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Impact of the Closure of the Strait of Hormuz on Crude Oil and Petroleum Product Markets

Seyyed Abdullah Razavi[1*], Leila Kashani[2], and Fatemeh Maralkhani Azar[3]

[1] Associate Professor, Department of Petroleum Economics and Energy Diplomacy, Petroleum University of Technology, Tehran, Iran

[2] Master of Economic Sciences, Islamic Economics, Department of Economics and Islamic Banking, Faculty of Economics, Kharazmi University, Tehran, Iran

[3] Master of Oil and Gas Economic, Tehran Faculty of Petroleum, Petroleum University of Technology, Tehran, Iran

Highlights

- Closure or severe restriction of the Strait of Hormuz would generate a systemic shock to global energy security, extending beyond oil transportation to affect export capacity, imports, global energy prices, economic growth as measured by gross domestic product (GDP), refining operations, and broader oil industry activities.
- The economies of Persian Gulf countries are particularly exposed to potential disruptions in the Strait of Hormuz, as substantial volumes of crude oil, liquefied natural gas (LNG), and petroleum products destined for major importers such as China, India, Japan, and South Korea transit through this critical chokepoint.
- Disruptions in the Strait would initially be reflected in geopolitical risk premiums in futures markets, which could subsequently transmit to physical supply chains through higher insurance costs, shipping delays, tanker rerouting, and increased pressure on refinery operations, ultimately contributing to higher spot prices and inflationary risks.
- The implications extend beyond oil markets to other commodity supply chains, including fertilizers, aluminum, and sulfur, highlighting broader risks to food security and industrial inputs and underscoring the need for alternative pipeline capacity, strategic reserves, and coordinated crisis-management mechanisms.

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[*] Corresponding author:

Email: srazavi@put.ac.ir

Abstract

The Strait of Hormuz is one of the world's most strategically important energy chokepoints, playing a critical role in the maritime transportation of crude oil and natural gas, with many Asian economies heavily dependent on this route. Following the escalation of tensions in 2026, vessel traffic through the strait declined sharply, disrupting more than 95% of shipping flows and reducing daily crossings to nearly zero, with only limited transits permitted under special authorization. The lack of effective alternative routes has intensified pressure on global energy markets and heightened concerns regarding supply stability. Consequently, energy-exporting countries face declining foreign exchange revenues, whereas energy-importing countries experience higher costs, increased inflationary pressures, and slower economic growth. Using a multivariate generalized autoregressive conditional heteroskedasticity model with the VECH approach (MGARCH-VECH) over the period 2000–2023, the results indicate that restrictions in the Strait of Hormuz generate persistent volatility and significant spillover effects among imports, exports, and energy prices. The findings suggest that disruptions in the strait amplify volatility in energy markets and transmit shocks to broader trade and financial systems.

Keywords: Import, Oil market export, Strait of Hormuz

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1. Introduction

The Strait of Hormuz is one of the world's most critical geopolitical energy chokepoints, and its role in maintaining the stability of global oil and gas markets is sufficiently important that any disruption could have consequences extending far beyond the Persian Gulf region. This narrow strait connects the Persian Gulf to the Gulf of Oman and, subsequently, to the Indian Ocean, serving as the primary export route for many of the Middle East's major oil and gas producers. The concentration of a substantial share of global oil production in the Persian Gulf states has made a significant portion of global energy trade dependent on transit through this strategic passage. Consequently, the Strait of Hormuz has become a key pillar of global energy security (Hinz et al., 2026; Razavi et al., 2026).

Energy market estimates indicate that approximately 20–22% of global crude oil consumption, equivalent to nearly 17 million barrels per day, passes through the Strait of Hormuz. This volume accounts for approximately 90% of the crude oil exported from the Persian Gulf. These flows include exports from major producers such as Saudi Arabia, Iraq, the United Arab Emirates, Kuwait, and Iran (Zamani, 2026). In addition to crude oil, a substantial share of global liquefied natural gas (LNG) trade also transits this route, with approximately 25–30% of global seaborne LNG trade dependent on the strait. Qatar, one of the world's largest LNG exporters, ships nearly all of its LNG exports through this passage, further underscoring the geopolitical significance of the Strait of Hormuz in global gas markets (Sağlam and Korkmaz, 2026).

The concentration of energy exports in the Persian Gulf gives the region's states a decisive role in meeting global energy demand. Saudi Arabia, the world's largest crude oil exporter, transports a substantial portion of its exports to global markets through the Strait of Hormuz. Iraq and Kuwait also transport virtually all of their crude oil exports to international markets through the Persian Gulf and the strait (Youvan, 2025; Faria, 2026; Razavi and Tarnian, 2026). In addition to its crude oil exports, the United Arab Emirates serves as a major regional hub for the trade and distribution of refined petroleum products. Consequently, the Strait of Hormuz effectively serves as a lifeline for energy exports from these countries (Atento et al., 2026).

The significance of this passage becomes even more evident when global oil demand patterns are considered. Most of the oil transiting the Strait of Hormuz is destined for major Asian economies such as China, India, Japan, and South Korea, which are among the largest importers of Middle Eastern oil (Sangwa et al., 2026). The heavy dependence of these countries on stable oil supplies from the Persian Gulf has made the security of the Strait of Hormuz a strategic priority. Any disruption to this corridor can directly affect their energy security and, through higher energy prices, influence global inflation, economic growth, and financial market stability (Arita et al., 2026; Razavi and Ordoei, 2026).

The geopolitical and energy-related importance of the Strait of Hormuz has prompted numerous studies examining its role in energy supply security. However, most previous research has focused on historical analyses, descriptive assessments, or short-term economic evaluations. The primary contribution of the present study is to examine the closure of the Strait of Hormuz not merely as a physical disruption to maritime transportation but as a transformative scenario with the potential to reshape the architecture of global energy security (Bukhari, 2026; Kaya, 2026). Using a scenario-based approach, this study analyzes the potential impacts of complete closure or severe restriction of the strait on global oil markets, petroleum product flows, the behavior of regional actors, and Asian consumers, thereby providing a forward-looking assessment of the resulting consequences. A key distinction of this research is that, in addition to evaluating economic and energy-related impacts, it incorporates geopolitical, strategic, and infrastructural dimensions across multiple scenarios to provide a multidimensional and reliable outlook for policymakers and researchers (Kassim and Osman, 2026).

Using a qualitative analytical approach and structural scenario planning, this study identifies the key variables influencing energy security in the Strait of Hormuz and analyzes their interrelationships to develop scenarios involving complete closure, severe restriction, and managed transit. The impacts of each scenario on global oil prices, regional exports, transportation costs, and the energy security of import-dependent countries are subsequently examined. This approach enables a comprehensive and forward-looking assessment of the implications of disruptions to this strategic passage.

