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Impact of Determinant Macro Economic Variables on Environmental Changes in Iran

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ABSTRACT: Sustainable economic development involves both improving the socio-economic quality of life in the present and improving environmental conditions for future generations. The main objective of the study was to investigate the impact of the determinant macroeconomic variables, including economic complexity, construction, energy consumption, and housing sector expenditures, on environmental changes in Iran over the period 1991 to 2019; using the autoregressive distributed lag (ARDL) model. The results show that at the macro level, an increase in the economic complexity index can reduce pollution in both the short and long term. The effects of further expansion of the housing sector and household energy consumption on pollution are positive and significant in both the short and long run. The error correction model (ECM = 0.65) shows that 65% of the imbalances in each period are corrected in the next period. Based on the obtained results, it is recommended to take serious measures to improve the structure of production and increase the country's economic complexity index; in other words, to produce goods with higher knowledge and technology and apply policies to improve the level of household energy consumption leading to air pollution reduction.

JEL: Q40, Q48, Q50, Q52

KEYWORDS: Economic complexity, housing sector, environment, energy consumption, sustainable development, ARDL model

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Introduction

The emission of greenhouse gases and the consequent pollution of the environment are important issues that are the concern of many policy makers in many countries. To reduce air pollution, the emission of greenhouse gases must be prevented; therefore, first, it is necessary to know the factors affecting the emission of greenhouse gases. By accurately knowing the factors affecting the emission of greenhouse gases and determining the effectiveness of each, in the next step, effective policies can be adopted to reduce environmental pollution; Therefore, in the continuation of this research, firstly, the reason for the importance of paying attention to greenhouse gas emissions and the factors affecting it will be discussed in detail, then the innovation of the research and the difference of the current research compared to the previous studies will be stated, and at the end of the introduction, the method and the way to respond to the questions are stated.

According to the National Aeronautics and Space Administration (NASA) research study, greenhouse gas emissions in the world are increasing, which has led to numerous environmental problems, including global warming. Environmental problems are one of the main problems around the world, which have been studied from different angles, including the Kuznets Curve Hypothesis. According to the environmental Kuznets curve hypothesis, there is an inverted U-shaped relationship between economic growth and environmental quality National Aeronautics and Space Administration (NASA).[1] Many studies such as Pita et al[2] and Rahman et al[3] have confirmed the impact of economic growth and development indicators on the environmental quality of countries. Sustainable economic growth and development have always been considered by governments and policymakers in most advanced developing countries, but despite its many benefits, it generally has its problems, of which pollution is one of the most important. In other words, as economic growth is usually accompanied by increased use of resources and factors of production such as energy, it can also lead to environmental degradation by increasing the emission of pollutants and eventually posing a serious challenge to long-term economic growth and sustainable economic development. According to the World Health Organization (WHO), about 7 million people worldwide die each year from air pollution-related diseases. It is noteworthy that about 88% of these people live in low and middle-income countries.[4]

Iran is one of the developing countries facing severe air pollution, and in most populous cities, air pollution has caused irreparable damage to public health and the economy. Therefore, studying the factors affecting pollution seems very necessary given the issues raised.[5] It is noteworthy that according to studies conducted by the Environmental Research Institute of Tehran University of Medical Sciences, and also according to the findings of other researchers, the air quality in various parts of Iran deviates significantly from the global

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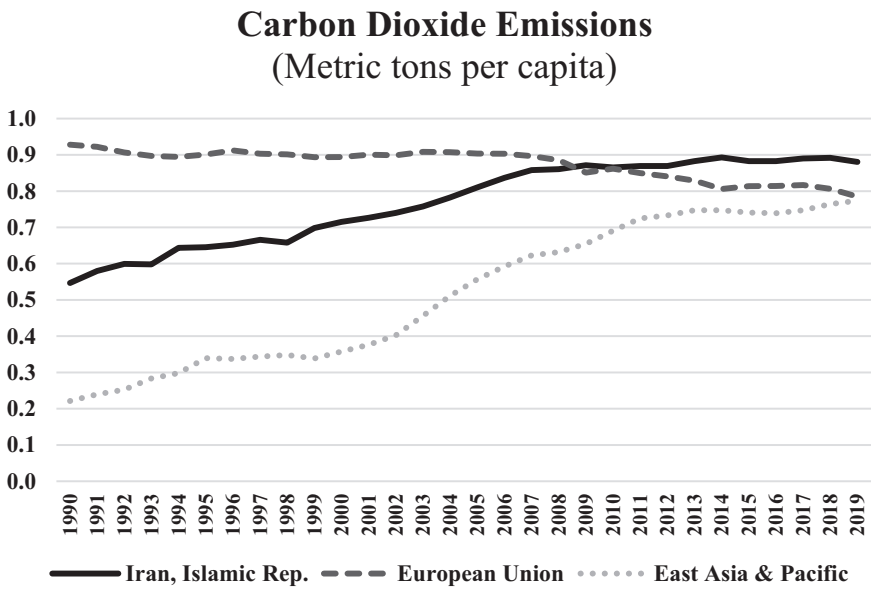

Figure 1. The rate of growth in carbon dioxide emissions 1990 to 2019.
Source: World Bank Database.[7]

standard values. Every year, about 40 000 people die in the country due to contact with particulate matter, which is about 10% of all deaths in the country.[6] Pollution in Iran has increased over time, so one of the biggest challenges facing the country in the last 2 decades has been environmental problems. The problems related to pollution in Iran, especially in urban areas, are much greater and this problem has led to air pollution becoming a major socio-economic challenge for planners and people. It is also noteworthy that the group most affected by air pollution is the elderly and their proportion in the country will increase in the coming years, so the problem of pollution may have a much greater impact in the future. It is noteworthy that among the types of greenhouse gases, carbon dioxide gas is one of the most important because according to the latest national report of Iran's greenhouse gases, CO_2, and methane account for 77.5% and 18.9% of the total mass emission, respectively. allocated; An increase in greenhouse gas emissions can cause environmental destruction and subsequent air pollution; Therefore, it is very important to investigate the variables that affect the emission of greenhouse gases and also the extent of their influence, and this is the main goal of this research. It is worth noting that the emission of carbon dioxide (CO_2) in Iran has continued to increase from 1991 to 2022, which can lead to sustainable economic growth in the face of major problems. Statistical data show that the quality of the environment and the amount of pollution in the air in Iran are not in a good condition compared to other countries in the world. Figure 1, shows the increasing trend of carbon dioxide emissions and it can be seen that the growth of carbon dioxide emissions in Iran is continuously increasing during the studied years.

