Analysis and study of the effects of the blue economy on the economic structure of the Islamic Republic of Iran

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Abstract

The blue economy is an ocean economy that aims to improve human well-being and social equity while also reducing environmental risks. The blue economy refers to the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and the health of ocean ecosystems is also ensured. By accessing the sea and taking advantage of its opportunities and potential, Iran can take steps towards economic growth and development. The present study seeks to identify the economic benefits of focusing on a sea-based economy, and the main research question is: What is the overall impact of focusing on the blue economy on the welfare and economy of Iran?In this study, the economic effects of focusing on the blue economy (fishery and aquaculture sector, maritime transportation, and oil and gas extraction from the seabed), based on the Multi-Regional Computable General Equilibrium Model (GTAP) and version 10 of its database, have been analyzed through 3 scenarios: 1. 90% reduction in tripartite tariff rates 2. Increased productivity of tripartite employees 3. Increased productivity in tripartite intermediate production factors with the GEMPACK software package.The results of this study show that by reducing the tariff on the aquaculture sector, the volume of aquaculture production will decrease, by increasing the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed, the welfare of Iran will increase, and by increasing the productivity of labor and intermediate inputs in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed, the trade balance of these two sectors will become positive.

Highlights

- The most important policy recommendation for the country, based on the research results, is that focusing on blue economy, especially paying attention to the maritime transportation sector, can be considered as a suitable policy option.
- Training and productivity of the workforce employed in blue economy sectors can lead to increased production.

1. Introduction

The definition of a marine economy, which is generally referred to as a blue economy in the global literature, is the sustainable use of the capacity of water resources and areas, including oceans, seas, lakes and islands, for economic growth, improving livelihoods and creating employment, and ultimately increasing gross domestic product. Therefore, the field of marine economy goes beyond fisheries and marine tourism and requires the emergence and support of water and sea-related industries, including maritime transport, maritime tourism, renewable energy, aquaculture and fisheries, marine biotechnology, biometeorology and marine mining.

Iran can take steps towards economic growth and development by accessing the sea and taking advantage of its opportunities and potentials. The country's potentials in the field of sea-based economy include access to open waters, small and large islands, port cities with diverse commercial, fishing, tourist and industrial functions, fishing (fishing, aquaculture), marine tourism, maritime transport, shipbuilding, subsurface resources, oil and gas mines and refineries, ports, wharves and marine structures, bunkering (fueling ships) and environmental activities. Today, more than 90 percent of world trade is carried out through maritime transport. Ports play an active role in the economic growth of countries. Ports are not only active in the field of transportation, but are also effective in the management cycle and have a strategic role in domestic and foreign development for developing and developed countries.

Sea-based development and the marine economy, which have recently received more attention than ever before and have also been mentioned in the Seventh Development Plan, can have great economic effects for Iran. Accordingly, the present study seeks to identify the economic benefits of focusing on the marine economy. The main question of the study is: What effect does focusing on the blue economy have on welfare, changes in the trade balance and employment, and the country's economic structure in general?

For this purpose, in this study, the economic effects of focusing on three important sectors of the sea-based economy, namely fishing and aquaculture, maritime transport, and oil and gas extraction from the seabed, on welfare, trade balance, and employment, based on the Global Trade Analysis Project (GTAP) model and version 10 of its database (version 10 of the GTAP database was published in 2020), through three scenarios: 1. 90 percent reduction in the tripartite tariff rates of the three sectors of fishing and aquaculture, maritime transport, and oil and gas extraction from the seabed 2. Increasing the productivity of the labor force employed in the three sectors of fishing and aquaculture, maritime transport, and oil and gas extraction from the seabed 3. Increasing the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transport, and oil and gas extraction from the seabed, using the GEMPACK software package. It should be noted that, so far, the effects of focusing on the sea-based economy have not been examined using the GTAP model, which is a

multi-regional computable general equilibrium model. For this purpose, the GTAP model has been used in this study.
This paper is organized as follows: After this introduction, the literature on the subject, including theoretical foundations and empirical studies, is presented. Then, in the third section, the model, the database used in the research, and statistical facts are specified. The fourth section is dedicated to the simulation of the model and the presentation of the research findings, and finally, in the fifth section, conclusions and suggestions are presented.

2. Theoretical Foundations

2.1 Blue Economy

Definition of the Blue Economy: Oceans are considered as a repository of living and non-living resources. Since ancient times, the ocean economy has had a distinct place in economic analysis. With the increase in environmental concerns and the unlimited use of marine resources, a new concept called the "blue economy" emerged in parallel (Hazreh and Bukta, 2022). In 2012, the concept of the blue economy was first introduced at the United Nations Conference on Sustainable Development held in Rio de Janeiro (UNCTAD, 2016). Since then, the promotion of the blue economy by various international institutions has begun in order to protect and preserve precious ocean resources. However, initially this new and ambiguous term was often used to mean the "ocean economy" or the "marine economy". To remove the ambiguity of these terms, the United Nations provided a completely distinct definition of the term blue economy in 2016. According to the United Nations definition, the blue economy is an ocean economy that aims to improve human well-being and social equity, while reducing environmental risks and environmental degradation (United Nations, 2016). In 2017, the World Bank introduced a new definition, according to which the "blue economy" refers to the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and the health of ocean ecosystems is also ensured (World Bank, 2017). In this definition, the blue economy has been described differently by different organizations and different authors, some of these definitions are mentioned below.
The "blue economy" seeks to increase economic growth, social inclusion, and maintain or improve livelihoods while ensuring the environmental sustainability of oceans and coastal areas. In this definition, socio-economic development and ocean-related activities are separated from environmental and ecosystem degradation (World Bank, 2017).
The blue economy encompasses a wide range of economic sectors and related policies that determine the sustainable use of ocean resources. This definition considers aspects of ocean sustainability, sustainable fisheries, ecosystem health and pollution prevention (World Bank and United Nations, 2017). The blue economy encompasses all sectoral and cross-sectoral economic activities based on or related to oceans, seas and coasts (European Commission, 2020). The sustainability of the ocean economy is ensured when the long-term capacity of

economic activities and the preservation of ocean ecosystems are in balance (Economist Information Unit, 2015).

