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RESEARCH PAPER

Investigating the Impacts of Changeable Policies with Climate Change on Iran's Agricultural Sector

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Abstract
In recent decades, climate change has been one of the most discussed and debated topics, and given its significant impact on the agricultural sector, the primary concern of policymakers in different countries is how to address this phenomenon in the agricultural sector within the context of emission reduction and adaptation. Accordingly, the current study investigated the effects of changeable policies on climate change in Iran's agricultural sector by enhancing technology and energy consumption efficiency, which is one of the emission reduction policies. To this end, Iran's economy is divided into agricultural and non-agricultural sectors, and based on the relationships between these two sectors and the dynamic stochastic general equilibrium (DSGE) approach within the New-Keynesian framework, two scenarios of technology improvement and energy efficiency improvement in the agricultural sector are developed. The results revealed that as a result of technological advancements and increased energy consumption efficiency in the agricultural sector, the price index has decreased, while production, real labor wages, investment, and capital stock have increased. Therefore, it is recommended that planners and policymakers take measures such as increasing the financial power of agricultural producers, bolstering the insurance of agricultural products and the prosperity of the insurance market, and creating favorable conditions for attracting labor with technical knowledge and high-level skills to develop the agricultural sector's technology infrastructure. In addition, since energy is relatively inexpensive in Iran compared to other countries, this vital input in the production process is frequently underutilized.
Keywords: Agricultural Sector, Climate Change, Dynamic Stochastic General Equilibrium (DSGE) Model, Energy Efficiency Improvement, Technology Improvement.
JEL Classification: B22, E71, Q43, Q54.

1. Introduction

Climate change issues that affect both humans and the environment have become the main concern of international organizations and the people of the world during the past decades (Wang et al., 2023; Farajzadeh et al., 2022). Many natural disasters that have occurred as a result of severe climate changes, un scenic fluctuations in temperature and rainfall have caused collective awareness and commitment to climate change management (Ojo and Baiyegunhi, 2021). Accordingly, in the 21st Paris Agreement, it is emphasized to keep the global temperature below 1.5 degrees Celsius. Also, the use of renewable energy and financial aid from developed countries to developing countries has been suggested to accelerate the achievement of this goal (Nugroho et al., 2023).

Agriculture is one of the most important sectors of any region, and more than 60% of the world's population is directly dependent on it, and it is the main source of livelihood and the backbone of the economic systems of most countries (Mateo-Sagasta, 2018). This sector is severely affected by climate change in the areas of production, investment, and consumption (Farajzadeh et al., 2022; Wu et al., 2023; Oduor et al., 2023; Demem, 2023; Nugroho et al., 2023). Due to being located in an arid and semi-arid climate, Iran has received the most negative effects of climate change in economic sectors, especially agriculture (Bahadoran et al., 2020; Asfew and Bedemo, 2022). The air temperature in Iran has increased by an average of 1.5 degrees since 1950. The average rainfall in the country has decreased by 45 mm in the last 50 years. Information from meteorological stations and satellite data shows that the level and depth of snow cover have decreased greatly in winter and the mountains of Iran. This decrease in the level and depth of snow is a sign of the decrease in the amount of water received by the rivers in the hot season of the year. Accordingly, Climate variability and change need appropriate adaptation measures and minimization of the effects at national and farm levels through designing policies that prevent the destruction of the natural environment (Ochieng et al., 2016). Adaptations to climate variability and change must be undertaken within the multifaceted context and address climate change, complementing overall governance for sustainable use. Adaptation responses are also tailored to the specific environmental, socio-economic, and cultural conditions of a particular area community, or nation, since climate change impacts vary between geographic areas (Demem, 2023). In other words, the main goal of this study is to investigate the impact of improving agricultural technology and energy consumption efficiency in the presence of climate change in the form of a DSGE model. The current study is separated from other previous studies due to the consideration of climate change in the New-Keynesian model. The rest of the paper is organized as follows. Theoretical literature, empirical studies, materials, and methods related to the article have been examined. The findings, conclusion, and recommendations are the final parts of this study.

2. Theoretical Literature

In order to reduce and regulate the emission of environmental pollutants, a number of economists have attempted to value climate management tools and market-based environmental policies to minimize the economic costs of achieving greenhouse gas emission reduction goals (Tiba and Omri, 2017). All of these climate management tools and market-based environmental policies can be divided into three categories: price-based tools, quantity-based tools, and intensity-based tools. These tools are exemplified by environmental tax policies (Rausch and Schwarz, 2016), greenhouse gas emission trading schemes[1](Liu and Fan, 2018), and emission permit policies (Jiang et al., 2016).

Weitzman (1974) utilized a partial equilibrium model to compare quantitative environmental policy and price-based environmental policy. Since then, numerous studies have analyzed the performance and effects of alternative environmental policies on controlling greenhouse gas emissions using various alternative methods (Quirion, 2005), such as the system dynamics model (Liu et al., 2015; Xiao et al., 2016), computable general equilibrium model (Cui et al., 2014; Xiao et al., 2015; Fan et al., 2017), input-output model (Dong et al., 2018) and dynamic stochastic general equilibrium model (Xu et al., 2016), all of which are primarily concerned with the macro effects of environmental policies.

Due to their theoretical foundation, DSGE models play an essential role in the simulation and analysis of policies within the branch of general equilibrium models. The structural DSGE model based on microeconomic principles can simulate the response of dynamic behavior and fluctuations to stochastic shocks in short-run and long-run equilibrium, which represents a transition from reduced-form modeling to structural modeling based on microeconomic principles (Benavides et al., 2015). Some researchers have therefore focused on the dynamic effects of the environment and macroeconomics and incorporated environmental policies into the DSGE model.

In summary, DSGE models that include pollution and environmental policies can be categorized into two categories: models that consider the real business cycle (RBC) with flexible prices and models that consider a New-Keynesian framework with price rigidity, such as Angelopoulos et al. (2010), Fischer and Springborn

[1]. Trading emissions is a cost-effective method for reducing greenhouse gas emissions. In order to encourage businesses to reduce emissions, the government establishes a cap on emissions and issues permits for each unit of emissions permitted below the cap.

(2011), and Heutel (2012) who regarded pollutant emissions as a byproduct of production; whereas in Fischer and Springborn's (2011) study, pollutant emissions are emitted by energy consumption. Fischer and Heutel (2013) reviewed the literature on environmental economics in depth. They concentrated on the application of two macroeconomic instruments, real business cycle models and endogenous technological growth models, to environmental economics. Since then, some researchers have begun to integrate environmental policies into DSGE models. Fried et al. (2013) examined a conventional DSGE model based on microeconomics and environmental feedback. The study's findings confirmed the correlation between carbon dioxide emissions and economic expansion.

Following the contributions of previous literature, we try to combine macroeconomics and environmental economics by embedding the environmental block into a New Keynesian DSGE model. Different from Annicchiarico and Di Dio (2015), we embedded energy consumption and energy efficiency into our model, and we used them to analyze the three different environmental policy regimes. In addition, along with the development of the economy, the uncertain factors from the economy and environment have gradually increased, which will affect the environmental policy effects. Hence, more uncertainties need to be taken into consideration when evaluating and selecting environmental policies.

