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Comparison of the Effect of Income Inequality and Petrol Quotas on Carbon Dioxide Emissions in Iran

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Highlights

- The Gini coefficient, as a substitute for inequality, positively affects carbon dioxide emissions in Iran.
- In the long run, the most important cause of pollution in Iran, after urbanization, is income inequality, and petrol prices have less effect on CO_2 emissions.
- Policy-making to reduce income inequality has a far more significant impact on reducing carbon dioxide emissions than increasing the petrol quota and price in Iran.

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Abstract

Income distribution and environmental destruction are two of the most critical sustainable development goals. However, the linkage between income inequality and carbon emissions remains controversial, especially in countries with natural oil and gas resources. This paper studies the link between carbon dioxide (CO_2) emissions and income inequality in Iran from 1985 to 2020. The modeling results indicate a trade-off between income inequality and CO_2 emissions. The vector autoregression approach found a direct relationship between the Gini coefficient and CO_2 emissions and an indirect relationship between petrol price and CO_2 emissions. Petrol prices have a smaller, although negative, impact on CO_2 emissions compared to the positive effect of inequality. Impulse response was checked out to investigate the effect of shocks. According to the variance decomposition, income inequality after carbon dioxide emissions is the most explanatory change in gas emissions, among other variables. This paper presents a positive effect of petrol price shocks on carbon dioxide emissions and a negative impact on long-term carbon dioxide emissions.

Keywords: Inequality, Carbon Dioxide Emissions, Income inequality

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1. Introduction

With the continuous progress of industrialization, issues such as global energy, environment, and climate change have become increasingly prominent (Jorgenson et al., 2017). Among them, climate change has led to a series of events such as global warming, rising sea levels, and increasing the likelihood of extreme weather events, which increase ecosystem vulnerability and threaten human society (Perrier et al., 2019; Wang and Feng, 2021). Despite climate change, fossil fuel consumption, one of the significant determinants of CO_2 emissions, has increased in recent years (World Bank, 2015).

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This seemingly contradictory situation requires a thorough examination of the determinants of demand for automobile fuel and other energy goods by households (Nikodinoska and Schröder, 2016).

On the other hand, inequality is the existing differences in economic, income, or well-being criteria among people of the same group, groups of the same population, or countries. Income inequality is a significant problem, especially in developing countries with high inequality. Societies reveal that inequality negatively affects the achievement of sustainability and well-being (Khan et al., 2018; Razkowski and Bartnyczak, 2018; Soava et al., 2020; Balezentis, 2020). Inequality hinders poverty reduction, makes more of the population vulnerable to poverty, and encourages migration due to poverty (Hübler, 2017; Balezentis, 2020). In addition, inequality causes health and social problems (Wilkinson and Pickett, 2009; Balezentis, 2020).

The recent global increase in fuel prices threatens the gains in reducing poverty and inequality that countries like Iran have made over the past few decades. Therefore, policymakers should understand the potential distributional effects of fuel price increases to evaluate the implementation of alternative measures to reduce these effects.

Since fuel is a high-consumption product, a price increase can affect all sectors of the economy and raise other prices, ultimately leading to periods of high inflation. Empirical evidence shows that high fuel prices affect livelihoods differently. For example, Arndt et al. (2008) examined the impact of food and fuel price increases in Mozambique on macroeconomic indicators and poverty using different approaches and considering short-term and long-term effects. They concluded that the short-term effects showed mainly regional differences, with urban households and those living in the southern region experiencing the most negative effects. In contrast, the long-term effects significantly adversely impacted poverty reduction and economic growth; they were felt nationwide. In another study, Ersado (2012) examined the direct poverty and distributional impacts of energy price increases in Armenia, focusing mainly on gas. This study showed that sharp increases in gas prices in Armenia had a regressive impact, as poor and vulnerable households were more affected by energy price shocks. In another study, Aziz, Yasin, and Anwar (2016) examined the impact of higher energy prices on the welfare of Pakistani consumers in the context of compensatory changes. They estimated the consumption losses that could result from an increase in energy prices and found a significant reduction in consumer welfare. More recently, Muthalib (2018) argued that fuel price increases were a barrier to access to employment and could, therefore, lead to social and economic exclusion. Finally, Feng et al. (2018) examined the impact of higher energy prices on different income groups using a developed energy input–output approach in Latin America. The research results indicated that households in the upper levels of the income distribution consumed more fuel. Therefore, high-income households benefited from energy subsidies more than low-income households (Canavire-Bacarreza et al., 2022).

