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The Role of South Pars Gas Field on Economic Growth of IRAN

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A B S T R A C T

IRAN economic Growth relies much on natural resources, leading to large quantities of greenhouse gas emissions. Petrochemical Sector is no doubt, vital for the stimulation of economic growth of any country, IRAN is not an exception. This sector needs more government assistance in technology expansion, and financial help in order to grow faster and compete with global competitors. This article presence the current scenario of the petrochemical industry in IRAN. South Pars Gas Field is the largest gas field in the world. This field in the Persian Gulf and is located on the border of Iran and Qatar. In it, Dalan–Kangan formations are containing gas reservoirs. Energy (renewable and non-renewable) plays a major role in the production process in the national economy. Natural gas (NG) plays a major role in linking fossil fuels to renewable fuels. When associated with other fossil fuels (coal and oil), NG produces half of the pollution. Current technological advancements have sparked a surge in natural gas production in the IRAN, with increased supplies and significantly cheaper costs expected well into the future. On the other hand, South Pars gas field as one of the world's largest gas fields can play key role on Iran's energy future. Therefore, in this research, effect of South Pars development projects on energy and consequently, economy of Iran has been discussed.

Keywords

South Pars Gas Field, Economic Growth, Natural Gas (NG), IRAN

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1. Introduction

The worldwide consumption of natural gas is rapidly increasing. To satisfy such a demand, there are some plans to transport natural gas from South-Pars gas field, the largest natural gas field of Iran, to some energy consuming countries. There are several possible technologies for transporting gas from production fields to consuming markets as gas, including PNG (pipeline natural gas), LNG (liquefied natural gas), CNG (compressed natural gas) and NGH (natural gas hydrate). Gas transmission projects are sensitive to technology selection and depending on the capacity and distance; chosen technology may affect the economy of the entire project noticeably. In this work, transporting 100×106 standard m3/d natural gas from port of Assaluyeh in south of Iran to potential markets using alternative technologies such as PNG, LNG, CNG and NGH has been investigated. To do such a study, required processes for converting natural gas to desired product and then transporting it to market have been designed and using an economical model, cost of transporting natural gas as a function of distance, has been estimated. Results show for the investigated case, PNG has the lowest production cost for distances up to 7600 km and for larger distances, LNG has the lowest production cost (Najibi et al, 2009).

The reserves of natural gas increased 18.2% between 2007 and 2017 worldwide, reaching 193.4 Trillion Cubic Meters [TCM] according to the following distribution: 40.9% in the Middle East, 30.6% in the Commonwealth of Independent States (CIS), 10.0% in Asia Pacific, 7.1% in Africa, 5.6% in North America, 4.2% in South and 1.6% in Central America and Europe. The production of natural gas between 2007 and 2017 raised 25.12% worldwide, ranging from 2.94 to 3.68 [TCM], allocated as follows: North America 25.9%, CIS 22.2%, Middle East 17.9%, Asia Pacific 16.5%, Europe 6.6%, and Africa 6.1%, South and Central America 4.9% [3]. In contrast, world consumption between 2007 and 2017 increased by 24.08%, from 2.96 to 3.67 [TCM]. The reported share of energy consumption was: North America 25.7%, Asia Pacific 21.0%, CIS 15.7%, the Middle East 14.6%, Europe 14.5%, South and Central America 4.7% and Africa 3.9% (Becerra-Fernandez et al, 2020). Natural gas is one of the important energy resources and recently its worldwide consumption is rapidly increasing because of the growing demand for clean energy and environmental concerns. It is predicted that the natural gas demand increases at an average rate of 2.4 percent annually until 2030 in the world (Javanmardi et al, 2006).

