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An Analysis of Macroeconomic Responses to Energy Price Reforms along Iran's Decarbonization Path: A Computable General Equilibrium (CGE) Modeling Approach

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Abstract

This study examines the economic and environmental impacts of aligning the domestic prices of natural gas, fossil fuels, and renewable electricity in Iran with international standards. Using the dynamic computable general equilibrium (CGE) model, a comprehensive assessment of the impact of energy price reforms on economic growth, trade balance, welfare, relative prices and carbon emissions is provided. Given the lack of CGE model-based studies in the field of energy policy in Iran, this research fills the existing gap by simultaneously examining the economic and environmental impacts of energy price reforms. In this research, two distinct policy scenarios have been simulated over different time horizons and in various sectors to provide precise insights into sectoral balances and long-term policy outcomes. The results emphasize the necessity of transitioning to a sustainable energy system, a transition that requires extensive investments in renewable energy infrastructure (especially solar and wind) with targeted subsidies and financial incentives. Complementary measures include improving energy efficiency in high-consumption sectors through low-consumption technologies and modernizing the agricultural sector using clean energy to reduce dependence on fossil fuels and decrease greenhouse gas emissions. Implementing these strategies can lead to reduced energy price volatility, increased economic resilience, and achieving sustainable growth in Iran.

Highlights

- This research used a dynamic CGE model to evaluate the macroeconomic and environmental effects of energy pricing reforms in Iran.
- Simulation outcomes indicate trade-offs: carbon pricing decreases emissions but incurs short-term welfare and growth expenses.
- Gradual price modifications, investments in renewable energy, and specific subsidies are crucial for an equitable and sustainable energy transition.

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1. Introduction

Iran is at a pivotal juncture in its energy policy. Endowed with some of the globe's most substantial reserves of oil and natural gas, the nation has traditionally relied significantly on these resources to fuel its economy. In 2023, Iran produced approximately 4,662 thousand barrels of oil daily and 247.7 billion cubic meters of natural gas annually. Electricity generation, an essential aspect of Iran's infrastructure, is primarily dependent on fossil fuels, with natural gas constituting approximately 84% of the energy mix, oil 7%, and renewables a mere 1.05%, while the remainder is sourced from hydropower and coal (BP, 2023). In contrast to coal and oil, the cleaner-burning natural gas maintains a stronger position as a transitional fuel towards cleaner energy sources. This has catalyzed a heightened interest among oil companies in exploring potential conventional and unconventional natural gas formations in previously neglected areas of the world (Ramu & Tourangbam, 2021).

Notwithstanding its substantial fossil fuel reserves, Iran is under increasing pressure to diversify its energy portfolio towards renewable sources. The nation's energy intensity is among the highest worldwide, and its massively subsidized fossil fuel prices have resulted in inefficient usage and increased environmental deterioration (IEA, 2022). Iran is significantly susceptible to the detrimental impacts of climate change, such as increasing temperatures, severe droughts, and water scarcity, which jeopardize agriculture, public health, and long-term economic stability (UNDP, 2021). Shifting to renewable energy is both a climate obligation and an economic requirement to guarantee sustained energy security and resilience amid dwindling natural gas reserves and global decarbonization obligations. Furthermore, the global shift towards carbon neutrality has heightened the geopolitical risks associated with sustaining an oil- and gas-dependent economy (BP, 2023). Despite its considerable solar and wind potential, renewable energy in Iran remains significantly underexploited. In 2023, renewable sources (excluding hydropower) constituted less than 1.1% of total electricity generation (SATBA, 2023). A systematic yet calculated augmentation of renewable energy's proportion could mitigate fiscal pressures from energy subsidies, diminish air pollution in metropolitan areas, and foster employment in sustainable sectors. Research indicates that a slight rise in the proportion of renewable electricity may produce significant macroeconomic and environmental advantages via enhanced energy efficiency, diminished emissions, and heightened sectoral productivity (Farhadi et al., 2022). Therefore, evaluating the economic implications of renewable energy integration becomes critical for Iran’s energy and environmental planning a gap this study aims to address through a Computable General Equilibrium framework.

The computable General Equilibrium (CGE) model is extensively employed to thoroughly assess the impacts of diverse policies. In the domain of energy and environmental economics, various enhanced CGE models are extensively utilized (Jia & Lin, 2022). In this context, the central government has significantly enhanced its carbon mitigation policies and established the “1 + N” policy framework. Achieving dual-carbon objectives necessitates the advancement of low-carbon energy transformation nationally and significant decarbonization at the subregional level. Inspired by the aspirations of national leaders, subregional governments have established their own dual carbon objectives and formulated action plans to mitigate carbon emissions (He et al., 2024) The increasing global focus on transitioning to a low-carbon economy, primarily aimed at reducing greenhouse gas emissions and alleviating global warming, has redirected electricity generation towards renewable energy sources. The shift from fossil fuel-based electricity generation to renewable energy is frequently subsidized globally (Ríos-Ocampo et al., 2021).

This study seeks to deliver a comprehensive evaluation of the effects of these developments on Iran's economic framework, employing a Computable General Equilibrium (CGE) model. This analysis centers on two policy scenarios: a rise in natural gas prices and a concurrent increase in fossil fuel-based electricity prices alongside a reduction in renewable electricity prices. These scenarios aim to capture intersectoral spillover effects while accurately reflecting the Iranian economy's potential response to energy price reforms. Critical indicators including economic growth, fluctuations in relative sectoral prices, net trade balance, variations in sectoral output, and greenhouse gas emissions are analyzed as target variables. This issue is significant because Iran's energy subsidy framework and the disparity in pricing between fossil fuels and renewables have resulted in considerable inefficiencies in resource distribution and present a major obstacle to fulfilling sustainable development objectives and the nation's international decarbonization obligations. Despite the growing momentum toward energy transition worldwide, Iran's unique economic and political conditions including extensive energy subsidies, high energy intensity, and international sanctions present a complex environment for implementing carbon pricing and subsidy reforms. These domestic constraints necessitate the design of customized policy scenarios that realistically reflect the country's institutional capacities and socio-economic sensitivities. This study seeks to examine the effects of bringing domestic prices, fossil-based power, and renewable electricity in line with global benchmarks for economic growth, foreign trade, relative prices, output, and environmental impact within the framework of Iran's economy. The CGE model is employed to analyze the systematic effects of variations in natural gas and renewable energy prices on macroeconomic variables. The essay highlights the lack of extensive, Iran-focused research utilizing CGE models to assess the simultaneous economic and environmental impacts of energy pricing reforms, particularly across different sectors and over the long term. Progression of documents This provides a dynamic CGE-based comparison study of two policy scenarios, yielding sector-specific, long-term insights into economic-environmental trade-offs and presenting policy suggestions for Iran's sustainable energy transition.This article is organized to methodically tackle the research question. Following the introduction and literature review, Section 3 outlines the theoretical framework. Following this, model estimation is performed, and

Section 5 presents the final observations. The study seeks to elucidate a more nuanced representation of the equilibrium between economic and environmental objectives within Iran's energy policy framework.

2. Literature Review

Recent years have seen significant study focused on the macroeconomic and environmental impacts of energy pricing reforms and decarbonization efforts. The results continuously highlight the importance of energy pricing in influencing inflation dynamics, production expenses, sectoral competitiveness, and household well-being. Numerous studies underscore the significance of carbon pricing and the elimination of subsidies as mechanisms to enhance economic efficiency and mitigate emissions; however, some also draw attention to the distributional consequences and inflationary pressures that these reforms may incite, especially in economies reliant on energy-intensive or fossil fuel sources. An increasing volume of work has examined the impact of renewable energy expansion on enhancing well-being, decreasing carbon intensity, and diversifying the energy portfolio. Moreover, new modeling initiatives have commenced the examination of the interrelationship of fossil fuel markets, electricity pricing, and carbon emissions trading systems, especially in the context of climate-related uncertainty. Notwithstanding these significant contributions, a considerable research gap persists in quantifying the concurrent effects of fossil fuel and renewable energy price fluctuations on essential macroeconomic indicators, particularly in middle-income nations such as Iran, which possesses a distinctive energy subsidy framework and elevated carbon intensity. Many current studies examine energy types in isolation or focus on static policy changes, neglecting the systemic interactions between fossil fuels and renewable electricity sources within a dynamic economic context. Furthermore, limited analyses use welfare and trade balance as combined outcome variables in conjunction with growth and emissions. This study establishes a scenario-based macroeconomic framework to examine the impacts of gas price reforms initially in isolation and subsequently alongside decreasing renewable electricity prices on essential economic and environmental metrics, such as household welfare, GDP growth, trade balance, and CO_2 emissions. This research simulates both targeted and complementary energy pricing reforms to provide a comprehensive and policy-relevant understanding of how concurrent changes in the electricity generation cost structure may affect economic performance and decarbonization outcomes in economies dependent on fossil fuels.

