lack of a long-run relationship is rejected, suggesting that there is a long-run relationship between variables. If the F-statistics is lower than the lower bound, the null hypothesis maintaining the lack

of a long-run relationship is not rejected, suggesting that there is not any long-run relationship between variables. If the F-statistics is placed between the two bounds, the test cannot determine whether there is a long-run relationship between the variables. Results from testing the presence of a long-run relationship are presented in Table 5. According to Table 5, the bounds test statistics is larger than the critical values of Narayan (2005). As a result, there is a long-run relationship between the model's variables. To calculate the model's long-run coefficient, the dynamic model of the section 3-1-2 can be used. These coefficients are listed in Table 6.

Table 5. Long-term relationship

	Coefficient	I(0)*	I(1)*
F	6.6723	3.74	5.06
t	-5.5265	-3.43	-4.60

Table 6 shows the estimation results for model using time series regression between NO2 emissions and foreign direct investment and fossil fuel energy consumption and stocks traded-total value and number of students. We discuss the results for the N as pollution proxy. The coefficient on FDI is positive and significant (0.0241; t-statistic = 2.6145). Foreign direct investment's role in the development of countries, particularly developing countries, makes it a crucial factor in the economic growth of societies. The recent decades have witnessed a rise in foreign direct investment, and the quest for access into the markets of other countries and attracting foreign assets without due regard for environmental standards has resulted in polluting industries moving from western countries to developing countries. Many environmental activists believe the ever increasing foreign investment at the global stage causes polluting industries to migrate towards regions with laxer environmental laws, effectively turning them into havens for such industries. According to pollution haven hypothesis, since developed countries impose more stringent environmental standards compared to other countries, their polluting industries move their operation and production lines to countries with weaker environmental policies. Developing countries also exploit the situation to their advantage to act as safe havens that attract polluting industries. Because of Iran's weak environmental regulations and standards, the industrial section has attracted the highest amount of foreign investment in polluting industries.

Table 6. Estimated long-run coefficients using the ARDL selected based on Akaike information criterion (AIC).

Regressor	Coefficient	standard deviation	t-statistics	p-value
LFDI	0.0177	0.0068	2.6145	0.0241
LFFEC	0.2467	0.0451	5.4742	0.0002
LSTTV	0.0002	0.0015	0.1165	0.9094
LNS	-0.0022	0.0005	-4.4604	0.0010

We do not observe the same relation between N and STTV. The coefficient on STTV is insignificant (0.9094, t-statistic=0.1165). However, the coefficient on FFEC and NS are positive and negative and significant (0.0002; t-statistic = 5.4742 and 0.0010; t-statistic = -4.4604). These Companies listed on the Stock Exchange of Iran are quite diverse in terms of their pollution output and therefore we did not find a significant correlation between stock's trade volume and greenhouse gas emissions. However, there is positive correlation between energy consumption and NO2 emissions. The increasing trend of NO2 emission in Iran calls for new environmental policies to reduce damage to the environment. Based on the model presented in this study, a rise in energy

consumption along with GDP growth, which translates to economic growth, causes higher pollution levels due to a rise in greenhouse gas emissions. Nevertheless, it is impossible to lower GDP as investment and employment levels would go down with it and fewer jobs would exacerbate the unemployment problem. However, it is possible to lower energy consumption by improving energy efficiency in manufacturing units. Also regarding the inverse correlation between the number of students and greenhouse gas emissions, it must be noted that the key factor in educating people is to enable them to make correct decisions, to change their behavior, and to make better use of natural resources. More environmentally-aware people leads to better implementation of the laws and a higher degree of public content. Furthermore, enabling people to follow environmental regulations coupled with an increased sense of responsibility will lead to emotional empowerment and inner motivation. Educating the public about ways to prevent damage to environment requires a well-organized plan based on society's priorities. To that end, responsible organizations should prioritize their plans according to their defined duties. Meanwhile a higher number of university students equates a higher level of social awareness among people.

Table 7 reports the short-term effects of the independent variables on NO2 emissions. The findings indicate that FFEC causes NO2 emissions to rise in the short run and the coefficient of this effect is stronger. The variables of FDI (-1) and DUM 2007 also stimulate NO2 emissions. FDI and STTV have no significant effect on NO2 emissions in the short run. The stability of the short- and long-run estimates over time is justified by the graphical plots of CUSUM and CUSUM of Squares (Fig2. 2A and 2B). It shows that estimated coefficients lie between the upper and lower critical bounds (blue lines in the figure) at the 5% significance level.

Table 7. Error correction representation for the selected ARDL selected based on AIC.

Regressor	Coefficient	standard deviation	t-statistics	p-value
Intercept	-1.1120	0.1655	-6.7178	0.0000
D(NO2(-1))	0.2156	0.1072	2.0114	0.0694
D(FDI)	-0.0008	0.0031	-0.2448	0.8111
D(FDI(-1))	0.0427	0.0087	4.9122	0.0005
D(LNFFEC)	0.1316	0.0229	5.7516	0.0001
D(LNSTTV)	-0.0003	0.0017	-.01985	0.8463
DUM2007	-0.0543	0.0071	-7.6396	0.0000
CointEq(-1)	-0.8521	0.1263	-6.7449	0.0000
$R^2 = 0.877$	DW=2.075			
F=15.221				

Conclusions and policy implications

Economic development, as a fundamental factor in a country's policy-making decisions, is closely related to industry and technology on one end, and the issue of environmental pollutions on the other. The experience of developed countries in this area shows that focusing solely on economic expansion and the industrial sector, while irresponsibly exploiting the environment, can pose a serious threat to sustainable development. Air pollution is one of the environmental problems made worse by industrialization and increased energy consumption. Given the crucial role of the industrial sector in the advancement of developing countries it is vital to pay attention to the relation between industrial activity and pollution levels. In recent decades, environmental issues especially global warming as a result of rising greenhouse gas emissions, have become a global

concern. Because of the importance of foreign direct investment some countries use their environment as leverage to attract such investment. By paying attention to the cultural aspects of energy consumption, such as the importance of well-educated human resources, it is possible to mitigate the negative side effects of technology on environment.