The South Pars field is a natural gas condensate field located in the Persian Gulf. It is the world's largest gas field, shared between Iran and Qatar. According to the International Energy Agency (IEA), the field holds an estimated 50.97 trillion cubic meters (1800 trillion cubic feet) of in situ gas and some 50 billion barrels of condensates and the field recoverable gas reserve is equivalent to some 215 billion barrel of oil and it also holds about 16 billion barrels of recoverable condensate corresponding of about 230 billion barrel of oil equivalent recoverable hydrocarbons. The estimates for the Iranian section are 500 TCF (14.2 TCM) of gas in place and around 360 TCF (10.1 TCM) of recoverable gas which stands for 36% of Iran's total proven gas reserves and 5.6% of the world's proven gas reserves (Samadi Afshar & Chabook,2016). Recently Iran has focused its energy sector on the exploration of the South Pars offshore natural gas fields in the Persian Gulf. Natural gas has been the main energy in

Iran in recently years, comprising over 58% of energy needs, while oil and hydroelectricity accounted for 39% and 2%, respectively.

2. South Pars Gas Field (SPGF)

South-Pars gas field is the largest Iran's natural gas field. It is geologically an extension of Qatar's 10.2×10^{12} standard m^3 North Field. South-Pars was first identified in 1988 and estimated to contain 3.4×10^{12} standard m^3 of natural gas or even more. Natural gas from South-Pars is planned to be transported to port Assaluyeh by pipelines where having separated liquid hydrocarbons, the natural gas is intended to feed some petrochemical plants, boost the pressure of some mature oil reservoirs, be exported by pipelines and possibly by liquefied natural gas (LNG) (Javanmardi et al, 2006).

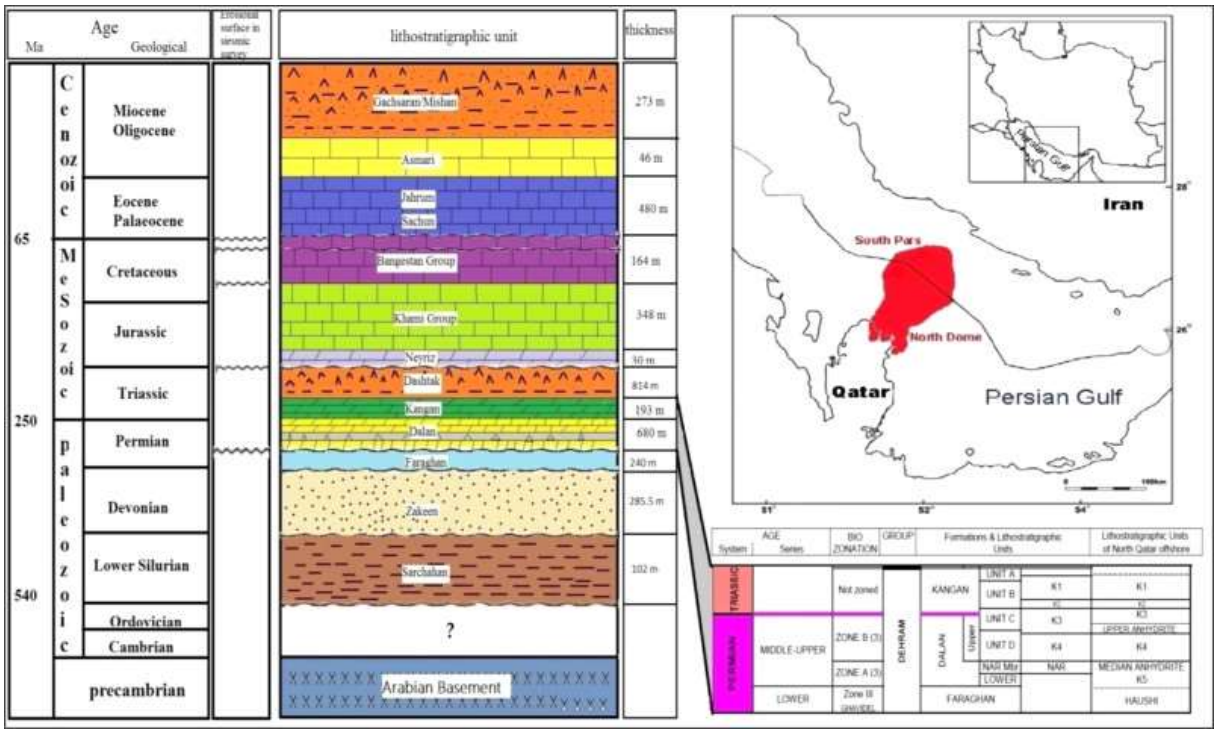

Fig. 1. Location map of South Pars Gas Field in the Persian Gulf (right) and stratigraphic position of the studied formations (left) (Sfidari et al, 2014)