In summary, the above definitions state that the blue economy includes all types of economic activities that directly or indirectly ensure the sustainable use of coastal and marine resources. Among these definitions, the World Bank definitions are relatively more acceptable in that they focus on the multifaceted role of the oceans and the sustainable use of their resources (Hazreh and Bukta, 2022). The blue economy emphasizes economic activities dependent on the sea and related sectors such as fishing, transport, maritime tourism and energy (Günter Pauli, 2010). Since the 21st century, the concept of "blue economy" has become increasingly common, with international communities believing that the blue economy consists of 3 main parts: economic coping with the global water crisis (McGlide et al., 2012), innovative and creative economic development (Pauli, 2009), and marine economic development (Behnam, 2012).

The economic effects of various economic policies can be evaluated in various ways. Methods for examining the economic effects of various economic policies are divided into two categories: ex-ante studies and ex-post studies (Elliott and Ikemoto (2004) and Romalis (2008). The time period and study method of ex-ante studies and ex-post studies are different. Ex-ante studies are used to predict or simulate the potential effects of various economic policies. Today, computable general equilibrium (CGE) and partial equilibrium (PE) models are used to conduct ex-ante studies of various economic policies. CGE models are used to predict the effects of various economic policies at a general level and it is not possible to analyze a specific market (Elliott and Ikemoto (2004) and Jayasingh and Sarker (2004). Partial equilibrium (PE) models are used to examine the effects of various economic policies in a specific market or a specific product. Ex-post studies are also used to examine the actual effects of various economic policies. Today, in order to conduct ex-post studies, computable general equilibrium (CGE) and partial equilibrium (PE) models are used to examine the effects of various economic policies at a general level.

Econometric methods are used, taking into account data before and after various economic policies (Jayasingh and Sarker (2004). In the present study, a general equilibrium model (GTAP) has been used. In the present study, the effect of productivity shocks and the elimination of trade tariffs in the aquaculture and maritime transport sectors on the entire Iranian economy has been investigated. In the same framework, studies related to the effects of productivity on the economy, the elimination of trade tariffs, and studies related to the aquatic economy have been presented. First, foreign studies and then domestic studies have been presented.

Bari (2017), in a study titled “Our Oceans and the Blue Economy: Opportunities and Challenges”, has examined the concept of blue economy in the context of sustainability. The results of this study show that Bangladesh as well as South Asia have great potential in the blue economy. The concept of blue economy is quite new in South Asia and Bangladesh. Blue economy is the long-term well-

being of a country or a region by preserving the environment and systematically using ocean resources. Political will, commitments, rigorous research, promoting social awareness and paying attention to the principles of blue economy can be important in the success of a sea-based economy.

In the study of Thompson et al. (2017), sustainable development methods of marine biotechnology, capacities and challenges are discussed. In this study, investment, infrastructure development and human capital are mentioned as important and effective factors in the development of this sector with marine resources.

In the study by Tigar and Garning (2018), factors affecting the development of marine and coastal tourism were examined. The results of this study show that in order to develop marine and coastal tourism, attention should be paid to such things as attractions (quality of natural landscapes and diversity of tourism activities), facilities (banking services, hotels and shops), accessibility (quality of roads and public transportation), human resources (quality of human resource skills, response to complaints, adequacy of human resources), mental image (quality of environmental conditions in terms of cleanliness, air pollution, noise pollution, etc.), and price of services.

In the study by Rogerson and Rogerson (2019), the challenges of the marine-based economy in South Africa were examined with an emphasis on coastal and marine tourism. The results of this study show that investment is the most important factor that can be effective in tourism development.

Al-Hariti and Hanif (2020), in the study titled "The Effects of the Water Economy on Economic Growth in SAARC Countries" using the generalized least squares technique and data from 1995 to 2018, examined the impact of water economy factors on economic growth in the South Asian Association for Regional Cooperation (SAARC) countries. The results of this study show that the water economy plays a statistically significant role in the economic growth of SAARC countries. In this study, total aquaculture production, total fisheries and agriculture production, forestry and fishing, trade, and inflation rate were used as control variables. Proper management and use of water resources is effective on economic growth and addressing food insecurity challenges by improving the supply of seafood in developing countries in South Asia.

Bir et al. (2020), in a study titled "Review of the Blue Economy in Bangladesh: Prospects and Challenges," examined the opportunities and challenges of the ocean-based economy in Bangladesh. The results of this study show that the opportunities and potential of the ocean-based economy for Bangladesh can be summarized in the fields of tourism and biotechnology. They also mentioned the challenges of the ocean-based economy in Bangladesh, such as frequent floods, marine pollution, including ocean acidification, lack of trained personnel, and poor ocean management.

Askari et al. (2024), in a study titled “Pakistan’s Water Economy: Challenges and Prospects”, examined the opportunities and challenges related to the water economy in Pakistan. The results of this study show that in Pakistan, governments

have not paid enough attention to the growth of the ocean economy. Pakistan's maritime sector has huge potential for growth, but it needs favorable policies and substantial investment to realize the dream of sustainable growth. Pakistan's future is linked to the development of the water economy, and a comprehensive strategy in the maritime sector by the government can pave the way for Pakistan's prosperity.