Mirzaei Khalilabad & Ahmadi (2016) utilized input-output analysis and price modeling to investigate the consequences of energy price fluctuations. Their findings suggest that aligning energy carrier prices with Persian Gulf FOB levels would result in a 47.65% rise in overall inflation. The fishing subsector within the agricultural sector will encounter the highest inflation rate at 62.89%, succeeded by forestry at 30.38%, livestock at 30.28%, and crop production at 7.76%.

Norani et al. (2022) analyze the influence of renewable and non-renewable energy consumption on economic welfare in Iran, revealing a positive correlation between economic welfare and factors such as per capita GDP, labor force, Gini index, and diverse energy sources, encompassing both renewable (solar, wind, hydro, and geothermal) and non-renewable (oil, gas, and gasoline) resources, in both the short and long term. Despite the considerable availability of non-renewable energy resources (oil and gas) in Iran and their inefficient utilization, the beneficial impact of renewable energy consumption on economic welfare indicates that a synergistic approach utilizing both renewable and non-renewable energy sources can improve overall societal welfare.

Jahangard et al. (2023), contend that an elevation in domestic natural gas prices, under certain assumptions, may enhance economic efficiency. Furthermore, export demand functions with higher elasticity correlate with elevated levels of welfare. The analysis concludes that the ideal domestic gas price for maximizing social welfare is 45% of the export price, which is substantially lower than the 65% benchmark established by Iran's Targeted Subsidy Law.

Gholami et al. (2023) contend that the scenario of increasing renewable energy while reducing energy produced from fossil fuels showed that welfare and GDP decreased by 3.17and 2.37 percent, respectively, and also that carbon emissions decreased by 10.89 percent in this scenario.

Arjmand et al. (2024) illustrate through a scenario-based modeling method for Canada's electrical sector that carbon pricing policies, especially those that reduce free emission allocations, can significantly decrease greenhouse gas emissions. The efficacy of these initiatives differs throughout provinces due to varying energy frameworks, underscoring the necessity for region-specific decarbonization approaches.

Weiwei et al. (2020), underscore a significant difficulty confronting China: enhancing the composition of its energy consumption. The results demonstrate that natural gas subsidies and carbon pricing regulations have positively influenced the augmentation of natural gas consumption and the optimization of the entire energy mix. The report offers policy recommendations to improve China's energy consumption structure, including strategic investment in the natural gas sector and decreasing the costs associated with transitioning between natural gas and alternative energy sources.

Li & Leung (2021), examine data from seven European nations spanning 1985 to 2018. Their findings demonstrate that fossil fuel prices, particularly coal and natural gas, significantly influence renewable energy demand. Specifically, escalating fossil fuel prices correlate with heightened utilization of renewable energy sources.

Böttger & Hartel (2022) illustrate in their article on wholesale electricity prices and market value within a carbon-neutral energy system that electricity prices display increased volatility in systems with a substantial proportion of renewable energy. The heightened price volatility may subsequently influence the income potential of renewable energy systems.

Huntington & Liddle (2022), examine data from 18 OECD nations spanning 1960 to 2016. Their findings demonstrate that a 10% rise in energy prices results in a 15% decline in economic growth, with the effect being more significant in industrialized and energy-dependent nations.

Liu et al. (2023), in their article on spillover effects among electricity prices, traditional energy prices, and the carbon market under climate risks, investigate the interrelationships between electricity prices, fossil fuel prices, and the carbon market amid climate-related uncertainties. Their findings indicate that increases in fossil fuel prices lead to higher electricity prices, which subsequently raise production and living costs.

Qi et al. (2023) perform a dynamic CGE study on feed-in tariffs and China's peak emission target to promote renewable energy. We examine the effects of carbon emissions trading systems (ETS) and feed-in tariffs (FIT) on China's electrical sector, carbon emission peak targets, renewable energy, and economic development using a dynamic computable general equilibrium (CGE) model. We evaluate policy overlap and integration and project strategies to align FIT and carbon ETS requirements for maximum efficacy. Generally, FIT subsidies exceed phasing-out scenarios. FIT enhances economic activity and government revenue, resulting in a fiscal burden that is less than its actual expenditure. Due to the multiplier effect of the FIT on government revenue and GDP growth, the ideal FIT should terminate in 2025, followed by subsidies in 2030 and 2035.

The International Energy Agency (IEA) (2022) study on the electricity market emphasizes that the global energy crisis has compelled numerous nations to prioritize power security and cost-effectiveness in their political agendas. Global power demand is projected to expand at an average annual rate of 3% over the next three years, with a notable rise in developing countries in Asia. The substantial expansion of renewable energy is anticipated to increase its proportion in the worldwide power generation mix from 29% in 2022 to 35% by 2025, whereas the contributions from coal- and gas-fired generation are forecast to diminish.

The International Energy Agency (IEA) report on natural gas markets (2024) states that almost 60% of the global surge in gas demand is ascribed to the Asian continent. In 2024, gas consumption in the Asia-Pacific area increased by about 5%, and compared to 2023, gas demand in Asia has surged by approximately 45%, mostly due to heightened utilization of gas in power generation. Moreover, owing to escalating demand from industrial and residential sectors, gas consumption is anticipated to rise by 3% in the gas-abundant economies of Africa and the Middle East.

Gao et al. (2024) investigate the global economic and ecological impacts of sustainable energy technology advancements under carbon reduction targets in their study focusing on 8 regions, 13 energy sectors, and 37 intermediary input sectors. Collectively, renewable energies exert a more significant impact than individual resources, with emerging sources such as wind and solar surpassing hydro and nuclear. Furthermore, advancements in alternative energy promote the synergistic integration of renewables with coal, gas, and other resources to optimize policy synergies and facilitate decarbonization.

Darandary et al. (2024), The reform of energy pricing has led to an annual decrease of around 8.8% in electricity use, generating multi-billion-dollar economic savings and reducing CO_2 emissions by an estimated 81 to 102 million tons.

Morão (2025), utilizes a Structural Vector Autoregression (SVAR) model to analyze the economic effects of carbon cap policies within the Euro Area. The results indicate that the post-2020 imposition of stricter emission limits has resulted in increased consumer prices, especially in the transportation and public utilities sectors. The research indicates that the macroeconomic impacts of the next phase of the EU Emissions Trading System (EU ETS) may have been undervalued, underscoring the necessity for more flexible and responsive climate policy formulation.

An analysis of the academic literature reveals gaps, indicating that prior studies have not thoroughly examined the specific relationships among the natural gas market, renewable energies, and electricity. The current models primarily concentrate on one of these domains, whereas systemic interactions have received insufficient attention. Numerous existing models and theoretical frameworks in the worldwide literature have been developed; however, there is a deficiency of research that tailors these models to the unique circumstances of Iran, including subsidies, sanctions, and the structure of the energy market. Limited research has examined the influence of Iran's subsidy policies on natural gas consumption, which is the primary source of power generation, and the advancement of renewable energy, despite these policies being pivotal in altering consumption patterns. This research introduces a model that accounts for the interconnections among the natural gas market, renewable energies, and electricity, so addressing the theoretical deficiency in interdisciplinary assessments and offering a more holistic perspective than the current literature. This research facilitates the development of a more appropriate theoretical framework for analyzing energy policy in Iran by localizing global models and adapting them to the nature of Iran's energy market.