3. Empirical Studies

Lintunen and Vilmi (2013) analyzed the periodicity of environmental policies using a DSGE model and determined that the optimal emission tax policy is periodic. In a study, Ponce et al. (2014) developed a multi-market agricultural model to analyze the effects of climate change in developing countries in light of climate change uncertainty. The obtained results demonstrated that the economic effects of climate change vary based on the type of activity. Tokunaga et al. (2015) used a dynamic panel data model to examine the effects of climate change on the production of agricultural products in Japan. Analysis of static and dynamic panel data models revealed that a one-degree Celsius increase in the average annual temperature reduces rice production by 5.8% in the short term and 3.9% in the long term. Using the DSGE model, Elshnnawy et al. (2016) investigated the impacts of climate change on Egypt's economic growth. According to the findings of their study, the phenomenon of climate change has a negative impact on economic development and the growth of the agricultural sector in this country. Huong et al. (2018) investigated the effects of climate change on the agricultural sector in the northwest region of Vietnam for the years 2050 and 2100 using the Ricardian method. According to the results, in 2050 and 2100, the net income will decrease by 17.7% and 21.28% due to climate change, respectively. Using the DSGE method, Xiao et al. (2018) analyzed China's macroeconomic fluctuations under distinct environmental policies. According to their results, the response of macroeconomic variables to various shock conditions indicates the effectiveness of environmental policies' "automatic stabilizer." Additionally, a positive energy efficiency shock results in an increase in energy inputs. Moreover, a policy regarding the intensity of greenhouse gas emissions will have a greater impact on the economy than environmental levies and greenhouse gas emissions. Etwire et al. (2019) used a Ricardian model to examine the impacts of climate change on farmers' income in Ghana's agricultural sector. The results indicated that severe climate change will reduce the average net income per hectare of maize, which accounts for more than half of Ghana's current food production.

Asad Falsafizadeh and Sabouhi Sabouni (2012) examined the effects of climate change on agricultural production in the city of Shiraz. According to their results, in contrast to the short-term decrease in agricultural income and profit in the same scenario, from the estimated values of 54% and 30% to 74% and 85%, respectively, the long-term decrease in agricultural income and profit under mild climate change in the dry year was estimated to be 4.5% and 6.4%, respectively. Khaleghi et al. (2015) investigated the effects of climate change on agricultural production and the Iranian economy. Their results indicated that the agricultural sector's output will decrease by 37.5% between 2000 and 2050 as a consequence of the predicted climate change in Iran. Using the dynamic stochastic general equilibrium model, Permeh et al. (2016) investigated the influence of economic shocks on the macro variables of the agricultural sector. In order to accomplish this, the coefficients of the model were estimated using the Bayesian method and data from 1971 to 2012. With these explanations, the results of the mentioned shocks on the agricultural sector indicate that, among the numerous investigated shocks, the productivity shock (technology) will have the most positive effect on the agricultural sector. Because it increases production, export, consumption, and investment in the agricultural sector, while simultaneously decreasing agricultural inflation and imports. Using the DSGE model, Khosravi et al. (2017) analyzed domestic utility shocks and the performance of Iran's agricultural sector. The results demonstrated that the positive shock of preferences increases consumption, production, prices, and employment, while decreasing investment, export, and the agricultural sector's real wage rate. Other investigated variables have decreased following the occurrence of a positive shock in the demand for money, except the price index for agricultural products, other investigated variables have decreased. The positive shock of labor supply increases employment in the agricultural sector, although production, investment, and exports decrease in the first period. Moreover, as a result of the increase in labor supply, the level of consumption and prices has increased while the real wage has declined. Using the DSGE model, Khosravi et al. (2017) simulated the impact of macroeconomic shocks on Iran's agricultural sector. According to the results, a positive productivity shock increases agricultural production, consumption of domestically produced products, capital stock, employment, and real wages while decreasing final costs and price indices. Except for the real wage, a positive monetary shock increases all other variables. In addition, production, employment, real wages, and price indices have declined as a result of the positive impact of oil revenues. As a result, government expenditure reduces real wages and capital stock. Ghaffari Esmaeili et al. (2019) examined the impact of climate change on the agricultural sector's economic development in Iran. The results indicated that the agricultural sector's production, consumption, investment, and export will decrease by 4.469%, 5.025%, 4.462%, and 13.770%, respectively, if the decrease in precipitation over the next twenty years until 2030 is accounted for. However, imports in this sector will increase by 5.504%. Environmental issues (climate change) and macroeconomic issues are going to be investigated concurrently within the framework of DSGE models, which distinguishes this study from those previously reviewed. In other words, in previous research, either environmental and climate change issues were investigated using econometric and Ricardian methods, or macroeconomic issues were investigated within the framework of DSGE models. In addition, the purpose of this study is to examine changeability policies (improvement of technology and improvement of energy consumption efficiency) in Iran's agricultural sector in the framework of macroeconomics using the DSGE method. In some studies, the effects of climate change on agricultural products using the DSSAT simulation model and meteorological data from MarkSim have been predicted and analyzed under different climate change scenarios during different periods. The results indicated that the yield of agricultural products will decrease under climate change scenarios. (Sayahi et al., 2023; Nouri et al., 2016).

Other studies, such as Barnard et al. (2023), Furtak and Wolińska (2023), and Odour et al. (2023), have measured the effects of climate change on the environment. Some other studies, such as Tokunaga et al. (2015), Al-Shanawi et al. (2016), Huang et al. (2018), Etoir et al. (2019), have measured the effects of climate change on the economic and agricultural sectors with use of Ricardian, econometrics methods. Also, other studies, such as Permeh et al. (2016), Khosravi et al. (2017), measured the effects of different shocks on the agricultural sector using the DSGE method. The innovation of the present research is that, contrary to the mentioned studies, the effects of climate change on both the agricultural and non-agricultural sectors have been investigated using the DSGE method, which has not been studied in this field so far.

4. Methods and Material

Greenhouse gases (NOx, SO2, SO3, CO, SPM, CO2, CH4, and N2O) are the leading cause of climate change, with 97% of greenhouse gas emissions attributable to CO2. The quantity of CO2 emissions in the industrial and agricultural sectors has been on the rise, with industrial emissions increasing from 89 million tons in 2011 to 114 million tons in 2019, a growth of 27.91%. The agricultural sector's CO2 emissions were 12,376,837 tons in 2011 and 13,869,836 tons in 2019, representing an increase of 12.063%. In addition, per capita CO2 emissions increased by 3.05% from 7224.5 kg in 2011 to 7445.14 kg in 2019 (Ministry of Energy, 2019).

The relationship between carbon intensity[1] and energy intensity[2] is one indicator of the quantity of greenhouse gases utilized in the production process of various economic sectors. Energy intensity is defined as energy consumption per unit of GDP, and carbon intensity is defined as carbon emissions per unit of GDP. The agricultural sector's carbon intensity increased from 40.52 units in 2011 to 48.91 units in 2019. Similarly, the energy intensity increased from 84.58 units to 107.09 units over the same time period, indicating that both carbon intensity and energy intensity increased during the period under study. In other terms, the utilization of carbon and energy in Iran's GDP has increased (Ministry of Energy, 2019). If these values are compared to the added value of agriculture, we will see that the growth of agriculture's added value during this time period has been driven by the increased use of energy and emissions. This sector's inability to use appropriate methods to reduce the use of energy and carbon in its production process contributes to climate change conditions in this and other economic sectors. In this sector, it is crucial to give close attention to adaptable climate-

[1]. It refers to how many grams of carbon dioxide (CO2) are released to produce a kilowatt hour (kWh) of electricity. Electricity that's generated using fossil fuels is more carbon intensive, as the process by which it's generated creates CO2 emissions.