In the study by Amogan Hagiwara (2024), the economic effects of Ethiopia's import tariff reduction with the East and Southern African Common Market (EASM) were examined. The results of this study, which used a multi-regional and stationary computable general equilibrium (GTAP) model, show that the reduction in import tariffs reduces Ethiopia's welfare through two terms of trade effects and the savings investment effect under full employment conditions.

Akomulafe et al. (2022), in a study titled "Challenges and Prospects for the Establishment of the Blue Economy in the Coastal Areas of Ondo State", examined and identified the strengths and weaknesses of the blue economy. The results of this study indicate that the oceans and seas are the engines of the global economy and there is great potential for the growth and development of coastal areas. The natural environment of Ondo State is suitable for tourism and hospitality. The natural occupation of the people of this area is fishing, and the fishing method currently used is outdated and cannot guarantee the welfare of the people. In addition to the oil that is being explored, other resources and minerals have not yet reached their maximum exploitation. Despite the availability of marine resources in this area, the strategies and components of the blue economy have not yet been fully implemented.

In the study of Mehrara and Ahmadzadeh (2009), the contribution of total factor productivity growth to the growth of production in major economic sectors (agriculture, industry and services) was examined. The results of this study show that during the three economic, social and cultural development programs of the country, the contribution of the service sector productivity to the growth of non-oil economy production is higher than that of other sectors and the contribution of the agricultural sector total factor productivity is lower than that of other sectors.

In the study of Mohammadi and Akbarifard (2008), the contribution of productivity shocks to Iran's economic growth was examined. The results of this study show that total factor productivity has a significant effect on economic growth.

Adeli (2019) has studied strategies for the fisheries economy in Iran in a study. The results of this study show that in addition to the necessity of economic studies in the field of fishing and aquaculture and related industries, drawing a clear vision of the fisheries economy requires proper planning based on collective wisdom and stakeholders, development of entrepreneurship and sustainable employment, healthy competition, and customer satisfaction while maintaining the capacity of reserves.

In the study by Hosseini et al. (2019), in order to investigate the development of employment in three dimensions of the marine economy (marine tourism, marine aquaculture, and marine biotechnology) in Bushehr province in Iran, futures research approaches and reliance on planning models were used. The results of this study show that urban competitiveness, model areas and tourism villages, local people's investment in the tourism sector, private sector investment, desirable and extensive coastal lands in the aquaculture sector, and the existence of a special marine science and technology zone, support for domestic production, and export of biotechnology products in the marine biotechnology sector will have the greatest impact on the process of employment development in Bushehr province.

In the study by Nejati et al. (2019), the economic effects of reducing import tariffs between Iran and the Eurasian Economic Union member countries were examined. The results of this study, which used a multi-regional and static computable general equilibrium model (GTAP), show that reducing import tariffs between Iran and the Eurasian Union member countries can increase the welfare of the countries.

In the study by Akbarpour et al. (2021), the historical obstacles to the sea-based development of the northern shores and hinterlands of the Persian Gulf and the Makran Sea were examined. The results of this study show that the lack of development of these regions is due to two main reasons; the first reason is due to the lack of investment, which itself is due to numerous political, historical, cultural and environmental reasons. The second reason is related to the interference of foreign governments in these regions.

The summary of the studies conducted shows that the productivity of production factors has a positive effect on economic variables, the elimination of trade tariffs can have different effects on the economies of countries and depends on the initial economic conditions of the countries, and studies have also been reported on the effects of the water economy on the economies of countries and coastal regions.

3. Methodology and Data

3.1 Global Trade Analysis Project (GTAP)

In this study, the empirical analysis and quantification of the results were carried out based on the Global Trade Analysis Project (GTAP) model. This model is a computable general equilibrium (CGE) model. The designers of this model provide researchers with the database, software related to solving the model (RunGTAP and GEMPACK), and other necessary documentation. Over the years, various versions of the GTAP model have been created and published, and its scope of application has also expanded. This study used version 10 of the GTAP database (updated in 2020). This data includes the Social Accounting Matrix (SAM) of 143 countries (or regions) and 67 sectors. The data in this matrix are grouped into specific sectors and regions based on the research objectives. GTAPagg software was also used for this purpose. In order to process the data in GEMPACK software, based on the research objectives, the model closure and the

policy impulse (reducing bilateral tariffs in different industrial sectors between Iran and Eurasia) have been considered appropriate. In the model output, the values of the changes of different variables and their decomposition can be seen. The social accounting matrix, equations and behavioral parameters can be extracted from the database.

Figure (1) presents the graphical structure of the GTAP model. The regional household is the core of the model, collecting all income and distributing it through the Cobb-Douglas utility function. In a closed economy without taxes, the only source of income for the regional household is the income from the sale of primary factors of production at factor endowment (VOA(endow)) and represents the value of all goods produced in the economy. Intermediate inputs are also used to produce goods, which is expressed in the figure as VDFA (value of goods sold by firms to other firms at factor endowment). Producers use three sources of income to purchase primary factors of production and intermediate inputs. On the one hand, private households and the government purchase goods from firms, which are represented in the figure by VDPA (value of domestic goods purchased by private households at factor prices) and VDGA (value of domestic goods purchased by government at factor prices). Before this, private households and the government are allocated a certain proportion of regional income, which is expressed as PRIVEXP (regional household expenditure allocated to private households as income) and GOVEXP (regional household expenditure allocated to government as income), respectively. The third source of firms' income is investment (NETINV), this amount is determined by the savings rate determined by the performance of the regional household and is then transferred to producers through the bank (Global Savings). In order to complete this cycle in a closed economy without taxes, it is assumed that saving equals investment. In an open economy, private households, the government, and producers can interact with the rest of the world. Thus, private households and governments can import goods, the value of imported goods purchased by private households at factor prices and the value of imported goods purchased by the government at factor prices are shown in the figure as VIPA and VIGA, respectively. Producers can also interact with the rest of the world, producers can substitute foreign intermediate inputs (VIFA) for domestic intermediate inputs (VDFA). In the figure, the value of imported intermediate inputs by firms is shown as VDFA. However, firms can also export their goods to the rest of the world. In the figure, the value of total goods exported by firms is shown as VXMD.

