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Relationship between CO_2 and Iran's economic growth with an emphasis on household welfare index (an economy with oil and economy without oil)

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ABSTRACT

Economic growth emphasizes the expansion of economic activity, while economic development focuses on improving the quality and sustainability of economic growth and social welfare. Environmental concerns have shifted the focus of countries from nominal growth to real growth. Sustainable development and climate change reduction are the policy principles in many welfare countries. Considering the emission of carbon dioxide in different production sectors of IRAN, the main purpose of this study was to determine the relationship between the volume of carbon dioxide emissions and economic growth by emphasizing the welfare index of households in two sectors of the economy based on oil income and without reliance. The oil revenue in Iran was obtained using time series data from 1981 to 2018. The results of the analysis showed a significant relationship between economic growth and carbon dioxide emissions in both cases (with oil and without). In other words, increasing the amount of carbon dioxide emissions led to increased economic growth in Iran. In the oil based economy, carbon dioxide emissions have led to a nominal increase in economic growth due to their negative effects on the household welfare index. The results of the estimate showed that the impact of pollution on household welfare ultimately reduced the rate of economic growth. In fact, when carbon dioxide emissions only increased the country's economic production without contributing to economic growth, there was no growth leading to sustainable development, even though it might lead to a short-term production boom. It may reduce the general level of prices, but the negative effects it has on the environment and people's well-being can lead to reduced economic growth in the long run.

1. Introduction

Economic growth emphasizes the expansion of economic activity, while economic development focuses on improving the quality and sustainability of economic growth and social welfare [1]. Along with economic growth, environmental protection incentives have become more important, including its importance in political programs [2-3]. Sustainable development and climate change reduction are the policy principles in many welfare countries. However, environmental policies must address many of the other challenges facing welfare states today, such as rising public debt, unemployment, socio-economic conflicts, and aging population [4]. On the other hand, today, the volume of negative impacts of polluting industries is so great that every unaided eye realizes its anomalies [5]. Contamination is associated with significant health problems. Low-income households are exposed to higher concentrations of pollutants due to their proximity to industrial and traffic pollution. The Federal Environment Agency of Germany reported in 2009 that children from low-income households were more prone to gasoline hazards and had more lead in their blood than similar groups in high-income households [6]. Economists and environmentalists have come to the conclusion that an increase in energy consumption is valuable when it leads to increased economic growth [7-8]. In fact, welfare states accept economic growth only as a

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precondition for dealing with social and economic problems [9]. Energy consumption and carbon dioxide emissions in Iran have increased significantly in recent decades. With an emerging economy, Iran is one of the countries with the highest levels of carbon dioxide emissions in the world. The economic cost of air pollution in Iran is estimated at 2.2 percent of the country's GDP and about $13 billion. A 2013 report by the International Energy Agency showed that CO_2 emissions are directly related to energy consumption. According to the Carbon Dioxide Information Analysis Center (CDIAC), there is a strong correlation between fossil fuel consumption, CO_2 emissions, and economic activity. From 1870 to 2010, CO_2 emissions from fossil fuel combustion increased exponentially around the world. According to the Climate Environment Research Center in Norway, fossil fuel combustion accounts for 75% of CO_2 emissions. Ten countries, namely China, the United States, India, Russia, Japan, Germany, Korea, Iran, Saudi Arabia, and Canada, account for 65% of the total CO_2 emissions and 64% of total energy consumption. In this ranking, Iran ranks eighth in the world in CO_2 emissions with a fall of one year compared to 2011 and tenth place in terms of energy consumption. High-income levels reflect high living standards. Economic growth may, to some extent, increase pollution or promote individual aspirations. But finally, when a rich and developed country is compared with a less developed country, there are significant differences in their quality of life, living standards, and health [10-11]. Examining Iran's position in the world in terms of energy consumption and CO_2 emissions, comparing energy intensity, energy per capita, and CO_2 emissions per capita in the country with the global average indicates that the country is not on a path of sustainable development. Therefore, the main issue of the present study is whether carbon dioxide emissions can lead to real economic growth in the country, given their negative effects on the household welfare index?

