



The Effects of Electricity Consumption on CO₂ Emissions in Iran

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Abstract

This study examined the empirical effects of electricity consumption on carbon dioxide (CO₂) emissions in Iran. To achieve this goal, we applied the autoregressive distributed lag (ARDL) approach. The results indicate that cointegration exists among electricity consumption, economic growth, foreign direct investment (FDI), financial development and carbon dioxide (CO₂) emissions. Also findings indicate that increase in electricity consumption has had a direct impact on carbon dioxide (CO₂) emissions in both the short and long run. However, financial development and foreign direct investment (FDI) have a negative and significant effect on carbon dioxide (CO₂) emissions. Therefore, it is proposed to reduce energy subsidies in the polluting industry. In addition, more investment in the use of renewable energy is required.

Keywords CO₂ emissions · Electricity consumption · Foreign direct investment · Financial development

Introduction

Today, the environment has become so important in human life that the last decades of the twentieth century can be considered the peak of the environmental issue. In fact, environmental degradation threatens humans' lives peace and security. The destruction of the environment intensified following the Industrial Revolution, and the advancement of science and technology enabled human to subjugate the nature while at the same time causing a gradual but continuous destruction of the environment. On the other hand, economic growth is the main goal of many economic policies of governments. In the process of economic growth, energy is the driving force to accelerate this process [8]. Rapid economic growth usually causes serious damage to the environment (due to the increasing use of natural resources); hence, there is a potential conflict between economic growth policies and the environmental state. In the process of sustainable development, attending the

environment has an undeniable role. Sustainable development can be defined as the basis of economic and social development with the least harmful environmental effects. Unprecedented global warming, climate pollution, greenhouse gas emissions, ecosystem destruction and ozone depletion are the most important consequences of the extreme exploitation of nature in service of human production activities and goods consumption.

The power plant section is one of the most important air pollutants which releases large amounts of pollutants and greenhouse gases into the Earth's atmosphere annually. Since more than 90% of Iran's electricity needs are supplied using fossil fuels, in addition to air pollution and social costs due to emissions and greenhouse gases, the major fossil assets are also running fast.

Environmentalists and free trade advocates alike have paid close attention to environmental issues. To address these concerns, first, the complex links between international trade and environmental quality should be identified. In many environmental studies, the foreign direct investment variable has been used as a substitute to express the effect of trades on the environment. How foreign direct investment affects the environmental quality is different, especially in developing countries.

On the other hand, financial development can accelerate economic growth and consequently reduce environmental pollution by attracting foreign direct investment and higher levels of R&D, and it provide opportunities and incentives for developing countries to use new technologies. This paves the way for using environmentally friendly technologies and the creation of less polluting industries, which will ultimately

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improve the global environment. This study intends to study the impact of electricity consumption, economic growth, financial development, foreign direct investment on CO₂ emissions in Iran using the Autoregressive-Distributed Lag (ARDL) model. The continuation of this article is organized as follows.

The structure of the present article consists of five sections. In the following and the second part, the theoretical foundations and background of the research are stated. The research method is described in the third section. Empirical results are presented in the fourth section and finally, the conclusion is presented in the final section.

Literature Review

The Effect of Economic Growth on CO₂ Emissions

The relationship between economic growth and environmental quality in a long-term context can be direct, inverse, or a combination of both. Numerous studies have examined the relationship between economic growth and environmental quality. Analyzing the formation of this field of studies shows that in the last few decades, there have been two general currents of thought in this field, which have finally become a third approach. The first approach deals with a choice between economic growth and the maintenance of environmental standards; In other words, economic growth and increment of production and consumption inevitably requires more raw materials as production input, which in turn, leads to environmental degradation. So as the level of income increases during the process of economic development, the extraction of more natural resources and the increase of environmental degradation will reduce humans' welfare. From this perspective, economic growth is a kind of risk. Therefore, it is argued that policymakers should choose between two options: they should accept environmental risks due to prioritizing higher economic growth, or they must be satisfied with very low levels of economic growth, if they believe in protecting the environment, which is essentially a difficult choice.