[2]. Energy intensity is a measure of the energy inefficiency of an economy. It is calculated as units of energy per unit of GDP or some other measure of economic output. High energy intensities indicate a high price or cost of converting energy into GDP.

related policies. In other words, the primary objective of this study is to determine the effectiveness of adaptable climate change policies in Iran's agricultural and other macroeconomic sectors. To this end, the Iranian economy was divided into agricultural and non-agricultural sectors, and the DSGE model was employed to analyze the related policies.

DSGE models are derived from the fundamentals of microeconomics and constrained decision-making. In these models, the general equilibrium and prices in the economy are determined so that all agents dynamically maximize their objectives under budget or resource constraints. These characteristics have made DSGE models an accepted method for analyzing economic shocks among economists. To this end, DSGE models have been utilized to investigate the impact of climate change on the agricultural sector of Iran. Iran's economy is divided into agricultural and non-agricultural sectors for this reason. In addition, this article illustrates the structure of the DSGE model with four economic agents: the representative household, producers of intermediate goods, producers of final goods, and the government.

4.1 Representative Household

Household is the owner of the workforce (L_t), capital stock (K_t), and energy (M_t) allocated by firms for the production of intermediate products. Labor force, capital stock, and energy are homogeneous goods; yet the economic agent does not differentiate between their various types.

The representative household has an infinite lifespan and maximizes its life function through Equation 1:

$$U = E_t \sum_{t=0}^{\infty} \beta^t \left\{ lnC_t - \frac{L_t^{1+\theta}}{1+\theta} - \frac{[(1-er_t)\mu M_t]^{1+\upsilon}}{1+\upsilon} \right\} \quad (1)$$

In addition, it is presumed that the supply of household labor (L_t) and energy (M_t) is distributed according to a Cobb-Douglas function.

$L_t = l_{na,t}^{\alpha_1} l_{ag,t}^{\alpha_2}$

$M_t = M_{na,t}^{\gamma_1} M_{ag,t}^{\gamma_2}$

where $l_{na,t}$ and $l_{ag,t}$ represent the agricultural and non-agricultural labor forces, respectively. Additionally, α_1 and α_2 represent the labor share of each component of the total labor supply, such that $\alpha_1 + \alpha_2 = 1$. In addition, $M_{na,t}$ and $M_{ag,t}$ represent the energy consumed by the non-agricultural and agricultural sectors, respectively, and $\gamma_1 + \gamma_2 = 1$.

In addition, Equation 1 is simplified as follows (Khosravi et al., 2017; Xiao et al., 2018):

$$Z_t = [(1 - er_t)\mu M_t] \quad (2)$$

The budget limit is expressed as Equation 3:

$$\begin{aligned} P_t C_t + P_t I_{na,t} + P_t I_{ag,t} + B_{t+1} \\ = (1 - \tau^L_{na,t}) W_{na,t} L_{na,t} + (1 - \tau^L_{ag,t}) W_{ag,t} L_{ag,t} \\ + (1 - \tau^K_{na,t}) R_{na,t} K_{na,t} + (1 - \tau^K_{ag,t}) R_{ag,t} K_{ag,t} \\ + (1 - \tau^M_{ag,t}) P^M_{ag,t} M_{ag,t} + (1 - \tau^M_{na,t}) P^M_{na,t} M_{na,t} + (1 + R^B_t) B_t \\ + D_t P_t + Tr_t \end{aligned} \quad (3)$$

Households own firms. Profit (D_t) is distributed as a dividend to the representative household for each intermediate product produced by the firm. The representative household also receives all payments for labor (W_t), capital stock (R_t), energy in the agricultural sector ($P^M_{ag,t}$), and energy in the non-agricultural sector ($P^M_{na,t}$) supplied for intermediate products as a single transfer from the government. Whereas the government imposes various tax rates on the income factor. The household spends its income on consumption (C_t), investment (I_t), and the acquisition of assets, such as government bonds (B_t).

The investment adjustment cost is a key feature of modern DSGE models (Christiano et al., 2007; Smets and Wouters, 2005). Equations 4 and 5 represent the law of capital movement, where δ_1 and δ_2 are the capital depreciation rates in the non-agricultural and agricultural sectors, respectively.

$$K_{na,t+1} = (1 - \delta_1) K_{na,t} + i_{na,t} \quad (4)$$

$$K_{ag,t+1} = (1 - \delta_2) K_{ag,t} + i_{ag,t} \quad (5)$$

4.1.1 Allocation of Consumption

The CES production function divides the total consumption of $C_{tag,t}$ into the consumption of agricultural goods ($C_{tna,t}$) and non-agricultural goods ($C_{tna,t}$):

$$\begin{aligned} C_t = [\alpha_c^{\frac{1}{\omega_c}} (c_{tna,t})^{(\omega_c - 1)/\omega_c} \\ + (1 - \alpha_c)^{1/\omega_c} (c_{tag,t})^{(\omega_c - 1)/\omega_c}]^{\frac{\omega_c}{\omega_c - 1}} \end{aligned} \quad (6)$$

So that α_c is the proportion of non-agricultural goods in total household consumption, and ω_c is the elasticity of substitution between agricultural and non-agricultural goods. To select the optimal combination of consumer goods, the household minimizes the purchase price of the consumer bundle, which consists of agricultural and non-agricultural products. Considering $P_{tag,t}$ and $P_{tna,t}$ as price indices for agricultural and non-agricultural products, the minimization problem for households is as follows:

$$\min\left(c_{tag,t}P_{tag,t} + c_{tna,t}P_{tna,t}\right)$$

subject to (7)

$$C_t = [\alpha_c^{\frac{1}{\omega_c}}\left(c_{tna,t}\right)^{(\omega_c-1)/\omega_c} + (1-\alpha_c)^{1/\omega_c}(c_{tag,t})^{(\omega_c-1)/\omega_c}]^{\frac{\omega_c}{\omega_c-1}}$$

From the solution of the above problem's first-order conditions, household demand functions for agricultural and non-agricultural products can be obtained.

$$c_{tna,t} = \alpha_c(\frac{P_{tna,t}}{P_t})^{-\omega_c}c_t \tag{8}$$

$$c_{tag,t} = (1-\alpha_c)(\frac{P_{tag,t}}{P_t})^{-\omega_c}c_t \tag{9}$$

As can be seen, the relative demand for consumer products $C_{tag,t}$ and $C_{tna,t}$ by domestic households depends on their relative prices. In addition, the greater the price elasticity of demand ω_c, the closer the products are to one another and the weaker the market power of the producing firms. By inserting Equations 8 and 9 into Equation 7, P_t of consumer price index (CPI) is obtained, which is a combination of its components (price indices of agricultural and non-agricultural products) (Khosravi et al., 2017):

$$P_t = [\alpha_c\left(P_{tna,t}\right)^{1-\omega_c} + (1-\alpha_c)(P_{tag,t})^{1-\omega_c}]^{\frac{1}{1-\omega_c}} \tag{10}$$

4.2 Production in the Non-Agricultural Sector

4.2.1 Producer of the Final Product

In addition to firms that produce intermediate goods, there are companies that purchase differentiated goods from companies that produce intermediate goods and integrate them to create final goods to sell to the final purchasers. Intermediate goods, having fixed elasticity of substitution, are differentiated and imperfect substitutes for each other. According to the constant returns to scale technology proposed by Stiglitz and Dixit (1977), the representative producer of the final good, utilizes $Y_{na,t}(j)$ units of each intermediate good from the interval [0,1] to produce the final good Y_{na}, where $\varphi > 1$ is the elasticity of substitution between various intermediate products:

$$y_{na,t} = (\int_0^1 (y_{na,t}(i))^{\frac{\varphi-1}{\varphi}}di)^{\frac{\varphi}{\varphi-1}} \tag{11}$$