There is a general consensus that the quality of the environment decreases with the growth of national income until the level of income increases to a certain degree. And then, the process of economic growth by itself solves the problems arising in the early stages of development [12]. Forster (1973) examined the effect of pollution reduction policies on economic growth. In addition to the production function, he also related the utility function to the environment; he showed that in this case, even the level of equilibrium growth is much lower than the case where only the production function depends on the quality of the environment [13]. Several studies have examined the impact of economic growth on the environment, known as EKC Environmental Kuznets Curve (EKC) studies [14-15]. Based on these studies, in the early stages of economic growth, an increase in the level of production leads to environmental degradation. Still, in the higher stages of growth, the demand for environmental standards increases, and a positive relationship is established between production growth and environmental quality. Therefore, based on the EKC hypothesis, there is an inverse U-shaped relationship between economic growth and environmental degradation. One of the major drawbacks of the EKC studies is the lack of attention to the interaction between environmental quality and economic growth. In these studies, only the effect of economic growth on environmental quality is examined, while the quality of the environment, in turn, directly and indirectly affects economic growth [16]. In the research results of Grossman and Krueger (1995), the relationship between air pollution and economic growth was studied empirically. The results showed a humane relationship between per capita sulfur dioxide emissions and per capita GDP. Shafik and Bandyopadhyay (1992), and a few years later Grossman and Krueger, conducted other studies using a variety of environmental indicators, including urban air pollution, water pollution, sediment pollution in the river basin, and pollution around the river by heavy metals [17-18]. Their studies confirmed Kuznets's environmental hypothesis. The Kuznets curve is an interesting generalization of how a country shifts from poverty to relative prosperity and its impact on changes in environmental quality. Until the mid-1990s, most studies in this area focused on the income variable and the extent of environmental degradation. In this regard, the GDP per capita is the variable of income, and the rate of environmental degradation is one of the types of pollution [19]. Among the variables, we can mention the social welfare one. Several studies have been conducted in this regard. Feldstein (1974) introduced two channels for influencing government welfare and social security spending on savings and consequent growth. Feldstein (1974) argued that social security and public welfare expenditures replace expected government transfers instead of personal savings and reduce investment and growth. On the other hand, pensions lead to early retirement and, consequently, to a more extended retirement period, which will increase savings. Another study by Bellettini and Ceroni (2000) also examined the relationship between these two variables. They used panel data to examine the effect of welfare and social security expenditures on the economic growth of 61 selected developing and developed countries from 1960-1990 [20]. Their results indicated that spending on welfare and social security by increasing the impact on human capital leads to increased economic growth in the study group. Yin et al. (2020) examined China's environmental data focusing on air, river, and coastal water pollution from 1989 to 2003 [21]. The results showed that the contaminants resulting from production confirmed the Kuznets environmental hypothesis. Sinha and Bhattacharya (2016) analyzed data from industrial and residential areas and found that emission levels were different for each stratum and class. For this reason, the policies adopted should be different for each specific group. In addition, the confirmation of Kuznets hypotheses reaffirms the impact of accelerating economic growth on the environment [22]. Ottelin et al. (2018) showed that government public services led to a 19% increase in carbon footprint and a 38% increase in another footprint [4]. They also stated that the welfare state had important features that ensure carbon reduction among citizens. Yahoo and Othman, in their study conducted in 2017, stated that global warming attracted a lot of attention in recent decades. This study examined the broad economic impact of implementing two types of CO_2 emission limiting policies in Malaysia: market-based policies (carbon taxation) and regulatory and control mechanisms (sector emission standards). The policy simulations include the elimination of government subsidies for petroleum products. Carbon emission tax seems to be more effective than regulatory and control policies in relation to the revenue neutrality hypothesis, as it doubles profit sharing. It is clear that changes in consumption patterns improve the well-being of society while helping to reduce carbon emissions. The simulation results show that when the carbon tax is applied, the production of renewable energy increases, and the elimination of subsidies is compensated by the revenue recovery process [23]. In their 2017 study, Pablo Romero and Sanchez Braza stated that global warming and pollution had led many countries to take steps to reduce fossil fuels. The results showed that the Kuznets hypothesis concerning the relationship between carbon footprint and final demand was not confirmed. It also found that the carbon footprint increased significantly with increasing demand [24]. Ahmadian et al. (2017) investigated the relationship between economic growth and environmental degradation index in a selection of developing countries using the dynamic panel method based on the generalized torque method. The results of this study showed that there was a positive and significant relationship between economic growth and environmental degradation. In other words, increasing the index of environmental degradation increased economic growth; this was due to the high rate of harvest and the depletion of resources and exceeding the rate of renewal of resources and pollution shelter theory in the countries under study [25]. Sadeghi et al. (2016) stated that the emission of more carbon pollutants from energy consumption had more devastating effects on the environment in recent decades. The share of some industries in the manufacturing sector is higher than other sectors and may vary from country to country. In this study, the commercial carbon footprint of 86 economic sectors was studied using the social accounting matrix method of 2010. The results showed that the total trade balance of the country's carbon footprint was negative, which was a small proportion of the total carbon footprint of economic sectors. The sectors of oil, natural gas distribution, manufacturing of chemicals and chemical products, and transportation had the highest trade balance of a positive carbon footprint, as well as the sectors of manufacturing of food products, basic metals, and motor vehicles, trailers, and semi-trailers. They have the most negative carbon trade balance [26]. Gholamipour et al. (2015) showed that with the increase in carbon dioxide emissions, the volume of imports to OPEC member countries had not decreased. In fact, by examining the statistics of carbon emissions and emissions, it showed an upward tendency in the import trend and the amount of carbon dioxide emissions. The results of estimating the export function showed that the export volume of OPEC member countries had no significant relationship with the amount of carbon dioxide emissions [27]. The results of research by Hajinejad et al. (2015) showed that about 38 grams of carbon dioxide were produced per supplying one cubic meter of drinking water in the city of Sepidan, Iran. Also, their results showed that supplying water from a spring at a higher point than all areas of the city, due to the special topography of the city that is in the form of slopes and steep heights, requires much less energy and emits less carbon monoxide [28].

2. Materials and method

In this study, the time-series data of Iran from 1981 to 2018 were used. The relationship between carbon dioxide emissions and economic growth with an emphasis on the welfare index of Iran in two cases, without oil revenues and considering oil revenues, was investigated. The method of data collection in this research is the library method, in which the necessary data from articles, research reports, and internal and external books were used. Also, data related to dependent and independent variables of the research were extracted from the system of the World Bank and the Central Bank of Iran.

2.1. Experimental pattern estimation

The relationship between carbon dioxide emissions and GDP can be explained linearly or quadratically. Since this study aimed to investigate the long-run relationship between the variables, a linear relationship between them was considered. In this section, first, the stagnation of variables, then the results of model estimation in two sections of an economy with oil and an economy without oil were done; the results of which are as follows.