The Upper Dalan and Kangan formations (equivalent of Khuff in the Arabian nomenclature) host part of the world's largest gas reservoir in the Middle East region. This field along with its southern extension, Qatari Dome, regionally called North Dome field, is the largest offshore gas field in the world. The Qatar arch is a north–northeast trending positive tectonic feature, extending into Persian Gulf and effectively dividing it into two basins. The eastern side of the Arch is a gently dipping monocline and the western side is bounded by Kazerun fault as mentioned and mapped by several authors (Konert et al, 2001; Ziegler, 2001). SPGF lies on the north–northeast plunge of this Arch. The Qatar structural Arch has had a fundamental influence on the tectonic pattern of the Persian Gulf and separates its trough in the central part of the Persian Gulf basin (Saudi Arabia, northern branch of the Persian Gulf and Bahrain) and Rub-Al-Khali in the U.A.E. (Ziegler, 2001).

3. Natural Gas, Petrochemical Industry & Economic Growth

3.1. Natural Gas (NG)

Coal was the driving force behind the Industrial Revolution in the 19th century, and crude oil took over that role in the 20th century. However, due to environmental concerns, the global energy demand has shifted to lower carbon fuels since the late 20th century. Natural gas is considered as a "transition fuel" toward a cleaner, more sustainable and environmentally-friendly energy supply (Soltani et al, 2021). Natural gas consists mainly of methane (80 to 95% by volume) and other light alkanes, commonly utilized for industrial electricity/heating load generation. Based on the anticipated data, the remaining reserve gas is about 6.879 trillion cubic feet. It is projected that the demand for natural gas will increase to 203 trillion cubic feet in 2040. To synthesize relatively pure methane (93 vol %), natural gas is first dewatered before distribution through pipelines, and after that it is devoid of carbon dioxide, hydrogen sulfide, and higher alkanes (Syah et al,2021). Natural gas fulfills almost 24% of the world's primary energy demand. One of the world's largest natural gas reserves is located in Iran, so the country is highly dependent on natural gas, from which 71% of the nation's required energy was generated in 2021. The natural gas value chain encompasses upstream, midstream, and downstream operations and activities to fulfill customer needs. Conventionally, after gas production and extraction, it is injected into the pipeline and transported to distributors. As a major energy source and a comparatively cleaner burning fossil fuel, natural gas has observed increasing demand in recent years. Gas delivery systems, including transportation and distribution, cannot satisfy the high demand for the product, thus, resulting in a widely unstable gas supply system with high and fluctuating prices. To remedy this situation, gas storage and underground gas storage ("UGS") in particular, guarantee the gas supply and enable the suppliers to meet gas demands (Shabani Jahromi & Shabani Jahromi, 2023).

3.2. Economic Growth

Economists have always been drawn to economic growth to understand better how it is achieved. Several questions have been proposed in this regard to obtain answers. For instance, what growth model does the economy follow? Why are there fluctuations in economic growth path in a specified economy? What factors cause some countries to grow at a faster rate than others? Numerous theoretical and applied research papers in the literature have analyzed the process of economic growth in both developed and developing countries. Indeed, in the case of developing countries and emerging markets, the importance of analyzing the evolution of economic growth is amplified. The main reason for this is the belief of the vast majority of economists that economic growth is the optimal way to alleviate poverty and achieve long-term development (Lotfy et al, 2023).

3.3. Petrochemical Industry

Economic analyses can help decision makers to decide the best approach to monetize gas resources. This can focus on fuels, like ethane-rich natural gas and liquefied petroleum gas (LPG), or petrochemical feedstocks, like lean natural gas, pure ethane and propane. Fuels such as LPG are the usual choice of natural gas processing facilities, although market changes may require new strategies concerning how natural gas richness is explored. Since petrochemicals are a non-carbon emitting use of fossil fuels, at least if dedicated to long-

lasting materials, its profitable production could endure even in greenhouse gas emissions restriction scenarios. In addition, Platts (2021) estimates that world natural gas use in chemicals and plastic could increase from 4.8 boe/d in 2020 to 15.9 boe/d in 2050, and refined oil in chemicals and plastic production will increase from 17.9 in 2020 to 28.7 boe/d. Besides naphtha, both ethane and propane are relevant petrochemicals feedstock (dos Santos et al, 2022).