At the other end of the spectrum is the second approach. Proponents of this approach believe that the path to improving environmental quality goes hand in hand with economic growth, and that economic growth should be aided in order to improve environmental standards. Because higher incomes increase demand for goods that use lower levels of raw materials, as well as demand for better environmental quality, which means accepting environmental protection standards and criteria.

The third approach, introduced in the early 1990s, describes the relationship between economic growth and environmental pollution as an inverted U. This approach is known as the environmental transfer hypothesis or the Kuznets

environmental curve hypothesis. This hypothesis states that in the early stages of economic growth, the degradation of the environment is high until it reaches its maximum point and then in the upper stages of growth, the environment condition improves [7].

The Effect of Electricity Consumption on CO₂ Emissions

The power plant section is one of the most important air pollutants which releases large amounts of pollutants and greenhouse gases into the Earth's atmosphere annually. In addition, this section require a great amount of energy. Since a large part of Iran's electricity needs are supplied using fossil fuels, in addition to air pollution and social costs due to emissions and greenhouse gases, major fossil assets are also running fast.

The Effect of Foreign Direct Investment on Carb CO₂ on Dioxide Emissions

According to theoretical foundations, how foreign direct investment affects CO₂ emissions can be a channel of economic growth. In fact, foreign direct investment is considered as one of the factors of economic growth and economic growth according to Kuznets environmental hypothesis affects the environment. The relationship between economic growth and environmental quality is described in the previous section.

The second channel of the impact of foreign direct investment on the quality of the environment can be analyzed based on the pollution haven hypothesis. This hypothesis states that countries with relatively weak environmental policies have an advantage in producing polluting industries. Also in many of these countries the level of per capita income is low. This theory emphasizes environmental policies to determine the comparative advantage and points that developed countries are mostly inclined to send their polluting industries to countries with lower environmental standards.

The third channel of the impact of foreign direct investment on the quality of the environment can be examined by the theory of primary factors of production. According to this theory, countries with large physical capital tend to export polluting goods, regardless of differences in environmental policies, and foreign direct investment also affects the environmental quality by changing the composition of production based on use or investment. If the inflow of foreign direct investment increases the production of consumer goods, resources are transferred from the contaminated sector to the clean sector. Therefore, a uniform negative relationship between income and pollution will arise. Conversely, if the inflow of foreign direct investment leads to the production of capital goods and human capital is reduced, clean industries will not grow and it accelerates the environment destruction and pollution increase.

The Effect of Financial Development on CO₂ Emissions

There are several reasons for the effect of financial development on the environmental quality, but in general, the importance of financial development in the realm of economic growth and environmental quality can be summarized in a few sentences. First, financial development can lead to faster economic growth and consequently, less environmental pollution by attracting foreign direct investment and higher levels of R&D. Second, financial development provides opportunities and incentives for developing countries to use new technologies. This paves the way for using environmentally friendly technologies and the creation of less polluting industries, which will ultimately improve the global environment. Third, on the other hand, economic growth resulting from increased financial development may lead to more environmental pollution. Financial development can play a crucial role in environmental efficiency since wider development in the financial sector, due to more equipment and efficient financial resources, makes it possible to finance all investments, including investments in environmental projects, at a lower financial cost. The possibility of wider access to financial resources for environmental projects can be considered by governments because most environmental protection projects are within the remit of governments.

Introducing and informing about the companies that attend environmental considerations in managing their activities, and developing the financial sector enforces the motivation to invest in these companies which results in improved environmental efficiency. In other words, the capital market can encourage investors to invest on shares of firms that pay special attention to maintaining the environmental quality in their activities by higher valuation of their shares. It helps to guide financial development to maintain the environmental quality.

