Environmental Energy and Economic Research (2017) 1(3): 321-332
DOI 10.22097/eeer.2018.99215.1014

The Nexus of Renewable Energy -Sustainable Development-Environmental Quality in Iran: Bayesian VAR Approach

Davood Behboudi, Parviz Mohamadzadeh, Soha Moosavi*

Economic Development Department, Economics and Management Faculty, Tabriz University, Tabriz, Iran

Received: 5 March 2017 /Accepted: 25 July 2017

Abstract

The use of renewable energy reduces environmental pollution and leads to achievement of sustainable development. The current study investigates the dynamic interrelationship between sustainable development, renewable and non-renewable energies and environment nexus by applying Bayesian vector autoregression (BVAR) and impulse response functions in Iran with an annual data frequency for the time span of 1980-2013. In this study, genuine savings (GS) were particularly examined to indicate sustainable development. The empirical results confirm the existence of cointegration long-run relationship among the variables. Based on BVAR analysis, SSVS-full and normal-Wishart functions were used as optimal prior functions to estimate renewable and non-renewable energies models, respectively. Results of impulse response functions indicate a positive impact of renewable and non-renewable energies consumption on sustainable development. Also, renewable and non-renewable energies consumption shocks positively affect CO_2 emissions, but the effect of non-renewable energy consumption on air pollution is more than that of renewable energy consumption. Moreover, the results reveal positive impact of sustainable development shock on renewable energy consumption and negative impact on non-renewable energy consumption.

Key words*:* Renewable energy, Environmental quality, Sustainable development, Bayesian vector auto regression

Introduction

In recent years, increasing global warming has caused a fundamental shift in the way government around the world approach energy related environment issues. Promoting sustainable development and combating climate change have become integral aspects of energy planning, analysis and policy making (Belaid and Youssef, 2017). Because energy accounts for two-thirds

* Corresponding Author Email: smoosavi@tabrizu.ac.ir

of total greenhouse gas emissions and 80% of CO_2, any effort to reduce emissions and mitigate climate change must include the energy sector (IEA, 2016).

In order to achieve sustainable development, environmental protection should constitute an integral part of the development process. Eradicating poverty and reducing disparities in living standards in different parts of the world are essential to achieve sustainable development (Baris and Kucukali, 2012). Sustainable development is a difficult concept to define; one of the original descriptions of sustainable development is credited to the Brundtland Commission: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and development, 1987). Sustainable development has three components: environment, society and economy. The aim of sustainable development is to establish a better balance between these three dimensions (Omri et al., 2015).

Energy is fundamental to sustainable development and economic growth across the world (Baris and Kucukali, 2012). Expansion of energy consumption activities (particularly, fossil fuel energy) leads to two major concerns: the depletion of the most easily accessible energy resources (mainly oil) and the problem of global warming caused by the rapidly increasing emissions of greenhouse gases such as carbon dioxide and methane. This global energy challenges require that renewable energy resources be appropriately used. Renewable energy is commonly defined as energy generated from solar, wind, geothermal, tide and wave, wood, waste and biomass. Renewable energy is clean, safe and inexhaustible. Therefore, it is growing fast around the world and according to expectations, it will occupy a leading position in the overall share of energy consumption (REN21, 2013).

Fast depletion of energy resources, energy scarcity, increasing cost of energy and environmental pollution are the reasons for increase in the use of renewable energy resources to protect societies from Green House effect, destruction of Ozone Layer and air pollution which cause acid rain and smog. Recently, extraction of shale oil and shale gas was proposed as a solution to reduce the use of fossil reserves. Despite increasing attention on shale oil and gas as a replacement for fossil fuel reserves, their extraction process leads to negative environmental impacts such as global warming, greenhouse gas emissions and the impact on groundwater. In general, adverse environmental effects and the high cost of production of shale oil and gas are the major impediments to development of the shale industry (ENVI, 2011). The use of renewable energy dramatically reduces the dependence on fossil fuel as a source of energy, hence, reducing air pollution. Also, renewable energy resources do not deplete over a lifetime and they are sustainable source of energy (IRENA, 2016)

Alternative energy sources are increasingly required to respond to this threat of climate change and skyrocketing energy demand in the world. The need for a shift from the use of primary energy sources that emits toxic pollutants to the environment to greener energy source is a current issue in energy led growth literature. Most advance countries of the world have established legal framework to encourage the use of renewable energy sources in line with the objectives of global energy organization and global climate change and environmental safety advocacy organization such as International Energy Agency (IEA) and Kyoto Protocol (Maji, 2015).