2.2. Static Study of variables

Before estimating the model, a static test must be performed for the variables to ensure that none of the variables were stacked in the second order, I (2), thus avoiding artificial results. If the time series variables used to estimate the parameters of the model are anonymous, the probability that the obtained regression is false is very high, in which case, the use of t and F statistics would be misleading. Therefore, the data were first tested for significance to prevent false regression. In the mana test, what matters is the strength of the unit root tests. There are various methods for performing a single root test by which the static variables can be checked. In this study, the generalized Augmented Dickey-Fuller test (ADF) was used [29]; the results are shown in Table 1.

Table 1. Results of unit root test.

Variable		ADF	Critical values			Prob
			1%	5%	10%	
GDP (fixed price in 1997)	y	-2.98	-2.63	-1.95	-1.61	0.00
Total economic productivity	A	-3.76	-4.32	-3.58	-3.22	0.03
Government Expenditure (General Government Final Consumption Cost (Percentage of GDP))	G	-5.95	-4.22	-3.53	-3.20	0.00
Labor force (amount of labor force participation for ages 15 to 24 years, total)	L	-5.73	-4.23	-3.54	-3.20	0.00
Capital (gross capital formation (percentage of GDP))	K	-7.75	-4.22	-3.53	-3.20	0.00
Emission rate of carbon dioxide (kiloton)	Co2	-5.27	-4.30	-3.57	-3.22	0.00
Emission of carbon dioxide * Welfare index	Co2*wlf	-2.53	-2.63	-1.95	-1/61	0.01
Fit amount of production in the economy	$\widehat{y_{t-1}}$	-6.89	-4.23	-3.54	-3.20	0.00

2.3. Specification of production function (with oil and without oil)

The researcher designed and estimated an appropriate model that could reasonably explain the changes in the variables in this portion of the research. Then, the data were analyzed, and the hypotheses were tested. Regarding the production function of Iran, in order to recognize the role of oil as a finite resource, the oil supply was separated from the real factors of production, such as private capital, labor, and government capital. The production function used is the Cobb Douglas production function with a constant return to the production scale in which the substitution elasticity is one. This function is defined as follows:

$$Y = AL^{\alpha}K^{\beta}G^{\gamma} \quad (1)$$

Where Y: product produced, A: total productivity of the economy, K: private capital, G: government capital and parameters α, β and γ are respectively production tractions to labor force, private capital and government capital. The strength of this general function of Cobb Douglas as a representative of the function of total production in Iran is the separation of private and public investment from each other. This distinction allows that under different assumptions and conditions of the model, the effects of public and private investment can be measured separately [30]. The Barro model (1990) examines the role of government in the economy [31]. Considering the effective role of the government and its impact on the Iranian economy in terms of budget and other issues in this article, we used the basics to explain and predict economic growth. The government only increases production by producing public goods, and the use of government-produced goods is possible for all firms; the use of one firm will not reduce the possibility of other firms using these goods. The existence of public goods produced by the government will increase production in the firm, and therefore, the Cobb Douglas production function form for the firm will be as follows:

$$Y = AL^{1-\alpha}K^{\alpha}G^{1-\alpha} \quad ; 0<\alpha<1 \quad (2)$$

This equation implies that the output will have a constant return to scale for the L and K inputs. Assuming that the total labor force is stable, the economy will have a declining return on capital if G is stable. But if G increases at the same time as K, the economy will have a constant return on scale. In this model, it is assumed that the government has a balanced budget, and government expenditures are provided at the following tax rate from GDP.

$$G = t.Y \quad (3)$$

In the above equation, it is assumed that t and Y / G are constant over time. Therefore, the profit of enterprises after tax will be:

$$L_i.[(1-t).Ak_i^{\alpha}G^{1-\alpha} - w - (r+\delta).k_i \quad (4)$$

where r: interest rate, δ: capital depreciation rate, w: wage rate, and r + δ: capital rental rate where:

$$k_i = {}^{K_i}/_{L_i} \quad (5)$$

In a fully competitive market, the rate of wage after tax equals the final output of labor, and the rate of rent of capital (r + δ) after tax equals the final output of capital. If ki = K, then the rent or capital ratio will be:

$$r + \delta = (1-t).\left(\frac{\partial y_i}{\partial K_i}\right) \quad (6)$$

So we can write Equation (2) and Equation (3) as follows:

$$G = tAL^{1/\alpha}k \quad (7)$$

Substituting the above equation into Equation (3), we have:

$$r + \delta = (1-t).\left(\frac{\delta y_i}{\delta K_i}\right) = \alpha A^{1/\alpha}(Lt)^{(1-\alpha)/\alpha}(1-t) \quad (8)$$

By placing the value of r from Equation (5) in Equation (4), the following equation is obtained:

$$\gamma = (1/\theta)[\alpha A^{1/\alpha}(Lt)^{(1-\alpha)/\alpha}.(1-t) - \delta - p] \quad (9)$$

In this equation, the effect of growth tax can be presented. So that (1-t) shows the negative effect of taxes and ⟦(t)⟧