In order to maximize its profit, the company producing the final goods purchases a portion of the intermediate goods based on their prices. The problem of maximizing profits for a firm producing final goods can be stated as follows:

$$\max P_{na} y_{na} - \int_{i=0}^{1} P_{na,t}(i) y_{na,t}(i) d_i$$

Subject to (12)

$$y_{na,t} = (\int_{0}^{1} (y_{na,t}(i))^{\frac{\varphi-1}{\varphi}} di)^{\frac{\varphi}{\varphi-1}}$$

By solving the first-order conditions, the above equation will be subject to the demand for each intermediary company's differentiated product as follows:

$$y_{na,t}(i) = \left(\frac{P_{na,t}(i)}{P_{na,t}}\right)^{-\varphi} y_{na,t} \quad (13)$$

Integrating the above equations results in obtaining the price index for non-agricultural goods:

$$P_{na,t} = (\int_{0}^{1} (P_{na,t}(i))^{1-\varphi} di)^{-\frac{1}{1-\varphi}} \quad (14)$$

4.2.2 Producer of Intermediate Goods

Among the chains of production companies ($i \epsilon [0,1]$), each company producing intermediate goods using the Cobb-Douglas function under monopolistic competition conditions produces goods:

$$y_{na,t}(i) = A_{na,t} \left(K_{na,t}(i)\right)^{\alpha_{na}} \left(l_{na,t}(i)\right)^{\beta_{na}} \left(M_{na,t}(i)\right)^{\kappa_{na}} \quad (15)$$

where α_{na} is the share of capital, β_{na} is the share of labor force, and κ_{na} is the share of energy in production, so that $\alpha_{na} + \beta_{na} + \kappa_{na} = 1$.

Where A_t is the total productivity factor, which is exogenous in the following way:

$$lnA_t - \ln A = \rho_A lnA_{t-1} - \rho_A lnA + \varepsilon_{t,A} \quad \varepsilon_{t.A} \backsim i.i.d.N(0, \sigma_A^2) \quad (16)$$

The intermediary company maximizes its profit by selecting the optimal quantity of input use and its optimal price. During each period, only $\varphi_{na} - 1$ percent of companies can optimize the final price of their product. So that the remaining companies (φ_{na} percent) only revise their prices based on the historical inflation rate (Calvo, 1983). Therefore, for those businesses unable to optimize their price in the new period, the following equation determines the price:

$$P_{na,t} = \pi P_{na,t-1} \quad (17)$$

The problem of maximizing the profits of non-agricultural intermediary enterprises is as follows:

$$\max E_{.} \sum_{s=.}^{\infty} \left[\frac{(\beta\varphi_{na})^{s} \lambda_{t+s} D_{na,t+s}(i)}{P_{t+s}} \right]$$

Subject to:

$$y_{na,t}(i) = A_{na,t} \left(K_{na,t}(i)\right)^{\alpha_{na}} \left(l_{na,t}(i)\right)^{\beta_{na}} \left(M_{na,t}(i)\right)^{\kappa_{na}} \quad (18)$$

$$y_{na,t}(i) = \left(\frac{P_{na,t}(i)}{P_{na,t}}\right)^{-\varphi} y_{na,t}$$

So that the company's profit function of $D_{na,t+s}(i)$ is:

$$D_{na,t+s}(i) = \pi^{s} \tilde{P}_{na,t}(i) Y_{na,t+s}(i) - R_{na,t+s} k_{na,t+s}(i) - W_{na,t+s} l_{na,t+s}(i) - P^{M}_{na,t+s} M_{na,t+s(i)} \quad (19)$$

where $\beta^{s}\lambda_{t+s}$ is the producer's time discount factor and λ_{t+s} is the final utility of consumption in period t+s. The first order conditions of the maximization problem regarding production inputs are:

$$r_{na,t} = \alpha_{na} \frac{Y_{na,t}(i)}{k_{na,t}(i)} mc_{na,t} \quad (20)$$

$$w_{na,t} = \beta_{na} \frac{Y_{na,t}(i)}{l_{na,t}(i)} mc_{na,t} \quad (21)$$

$$p^{M}_{na} = \kappa_{na} \frac{Y_{na,t}(i)}{M_{na,t}(i)} mc_{na,t} \quad (22)$$

Where r$r_{na,t} = \frac{R_{na,t}}{P_t}$, $w_{na,t} = \frac{W_{na,t}}{P_t}$, $p_{na,t} = \frac{P_{na,t}}{P_t}$ and $mc_{na,t} = \frac{MC_{na,t}}{P_t}$, respectively, are the real return rate of capital, the real wage, the real price of energy, and the final cost of production in the non-agricultural sector. The real final cost can be obtained by inserting Equations 20 to 22 into Equation 16:

$$mc_{na,t} = (\frac{1}{\beta_{na}})^{\beta_{na}} (\frac{1}{\alpha_{na}})^{\alpha_{na}} (\frac{1}{\kappa_{na}})^{\kappa_{na}} (w_{na,t})^{\beta_{na}} (r_{na,t})^{\alpha_{na}} (p^{M}_{na})^{\kappa_{na}} \quad (23)$$

The first order condition for the above optimal price obtaining problem is:

$$\frac{\delta\pi_t}{\delta\tilde{P}_{na,t}(i)} = 0 \Rightarrow E_{.}\sum_{s=0}^{\infty}(\beta\varphi_{na})^s\lambda_{t+s}\left[\pi^s\left(\frac{\pi^s\tilde{P}_{na,t}(i)}{P_{na,t+s}}\right)^{\theta}Y_{na,t+s} - \theta\left(\frac{\pi^s\tilde{P}_{na,t}(i)}{P_{na,t+s}}\right)^{-\theta-1}\frac{\pi^sY_{na,t+s}}{P_{na,t+s}}\pi^s\tilde{P}_{na,t}(i) + \theta\left(\frac{\pi^s\tilde{P}_{na,t}(i)}{P_{na,t+s}}\right)^{-\theta-1}\frac{\pi^sY_{na,t+s}}{P_{na,t+s}}MC_{na,t+s}\right] = 0 \quad (24)$$

$$\frac{\delta\pi_t}{\delta\tilde{P}_{na,t}(i)} = 0 \Rightarrow E_{.}\sum_{s=0}^{\infty}(\beta\varphi na)^s\lambda_{t+s}Y_{na,t+s} + sp_{na,t+s}^{\theta}\prod_{k=1}^{s}\pi^{-s\theta}\pi_{t+k}^{\theta}[(1 - \theta)\tilde{P}_{na,t}(i)\prod_{k=1}^{s}\pi^{-s}\pi_{t+s}^{-1} + \theta mc_{na,t+s} \quad (25)$$

In conclusion, the optimal price of the intermediary firm can be calculated as follows:

$$\tilde{P}_{na,t}(i) = \left(\frac{\theta}{\theta-1}\right)\frac{E_{.}\sum_{s=0}^{\infty}(\beta\varphi na)^s\lambda_{t+s}Y_{na,t+s} + sp_{na,t+s}^{\theta}mc_{na,t+s}\prod_{k=1}^{s}\pi^{-s\theta}\pi_{t+k}^{\theta}}{E_{.}\sum_{s=0}^{\infty}(\beta\varphi na)^s\lambda_{t+s}Y_{na,t+s} + sp_{na,t+s}^{\theta}\prod_{k=1}^{s}\pi^{s(1-\theta)}\pi_{t+k}^{\theta-1}} \quad (26)$$

So that $p_{na,t+s} = \frac{P_{na,t+s}}{P_{t+s}}$, $\tilde{p}_{na,t}(i) = \frac{\tilde{P}_{na,t}(i)}{P_t}$, and $\pi_{t+s} = \frac{P_{t+s}}{P_t}$ are the relative price of non-agricultural goods, the real optimal price in the non-agricultural sector, and the inflation index, respectively.