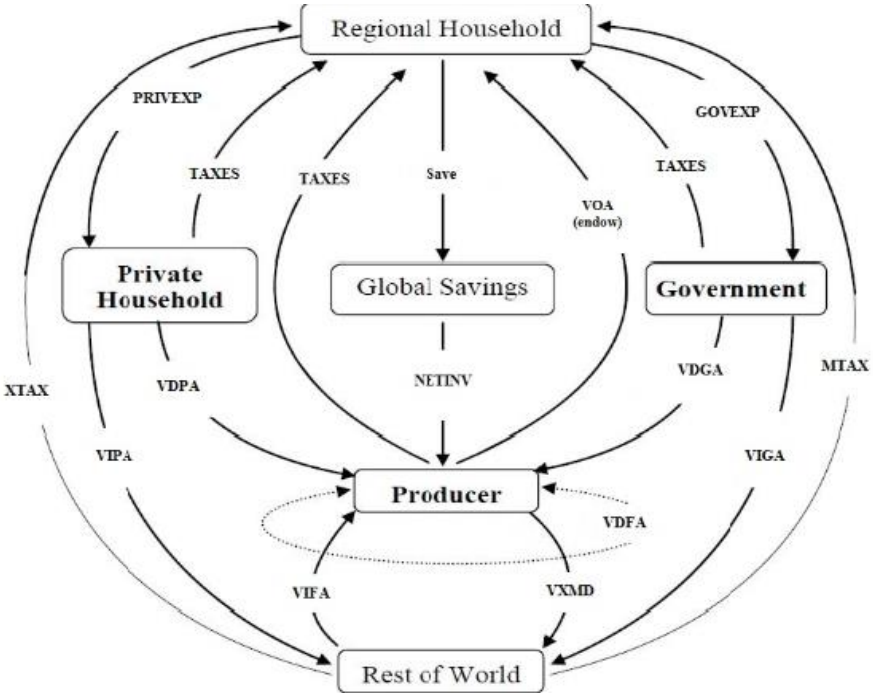

Figure 1. Graphical structure of the GTAP

Source: *Brockmeier, M. (2001)*

Taxation leads to price distortions and it is necessary to use market prices instead of factor prices in calculations. The range of applicable taxes is very wide, the regional household receives all taxes (types of taxes received from private households, government and enterprises (TAXES), taxes on imported goods (MTAX) and taxes on exported goods (XTAX)), which are redistributed through a Cobb-Douglas function. Finally, by considering this cycle and the accounting relationship between them, a general equilibrium model can be designed, the quantitative values of the accounting relationships can be calculated through the Social Accounting Matrix (SAM) provided in the GTAP database. The general equilibrium model is designed in an environment where all markets are settled. The macro-structure of the model presented in this study is a Savings-Driven Model, in which total investment depends on the total savings of the model.

Given the large number of relationships and equations in the GTAP model, a complete presentation of the model equations is beyond the scope of this article and is beyond the scope of this discussion. For further reading, it is recommended to refer to Hertel & Tsigas (1997), Rutherford (1998), Burfisher (2021), and the gtap.tab or TABmate file from the RunGTAP and GEMPACK software packages. In this study, changing policies will lead to a new set of global and domestic prices, which directly change the trade balance of different regions. Such a policy will lead to a change in the price of the commodity as well as the production relations associated with the commodity in question. Therefore, within the

framework of the general equilibrium model, other sectors will also be affected by such changes.

Database and aggregation of sectors, regions and data: In this study, various scenarios were analyzed based on the Global Trade Analysis Project (GTAP) model and version 10 of its database. Version 10 of the GTAP database was published in 2022 and includes 143 regions and 67 sectors that indicate the global economy, and the years 2012, 2016 and 2020 are considered as the benchmark (baseline). In this study, the simulation was carried out based on the base year 2020 and with GEMPACK software.

The data includes the social accounting matrix of 143 countries (or regions) and 67 sectors in 2020 and are aggregated into specific sectors and regions based on the research objective. For this purpose, the GTAPag software is attached to the GTAP database, which is used to aggregate data for use in regional general equilibrium models. The data is aggregated in the form of 67 sectors and 4 factors of production (labor, natural resources, land and capital) and 2 regions (Iran and other countries of the world).

3.2 data

In this section, statistical facts related to the three sectors of fishing and aquaculture, maritime transport and oil and gas extraction from the seabed are presented. Next, Iran's trade dependence with other countries of the world (exports and imports), tariff rates and employment levels in the three sectors of fishing and aquaculture, maritime transport and oil and gas extraction from the seabed are examined. Statistical facts can be effective in determining the potential effects of policy shocks. Table (1) shows Iran's exports to the whole world and the whole world's exports to Iran in the three sectors of fishing and aquaculture, maritime transport and oil and gas extraction from the seabed in 2012, 2016 and 2020 in world prices in million dollars.