South Pars Industrial Zone is located near an Assaluyeh city on the coast of the Persian Gulf and is known as the energy capital of Iran. In the last hundred years, to reach more manufacturing, supplying and consumption, using fossil fuel increased in industries, such as refineries, petrochemical and industrial complexes, etc. It is worth mentioning that there is a reliable planning and allocation sector which is associated with population and consumption, and that forecasting is crucial. Because of its operational features, NG can be distributed to different sectors of energy consumers. NG is the main fuel used by petrochemical and refinery industries to gain added value. However, a significant proportion of NG is consumed in transportation, domestic heating and cooking, and industry. NG allocation should be associated with the expansion of social welfare over time, and this measure must be considered as the opportunity cost of gas distribution to various sectors. Consequently, the cost of allocation between the NG exploitation time and various sectors' uses should be minimized. Hence, a function of the profit and costs of gas allocation to the different sectors should be considered. In fact, optimally allocating limited sources of NG to different consumers is a crucial political and economic challenge (Meidute-Kavaliauskiene et al, 2021). Moreover, based on the report published in a statistical review of world energy markets, Iran has 17.3% of the world's whole natural gas reserves and has been ranked as the second richest country in this regard. So, it can be considered a promising region to investigate and develop Ethylene, Polyethylene, propylene and methanol and etc., production plants. From technical viewpoint, a significant chunk of natural gas includes methane and other components of natural gas; for instance, ethane can be produced through steam cracking. In addition, other natural gas components such as propane and butane can be used to produce propylene and butadiene, respectively. These olefins are the building blocks of many chemicals, namely, resins, plastics, and adhesives. Reportedly, ethylene generation in 2015 was around 150 million tons, and it is projected that the worldwide demand for olefin will increase steadily at a rate of 1.5–4.1% per year. In contrast to olefin production from light naphtha cracking, olefins can also be produced from natural gas condensates. This is the least expensive method of producing olefins in the United States. Utilizing natural gas as a feed is the more environmentally friendly process as it generates lower carbon dioxide (Syah et al, 2021).

3.4. Natural Gas & Economic Growth

Energy is a main ingredient in the process of production and the backbone of the industrial sector. In this sense, the targets of economic growth cannot be achieved without the use of energy sources, and concurrently economic growth increases the level of energy use. Since 1973, during the period of oil crises, the theory of unit elasticity has taken importance. According to this theory, a unit change of economic growth leads to one unit change in use of energy sources, as was apparent in OECD countries during the1973–74 oil crises (Li et al,

2021). Natural gas (NG hereafter) is an alternative non-renewable energy source that boost economic activities in nations endowed with huge deposit either developed, developing or emerging economics. NG a form of hydrocarbon gas element occurs naturally, consisting primarily of methane, generally, NG most frequently constitute varying amounts of other higher alkanes sometimes a small fraction of carbon dioxide, nitrogen, hydrogen sulfide, or helium. In the face of continuous decline in oil reserves in most oil producing economies, NG has been identified as a suitable alternative as it produces 30% less carbon dioxide than crude oil and 45% less than burning coal (Balsalobre-Lorente et al, 2019).

With the industrial revolution in the world, the relationship between energy consumption and economic growth has had an undeniable dimension. As it is known, the energy needs of the industry can be met mostly from underground fossil fuels with high calories, and these resources also bring with them the intolerable risk and cost cycle. It is necessary to develop energy policies by taking into account the effects of increasing energy consumption, global warming, and the chain reactions that cause it, which are fundamental to the industry (Korkmaz, 2022). As mentioned before, energy resources are one of the primary determinants of a growing economy. The economic growth in most countries of the globe is unstable because of addiction to fossil energy sources (oil, gas, coal). After all, it is undeniable that the irrational use of natural resources negatively influences the environment (Shvartsburg et al, 2017).