3. Theoretical foundations

In the realm of a thorough examination of the economic impacts of carbon abatement strategies, Computable General Equilibrium (CGE) models are acknowledged as among the most extensively utilized and dependable instruments in energy and environmental economics. Computable General Equilibrium (CGE) models, based on Walrasian equilibrium theory, facilitate the analysis of inter-sectoral and inter-factor interactions within the economy, while concurrently evaluating the effects of diverse policies at both micro and macro levels. Carbon dioxide-induced environmental pollution can affect all macroeconomic and microeconomic variables through intersectoral linkages, economic considerations, and regional connections. This study utilizes a model characterized as an open economy with an international framework to assess the impacts of carbon abatement policies on trade balance, relative commodity prices, sectoral production variations, economic welfare, and economic growth. This database is calibrated with the Social Accounting Matrix (SAM) and includes CES production functions, LES preference consumption functions, and trade relations based on Armington substitution elasticity, facilitating dynamic analysis of producers, consumers, and government actions in the context of climate policy implementation. The multi-factor, multi-sector, and multi-region GTAP-E model has been employed for this purpose. This model is an augmented version of the general equilibrium GTAP model initially created by Hertel (1997). The GTAP model is a static framework. The behavioral activities and inter-sectoral and inter-regional exchanges comprise two primary components: accounting identities and behavioral equations. The accounting identities include data from the Social Accounting Matrix and input-output tables, whereas the behavioral equations depict the actions of economic players in production, consumption, saving, and regional investment. The GTAP model incorporates energy as a variable and accounts for carbon dioxide emissions from fossil fuels, enabling the evaluation of environmental measures; hence, this enhanced model is referred to as GTAP-E. The GTAP-E model (Fig. 1) employs a tiered production framework that facilitates energy substitution and emission analysis; our research concentrates on a specific configuration of that framework.

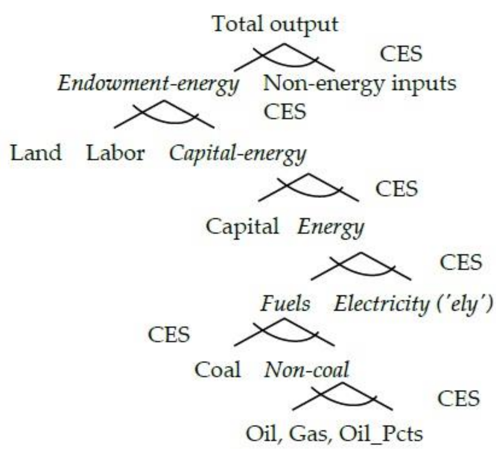

Figure 1. A form of the production structure in the GTAP-E model
Source: *Burniaux & Truong2002*

This paper analyzes the configuration of electricity generation as depicted in the GTAP-E-Power and GTAP-E-Power S models, which enhance the conventional GTAP framework by integrating intricate dynamics of the power sector.

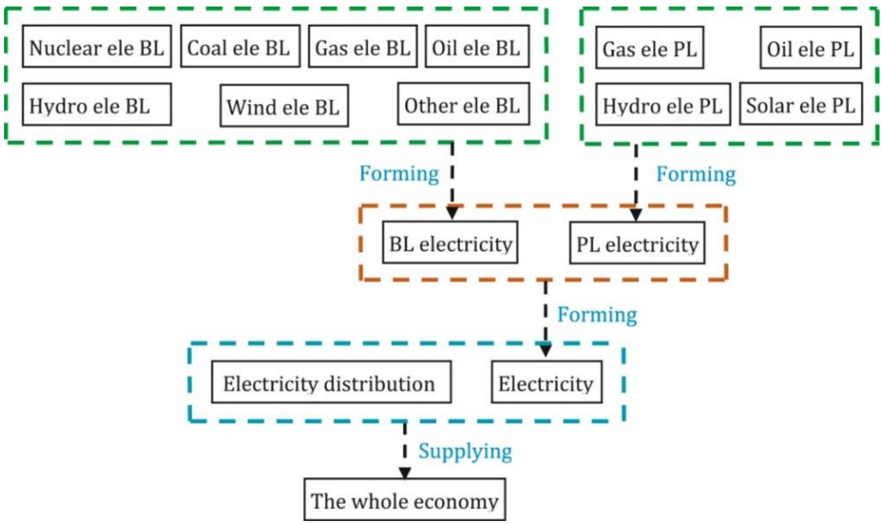

Figure 2. The electricity generation structure in the GTAP-E-Power and GTAP-E-Power S models
Source: *Nong,2020*

The production block comprises input decisions and output distributions. The ideal input decision is dictated by the principle of cost minimization, employing the Constant Elasticity of Substitution (CES) function to illustrate incomplete substitution. The allocation of output between local and export markets is governed by the principle of profit maximization, employing the Constant Elasticity of Transformation (CET) function.

$$Y1 = A1[\delta_1(A1_1X1_1)^\rho + \delta_2(A1_2X1_2)^\rho]^{\frac{1}{\rho}} \quad (1)$$

$$X1_1 = \left(\frac{A1^\rho \delta_1 P1Y1}{P1_1}\right)^{\nu/(1-\rho)} Y1 \quad (2)$$

$$X1_2 = \left(\frac{A1^\rho \delta_2 P1Y1}{P1_2}\right)^{V(1-\rho)} Y1 \quad (3)$$

Where is the $Y1$ output? $X1_1$ and $X1_2$ represent two input factors, whereas δ_1 andδ_2 denote the respective shares of these input factors, satisfying the equation $\delta_1 + \delta_2 = 1$. $P1_1$ and $P1_2$ represent the prices of two inputs. $P1_1$represents the mean price of two inputs. $A1$, $A1_1$, and $A1_2$ are coefficients of technical advancement. When ρ∈ (∞,0) ∪ (0,1), Equation (1) represents the usual form of the CES function. When ρ > 1, Equation (1) represents a CET function.

Equations (2) and (3) illustrate the production relationship established by the CES production function and the demand functions for the two inputs. The Leontief production function is utilized at the highest level to define the input relationships between energy, primary factor composite products, and non-energy intermediate inputs (Liu,2023).

In the second layer, the CES function demonstrates the interconnections among energy, capital composites, labor, and land. At the tertiary level of classification, energy items are divided into electric and non-electric categories. On-electric energy includes coal composites, oil composites, and natural gas composites, while electric energy consists of various sectors such as coal power, gas power, nuclear power, hydroelectric power, wind power, solar power, biomass power, and electricity transmission and distribution. The CES function is utilized to incorporate coal composites, petroleum composites, and natural gas composites inside the hierarchical structure of non-electric energy. The electric sector is primarily categorized into power generation and transmission and distribution sectors. The Leontief production function is employed to delineate their substitution relationship, assuming a constant ratio between power generation and delivery. In the second nesting, electricity composites consist of the primary power supply and the auxiliary power supply, which are integrated using the CES function. An imperfect substitution relationship is assumed at the basic level, employing the CES function to define the substitution dynamics among coal, gas, hydroelectric, and nuclear power sources.

The energy-environment block offers a comprehensive analysis of the correlation between producers' economic activity and the emissions of CO2 and pollutants, alongside the influence of energy and environmental laws on costs. The model establishes a linear relationship between the value and amount of energy inputs in the production sector. This section addresses the expenses incurred by producers due to energy and environmental legislation, and how these expenses influence production decisions and costs. The quantity of carbon and pollutant emissions produced by burning is contingent upon fluctuations in energy consumption within the primary sectors of economic activity. These emissions will be modified in accordance with alterations in energy consumption in industrial production and home uses. The release of waste gas and wastewater is associated with the production of the emissions sector. The precise steps are as follows:

$$\mathrm{PG}_{n,u.c,s} = a_{n,u,es} \times \mathrm{DE}_{u.c,s} \tag{4}$$

$$\mathrm{PE}_{g,i} = b_{g,i} \times Q_i \tag{5}$$

$$\mathrm{PW}_{\mathrm{w,u}} = c_{\mathrm{w,u}} \times Q_{\mathrm{u}} \tag{6}$$

where n signifies the emission of carbon dioxide and waste gases, including SO2 and NOx. u represents users, encompassing 159 industries i and a singular household type h.e represents several, including coal, refined oil, natural gas, coke, and oil and gas. s represents sources, encompassing both domestic and imported products. w represents wastewater, encompassing NH3 and COD. $PG_{n,u.c,s}$ is the emission n produced through the utilization of energy e from source s by user u, $DE_{u.c,s}$ represents the energy demand of user u , $a_{n,u,es}$ signifies combustion emission coefficient for user u , $PE_{g,i}$ is the process emission of waste gas g generated by industry i , $b_{g,i}$ is the process emission coefficient, and Q_i denotes the output of industry, i. $PW_{w,u}$ is the wastewater discharge of user u , $c_{w,u}$ is the wastewater process emission coefficient of user u , and Q_u signifies the output and consumption of industry i and resident h. In the context of taxation or carbon trading, the emission resulting from a company's production will be seen as a component of its production costs. A virtual consumption tax is employed in our model to replicate this cost component. The policy cost will influence the producer's price level and therefore effect customer behavior at the product level. The prices format is as follows:

$$P1_{c,s,t} = \left(1 + t_{cs,t}\right) * P0_{cs} \tag{7}$$

where $P1_{c,s,t}$ denotes the cost incurred by of industry i for acquiring commodity c from source s ,while $P0_{cs}$ represents the price of commodity obtained sourced from s . $t_{cs,t}$ is the tax rate employed by industry i uses for commodity c obtained from sourced s, encompassing the carbon tax rate.