Finally, the price index for non-agricultural products, which is a composite of the prices of companies that can optimize their prices and those that cannot, is:

$$(p_{na,t})^{1-\theta} = \varphi_{na}(\pi\frac{p_{na,t-1}}{\pi_t})^{1-\theta} + (1-\varphi_{na})\left(\tilde{P}_{na,t}\right)^{1-\theta} \quad (27)$$

4.3 Production in the Agricultural Sector

4.3.1 Producer of the Final Product

In the agricultural sector, there are chains of businesses that produce intermediate goods, each of which is a producer of $Y_{ag,t}(i)$ per unit of goods. In addition to intermediary companies, some companies purchase differentiated goods from companies that produce intermediate goods and then combine them to create final goods that are sold to final purchasers. Intermediate goods, having fixed elasticity of substitution, are differentiated and imperfect substitutes for each other. The constant returns to scale technology suggested by Stiglitz and Dixit (1977), the representative producer of the final good utilizes $Y_{ag,t}(i)$ units of each intermediate good in the interval [0,1] to create the final good of Y_{ag}, where $\varphi > 1$ is the elasticity of substitution between various intermediate products:

$$y_{ag,t} = (\int_0^1 (y_{ag,t}(i))^{\frac{\varphi-1}{\varphi}} di)^{\frac{\varphi}{\varphi-1}} \quad (28)$$

To maximize its profit, the company producing the final goods purchases a portion of the intermediate goods based on their prices. The problem of maximizing profits for a firm producing final commodities can be stated as follows:

$$\max P_{ag} y_{ag} - \int_{i=0}^1 P_{ag,t}(i) y_{ag,t}(i) d_i$$

Subject to (29)

$$y_{ag,t} = (\int_0^1 (y_{ag,t}(i))^{\frac{\varphi-1}{\varphi}} di)^{\frac{\varphi}{\varphi-1}}$$

By solving the first-order conditions of the aforementioned equation, the demand function for the differentiated product manufactured by each of the intermediary firms will be as follows:

$$y_{ag,t}(i) = \left(\frac{P_{ag,t}(i)}{P_{ag,t}}\right)^{-\varphi} y_{ag,t} \quad (30)$$

Combining the above equations enables the calculation of the agricultural commodities price index:

$$P_{ag,t} = (\int_0^1 (P_{ag,t}(i))^{1-\varphi} di)^{-\frac{1}{1-\varphi}} \quad (31)$$

4.3.2 Producer of Intermediate Goods

On the product market, producers of intermediate goods are monopolistic, and the prices are constant. The representative firm utilizes labor ($L_{ag,t}(j)$), capital stock ($K_{ag,t}(j)$), and energy ($M_{ag,t}(j)$) to produce ($Y_{ag,t}(j)$) by using Cobb-Douglas production function as follows:

$$y_{ag,t}(j) = A_{ag,t} \left(K_{ag,t}(j)\right)^{\alpha_{ag}} \left(\eta^L_{ag,t} l_{ag,t}(j)\right)^{\beta_{ag}} \left(\eta^M_{ag,t} M_{ag,t}(j)\right)^{\kappa_{ag}} \quad (32)$$

where A_t represents the total productivity factor that, if exogenous, is defined as follows:

$$lnA_{ag,t} - lnA = \rho_A lnA_{ag,t-1} - \rho_A lnA + \varepsilon_{t,A} \qquad \varepsilon_{t,A} \backsim i.i.d.N(0,\sigma_A^2) \tag{33}$$

In Equation (32), efficiency variables are added to labor and energy. It is also assumed that energy efficiency can be enhanced by increasing energy consumption. It is assumed that there is a correlation between energy input efficacy and energy consumption during the production process. q_t is a variable that improves energy consumption efficiency and follows the AR (1) process.

$$\eta_{ag,t}^M = q_{ag,t} M_{ag,t}^{(o-1)} \tag{34}$$

$$lnq_{ag,t} - lnq = \rho_q lnq_{ag,t} - \rho_q lnq + \varepsilon_{t,q} \qquad \varepsilon_{t,q} \backsim i.i.d\left(0,\sigma_q^2\right) \tag{35}$$

The consumption of energy results in the emission of $Z_{ag,t}(j)$ pollutants. The emission coefficient is signed by μ. It is presumed that a representative firm can calculate its contribution to pollution reduction in $er_{ag,t}(j)$ as follows:

$$Z_{ag,t}(j) = \left(1 - er_{ag,t}(j)\right)\mu M_{ag,t}(j) \tag{36}$$

The final (shadow) mitigated expense of $MCE_{ag,t}(j)$ is a function of the proportion of pollution reduction:

$$MCE_{ag,t}(j) = \Lambda \ln\left(1 - er_{ag,t}(j)\right) \tag{37}$$

The total emission reduction cost of $CE_{ag,t}(j)$ can be calculated using the integral of $MCE_{ag,t}(j)$ in the interval between 0 and $RE_{ag,t}(j)$, where the emission reduction is equal to $RE_{ag,t}(j) = \mu.er_{ag,t}(j)$.

$$CE_{ag,t}(j) = \int_0^{RE_{ag,t}(j)} \Lambda \ln\left(1 - \frac{RE_{ag,t}(j)}{\mu M_{ag,t}(j)}\right) dRE_{ag,t}(j) = -\Lambda\mu M_{ag,t}(j).[\ln\left(1 - er_{ag,t}(j)\right)\left(1 - er_{ag,t}(j)\right) + er_{ag,t}(j)] \tag{38}$$

It is anticipated that the emission of pollutants will reduce the productivity of the workforce. Equation 40 depicts the law of movement of pollution accumulation, and δ_z is the rate of depletion of pollutant reserves:

$$\eta_{ag,t}^L = 1 - \left(\eta_0 + \eta_1 ST_{ag,t} + \eta_2 ST_{ag,t}^2\right) \tag{39}$$

$$ST_{ag,t} = (1 - \delta_Z) ST_{ag,t-1} + Z_t \tag{40}$$

Now, the problem for the production of intermediate commodities by the representative firm J can be expressed as follows, where P_t^z is the cost of purchasing one emission permit from the government:

$$\max \Pi = \frac{P_{ag,t}(j)}{P_t} Y_{ag,t}(j) - \frac{W_{ag,t}}{P_{ag,t}} L_{ag,t}(j) - \frac{R_{ag,t}}{P_t} K_{ag,t}(j) - \frac{P^M_{ag,t}}{P_t} M_t(j) - \frac{P^Z_{ag,t}}{P_{ag,t}} \left(1 - er_{ag,t}(j)\mu M_{ag,t} - CE_{ag,t}(j)\right)$$
$$\text{s.t.} \quad y_{ag,t}(j) = A_{ag,t} \left(K_{ag,t}(j)\right)^{\alpha_{ag}} \left(\eta^L_{ag,t} l_{ag,t}(j)\right)^{\beta_{ag}} \left(\eta^M_{ag,t} M_{ag,t}(j)\right)^{\kappa_{ag}} \quad (41)$$