Exports from all over the world to Iran			Iran's exports to the whole world			
۲۰20	۲۰16	۲۰12	۲۰20	2016	2012	Sea-oriented sectors - Year
11.87	13.54	5.20	۲۵.۳۸	۱۲۵.۵۲	10.54	Fisheries and Aquaculture Department
۱۹۶	۲۴۸	۲۵۶	۹۳۵۰	۱۱۳۵۰	۲۵۲۱۲	Oil and gas extraction sector from the seabed
796.58	984.55	586.79	۷۶۵.۰۱	۹۴۰.۸۰	570.70	Maritime transportation sector
۱۰۰۴.۴۵	۱۲۴۶.۰۹	۸۴۷.۹۹	۱۰۱۴۰.۳۹	۱۲۴۱۶.۳۲	۲۵۷۹۳.۲۴	Total of all sections

Table (1) Iran's imports and exports in world prices (million dollars)

Source: *GTAP Database Version 10*

For example, in relation to the "Maritime Transportation" sector in 2020, it can be stated that Iran's exports to the whole world at world prices are equal to 765 million dollars and the whole world's exports to Iran at world prices are equal to 796.58 million dollars. The simultaneous export and import of goods and services in a field of activity or a specific industry can be explained based on the theory of intra-industry trade. Intra-industry trade is the simultaneous export and import of goods and services that are categorized in one or more similar industrial groups. Intra-industry trade is divided into two sectors: horizontal and vertical intra-industry trade, which are defined by the trade of products in one similar quality and the other with different qualities, respectively (Younespour and Tayyibi, 2010). Iran's exports in the maritime sectors are very small compared to exports in other sectors and can be increased with appropriate planning.

Table (2) presents the tariff rates for Iran's imports from countries around the world and the tariff rates for imports from countries around the world from Iran in the three sectors of fishing and aquaculture, maritime transport, and oil and gas extraction from the seabed in 2012, 2016, and 2020 in percentage terms. As shown in Table (2), the tariff for the maritime transport and oil and gas extraction sectors is zero.

Tariffs for imports from Iran to countries around the world			Iran's import tariffs from countries around the world			
۲۰20	۲۰16	۲۰12	۲۰20	۲۰۱6	۲۰12	Sea-oriented sectors - Year
۳.۹۴	۰.۶۹	۱.۱۳	14.47	15.02	19.43	Fisheries and Aquaculture Department
۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	Maritime transportation sector
۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	۰.۰۰	Oil and gas extraction sector from the seabed
۳.۹۴	۰.۶۹	۱.۱۳	۱۴.۴۷	۱۵.۰۲	۱۹.۴۳	Total of all sections

Table (2) Tariff rates for imports from Iran to other countries in the world and tariff rates for imports from other countries in the world to Iran (percentage)

Source: *GTAP Database Version 10*

Table (3) presents the amount of payment for labor employment in Iran and other countries of the world in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed in 2012, 2016, and 2020, in millions of dollars.

Other countries in the world			Iran			
۲۰20	۲۰16	۲۰12	20۲۰	۲۰16	۲۰12	Sea-oriented sectors - Year
۵۳۳۴/۳۶	۴۶۹۲/۴۷	۲۹۲۵/۲۲	۱۰/۱۱	۱۴/۶۹	۵/۲۵	Fisheries and Aquaculture Department
۳۷۶۵۷/۴۶	۳۷۹۴۳/۸۷	۳۰۶۸۹/۰۲	۴۱/۱۴	۸۶/۹۹	۴۲/۳۶	Maritime transportation sector
۴۵۸۱۷/۳۶	۴۵۶۹۹/۳۲	۴۵۶۹۸/۱۸	۵۵/۲۳	۸۹/۲۵	۴۹/۲۵	Oil and gas extraction sector from the seabed
۱۶۵۸۲۷۹۶	۱۴۹۸۲۷۸۱	۱۲۳۶۳۶۵۹	۳۰۶۵۸/۱۸	۳۱۲۵۹۲۵	۲۶۲۱۲/۳۱	Total of all sections

Table (3) Amount of payment for labor employment in the three sectors of fishing, aquaculture, maritime transportation, and oil and gas extraction from the seabed (million dollars)

Source: *GTAP Database Version 10*

4. Experimental results and analysis

One of the main goals of using computable general equilibrium models is simulation or scenario building. With scenario building, the effects of different policies can be examined quantitatively (Nejati, 2021). The three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed are among the important economic sectors that are considered in the ocean-based economy. Evaluating the economic effects of focusing on these two sectors is of particular importance on the country's economy, and this issue has also been mentioned in the Seventh Development Plan. In this regard, in this study, the economic effects of focusing on these two sectors, based on the Multi-Regional Computable General Equilibrium Model (GTAP) and version 10 of its database, have been analyzed through 3 scenarios (1. 90% reduction in tripartite tariff rates for sea-based sectors, 2. Increasing the productivity of the workforce employed in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed, 3. Increasing the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed) using the GEMPACK software package. In the following, the effects of the three mentioned scenarios on the welfare, trade balance, and production of Iran have been examined and analyzed.

Scenario 1: 90% reduction in trilateral tariff rates for maritime sectors

With changes in tariff rates, the cost of a commodity changes in different regions (Iran and other countries in the world). With changes in tariff rates in sea-based

sectors, new trade flows are created in different regions and in different economic sectors. These changes lead to changes in the level of welfare and changes in the trade balance of different sectors in different regions. In this section, the economic effects of a 90 percent reduction in bilateral tariffs between Iran and other countries in the fishing and aquaculture sector are analyzed (the tariff rate for maritime transportation and oil and gas extraction from the seabed is zero). In Table (4), the change in the trade balance (DTBALi) is presented separately in terms of the change in the value of exported goods DVXW(i,r) and the change in the value of imported goods DVIW(i,r) in terms of thousand dollars. In Iran, with a 90 percent reduction in the tripartite tariff rates of sea-based sectors, a positive change is created in the trade balance of the aquaculture sector. The positiveness of this index indicates that the increase in the value of exports at FOB prices is greater than the increase in the value of imports at CIF prices. The positive change in the trade balance of the aquaculture sector in Iran was due to the increase in exports ($2,560,000) and the increase in imports ($2,160,000).