The energy sector of Iran is dominated by oil and gas. Iran is OPEC's second largest oil producer and hold 8.6% of the world's oil reserves and 17% of its gas reserves. As compared to oil and gas, other forms of primary energy (including renewable energy) have limited importance and play only a minor role in the economy of the country. Iran as a rapidly developing country, whose economy is enriched with oil and gas exports, has integrated Green Economy concept into its energy sector to achieve fast and sustainable green growth (Ardestani et al., 2016)

Theoretical and empirical literature review

The interest in possible relationships between energy use, CO_2 emissions and economic development dates back to the early 1970's (Mezghani and Haddad, 2017). The literature on causal relationship between energy consumption and economic growth is on four testable hypotheses: growth, conservation, feedback and neutrality. The empirical support for the growth hypothesis is based on the presence of unidirectional causality from energy consumption to economic growth. The conservation hypothesis is supported if there is unidirectional causality from economic growth to energy consumption. In this situation, energy conservation policies designed to reduce energy consumption will not have an adverse effect on economic growth. The feedback hypothesis is supported by the presence of bidirectional causality between energy consumption and economic growth. The neutrality hypothesis is supported by the absence of causality between energy consumption and economic growth (Apergis and Payne, 2012).

The existing literature in this field can be classified into three groups. The first group consists of studies that investigated the causal links between energy consumption and economic growth (Cowan et al., 2014; Bozoklu and Yilanci, 2013). The second group of studies concentrated on the relationship between economic activity and emissions (Furuoka, 2015; Wang and Feng, 2015). Finally, the third group of studies combined the two aforementioned relationships and thus used a unified framework to identify the links among energy consumption, emissions and economic growth (Antonakakis et al., 2017; Mezghani and Ben Haddad, 2017; Cowan et al., 2014). Some of studies related to subject of energy consumption, economic growth and pollutant emissions have been presented as follows.

Antonakakis et al., (2017) analyzed the causal relationship between energy consumption and economic growth in 106 selected countries over the period of 1971–2011. Using panel vector autoregression (PVAR), they found the bidirectional Granger causality between total energy consumption and economic growth in the long-run. Gasper et al. (2017) used Panel-Corrected Standard Errors estimators, to compare a sustainable development approach using the ISEW, with the traditional economic growth approach using GDP, and its relationship with energy consumption in twenty European countries for the period of 1995–2014. The results indicate a new negative feedback hypothesis for the alternative measure of development and a conservative hypothesis for economic growth with energy consumption.

Belaid and Youssef (2017) explored the dynamic causal relationship between CO_2 emissions, renewable electricity consumption, non-renewable electricity consumption and economic growth in Algeria using Autoregressive Distributed Lag Cointegration approach over the period of 1980–2012. They found that, in the long-run, economic growth and non-renewable electricity consumption have a detrimental effect on the environment quality, whereas renewable energy use has a beneficial environmental effect. Mezghani and Ben Haddad (2017) employed the Time-Varying Parameters Vector Autoregressive (TVP VAR) model to examine inter-temporal dynamics between Saudi Arabian real GDP (oil, non-oil), electricity consumption and CO_2 emissions levels for 1971–2010. They observed high volatility of electricity consumption with persistent negative effects on oil GDP levels and CO_2 emissions and positive effects on real non-oil GDP levels.

Amri (2016) analyzed the nexus among energy consumption, FDI inflows and output in 75 countries in the period of 1990–2010. The present results show that there is proof of bidirectional linkage between FDI and output per capita, with regards to renewable energy consumption and gross domestic product per capita, and non-renewable energy and gross domestic product per capita in the three groups of countries (developed, all and developing). Cowan et al. (2014)

examined the causal link between electricity consumption, economic growth and CO_2 emissions in the BRICS countries for the period of 1990– 2010, using panel causality analysis. The empirical results support evidence on the feedback hypothesis for Russia and the conservation hypothesis for South Africa. However, a neutrality hypothesis holds for Brazil, India and China, indicating neither electricity consumption nor economic growth is sensitive to each other in these three countries.