A critical aspect of CGE model design is selecting a suitable closure in accordance with the research topic. The essential aspect of establishing closure is the selection of suitable endogenous variables, ensuring their quantity matches the number of equations, hence facilitating the model's resolution. The determination of exogenous and endogenous variables is grounded in the relevant macroeconomic theory. The Keynesian macro closure is appropriate for short-term simulations. In the context of macroeconomic depression, labor is extensively unemployed, while capital remains unutilized. Consequently, the availability of manufacturing elements, labor and capital, remains unimpeded. Owing to price stickiness, the real pay remains constant in the near run; nevertheless, labor can transition freely between industries, with total employment being endogenous and solely controlled by demand. In sectors influenced by market conditions, investment fluctuates in accordance with the rate of capital return. The overall return rate is ascertained by capital rental and investment product valuations. The formula for the current investment return rate is as follows:

$$\mathrm{RORC}_t = \mathrm{GERT}_t - \mathrm{DEP}_t = \frac{\mathrm{P1CAP}_t}{\mathrm{P2TOT}_t} - \mathrm{DEP}_t \tag{8}$$

RORC_t represents the current net investment return rate of industry i ; GERT_t , denotes the total return rate, and DEP_t signifies the depreciation rate. $\mathrm{P1CAP}_t$ denotes the capital rent, while $\mathrm{P2TOT}_t$ represents the investment product price.

Neoclassical macroeconomic closure is appropriate for long-term simulation. All prices, encompassing factor prices and commodity prices, are entirely elastic and determined endogenously by the model. The current supply of factors, including labor and capital, is completely used. In the simulation, the factor price is endogenous, the factor endowment is exogenous, and unemployment is absent. In the long-run closure, industrial investment is influenced by the market and fluctuates with capital stock. Capital can be converted into production capacity, rendering it variable; the rate of return remains constant (with rent and costs changing proportionately), the capital growth rate is fixed (as per Eq. (9)), the anticipated return rate across industries is uniform, and investment in each industry fluctuates in accordance with changes in industry capital stock. The equation is stated as follows:

$$X2\mathrm{TOT}_t = X1\mathrm{CAP}_t \times \overline{\mathrm{GGRO}_t} \qquad (9)$$

where $X2\mathrm{TOT}_t$ is the amount of investment of industry $i; X1CAP_t$ is the capital stock, GGRO_t is the capital growth rate.(Liu,2025)

3.1 Data Description and Sources:

The standard model is static (single-period) or involves one or more countries with fixed factors of production. The GTAP (Global Trade Analysis Project) model is a multi-regional, static model with a Version 11 database, including a social accounting matrix for 161 countries and 76 sectors. The GTAP model's theoretical foundation is similar to other multi-regional CGE models. The system of equations of this model includes two types of equations: accounting relationships, ensuring that the income and cost of each economic agent are equilibrium equations and behaviors, based on micro -economic theory and describing the optimization behavior of agents such as companies and consumers (Brockmeier, 2001). Hertel presented this model (1997). This study employs a multi-regional model encompassing Iran, the BRICS nations, and additional countries. The utilized database is the GTAP-Power edition, which offers specific information pertaining to the energy sector, including renewable electricity, fossil fuel-based electricity, and natural gas. This study investigates the macroeconomic effects of natural gas price increases on five critical sectors of the Iranian economy agriculture, industry, services, renewable electricity, and fossil-based electricity within the context of price-based policy instruments for decarbonization. The primary aim is to evaluate the impact of a rise in natural gas prices on essential economic factors, such as carbon emissions, social welfare, net trade balance, and economic growth. The preliminary raw data included in this investigation are globally comprehensive.

Table 1. The electricity generation structure in the GTAP-E-Power and GTAP-E-Power S models.

Factors of production	Sections	Regions
Natural resources	Agriculture	Iran
Capital	Services	BRICS nations
Land	Base-load renewable energy	Additional countries
Skilled labor	Base-load fossil-fueled energy	
Unskilled labor	Various industrial sectors	

Source: *Research calculations*

Considering the structural attributes of Computable General Equilibrium (CGE) models, it is essential to incorporate the global context to provide dependable and thorough results. British Petroleum Energy Outlook 2024 Summary (Decarbonization Policies and Energy Mix by 2050): Power: Shift to wind, solar, nuclear, and hydrogen with CCUS1, especially in emerging economies (net zero carbon emissions). Strengthen grid resilience. Industry: Electrify processes, adopt low-carbon hydrogen, CCUS, and efficiency measures, with stronger Net Zero policies post-2035. Transport: Promote EV adoption, charging infrastructure, and hydrogen/biofuels for aviation/marine in Net Zero. Buildings: Enforce efficiency standards, electrify heating, and use solar thermal in emerging economies. CCUS: Scale up with incentives for industry, power, and carbon removal, critical in Net Zero. Hydrogen: Subsidize low-carbon hydrogen for hard-to-electrify sectors, focusing on regional markets. Investment/Minerals: Boost renewable investments and secure minerals such as lithium, cobalt, nickel, graphite and copper. Nevertheless, the fundamental analytical emphasis continues to be on the Iranian economy. This study assesses the direct impacts of rising natural gas prices, both as a primary energy source and as fuel for electricity generation, while also examining a series of prospective price scenarios: a 25% increase in fossil-based electricity prices by 2030 and a 50% increase by 2050, coupled with a 20% decrease in renewable electricity prices by 2030 and a 30% decrease by 2050. The analysis evaluates the impact of these adjustments on the specified economic variables within the framework of the five principal economic sectors. Data and statistics were sourced from different authoritative entities, including the GTAP database, Iran’s national energy balance sheets, and international energy databases, to guarantee the robustness and precision of the modeling framework.

3.2 Methodology

This study is an applied-analytical research endeavor aimed at assessing the impact of decarbonization measures on Iran's macroeconomic variables. The Computable General Equilibrium (CGE) model has been utilized to attain this

[1] Carbon Capture, Utilization, and Storage

objective, serving as a tool in economic and environmental policy evaluations. The model's architecture is grounded in the essential structure of general equilibrium systems, incorporating the optimization behavior of companies and families, factor substitution, market equilibrium, and intersectoral interactions. The constructed model encompasses the primary sectors of the Iranian economy, including agriculture, industry, services, and energy (both fossil and renewable electricity). Within this framework, the factors of production comprise capital, land, skilled labor, unskilled labor, and natural resources, while the production functions are articulated as CES with defined substitution elasticities. The model is intended to facilitate the analysis of the economic system's reaction to price fluctuations in the energy market, the enactment of environmental policies, and alterations in the energy consumption framework. The data utilized in this research were sourced from the Gtab database, the energy balance of Iran, and the energy balance provided by the International Energy Agency (IEA). This study is applied-analytical in nature and aims to assess the impact of decarbonization initiatives on Iran's macroeconomic variables.