DTBALi	DVXW	DVIW	Economic activity	Regions
۴۰۰	۲۵۶۰	۲۱۶۰	Aquaculture and fishing	Iran
0	0	0	Sea transportation	
۰	۰	۰	Extraction of oil and gas from the seabed	
-۷۶۰	490	۱۲۵0	Aquaculture and fishing	Other countries in the world
۳۶۵	۴۲۰	۵۵	Sea transportation	
۵۳۳۱	۳۷۸۹۴	۳۲۵۶۳	Extraction of oil and gas from the seabed	

Table (4) Economic effects (trade balance) of tariff reduction in the Peruvian aquaculture sector (thousand dollars)

Source: *Research results (based on GTAP database version 10)*

Table (5) shows the effect of reducing the tariff on the aquaculture sector on changes in production. In Iran, by reducing the tariff on the aquaculture sector, the volume of aquaculture production will decrease by $120,000. Given Iran's access to open waters, this figure can be increased with proper planning.

Volume of changes	Percentage of changes	Post-impulse production	Pre-impulse production	Economic activity	Regions
-۱۲۰	-۰/۰۱	۱۳۸۰۲۶۰	۱۳۸۰۳۸۰	Aquaculture and fishing	Iran
۰/۰۰	۰/۰۰	۴۱۵۶۶۱۰	۴۱۵۶۶۱۰	Sea transportation	
۰/۰۰	۰/۰۰	۹۵۶۲۵۷۹	۹۵۶۲۵۷۹	Extraction of oil and gas from the seabed	
-۵۰۰	-۰/۰۳	۳۹۰۳۳۶۸۱۰	۳۹۰۳۳۷۳۱۰	Aquaculture and fishing	Other countries in the world
۳۸۰	۰/۰۰	۸۴۸۲۹۵۵۰۰	۸۴۸۲۹۵۱۳۰	Sea transportation	
-۱۴۲۸۶۸	-۰/۰۲	۱۸۳۵۶۹۳۲۵۷	۱۹۷۸۵۶۲۱۴۳	Extraction of oil and gas from the seabed	

Table (5) Economic effects (production changes) of tariff reduction in the Peruvian aquaculture sector (thousands of dollars)

Source: *Research results (based on GTAP database version 10)*

Second scenario: Increasing the productivity of the workforce employed in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed.

Achieving sustainable economic growth requires investment in infrastructure to increase production capacities. Such investments include not only physical investments, but also investments in human resources, education, and health (Miqdad Moeini, 2021). Improving the quality of the workforce can increase labor productivity, thereby having a favorable impact on future investment and economic returns. Accumulation of human capital through education plays an important role in the process of economic development. In this section, the policy impetus for increasing labor productivity in the three sectors of aquaculture, maritime transportation, and oil and gas extraction from the Iranian seabed has been analyzed. In Iran, a 15 percent increase in labor productivity in the two sectors of aquaculture and maritime transportation will create a positive change in the trade balance of both sectors. Table (6) presents the change in the trade balance (DTBALi) by dividing the change in the value of exported goods DVXW(i,r) and the change in the value of imported goods DVIW(i,r) in

thousands of dollars. The positive change in the trade balance of the aquaculture sector in Iran was due to an increase in exports ($130,000) and a decrease in imports ($60,000), and the positive change in the trade balance of the maritime transport sector in Iran was due to an increase in exports ($4,190,000) and a decrease in imports ($1,850,000). Table (7) shows the effect of a 15 percent

DTBALi	DVXW	DVIW	Economic activity	Regions
۷۰	1۳0	-۶0	Aquaculture and fishing	Iran
۲۳۴۰	۴190	-1۸۵0	Sea transportation	
۵۲۹۰	۸۵۴۰	-۳۲۵۰	Extraction of oil and gas from the seabed	
130	140	-10	Aquaculture and fishing	Other countries in the world
۱۱۵۰۰	12030	-530	Sea transportation	
۱۷۷۸۵	۱۸۷۴۵	-۹۶۰	Extraction of oil and gas from the seabed	

Table (6) Economic effects (trade balance) of increasing the productivity of the workforce employed in the three sectors of aquaculture, maritime transportation, and oil and gas extraction from the seabed (thousand dollars)

Source: *Research results (based on GTAP database version 10)*

increase in the productivity of the workforce employed in the aquaculture and maritime transport sectors on the changes in the production of these two sectors. In Iran, the volume of production in the aquaculture sector increases by $1,450,000 and the volume of production in the maritime transport sector increases by $12,740,000. Productivity leads to an increase in the production of these two sectors.