This study aims to measure and investigate the impact of two welfare policies simultaneously on greenhouse gas emissions in Iran as a developing country. Accordingly, it examines the effect of petrol prices as a policy factor to increase petrol rationing and income inequality in recent years and greenhouse gas emissions in Iran from 1985 to 2020. Statistics for this study are obtained from the World Bank. Since the statistics of recent years are not available on the World Bank website, they have been received from the website of the Statistics Center of Iran.

Other contents of this article are arranged as follows. Section 2 covers background and theoretical foundations. Section 3 develops the methodology and describes the data sources and processes, and Section 4 discusses the results. Section 5 summarizes the paper.

2. Theoretical foundations

The study of Dou et al. (2021) inspires theoretical foundations. They considered households in such a way that they sought to maximize the sum of the discounted values of instantaneous utility at infinite time, which was also a function of environmental pollution and consumption. By simplifying their model, they introduced a new variable of household attention to environmental pollution. On the other hand, using models of Zhou (2020) and Hu (2017), Dou et al. (2021) introduced the production function in such a way that the type of production function was the production function of Cobb Douglas; of course, it was also constant in scale. This production function focused on capital, labor, and energy. This model assumed that environmental pollution was a function of society's total output and environmental protection costs. On the one hand, the output was the primary source of pollution. On the other hand, ecological production costs could effectively reduce pollution. Therefore, a pollution function was defined in addition to the production function. The main variables were average household consumption in the community due to pollution and government expenditures to reduce environmental pollution. Therefore, the household budget and the government budget were inevitably included in the equations.

At this point, a Hamiltonian function was formed. The first condition of the Hamiltonian function determined the optimal tax rate. Therefore, the optimal tax rate solution for households with average energy consumption levels was as follows:

$$\tau = 1 + \frac{1}{\omega}\left(\frac{K_i}{K_a}\right)^a \left(\frac{L_i}{L_a}\right)^\beta (J_i)^\mu, \quad where\ J_i = {E_i}/{E_a} \tag{1}$$

where ω, *K*, *L*, and *E* stand for a household's attention to environmental pollution, capital, labor force, and energy utilization. All the equations are available in the work of Dou et al. (2021).

In the above equation, they assume that the *m*th household represents a household with moderate energy consumption. E_m represents the average household energy consumption; therefore, $J_m = {E_m}/{E_a}$ can indicate energy inequality (Magnani, 2000). Notably, a smaller J_m means severe energy inequality in an economy. Thus, the optimal tax rate solution for households with average energy consumption levels is given by:

$$\tau^* = 1 + \frac{1}{\omega}\left(\frac{K_m}{K_a}\right)^a \left(\frac{L_m}{L_a}\right)^\beta (J_m)^\mu \tag{2}$$

The relative energy consumption on the optimal tax rate is as follows:

$$\frac{\partial \tau^*}{\partial J_m} = \frac{\mu}{\omega}\left(\frac{K_m}{K_a}\right)^a \left(\frac{L_m}{L_a}\right)^\beta (J_m)^{\mu-1} < 0 \tag{3}$$

Accordingly, the impact of energy inequality on environmental pollution can be calculated as:

$$P(t) = Y_a(t)^\gamma \Gamma(t)^{-\theta} \tag{4}$$

where *P* describes the average population of the society induced by human activities, and Γ represents government expenditure on pollution reduction. Y_a denotes the average household consumption in society. Γ and θ are the pollution production elasticity concerning output and environmental spending, respectively. To simplify the model, they assume γ – θ = 1.

Given that ω, μ> 0, 0 <τ <1, $\frac{\partial P}{\partial J_m} < 0$, they showed that the smaller J_m, the more severe the environmental pollution. However, considering J_m is an opposite indicator of energy inequality, Equation (5) shows a positive relationship between environmental pollution and energy inequality. In addition, since J_m appears in the denominator of the expression to the right of Equation (5), the final positive effect of energy inequality on environmental pollution is amplified by increasing energy inequality (i.e., decreasing J_m). Based on this, they proposed the following hypothesis:

- Inequality will increase CO_2 emissions;
- An increase in petrol price will decrease CO_2 emissions;
- The effect of reducing inequality on reducing carbon dioxide emissions is greater than increasing the price of petrol on reducing carbon dioxide emissions.