This study used a Recursive Dynamic Computable General Equilibrium (CGE) model to assess the dynamic implications of energy pricing reform measures in Iran. This modeling method facilitates the evaluation of intertemporal dynamics without necessitating intertemporal optimization. The long-term effects of policy scenarios on macroeconomic variables, including output, employment, trade, prices, and carbon emissions, are assessed by presuming incremental market adjustments in each period. The model framework is predicated on the essential architecture of general equilibrium systems, encompassing the optimization behaviors of enterprises and households, the substitution among production factors, market equilibrium, and the interactions among various economic sectors. The constructed model encompasses the primary sectors of the Iranian economy, including agriculture, industry, services, and energy (both fossil and renewable electricity). Within this framework, the factors of production encompass capital, land, skilled labor, unskilled labor, and natural resources, while the production functions are articulated as CES with defined replacement elasticities. The model facilitates the analysis of the economic system's reaction to price fluctuations in the energy market, the enforcement of environmental rules, and alterations in the energy consumption framework. The data utilized in this study were sourced from the Gtab database, the energy balance of Iran, and the energy balance of the International Energy Agency (IEA). The calibration process is conducted using the social accounting matrix, relative prices, and technical factors to ensure the model's internal compatibility with Iran's economic reality.

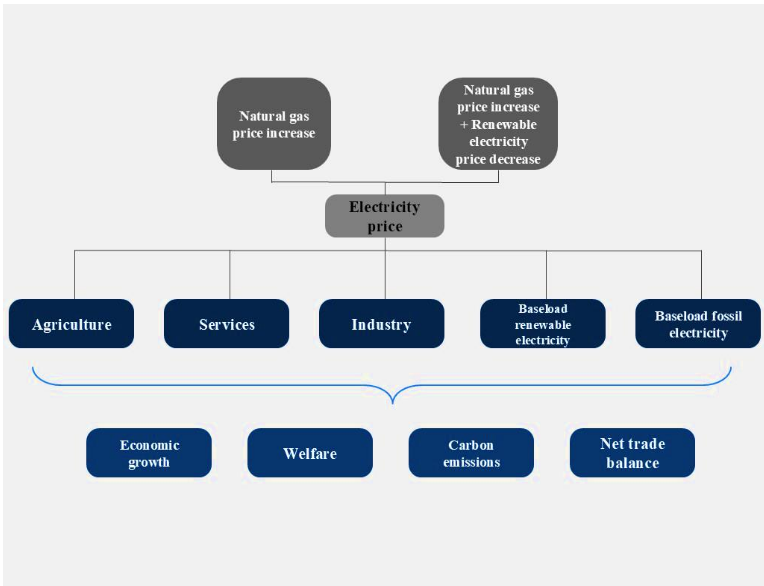

Figure 3. The phases and procedures of operation in this model
Source: *Research finding*

4. Empirical Results

This section analyzes the impact of price fluctuations in the markets for natural gas, fossil-based power, and renewable electricity on Iran's principal macroeconomic variables. The methodological framework uses Computable General Equilibrium (CGE) models to study the effects of price fluctuations by implementing various policy scenarios.

4.1 Scenario 1

This scenario assesses the concurrent effects of a 50% rise in the domestic price of natural gas by 2030 and a 100% rise by 2050 on specific macroeconomic variables. The analysis concentrates on five principal economic sectors: agriculture, services, base-load renewable energy, base-load fossil-fueled energy, and various industrial sectors.

Figure 4 depicts the effects of natural gas price fluctuations on Iran's economic welfare (EV) from 2025 to 2050.

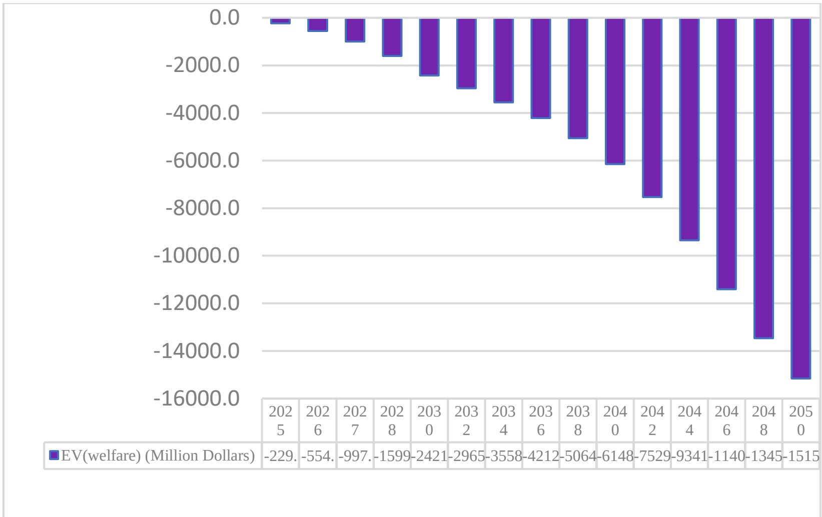

Figure 4. Effect of natural gas price shock on Iran's economic welfare (Equivalent Variation, EV) from 2025 to 2050
***Source:** Research finding*

Equivalent Variation (EV) in Computable General Equilibrium (CGE) models denotes the monetary value of welfare change resulting from a policy shock, quantified as the disparity between the initial and post-shock utility levels. A more adverse EV signifies a more substantial deterioration in welfare. The escalation of natural gas prices, a vital component in energy production and consumption, affects wellbeing through two main avenues: elevated production costs and heightened consumer prices. During the initial period (2025–2030), the welfare loss is comparatively moderate, fluctuating between around -230 million USD and nearly -3,000 million USD. This decrease is chiefly attributable to escalating living expenses, a loss in real wages, and a surge in the prices of energy-intensive commodities and services. In the second phase (2030–2040), the welfare loss intensifies, exceeding -6,000 million USD by 2040. The aggregate impact of the natural gas price shock becomes increasingly evident throughout the economy. Fossil-based electricity generation, energy-intensive enterprises, and energy-dependent services, particularly those associated with transportation, endure the most substantial declines in welfare. The insufficient swift transition to renewable energy sources as an alternative intensifies the welfare recession. During the third era (2040–2050), the decline in welfare intensifies, ultimately culminating in approximately -15,500 million USD by 2050. During this phase, the complete execution of the 100% price shock, coupled with a persistent escalation in gas prices, results in a significant increase in energy expenses. Notwithstanding the growth of renewable electricity generation, complete replacement of natural gas remains unfeasible. As a result, the ensuing negative effects, including a marked decrease in real household income, rising prices of final products, and ongoing structural inflation, contribute to a pronounced fall in overall welfare.

Figure 5 depicts the effect of Scenario 1 on carbon emissions across several economic sectors in Iran from 2025 to 2050.

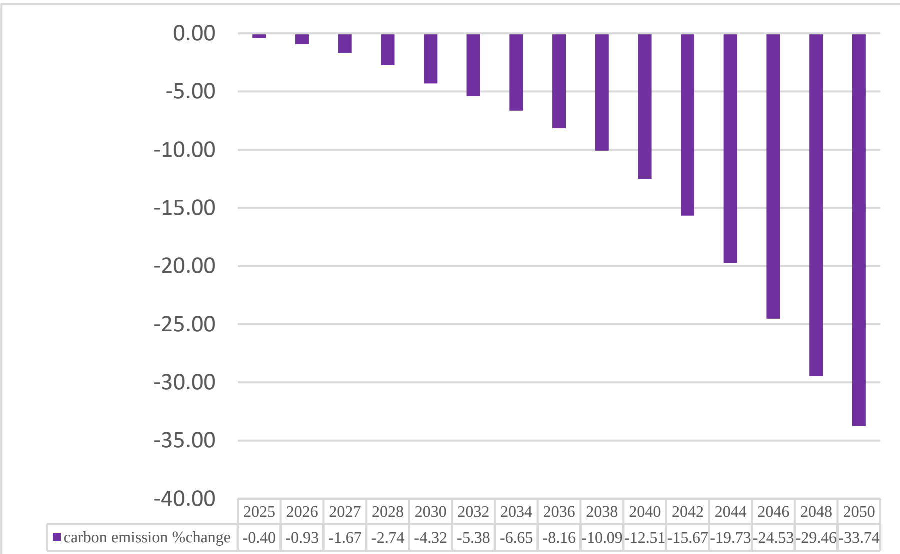

Figure 5. Effect of Natural Gas Price Shock on Carbon Emissions in Iran, 2025–2050
Source: *Research finding*

The natural gas price surge (a 50% increase by 2030 and 100% by 2050) has both direct and indirect impacts on mitigating greenhouse gas emissions via pricing mechanisms, input substitution, and reduced fossil fuel usage. Figure 3 illustrates that the cumulative decline in CO_2 emissions intensifies over time, commencing with a reduction of less than 1% in 2025 and culminating in a reduction over 33% by 2050. The pace of change post-2030 markedly intensifies, signifying an increasing trend in emission reduction.