In contrast, the capital market can disclose information about the largest polluting firms and enforce investors' sensitivity to their activities which forces these firms to take environmental considerations into account. Ultimately, financial development both by attracting more foreign direct investment and directly affecting economic growth, accelerates the process of economic growth and thus reduces the slope of the Kuznets environmental curve. Thus, for a certain level of economic growth, less pollution (carbon dioxide) is released.

Some studies have focused on the relationship between energy consumption, CO₂ emissions and economic growth by applying numerous techniques. These studies include:

Pao et al. [13] applied the cointegration technique and conducted a causality test to examine the dynamic relationships between CO₂ emissions, energy use, and real output for Russia for the period 1990–2007. They did not find any support in favor of the EKC hypothesis.

Pao et al. [12] undertook an empirical exercise to forecast CO₂ emissions, energy consumption, and economic growth in China. A long-run relationship between the variables was observed. CO₂ emissions were found to be output-inelastic, while energy consumption is output-elastic.

Bella et al. [2] used the panel VECM method to investigate the relationship between CO₂ emissions, electricity and GDP in OECD countries. They found two independent nonlinear relationships between the variables which seemed to be largely heterogeneous in countries.

Salahuddin and Gow [17] examined the empirical relationship between economic growth, energy consumption and CO₂ emissions in GCC countries for the period 1980 to 2012. They found a positive and significant relationship between energy and CO₂ emissions, as well as between economic growth and energy in the short and long term.

Heidari et al. [7] studied the relationship between economic growth, CO₂ emissions and energy to test the validity of the environmental Kuznets curve (EKC) hypothesis in five ASEAN countries (Indonesia, Malaysia, Philippines, Singapore and Thailand) using the PSTR model. Their empirical evidence refused the null hypothesis of the linear relationship. They showed that in a structure with a GDP per capita below \$ 4686, the environmental degradation increases with economic growth, but this relation was converse in a structure with GDP per capita above \$ 4686. Another finding was that in the two structures mentioned, energy consumption led to an increase in CO₂. Overall, the results of this study confirm the validity of the EKC hypothesis in ASEAN countries.

Saidi and Hammami [16] evaluated the impact of CO₂ growth and emissions on energy for 58 countries and regions in Europe and North Asia, Latin America and the Caribbean, and sub-Saharan Africa using the GMM method in 1990–2012. They reported the powerful effect of CO₂ on energy and the positive significant effect of economic growth on energy consumption. The causal relationship between energy, carbon dioxide emissions, growth, trade openness and urbanization for the new member states and the EU candidate in 1992–2010 was investigated by Kasman and Duman [1]. They used panel unit root tests, panel aggregation methods and panel causality test to investigate this relationship. The findings confirmed the hypothetical accuracy of EKC, and manifested a short-term and one-way panel causality from energy to CO₂ emissions.

Chen et al. [3] examined the relationship between economic growth, energy consumption and greenhouse gases by using the panel convergence model and the error vector correction model for 188 countries in 1993–2010. The experimental results revealed a long-term relationship between economic growth, energy and CO₂ emissions for all countries. They found that 1% increase in GDP would augment energy consumption by 5.4%, 8.2% and 4.5% in the world, developed and developing countries, respectively. Likewise, energy

had significant effects on CO₂ emissions since 1% increase in energy would expand CO₂ emissions by 7.6%, 26.1% and 13.5% in developed countries, developing countries and the world, respectively. This shows the positive relationship between these two variables in the long run. It should be noted that energy had a negative impact on world GDP and developing countries, but this was not the case in developed countries. They discovered that 1% increase in per capita energy consumption reduced GDP per capita by 3.0% and 4.2% in the world and developing countries, respectively. However, CO₂ emissions had a positive effect on GDP. 1% increase in per capita CO₂ emissions leads to a 6.7%, 11.9% and 6.1% increase in GDP in the world and in developed and developing countries, respectively.