The debate on the relationship between energy consumption and real income growth led to the emergence of divergent views. Neo-classical economists pointed out that energy is an intermediate good rather than a primary input for production. On the opposite view, ecological economists criticize the neo-classical views due to the account for two laws of thermodynamics: mass-balance principal and entropy law. Based on these two laws, for ecological economists, energy is a fundamental factor in the production. From this perspective, the possibility of decoupling energy use from economic growth seems more limited (Heidari et al, 2013).

3.5. South Pars Gas Field and IRAN Economic Growth

As of December 2017, 22 onshore and offshore gas fields were active, including 18 onshore and four offshore gas fields. The natural gas transmission system plays a decisive role in the supply of gas to consumers. The main components of this system are gas transmission lines, gas pressure-raising and reducing facilities and distribution networks. At the end of 2017, more than 38.4 thousand kilometers of gas transmission lines have been constructed and 288 turbochargers are operating in 81 gas pressure boosting stations in the country. Natural gas accounts for the largest share (88.4%) of total fuel consumption in the country's power plants. According to the country's energy policy, efforts have been made to use natural gas in power plants because of ease of operation, lower maintenance costs and less adverse environmental effects. The largest consumer of natural gas is the residential sector (39.1%), followed by industry (24.9%) and petrochemical (21.8%). The South Pars gas field is the largest in the world. It is located at the depth of 3000 m below the bottom of the Persian Gulf is jointly in the territorial waters of Iran and Qatar. The area of this field is 9700 square kilometers, of which 3700 square kilometers are in the territorial waters of Iran and the rest are in the

territorial waters of Qatar. The field is mainly developed by local companies. The Iranian share of the field is 14 trillion cubic meters of in situ gas and 18 billion barrels of gas condensate (9 billion barrels of recoverable gas), which represents 50% of Iran's proven natural gas reserves and 8% of the world's gas reserves. One of the goals of the National Iranian Gas Company is to increase the export of natural gas to regional and international markets. In this regard, Iran has been exporting gas to neighboring countries for many years, having enough gas for domestic consumption and export. Turkey, Armenia, Azerbaijan, Nakhichevan and Iraq are the current markets of Iranian gas exports. Iran also imports natural gas from Turkmenistan and Azerbaijan, as well as exports to Turkey, Nakhichevan, Azerbaijan, Armenia and Iraq. The country's natural gas imports in 2017 reached about 3.9 billion cubic meters and its exports reached 13.2 billion cubic meters. (Solaymani, 2021).

The adoption of NG as a feasible alternative to other fossils fuels has resulted in an increase in Iran's domestic consumption of NG. This increment is also noticeable in exports as the country's NG exports increased by five-fold to 60 billion m^3 by 2014 as outlined by Iran Oil Ministry Annual Bulletin, 5th edition. This increase in NG consumption is a result of the combination of the following factors: reduction in the domestic supply price of NG, wasting energy technologies, inappropriate and abundant use of NG. This consumption situation raises certain issues; on one hand, one may assume that increased NG consumption will produce a cleaner environment and birth economic prosperity, while on the other hand however, numerous researchers have suggested that in general, resource extraction often crowds out other economic activities, especially manufacturing, and reduces the growth impact of other sectors of the economy. The above assertion is known as Dutch disease hypothesis. Thus, it pertinent to examine how NG affects the economic growth of Iran. Also, while NG demand may be able to affect economic growth, economic growth may also have effect on NG demand, as the strength of an economy can influence the energy market. For example, during periods of boom, increases in demand for goods and services may cause increases in NG consumption. Thus, the need to underpin the directional causality flow between NG consumption-economic outputs is pertinent and timely (Balsalobre-Lorente et al, 2019).