By applying the aforementioned functions to the solution of the first-order conditions, we have:

$$-\frac{W_t}{P_t} = \psi_t \beta A_t K^\alpha_t(j) (\eta^L_t)^\beta L_t(j)^{\beta-1} [\eta^M_t M_t(j)]^\kappa$$
$$-\frac{R_t}{P_t} = \psi_t \alpha A_t K^{\alpha-1}_t(j) \left(\eta^L_t L_t(j)\right)^\beta [\eta^M_t M_t(j)]^\kappa$$
$$-\frac{P^z_t}{P_t} \mu\left(1 - er_t(j)\right) - \frac{P^M_t}{P_t} = \psi_t(1 - \alpha - \beta) A_t K^\alpha_t(j) [\eta^L_t L_t(j)]^\beta \frac{(\eta^M_t M_t(j))^{(1-\alpha-\beta)}}{M_t(j)} \quad (42)$$
$$\frac{P^Z_t}{P_t} = \Lambda \ln(1 - er_t(j))$$

Based on the approach of Calvo (1983), we presume that intermediary firms can only alter their nominal prices in response to a random signal. The probability that a company will alter its price during any given time interval is equal to $\omega - 1$. Firms with the ability to alter their prices at t choose their prices so as to maximize their future total discounted real profit.

$$maxR_{P_t(j)} = E_t \sum_{i=0}^{\infty} (\beta\omega)^t \frac{\grave{U}(C_{t+1})}{\grave{U}(C_t)} Y_{t+1} \left[\frac{P_t(j)}{P_{t+1}} \left(\frac{P_{t+1}}{P_t(j)}\right)^\varphi - MC_{t+1} \left(\frac{P_{t+1}}{P_t(j)}\right)^\varphi\right] \quad (43)$$

By applying the aforementioned functions to the solution of the first-order conditions, we have:

$$(\varphi - 1) X_{1.t} = \varphi X_{2,t}$$
$$X_{1,t} = \grave{U}(C_t) Y_t (p^*_t)^{\varphi-1} + \beta\omega E_t [X_{1,t+1} (p^*_t)^{1-\varphi} (p^*_{t+1})^{\varphi-1} \pi^{\varphi-1}_{t+1}] \quad (44)$$
$$X_{2,t} = \grave{U}(C_t) Y_t MC_t (p^*_t)^{-\varphi} + \beta\omega E_t \left[X_{2,t+1} (p^*_t)^{-\varphi} (p^*_{t+1})^{-\varphi} \pi^\varphi_{t+1}\right]$$

$$1 = (1-\omega)(p_t^*)^{1-\varphi} + \omega\pi_t^{\varphi-1}$$

4.4 Producer of the Final Product

Produced under conditions of perfect competition, the final commodity in the economy is a combination of agricultural and non-agricultural goods combined using CES technology,

$$V_t = [\gamma_{na}^{\frac{1}{\upsilon}} y_{na,t}^{\frac{\upsilon-1}{\upsilon}} + \gamma_{ag}^{\frac{1}{\upsilon}} y_{ag,t}^{\frac{\upsilon-1}{\upsilon}}]^{\frac{\upsilon}{-1}} \quad (45)$$

where υ is the elasticity of substitution between agricultural and non-agricultural domestically produced products. γ_{na} and γ_{ag} are the proportions of non-agricultural and agricultural goods, respectively, so that $\gamma_{na} + \gamma_{ag} = 1$.

The final producer optimizes their profit by determining the quantity of each product to produce. Equation 46 maximizes the final product's manufacturer's profit:

$$\begin{aligned} &\max P_t V_t - P_{ag,t} y_{ag,t} - P_{na,t} y_{na,t} \\ &\text{subject to} \\ &V_t = [\gamma_{na}^{\frac{1}{\upsilon}} y_{na,t}^{\frac{\upsilon-1}{\upsilon}} + \gamma_{ag}^{\frac{1}{\upsilon}} y_{ag,t}^{\frac{\upsilon-1}{\upsilon}}]^{\frac{\upsilon}{-1}} \end{aligned} \quad (46)$$

Solving the aforementioned problem results in the obtaining of the pertinent demand functions and price index:

$$y_{na,t} = \gamma_{na}(\frac{P_{na,t}}{P_t})^{-\vartheta} V_t \quad (47)$$

$$y_{ag,t} = \gamma_{ag}(\frac{P_{ag,t}}{P_t})^{-\vartheta} V_t \quad (48)$$

$$P_t = [\gamma_{na}(P_{na,t})^{1-\vartheta} + \gamma_{ag}(P_{ag,t})^{1-\vartheta}]^{\frac{1}{1-\vartheta}}$$

4.5 The Government

Periodically, the government passively modifies aggregate transfers to balance the budget. Assume that there is no net supply of bonds. Accordingly, the government's spending limit is calculated as follows (Xiao et al., 2018):

$$\begin{aligned} P_{ag,t} G_{ag,t} + P_{na,t} G_{na,t} + (1 + R_t^B) B_t + Tr_t \\ = \tau_t^L W_L L_t + \tau_t^K R_t K_t + \tau_t^M P_t^M M_t + P_t^Z Z_t + B_{t+1} \end{aligned} \quad (50)$$

4.6 Market Settlement

On the market for final commodities, equilibrium in the economy is described as follows:

$$C_t = C_{ag,t} + C_{na,t} \tag{51}$$

$$i_t = i_{ag,t} \;\; i_{na,t} \tag{52}$$

$$G_t = G_{na} + G_{ag} \tag{53}$$

$$y_t = \frac{P_{na,t}}{P_t} y_{na,t} + \frac{P_{ag,t}}{P_t} y_{ag,t} \tag{54}$$

$$y_t = C_t + i_t + G_t + CE_{ag} \tag{55}$$

Based on the above equations, all production of agricultural and non-agricultural final goods is allocated to the consumption of households, the government, and investment in the production sector to ensure a balanced market for final goods. In addition, the time series of Iran's economic data published by the Statistics Center of Iran, the Central Bank of the Islamic Republic of Iran, and the energy balance sheet from 1991 to 2019 were used to calculate the model's parameters.

5. Results

The current study's model consists of 49 equations and 49 unknown variables, which were logarithmically linearized using Ehlig's method and solved using the Dynar software in the Matlab environment. After logarithmically linearizing the equations, the parameters are calculated depending on the researcher's objective, their perspective, the computational features of the model using the calibration or estimation method (such as Bayesian estimation), or both. If the objective of the research is to elucidate economic realities or to obtain the dynamic properties of the model, quantification can be used in place of econometric estimation (Kydland and Prescott, 1982). Quantification is a prevalent technique used in dynamic stochastic general equilibrium-based research. In this method, numerical values for the parameters of the desired economic world are determined, and its use has increased over the past few decades due to its success.

According to Hoover (1995), a model is validated when its coefficients are selected from other empirical studies or econometric studies (even unrelated ones) or by the researcher in general in such a way that the model can reproduce certain characteristics of the actual world. The valuation method, according to Canova (1994), is an econometric technique in which the coefficients are estimated using econometric criteria rather than statistical criteria. Therefore, in this investigation, two calibration and quantification methods were used to estimate the required parameters (Table 1).