Volume of changes	Percentage of changes	Post-impulse production	Pre-impulse production	Economic activity	Regions
۱۴۵۰	۰/۱۱	۱۴۹۱۸۵۰	۱۴۹۰۵۶۰	Aquaculture and fishing	Iran
۱۲۷۴۰	۰/۴۳	۴۱۸۸۴۵۰	۴۱۲۴۶۱۰	Sea transportation	
۷۴۸۵۱۲	۰/۹۷	۹۹۸۳۲۶۴	۹۲۳۴۷۵۲	Extraction of oil and gas from the seabed	
-۱۸۰	-۰/۰۰	۳۸۵۳۳۷۱۳۰	۳۸۵۳۳۷۳۱۰	Aquaculture and fishing	Other countries in the world
-۱۴۹۹۰	-۰/۳۶	۸۴۸۲۸۰۴۴۵	۸۴۸۲۹۵۶۹۵	Sea transportation	
-۳۶۵۹۴۱۳۹	-۰/۳۲	۱۱۶۳۵۷۸۹۲۴	۱۱۲۶۹۸۴۷۸۵	Extraction of oil and gas from the seabed	

Table (7) Economic effects (production changes) of increasing the productivity of the labor force employed in the three sectors of aquaculture, maritime transportation, and oil and gas extraction from the seabed (thousand dollars)

Source: *Research results (based on GTAP database version 10)*

The results of this part of the research can help the country's planners and policymakers in adopting appropriate policies in the field of investment and training of the workforce employed in the maritime-based sectors, which will ultimately lead to increased economic growth and increased exports of this sector. As stated in Table (7), training and productivity of the workforce employed in the maritime-based sectors can lead to increased production.

Third scenario: Increasing the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed.

Intermediate goods can be considered as one of the factors of economic growth and development, like capital, human resources, etc. The main implication of the effect of intermediate goods on economic growth and development is from the perspective of capital that exists towards intermediate goods, in other words, in the growth process, intermediate goods are as important as capital. The first recognition obtained from intermediate goods is that they are very similar to capital. In fact, the difference between intermediate goods and capital is related to the time used. Intermediate goods are installed earlier than capital and are completely depreciated in the production process; however, capital is not completely depreciated during production. In the long run, capital and intermediate goods are completely the same and more importantly, both are

factors of production. (Esfandyar Jahangard, 2011). Scientific recognition of the sources of production growth is one of the requirements for achieving sustainable and endogenous economic growth. According to the Solow growth model, economic growth is achieved from two sources, namely the growth of production factors and the growth of productivity of production factors.

In the early literature on growth in economic growth patterns, emphasis was mainly placed on the role of production factors such as labor, capital, and even energy and land. While in the new literature in this field, emphasis is placed on other aspects and factors affecting economic growth, including productivity of production factors, accumulation of knowledge and research and development (R&D), human and social capital (Futros et al., 2012). Productivity has a special place due to the scarcity of production factors such as specialized human resources, capital, and intermediate factors. Productivity of production factors can be explained as a change in the rate of production with fixed production factors, in which case it can be considered as a residual or a measure of the effect of unknown factors. Given the importance of the productivity impulses mentioned above, in this section, the policy impulse to increase productivity in intermediate inputs in three sectors of aquaculture, maritime transportation, and oil and gas extraction from the Iranian seabed is analyzed. The desired impulse was a 15 percent increase in the productivity of intermediate inputs in the three sectors of aquaculture, maritime transport, and oil and gas extraction from the seabed in Iran. Table (8) presents the change in the trade balance (DTBALi) by separating the change in the value of exported goods DVXW(i,r) and the change in the value of imported goods DVIW(i,r) in terms of thousand dollars.

In Iran, a 15 percent increase in the productivity of intermediate inputs in the two sectors of aquaculture and maritime transport creates a positive change in the trade balance of both sectors. For example, the positive change in the trade balance of the aquaculture sector in Iran was due to an increase in exports ($710,000) and a decrease in imports ($420,000), and the positive change in the trade balance of the maritime transport sector in Iran was due to an increase in exports ($92,340,000) and a decrease in imports ($35,220,000). Increasing the trade balance of the maritime transport sector is significant and can be considered as a policy option.

DTBALi	DVXW	DVIW	Economic activity	Regions
۲۹۰	۷۱۰	-٤۲۰	Aquaculture and fishing	Iran
٥۷۱۲۰	۹۲۳٤۰	-۳٥۲۲۰	Sea transportation	
٤۰٦۸۱	۱۳٦۸۹٥	-۹٦۲۱٤	Extraction of oil and gas from the seabed	
٥۹۰	۷٥۰	-۱٦۰	Aquaculture and fishing	Other countries in the world
۱۱۰۲۲	۲۲٥۹٦	-۱۱٥۷٤	Sea transportation	

١٤٢١١	٩٩٨٧٤	-٨٥٦٦٣	Extraction of oil and gas from the seabed	

Table (8) Economic effects (trade balance) of increasing productivity in intermediate inputs in the three sectors of aquaculture, maritime transport, and oil and gas extraction from the seabed (thousand dollars)

Source: *Research results (based on GTAP database version 10)*

Table (9) shows the effect of a 15 percent increase in productivity in intermediate inputs in the aquaculture and maritime transport sectors on changes in production in these two sectors. For example, in Iran, the volume of production in the aquaculture sector increases by $7,900,000 and the volume of production in the maritime transport sector increases by $265,590,000. Productivity leads to an increase in the production of these two sectors.

Volume of changes	Percentage of changes	Post-impulse production	Pre-impulse production	Economic activity	Regions
٧٩٠٠	٠/٦١	١٤٩٨٢٢٠	١٤٨١٣٧٠	Aquaculture and fishing	Iran
٢٦٥٥٩٠	٦/٠٦	٤٤٢٢٧٠٠	٤١٧١١١٠	Sea transportation	
١١٥٤٩٣٣	٧/٠٩	١٢٥٣٦٩٤٧٨	٩٨٧٥٥٣٣	Extraction of oil and gas from the seabed	
-٧٩٠	-٠/٠٠	٣٩٠٣٣٣٢٤٠	٣٩٠٣٨٩٣١٠	Aquaculture and fishing	Other countries in the world
-٢٦٨٥٩٠	-٠/٠٣	٨٤٨٠٢٨٦٥٢	٨٤٦٢٩٥١٤٠	Sea transportation	
-٥٦٩٤٧٨٣	-٠/١١	١٢٥٦٩١٢٤٥٧	١٣٠٢٥٦٨٤٢٣	Extraction of oil and gas from the seabed	