The structure of this paper is designed to progressively familiarize the reader with the various dimensions of the topic. The introduction outlines the geopolitical importance of the Strait of Hormuz, its role in global energy markets, and the need to assess the consequences of disruptions to this passage. The following section reviews the theoretical foundations and literature on energy security and maritime chokepoints, with particular emphasis on gaps in forward-looking analyses. The methodology section describes the theoretical foundations of energy security, the logic of scenario planning, and the stages of the research process. The section on current conditions examines critical variables, including energy trade flows, the capacity of alternative routes, the dependence of Asian importers, and relevant geopolitical factors. The subsequent section presents future scenarios together with their underlying assumptions and likely consequences for crude oil and petroleum product markets. The findings section compares the scenarios and evaluates their economic, geopolitical, and energy-related implications. Finally, the conclusion presents policy recommendations for risk management, strengthening the resilience of energy supply systems, and enhancing energy security at both regional and global levels.

2. Literature review

2.1. Production and export channel for crude oil and petroleum products

One of the most significant channels through which the closure or restriction of the Strait of Hormuz can affect global energy markets is its impact on the production and export of crude oil and petroleum products by the Persian Gulf states. The strait serves as the primary artery for transporting Middle

Eastern oil to global markets, and countries such as Saudi Arabia, Iraq, Kuwait, the United Arab Emirates, and Qatar export a substantial share of their crude oil and petroleum products through this route. Consequently, any disruption in the Strait of Hormuz could rapidly constrain these countries' exports and, by reducing global supply, affect the balance of the global oil market.

As shown in Figure 1, based on data from the *OPEC Annual Statistical Bulletin 2025*, crude oil export volumes from Persian Gulf countries varied considerably in 2024. Saudi Arabia ranked first, with exports of 6.05 million barrels per day, followed by the United Arab Emirates at 2.72 million barrels per day and Iran at 1.57 million barrels per day. Iraq, Kuwait, and Oman exported 1.36, 1.18, and 0.89 million barrels per day, respectively, each accounting for a notable share of regional exports. By comparison, Qatar and Bahrain recorded the lowest export volumes, at 0.54 and 0.14 million barrels per day, respectively. This distribution demonstrates that a substantial proportion of oil exports from the Persian Gulf is concentrated among a few major producers, particularly Saudi Arabia.

Figure 1

Oil exports through the Strait of Hormuz by the exporting countries in million barrels per day (OPEC Annual Statistical Bulletin, 2025)

As illustrated in Figure 2, based on data from the U.S. Energy Information Administration, the Strait of Hormuz is the world's most critical energy chokepoint, with approximately 20% of global oil and liquefied natural gas supply transiting this passage. In the LNG sector, measured in billion cubic meters, other Asian countries receive approximately 26, China 23, the Americas 20, India 18, Europe 18, Japan and South Korea 16, and Africa less than 1. In the oil sector, measured in million barrels per day, China receives approximately 4, Japan and South Korea 3.5, other Asian countries 3.5, India 2, Europe approximately 1, and the United States less than 1. This distribution highlights the comparatively high dependence of Asian economies on energy flows transiting the strait.

Structurally, the heavy reliance of Persian Gulf producers on maritime export routes means that alternative export capacity is extremely limited in the event of a closure of the Strait of Hormuz. Some countries have developed pipeline infrastructure, such as Saudi Arabia's East–West Pipeline, which transports oil to the Red Sea port of Yanbu, and the United Arab Emirates' Habshan–Fujairah Pipeline, which enables exports through the Gulf of Oman. However, the capacity of these alternative routes can accommodate only a fraction of the region's total exports and cannot fully replace the substantial volume of oil normally transported through the strait. Consequently, any disruption to this passage could significantly constrain the region's oil export capacity.

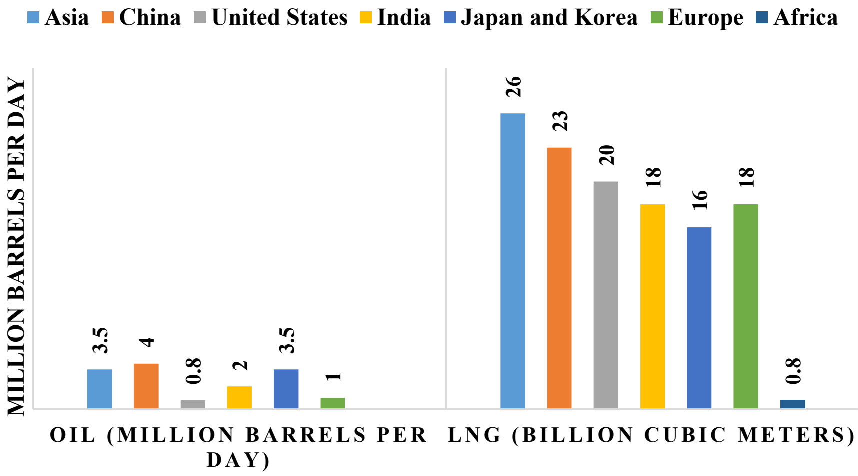

Figure 2

Global oil and liquefied natural gas supply through the Strait of Hormuz (U.S. Energy Information Administration, 2024)

Iran

Before the closure of the Strait of Hormuz, Iran's oil production and exports operated under the constraints imposed by international sanctions. Total production of oil and other petroleum liquids increased from less than 3 million barrels per day in 2020 to approximately 4 million barrels per day in 2023, of which about 2.9 million barrels per day consisted of crude oil. During this period, Iran relied on the expansion of domestic oil fields, the drilling of new wells, and approximately 1.2 million barrels per day of refining capacity to maintain the production-to-export chain for crude oil and petroleum products.

As shown in Figure 3, based on data from OPEC (2026) and the U.S. Energy Information Administration (2025), Iran's oil production experienced substantial fluctuations between 2010 and 2025. Production declined from a peak of 1.46 million barrels per day in 2010 to 1.35 million barrels per day in 2011, 1.02 million barrels per day in 2012, and 0.99 million barrels per day in 2013. Following the Joint Comprehensive Plan of Action (JCPOA), production increased to 1.02 million barrels per day in 2014, 1.06 million barrels per day in 2015, 1.35 million barrels per day in 2016, 1.39 million barrels per day in 2017, and 1.30 million barrels per day in 2018. Following the reimposition of sanctions, production declined sharply to 0.73 million barrels per day in 2019 and reached a low of 0.72 million barrels per day in 2020. Production subsequently recovered, increasing to 0.80 million barrels per day in 2021, 0.93 million barrels per day in 2022, 1.16 million barrels per day in 2023, 1.33 million barrels per day in 2024, and approximately 1.42 million barrels per day in 2025, representing its highest level since 2010.