Sebri and Ben Salha (2014) investigated the causal relationship between economic growth and renewable energy consumption in the BRICS countries over the period of 1971–2010 using ARDL bounds testing approach. With regards to the VECM results, bidirectional Granger causality exists between economic growth and renewable energy consumption, suggesting the feedback hypothesis. You (2011) employed the structural vector autoregressions framework and the generalized impulse response functions to study the long-term dynamic relationship between China's energy consumption and sustainable economic growth. The analysis showed that clean and renewable energy increases the country's genuine savings.

Fotros et al., (2013) studied the relationship between renewable and non-renewable energy consumption and economic growth in developing countries over the period of 1980-2009 using panel cointegration approach. The results show that the effect of non-renewable energy consumption on economic growth is more than that of renewable energy consumption. Fakher and Abedi (2017) evaluated the relationship between environmental quality (based on environmental performance index) and economic growth in selected developing countries for the time span of 1983-2013. Auto Regressive Distributed Lag (ARDL) model and bounds test were adopted in panel data. Results indicate a positive and significant impact of environmental performance index on economic growth.

There are two underlying limitations in previous studies. On one hand, the aim of these studies are only to reveal whether there are causality links between variables, but not to suggest how economic development reacts to shocks from changing patterns of energy consumption. On the other hand, the overwhelming majority use Gross Domestic Product (GDP) as the indicator of economic growth or a set of human development indicators representing sustainability (You, 2011). But, GDP is insufficient to evaluate sustainable development. Indeed, GDP cannot measure environmental damage and it is inefficient for quantifying social welfare (Gasper et al., 2017). As Hamilton argued, genuine savings (GS) index includes all kinds of capital and captures the depreciation of both man-made and natural capital. Based on intertemporal optimization with undeclined social welfare, GS "equate to a modification of the so-called Hartwick rule" and serve as an indicator of weak sustainability (You, 2011).

In the present study, an attempt was made to resolve the limitations of previous empirical studies. The two aspects of innovation in this research are as follows: First, an efficient indicator (GS) was used to express sustainable development; Second, to study the effect of different types of energy consumption on sustainable development, the Bayesian Vector Auto Regression Approach (BVAR) was used to eliminate the problem of data limitation and abundance of parameters that are found in Structural Vector Auto Regression models.

Materials and Methods

Models and description of variables

To investigate the relationship between sustainable development, energy consumption and CO_2 emissions, the proposed model, based on Antonakakis et al. (2017) and You (2011), was given by the following equation:

$$\begin{bmatrix} Y_t \\ E_t \\ CO_{2_t} \end{bmatrix}' = z_t' C + \sum_{j=1}^{p} \left(\begin{bmatrix} Y_{t-1} \\ E_{t-1} \\ CO_{2_{t-1}} \end{bmatrix}' A_j \right) + \begin{bmatrix} \varepsilon_t^Y \\ \varepsilon_t^E \\ \varepsilon_t^{CO_2} \end{bmatrix}' \tag{1}$$

Where ε_t is the error term and z_t is vector of fixed components; E is divided into E-RE and E-NRE where E-RE is percentage of electricity generated from renewable energies and E-NRE represents percentage of electricity generated from non-renewable energies; CO_2 denotes carbon emissions defined in metric tons per capita; Y is divided into GS and GDP where GS denotes sustainable development defined in current US dollars per capita and GDP represents economic growth defined in current US dollars per capita. All the variables are presented in logarithmic form in this study.

The genuine savings (GS) is calculated according to the World Bank Little Green Data Book 2006 as follows:

$$GS_t = GNS_t – Ncd_t – Fcd_t – Env_t + Edu_t \tag{2}$$

Where GNS is gross national savings, Ncd represents natural capital depreciation; Fcd denotes fixed capital depreciation, Env is cost of environmental damage and Edu denotes spending on education. All the variables in Eq. 2 are defined in US dollars per capita.