Table 1. Values of Model Parameters

No.	Parameter	Value	Description	Source
1	α_1	0.84	Share of non-agricultural workforce	Research finding
2	α_2	0.16	Share of agricultural workforce	Pop (2017)
3	θ	1.97	Elasticity of labor supply	Research finding
4	γ_1	0.96	Share of energy consumption in the non-agricultural sector	Research finding
5	γ_2	0.04	Share of energy consumption in the agricultural sector	Research finding
6	ν	0.42	Elasticity of substitution of energy and workforce	Kemfert (1998)
7	β	0.99	Rate of consumer's time preferences	Xiao et al. (2018)
8	δ_1	4.60	Cost of agricultural sector's capital stock adjustment	Khosravi (2017)
9	δ_2	4.21	Cost of non-agricultural sector's capital stock adjustment	Khosravi (2017)
10	ω_c	3	Elasticity of substitution between agricultural and non-agricultural goods	Khosravi (2017)
11	α_c	0.68	Non-agricultural products' share of total household consumption	Khosravi (2017)
12	α_{na}	0.483	Share of investment in the non-agricultural production	Khosravi (2017)
13	β_{na}	0.5021	Share of workforce in the non-agricultural production	Khosravi (2017)
14	κ_{na}	0.0149	Share of energy in the non-agricultural production	Research finding
15	φ_{na}	0.367	Share of non-agricultural businesses unable to alter prices	Khosravi (2017)
16	o	2.136	Elasticity of energy consumption in efficiency	Yang et al. (2014)
17	α_{ag}	0.33	Share of investment in the agricultural production	Nalban (2018)
18	β_{ag}	0.58	Share of workforce in the agricultural production	Fischer and Springborn (2011), Pop (2017)
19	μ	0.6	Pollution diffusion coefficient	Xu et al. (2016)
20	δ_Z	0.005	Rate of polluting reserves depreciation	Xiao et al. (2018)
21	φ	6	Intermediate good price elasticity	Xu et al. (2016)
22	ω	0.75	Nominal rigidity	Nalban (2018)

No.	Parameter	Value	Description	Source
23	υ	3.2	Elasticity of substitution between agricultural and non-agricultural goods	Khosravi (2017)
24	γ_{na}	0.823	Share of non-agricultural goods in production	Research findings
25	γ_{ag}	0.176	Share of agricultural goods in production	Research finding

After devising, specifying, and estimating the DSGE model for Iran's economy, it is essential to ensure the model's ability and efficiency in generating and simulating data, as well as to assess its predictive capability. One of the common experimental evaluation techniques for DSGE models is to compare the secondary moments of the actual data (logarithmized and detrended via the HP filter) to the results derived from the estimated data (simulated data) of the model. The proximity and similarity between actual and simulated moments demonstrate the model's precision and efficacy. The results in Table 2 indicate that the model is well-fitted and has performed reasonably well in simulating the actual economic data of Iran. Therefore, the model can simulate the relevant fluctuations.

Table 2. A Comparison of Moments of the Model's Actual and Simulated Values

Variable	Standard deviation		First-order autoregression	
	Real	**Simulated**	**Real**	**Simulated**
Consumption	1.921	1.916	0.935	0.930
Production in the agricultural sector	2.362	2.358	0.945	0.940
Production in the non-agricultural sector	1.260	1.247	0871	0.861
Price index	2.245	2.240	0.880	0.872
Wages in the agricultural sector	3.260	3.258	0.895	0.890
Wages in the non-agricultural sector	1.258	1.257	0.862	0.860
Energy costs in the agricultural sector	2.457	2.450	0.869	0.867
Energy costs in the non-agricultural sector	2.550	2.545	0.958	0.951
Investment in the agricultural sector	1.360	1.355	0.962	0.960
Investment in the non-agricultural sector	2.251	2.249	0.972	0.970
Agricultural sector's capital stock	3.657	3.651	0.960	0.952
Non-agricultural sector's capital stock	2.260	2.258	0.953	0.950

Source: Research finding.

5.1 An Analysis of Response Functions

In the current study, impulse response functions are utilized to explain the behavior of variables when an economy is in a steady state and a sudden positive shock occurs. The response of a variable to a shock is expressed as a proportion of the variable's logarithmic deviation from its stable values a percentage. Therefore, the percentage values depicted on the vertical axis of the impulse response diagrams represent the changes of the variable in question. To combat the effects of climate change, after ensuring the model's viability, two policies involving the development of technology and energy consumption efficiency in the agricultural sector were studied.

5.2 The Effects of Technology Improvement Shock

Figure 1 depicts the impulse response functions of technological advancement in the agricultural sector, which is a one standard deviation shock to the technological factor in this sector. According to the results of the research modeling, technological advancement in the agricultural sector has an effect on the production costs in this sector, which in turn influences the wages of labor, the real rate of return on capital, and the production and prices in the agricultural sector. The results of impulse response functions indicate that, as a consequence of technological progress, the average production per unit of production factor has increased, enabling firms to produce more with the same amount of production inputs. In addition, technological advancements reduce the final cost of production by increasing output per unit of input, conserving production resources, and reducing agricultural sector risk. After the aforementioned shock, it is not remarkable that the prices of domestically produced agricultural products decreased. Because, on the one hand, the company's final cost of production has decreased, and its pricing is a function of its final cost of production. On the other hand, technological progress will cause the product's supply curve to migrate to the right, so that even with an increase in demand (less than the shift in the supply curve), an excess supply will be created, resulting in a decline in agricultural sector prices. Due to the rigidity of the prices, the quantity of (total) price level reduction has gradually decreased, and after 10 periods, it has attained a stable trend. Employment has increased as a consequence of technological advancements in the agricultural sector. Companies are motivated to hire more workers with technical expertise and advanced skills to reduce production costs, improve the quality of goods, increase the profitability of production, and increase their ability to compete with other firms that produce the same goods. In conclusion, the increase in labor demand in the agricultural sector has led to a rise in real wage. In other words, the results of this study are consistent with the principles of the New-Keynesian framework with price rigidity. Also, the findings of this study are similar to the results of Fischer and Springborn, 2011; Fischer and Heutel, 2013; Fried et al., 2013; Elshnnawy et al., 2016; Huong et al., 2018; Etwire et al., 2019. The price of energy fluctuates in both the agricultural and non-agricultural sectors, but the introduction of technology has led to a greater decrease in the agricultural sector. As a result of the technological shock in the agricultural sector, investment in this sector (K2) has increased relative to the non-agricultural sector (K1). Similar to the study of Permeh et al., 2016; Khosravi et al., 2017, this increase in investment is attributable to the presence of technology in this sector, which has increased performance and production, thereby making it more profitable than other economic sectors; consequently, the agricultural sector has experienced an influx of capital. The capital stock variable in the agricultural and non-agricultural sectors (L2, L1) follows the same trend as investment.