The role of housing sector activities in economic growth and development by adding value as a contributor to gross domestic product (GDP) and creating jobs and employment opportunities is critical for many developing countries. The impact of housing sector activities on other macroeconomic variables such as employment, public expenditure, GDP, and many other variables have been examined in most empirical studies and have found that despite the significant benefits of housing sector activities, the development of this sector also poses problems.[8] It should be noted that activities related to the construction of buildings and their implementation generally have a high share of GDP in developing countries; this has also led to the housing sector being economically more important in this group of countries. For example, in Iran, between 5% and 10% of the national income is related to the added value of the housing sector. Figure 2 shows the share of the added value of the housing sector in the national income. As shown in the graph, despite its high fluctuations, is always a significant percentage of the national income related to the share of the housing sector.

The housing sector is one of the leading economic sectors in most developing countries due to the creation of various jobs and poverty reduction.[9] One of the most important problems in the development of the housing sector is the high consumption of natural resources and energy in this sector. For example, the housing sector in China is the second-largest producer of carbon. The high energy consumption in the housing sector has led to an increase in greenhouse gas emissions, which may also result in increased pollution.[10-12]

The housing sector in Iran is more important than in any other developing country because many people in Iran invest in the housing sector. In other words, due to high inflation in Iran, the housing sector is considered a durable goods investment sector in addition to meeting people's consumption needs. Therefore, the housing sector in Iran has not only met people's consumption needs but has always been considered an effective

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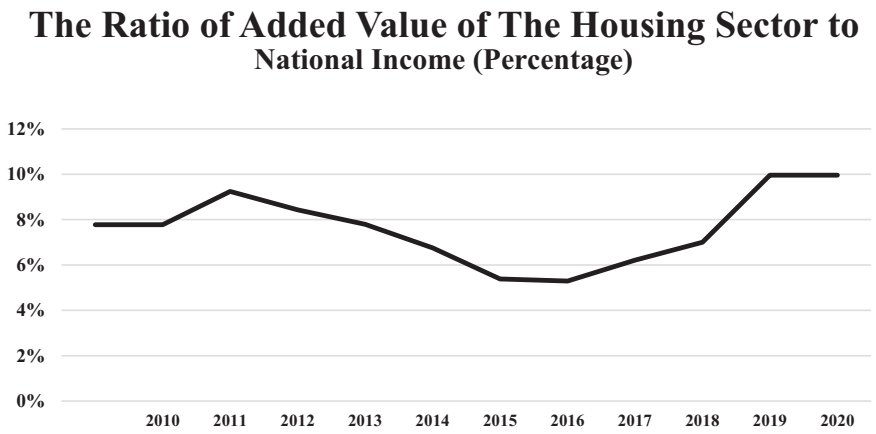

Figure 2. The ratio of added value of the housing sector to national income 2010 to 2020.
Source: Central Bank of Iran.

option for preserving the value of assets compared to other investments.[13] Despite the great importance of the housing sector, this sector is also known as one of the sectors that pollute the environment. Regarding the impact of the housing sector on environmental pollution, important cases can be mentioned such as improper disposal of construction waste through demolition, non-compliance with laws and regulations related to energy conservation, and conversion of natural forests and agricultural land into residential areas. He pointed out that problems that are not addressed will lead to significant environmental pollution.

Another area that seems to be related to pollution is the structure of production. In recent studies, the relationship between the structure of CO_2 production and emissions has been investigated and confirmed by many researchers.[14,15] An economic complexity index can be used to show the structure of production. This index was developed by Hidalgo and Hausmann and is an indicator of the complexity of economies. In other words, this index is considered one of the determinants of production structure in terms of technology use. Economic complexity determines the productive capacity of a country with the aim of sustainable growth and development of human capital, institutional quality and innovation processes, and concentration on export goods based on technology and technical knowledge. Typically, countries with higher rankings in the economic complexity index export more complex products and also have higher GDP, per capita income, and growth rates.[16-19]

Given the given definition, we can say that countries with higher economic complexity are likely to have more complex production structures. Accordingly, we expect that a country with higher economic complexity will practically use newer technologies and techniques in the production of its products. In other words, because countries with higher economic complexity are likely to use newer techniques and methods in manufacturing products, we expect emissions of environmental pollutants to decrease in this group of countries.[20]

Experimental and field studies in Iran have shown that in Iran, due to the special conditions of environmental quality and severe pollution beyond global standards, especially in densely populated cities, it is necessary to pay more attention to effective factors. While until now, few coherent kinds of research have been done in terms of examining the effective factors at the macroeconomic level. Since many developing countries such as Iran, it is necessary to conduct such studies at the international level to reduce environmental problems. While previous studies have examined the effect of various variables on environmental pollution from different aspects, it seems that these studies are not comprehensive enough. For this purpose, in this research, while paying attention to the previous studies, we contribute to the development of the existing literature with a comprehensive model and investigate and analyze the variables affecting environmental pollution. This study uses the ARDL method to examine the relationship between the housing sector, economic complexity, household energy consumption, and environmental pollution indicators (CO_2 emissions). It is noteworthy that the purpose of this study is to investigate the impact of different variables on the amount of greenhouse gas emissions. In order to achieve this goal, we are trying to take a comprehensive look at variables affecting environmental pollution by developing previous studies and aggregating previous studies, so that we can take a step toward improving the literature of this important field by presenting a more comprehensive model than previous studies. According to the stated purpose, the results of this study can be useful for economic planners in the housing sector and related activities, so that the opinion of economic politicians could be directed to identify the effective factors in environmental pollution by using technical knowledge and the use of economic complexity in the production of goods and services and housing, to control the level of environmental pollution.

Following, we will examine the issue first from a theoretical point of view and then from an experimental point of view; Therefore, the continuation of the article is as follows: the

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second part is related to the review of theoretical literature, the third part is the review of the research method, the fourth part is the review and statistical analysis, and the fifth part is the conclusion and policy recommendations based on the results obtained in the research.

Theoretical Background

Global warming and climate change and increasing awareness of the problems caused by it have increased the importance of knowing and investigating the factors affecting this problem. This issue has also led to the creation of extensive literature related to the effects of greenhouse gas emissions, especially carbon dioxide. Due to the high importance of the issue, almost all countries have agreed to implement policies to reduce carbon dioxide emissions. Global warming, environmental degradation and climate change are still considered the most dangerous issues in the world. To control these problems, many efforts have been made to identify the main factors of environmental degradation.[21-23] To reduce carbon dioxide emissions, we must first identify the factors affecting it; Therefore, in the following, we will examine the effect of different variables on the emission of carbon dioxide:

Economic growth and the environment

The phenomenon of economic growth and development in countries is statistically significant, and higher numbers indicate that countries are more suitable in terms of growth, but on the other hand, points in this direction, what has been the effect of economic growth on the environment? The development of studies began with Grossman and Krueger,[24] who studied the impact of economic growth on environmental pollutants and confirmed the existence of an inverted U-shaped relationship between per capita income and the emission of particulate matter and other pollutants in the air. Previous studies show that economic growth in its initial phase leads to environmental degradation. Galbraith[25] studied the relationship between energy consumption in the early stages of economic growth and carbon emissions in France, and the result showed the impact of energy consumption on carbon emissions. Given the great importance of economic growth and the destructive effects of pollution, it seems very necessary to study the relationship between economic growth and the environmental degradation index.[26,27] From the previous studies, a significant part of greenhouse gases emitted worldwide is in the form of carbon dioxide, which is also caused by fossil fuels; therefore, the energy sector has the largest share of environmental problems. In other words, based on the cases, it was found that energy policy and environmental policies are closely related.[28] Regarding the previous studies, it can be briefly stated that these studies focused more on the relationship between energy consumption, environment, and economic growth, while this study focuses on economic complexity and the housing sector and related factors.