To investigate the interrelationship between variables in this research, Bayesian VAR method was used. One of the main advantages of this method is that it eliminates the problem of abundance of parameters that is observed in Vector Autoregressive Models. This method has a special application in eliminating the uncertainty of vector self-regression models in the face of data constraints (Sahebhonar and Nadri, 2014). Also, the impact of renewable and non-renewable energy consumption on sustainable development was estimated and the results were compared. Therefore, the proposed models in this study include 2 models as follows:

1. GS, E-RE, CO_2
2. GS, E-NRE, CO_2

Methodology

All Bayesian models have three basic components: Prior density function, Likelihood function and Posterior density function. Using different types of Prior functions, different results can be obtained; therefore, the choice of the optimal prior function is important (Koop and Korobilis, 2010).

- *The diffuse prior*
  The diffuse prior for α and Σ takes the form

$$p(\alpha, \Sigma) \propto |\Sigma|^{-(M+1)/2} \tag{3}$$

- *The Natural Conjugate Prior*
  The natural conjugate prior has the form

$$a|\Sigma \sim N\left(\underline{\alpha}, \Sigma \otimes \underline{V}\right) \tag{4}$$
$$\Sigma^{-1} \sim W\left(\underline{S}^{-1}, \underline{v}\right) \tag{5}$$

- *The Minnesota Prior*
  The Minnesota Prior refers mainly to restricting the hyperparameters of α. The data-based restrictions are the ones presented in the monograph. The prior for α is still normal and the posteriors are the similar to the Natural conjugate prior case. Σ is assumed known in this case (for example equal to b $\hat{\Sigma}$).

- *The Independent Normal-Wishart Prior*
  It can be seen that the restricted VAR can be written as a Normal linear regression model with an error covariance matrix of a particular form. A very general prior for this model is the independent Normal-Wishart prior

$$p(\beta, \Sigma^{-1}) = p(\beta)p(\Sigma^{-1}) \tag{6}$$
$$\beta \sim N\left(\underline{\beta}, \underline{V_\beta}\right) \tag{7}$$
$$\Sigma^{-1} \sim W\left(\underline{S^{-1}}, \underline{v}\right) \tag{8}$$

- *The SSVS-Wishart Prior*
  we can introduce the SSVS prior which is a hierarchical prior of the form

$$\alpha|\gamma \sim N(0, DRD) \tag{9}$$

where D is a diagonal matrix. If we write its j_th diagonal element as Dj,j , this prior implies that there is dependence on a hyperparameter of the following form

$$d_j = \begin{cases} k_{0j} & if \quad \gamma_j = 0 \\ k_{1j} & if \quad \gamma_j = 1 \end{cases} \tag{10}$$

- *The SSVS-Full Prior*
  In this method, the variance of the error components has a prior SSVS distribution. Thus, the variance-covariance matrix of the error components can be written as follows:

$$\Sigma^{-1} = \Psi'\Psi \tag{11}$$

Results

Unit root test

Time series univariate properties were examined using two unit root tests: Augmented Dickey-Fuller and Phillips-Perron tests. Table 1 shows that all the variables are non-stationary in levels and stationary with respect to first differences.

Table 1. Results of unit root tests

Variable	ADF		PP	
	Level	First difference	Level	First difference
	t-statistics(P-value)	t-statistics(P-value)	t-statistics(P-value)	t-statistics(P-value)
GS	-0.88 (0.94)	-4.78 (0.00)*	-0.88 (0.94)	-4.83 (0.00)*
E-RE	-2.68 (0.24)	-5.51 (0.00)*	-2.23 (0.45)	-11.11 (0.00)*
E-NRE	-3.05 (0.13)	-7.27 (0.00)*	-3.04 (0.13)	-8.01 (0.00)*
CO_2	-3.10 (0.12)	-6.33 (0.00)*	-3.08 (0.12)	-6.50 (0.00)*

* indicate the significance at 5% level. (Source: Research findings)

Cointegration test

Two proposed VAR models with one lag appear to fulfill the diagnostic tests. [1] Johansen cointegration tests were performed to determine the number of cointegrating vectors. They suggest the existence of one cointegrating vector present in the 2 proposed models. The results of the cointegration tests are presented in Table 2.