Rafindadi [15] studied the relationship between economic growth, energy, economic development, trade and CO₂ emissions in Nigeria from 1971 to 2011. In this study, the ARDL bounds testing approach to cointegration, Zivot-Andrew structural failure test and Bayer-Hanck combination cointegration test were used. The outcomes manifested that energy consumption led to a significant increase in CO₂ emissions.

Furuoka [4] examined the relationship between renewable and non-renewable electricity consumption and economic development in the Baltic region in 1992–2011. He observed a one-way causality from economic development to renewable energy consumption.

He et al. [6] pursued the relationship between electricity consumption and economic growth in Guangzhou for 64 years, and discovered a one-way Granger causality from electricity consumption to the economic performance of the metropolis in the short term. Another finding was that the effects of different types of energy on the growth and emission of CO₂ on different groups of countries were heterogeneous. In addition, causality was mutual between growth and energy.

Gorus and Aydin [5] investigated The relationship between energy consumption, economic growth, and CO₂ emission in MENA countries. Analysis of the results shows Energy consumption is the Granger cause of CO₂ in the short-run. Also Two-way causality exists between energy use and CO₂ except for the short-run. Moreover, policies to control air pollution can be designed by policymakers because of the absence of the causal nexus between economic growth and CO₂ emission.

Wasti and Zaidi [22] studied the link among CO₂ emissions, energy consumption, gross domestic product, and trade liberalization as related to Kuwait. results explained Carbon dioxide and energy consumption increase economic growth; an increase in CO₂ emission also plays a significant role in increasing energy consumption. Furthermore, the Granger Causality test shows evidence of bi-directional causality existing between CO₂ emissions and energy consumption.

Tong et al. [20] studied energy consumption, and carbon dioxide emissions in the E7 countries. This research utilizes a bootstrap ARDL bound test accompanied with structural breaks to test the cointegration and causality relations among economic growth, energy consumption, and carbon dioxide (CO₂) emissions in the E7 countries. The results manifestation is that the main cause of CO₂ emissions is energy consumption which has sparked the emergence of global warming problems.CO₂ emissions raise force the E7 countries to form sound policies on energy consumption and environmental pollution.

Li and Haneklaus [9] investigated the relationship between renewable energy, fossil fuel consumption and CO₂ emissions in China by Autoregressive Distributed Lag (ARDL) model. The aspiration of this work is to test the role of long- and short-term dynamics of renewable energy consumption in reducing CO₂ emissions in China. The findings indicate that fossil fuel consumption increases the level of CO₂ emissions in China. The role of renewable energy consumption in reducing CO₂ emissions may come from a cumulative effect. In the long run, a 1% increase in renewable energy consumption per capita decrease the CO₂ emissions per capita by 0.259%.

Pachiyappan et al. [11] examined causal effects of CO₂ emissions and energy use in India by comparing the VECM and “auto regressive distributed lag”. Outcomes suggest a long-term equilibrium between CO₂ and energy consumption. The Granger causality results manifest that there exists unidirectional causality between CO₂ and energy consumption. Variance decomposition shows that 58.4% of the future fluctuations in CO₂ are due to changes in Energy Use.

Mohsin et al. [10] inspect the impacts of fuel energy consumption, foreign direct investment and GDP on CO₂ emission in Central Asia and Europe. The ARDL method has been adopted. Findings show that energy consumption and FDI Granger cause CO₂ emission. Also, energy consumption is the most important source of CO₂ emission. In addition, Environmental Sustainability of Europe and Central Asian Countries can be improved by reforming the main sectors of CO₂ emission.