Due to the lack of statistics in Iran and the lack of statistics for household energy consumption separately from the commercial and public sectors, instead of inequality in energy consumption, we used income inequality in Iran to show the effect of this inequality on greenhouse gases in Iran. Of course, household energy expenditure statistics are available in 10 deciles. Still, due to the small amount of data, reviewing the statistics in a time series is impossible.

2.1. Background

Golley and Meng (2012) concluded that affluent households produced more per capita than poor households due to their direct energy consumption and higher spending on energy-intensive goods and services. In China's econometric analysis, average inputs confirmed a positive relationship between emissions and income and established a trend in marginal emissions to increase slightly in the corresponding income range.

David and Montague (2014) concluded that a tax on car-produced carbon dioxide emissions optimally counters the marginal social costs of fuel burning. This is because CO_2 emissions depend only linearly on the amount of fuel burned, so fuel tax prices set all the relevant decision margins and give individuals and other entities, such as producers, a good deal. The car offers incentives for optimal social decision-making. Second, a fuel tax is simple and easy to administer, making it a good candidate for a policy on which countries can coordinate.

Sharaai et al. (2015) identified the primary factor that contributes to household carbon emission (HCE) in a residential area in Penang with the application of structural equation modeling (SEM). The independent variables involved in the research were the number of households, household total incomes, electricity consumption, LPG consumption, and transportation fuel. The samples consisted of 52 households using simple random sampling. Significant positive correlations existed between total household income, electricity consumption, transportation fuel, and HCE amount. Transportation fuel was the main contributor to HCE in the residential area. The result highlighted that household carbon emission was determined by household size, income, energy consumption, and transportation. However, the most significant contributor to household carbon emissions was transportation fuel, which significantly influenced household carbon emissions. It could act as a reference for the local community and decision-makers, such as related government agencies, in tackling and reducing the carbon emission of residential areas.

Nikodinoska and Schröder (2016) examined how a German car fuel tax changes private households' CO_2 emissions, living standards, and after-tax income distribution using demographically scaled quaternary quasi-ideal demand system (DQUAIDS) estimates. Their results showed that the tax implied a trade-off between the goal of reducing emissions and vertical equity, which referred to the idea that people who could afford the tax should pay more. First, they estimated the demographic profile of a quasi-ideal quadratic demand system, which described how household demand responded to changes in price and income. Estimated price elasticities showed how household demand responded to changes in automobile fuel taxes. Second, based on estimates of the demand system, they determined the following three outcomes for different tax levels: (a) emissions; (b) inequality, using a comprehensive set of inequality indicators; and (c) household welfare, using equivalent/compensatory changes and tax burden over the income distribution quotient. Their estimates suggested the existence of an emission-inequality trade-off.

Sommerfeld (2017) used an adaptive theoretical framework to analyze the effects of climate policies such as fuel taxes and the number of alternative vehicles for private transport on family and social well-being and income inequality in Germany. First, a refined method based on Hausmann (1981) was employed to estimate welfare effects that considered price and income effects. Second, panel data were used to model driving behavior, and third, income inequality was considered an essential consequence of private transportation policies. Additional taxes on conventional fuel were regressive. However, repatriating additional tax revenue through lump sum transfers could reduce this effect. Second, when the extra income was also used to finance electric vehicles and compressed natural gas (CNG) subsidies, households that own such vehicles experienced welfare benefits. However, support for more efficient cars had less impact on increasing inequality. In addition, a carbon tax could be used as a tool to reduce income inequality. In conclusion, this paper provided empirical evidence that supported the imposition of a higher carbon tax on car fuel based on equity and pollution reduction. It is estimated that with a 30% increase in fuel tax, pollution will decrease by 9%. His results showed that the most efficient policy in reducing CO_2 emissions and equity concerns was a sharp increase in taxes on conventional fuels, followed by reallocation of excess revenues.

Milan and Creutzig (2017) illustrated that well-designed transit interventions and participatory planning processes could make cities more climate-friendly and equal. They made use of a detailed questionnaire of 187 questions from 2009 and 2012, aggregated responses into 14 indicators in Medellin, Columbia, and compared changes in quality of life between three transit development zones (communes), between three non-intervention zones, and between income levels and gender.