Table 2. Results of cointegration test

Model	Null Hypothesis	λ_{Trace}	Critical value 5%
GS, E-RE, CO_2	r=0	24.89*	24.27
	r≤1	9.84	12.32
	r≤2	3.87	4.12
GS, E-NRE, CO_2	r=0	36.99*	35.01
	r≤1	13.53	18.39
	r≤2	2.63	3.84

* indicate rejection of the null hypothesis at 5% level. (Source: Research findings)

Bayesian VAR Method

MATLAB software was used to select the appropriate prior function. The accuracy of the out-of-sample forecasts for 1980 to 2013 is measured by the RMSE defined as follows:

$$RMSE = \sqrt{\frac{\sum_{\tau=\tau_0}^{T-h}\left[y_{i,\tau+h}^{0} - E\left(y_{i,\tau+h}\middle|\mathrm{Data}_{\tau}\right)\right]^2}{T-h-\tau_0+1}} \tag{12}$$

The RMSE index for various prior functions with different predictive horizons is presented in Table 3. According to the results, the SSVS-Full prior function has more accurate prediction. Therefore, the Bayesian method with the SSVS-Full prior function can be used to estimate the impulse response function in the first model (GS, E-RE, CO_2). Also, based on similar calculation

1. The results of lag determination for 2 proposed models obtained using the STATA software, are omitted here to save spaces.

processes, in the second model (GS, E-NRE, CO_2), the Normal-Wishart prior function was more accurate.

Table 3. RMSE index prediction of model (GS, E-RE, CO2)

Prior function	h=1	h=2	h=3	h=4	Mean of h=1 to 4	Relative Index
Diffuse	0.106	0.151	0.162	0.120	0.135	0.48
Minnesota	0.099	0.140	0.166	0.148	0.138	0.49
Natural Conjugate	0.092	0.167	0.253	0.299	0.202	0.73
Normal-Wishart	0.145	0.256	0.335	0.373	0.277	1
SSVS-Wishart	0.053	0.113	0.175	0.118	0.115	0.42
SSVS-Full	0.064	0.131	0.171	0.091	0.114	0.41

Source: Research findings

To investigate the impact of variable shocks and the response of other variables, impulse response functions were used. Impulse responses are the time paths of one or more variables as a function of a one-time shock to a given variable or set of variables. Impulse responses are the dynamic equivalence of elasticities. Fig. 1 shows impulse responses of sustainable development to positive shocks on renewable and non-renewable electricity generation.

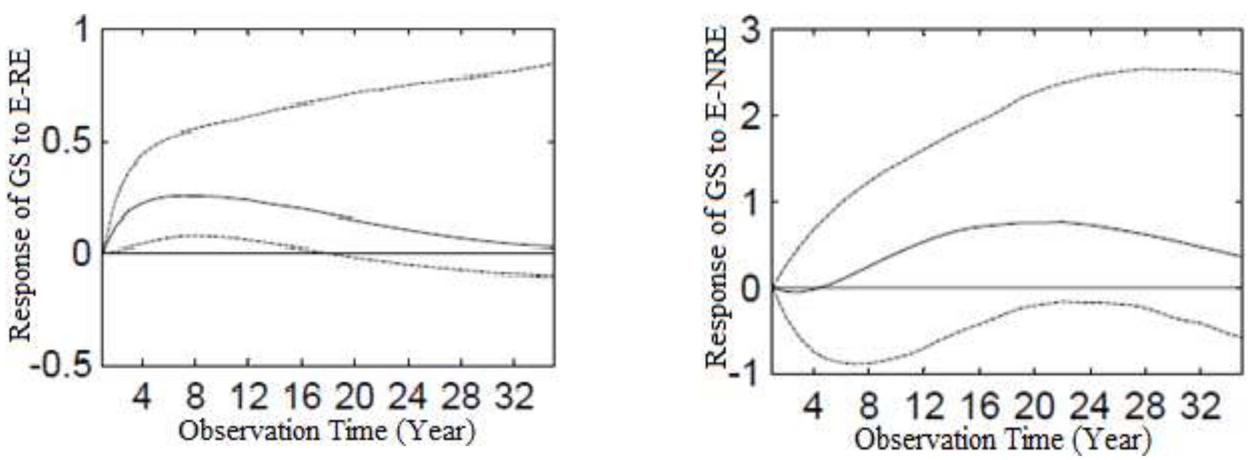

Figure 1. The impact of renewable and non-renewable energy shock on sustainable development
Source: Research findings