As shown in Figure 4, Iran's crude oil exports averaged approximately 2.0–2.8 million barrels per day during 2016–2018. A downward trend emerged in late 2018, with exports declining to approximately 0.2–0.5 million barrels per day in 2019. Between 2020 and 2021, exports gradually recovered to approximately 0.7–1.1 million barrels per day and increased further to 1.2–1.5 million barrels per day in 2022 and 2023. In 2024, exports ranged from approximately 1.5 to 1.7 million barrels per day, indicating a substantial recovery relative to 2019–2020, although they remained below the pre-sanctions level of approximately 3 million barrels per day.

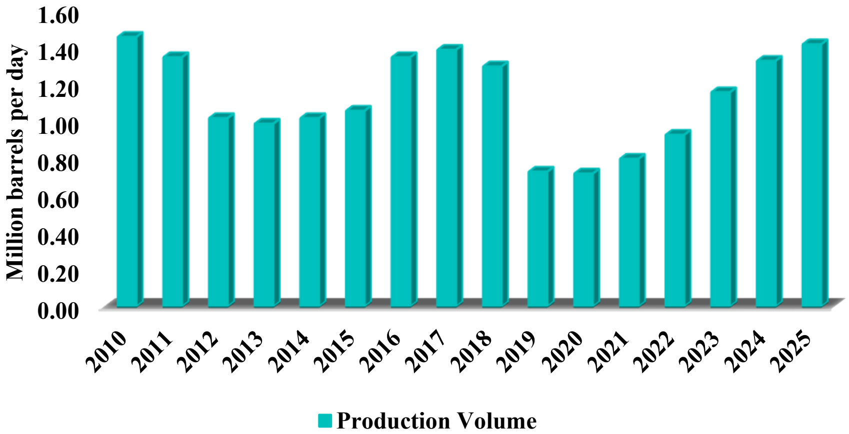

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Figure 3

Iran's oil production volume from 2010 to 2025 (OPEC, 2026; U.S. Energy Information Administration, 2025; Fact Statistics, 2025)

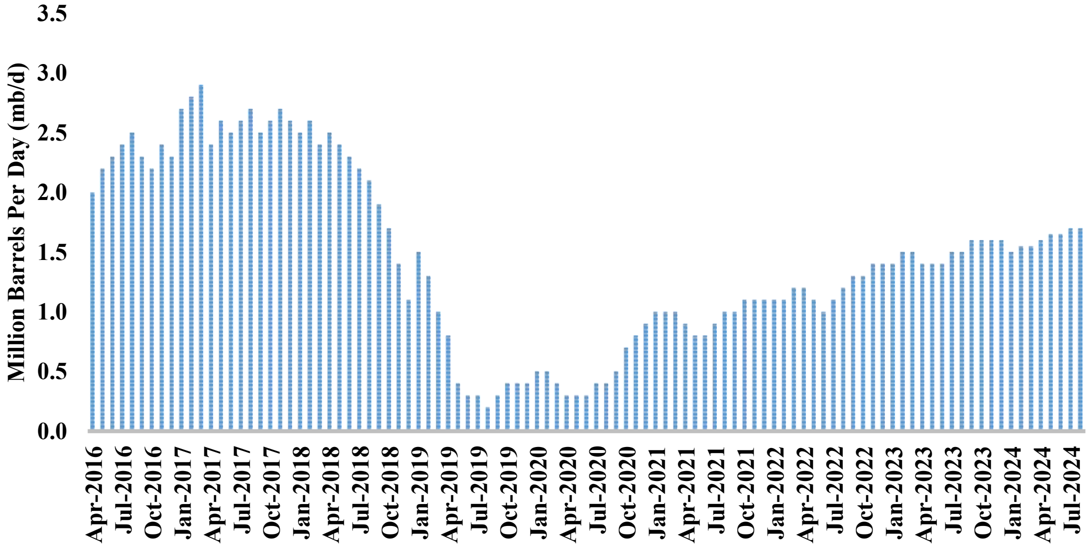

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Figure 4

Iran's monthly crude oil exports, January 2016–August 2024 (U.S. Energy Information Administration, 2025; Vortexa Tanker Tracking, 2024)

As shown in Figure 5, based on the U.S. Energy Information Administration's 2025 report on Iran's oil market, China was the dominant destination for Iranian crude oil exports in 2023, accounting for 89% of total exports. Syria ranked second, accounting for approximately 6% of exports, followed by the United Arab Emirates at approximately 3% and Venezuela at approximately 2%. This distribution indicates that Iran's crude oil export market was highly concentrated in 2023, with a substantial dependence on China as its primary export destination.

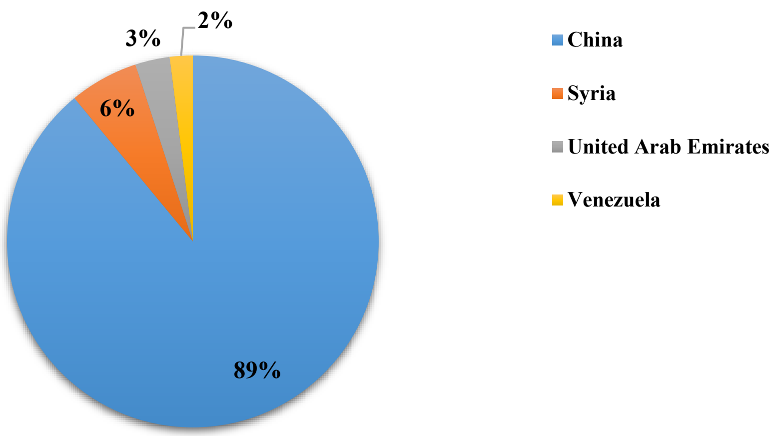

Figure 5

Dominant export destinations for Iranian crude oil in 2023 (U.S. Energy Information Administration, 2025; Vortexa Tanker Tracking, 2024)

As illustrated in Figure 6, the closure of the Strait of Hormuz by Iran, combined with restrictions on oil exports from Western countries and their allies, would lead to significant changes in the global oil market. Iran would increase its own exports by 4% through its control over tanker transit routes, while Oman would raise its exports by 7%. Russia, following the lifting of oil sanctions by the Trump administration, would experience a notable 14% increase in oil exports. These developments would indicate a shift in the global energy balance toward Iran and its partner countries.