^ (((1-α)) ⁄α) reflects the positive effect of taxes on economic growth. In Equation (9), as mentioned, 〖(Lt)〗 ^ (((1-α)) ⁄α) shows the positive effect of government spending on economic growth, and phrase (1-t) shows the negative effect on economic growth. In this model, which is also clear from its relations, it cannot be said with certainty that government spending increases production and economic growth, but depends on the volume and scope of government activities. Now, according to the theoretical foundations presented above, it can be accepted that in addition to the factors of labor and capital production, government spending also affects economic growth, the effect of which is not already known in any country. To test and present an empirical growth model for the Iranian economy according to the "go" production function, the following relation can be written:

$$Ln(y) = Ln(A) + (1-\alpha) LnL + \alpha Ln(K) + \gamma LnG \quad (10)$$

The estimated model for estimating the contribution of each factor to production and growth is written as follows: t is part of the model error. Therefore, the final production function without considering oil revenues will be as follows (Oil-free production function):

$$Ln(y) = Ln(A) + (1-\alpha) LnL + \alpha Ln(K) + \gamma LnG + \varepsilon \quad (11)$$

Since oil extraction and export play a very important role in the performance of the Iranian economy, the value of oil revenue is added to the actual production function, and the total production function is as follows:

$$Y = AL^{1-\alpha}K^{\alpha}G^{\gamma}oil \quad (12)$$

By logarithmization of the parties, we will have the production function taking into account oil revenues as follows (oil production function):

$$Ln(y) = Ln(A) + (1-\alpha) LnL + \alpha Ln(K) + \gamma LnG + Ln\, oil + \varepsilon_t \quad (13)$$

By intervening oil in the production function, it is possible to measure the role of the factors of production in the economy and separate it from the role of oil as national wealth.

2.4. Household welfare function

In the literature on household welfare functions, various criteria have been developed by [32] Dasgupta, Sen & Start (1970), [33] Shishinsky (1972), [34] Sen (1974), [35] Yetzhaki (1979), [36] Shurokz (1983), [37] Kakwani (1984), [38] Dogum (1990 and 1993), [39] Macapede (2001, 2003 and 2004), etc. The Amartyasen welfare function is very important due to its strong theoretical foundations and introduction of welfare axioms. The Social Welfare Index shows the relationship between per capita income and the degree of inequality in income distribution. In 1974, [40] Sen proposed this function as a function of social welfare.

$$WLF = \mu(1-G) \quad (14)$$

where WLF is social welfare per capita income and G is the Gini coefficient. In addition to using the Chinese coefficient as one of the criteria for income distribution, this index also uses the real per capita income criterion as one of the most important criteria for welfare. Therefore, due to the existence of two very important criteria that play a major role in the welfare of communities, it is one of the most important indicators for assessing the social welfare of communities. After estimating the production function (in both cases, with oil and oil body) and also calculating the welfare function of the households above, we obtain the values (y_ (oil, t)̂ and (y_t) that are the proportional amounts of production in the economy with oil and without oil, respectively. Finally, to measure the relationship between CO_2 and economic growth in terms of welfare index, the following regressions are estimated. This model is adapted from the study of Zhang and Zhang (2018):

Economy with Oil

$$Ln\hat{y}_{oil,t} = \beta_0 + \beta_1 LnCO2_t + \beta_2 Ln(CO2 * WLF)_t + \beta_3 Ln\hat{y}_{t-1} + u_t \quad (15)$$

Oil-free economy

$$Ln\hat{y}_t = \beta_0 + \beta_1 LnCO2_t + \beta_2 Ln(CO2 * WLF)_t + \beta_3 Ln\hat{y}_{t-1} + u_t \quad (16)$$

where (y_ (oil, t)̂: fit amount of production in the economy with oil; (y_t)̂: fit amount of production in the economy without oil; (y_ (oil, t-1)̂: production of the previous period in the economy with oil; (y_ (t-1)̂: production of the previous period in the economy without oil; CO_2: emission of carbon dioxide; and WLF: household welfare index.

3. Results and discussion

Unit root test

The results of the unit root test (generalized Dickey Fuller) for all dependent and independent variables of the model are as described in Table (1); all research variables are constant.

3.1. Production function estimation (oil-free economy)

To estimate the production function, we first examine the classical hypotheses. The first assumption is the lack of autocorrelation between the components of the perturbation; if such a correlation exists, although the ordinary least squares estimates remain unbiased and consistent even in the presence of autocorrelation, they will no longer work. As a result, normal t and F tests do not show good significance. Therefore, it is necessary to eliminate self-solidarity [41] (Gujarati, 2009). In the present study, the Correlation LM test was used to test the first hypothesis. Given the estimated probability, the assumption of no autocorrelation in the model is not confirmed; therefore, to solve this problem, we enter the AR component into the model (Table 2). Another classic assumption is the homogeneity of variance. In the present study, the White test was used to test the hypothesis of variance homogeneity.

Table 2. Correlation LM test output (production function estimation).

Model	Correlation LM	Critical value	Estimated probability
y	F-statistic	24.28	0.00
	Obs* R-square	22.90	0.00

According to the obtained results, it is observed that the heterogeneity model has no variance (Table 3). The next assumption is to test the normality of residual sentences. If the remainder of the model has a normal distribution, t and f tests based on the significance of each coefficient and the significance of the whole regression are reliable.

Table 3. Exit of Heteroskedasticity test (production function estimation).