The results indicate that renewable and non-renewable electricity generation shocks had a positive impact on GS. Creating a shock in renewable energy will increase sustainable development from the first period and slowly mitigate after maximization in period 6. Also, the effect of increasing non-renewable energy on sustainable development appeared after 5 periods and maximized at period 20. This result is similar to those of studies that examined the impact of renewable and non-renewable energy shocks on economic growth in different countries (Mezghani, 2016; Antonakakis, 2017; You, 2011). Due to the fact that economic growth and gross national savings (GNS) are effective components of sustainable development, any factor that promotes rapid economic growth can improve sustainable development index of a country in the short term. But in the long term, focusing on economic growth and consumption of fossil fuels in the country will have devastating effect on the environment. Fig. 2 represents impulse responses of renewable and non-renewable electricity generation to sustainable development shock.

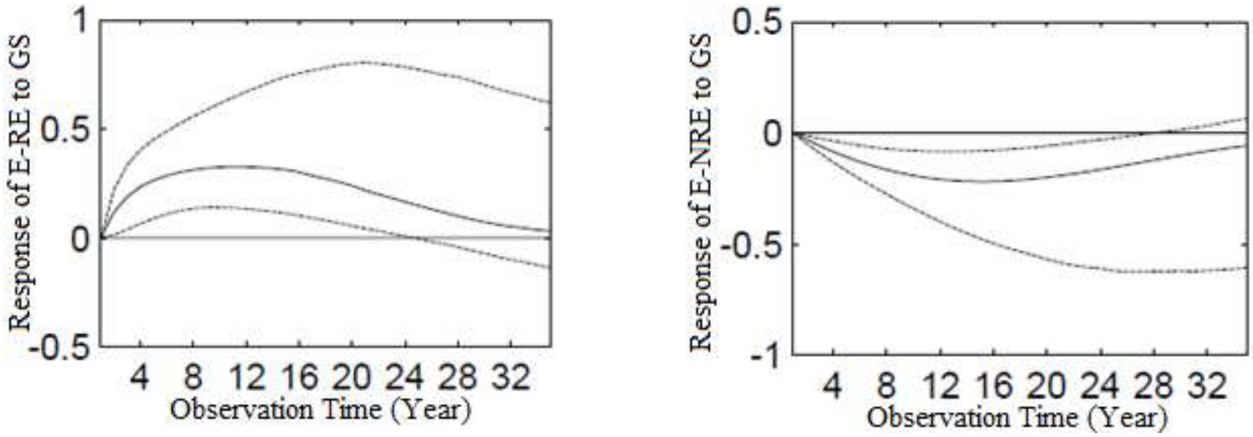

Figure 2. The impact of sustainable development shock on renewable and non-renewable energy
Source: Research findings

Fig. 2 shows positive impact of sustainable development shock on renewable energy and negative impact of sustainable development shock on non-renewable energy. In other words, sustainable development shock and achievement of higher levels of sustainable development in the country will increase the focus on environmental quality and social welfare, which are other elements of sustainable development. Therefore, government should encourage more investment to expand renewable energies and reduce fossil fuel consumption. Fig. 3 shows the effects of renewable and non-renewable energies shocks on CO_2 emmision.