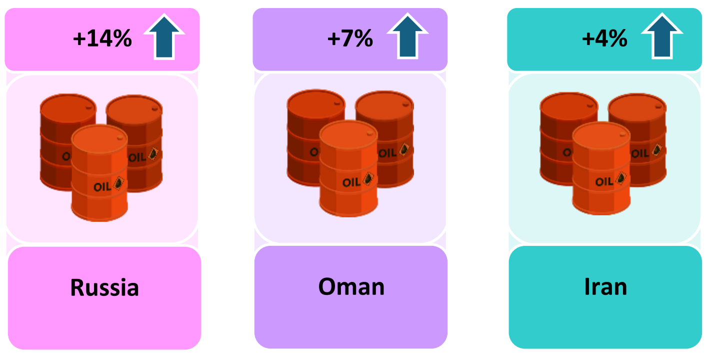

Figure 6

The impact of closing the Strait of Hormuz on global oil exports

Under a scenario in which the Strait of Hormuz remains closed and tanker movements are controlled by Iran, the structure of crude oil production and export channels would change fundamentally. Only Iran and countries aligned with it would be assured of safe passage for their tankers. With more than 8 million barrels per day of loading capacity and infrastructure such as Persian Gulf export terminals and the Goreh–Jask pipeline, Iran would be able not only to maintain its own exports but also to influence the transit conditions of other producers. Under these circumstances, the development of border oil fields, particularly those in West Karun, expansion of refinery capacity for gasoline and diesel production, commencement of production from fields such as Jofeir and Sepehr, and completion of infrastructure such as the Jask terminal and domestic transmission lines would enhance Iran's flexibility in managing the production and export of crude oil and petroleum products.

United Arab Emirates

Before the closure of the Strait of Hormuz, the United Arab Emirates (UAE), with approximately 111 billion barrels of proven oil reserves in 2023, played a significant role in the Persian Gulf oil supply. The country exported its principal crude oil grades, including Murban and Upper Zakum, primarily through the strait. These grades are important components of the Dubai/Oman pricing benchmark, which, together with Brent and West Texas Intermediate (WTI), serves as a major reference in global crude oil markets. At the same time, the Abu Dhabi National Oil Company (ADNOC), through its USD 150 billion investment program for the 2023–2027 period, sought to expand production capacity to approximately 5 million barrels per day by 2027.

As shown in Figure 7, the UAE's oil production followed a generally upward trend from 2013 to 2025. Production stood at approximately 2.6 million barrels per day in 2013 and increased to 2.7 and 2.8 million barrels per day in 2014 and 2015, respectively. It remained relatively stable at approximately 2.9 million barrels per day from 2016 to 2018 before increasing to 3.1 million barrels per day in 2019. Production subsequently declined to 2.8 million barrels per day in 2020 and 2.7 million barrels per day in 2021. This trend reversed in subsequent years, with production increasing to 3.0 million barrels per day in 2022, 3.1 million barrels per day in 2023, and 3.4 million barrels per day in 2024. By 2025, production had risen to approximately 4.0 million barrels per day, indicating substantial growth in the UAE's oil production capacity.

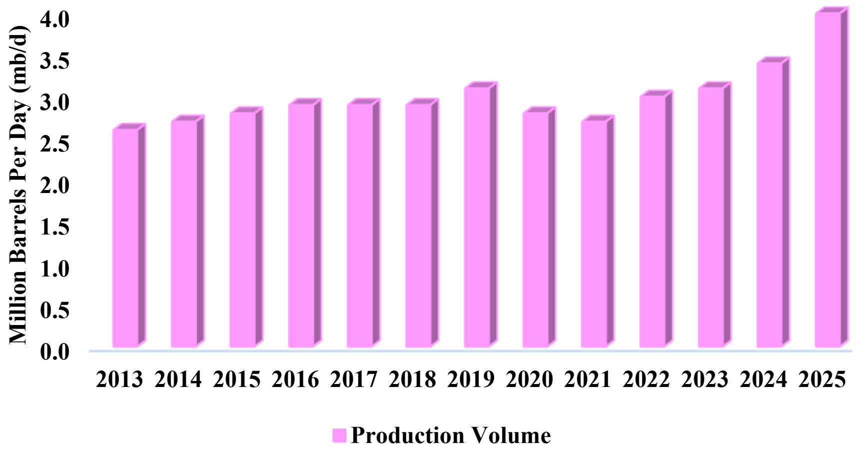

Figure 7

UAE crude oil production from 2013 to 2025 (U.S. Energy Information Administration Report on the UAE Oil Market (2023); Trading Economics (2025))

As shown in Figure 8, the UAE's oil exports exhibited an overall upward trend from 2013 to 2026, despite several fluctuations. Exports stood at approximately 2.6 million barrels per day in 2013 and remained at similar levels during 2014–2015. They subsequently declined to approximately 2.4 million barrels per day during 2016–2018 before increasing to 2.7 million barrels per day in 2019. Exports then decreased to 2.6 million barrels per day in 2020 and 2.5 million barrels per day in 2021. Thereafter, exports increased to 3.0 million barrels per day in 2022, followed by 2.7 million barrels per day in 2023, 2.8 million barrels per day in 2024, and 2.9 million barrels per day in 2025. By 2026, before the outbreak of the U.S.–Israeli war with Iran, exports had reached approximately 3.2 million barrels per day. Overall, this pattern indicates a gradual recovery and expansion of the UAE's oil export capacity following the downturn of the mid-2010s.

Figure 8

UAE oil exports from 2013 to 2026 (U.S. Energy Information Administration Report on the UAE Oil Market (2023); Economic (2024); V-Payment (2025); Trading Economics (2026))

As shown in Figure 9, the UAE's crude oil exports were highly concentrated in the Asia-Pacific region in 2022, accounting for 98% of total exports. Among these destinations, Japan represented the largest share at 29%, followed by China at 23%, other Asia-Pacific countries at 21%, India at 15%, and Thailand at 11%. Europe accounted for only 2% of total exports, with the Netherlands representing approximately 1% and France and Poland each accounting for a negligible share.