Model	Heteroskedasticity	Critical value	Estimated probability
Final	F-statistic	1.02	0.31
	Obs* R-square	1.05	0.30

Therefore, it is very important to determine that the remnants of the model have a normal distribution. Given the amount of load capacity statistics and the calculated probability value, the null hypothesis that the model residues are normal is accepted (Figure 1). After examining the classical hypotheses, the correlation coefficient between the variables is also examined. The correlation coefficient is an important statistical tool to determine the type and degree of correlation of one quantitative variable with another quantitative variable (Table 4). According to the results presented in Table 4, the correlation between the variables is less than 30%, so it is not enough to be considered as a strong correlation. Therefore, it can be ignored. After explaining the model and selecting the best estimation method, the estimation results are as follows (Table 5).

Table 4. Correlation coefficient between variables (production function estimation).

Variable	Y	K	L	G	A
Y	1				
K	-0.05	1			
L	-0.23	0.004	1		
G	-0.15	-0.20	0.09	1	
A	-0.27	-0.23	0.03	0.16	1

Table 5. Model estimation output.

Variable	Coefficient	Statistics t	Prob
Ln A	1304.3	-1.91	0.06
Ln G	-2.50	-0.19	0.84
Ln K	3.93	2.55	0.01
Ln L	-0.04	-0.20	0.83
C	26.23	7.34	0.00
AR (1)	1.63	14.36	0.00
AR (2)	-0.71	4.54	0.00
	Adjusted R-squared=0.91	R-squared=0.93	
	Prob(F)= 0.00	F-statistic=61.47	
D.W=2.17			

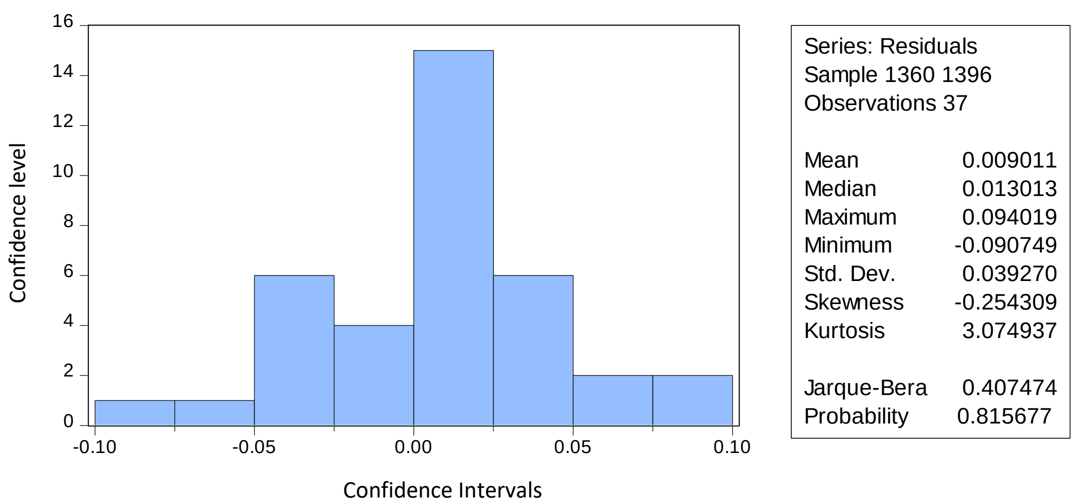

Fig. 1. Test of normality of waste sentences (estimation of production function).

As can be seen from the output of the estimate among the independent variables, only the capital variable has a significant relationship with the production. This result is not far from expected because investment has been the most important input in the process of production and supply of infrastructure in the country. The existence of a coefficient of determination of 93% and a modified coefficient of determination of 91% indicates the high explanatory nature of the independent variables. In other words, the regression coefficient indicates the good fit of the model. The value of the F statistic in the present model is equal to 61.47, and despite the estimated probability of less than 0.05 (0.00), the significance of the whole regression can be claimed. The Watson (D-W) camera statistics in the current model is 2.17. Therefore, the health of the estimated model can be claimed. The purpose of estimating the production function is to obtain the values (y_t). In this section, in order to calculate the welfare function (WLF = 1 (1-G)) according to the information related to per capita income and Gini coefficient, the value of the welfare index in Iran from 1981-2007 was calculated. According to this definition of welfare, the rate of this index in Iran has always been below the curve and has generally had a downward trend (Figure 2).

The amount of the fitted output, (y_t)̂, is entered into the model as a dependent variable, and finally, the following equation is estimated to measure the relationship between CO_2 and economic growth in terms of the welfare index:

$$\mathrm{Ln}\hat{y}_t = \beta_0 + \beta_1 \mathrm{LnCO2}_t + \beta_2 \mathrm{Ln}(\mathrm{CO2} * \mathrm{WLF})_t + \beta_3 \mathrm{Ln}\hat{y}_{t-1} + u_t \quad (17)$$

Table 6. Correlation LM test output (fitting production function estimation).

Model	Correlation LM	Critical value	Estimated probability
Final	F-statistic	5.12	0.01
	Obs* R-square	9.19	0.01

Table 7. Heteroskedasticity test output (fitting production function estimation),

Model	Heteroskedasticity	Critical value	Estimated probability
Final	F-statistic	0.72	0.40
	Obs* R-square	0.75	0.38

The results of the variance homogeneity test for the final model are shown in Table 6, and the estimated probability is more than 0.05; so, the models do not have variance homogeneity. The normality test of the residual statements also confirms the null hypothesis that the model residuals are normal (Figure 3).