Data and Methodological Framework

According to the literature on the effect of financial development, economic growth; electricity consumption and foreign direct investment in carbon dioxide emissions in Iran, the ARDL model has been used. Uddin et al. [21] recommend that conventional cointegration techniques do not contribute to sincere results when data are interfered with structural breaks. Therefore, this study employed the Autoregressive Distributed Lag bounds testing approach developed by Pesaran et al. [14] to estimate the cointegrating or long-run relationship between the variables. The ARDL approach has

already proved to be efficient in cases of small sample size. Moreover it irradiates the problems of omission bias and autocorrelation. Also, the ARDL approach provides unbiased estimates of the longrun model and valid t-statistics, even in the presence of the problem of endogeneity. [18] The model studied in this research is as follows:

$$co2_t = \beta_0 + \beta_1 Growth_t + \beta_2 EC_t + \beta_3 Finan_t + \beta_4 FDI_t + \varepsilon_t$$

Where:

CO2: Per capita carbon dioxide emissions, Growth: GDP growth, Energy: Per capita electricity consumption, EC: Per capita electricity consumption, Finan: Financial development i.e., domestic credit available to the private sector as share of GDP, FDI: Foreign Direct Investment as share of GDP.

The research period is from 1970 to 2018 based on the data availability.

To examine the existence of a long-term relationship, it is necessary to test the correlation between the model variables. The condition of the variables accumulation is that the sum of the coefficients of the dependent intermittent variables that appear as the explanatory variable in the model is less than 1. To confirm the above result, the following hypothesis should be tested:

$$\begin{cases} H_0 : \sum_{i=1}^s \alpha_i - 1 \geq 0 \\ H_1 : \sum_{i=1}^s \alpha_i - 1 < 0 \end{cases}$$

The test statistic used to evaluate the null hypothesis is the absence of a long-term equilibrium relationship between the model variables of type t and its value is calculated from the following formula:

$$\tau = \frac{\sum_{i=1}^s \alpha_i - 1}{\sum_{i=1}^s SE \alpha_i}$$

Then the above computed statistics should be compared with the values of the Dolado-Master-Benerji table.

Empirical Results

First, before examining the effects of electricity consumption on carbon dioxide (CO2) emissions, examine the unit root. Here, the Augmented Dickey-Fuller test is used to examine the unit root. The results are reported in Tables 1 and 2.

The ADF test confirms that the economic growth is sustainable in level. While it is not the case for other variables. The results of this test for the first-order difference of are given in Table 2 which show that the series are first difference stationary.

Table 1 Results of the Augmented Dickey-Fuller test.

Variable	Statistic	T Statistics	Prob
CO2	-3.51	-1.15	0.90
GROWTH	-3.52	-4.74	0.0023
ENERGY	-3.51	0.39	0.99
FINAN	-3.52	-1.16	0.90
FDI	-1.94	-1.77	0.07

- Estimation of the short-term dynamic model.

As mentioned, this study aimed to investigate the effect of financial development, economic growth, electricity consumption and foreign direct investment on carbon dioxide emissions in Iran.

Among the 3125 estimated dynamic patterns, a model with the optimal interval according to the Schwartz-Bayesian criterion is presented in Table 3.

According to Table 3, electricity consumption in the 99% confidence interval is significant and has a direct effect on carbon dioxide emissions in Iran. The ever-increasing human need for electrical appliances and the importance of this energy in various sectors, including industry, and government and non-governmental organizations, has caused a large part of electricity to be supplied from fossil sources. Therefore, in addition to air pollution and social costs due to emissions and greenhouse gases, the major fossil assets are also running fast. It should be noted that more than 90% of the Iran electricity needs are supplied by fossil fuels. This finding is consistent with that of Salahuddin [18] and Soytas and Sari [19].

Foreign direct investment has a positive and inverse effect on carbon dioxide emissions. Countries with large physical capital tend to export polluting goods, regardless of differences in environmental policies, and foreign direct investment also affects the environmental quality by changing the composition of production based on use or investment. If the inflow of foreign direct investment increases the production of consumer goods, resources are transferred from the contaminated sector to the clean sector. Therefore, a uniform negative relationship between income and pollution will arise. Conversely, if the inflow of foreign direct investment leads

Table 2 Results of the ADF test for the first-order differentiation.