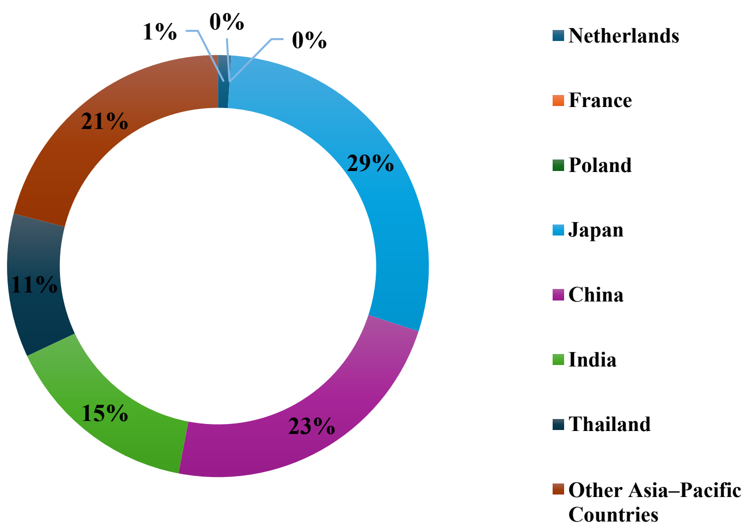

Figure 9

UAE crude oil export destinations in 2022 (U.S. Energy Information Administration Report on the UAE Oil Market (2022))

According to Bloomberg, following the closure of the Strait of Hormuz and the escalation of regional tensions, the UAE reduced its oil production by approximately 50%, equivalent to about 0.5–0.8 million barrels per day. This development forced the Abu Dhabi National Oil Company (ADNOC) to curtail production and severely constrained the country's crude oil exports, which remain highly dependent on this strategic maritime passage. Consequently, even with a production capacity of approximately 4.0–

4.5 million barrels per day, the UAE's effective ability to supply global markets remains dependent on secure access to export routes, and its export volumes could decline by as much as 50%.

Saudi Arabia

Before the closure of the Strait of Hormuz, Saudi Arabia, one of the world's largest oil producers, produced approximately 9.5 million barrels per day of crude oil in 2023. With approximately 17% of the world's proven oil reserves, the Kingdom transported a substantial share of its exports to global markets through the Persian Gulf and the Strait of Hormuz. With a refining capacity of approximately 3.3 million barrels per day and the development of major refining complexes such as SATORP, YASREF, and Jazan, Saudi Arabia also exported a significant portion of its petroleum output in the form of refined petroleum products.

As shown in Figure 10, Saudi Arabia's crude oil production fluctuated considerably between 2013 and 2025. Production increased from 9.6 million barrels per day in 2013 to 9.7 million barrels per day in 2014, 10.0 million barrels per day in 2015, and approximately 10.4 million barrels per day in 2016. It then declined to approximately 10.0 million barrels per day in 2017, increased to 10.3 million barrels per day in 2018, and decreased again to 9.7 million barrels per day in 2019. Production subsequently fell to 9.2 million barrels per day in 2020 and 9.1 million barrels per day in 2021. It then recovered to 10.4 million barrels per day in 2022 before declining to 9.5 million barrels per day in 2023 and 8.3 million barrels per day in 2024. By 2025, production was estimated at approximately 9.8 million barrels per day. Overall, these fluctuations reflect changes in market conditions and supply-side policy decisions.

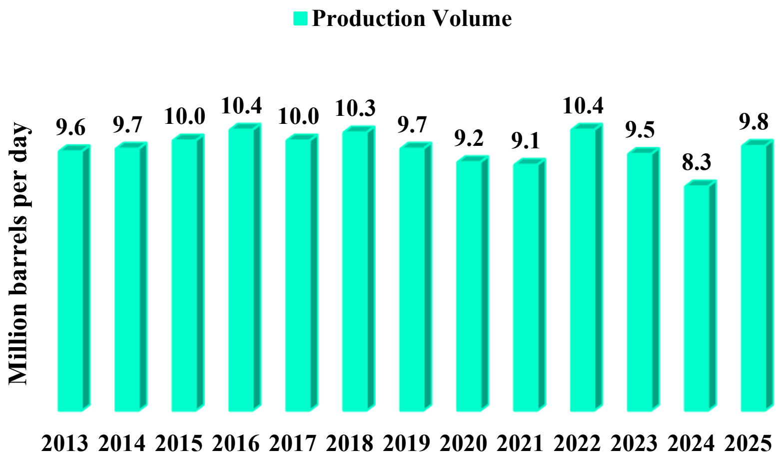

Figure 10

Saudi Arabia's crude oil production from 2013 to 2025 (Trading Economics, 2026; Fararu, 2025)

As shown in Figure 11, Saudi Arabia's oil exports fluctuated considerably between 2019 and 2025. Exports increased from 7.7 million barrels per day in 2019 to 8.4 million barrels per day in 2020 before declining to 7.2 million barrels per day in 2021. They subsequently increased to 7.4 million barrels per day in 2022 and 7.8 million barrels per day in 2023. In 2024, exports reached a peak of 8.9 million barrels per day, representing the highest level during the period under review, before declining to 7.3 million barrels per day in 2025.

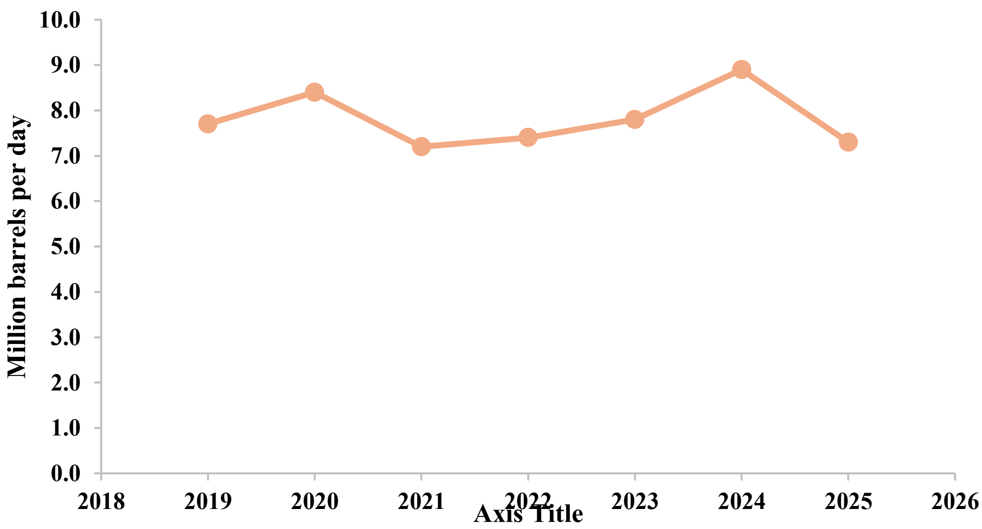

Figure 11

Saudi Arabia's oil exports from 2019 to 2025 (U.S. Energy Information Administration Report on the Saudi Oil Market (2024); Javan Online News Agency (2025); Daneshjoo News Agency (2025))

As shown in Figure 12, approximately 75% of Saudi Arabia's crude oil exports in 2023 were directed to the Asia-Pacific region. China accounted for 23% of total exports, followed by Japan at 14%, South Korea at 13%, India at 10%, and other Asia-Pacific countries at 15%. Europe received 10% of Saudi crude oil exports, including the Netherlands at 2%, Poland at 3%, and other European countries at 5%. Africa accounted for 9%, with Egypt receiving 8% and South Africa 1%. North America received 5%, comprising the United States at 4% and Canada at 1%, while Central and South America accounted for 1%, represented primarily by Brazil. The Middle East and other regions each accounted for approximately 0.3% of total export destinations.