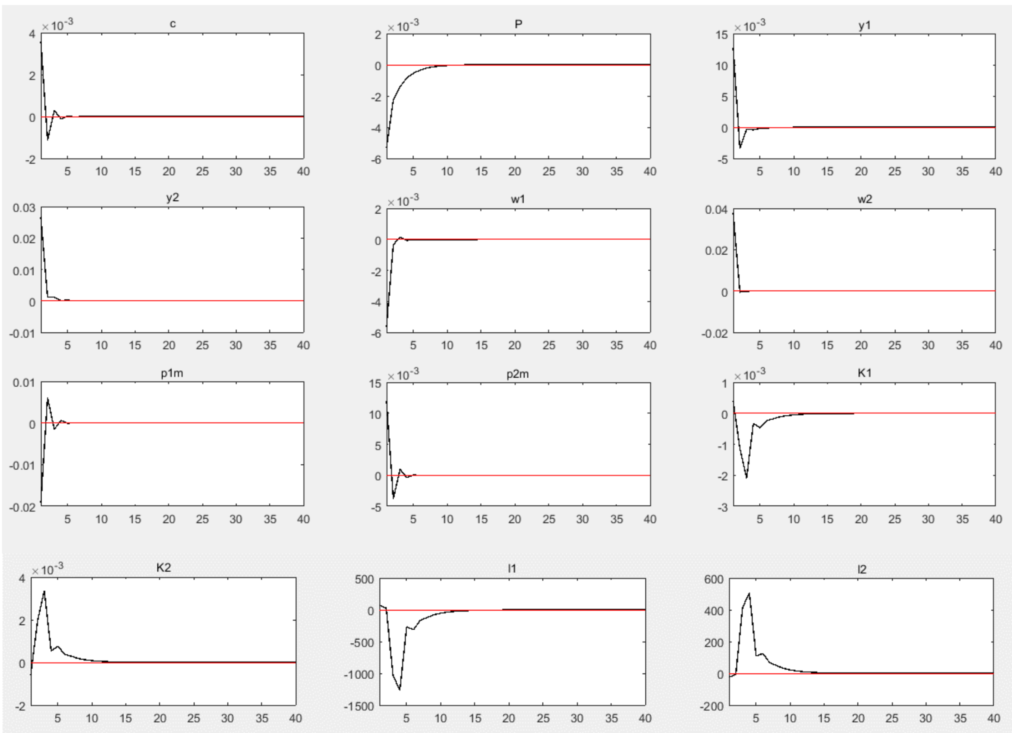

Figure 1. Impulse Response Functions of Technology Improvement

Source: Research finding.

5.3 The Effects of Energy Consumption Efficiency Shock

Figure 2 depicts the impulse response functions of energy efficiency improvement in the agricultural sector, which corresponds to a shock of one standard deviation to the sector's energy efficiency factor. The trend of the amount of consumption (c) fluctuates, and after 8 periods, the amount of consumption remains constant. The variable representing the price index (P) has decreased. In other words, by increasing the efficacy of energy consumption in the agricultural sector, the cost of products in this sector will decrease, resulting in a decline in the general price level (P). The quantity of agricultural products produced (y2) has increased. While the trend for non-agricultural products (y1) is fluctuating. In other words, the improvement in energy consumption in the agricultural sector has led to an increase in production in this sector, and the link between agricultural and non-agricultural production (industry and services) has led to changes in production in the non-agricultural sector. The theoretical foundations of the New-Keynesian framework with price rigidity and the results of studies by Khaleghi et al., 2015; Permeh et al., 2016; Xiao et al., 2018; Khosravi et al., 2017 confirm this subject.

As a result of the improvement in energy consumption efficiency and the high proportion of energy costs in the production of agricultural products, the final cost of production in this sector has decreased significantly, and producers are less willing to hire labor with higher wages to maintain or increase production profit. Consequently, agricultural sector wages (w2) have decreased. This shifts the labor force from the agricultural sector to the non-agricultural sector. Since the non-agricultural sector's energy efficiency has not improved, more workforce is required in the production process, resulting in an increase in wages in the non-agricultural sector (w1). The price of energy fluctuates in both the agricultural and non-agricultural sectors, but it has decreased more in the agricultural sector than in the non-agricultural sector due to increased energy efficiency. The results of the study of Khosravi et al., 2017 confirm this subject. the next variable to be examined in this section is investment (K). Investments in the agricultural sector (K2) have increased relative to the non-agricultural sector (K1) as a result of the agricultural sector's enhanced energy efficiency. Similarly, to investment, the capital stock variable in the agricultural and non-agricultural sectors (L2, L1) exhibits a similar trend. The results of studies by Permeh et al., 2016; Khosravi et al., 2017; Xiao et al., 2018 confirm this subject.

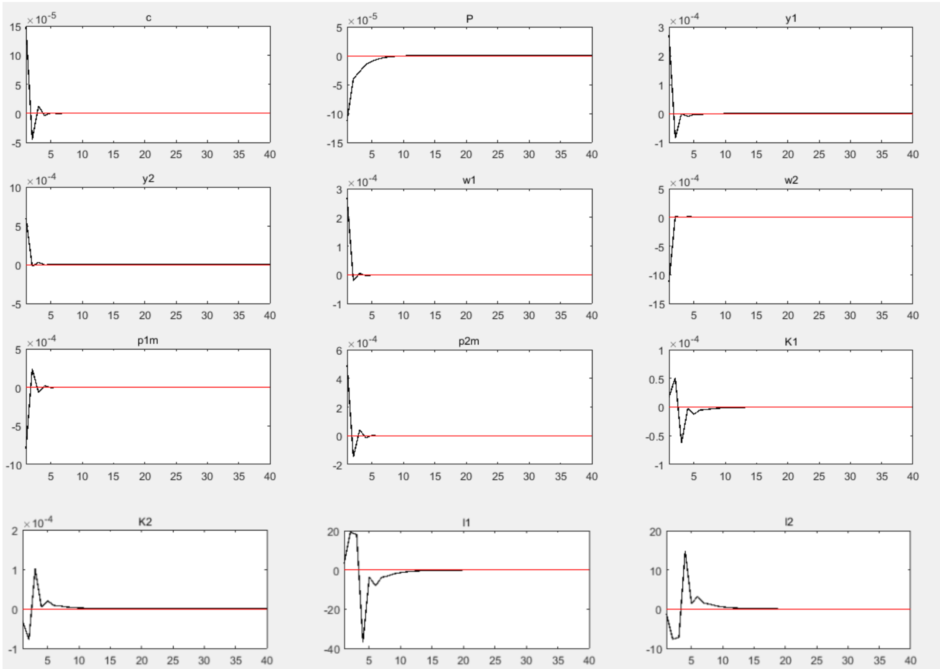

Figure 2. Impulse Response Functions of Energy Efficiency
Source: Research finding.

6. Conclusion and Recommendation

In recent decades, the issue of climate change has received considerable attention from the international community and scholars from various disciplines have attempted to discuss and investigate various aspects of climate change. In this study, the effects of variable policies with climate change on Iran's agricultural sector were analyzed, and Iran's economy has been investigated in a three-sector model (household, enterprise, government) and in the form of two agricultural and non-agricultural sectors and using the dynamic stochastic general equilibrium model approach. The variable of energy consumption was entered into the model as a variable affecting climate change. After initializing and solving the model and ensuring that the simulated results match the actual values of the model variables, the results of improving agricultural technology and energy consumption efficiency were investigated and analyzed.

The results of the survey showed that with the improvement of technology in the agricultural sector, the variable of energy consumption is considered an influential variable in climate change. Therefore, it is suggested to provide the conditions for the use of new and up-to-date technologies in the agricultural sector for producers of this sector to increase the amount of production and waste less energy in this sector. Also, the survey revealed that labor wages, investment, and capital stock in the non-agricultural sector have decreased due to technological advancements in the agricultural sector. In the agricultural sector, production, labor wages, investment, and capital stock have increased. Therefore, to re-establish the balance between the agricultural and non-agricultural sectors, it is suggested to provide the conditions for the use of modern technologies in the non-agricultural sector (industry and services).

By implementing the shock of improving energy consumption efficiency, the amount of energy consumption will decrease as a variable affecting climate change. Investment and capital stock in the non-agricultural sector and labor wages in the agricultural sector have decreased. In contrast, production, investment, and capital stock in the agricultural sector and labor wages in the non-agricultural sector have increased. Therefore, it is suggested that the government provide conditions for optimal energy consumption in various industries by increasing environmental standards. In addition, an important factor in the optimal consumption of energy and thus the control of climate change is the use of incentive and punishment tools for households and producers. According to the price stickiness based on the New Keynesian model, fewer intermediate goods are needed to produce the product, resulting in a reduction in emissions. Additionally, considering that countries worldwide are required to take action on climate change by 2030, Iran can take effective steps in this field by utilizing climate management tools and environmental policies based on market mechanisms.

Statements and Declarations

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