Housing sector and the environment

Buildings are 1 of the 7 major drivers of resource use, and empirical studies show that the intensity of resource use in buildings is such that, on average, buildings account for one-sixth of the world's freshwater and one-fourth of the world's harvested wood.[29-32] In addition, they are considered an important cause of environmental pollution. It is estimated that the construction industry alone consumes 25% of the world's virgin wood and 40% of raw stone and sand each year. It is also noteworthy that the residential construction sector consumes 40% of the materials imported into the global economy and is responsible for 40% to 50% of global greenhouse gas (GHG) production.[33] The major and minor activities associated with the housing industry emit carbon dioxide throughout their supply chain. Babak[34] studied the impact of construction activities on the Russian environment. The results of this study showed that the production phase of materials has the greatest negative impact on the construction of a building. Ametepey and Ansah[35] conducted a similar study in Ghana. The results of this article also showed that the group of energy consumption, including the consumption of electricity and fossil fuels, has the greatest impact. The destructive impact of economic activities on the environment increased over time so since the first decade of the 18th century, the destructive impact of economic activities on the environment was considered a major challenge by planners and policymakers of different societies. This issue also led some economists to consider government intervention necessary.[36]

Developing countries have always faced the problem of how to achieve economic growth and environmental protection at the same time. Many experts believe that housing can help in this regard. Through the intelligent design of the city and buildings, economic growth, and environmental protection can be achieved simultaneously.[37] The results of many studies in this field have also confirmed the reduction of CO_2 emissions through smart city design. Building a smart city can improve CO_2 emissions by improving productivity and reducing energy consumption; therefore, the importance of the housing sector is quite clear due to its significant impact on economic growth and greenhouse gas emissions.[38] It is worth noting that at the international level, housing is in short supply and approximately 2 billion homes will need to be built by the end of the 21st century.[39]

Given the great importance of the housing sector, it is very important to maximize efficiency in this sector. Wilson and Boehland[40] pointed out that resource efficiency can be achieved by designing small dwellings. Similarly, a study by Kumardar pointed out the importance of flexibility in housing design. In this context, and to reduce the negative impact of housing on the environment, planners focused on the industrialization of housing production. Industrial housing construction (IHC) is a broad term that encompasses approaches such as prefabricated construction, modular construction, off-site

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construction, or modern methods of construction (MMC). IHC is a strategy for using innovations for resource-efficient housing construction.[41] Examples include product innovations such as cross-section lumber (CLT) and process innovations such as lean manufacturing. Although resource efficiency should be an integral part of comparing IHCs to conventional housing, there is little evidence of this.[42] In this context, Sandanayake et al[43] studied the impact of the construction sector on environmental emissions such as CO_2. The results of their study showed that the construction sector plays a significant role in energy consumption and environmental emissions. Jiang et al[44], investigated ways to reduce CO_2 emissions in the building sector of Shenzhen. The results of this study showed that CO_2 emissions in Shenzhen's building sector can be limited from 2022 to 2025 (by 2030, it is possible to reduce CO_2 emissions by up to 60%).

This study emphasized the importance of accelerating the retrofitting of existing buildings and paying attention to increasing energy efficiency and its implementation. Managing energy savings in the building sector and promoting the use of renewable energy can enable a rapid downward trend in greenhouse gas emissions. The significant impact of the housing sector on economic growth has been investigated and confirmed in several studies, including Enshassi et al,[45] Hossain and Poon,[46] and Yan et al.[47] Also, Odugbesan and Rjoub[48] conducted a study to investigate the relationship between economic growth, CO_2 emissions, energy consumption, and urbanization in Mexico, Indonesia, Nigeria, and Turkey (MINT countries) from 1993 to 2017, and the results showed that there is a causal relationship between energy consumption and economic growth for all MINT countries.

Energy consumption and the environment

The level of energy consumption in developing countries, like other factors of production, depends on the level of economic activity and is strongly influenced by economic growth.[49-51] Energy is considered one of the most important inputs for production. The level of energy consumption is also a function of the level of production and also depends on the production technology.[49-51] The impact of private and public spending in the construction sector on the environment can be studied from 2 perspectives. From the first perspective, it is expected that with the increase and growth of the capital factor, the volume of economic activities will also increase; therefore, the growth of the country's GDP will also increase. According to this view, as the volume of GDP increases, so does energy consumption and, consequently, emissions.[52] The second view, also known as the optimistic and compensatory view, assumes that increasing investment and GDP will be accompanied by technological changes and the use of new technologies in the construction process. According to this view, as investment expands, environmentally friendly technologies will be created in place of old technologies, emitting fewer pollutants, and improving the quality of the environment.[53,54]

Soytas and Sari[55] studied the relationship between energy consumption and carbon emissions in the United States and confirmed the relationship between energy consumption and carbon emissions. Subsequent studies by Halicioglu,[56] Iwata et al,[57] Jalil and Feridun,[58] Shahbaz et al,[59] etc. have partially confirmed the impact of energy consumption on carbon emissions. Majeed et al[22] and Bekun et al[60] respectively and in separate articles examined and confirmed the impact of energy consumption on greenhouse gas emissions in 16 economies of the European Union and the Persian Gulf Cooperation Council countries.

The construction industry is one of the industries with the highest energy and material consumption in the world. If current construction methods are maintained, the world expects significant environmental challenges in the future given the increasing prospects for global demand. In other words, the use of current construction methods and procedures will lead to a significant increase in pollution in the future; therefore, a change in construction methods seems to be urgently needed.