Sovacool et al. (2019) explored that decarbonization and innovation reduced vulnerability to poverty but could create new inequities unless risks were actively reduced. They showed how, in each case, such innovations came with a set of opportunities and threats. In doing so, the paper sought to uncover the "political economy" of low-carbon innovations, identifying specific tensions around who wins and who loses and the scope and temporality of these outcomes. Thus, in general, if people with low incomes have little access to affordable and low-polluting energy services, this can still lead to qualitative inequities alongside radical innovations or those that require fundamental changes in usage patterns. However, support for more efficient vehicles has less impact on increasing inequality.

Baležentis et al. (2020) showed a non-linear relationship between income inequality and per capita greenhouse gas emissions and a U-shaped relationship between per capita GDP and greenhouse gas emissions. This indicated that appropriate environmental policies were needed for regions with diverse economic structures. They showed reducing income inequality and climate change could be achieved simultaneously.

Using provincial panel data of China's residential sector from 2005 to 2017, Wang and Feng (2021) examined residential CO_2 emission inequality (carbon inequality) and its drivers from static and dynamic perspectives to provide empirical support for policy formulation. Their results showed that residential carbon inequality had increased from 2005 to 2017. The difference in energy intensity was the main factor in promoting the increase of carbon inequality, and its effects demonstrated an increasing trend. Per capita income inequality was the second most significant factor in the growth of residential carbon inequality, contributing almost 20%. In addition, urban–rural structure also positively increased carbon inequality, but its contribution decreased. In contrast, energy structure inequality actively facilitated the reduction of carbon inequality although such active effects were minor. Based on these results, policies related to reducing the regional gaps in energy intensity, per capita income, and urbanization were proposed to reduce the carbon inequality in China's residential sector.

Dong et al. (2022) investigated the effects of energy efficiency on income inequality and energy poverty in China. They developed a dynamic panel model using a balanced panel data set covering 30 provinces from 2004 to 2017. Using the generalized system of moments method (SYS-GMM), they estimated the role of energy efficiency and performed a regional asymmetric and heterogeneous analysis. They also discussed potential moderating effects on the relationship between energy efficiency, poverty, and income inequality. The main findings revealed that (1) improving energy efficiency could simultaneously reduce income inequality and energy poverty, (2) there was significant heterogeneity and asymmetry in the effects of energy efficiency on energy poverty and income inequality, and (3) the government could reduce revenue. Energy inequality and poverty could be reduced by increasing the share of energy efficiency through technological evolution and increasing support for green innovation.

Li et al. (2022) employed an innovative, dynamic autoregressive distributed lag simulation technique to evaluate data from 1980 to 2015. Their findings showed that unequal distribution of wealth negatively affected carbon emissions. Likewise, globalization and human capital contributed to environmental degradation. The inclusion of transition variables confirmed the findings of the study.

Bloch and Danish (2022) filled a welcome gap in the literature by examining the effects of income inequality and renewable energy on consumption-based CO_2 emissions for BRICS economies. Due to the unique income distribution characteristics, two income inequality indices, the Gini index and the income earned by the top 10%, were used to understand different analytical approaches. Several panel data estimation techniques were applied from 1994 to 2018 to obtain consistent and reliable estimates for the BRICS economies. The empirical results demonstrated that income inequality contributed to consumption-based CO_2 emissions in the atmosphere. However, renewable energies helped reduce consumption-based CO_2 emissions. Based on empirical findings, this study suggested essential policy implications for BRICS countries to control environmental impacts.

Sampedro et al. (2022) determined the long-term implications of alternative future income distributions for state-level residential energy demand, investment, greenhouse gas, and pollutant emission patterns in the United States (US) by combining income quintiles in the residential energy sector of the global change analysis model. With a breakdown of the 50 states, they found that if income distribution within each US state became more equal than now, that is, the income gap between the richest and poorest narrowed over time, residential energy demand could increase by 10% (4% to 14% across states). This increase in residential energy demand would reduce energy poverty with a minimal increase in economy-wide CO_2 emissions (1% to 2%). On the other hand, if the US states shifted to a less equitable income distribution than they currently did, residential energy demand could be 19% lower (12%–26% across states) as the gap between the richest and poorest widened over time.