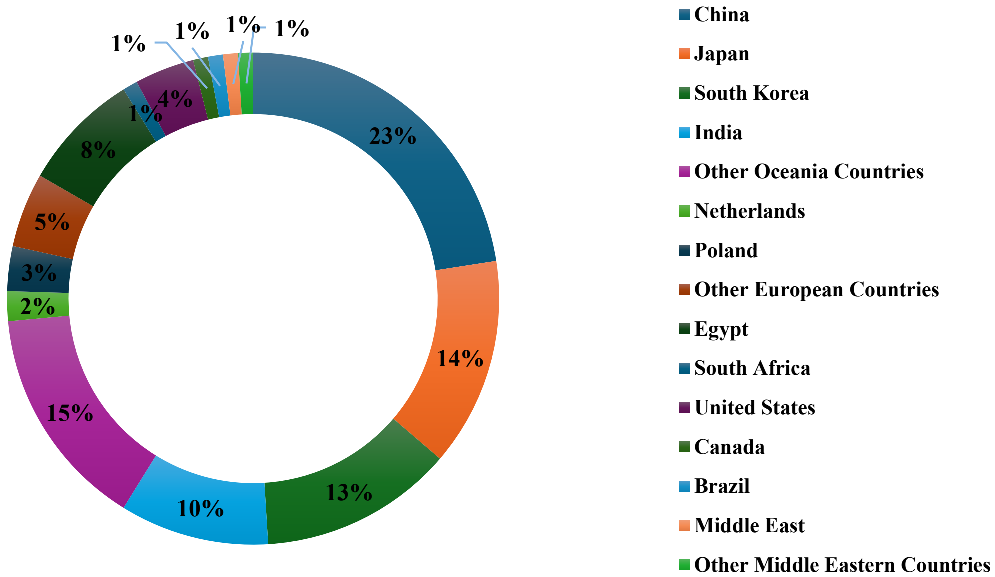

Figure 12

Saudi Arabia's crude oil export shares by destination in 2023 (U.S. Energy Information Administration Report on the Saudi Oil Market (2024))

According to Bloomberg, following the outbreak of the U.S.–Israeli war with Iran and the closure of the Strait of Hormuz, Saudi Arabia reduced its oil production by approximately 2.0–2.5 million barrels per day, shut down the 550,000-barrel-per-day Ras Tanura refinery, and sought to offset the disruption by increasing exports from the port of Yanbu from approximately 800,000 barrels per day to nearly 3.94 million barrels per day in March. However, Anadolu, citing Kpler on March 27, 2026, reported that the port, which was intended to expand its capacity to approximately 5 million barrels per day, had been attacked and rendered effectively nonoperational. Under a scenario in which the Strait of Hormuz remains closed, Saudi Arabia's effective ability to supply global oil markets, despite its production capacity of approximately 12 million barrels per day and substantial reserves in fields such as Ghawar and Safaniyah, would depend increasingly on the availability and security of alternative export routes. This situation could significantly alter the balance of oil production and export capacity in the Persian Gulf.

Iraq

Before the closure of the Strait of Hormuz, Iraq's oil production and export system was characterized by growing petroleum liquids output, which averaged approximately 4.5 million barrels per day in 2024, and substantial dependence on the Persian Gulf route for transporting the majority of its exports, particularly to Asian markets. Oil revenues accounted for approximately 90% of government revenue. At the same time, southern oil field development projects, refinery capacity expansion, completion of the Karbala refinery, and redevelopment of the Kirkuk fields were underway, with the objective of stabilizing production capacity at approximately 7 million barrels per day by 2029 and increasing exports of refined petroleum products.

As shown in Figure 13, Iraq's total production of crude oil and other petroleum liquids increased from approximately 2 million barrels per day in 1990 to about 4.5 million barrels per day in 2024, although the overall trend was marked by substantial fluctuations associated with geopolitical developments. Production declined sharply in 1991 and 1992 before increasing again in 1997, 1998, and 2000. Following the Iraq War, production fell to approximately 1.3 million barrels per day in 2003. From 2004 onward, however, output gradually recovered, reaching approximately 2.0 million barrels per day in 2004, 1.9 million barrels per day in 2005, 2.0 million barrels per day in 2006, 2.1 million barrels per day in 2007, 2.4 million barrels per day in both 2008 and 2009, and 2.45 million barrels per day in 2010. This upward trend continued over the following decade, culminating in production of approximately 4.5 million barrels per day in 2019. Although output declined in 2020 as a result of the COVID-19 pandemic, it subsequently recovered and stabilized at more than 4 million barrels per day in the following years.

As shown in Figure 14, of Iraq's approximately 3.2 million barrels per day of seaborne crude oil exports in 2024, Asia accounted for the largest share at 72%. China received 35% of total exports, followed by India at 27%, South Korea at 8%, and other Asian countries at 2%. Europe ranked second, accounting for 21% of exports, including the Netherlands at 5%, Italy at 4%, Greece at 4%, and other European countries at 8%. The Americas accounted for 6%, almost entirely represented by the United States, while Africa, the Middle East, and other regions collectively accounted for only 1%. This distribution highlights Iraq's heavy dependence on Asian markets for its crude oil exports.