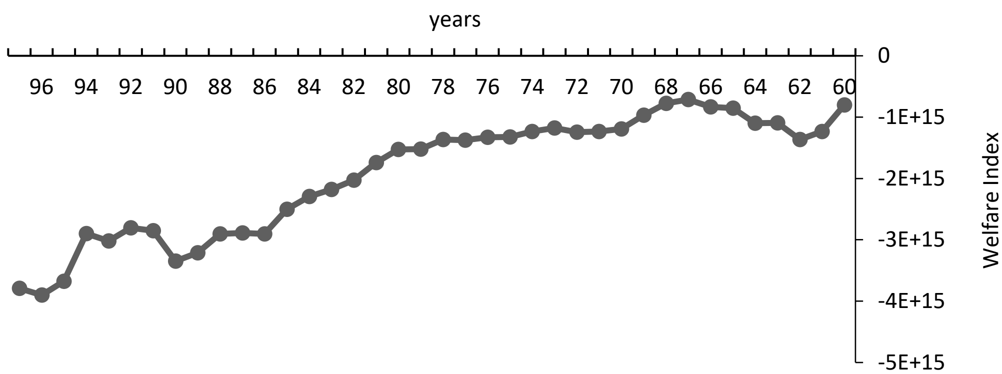

Fig. 2. Calculated WLF values.

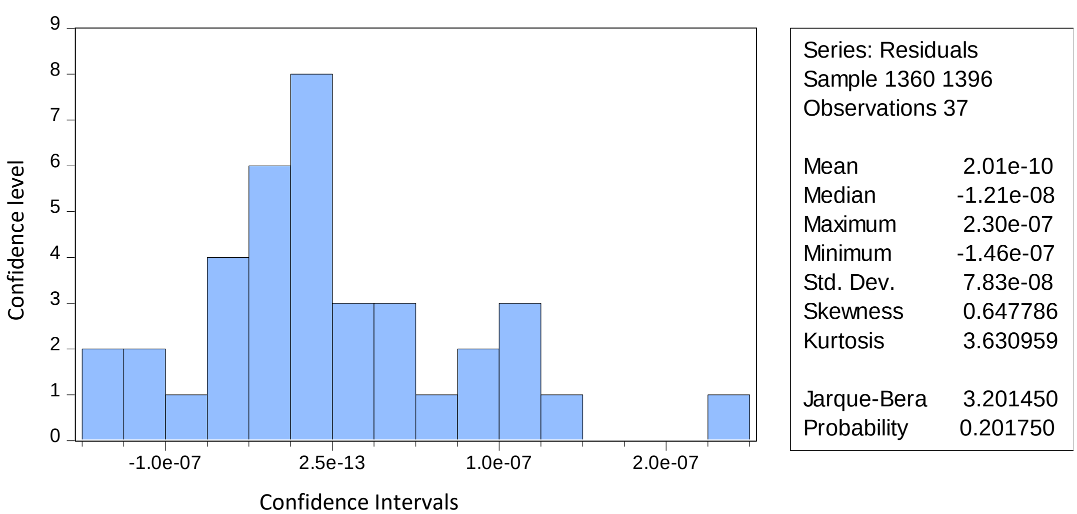

Fig. 3. Test of normality of waste statements (estimation of fitted production function).

Table 8. Correlation coefficient between variables.

Variable	Yb	Ybt	Co2	Co2wlf
Yb	1			
Ybt	0.21	1		
Co2	-0.21	-0.20	1	
Co2wlf	-0.04	-0.04	-0.29	1

Therefore, the estimation results are as follows (Table 9).

Table 9. Model estimation output.

Variable	Coefficient	Statistics t	Prob
Ybt	0.03	10.24	0.00
Wlfco2	-7.91	1.02	0.32
Co2	4.47E-11	2.05	0.04
C	2052	29515	0.00
Ar(1)	0.58	3.19	0.00
Ar(2)	-0.55	-4.18	0.00
	Adjusted R-squared=0.70		R-squared=0.75
	Prob(F)= 0.00		F-statistic=15.25
D.W=1.80			

As can be seen from the estimated output, increasing the amount of carbon dioxide emissions will lead to increased economic growth, regardless of oil revenues in Iran. There is also a significant relationship between the production of the previous period and economic growth without considering oil revenues. But in this model, the welfare index has no significant relationship with economic growth. The coefficient of determination is 75%, and the modification coefficient is 70%. The value of the F statistic in the present model is equal to 15.25, and despite the estimated probability of less than 0.05 (0.00), the significance of the whole regression can be claimed. The Watson (D-W) camera statistics in the current model is 1.80. Therefore, the health of the estimated model can be claimed.

3.2. Production function estimation (economy with oil)

In this section, in order to estimate the production function, the classical hypotheses must first be examined. The test results related to the lack of autocorrelation hypothesis showed that this hypothesis was not confirmed (Table 10); so, to solve this problem, the AR component was included in the model. According to the obtained results, the heterogeneity model had no variance (Table 11). The null hypothesis that the model residuals were normal is also accepted (Figure 4) In Figure 4 Y is Gross National Product (GNP). Graph X in order of A or Total Productivity of the economy G or Government spending L or Labor K Private Capital OIL or Oil Value added is. Of course, this diagram is related to the test of normality of waste sentences, which is the output of the software. The correlation coefficient was also examined after the classical assumptions. The results presented in Table (12) show that the correlation between the independent variables is less than 30%, and therefore, it can be ignored.

Table 10. Correlation LM test output (production function estimation).

Model	Correlation LM	Critical value	Estimated probability
Final	F-statistic	50.30	0.00
	Obs* R-square	29.04	0.00

Table 11. Heteroskedasticity test output (production function estimation).