The field of study of this article is the field of inequality. Therefore, more related studies will be discussed. However, extensive studies have been conducted on the sustainable development of environmental pollution through the emission of greenhouse gases. Among them is the study of Ghazelbash et al. (2023). They used a panel data model to examine the impact of carbon dioxide and non-CO_2 greenhouse gas emissions on global investment in renewable energy and data from 63 countries. Their paper concluded that carbon dioxide positively affected clean energy investment, while non-CO_2 emissions negatively impacted all three types of clean energy investment.

3. Methodology

According to Balezentis et al. (2020), several control variables regarding the relationship between income distribution, petrol price, and CO_2 emissions are also used. According to the study by Blázquez et al. (2017), a sharp increase in fossil fuel prices favors a significant decrease in carbon emissions, and the same happens when there is a negative technological shock. Thus, we used petrol price as a domestic fuel. This widespread expansion of worldwide production requires more energy sources that are potential carbon dioxide (CO_2) emissions sources. Hence, we use the following regression for examining income inequality, petrol price, and carbon emissions:

$$lnCO_{2t} = a_1 Gini_t + a_2 lnGDP_t + a_3 lnPetrol\_price_t + u_t \qquad (6)$$

where CO_2 is carbon dioxide emissions, *Gini* is the Gini coefficient, *GDP* indicates the gross domestic product, *Petrol price* denotes the price of petrol in rials, *u* represents the noise term, and *t* is the time index.

The primary purpose of this work is to investigate the effect of inequality and petrol prices on CO_2 emissions in Iran. The sample period is from 1985 to 2020. The model variables with the following symbols and definitions are considered:

Table 1

Variables Introduction

Variable	Statement	Resource
CO_2	CO_2 emissions (kt)	http://data.worldbank.org
Gini	Income distribution across a population	https://www.amar.org.ir/
Petrol price	The price of petrol in Iran	Iran Energy Balance 2000–2020
GDP	Gross domestic product	http://data.worldbank.org

4. Results

We used the vector autoregressive (VAR) model to analyze the relationship between the variables. The vector autoregression model is one of the flexible models in multivariate time series analysis. In this model, the effects of variables on each other are tested by examining the impulse response functions and analysis of variance.

Now, using unit root tests (Table 2), VAR lag order selection criteria (Table 3), and Johansen cointegration test (Table 4) for the confirmation of the variables and their relationships, we examine the model.

Table 1

Unit root test

Variable	ADF test		BP test		PP test	
	1st difference	Level	1st difference	Level	1st difference	Level
CO_2	–7.183	–1.651	–8.771	–2.751	–6.971	–1.585
Gini	–5.490	–1.355	–7.625	–7.761	–5.489	–1.415
Petrol price	–6.127	–0.228	–10.461	–1.639	–6.227	–0.045
GDP	–4.939	–0.270	–4.314	–2.125	–5.099	–.398

The results of ADF and PP tests indicate that CO_2, Gini, and GDP are non-stationary, while Urban and Trade are stationary. The BP test CO_2 and GDP results are non-stationary at the level, while Urban, Trade, and Gini are stationary.

Table 3

VAR lag order selection criteria

Lag	Log*L*	LR	FPE	AIC	SC	HQ
0	94.466	NA	$2.29 \times 10^{-0.8}$	–6.259	–6.051	–6.170
1	196.260	151.844	8.16×10^{-11}	–11.860	–10.937	–11.684
2	216.292	31.768	5.46×10^{-11}	–12.354	–10.677	–11.633
3	228.543	15.725	7.54×10^{-11}	–12.244	–9.782	–11.576
4	262.014	25.217	4.14×10^{-11}	–13.242	–1.136	–12.338
5	315.953	30.311*	$6.61 \times 10^{-12*}$	–15.927*	–11.967*	–14.687*

Table 3 indicates the optimal lag, which is determined by the Akaike information criterion (AIC), Final prediction error (FPR), and Hannan-Quinn (HQ). According to this table, the optimal lag for the model is lag 5.

Table 4

Johansen cointegration test result

Hypothesized No. of CE(s)	Trace statistic	0.05 Critical value	Prob.**
None*	51.440	47.846	0.022
At most 1	28.243	29.647	0.075
At most 2	15.216	15.474	0.055
At most 3*	4.400	3.841	0.035

Johansen's cointegration test is to observe the long-term equilibrium relationship between the non-stationary variables. Table 5 indicates that there is at least one long-run relationship.