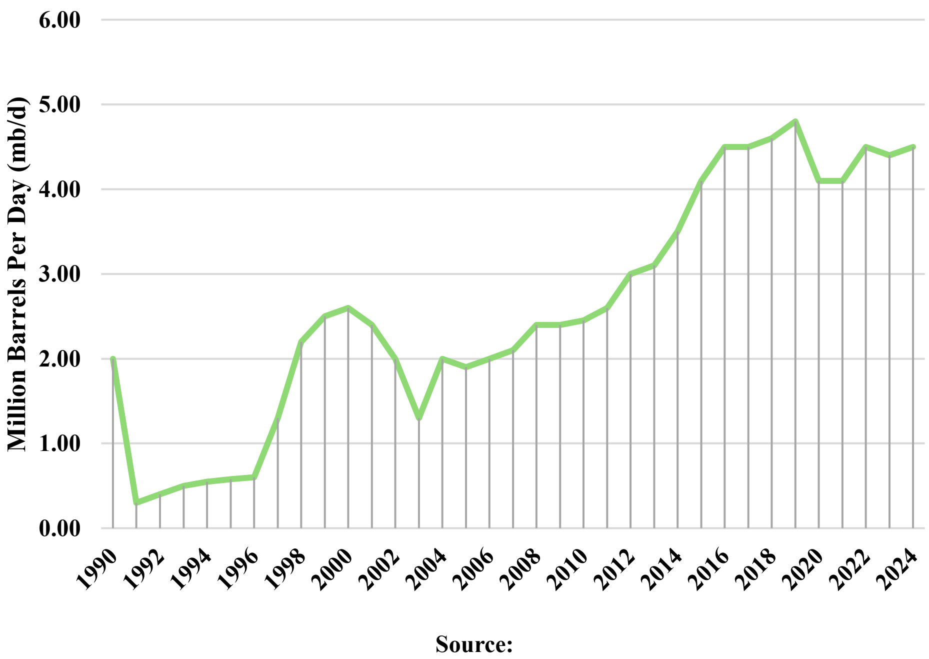

Figure 13

Iraq's oil production from 1990 to 2024 (U.S. Energy Information Administration Report on the Iraq Oil Market (2025))

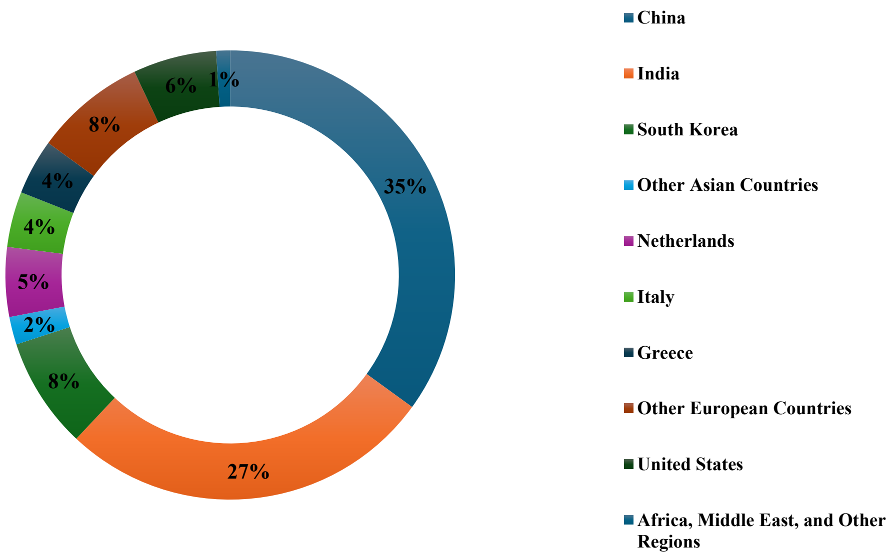

Figure 14

Iraq's seaborne crude oil exports by destination in 2024 (U.S. Energy Information Administration Report on the Iraq Oil Market (2025))

Following the closure of the Strait of Hormuz amid the U.S.–Israeli war against Iran and the imposition of transit fees on vessel movements, Iraq lost access to approximately 4.3 million barrels per day of export capacity through Basra. As storage facilities reached capacity, Iraq was forced to reduce production by approximately 2.9 million barrels per day. Production by the Basra Oil Company declined from 3.3 million to approximately 900,000 barrels per day, while Baghdad's production fell by 70%. In addition, the shutdown of six southern oil fields, including the Rumaila field with a production capacity of approximately 1.4 million barrels per day, resulted in a 76% decline in southern exports and a 49% decline in northern exports. These developments severely weakened Iraq's oil production and export capacity.

Kuwait

Before the closure of the Strait of Hormuz, Kuwait, with approximately 102 billion barrels of proven oil reserves, was considered one of OPEC's key oil suppliers. In 2022, the country produced more than 3 million barrels per day of petroleum liquids, including approximately 2.7 million barrels per day of crude oil. Most of this crude oil was produced from fields in southeastern Kuwait, particularly the Burgan field, and exported to international markets. Kuwait's production structure includes medium and sour crude oil, ultra-light oil from Jurassic formations, and heavy oil from northern fields. At the same time, the country pursued refinery expansion and the commissioning of the Al-Zour refinery to increase its exports of refined petroleum products.

As shown in Figure 15, Kuwait's production of crude oil and other petroleum liquids fluctuated substantially between 1987 and 2025. Production stood at approximately 1,600 thousand barrels per day in 1987, 1,550 thousand barrels per day in 1988, and 1,850 thousand barrels per day in 1989. Following Iraq's invasion of Kuwait in 1990, production declined sharply to approximately 1,200 thousand barrels per day and fell further to around 200 thousand barrels per day in 1991. A recovery subsequently began, with production increasing to approximately 1,100 thousand barrels per day in 1992, 1,850 thousand barrels per day in 1993, 2,100 thousand barrels per day in 1994, 2,150 thousand barrels per day in both 1995 and 1996, 2,100 thousand barrels per day in 1997, 2,200 thousand barrels per day in 1998, 2,000 thousand barrels per day in 1999, 2,200 thousand barrels per day in 2000, 2,100 thousand barrels per day in 2001, and 2,000 thousand barrels per day in 2002. Production then increased to 2,200 thousand barrels per day in 2003, 2,500 thousand barrels per day in 2004, 2,700 thousand barrels per day in both 2005 and 2006, 2,600 thousand barrels per day in 2007, 2,700 thousand barrels per day in 2008, 2,500 thousand barrels per day in 2009, 2,450 thousand barrels per day in 2010, 2,750 thousand barrels per day in 2011, 2,850 thousand barrels per day in 2012, 2,900 thousand barrels per day in 2013, 2,880 thousand barrels per day in 2014, 3,050 thousand barrels per day in 2015, and 3,150 thousand barrels per day in 2016.