Table (9) Economic effects (production changes) of increasing productivity in intermediate inputs in the three sectors of aquaculture, maritime transport, and oil and gas extraction from the seabed (thousands of dollars)

Source: *Research results (based on GTAP database version 10)*

4.1 Welfare effects of different scenarios

In the first scenario: a policy impulse to reduce tariffs has been applied, with a reduction in tariffs for maritime sectors (a 90% reduction in bilateral tariff rates

between Iran and other countries in the maritime sectors), the change in Iran's welfare is equal to $1,420,000 and for other countries in the world is equal to $132,000.
In the second scenario: a policy impulse to train the workforce employed in maritime sectors (increasing the productivity of the workforce employed in the three sectors of aquaculture, maritime transport and oil and gas extraction from the seabed) has been applied, with the application of the desired impulse (a 15% increase in the productivity of those employed in maritime sectors in Iran), the change in Iran's welfare is equal to $9,026,000 and for other countries in the world is equal to $70,200,000.
In the third scenario: The policy impulse to use advanced intermediate inputs in sea-based sectors (increasing the productivity of intermediate inputs in the two sectors of aquaculture and maritime transport) has been applied. By applying the desired impulse (15% increase in the productivity of intermediate inputs in the three sectors of aquaculture, maritime transport and oil and gas extraction from the seabed in Iran), the change in welfare in Iran is equal to $16,120,000 and for the rest of the world it is equal to $128,600,000. The lowest welfare is related to the first scenario and the highest welfare is related to the third scenario. In this study, welfare changes are measured by equivalent changes (EV).

Third scenario	Second scenario	First scenario	Regions
۱۶۱۲۰	9026	1420	Iran
۱۲۸۶۰۰	70200	132000	Other countries in the world

Table (10) Welfare impacts of different scenarios (USD)
Source: *Research results (based on GTAP database version 10)*

5. Conclusions

One of the pending development opportunities in the country is the maritime economy. Maritime development and the maritime economy, which have recently received more attention than ever before, are a very general issue and it is necessary to draw a clear picture of it. In this study, an attempt has been made to express some of the realities of the maritime economy in the country. Accordingly, in this study, the economic effects of focusing on these two sectors, based on the Multi-Regional Computable General Equilibrium Model (GTAP) and version 10 of its database, have been analyzed through 3 scenarios (1. 90% reduction in tripartite tariff rates for maritime sectors, 2. Increasing the productivity of the workforce employed in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed, 3. Increasing the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transportation, and oil and gas extraction from the seabed) with the GEMPACK software package.
The results show that with a 15 percent increase in the productivity of intermediate inputs in the three sectors of fishing and aquaculture, maritime transport, and oil

and gas extraction from the seabed, a positive change is created in the trade balance of all three sectors. The positive change in the trade balance of the sea-based sectors is due to an increase in exports and a decrease in imports. The increase in the trade balance of the maritime transport sector is significant and can be considered as a policy option. The effect of a 15 percent increase in productivity in intermediate inputs in the two sectors of aquaculture and maritime transport on production changes shows that, in Iran, the volume of production in the aquaculture and maritime transport sectors increases. Productivity leads to an increase in the production of these two sectors. With a 15% increase in the productivity of intermediate inputs in the two sectors of aquaculture and maritime transport, the change in Iran's welfare is equal to $16,120,000 and for the rest of the world it is equal to $128,600,000. The increase in the trade balance of the maritime transport sector resulting from a 15% increase in the productivity of the workforce employed in the two sectors of aquaculture and maritime transport is significant and can be considered as a policy option. The most important policy recommendation for the country, according to the research results and based on the GTAP model, is that focusing on the sea-based economy, especially paying attention to the maritime transport sector, can be considered as an appropriate policy option.

The results of this study can help the country's planners and policymakers adopt appropriate policies in the field of investment and training of the workforce employed in maritime sectors, which will ultimately lead to increased economic growth and increased exports of this sector. As stated, training and productivity of the workforce employed in maritime sectors can lead to increased production. One of the variables that can affect productivity is investment in maritime sectors. Iran's maritime advantage is unparalleled, and economic activities cannot be advanced solely by using government investment, and the capacity of the private sector should be best utilized in the maritime and port areas by domestic investment and by creating attractiveness for foreign investors. Foreign investment is an integral part of an open and effective system in the international economy and is a factor for the development and sustainable profitability of countries. Today, developing societies have taken steps to attract foreign investors in order to participate in the global economy and trade, transfer capital, expertise, and technology.

In this study, in order to focus on the maritime economy, only the reduction of tariffs and the productivity of the workforce employed in these sectors, as well as the productivity of intermediate inputs, have been used. Focusing on the maritime economy includes other measures such as the development of islands, coasts, maritime capacities, ports, maritime businesses, logistics infrastructure and transportation infrastructure, the development of ports, fisheries, shipping, shipbuilding complexes and their related industries, as well as the establishment of mother industries and a stable population on the coasts and seas. Therefore, by considering other policies, more accurate results can be achieved on the effects of focusing on the maritime economy on the welfare of society and other

macroeconomic variables. Given the sensitivity of the subject, in terms of research methodology, it is recommended to use the dynamic multi-regional computable general equilibrium model in future studies to measure the effects of focusing on the maritime economy on economic variables and indicators over time.

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This article is based on "Professional Conflict and Intellectual Property: Organizational Development and My Personal Expertise as the Responsible Author." or "No Conflict of Interests are Declared by the Authors."

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