Table 5

Variance decomposition

Period	S.E.	CO_2	Gini	Petrol price	GDP
1	0.038	100	0	0	0
2	0.041	94.378	4.293	0.032	1.285
3	0.044	87.213	9.012	2.537	1.146
4	0.049	80.744	7.136	4.224	7.914
5	0.052	78.512	7.123	3.998	10.355
6	0.060	63.283	21.099	6.023	9.582
7	0.074	51.802	26.781	8.472	12.844
8	0.087	56.279	25.259	8.137	10.432
9	0.098	59.080	24.285	6.685	9.948
10	0.112	57.153	19.234	10.728	12.903

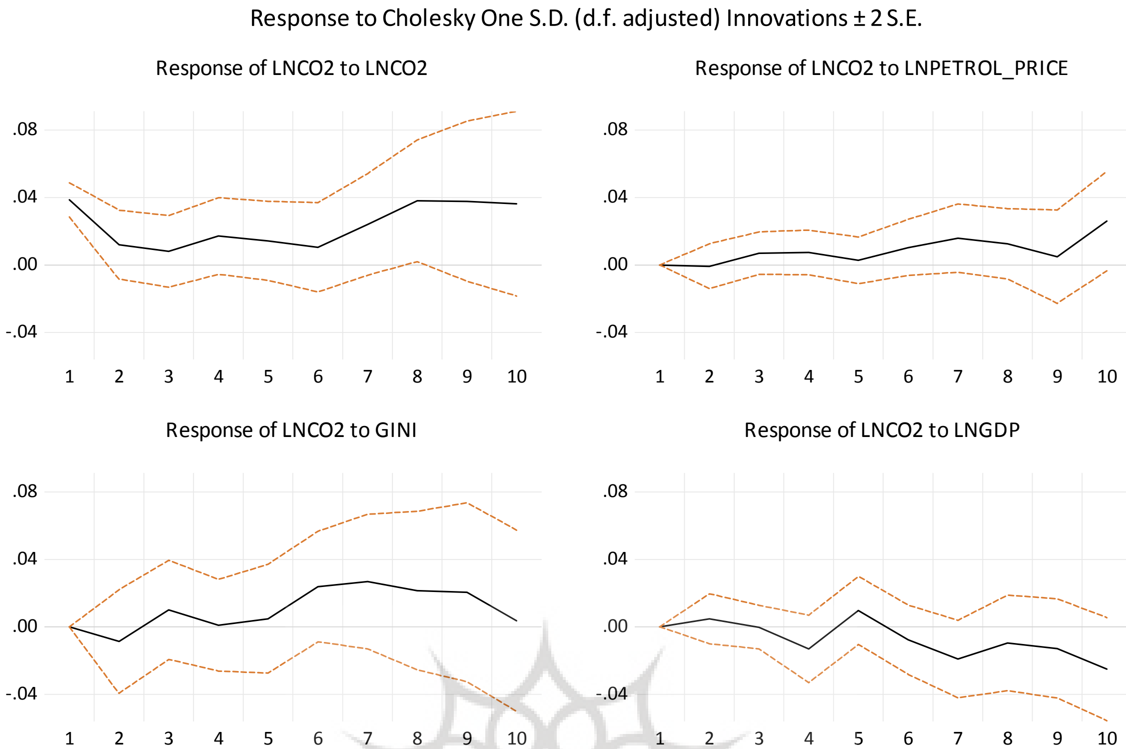

Figure 1

The shocks of independent variables on CO_2 emissions

The results of variance decompositions reveal that most of the changes in CO_2 after the shocks on it are explained by itself and then by the Gini, GDP, and Petrol price, respectively. As it is clear from the numbers in Table 5, Gini has the most explanation after CO_2 by about 19.2%. Petrol price has about a 10.7% effect on the explanation of CO_2 changes at the end of the period.

5. Conclusions

This study brings "social and political economy" to analyze the relationship between income inequality, gasoline prices, and carbon dioxide emissions. However, this is not all that needs to be done in this field, and many research gaps exist. Following Boyce (1994), a more equitable income distribution is assumed to lead to better environmental quality.

In addition to having apparent benefits, environmental protection can have the added benefit of creating a fair and just society. Vulnerable groups in an unequal society are disproportionately affected by pollution because they have less capacity to cope with environmental hazards and insufficient access to infrastructure or prevention services to protect themselves from pollution-related harm. Pollution disproportionately threatens their health, livelihoods, and well-being, increasing income inequality within a country and creating a vicious cycle (Das and Basu, 2022).