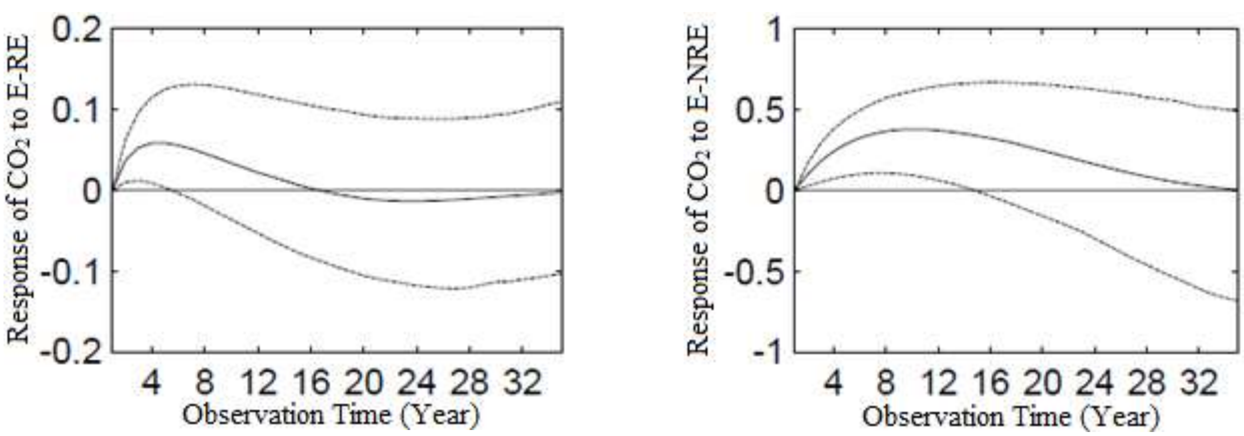

Figure 3. The impact of renewable and non-renewable energies shock on CO_2 emmision
Source: Research findings

The positive renewable energy shock increased carbon dioxide emissions, but after 3 periods, air pollution was reduced. The positive non-renewable energy shock increased the air pollution and this effect was eliminated after 33 periods.

Conclusion

In the present study, the interrelationship between renewable and non-renewable electricity generation, sustainable development and CO_2 emissions were investigated from 1980 to 2013 in Iran. The unit root tests, cointegration test, Bayesian Vector Autoregressive model and Impulse response functions were employed to estimate the proposed model.

According to the findings, there is a co-integration relationship among the variables of the model. Also, based on RMSE, SSVS-full prior function in GS, E-RE and CO_2 model and Normal-Wishart prior function in GS, E-NRE and CO_2 model were nominated as the most appropriate functions. The results of impulse response functions can be expressed as follows:

Based on the results in Fig. 1, positive shocks of renewable and non-renewable energies have a positive impact on sustainable development in Iran. The response of sustainable development to non-renewable energy shock is not significant; but during the examined period, the response of sustainable development to renewable energy shock was positive and significant, which indicates the high sensitivity of sustainable development to renewable energy. Also, as shown in Fig. 2, renewable energy has positive response to sustainable development shock and non-renewable energy has negative response to it. In other words, the growth of sustainable development increases the use of renewable energy and decreases non-renewable energy consumption.

Although, consumption of renewable and non-renewable energies increases sustainable development, the promotion of sustainable development leads to reduction of non-renewable energy use and renewable energy will replace fossil fuel. In order to achieve sustainable development, especially in developing countries such as Iran, it is necessary to use different types of energies (renewable and fossil fuels). It is impossible to achieve sustainable development by using only renewable resources and discarding non-renewable resources because of their environmental damages. Renewable energy resources have considerable limitations and barriers. The electricity generation capacity is not large enough as compared to traditional forms of energy generation like fossil fuel. Also, renewable energy technologies depend on weather (such as sun and wind) to be able to harness any energy; hence, renewable resources can be unreliable. These limitations reduces the stability of energy supply and a balance of different energy sources (including renewable and non-renewable energies) is required to achieve sustainable electric power.

As shown in Eq. 1, gross national savings (GNS) is the most important factor of sustainable development, so it is essential to focus on it and attempt to grow it in the short term. For this purpose, different types of energy (renewable and non-renewable) must be used in the energy sector. But in the long run, it is important to pay attention to other components of sustainable development, such as reduction of natural resources and emission of environmental pollutants. Therefore, the growth of the sustainable development index will increase the tendency towards investment in the renewable energy sector.

Moreover, the growth of renewable and non-renewable energies use increases carbon dioxide emissions, but the effect of non-renewable energy consumption on environmental pollution is more than that of renewable energy consumption. As mentioned in previous sections, renewable energy sources produce less pollution than non-renewable energy; therefore, the use of renewable energy sources is preferred to non-renewable resources.

Overall, attention on GNS growth as a fundamental component of sustainable development leads to high consumption of energy that causes environmental pollution. Thus, it is suggested that policy makers support the energy diversification policies and increase the share of renewable resources. Also, GDP is a suitable indicator to measure financial variations, but it is not appropriate for the challenges that will be faced by the society in the near future. Thus, policy makers must consider genuine savings (GS) indicator in macroeconomic decisions. The adoption of GS as an efficient indicator can make policymakers to implement energy efficiency policies.

References

Amri, F. (2016). The relationship amongst energy consumption, foreign direct investment and output in developed and developing Countries. Renewable and Sustainable Energy Reviews, 64, 694-702.