In recent decades despite the economic aspects of development, everyone seems to have accepted that development is more than economic growth aside from improving the material and social justice, honor the values and traditions of indigenous covers. Nevertheless, development can be considered a process that makes the living conditions unfavorable to favorable conditions. Generally, industry entry to local communities caused changes in the structure of ecological, economic and social relations, livelihood and lifestyle and the people of the region. However, sometimes the officials of his attention will be focused solely on economic growth and development. This despite the fact that during the course of industrial development should not be indifferent to the changes in the local communities over community development projects near the indigenous people of the area that they neglect is that why industrial development can be considered as certain conditions was conducive to social development. In addition, its positive effects in addition to furthering the objectives of development projects, the presence of oil and gas industry in the province due to its economic potential top (Hashemi & Rashidi, 2016).

Iran owns the second largest oil and gas reservoir in the world. Iran is also the fourth largest producer and consumer of gas and the fourth largest producer and exporter of oil in the world. A strong dependency has been created between the oil and gas sectors and the economic growth in the country during the hundred years of oil production and the forty years of development of gas consumption network. Oil revenue is also the biggest provider of the government's budget and the growth of all sectors of the economy directly and indirectly is affected by Petro-dollars (Kiani & Pourfakhraei, 2010).

4. Research Background

Wang et al (2023) in these study that aimed to explore whether nuclear energy can promote economic growth without increasing carbon emissions. In order to have a more comprehensive understanding of the relationship between nuclear energy, economic growth, and carbon emissions, this study also discusses the impact of coal, oil, natural gas, and renewable energy on economic growth and carbon emissions. The second-generation panel unit root test, panel cointegration test, panel fully modified ordinary least squares, and Heterogeneous Dumitrescu and Hurlin causality test were used to estimate the long-term elasticity and causality among variables. Results based on panel data from 24 countries with nuclear energy from 2001 to 2020 show that both nuclear energy and renewable energy can curb carbon emissions. Especially in Canada, Finland, Russia, Slovenia, South Korea, and The United Kingdom, nuclear energy reduces carbon emissions more significantly than renewable energy. Meanwhile, there is a positive relationship between increased nuclear energy, increased renewable energy, and economic growth, which means that nuclear energy and renewable energy could increase economic growth as well. There is a positive relationship between increased oil, increased natural gas, and economic growth, while there is a negative relationship between the increase in coal and economic growth. Meanwhile, there is a positive relationship between increased oil, increased coal, and increased carbon emissions, while the positive relationship between increased natural gas and increased carbon emissions is not significant. Thus, in the 22 countries with nuclear power, increased coal consumption does not drive economic growth but increases carbon emissions. Increased oil consumption increases economic growth, but it increases carbon emissions. Increased natural gas consumption boosts economic growth but adds little to carbon emissions. In the authors' view, nuclear power and renewable energy are all options for these nuclear-power countries to pursue economic growth without increasing carbon emissions. Moreover, nuclear power has a better effect on curbing carbon emissions in some countries than renewable energy. Therefore, under the premise of safety, nuclear power should be seriously considered and re-developed.

Maddah et al (2022) Using dynamic panel threshold kink model approach, this paper measures the threshold level of political competition maximizing economic growth in the provinces of Iran during the years 2000–2019 and analyzes the moderation role of political competition in functioning of the resource curse hypothesis. Our results show that various indicators of political competition have a threshold effect on economic growth and the nonlinear relationship between political competition and economic growth is confirmed as U-shaped, based on which political competition above the threshold level leads to more economic growth. We also find that political competition affects the functioning of resource

curse hypothesis in the provinces of Iran by moderating the effect of oil revenues on economic growth. Considering the spatial effects in the dynamic panel threshold kink regression model, which has been modeled for the first time in the provinces of Iran, has led to the robustness of the research findings. Our findings support the positive and significant effect of political competition on economic growth in countries with natural resources.

Maruf Hasan & Yousaf Reza (2022) in his research investigates the nexus between natural gas consumption (NGC), economic growth (EG), urban population, unemployment, and services value-added in Bangladesh during 1990–2019. This study employs various quantitative methods, including autoregressive distributed lag (ARDL), ARDL bounds and vector error correction models to estimate the impacts of NGC on key economic factors to approximate the short and long-run cointegration bond. According to the findings, EG, NGC, unemployment, urban population, and service value-added are all cointegrated in both short and long-term interactions, which mean that gas consumption causes economic growth. The empirical results also estimate that unemployment and urban population found significant relationships with NGC. NGC and EG have a bidirectional link, according to the findings on causality breakdown. Also, it is found the association between urban population, unemployment, and service value-added and NGC is bidirectional. Therefore, to regulate both NGC and other factors could help Bangladesh's prospects for achieving development goal under Vision-2041 over future. Further policies may employ our findings to state applicable policies to enhance the economy, environment and to reduce carbon emission using modern technologies across Bangladesh.