In this article, the time series data are used for the estimation. The dataset includes the years 1985–2020. According to the first hypothesis, the result of the model indicates that the Gini coefficient, as a substitute for inequality, positively affects carbon dioxide emissions in Iran. In previous studies, equations have been used to investigate the impact of various factors on carbon emissions. However, in this study, the effect of inequality on carbon emissions has also been considered. Therefore, the results show that income inequality is the most important cause of pollution in Iran after urbanization in the long run. Petrol price has less effect on CO_2 emissions. Moreover, policy-making to reduce income inequality has a far more significant impact on reducing carbon dioxide emissions than increasing the petrol quota and price in Iran. Therefore, the second hypothesis is weak in the result of this paper. According to the result of impulse responses and variance decomposition, the third hypothesis is also confirmed.

Given that petrol has a unique position in the market basket of relatively low-income people in Iran, increasing its price will not reduce its consumption. Furthermore, given that people are sensitive to the cost of petrol, it appears that future petrol quotas considered by policymakers will not be met.

The rich people's consumption behavior can effectively determine this probability. In addition, fuels and technologies installed in imported or domestically made cars to use the most minor and cleanest fuel in compliance with the Euro 6 standard can play an essential role in reducing carbon dioxide emissions.

Nomenclature

ADF	Augmented Dickey Fuller
AIC	Akaike information criterion
CNG	Compressed natural gas
CO_2	Carbon dioxide
DQUAIDS	Demographically scaled quaternary quasi-ideal demand system
E	Energy utilization
E_m	Average household energy consumption
FPR	Final prediction error
GDP	Gross domestic product
Gini	Gini coefficient
HCE	Household carbon emission
HQ	Hannan-Quinn
J_m	Severe energy inequality
K	Capital
L	Labor force
P	Average population of the society
Petrol Price	Price of petrol in rials
PP	Philips Peron
SEM	Structural equation modeling
SYS-GMM	System of moments method
VAR	Vector autoregressive
Y_a	Average household consumption in society
Γ	Government expenditure on pollution reduction
ω	Household's attention to environmental pollution

References

Andrew, J., Juliet, S., and Xiaorui, H. (2017). Income Inequality and Carbon Emissions in the United States: A State-level Analysis, 1997–2012. Ecological Economics, 40–48. doi: 10.1016/j.ecolecon.2016.12.016

Balezentis , T., Liobikiene, G., Streimikiene, D., and Sun, K. (2020). The impact of income inequality on consumption-based greenhouse gas emissions at the global level: A partially linear approach. Journal of Environmental Management. doi: https://doi.org/10.1016/j.jenvman.2020.110635

Baležentis, T., Liobikienė, G., Štreimikienė, D., and Sun, K. (2020). The impact of income inequality on consumption-based greenhouse gas emissions at the global level: A partially linear approach. Journal of Environmental Management, 267. doi: https://doi.org/10.1016/j.jenvman.2020.110635

Baloch, M., and Danish. (2022). The nexus between renewable energy, income inequality, and consumption-based CO_2 emissions: An empirical investigation. Sustainable Development. doi: https://doi.org/10.1002/sd.2315

Blazquez, J., Maria Martin-Moreno, J., Perez, R., and Ruiz, J. (2017). Fossil Fuel Price Shocks and CO_2 Emissions: The Case of Spain. The Energy Journal, 38, 161–176. Retrieved from https://www.jstor.org/stable/26534394

Canavire-Bacarreza, G., Gayoso de Ervin, L., Galeano, J. J., and Baquero, J. P. (2022, December). Understanding the Distributional Impacts of Increases in Fuel Prices on Poverty and Inequality in Paraguay. World Bank Group.