Variable	Statistic	T statistic	Prob
CO2	-3.52	-5.70	0.0001
ENERGY	-3.52	-6.74	0.0000
FINAN	-3.52	-5.78	0.0001
FDI	-1.94	-8.46	0.0000

Table 3 Results of estimating the short-run coefficients using the ARDL(2,0,0,4,0).

variable	coefficient	Standard deviation	T statistic	Prob
Co2(-1)	0.65	0.16	4.04	0.0006
Co2(-2)	-0.36	0.21	-1.69	0.10
Energy	0.005	0.0015	3.86	0.0009
Fdi	-0.16	0.08	-1.99	0.05
Finan	-0.05	0.019	-2.64	0.01
Finan(-1)	0.051	0.023	2.25	0.03
Finan(-2)	-0.01	0.024	-0.80	0.43
Finan(-3)	-0.022	0.021	-1.03	0.31
Finan(-4)	-0.04	0.019	-2.14	0.04
Growth	0.006	0.007	0.84	0.40
C	3.13	0.80	3.89	0.0008
@trend	-0.22	0.06	-3.65	0.0015
		$R^2=0.98$	Prob(F-statistic)=0	Schwarz criterion=0.57

to the production of capital goods and human capital is reduced, clean industries will not grow and it accelerates the environment destruction and pollution increase. In Iran, the inflow of foreign investment will increase the production of consumer goods and reduce carbon dioxide emissions.

Also, the results of model estimation show that financial development has a significant and inverse effect on carbon dioxide emissions. The importance of financial development in the realm of economic growth and environmental quality can be summarized in a few sentences. First, financial development can accelerate economic growth and consequently reduce environmental pollution by attracting foreign direct investment and higher levels of R&D. Second, financial development in developing countries provides opportunities and incentives for to use new technologies. This paves the way for using environmentally friendly technologies and the creation of less polluting industries, which will ultimately improve the global environment. Financial development can play a crucial role in environmental efficiency since wider development in the financial sector, due to more equipment and efficient financial resources, makes it possible to finance all investments, including investments in environmental projects, at a lower financial cost.

It is also observed that financial development with an interruption period of 95% confidence interval is significant and has a direct effect on carbon dioxide emissions which could be explained by the fact that financial development with a period of interruption helps to the country economic growth. Economic growth and increment of production and consumption inevitably requires more raw materials as production input, which in turn, leads to environmental degradation. So as the level of income increases during the process of economic development, the extraction of more natural resources and the increase of environmental degradation will reduce humans' welfare. From this perspective, economic growth is a kind of

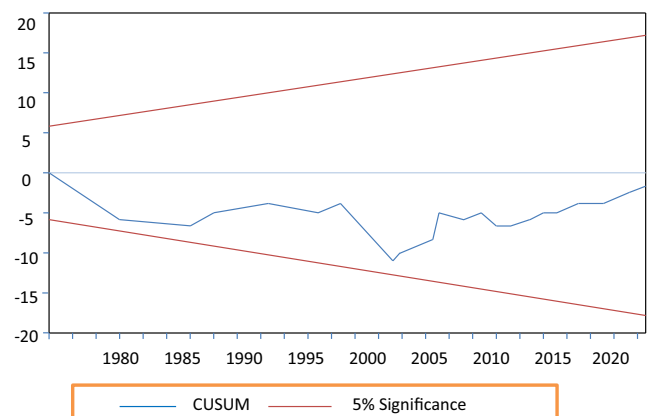
risk. Therefore, it is argued that policymakers should choose between two options: they should accept environmental risks due to prioritizing higher economic growth, or they must be satisfied with very low levels of economic growth, if they believe in protecting the environment, which is essentially a difficult choice. Salahuddin [18] reported the same finding.

– Structural stability test.

Estimated parameters may change over time, and instability parameters may lead to inaccurate diagnosis. Therefore, performing the structural stability test seems to be necessary. Diagnostic tests are used to determine the stability of the model and to determine the structural stability.