Economic complexity and the environment

In general, production technology is expected to affect energy consumption and thus the environment.[61] Due to increasing energy conservation and efficiency, as well as the active use of clean energy technologies (such as solar panels and hydropower), the reallocation of production factors from traditional to modern activities may be beneficial to the environment. Over time, we expect the increasing economic complexity to improve the quality of green technologies and innovations in environmental technologies that can pave the way for reducing CO_2 emissions.[62,63] In recent years, the production system of countries has undergone significant changes. The diversity of production has increased and economies have changed from traditional to modern systems. The production structure of countries, also known as economic complexity, has increased with economic growth. Experimental results show that economic complexity reduces greenhouse gas emissions. For example, Romero and Gramkow[15] indicated in their study that increasing economic complexity reduces CO_2 emissions by 23% and leads to an improvement in environmental quality. In this context, Can and Gozgor[64] investigated the impact of economic complexity on CO_2 emissions and confirmed the importance of the environmental Kuznets curve (EKC) hypothesis using second-generation dynamic unit tests and conventional dynamics. Doğan et al,[14] Bashir et al,[65] Chen and Zhao,[66] and Marco et al[67] confirmed the impact of economic complexity on CO_2 emissions in their study. Balsalobre-Lorente et al[68] also confirmed the relationship between economic complexity and pollution in PIIGS countries.

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The main focus of the present study is to examine the impact of determinant macroeconomic variables, including economic complexity (ECCI), housing (RBCN), and household energy consumption (HENC), as well as the logarithm of housing sector expenditures (HEXP), on environmental changes in Iran during 1991 to 2019; using the autoregressive distributed lag model (ARDL).

Material and Methods

Based on the objective of the study and the literature review of the previous empirical studies investigating the impact of the determinant macroeconomic variables on environmental changes in Iran considering the volume of carbon dioxide emissions as the dependent variable and the index of economic complexity, housing units produced, household energy consumption and housing sector expenditure as independent descriptive variables. For this purpose, the ARDL model has been used to estimate the model. One of the suitable methods for analyzing long-term and short-term relationships between variables is the ARDL approach. This method estimates the long-term and short-term patterns of the model at the same time and solves the problems related to the elimination of variables and autocorrelation. In the auto-regression distributed lag model developed by Pesaran et al,[69] the ARDL approach is suitable for smaller samples, while larger samples are required to trust the results of the VAR and VECM approaches. In this model, the dependent variable is affected by the lag of these variables and other independent variables. ARDL method estimates are sparse and efficient due to avoiding problems such as autocorrelation and endogeneity. Finally, we include the error correction component resulting from the long-term relationship estimation as an explanatory variable in the existing models. There is a close relationship between clustering and error correction models. In ECM, information related to data is usefully used to model short-term and long-term relationships. For this reason, despite the different interpretations of correction models, their use has been widely accepted in applied econometrics. The main reason for the popularity of these models is that they relate short-term fluctuations to long-term equilibrium values of variables. These models are actually a type of partial adjustment models in which by entering the stable residual from a long-term relationship, the effective forces in the short term and the speed of approaching the long-term equilibrium value are measured. Based on the stated cases and the following estimation model was developed following the study of Lavagna et al[70] as equation (1) for the years 1991 to 2019; using the autoregressive distributed lag model (ARDL).

$$ICO_2 = \beta_1 + \beta_2\, LECCI + \beta_3\, LHENC + \beta_4\, LHEXP + \beta_5\, LRBCN + u_t \quad (1)$$

Where LCO_2 is the logarithm of environmental effects in terms of CO_2 emissions, LECCI is the logarithm of economic complexity, LHENC is the logarithm of residential energy consumption, LHEXP is the logarithm of residential spending, and LRBCN is the logarithm of construction in terms of the number of building units constructed. It should be noted that the sample of the study is Iran and the study period is between 1991 and 2019 (Appendix 1).

Carbon Dioxide Emissions (CO_2) are the main cause of global climate change. Many researchers believe that greenhouse gas emissions must be reduced immediately to prevent the worst effects of climate change in the world. The relevant data collected shows the amount of carbon dioxide emissions.

Economic Complexity Ranking (ECCI) is a measure of a given country's capabilities and knowledge based on the diversity, scale, and complexity of the products it exports.

Households Energy consumption (HENC) is used for a variety of purposes, including space and water heating and cooling, cooking, lighting, and electrical appliances, among other uses; therefore, the data in this section show household energy consumption.

Housing Sector Expenditures (HEXP) is used to emphasize the importance of the housing sector and its relationship with macroeconomic variables of other sectors' economic activities. The housing sector is always considered one of the drivers of economic growth, and any investment in the housing sector is measured by the number of expenditures on the construction of buildings.

Residential Building Construction (RBCN) shows the number of new buildings constructed each year, and its value-added is counted annually in the gross domestic product.

The sources of data collection are reliable, as the data for CO_2 emissions are from the World Bank database, the data for economic complexity are from the Atlas of Economic Complexity, the data for energy consumption are from the World Energy Balance, and the data for housing and building construction expenditures are from the Central Bank of Iran database. Table 1 shows the descriptive statistics of the variables over the period 1991 to 2019.

Finding and Results

This study aimed to investigate the impact of the determinant macroeconomic variables on environmental changes in Iran. For this purpose, the auto-regression distributed lag (ARDL) model and time-series data for the period 1991 to 2019 were used. In the auto-regression distributed lag model developed by Pesaran et al,[69] the ARDL approach is suitable for smaller samples, while larger samples are required to trust the results of the VAR and VECM approaches. In this model, the dependent variable is affected by the lag of this variable and other independent variables. This model has advantages compared to other statistical models. Considering that the ARDL method can be used only when the independent variables are stationary at level I(0) or I(1); therefore, the stationary of the variables should be checked first.

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Table 1. Descriptive statistics of the variables, years 1991-2019.

VARIABLE	NUMBER OBSERVATION	AVERAGE VALUE	MIN VALUE	MAX VALUE	STD. DEV VALUE
CO_2 (Metric-ton)	29	78.44	35.16	106.69	22.99
ECCI (Index)	29	−0.21	−0.59	0.11	0.19
HENC (Million barrels)	29	269.60	139.60	402.30	86.10
HEXP (Billion Rials)	29	215310	2944	810562.6	267726.9
RBCN (Building Units)	29	166662	94232	263491	43956.45

Table 2. Results of augmented Dickey-Fuller test.

VARIABLE	STATIONARY LEVEL	5% CRITICAL	STATISTIC	PROB.
LCO_2	I_1	−2.99	−7.08	.00
LECCI	I_1	−3.01	−3.30	.02
LHEXP	I_1	−2.99	−3.07	.04
LHENC	I_1	−2.99	−8.13	.00
LRBCN	I_1	−2.99	−3.84	.00

Table 3. Model estimation results of ARDL (1,0,0,0).

VARIABLE	COEFFICIENT	STATISTIC	PROB.
$LCO_{2(-1)}$	−0.218	−1.52	.15
LECCI	−0.222	−2.55	.02
LHENC	0.517	3.82	.00
LHEXP	0.091	2.71	.01
LRBCN	0.025	0.83	.41
C	1.074	1.95	.07
$R^2 = 0.98$	D.W = 2.02	$F = 140.62$	Prob. (.00)

Table 4. Diagnostic tests.