David, P., and Montag, J. (2014). Taxing Car-produced Carbon Dioxide Emissions: Matching the Cure to the Disease. Procedia Economics and Finance, 111–120. doi: https://doi.org/10.1016/S2212-5671(14)00326-8

Dong, K., Dou, Y., and Jiang, Q. (2022). Income inequality, energy poverty, and energy efficiency: Who cause who and how? Technological Forecasting and Social Change. doi: https://doi.org/10.1016/j.techfore.2022.121622

Dou, Y., Zhao, J., Dong, X., and Dong, K. (2021). Quantifying the impacts of energy inequality on carbon emissions in China: A household-level analysis. Energy Economics. doi: https://doi.org/10.1016/j.eneco.2021.105502

Golley, J., and Meng, X. (2012). Income inequality and carbon dioxide emissions: The case of Chinese urban households. Energy Economics, 1864–1872. doi: http://dx.doi.org/10.1016/j.eneco.2012.07.025

Hu, Wenjun; (2017). Fiscal Expenditure, Trade Openness, and Income Distribution. Finance Trade Econ, 38, 35–50. doi: https://doi.org/10.1515/cfer-2018-070304

Khan, A., Saleem, N., and Fatima, S. (2018). Financial development, income inequality, and CO_2 emissions in Asian countries using the STIRPAT model. Environmental Science and Pollution Research, 6308–6319.

Li, N., Ulucak , R., and Danish. (2022). Turning points for environmental sustainability: the potential role of income inequality, human capital, and globalization. Environmental Science and Pollution Research, 40878–40892. doi: https://doi.org/10.1007/s11356-021-18223-6

Magnani, Elisabetta; (2000). The Environmental Kuznets Curve, environmental protection policy, and income distribution. Ecological Economics, 32(3), 431–443. doi: https://doi.org/10.1016/S0921-8009(99)00115-9

Milan, B., and Creutzig, F. (2017). Lifting peripheral fortunes: Upgrading transit improves spatial, income, and gender equity in Medellin. Cities, 122–134. doi: http://dx.doi.org/10.1016/j.cities.2017.07.019

Nikodinoska , D., and Schröder , C. (2016). On the emissions–inequality and emissions–welfare trade-offs in energy taxation: Evidence on the German car fuels tax. Resource and Energy Economics, 206–233. doi: 10.1016/j.reseneeco.2016.03.001

Perrier, Q., Guivarch, C., and Boucher, O. (2019). Diversity of greenhouse gas emission drivers across European countries since the 2008 crisis. Climate Policy, 1067–1087. doi: https://doi.org/10.1080/14693062.2019.1625744

Raszkowski, A., and Bartniczak, B. (2018). Towards sustainable regional development: Economy, society, environment, good governance based on the example of Polish regions. Transformations in Business and Economics, 225–245.

Sampedro, J., Iyer, G., Msangi, S., Waldhoff, S., Hejazi, M., and Edmonds, J. (2022). Implications of different income distributions for future residential energy demand in the U.S. Environmental Research letters.

Shahbaz, M., Nasreen, S., Ahmed, K., and Hammoudeh, S. (2017). Trade openness–carbon emissions nexus: The importance of turning points of trade openness for country panels. Energy Economics, 61, 221–232. doi: http://dx.doi.org/10.1016/j.eneco.2016.11.008

Sharaai, A., Mokhtar, A., Jin, N., and Azali, N. (2015). Determining the primary factor contributing to household carbon emission using Structural Equation Modelling (SEM). Procedia Environmental Sciences, 344 – 348. doi: https://doi.org/10.1016/j.proenv.2015.10.061

Soava , G., Mehedintu , A., and Sterpu , M. (2020). Relations between Income Inequality, Economic Growth, and Poverty Threshold: New Evidence from EU Countries Panels. Econ. Dev. Econ., 290–310. doi: https://doi.org/10.3846 /

Sommerfeld, Miguel A. Tovar-Reanos Katrin; (2017). Fuel for inequality: Distributional effects of environmental reforms on private transport. Resource and Energy Economics, 1–48. doi: https://doi.org/doi:10.1016/j.reseneeco.2017.10.007

Sovacool, B., Lipson, M., and Chard, R. (2019). Temporality, vulnerability, and energy justice in household low carbon innovations. Energy Policy, 495–504. doi: https://doi.org/10.1016/j.enpol.2019.01.010

Wang, M., and Feng, C. (2021). The inequality of China's regional residential CO_2 emissions. Sustainable Production and Consumption, 2047–2057. doi: https://doi.org/10.1016/j.spc.2021.05.003

Zhao, J., Jiang, Q., Dong, X., and Dong, K. (2020). Would environmental regulation improve the greenhouse gas benefits of natural gas use? A Chinese case studies. Energy Economics, 87. doi: https://doi.org/10.1016/j.eneco.2020.104712