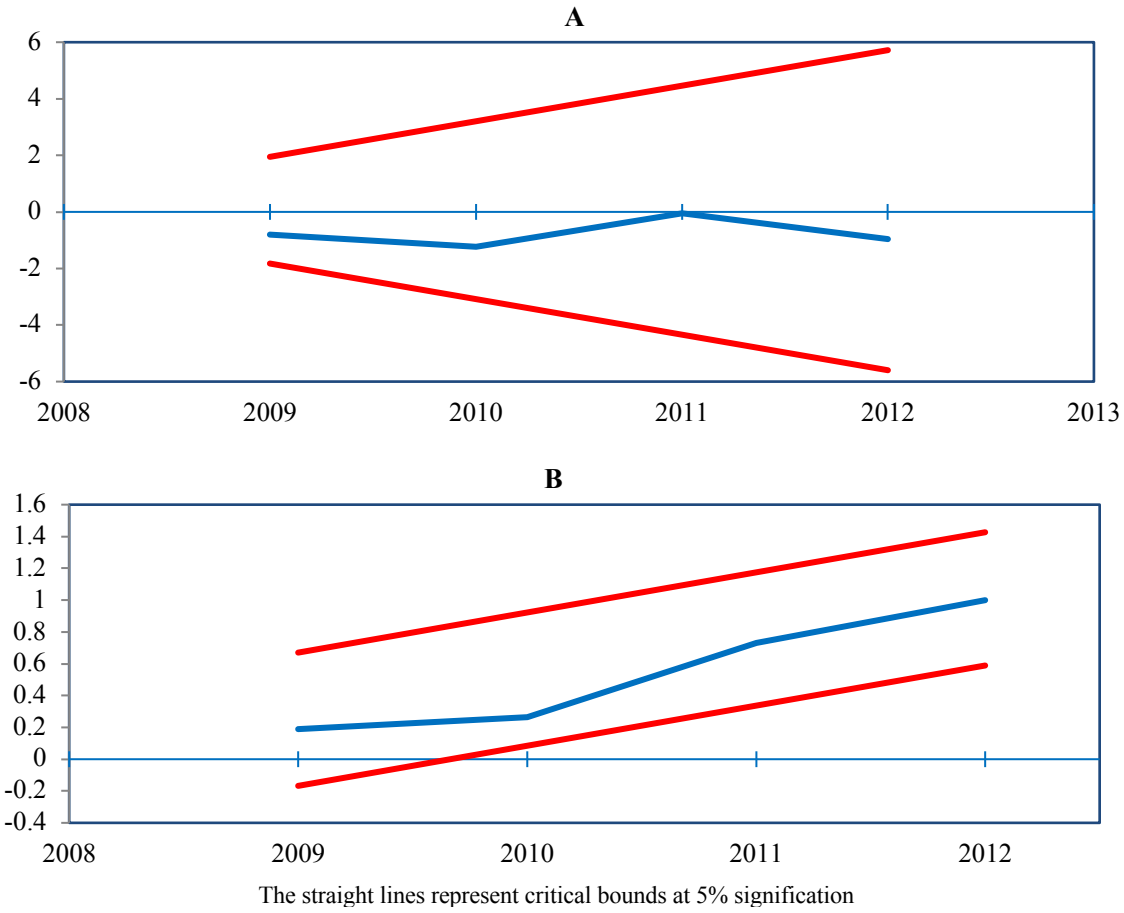

Figure 2. A: Plot of the cumulative sum of recursive residuals B: Plot of the cumulative sum of squares of recursive residuals.

As part of the process of change, sustainable development takes into consideration the current and future needs so as to address issues such as tapping resources, investment management, orientating technological advancement, and organizational change. A crucial step in formulating environmental policies would be to identify and explicate the environmental views of students as a well-aware and influential tier of the society. Therefore, in terms of life style, individuals' actions and their consequences need to be studied. Stock's trade volume was another important issue investigated in this study and similar to many other studies in Iran, there was no a significant correlation between stock's trade volume and air pollution. In general, the following points can be said about greenhouse gases and pollutants:

1- Policies for reducing greenhouse gas emissions can be implemented in two ways: a) Elimination or reduction of fossil fuels (which are sources of CO2 and a few other pollutants) and replacing them with renewable energies. b) Using greenhouse gas filters. The first solution of reducing or eliminating fossil fuels can decrease CO2 and N2O emissions and also can directly

reduce emission of pollutants such as SO2, NOx, particulate matters, CO and O3, resulting in improved air quality. However, greenhouse gas absorbing filters (e.g. storing CO2 in ocean beds or injecting it in declining oil fields) have no effect on reducing air pollution without elimination or reduction of fossil fuels. It must be noted that due to the high costs entailed in using filters or eliminating greenhouse gases, it is impossible to implement them in developing countries and thus emission reduction policies must focus on the first method, which prescribes cutting down on fossil fuel consumption in order to reduce pollutant gas emissions.

2- Policies for reducing greenhouse gas emissions (especially CO2 and NO2) can indirectly result in reduced air pollutants and better air quality through climate's effect on temperature, precipitation, wind and synoptic patterns. Although such effects cannot be completely verified because of the models' uncertainty and varied effects in different regions. It must be noted that greenhouse gas reduction policies cannot produce immediate results in changing wind and precipitation patterns and thus mitigating climate change effects.

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