STATISTICAL TEST	STATISTIC	PROB.
Ramsey Reset	F (19,1) = 2.89	.11
ARCH	0.54	.46
Serial Autocorrelation	0.27	.76
Normality (Jarque–Bera)	J-B = 2.77	.24

The stationary test of the variables

To avoid false regressions in model estimation, the significance of variables was examined using the extended Dickey-Fuller unit root test. The Schwartz-Bayes method was used to determine the optimal lag due to the small amount of data. Based on the results of the stationary test presented in Table 2, all variables are non-stationary at the level and all are stationary with the first difference. The results obtained confirm the use of the ARDL method. Since the variables are not stationary at the level, if general econometric models are used, there is a possibility of spurious regression. But studies show that there is no spurious regression problem in ARDL models if all variables are stationary at level I(1) level. Ghouse et al[71] showed in a study that the ARDL model can be used as an alternative tool to avoid the spurious regression problem.

ARDL model estimation

After making sure that the conditions for using the ARDL method are met, Table 3 shows the model estimation along with the summarized results in terms of the extracted coefficients. It is noteworthy that the probability level of less than 5% indicates that the studied variables have a significant impact on the environment. Considering that the probability of F statistic is less than 5%, the whole model is significant and the coefficient of determination of 98% indicates the adequacy of the variables examined in this study. As can be seen in Table 3, the increase in economic complexity causes a decrease in pollution, so for a 1% increase in economic complexity, pollution decreases by 0.22%. It should be noted that the increase in energy consumption and investment in housing also causes an increase in pollution; the results of Table 3 also show that when energy consumption and investment in housing increase by 1%, pollution increases by 0.51% and 0.09%, respectively. The effect of the number of buildings produced on pollution is also positive but not statistically significant.

Diagnostic tests

As with any other econometric model estimation method, the ARDL requires testing the best fit and goodness of the model using tools and indicators to ensure that it is appropriate. To this end, the fit of the model is tested and the results are summarized in Table 4. The test results, which can be seen in Table 4, confirm the goodness of the model. In other words, considering that the confidence level of all diagnostic tests is above 5%, the functional form of this model is appropriate, and this model is normal and does not have the problem of autocorrelation and heterogeneity of variance.

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Table 5. Long-run ARDL model estimation.

VARIABLE	COEFFICIENT	STATISTIC	PROB.
LECCI	−.182	−2.74	.01
LHENC	.424	3.94	.00
LHEXP	.074	3.06	.00
C	1.07	2.11	.05

Table 6. Error correction model estimation (ECM).

VARIABLE	COEFFICIENT	STATISTIC	PROB.
Coint. Eq (−1)	−.65	−3.71	.00

Long-run relationship test

The results of the long-term relationship of the variables are examined and summarized in Table 5. This shows that the variables of economic complexity, energy consumption, and housing expenditures affect the environment in the long run, and their effects are fully consistent with the theoretical basis. The results also show that CO_2 emissions in the previous year and the number of building units constructed in the long term do not have a significant impact on the environment, considering the technological improvement in construction in the long term. Therefore, this variable was omitted in the calculation of the long-term relationship.

The results of Table 5 show that the increase in economic complexity leads to a decrease in pollution in the long run; thus, for a 1% increase in economic complexity, pollution will decrease by 0.18% in the long run. The effects of increasing energy consumption and housing investment on pollution, in the long run, are similar to those in the short run, so for a 1% increase in the above variables, pollution increases by 0.42% and 0.07%, respectively.

Error correction model estimation (ECM)

After estimating the long-run pattern, we estimate the error correction model (ECM). The error correction model represents the fit of the short-term fluctuations to the long-term relationship. In other words, the error correction model relates the short-term fluctuations of the variables to their long-term values. The result of the error correction test can be seen in Table 6. The coefficient (ECM = −0.65) is negative, less than one, and significant, confirming the existence of convergence in the model and indicating that about 65% of the disequilibrium is corrected to approach a long-term relationship in each period.

Discussion and Conclusions

With the emergence and spread of environmental problems, both in developed and developing countries, the importance of environmental protection has been felt more than in the past. Since the early 1960s, the environment has prompted leaders and thinkers in Western countries to consider how to escape its dire consequences. It is noteworthy that more attention has been paid to the environment in the last 2 decades than in the past, which shows the great importance of the environment for sustainable development. The study of factors affecting environmental pollution is important and necessary in all societies, but it should be noted that the environment in Iran has gone through difficult times in the last decade due to the imposition of extensive financial and economic sanctions. Increased pollution in Iran, especially in densely populated cities, has caused many problems, including threats to people's health and the closure of many polluting factories.

Economic complexity is an important variable whose relationship with pollution has recently received much attention. It is believed that the more complex the economy, the less it pollutes the environment because it uses newer technologies. The estimation results of the model show that economic complexity has a negative and significant impact on environmental change. In other words, the results of this research show that the increase in economic complexity reduces environmental pollution in both the short and long term.

The results of the statistical tests conducted in this study showed that with a 1% increase in economic complexity, environmental pollution decreases by 0.22% and 0.18% in the short term and long term, respectively. It is noteworthy that in the study of You et al,[72] the existence of a causal relationship between economic complexity and environmental pollution was confirmed. In the study of Caglar et al,[73] as well as Khezri et al,[74] the existence of a relationship between economic complexity and environmental quality was confirmed. In the present study, in addition to confirming the existence of the relationship between the mentioned variables, the degree of relationship in the short and long term has also been determined. In other words, in this study, the same as the study of You et al, Caglar et al, and Khezri et al the effect of the economic complexity variable on environmental pollution was confirmed; In addition, in this study, the impact of economic complexity on the environment has been separated in 2 short-term and long-term period. Considering the significant influence that economic complexity has on pollution, special attention should be paid to this variable to reduce pollution. In other words, the use of advanced technologies in the production of goods can play an important role in reducing pollution in both the short and long term. In the study of Qin et al,[21] the positive effect of increasing research and development (a key variable on the increase of economic complexity) on the reduction of carbon dioxide emissions was confirmed.

On the other hand, research results show that with an increase in energy consumption in the residential sector, pollution also increases. In other words, energy consumption in the residential sector increases pollution both in the short term and in the long term. It should be noted that the impact of energy

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consumption in the residential sector on the environment is significant both in the short term and in the long term. The results of the statistical tests concluded in this study showed that with a 1% increase in energy consumption, environmental pollution increases by 0.51% and 0.42% in the short term and long term, respectively. The obtained result is consistent with the studies of Khezri et al[74]. Also, the study of Majeed et al[22] also confirmed the negative impact of energy consumption on environmental pollution. Considering the large impact of energy consumption in the residential sector on pollution, this is one of the sectors that should be paid special attention to reduce pollution. In conclusion, efforts to increase the efficiency of energy consumption in the residential housing sector can reduce pollution in the short and long term.