Antonakakis, N., Chatziantoniou, I. and Filis, G. (2017). Energy consumption, CO 2 emissions, and economic growth: an ethical dilemma. Renewable and Sustainable Energy Reviews, 68, 808-824.

Apergis, N. and Payne, J. E. (2012). Renewable and non-renewable energy consumption-growth nexus: evidence from apanel error correction model. Energy Economics, 34, 733-738.

Ardestani, M. Shafie-Pour, M. and Tavakoli, A. (2017). Integration of Green Economy concept into Fossil Fuels (Production and Consumption: Iran). Environmental Energy and Economic Research, 1(1), 1-14 (In Persian).

Baris, K., and Kucukali, S., (2012). Availability of renewable energy sources in Turkey: Current situation, potential, government policies and the EU perspective. Energy Policy, 42, 377-391.

Belaid, F. and Yussef, M. (2017). Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria. Energy Policy, 102, 277-287.

Bozoklu, S. and Yilanci, V. (2013). Energy consumption and economic growth for selected OECD countries: Further evidence from the Granger causality test in the frequency domain. Energy Policy, 63, 877-881.

Cowan, WN., Chang, T., Inglesi-Lotz, R. and Gupta, R. (2014). The nexus of electricity consumption, economic growth and CO_2 emissions in the BRICS countries. Energy Policy, 66, 359-68.

ENVI, (2011). Impact of Shale gas and shale oil extraction on the environment and on human health. European Parliament Committees.

Fakher, H. A. and Abedi, Z. (2017). Relationship between Environmental Quality and Economic Growth in Developing Countries (based on Environmental Performance Index). Environmental Energy and Economic Research, 1(3), 300-310 (In Persian).

Fotros, M.H., Aghazadeh, A. and Jebraeili, S. (2013). Investigation of the effect of renewable and non-renewable energy consumption on economic growth in selected developing countries (including Iran). Journal of Energy Economic Studies, 9(32), 51-72 (In Persian).

Furuoka, F. (2015). Electricity consumption and economic development in Asia: new data and new methods. Asian-Pacific Economic Literature, 29(1), 102-125.

Gaspar, J., Marques, A. C. and Fuinhas, J. A. (2017). The traditional energy-growth nexus: A comparison between sustainable development and economic growth approaches. Ecological Indicators, 75, 286-296.

IEA. (2016). International Energy Agency. , https://www.iea.org/.

IRENA. (2016). Renewable energy benefits: measuring the economics. IRENA, Abu Dhabi, https://www.irena.org/.

Koop, G. and Korobilis, D. (2010). Bayesian multivariate time series methods foe empirical macroeconomics. Manuscript available at http://personal.strath.ac.uk/ gary.koop/.

Maji, I.K. (2015). Does Clean Energy Contribute to Economic Growth? Evidence from Nigeria. Energy Reports, 1, 145–150.

Mezghani, I. and Haddad, H. B. (2016). Energy consumption and economic growth: An empirical study of the electricity consumption in Saudi Arabia. Renewable and Sustainable Energy Reviews, 75, 145-156.

Omri, E., Chtourou, N., and Bazin, D. (2015). Solar thermal energy for sustainable development in Tunisia: The case of the PROSOL project. Renewable and Sustainable Energy Reviews, 41, 1312-1323.

REN21. (2013). Renewables 2013 global status report, Paris, www.ren21.net.

Sahebhonar, H. and Nadri, K. (2014). The economic analysis of the oil revenues increase impact on income distribution with a BVAR approach: case study of Iran. Journal of Iranian Energy Economics, 3(9), 115-149 (In Persian).

Sebri, M. and Ben-Salha, O. (2014). On the causal dynamics between economic growth, renewable energy consumption, CO 2 emissions and trade openness: fresh evidence from BRICS countries. Renewable and Sustainable Energy Reviews, 39, 14-23.

You, J. (2011). China's energy consumption and sustainable development: Comparative evidence from GDP and genuine savings. Renewable and Sustainable Energy Reviews, 15, 2984-2989.

Wang, Z. and Feng, C. (2015). A performance evaluation of the energy, environmental, and economic efficiency and productivity in China: an application of global data envelopment analysis. Applied Energy, 147, 617-626.

WCED, U. (1987). Our common future. World Commission on Environment and Development, Oxford University Press.