Muhammad (2019) in his study by objective to examine the effect of economic growth, energy consumption and CO2 emissions on each other for a panel of 68 countries. He used panel data from 68 countries over the period 2001–2017 for developed, emerging and the Middle East and North Africa (MENA) countries. I applied seemingly unrelated regression (SUR) and dynamic models estimated through means of the generalized method of moments (GMM) and System generalized method of moments (Sys GMM) for data analysis. The estimated empirical results indicates that economic growth increase with increase in energy consumption in developed and emerging countries while declined in MENA countries; CO2 emissions increase in all countries due to increase in energy consumption. Energy consumption increase in all countries but economic growth increase in all countries except MENA due to increase in CO_2 emissions. The CO_2 emissions increase while the energy consumption decrease in developed and MENA countries but energy consumption increase and CO_2 emissions decrease in emerging countries due to increase in economic growth. Based on the estimated results it is recommended that the policy maker in these countries should adopt such strategies that should focus to adopt environmentally friendly technologies to decrease the CO2 emissions.

Furouka (2016) in his paper examined the relationship between natural gas consumption and economic development in two largest natural gas consumers in Asia, namely, China and Japan for the period of 1980–2012. It used the autoregressive distributed lags (ARDL) method for the empirical analysis. The findings revealed some similarities in the natural gas consumption and economic development nexus in China and Japan. Thus, a cointegration relationship

between natural gas consumption and economic development was found to exist both in China and Japan. However, there was an important difference in the findings. In the case of China, the findings indicated the existence of a unidirectional causality from natural gas consumption to economic development, which was in line with the growth hypothesis. In Japan, there was bidirectional causality between natural gas consumption and economic development, which supported the feedback hypothesis.

5. Conclusion

The fulfillment of maintainable economic growth is the objective of nearly every nation. Inside this scope, energy has an imperative key part since it is a basic input within the generation preparation. Alike, energy may be a noteworthy vital asset for countries additionally the asset calculation sets the limits of both economic and social advancement. It plays a critically imperative part in touting and securing a state's economy. It is broadly accepted that energy is critical, and one of the most components of economic growth & development. In the context of the importance of natural energy resource utilization, specifically, oil, coal, natural gas consumption, and their implications for economic development & growth, we focused on the natural gas. Our empirical findings lead us to conclude that there is a long-term association between Natural Gas & Economic Development & Economic Growth. Iran’s economy is heavily dependent to energy sector. Also, natural gas is one of the main energy sources in Iran. Hence, developing of South Pars gas field projects can have a significant role on Iran’s energy and economy future. Because, by increasing of natural gas production and optimal consumption, in addition to domestic needs in term of energy, export increasing will be achieved too. As a result, it helps to achieve economic and political security and finally by improving economic and political status, social welfare, and gross domestic product (GDP) growth will be better.

With regards to this trend investigating the empirical relationship between natural gas consumption and economic growth has important implications for policy makers. If there is a unidirectional causality running from natural gas consumption to economic growth, natural gas conservation policies are likely to have adverse effects on economic growth? In contrast, if there is a unidirectional causality running from economic growth to natural gas consumption, Natural gas conservation policies can be implemented. On the other hand, if there is no-causality running in any direction the natural gas conservation policies have no effect on economic growth. In contrast, if there is bidirectional causality between natural gas consumption and economic growth, natural gas consumption and economic growth are jointly determined and affected at the same time. But, the results of empirical studies on the causal relationship between natural gas consumption and economic growth have been mixed and conflicting.

Conflicts of Interest

The author has seen and agrees with the contents of the manuscript and there is no financial interest to report. I certify that the submission is original work and is not under review at any other publication.

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