The housing sector is very important in the Iranian economy for several reasons, including the high inflation in the country. This sector not only meets the consumption needs of people but also meets the needs of investors. In the Iranian economy, the housing sector is a leading sector whose prosperity can also affect other sectors of the country's economy. Despite many advantages of housing sector activities in economic growth and development, it is considered one of the most important sectors in the field of environmental pollution. The results show that the impact of housing expenditures on pollution is positive and significant in both the short run and the long run.

The results of the statistical tests in this study showed that with an increase of 1% in spending on housing construction, environmental pollution increases by 0.09% and 0.07% in the short term and long term, respectively. This means that with the increase in spending on housing construction, pollution increases both in the short and long term. According to the results extracted, it can be said that despite the great importance of housing sector activities on other macroeconomic variables in the economy, their negative effects should not be neglected. In other words, through complementary policies to the investments and while maintaining the positive effects of the investments, their negative effects on the environment should be reduced as much as possible. Special attention to the materials used in the construction of buildings, the building architecture, the control of heating and cooling systems, and similar factors can have a significant impact on reducing energy consumption and, consequently, on reducing environmental impact. Among the cases mentioned, the role of building materials in reducing pollution caused by construction is very impressive.

Research limitations and recommendations

The main limitation of the current study was the lack of access to data for other neighboring countries of Iran. Considering the great impact of economic complexity and energy consumption on environmental pollution, a comparative panel study is strongly recommended to include some other countries facing the same problem of the impact of macroeconomic variables on environmental changes, especially concerning the index of economic complexity of countries. Considering that a significant part of the income in developing countries such as Iran is obtained from the production of goods with less technology and in this production process, negative external consequences are brought to the environment, it is recommended that in these countries, technology and higher technology should be used that have fewer negative effects. Because in an action of moving toward economic complexity and producing goods with superior technology level, in addition to creating higher added value, we can also try to reduce environmental pollution. Finally, it is necessary to mention the housing and construction sector in the increase of excessive energy consumption in Iran, which in its place causes a lot of environmental pollution in the society. Since the housing sector in Iran plays a pioneering role in the country's economic activities, it is necessary to conduct a separate study in this regard so that basic measures can be taken by changing the housing production process in the direction of the harmful environmental effects of housing production.

Limitations of the current study

One of the important limitations in this study is not having access to the complete data of the variables used in this research before 1991. In statistical topics, the longer the data, the more reliable results can be obtained; Also, longer data allows us to examine the impact of more variables on environmental pollution without fear of reducing the degree of freedom. But unfortunately, in Iran, it is not possible to access the data before 1991. In other words, the lack of data made us unable to examine the impact of more variables on environmental pollution. In subsequent studies and in other countries, due to the availability of the data of the studied variables for longer periods of time, it is possible to examine the impact of more variables on environmental pollution.

In Iran, due to the current special conditions (sanctions), the results may have been slightly affected by the conditions. In the next studies in Iran, the impact of sanctions can also be included in the model. In the study of other countries, due to the lack of sanctions or the lower intensity of sanctions, more reliable results can be achieved.

One of the important things in the results of the current study is the specific conditions of the housing sector in Iran compared to other countries. In Iran, due to high inflation, the housing sector is considered a capital good in addition to consumer goods, and a significant part of investors invest in this sector with the aim of maintaining the value of the national currency and escaping high inflation. In subsequent studies in Iran, the effect of inflation can also be considered in the model.

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Suggestions for future studies

In this study, an attempt was made to cover the existing study gap as much as possible by presenting a more comprehensive model than previous studies. It is noteworthy that in this study, an attempt was made to investigate the effect of various variables on environmental pollution only in Iran. In future studies, this study can be extended to all countries by expanding the studied sample. To achieve a better result, it is suggested to separate the countries into different groups, for example, high-income countries, middle-income countries, and low-income countries. Also, in another survey, countries can be divided into oil and non-oil groups.

Author Contributions

Hamid Sepehrdoust Research plan, Data procurement. Mohsen Tartar Model estimation, Data Analysis. Sara Mohtashami Final editing.