Model	Heteroskedasticity	Critical value	Estimated probability
Final	F-statistic	0.0051	0.943
	Obs* R-square	0.0053	0.941

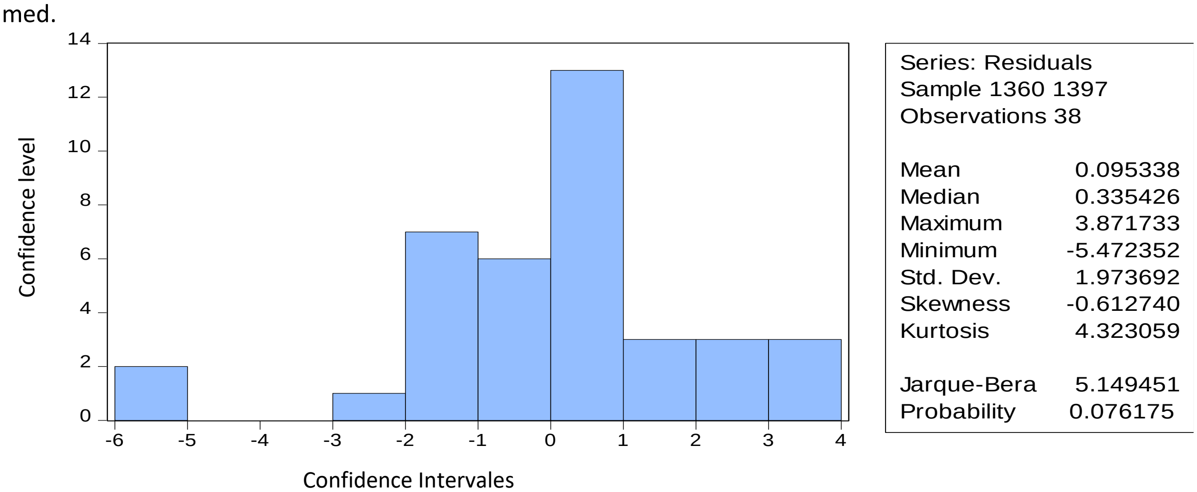

Fig. 4. Test of normality of waste sentences (estimation of production function).

Table 12. Correlation coefficient between variables (production function estimation).

Variable	Y	K	L	G	A	oil
Y	1					
K	-0.05	1				
L	-0.23	0.004	1			
G	-0.15	-0.20	0.09	1		
A	-0.47	-0.23	0.20	0.16	1	
Oil	0.08	-0.24	0.20	0.20	0.75	1

But the total productivity variable had a high correlation with oil revenue and the model dependent variable; therefore, the mentioned variable was removed from the model, and finally, the following model was examined:

$$Ln(y)= (1-\alpha) LnL+\alpha Ln(K)+\gamma LnG+Ln\ oil +\varepsilon$$

After the above steps, the estimation results are as follows (Table 13):

Table 13. Model estimation output.

Variable	Coefficient	Statistics t	Prob
Ln L	8.69	0.74	0.46
Ln G	-0.01	-0.08	0.92
Ln K	4.16	2.85	0.00
Ln Oil	29.19	4.13	0.00
C	29.19	4.65	0.00
AR(1)	1.62	11.75	0.00
AR(2)	-0.70	-5.23	0.00
Adjusted R-squared=0.93		R-squared=0.94	
Prob(F)= 0.00		F-statistic=73.16	
D.W=2.11			

As can be seen from the output of the estimate, there is a significant relationship between production among the independent variables, capital, and oil revenue variables. More than 93% of the changes in the dependent variable can be explained by independent variables. In other words, the regression coefficient indicates the good fit of the model. The value of the F statistic in the present model is equal to 73.16, and despite the estimated probability of less than 0.05 (0.00), the significance of the whole regression can be claimed. The Watson (D-W) camera statistics in the current model is 2.11. Therefore, the health of the estimated model can be claimed. In this part, when we obtain the fitted production function, we enter the following model as a dependent variable to estimate the relationship between CO_2 and economic growth in terms of welfare index by holding the calculated welfare function values:

$$\mathrm{Ln}\hat{y}_{oil,t} = \beta_0 + \beta_1 \mathrm{LnCO2}_t + \beta_2 \mathrm{Ln}(\mathrm{CO2} * \mathrm{WLF})_t + \beta_3 \mathrm{Ln}\hat{y}_{t-1} + u_t \quad (18)$$

Before estimating the model, the correlation coefficient of the variables was examined. It was found that the correlation between the variables was not large enough to be considered as a strong correlation (Table 14). The classical assumptions for the final model were also examined. The results of the LM correlation test showed that the assumption of non-correlation of the model was not confirmed (Table 15), so to solve this problem, the AR component was included in the model. The results of the variance homogeneity test for the final model are shown in Table (16); it was observed that the models did not have variance homogeneity.

Table 14. Correlation coefficient between variables (estimation of fitted production function).

Variable	Yb	Ybt	Co2	Co2wlf
Yb	1			
Ybt	-0.30	1		
Co2	-0.11	-0.05	1	
Co2wlf	-0.38	-0.28	-0.03	1

Table 15. Correlation LM test output (fitting production function estimation).

Model	Correlation LM	Critical value	Estimated probability
Final	F-statistic	4.93	0.01
	Obs* R-square	8.93	0.01

Table 16. Heteroskedasticity test output (fitting production function estimation).