In this research, CUSUM diagram has been used for testing the model stability. If the statistical graph intersects one of the side lines at the 5% level, the model will not be stable. Figure 1 shows the absence of structural break in this time period.

– Testing the existence of a long-run relationship between the variables.

**Fig. 1** Structural stability test results

Since in this study some variables are stationary at level and some have been stationary by one-time differentiation, the existence of a long-term relationship is examined by the Bounds test. The null hypothesis in this test indicates the absence of a long-term relationship (Table 4).

The value of the estimated F statistic at the significance level is 10% higher than the critical value of the upper bound and the null hypothesis is rejected.

– The long-run model estimation

As noted above, the estimated F-statistic at the significance level is 10% higher than the critical value of the upper bound, and the existence of a long-term relationship between the variables is confirmed. Therefore, the long-term model estimates the factors affecting carbon dioxide emissions and the estimation results are given in Table 5.

As can be seen in Table 5, electricity consumption at the 99% confidence interval is significant and has a direct effect on carbon dioxide emissions in the long-term. Therefore, the inflow of foreign investment in Iran will increase the production of consumer goods and reduce carbon dioxide emissions. As mentioned, more than 90% of Iran electricity needs are supplied using fossil fuels, and the increasing use of fossil fuels not only lead to excessive carbon dioxide emissions and threatens the environment, but brings about various destructive side effects.

Long-term financial development is significant in the 99% confidence interval and has an inverse effect on carbon dioxide emissions. As previously stated, financial development can accelerate economic growth and consequently reduce environmental pollution by attracting foreign direct investment and higher levels of R&D. It also provides opportunities and incentives for developing countries to use new technologies. This paves the way for using environmentally friendly technologies and the creation of less polluting industries, which will ultimately improve the global environment.

According to the results of this study, economic growth in the long-term is not significantly associated with carbon dioxide emissions.

Table 4 Results of the Bounds test.

Test Statistic	Value	Significant level	I(0)	I(1)
F statistics	3.19	1%	3.29	4.37
		2.5%	2.88	3.87
		5%	2.56	3.49
		10%	2.2	3.90

Table 5 Results of the long-run model estimation.

variable	coefficient	Standard deviation	T statistic	Prob
Energy	0.008	0.0009	8.64	0
Fdi	-0.23	0.13	-1.72	0.09
Finan	-0.11	0.02	-4.92	0.0001
Growth	0.008	0.01	0.79	0.43
@Trend	-0.32	0.04	-7.36	0

Conclusions

Rising greenhouse gas emissions is one of the most important factors of the world's climate change. Often, small changes in the climate lead to large-scale continental changes, natural disasters, and economic damage. Many environmentalists believe that increasing greenhouse gas emissions in the coming decades will cause the Earth to face environmental and climate crises. This study attempted to investigate the effects of economic growth, electricity consumption, financial development and foreign direct investment on carbon dioxide emissions in Iran. Findings showed that both in the short-term and long-term, electricity consumption has a positive significant effect on carbon dioxide emissions. Thus, citing the positive relationship between electricity consumption and carbon dioxide emissions in Iran, it is proposed to reduce subsidies for energy carriers in the polluting industry and to invest more on using new and renewable energy with low pollution.

In addition, the results of the ARDL model estimation indicate that increased foreign direct investment and financial development will reduce carbon dioxide emissions in the short-term and long-term.

Therefore, the government can prevent the increase of foreign direct investment in sectors and industries with high environmental pollution without the transfer of clean technology by imposing strong environmental regulations. It can also guide the flow of foreign investment to increase the production of consumer goods since if the inflow of foreign direct investment causes the production of capital goods and human capital is reduced, clean industries will not grow, and environmental degradation and pollution increases. Financial institutions should support investment in environmentally friendly technologies by increasing domestic lending to the private sector.

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