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REFERENCES

1. National Aeronautics and Space Administration (NASA). NASA finds sustained long-term climate warming trend. 2014. https://www.giss.nasa.gov/research/news/20140121/
2. Pita P, Winyuchakrit P, Limmeechokchai B. Analysis of factors affecting energy consumption and CO_2 emissions in Thailand's road passenger transport. *Heliyon*. 2020;6:e05112.
3. Rahman MM, Nepal R, Alam K. Impacts of human capital, exports, economic growth and energy consumption on CO2 emissions of a cross-sectionally dependent panel: evidence from the newly industrialized countries (NICs). *Environ Sci Policy*. 2021;121:24-36.
4. Frankel JA. Environmental effects of international trade. HKS Faculty Research Working Paper Series RWP09-006. 2009.
5. Ahmad A, Zhao Y, Shahbaz M, et al. Carbon emissions, energy consumption, and economic growth: an aggregate and disaggregate analysis of the Indian economy. *Energy Policy*. 2016;96:131-143.
6. Iranian Government News Agency (IRNA). 2021). Air Pollution Research Center. Annual Report. https://www.irna.ir/news/84169970/
7. World Bank Database. 2020. World Economic Indicators for Developed and Developing countries.
8. Salari M, Javid RJ, Noghanibehambari H. The nexus between CO_2 emissions, energy consumption, and economic growth in the U.S. *Econ Anal Policy*. 2021;69:182-194.
9. Sundarakani B, Sikdar A, Balasubramanian S. System dynamics-based modelling and analysis of greening the construction industry supply chain. *Int J Logist Syst Manag*. 2014;18:517-537.
10. Kein ATT, Ofori G, Briffett C. ISO 14000: its relevance to the construction industry of Singapore and its potential as the next industry milestone. *Constr Manag Econ*. 1999;17:449-461.
11. Li XL, Chang T, Miller SM, Balcilar M, Gupta R. The co-movement and causality between the US housing and stock markets in the time and frequency domains. *Int Rev Econ Finance*. 2015;38:220-233.
12. Zhu W, Feng W, Li X, Zhang Z. Analysis of the embodied carbon dioxide in the building sector: A case of China. *J Clean Prod*. 2020;269:122438.
13. Sepehrdoust H. The impact of migrant labor force on housing construction of Iran. *J Hous Built Environ*. 2013;28:67-78.
14. Doğan B, Ghosh S, Hoang DP, Chu LK. Are economic complexity and eco-innovation mutually exclusive to control energy demand and environmental quality in E7 and G7 countries? *Technol Soc*. 2022;68:101867.
15. Romero JP, Gramkow C. Economic complexity and greenhouse gas emissions. *World Dev*. 2021;139:105317.
16. Mealy P, Farmer JD, Teytelboym A. Interpreting economic complexity. *Sci Adv*. 2019;5:eaau1705.
17. Doğan B, Balsalobre-Lorente D, Nasir MA. European commitment to COP21 and the role of energy consumption, FDI, trade, and economic complexity in sustaining economic growth. *J Environ Manag*. 2020;273:111146.
18. Mealy P, Teytelboym A. Economic complexity and the green economy. *Res Policy*. 2022;51:103948.
19. Hausmann R, Hidalgo CA, Bustos S, Coscia M, Simoes A, Yildirim MA. *The Atlas of Economic Complexity: Mapping Paths to Prosperity*. MIT Press; 2014.
20. Sepehrdoust H, Tartar M, Gholizadeh A. Economic complexity, scientific productivity, and income inequality in developing economies. *Econ Transit Inst Change*. 2022;30:737-752.
21. Qin L, Kirikkaleli D, Hou Y, Miao X, Tufail M. Carbon neutrality target for G7 economies: examining the role of environmental policy, green innovation and composite risk index. *J Environ Manag*. 2021;295:113119.
22. Majeed A, Wang L, Zhang X, Kirikkaleli D. Modeling the dynamic links among natural resources, economic globalization, disaggregated energy consumption, and environmental quality: Fresh evidence from GCC economies. *Resour Policy*. 2021;73:102204.
23. Gil L, Bernardo J. An approach to energy and climate issues aiming at carbon neutrality. *Renew Energy Focus*. 2020;33:37-42.
24. Grossman GM, Krueger AB. Environmental impacts of a North American free-trade agreement. NBER Working Papers Series 3914, 1991.
25. Galbraith JK. Global inequality and global macroeconomics. *J Policy Model*. 2007;29:587-607.
26. Selden TM, Song D. Environmental quality and development: is there a Kuznets curve for air pollution emissions? *J Environ Econ Manag*. 1994;27:147-162.
27. Pablo-Romero MDP, Pozo Barajas R, Yñiguez R. Global changes in residential energy consumption. *Energy Policy*. 2017;101:342-352.
28. Beckerman W. Economic growth and the environment: whose growth? Whose environment? *World Dev*. 1992;20:481-496.
29. Yan H, Shen Q, Fan LCH, Wang Y, Zhang L. Greenhouse gas emissions in building construction: a case study of one Peking in Hong Kong. *Build Environ*. 2010;45:949-955.
30. Seo S, Hwang Y. Estimation of CO_2 emissions in life cycle of residential buildings. *J Constr Eng Manag*. 2001;127:414-418.
31. Buyle M, Braet J, Audenaert A. Life cycle assessment in the construction sector: a review. *Renew Sustain Energ Rev*. 2013;26:379-388.
32. Zhang X, Shen L, Zhang L. Life cycle assessment of the air emissions during building construction process: a case study in Hong Kong. *Renew Sustain Energ Rev*. 2013;17:160-169. 3.
33. Khasreen M, Banfill PF, Menzies G. Life-cycle assessment and the environmental impact of buildings: a review. *Sustainability*. 2009;1:674-701.
34. Babak NA. Transport construction negative impact on the environment. *Procedia Eng*. 2017;189:867-873.
35. Ametepey SO, Ansah SK. Impacts of construction activities on the environment: the case of Ghana. *J Constr Project Manage Innov*. 2014;4:934-948.
36. Ferrari S, Blázquez T, Dall'O' G. Energy performance indexes based on monitored data of social housing buildings in Northern Italy. *Appl Energy*. 2021;298:117264.
37. Guo Q, Wang Y, Dong X. Effects of smart city construction on energy saving and CO_2 emission reduction: evidence from China. *Appl Energy*. 2022;313:118879.
38. Sepehrdoust H, Tartar M, Davarikish R. Does scientific productivity stimulate intensified technology exports in developing economies. *J Knowl Econ*. 2021;12:2111-2135.
39. Aalbers MB. The great moderation, the great excess, and the global housing crisis. *Int J Hous Policy*. 2015;15:43-60.
40. Wilson A, Boehland J. Small is beautiful U.S. house size, resource use, and the Environment. *J Ind Ecol*. 2008;9:277-287.
41. Rohn H, Pastewski N, Lettenmeier M, Wiesen K, Bienge K. Resource efficiency potential of selected technologies, products, and strategies. *Sci Total Environ*. 2014;473-474:32-35.
42. Pan W, Dainty ARJ, Gibb AGF. Establishing and weighting decision criteria for building system selection in housing construction. *J Constr Eng Manage*. 2012;138:1239-1250.
43. Sandanayake M, Zhang G, Setunge S. Estimation of environmental emissions and impacts of building construction – a decision making tool for contractors. *J Build Eng*. 2019;21:173-185.
44. Jiang JJ, Ye B, Zeng ZZ, Liu JG, Yang X. Potential and roadmap of CO_2 emission reduction in urban buildings: case study of Shenzhen. *Adv Clim Change Res*. 2022;13:587-599.
45. Enshassi A, Kochendoerfer B, Rizq E. Evaluación de los impactos medioambientales de los proyectos de construcción. *Rev Ing Constr*. 2014;29:234-254.
46. Hossain MU, Poon CS. Global warming potential and energy consumption of temporary works in building construction: a case study in Hong Kong. *Build Environ*. 2018;142:171-179.
47. Yan H, Ding G, Feng K, et al. Systematic evaluation framework and empirical study of the impacts of building construction dust on the surrounding environment. *J Clean Prod*. 2020;275:122767.
48. Odugbesan JA, Rjoub H. Relationship among economic growth, energy consumption, CO_2 emission, and urbanization: evidence from MINT countries. *SAGE Open J*. 2020;10:21582440209.