Model	Heteroskedasticity	Critical value	Estimated probability
Final	F-statistic	0.30	0.58
	Obs* R-square	0.31	0.57

The normality test of the residual statements also confirmed the null hypothesis that the residuals of the model were normal (Figure 5). In Figure 5, Y is Gross National Product (GNP). Graph X in respectively the amount of carbon dioxide emissions= Emission of carbon dioxide * Welfare index Production in the economy in US dollars of the previous period, Fit amount of production in the economy. Therefore, the estimation results are as follows (Table 17). As can be seen from the estimated output, the carbon dioxide emissions and production have a significant relationship with each other, which is a positive relationship, i.e., increasing the amount of carbon dioxide emissions, leading to increased economic growth in Iran with considered oil revenues. Also, according to the household welfare index, the increase in carbon dioxide in the economy with Iranian oil has a positive and significant relationship with economic growth. In other words, carbon dioxide emissions have led to increased economic growth due to the negative effects it has on the household welfare index. But no significant relationship is found between the production of the previous period and economic growth in the country. The coefficient of determination is 99%, and the coefficient of modification is 98%. The value of the F statistic in the present model is equal to 479.87, and despite the estimated probability of less than 0.05 (0.00), the significance of the whole regression can be claimed. The Watson (D-W) camera statistics in the current model is equal to 1.88. Therefore, the health of the estimated model can be claimed.

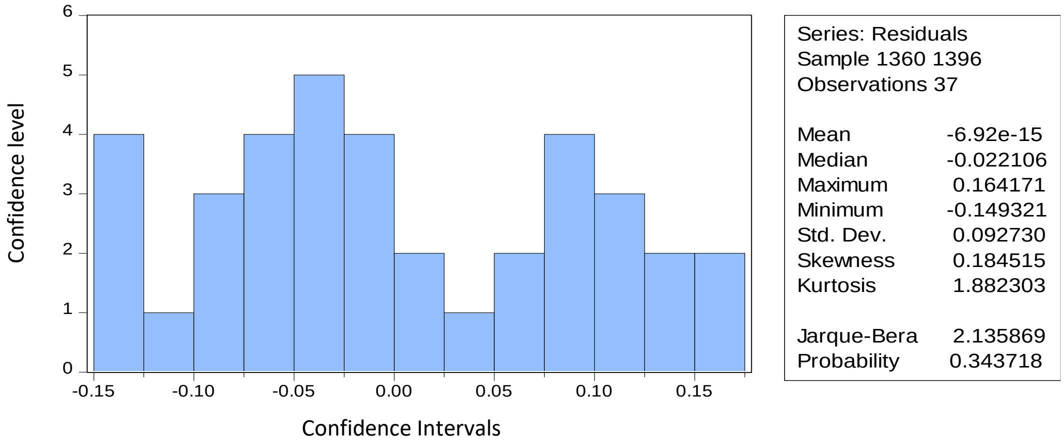

Fig. 5. Test of normality of waste statements (estimation of fitted production function).

Table 17. Model estimation output.

Variable	Coefficient	Statistics t	Prob
Ybt	-0.04	-0.18	0.85
Wlfco2	2.44E-06	4.11	0.00
Co_2	1.06	37026	0.00
C	0.48	1.55	0.12
Ar(1)	0.54	3.36	0.00
Ar(2)	0.14	0.55	0.58
Adjusted R-squared=0.98		R-squared=0.99	
Prob(F)= 0.00		F-statistic=479.87	
D.W=1.88			

4. Conclusions

In the present study, two sections were considered to investigate the relationship between carbon dioxide and the economic growth of a country in terms of household welfare index. The first part examines the relationship between carbon dioxide and economic growth without considering oil revenues, and the second part examines oil revenues in Iran. The results showed that increasing the amount of carbon dioxide emissions led to increased economic growth. There was also a significant relationship between the production of the previous period and economic growth. The results of the second part showed that carbon dioxide emissions and production had a significant and positive relationship with each other, i.e., increasing the amount of carbon dioxide emissions, led to increased economic growth in Iran. Also, according to the household welfare index, the increase in carbon dioxide in the economy with Iranian oil had a positive and significant relationship with economic growth. In other words, carbon dioxide emissions led to increased economic growth due to the negative effects it had on the household welfare index. But no significant relationship was found between the production of the previous period and economic growth in the country. When carbon dioxide emissions only increased economic production and did not contribute to economic growth, there was no growth that led to sustainable development in the country. In the short term, it might lead to a boom in production and the reduction of prices in general, but its negative effects on the environment and people's well-being could lead to slower economic growth in the long run. Thus, there can be a non-linear relationship between economic growth and carbon emissions. The results of this study confirmed that the effect of pollution on the reduction of welfare ultimately reduced the rate of economic growth. In other words, the emission of carbon dioxide gas led to a decrease in the welfare in the country. Therefore, economic policymakers should pay special attention to this variable, the welfare strategies, and identify the variables affecting that context to benefit the poor. Also, the production of goods and services that cost the society must be taken into account to calculate the gross national product. In addition, the pollutants from manufacturing plants cause a decrease in welfare and are not included in the national accounts, which only contain the main products of factories. Thus, the government must take into account welfare developments in all executive policies: the use of standard tools that drive technology development, such as pollution taxes, environmental regulations, or exchangeable licenses; reduce the trend of fossil energy consumption by optimizing the consumption pattern and minimizing energy waste in the domestic, commercial, and industrial sectors; provide free access to cleaner technologies and avoid the use of fossil fuels; and eliminate the spirit of monopoly in the development of renewable energy.

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