Figure 6 depicts the study of the initial scenario and emphasizes the dynamic alterations that could result in resource reallocation, structural modifications in production, and subsequently, changes in the net trade balance among various economic sectors.

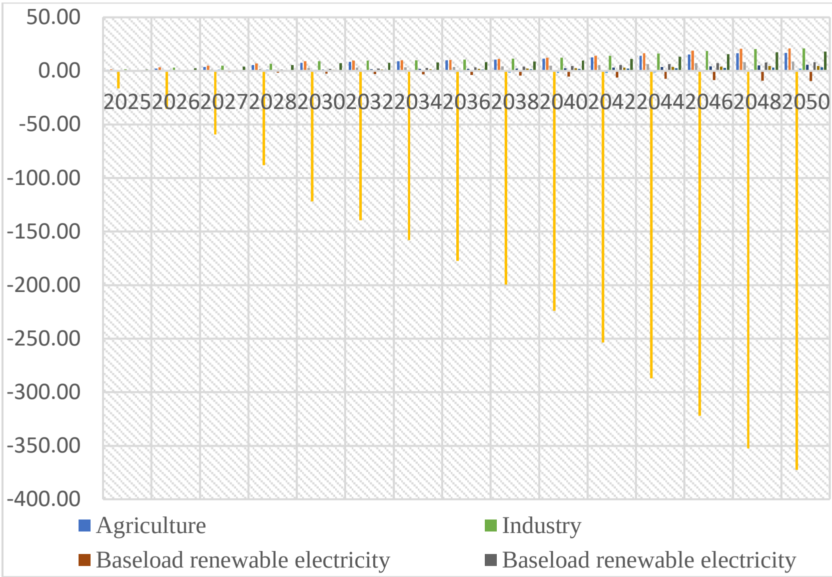

Figure 6. Effect of the Natural Gas Price Shock (50% Increase by 2030 and 100% by 2050) on Iran's Net Trade Balance
Source: *Research finding*

Figure 6 shows the net trade balance in the agriculture sector has an upward trajectory from 2025 to 2050, increasing from USD 1.06 billion in 2025 to USD 16.91 billion in 2050. The increase in energy prices results in elevated production costs for energy-intensive industries, thus augmenting the comparative advantage and international competitiveness of agriculture. With rising industrial costs, resources including capital and manpower are redirected to the agricultural sector, leading to an increased surplus production for export. The result indicates a consistent enhancement in the net trade balance of the industrial sector, rising from USD 1.52 billion in 2025 to USD 21.09 billion in 2050. This sector encompasses industries that, although not directly reliant on natural gas, get advantages from energy optimization, technological advancements, and resource reallocation. The persistent improvement in trade balance signifies that these industries have effectively adjusted their production frameworks in reaction to fluctuations in energy prices. Investment in energy-efficient technologies and improved productivity have sustained and even bolstered their competitive standing in global markets. The renewable base-load electricity market is projected to experience a steady rise from USD 0.15 billion in 2025 to USD 4.64 billion by 2050. As natural gas prices escalate, fossil-fuel electricity becomes costlier, enhancing the comparative benefit of renewable energy. Favorable policies and enhanced economic appeal have stimulated investment in renewable energy, resulting in a gradual growth in their export potential. The fossil-based electricity sector exhibits a continuous negative trend in its net trade balance, decreasing from USD 0.18 billion in 2025 to USD -0.32 billion in 2050. The sector's significant dependence on natural gas renders it susceptible to escalating fuel expenses, thus undermining its competitiveness in global markets. Notwithstanding elevated electricity prices, the diminished cost-effectiveness of this sector has resulted in a contraction in export capacity and a decline in trade performance. Moreover, enduring carbon reduction initiatives and the worldwide transition to clean energy have intensified these issues. Simultaneously, the services sector demonstrates a strong and continuous increase in its net trade balance, rising from USD 1.29 billion in 2025 to USD 18.06 billion in 2050. The sector benefits from resource reallocation and structural modifications due to its reduced susceptibility to natural gas price spikes. The widening trade balance indicates improvements in productivity, the exportation of knowledge-intensive, financial, consulting, and engineering services, as well as a strengthened presence in international markets. Within a resilient economy, the services sector appears as a prospective catalyst for growth, supplanting energy-intensive industries, a transition distinctly reflected in the empirical findings.

Figure 7 depicts the effect of a natural gas price shock (a 50% increase by 2030 and 100% by 2050) on the percentage variation in Gross Domestic Product (GDP). The findings indicate a continual and escalating adverse impact of increasing natural gas costs on economic growth. In 2025, the effect is negligible at roughly -0.03%, but this reduction gradually intensifies, culminating in -3.57% by 2050. The data indicate that the gas price shock exerts a cumulative and structural influence on the economy, with its negative impacts intensifying with time. The adverse effects of natural gas price fluctuations on GDP can be elucidated through many economic methods. Initially, escalating gas prices elevate production expenses in gas-dependent industries such as petrochemicals, cement, steel, and power generation, where natural gas serves as either feedstock or fuel. Secondly, the expense of fossil-fuel-based electricity significantly increases due to the major dependence of thermal power plants on natural gas. Third, spillover effects impact the services, transport, and agriculture sectors due to elevated final costs for products and services, which diminish both intermediate and final consumption. Moreover, investment diminishes in impacted industries, prompted by anticipations of escalating operational expenses and diminished profitability. Ultimately, aggregate demand diminishes when households suffer a decline in purchasing power resulting from escalating energy and consumer prices.

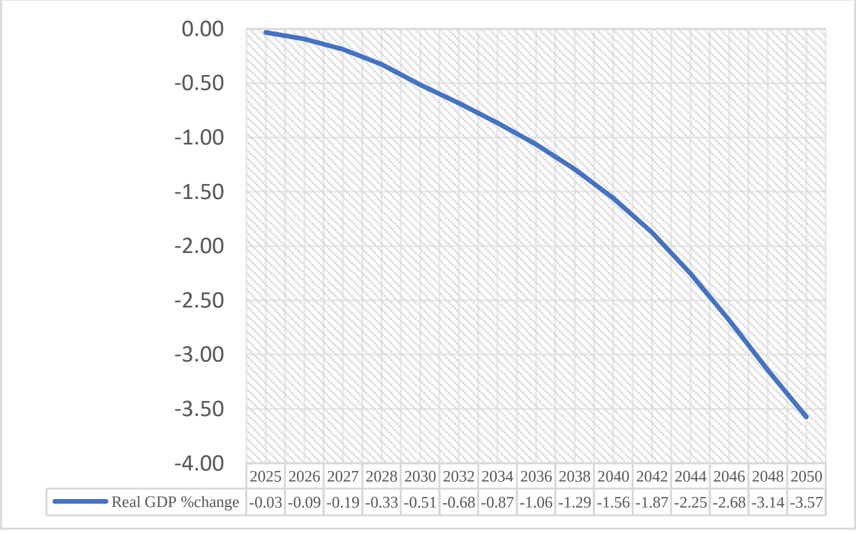

Figure 7. illustrates the effect of a natural gas price shock (a 50% increase by 2030 and a 100% increase by 2050) on the percentage variation in Gross Domestic Product (GDP).
Source: *Research finding*

4.2 Scenario 2

This scenario analyzes the economic consequences of a 25% rise in fossil-based power prices by 2030 and a 50% rise by 2050, alongside a 20% reduction in renewable electricity prices by 2030 and a 30% reduction by 2050. The analysis concentrates on five principal areas: agriculture, services, baseload renewable energy, baseload fossil energy, and various industrial sectors.

Figure 8 indicates that, with a 25% rise in fossil power prices by 2030 and a 50% rise by 2050, alongside a concurrent 20% and 30% decrease in renewable electricity prices during the same intervals, economic welfare in Iran exhibits a declining trajectory.