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49. Cleveland CJ, Costanza R, Hall CA, Kaufmann R. Energy and the U.S. Economy: a biophysical perspective. *Science*. 1984;225:890-897.
50. Martinez-Soto A, Iannantuono M, Macaya-Vitali P, Nix E. Towards low-carbon housing in Chile: optimisation and life cycle analysis of energy-efficient solutions. *Case Stud Therm Eng*. 2021;28:101579.
51. Pineiro Chousa J, Tamazian A, Chaitanya VK. Rapid economic growth at the cost of environment degradation; Panel data evidence from BRIC. *Economies Electronic copy*. 2008. http://ssrn.com/abstract=1143537.
52. Frankel JA, Romer D. Does trade cause growth? *Am Econ Rev*. 1999;89:379-399.
53. Stern DI. Progress on the environmental Kuznets curve? *Environ Dev Econ*. 1998;3:173-196.
54. Sharif SA, Hammad A. Simulation-based multi-objective optimization of institutional building renovation considering energy consumption, life-cycle cost, and life-cycle assessment. *J Build Eng*. 2019;21:429-445.
55. Soytas U, Sari R. Energy consumption, economic growth, and carbon emissions: challenges faced by an EU candidate member. *Ecol Econ*. 2009;68:1667-1675.
56. Halicioglu F. An econometric study of CO_2 emissions, energy consumption, income, and foreign trade in Turkey. *MPRA paper* 11457, 2008.
57. Iwata H, Okada K, Samreth S. Empirical study on the environmental Kuznets curve for CO2 in France: the role of nuclear energy. *Energy Policy*. 2010;38:4057-4063.
58. Jalil A, Feridun M. The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *J Energy Econ*. 2011;33:284-291.
59. Shahbaz M, Hye QMA, Tiwari AK, Leitão NC. Economic growth, energy consumption, financial development, international trade, and CO_2 emissions in Indonesia. *J Renew Sustain Energy Rev*. 2013;25:109-121.
60. Bekun FV, Alola AA, Sarkodie SA. Toward a sustainable environment: nexus between CO2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries. *Sci Total Environ*. 2019;657:1023-1029.
61. Gozgor G, Can M. Export product diversification and the environmental Kuznets curve: evidence from Turkey. *Environ Sci Poll Res*. 2016;23:21594-21603.
62. Apergis N, Ben Jebli M, Ben Youssef S. Does renewable energy consumption and health expenditures decrease carbon dioxide emissions? Evidence for sub-Saharan Africa countries. *Renew Energy*. 2018;127:1011-1016.
63. Neagu O, Teodoru M. The relationship between economic complexity, energy consumption structure, and greenhouse gas emission: heterogeneous panel evidence from the EU countries. *Sustainability*. 2019;11:497.
64. Can M, Gozgor G. The impact of economic complexity on carbon emissions: evidence from France. *Environ Sci Poll Res*. 2017;24:16364-16370.
65. Bashir MF, Ma B, Hussain HI, Shahbaz M, Koca K, Shahzadi I. Evaluating environmental commitments to COP21 and the role of economic complexity, renewable energy, financial development, urbanization, and energy innovation: empirical evidence from the RCEP countries. *Renew Energy*. 2022;184:541-550.
66. Chen J, Zhao D. Complexity of domestic production fragmentation and its impact on pollution emissions: evidence from decomposed regional production length. *Struct Change Econ Dyn*. 2022;61:127-137.
67. Marco R, Llano C, Pérez-Balsalobre S. Economic complexity, environmental quality, and income equality: a new trilemma for regions? *Appl Geogr*. 2022;139:102646.
68. Balsalobre-Lorente D, Ibáñez-Luzón L, Usman M, Shahbaz M. The environmental Kuznets curve, based on the economic complexity, and the pollution haven hypothesis in PIIGS countries. *Renew Energy*. 2022;185:1441-1455.
69. Pesaran MH, Shin Y, Smith RJ. Bounds testing approaches to the analysis of level relationships. *J Appl Econ*. 2001;16:289-326.
70. Lavagna M, Baldassarri C, Campioli A, et al. Benchmarks for environmental impact of housing in Europe: definition of archetypes and LCA of the residential building stock. *Build Environ*. 2018;145:260-275.
71. Ghouse G, Khan SA, Rehman AU. ARDL model as a remedy for spurious regression: problems, performance, and prospectus. Munich Personal RePEc Archive paper 83973, 2018. https://mpra.ub.uni-muenchen.de/83973/
72. You W, Zhang Y, Lee CC. The dynamic impact of economic growth and economic complexity on CO_2 emissions: an advanced panel data estimation. *Econ Anal Policy*. 2022;73:112-128.
73. Caglar AE, Zafar MW, Bekun FV, Mert M. Determinants of CO_2 emissions in the BRICS economies: the role of partnerships investment in energy and economic complexity. *Sustain Energy Technol Assess*. 2022;51:101907.
74. Khezri M, Heshmati A, Khodaei M. Environmental implications of economic complexity and its role in determining how renewable energies affect CO_2 emissions. *Appl Energy*. 2022;306:117948.

Appendix 1. Explanation and definition of terms used in this research.

REFERENCE	DEFINITION	CONCEPTS
Cesar A. Hidalgo, Ricardo Hausmann (2009). "The Building Blocks of Economic Complexity." Proceedings of the National Academy of Sciences. PNAS. 106 (26): 10570–10575. arXiv:0909.3890. Bibcode:2009PNAS.10610570H. doi:10.1073/pnas.0900943106. PMC 2705545. PMID 19549871. Atlas of Economic Complexity	The Economic Complexity Index (ECI) is a holistic measure of the productive capabilities of large economic systems, usually cities, regions, or countries. In particular, the ECI looks to explain the knowledge accumulated in a population and that is expressed in the economic activities present in a city, country, or region. To achieve this goal, the ECI defines the knowledge available in a location, as the average knowledge of the activities present in it, and the knowledge of an activity as the average knowledge of the places where that economic activity is conducted. The product equivalent of the Economic Complexity Index is the Product Complexity Index or PCI.	Economic Complexity
Climate Watch. 2020. GHG Emissions. Washington, DC: World Resources Institute. Available at: https://www.climatewatchdata.org/ghg-emissions. See SP.POP.TOTL for the denominator's source. World Bank database	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	Carbon Dioxide Emissions
United Nations General Assembly (1987) Report of the World Commission on Environment and Development: Our Common Future. Transmitted to the General Assembly as an Annex to document A/42/427 – Development and International Co-operation: Environment. And United Nations General Assembly (20 March 1987). "Report of the World Commission on Environment and Development: Our Common Future; Transmitted to the General Assembly as an Annex to document A/42/427 – Development and International Co-operation: Environment; Our Common Future, Chapter 2: Towards Sustainable Development; Paragraph." United Nations General Assembly. Retrieved March 2010.	Sustainable development is an organizing principle for meeting human development goals while also sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend. The desired result is a state of society where living conditions and resources are used to continue to meet human needs without undermining the integrity and stability of the natural system. Sustainable development was defined in the 1987 Brundtland Report as "Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." As the concept of sustainable development developed, it has shifted its focus more towards the economic development, social development and environmental protection for future generations.	Sustainable Development

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Appendix 1. (Continued)

REFERENCE	DEFINITION	CONCEPTS
World Energy Balance	Households Energy consumption (HENC), is used for a variety of purposes, including space and water heating and cooling, cooking, lighting, and electrical appliances, among other uses; therefore, the data in this section show household energy consumption.	Households Energy consumption (HENC)
Central Bank of Iran	Housing Sector Expenditures (HEXP), is used to emphasize the importance of the housing sector and its relationship with macroeconomic variables of other sectors' economic activities. The housing sector is always considered one of the drivers of economic growth, and any investment in the housing sector is measured by the number of expenditures on the construction of buildings.	Housing Sector Expenditures (HEXP)
Central Bank of Iran	Residential Building Construction (RBCN), shows the number of new buildings constructed each year, and its value-added is counted annually in the gross domestic product.	Residential Building Construction (RBCN)

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