Figure 8. illustrates the effect of executing Scenario 2 on Iran's economic welfare
Source: *Research finding*

Figure 8 demonstrates that the escalation of fossil fuel electricity prices immediately elevates production expenses in the agricultural sector, especially in energy-intensive processes like greenhouse management, water pumping, and crop processing. This increase in costs results in diminished production and, thus, a decrease in farmers' revenue. The elevated energy intensity and comparatively low energy efficiency of agriculture in Iran result in a more significant welfare loss in this sector than in others. In energy-intensive sectors like steel, cement, and petrochemicals, elevated fossil electricity prices escalate manufacturing costs, thereby diminishing export competitiveness, profitability, and ultimately, output. As output and profitability diminish, new investments decrease and employment levels suffer, leading to a deterioration in household wellbeing. The reduction in renewable electricity costs partially enables the replacement of clean energy for fossil fuels. Although this may mitigate certain welfare losses in the long term, its immediate impact is constrained by the now minimal proportion of renewables in Iran's energy composition. The data indicates that the prevailing tendency continues to reflect a net welfare decrease. By 2030, fossil fuels (natural gas and diesel) will continue to dominate energy generation in Iran. Consequently, increasing fossil fuel electricity prices augment both production and consumer expenses. Industries, agriculture, and service sectors reliant on inexpensive fossil-fuel electricity face considerable short-term welfare declines. The service sector is indirectly impacted by increasing input costs in upstream industries. Rising production and transportation expenses result in elevated economic prices, eroding customers' purchasing power and decreasing demand for services, thereby adversely affecting welfare in this sector.

Figure 9 demonstrates that the percentage change in carbon emissions, due to rising fossil power prices and falling renewable electricity prices until 2050, shows a steady and gradual reduction over time. By 2050, emissions are anticipated to diminish by roughly 4.6%.

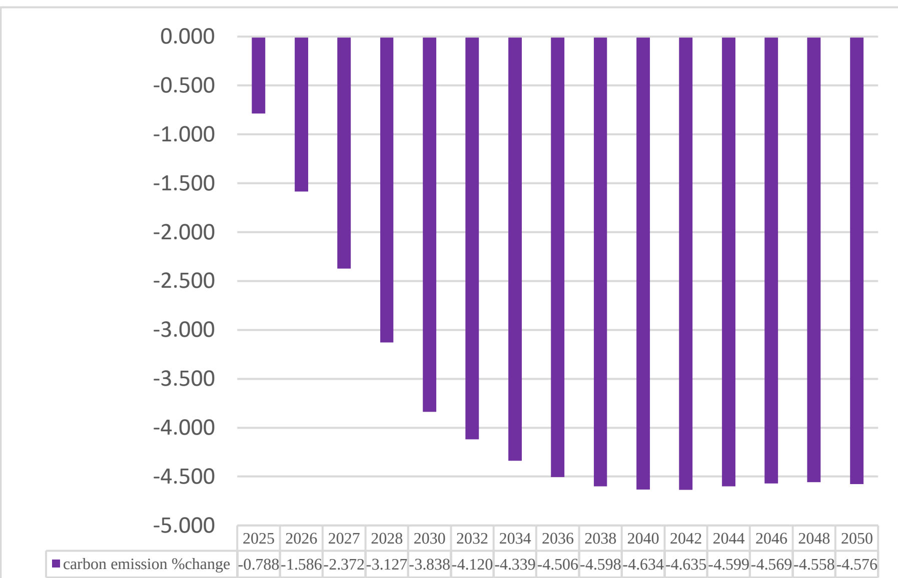

Figure 9. The Effect of Scenario 2 on Carbon Emissions in Iran
Source: *Research finding*

The agriculture sector's risk to the implemented scenario is rather minimal, chiefly due to the growing dependence on solar energy and clean-powered irrigation systems in modern agricultural technology. Furthermore, the incremental decrease in fossil fuel utilization in agricultural gear aids in reducing emissions. Nonetheless, considering that agriculture is a low energy-intensive sector, its contribution to global carbon mitigation remains limited. Conversely, energy-intensive industrial sectors, including cement, steel, and petrochemicals, are anticipated to experience structural energy optimization and technical transformation owing to the escalating costs of fossil-based power and incentives to migrate to renewable energy sources. This transition will yield significant reductions in greenhouse gas emissions. The impact might be significantly enhanced if bolstered by supplementary carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, positioning industry as a principal contributor to overall carbon reduction. The reduction in renewable energy costs is anticipated to encourage investment and capacity growth in base-load renewable electricity. Electricity production from solar, wind, and geothermal sources generates minimal to no carbon emissions, directly facilitating the projected 4.5% decrease in emissions by 2050. Regarding base-load fossil electricity, although this sector is the predominant producer of carbon emissions, the price surge resulting from elevated fossil-based electricity costs induces a significant decline in demand, so indirectly aiding in emission reduction.

Figure 10 Effects of Increases in Fossil Electricity Prices and Decreases in Renewable Electricity Prices on Net Trade Balance. In the short term, the agriculture industry gains from reduced renewable electricity prices, particularly in areas where the deployment of clean energy is viable. In the long term, if fossil electricity prices consistently increase, agricultural sub-sectors dependent on fossil-based electricity, such as diesel engines and industrial refrigeration utilized in export logistics, would encounter rising production costs. This undermines their competitiveness relative to nations that move more rapidly to renewable energy, ultimately resulting in a decrease in agricultural exports. A modest rise in net exports is noted in the industrial sector until roughly 2032, after which a slow decrease occurs, culminating in an approximate decline of –8% by 2050. Energy-intensive sectors such as basic metals, cement, ceramics, and chemicals are significantly impacted due to their substantial reliance on fossil fuel-based energy. The escalating expenses of fossil-derived inputs diminish international competitiveness, compress profit margins, and limit production, thereby undermining the trade performance of these sectors over time.

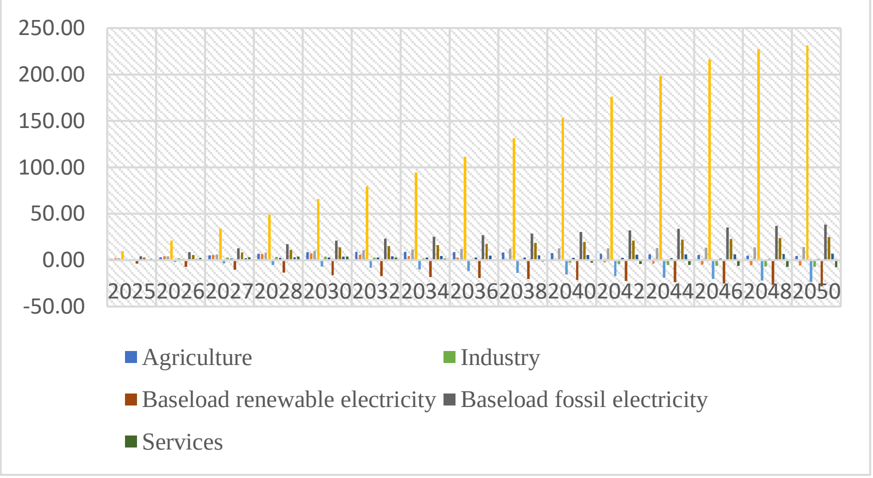

Figure 10. Effect of a 25% Rise in Fossil Electricity Prices by 2030 and 50% by 2050, Coupled with a 20% Reduction in Renewable Electricity Prices by 2030 and 30% by 2050, on Iran's Net Trade Balance
Source: *Research finding*

The decline in renewable electricity prices yields a beneficial effect; yet, this benefit is constrained by the gradual infrastructure shift to clean energy in this sector relative to others. As fossil fuel electricity prices escalate, the prices of finished goods rise, resulting in a decrease in foreign market shares. The decline in net exports stems from the erosion of the nation's comparative advantage in energy-intensive manufacturing. The base-load renewable electricity sector derives the greatest advantage from these disturbances. The increasing global demand for clean energy, along with decreasing production costs, enhances international competitiveness and promotes the export of power and associated technology, including solar cells, turbines, and batteries. Conversely, the base-load fossil electricity sector suffers a direct decline in export competitiveness attributable to elevated pricing. Importing nations are progressively eschewing expensive fossil-fuel-based electricity in favor of sourcing renewable energy from other origins. In the services sector, immediate benefits from reduced energy expenses facilitate the expansion of exportable services, including tourism, transportation, and education. In the long term, increasing infrastructure and transportation expenses resulting from elevated fossil electricity prices adversely impact service exports.

Figure 11 depicts the effect of Scenario 2 on real GDP, indicating a progressive decrease to roughly 1.5% by 2050. The prevailing pattern suggests that from 2025 to about 2046, the decline in real GDP becomes increasingly pronounced. Post-2046, this decrease ceases and exhibits a marginal enhancement (the downward trajectory diminishes), indicating the economy's eventual acclimatization to fluctuations in energy prices.

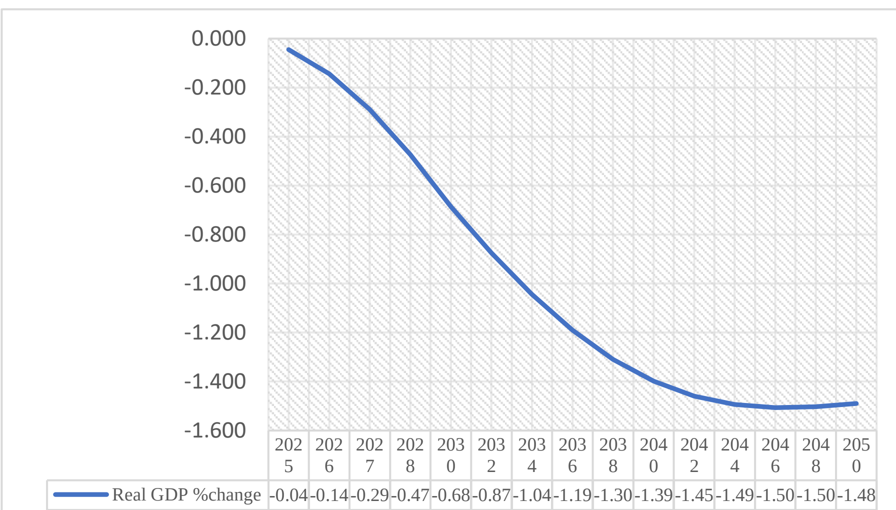

Figure 11. Effect of Scenario 2 on Iran's Real GDP Growth
Source: *Research finding*

The agricultural industry is the most susceptible to fluctuations in fossil-based electricity prices, owing to its significant reliance on water pumps, cold storage facilities, antiquated gear, and limited mechanization. The decline in renewable electricity prices does not adequately offset this vulnerability, as inadequate infrastructure constrains the sector's capacity for transition. Consequently, agriculture is anticipated to have the most substantial drop in productivity under this scenario. The industrial sector's significant dependence on fossil-fuel-based electricity for production and machinery results in elevated short-term production costs. As the proportion of inexpensive renewable electricity increases by 2050, large-scale and capital-intensive sectors are expected to adjust and withstand the impacts. The base-load renewable electricity sector is the primary beneficiary of this pricing scenario. The price decrease in this sector enhances demand and investment, potentially guiding the economy towards increased resilience over time. If this growth is promoted, the noted decrease in GDP may stabilize or potentially reverse by 2046. In contrast, the base-load fossil fuel electricity sector is experiencing escalating costs, resulting in increased consumer prices and diminished economic productivity. This sector is anticipated to be progressively eliminated from the production mix. In the services sector, whereas several operations are not directly energy-intensive, they are indirectly influenced by escalating input and transportation expenses. A decrease in household demand for services, prompted by losses in real income, exacerbates the negative impacts on this sector.

5. Conclusion

This study aims to assess the macroeconomic effects of decarbonization measures in Iran, concentrating on critical variables such economic welfare, GDP growth, carbon emissions, and the net trade balance. The variables are examined across many economic sectors, including agriculture, industry, services, fossil fuel-based electricity, and renewable electricity. Due to the interrelated nature of these factors, the study utilizes a Computable General Equilibrium (CGE) model to elucidate the structural interconnections within the economy. A primary concern in evaluating the effects of decarbonization is the replacement of natural gas with renewable energy sources. Two pricing-based policy scenarios were developed to model this shift. In the initial scenario, natural gas prices escalate by 50% by 2030 and by 100% by 2050. The CGE simulation indicates that economic welfare diminishes as a result of increasing living expenses and a decrease in real income. Furthermore, the elevated production costs deter investment, resulting in diminished economic growth. This scenario results in a substantial decrease in CO_2 emissions, underscoring the effectiveness of price signals in facilitating the transition to renewable energy. Furthermore, the net trade balances in the agricultural and manufacturing sectors enhance under this scenario. In the second scenario, fossil electricity prices increase by 25% by 2030 and by 50% by 2050, whereas renewable electricity prices decrease by 20% and 30% during the same intervals, respectively. The model findings demonstrate decreases in both economic welfare and carbon emissions. Nevertheless, the sluggish adaptation of agriculture, industry, and services to renewable energy, coupled with a decline in productivity, results in a contraction of economic growth. Moreover, net exports in these industries diminish, highlighting the essential contribution of natural gas to Iran's economic performance. The findings indicate that although carbon pricing regimes significantly diminish emissions, they may negatively impact macroeconomic performance. This highlights the imperative of regulating the economic expenses associated with decarbonization to guarantee an equitable and sustainable energy transition. The policy proposal is to undertake decarbonization, notwithstanding its short-term economic disadvantages. Price adjustments should be executed incrementally, supplemented by focused assistance for the adoption of renewable energy to alleviate adverse economic effects.

5.1 Discussion

This study's findings indicate that carbon pricing policies, although effective in substantially decreasing greenhouse gas emissions, may have major negative impacts on Iran's macroeconomic performance, especially regarding GDP growth, household welfare, and the trade balance. In the initial scenario, the escalation of natural gas prices, a fundamental input in fossil fuel-based electricity generation, results in elevated production costs, a decrease in real income, and diminished investment, which collectively hinder economic growth. The significant decrease in CO_2 emissions in this scenario validates the effectiveness of price signals in facilitating the shift to renewable energy sources. Nonetheless, within the structural framework of Iran's economy, which is heavily reliant on fossil fuels particularly natural gas abrupt price fluctuations can considerably diminish output in critical sectors such as agriculture, industry, and services. Conversely, the noted enhancements in the trade balances of sectors such as agriculture and manufacturing indicate significant chances for augmenting exports by diminishing dependence on energy-intensive inputs or imported fossil-based components. In the second scenario, the reduction in renewable electricity prices coupled with the rise in fossil electricity prices leads to diminished emissions and energy consumption. However, the gradual adjustment of productive sectors to clean energy and the decrease in sectoral productivity contribute to a reduction in economic growth. This indicates the existing constraints in Iran's renewable energy infrastructure and underscores the necessity for strategic investments. From a policy perspective, price adjustments should be executed incrementally and accompanied by supplementary measures to mitigate the socio-economic effects. Targeted subsidies for renewable energy adoption, incentives for green investment, and the dissemination of energy-efficient technologies in high-consumption industries could alleviate negative impacts. Moreover, enhancing carbon markets and implementing carbon taxes may function as useful supplementary mechanisms. Ultimately, policymakers must achieve a judicious equilibrium between enduring environmental advantages and immediate economic demands. To attain a successful and equitable energy transition in Iran, it is imperative to implement flexible, inclusive, and well-coordinated policies that correspond with the structural capacity of the national economy.

Author Contributions

Conceptualization, Mahdis Sadat Jalaee Esfandabadi and Zeinolabedin Sadeghi; methodology, Mehdi Nejati and Mahdis Sadat Jalaee Esfandabadi and Mohammad Ali Yaghoobi; validation, Seyyed Abdolmajid Jalaee Esfandabadi and Zeinolabedin Sadeghi; formal analysis, Mahdis Sadat Jalaee Esfandabadi and Seyyed Abdolmajid Jalaee Esfandabadi; resources, Zeinolabedin Sadeghi and Mahdis Sadat Jalaee Esfandabadi ; writing—original draft preparation, Mahdis Sadat Jalaee Esfandabadi; writing—review and editing, Zeinolabedin Sadeghi, and Seyyed Abdolmajid Jalaee Esfandabadi and Mehdi Nejati ; supervision, Mehdi Nejati and Mohammad Ali Yaghoobi. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

This study uses data from the Global Trade Analysis Project (GTAP) database, version GTAP 11 .https://www.gtap.agecon.purdue.edu/databases (accessed on: April 2023)

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