Figure 15

Kuwait's oil and petroleum products production from 1987 to 2025 (U.S. Energy Information Administration Report on Kuwait's Oil Market (2023); Trading Economics (2026))

Production subsequently declined to approximately 3,000 thousand barrels per day in 2017, increased slightly to 3,050 thousand barrels per day in 2018, and decreased again to approximately 3,000 thousand barrels per day in 2019. It then fell to approximately 2,700 thousand barrels per day in both 2020 and 2021 before recovering to around 3,000 thousand barrels per day in 2022. According to additional data, production declined to approximately 2,100 thousand barrels per day in 2023 before recovering to 2,450 thousand barrels per day in 2024 and approximately 2,580 thousand barrels per day in 2025. Overall, these fluctuations reflect the combined influence of geopolitical disruptions, global oil market conditions, and OPEC supply-management policies on Kuwait's production trajectory.

As shown in Figure 16, Kuwait's exports of crude oil and condensates in 2022 were heavily concentrated in Asian markets. China was the largest export destination, accounting for 31% of total exports, followed by South Korea at 17%. Japan and India each accounted for 12%, while Taiwan and Vietnam represented 10% and 9%, respectively. Other Asian countries accounted for 5%, whereas all other regions combined represented only 4%. Overall, these data indicate Kuwait's strong dependence on East and Southeast Asian energy markets.

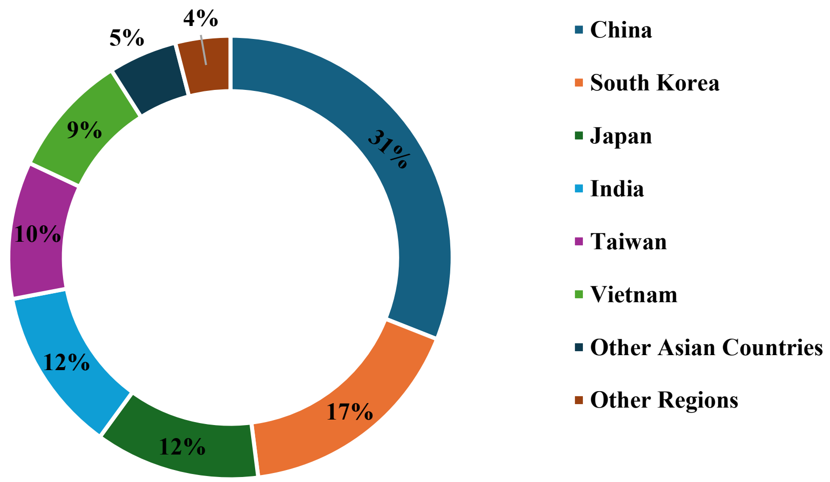

Figure 16

Kuwait's oil export shares by destination in 2022 (U.S. Energy Information Administration Report on Kuwait's Oil Market (2023))

Following the outbreak of the U.S.–Israeli war against Iran and the closure of the Strait of Hormuz, which restricted tanker movements, Kuwait's primary export route was effectively blocked. Consequently, the country was compelled to reduce production by approximately 500,000 barrels per day to prevent storage facilities from reaching full capacity. If this situation were to persist, Kuwait's near-total dependence on the Persian Gulf and the Strait of Hormuz for its oil exports would significantly constrain its ability to supply international markets. Thus, despite production capacity of several million barrels per day and plans to increase capacity to approximately 4 million barrels per day, disruption of export routes could sharply reduce actual supply and lower exports by as much as 72%.

Qatar

Before the closure of the Strait of Hormuz, Qatar maintained relatively stable production and exports of crude oil, condensates, and natural gas liquids (NGLs). By 2024, its total liquids production had reached approximately 1.9 million barrels per day. Despite a decline in crude oil production, the expansion of gas field development and substantial refining capacity had established Qatar as a major exporter of petroleum products and condensates.

As shown in Figure 17, Qatar's total production of crude oil and other petroleum liquids generally followed an upward trend, with relatively limited fluctuations, between 2000 and 2024. Production increased from approximately 880 thousand barrels per day in 2000 and 870 thousand barrels per day in both 2001 and 2002 to 1,000 thousand barrels per day in 2003, 1,150 thousand barrels per day in 2004, 1,250 thousand barrels per day in 2005, 1,280 thousand barrels per day in 2006, 1,350 thousand barrels per day in 2007, 1,470 thousand barrels per day in 2008, and 1,460 thousand barrels per day in 2009. Production continued to increase, reaching approximately 1,680 thousand barrels per day in 2010, 1,830 thousand barrels per day in 2011, and a peak of 2,000 thousand barrels per day in both 2012 and 2013.

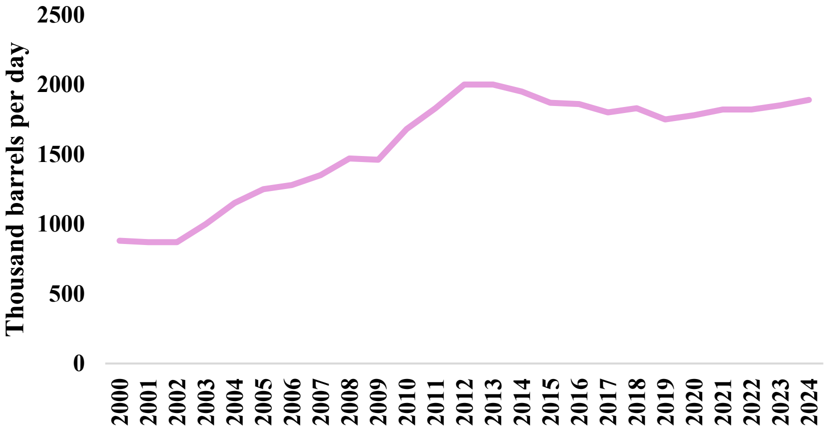

Figure 17

Qatar's crude oil and condensate production from 2000 to 2024 (U.S. Energy Information Administration Report on the Qatar Oil Market (2025))

Thereafter, production fluctuated moderately, declining to approximately 1,950 thousand barrels per day in 2014, 1,870 thousand barrels per day in 2015, 1,860 thousand barrels per day in 2016, and 1,800 thousand barrels per day in 2017. It subsequently increased to 1,830 thousand barrels per day in 2018, declined to 1,750 thousand barrels per day in 2019, and recovered to 1,780 thousand barrels per day in 2020. Production then reached approximately 1,820 thousand barrels per day in both 2021 and 2022, 1,850 thousand barrels per day in 2023, and 1,890 thousand barrels per day in 2024. Overall, this pattern indicates that Qatar's production has remained relatively stable at approximately 1.8–2.0 million barrels per day in recent years.

As shown in Figure 18, Qatar's crude oil and condensate exports exhibited an overall downward trend, with moderate fluctuations, between 2017 and 2024. Exports increased from approximately 760 thousand barrels per day in 2017 to 770 thousand barrels per day in 2018, reaching a peak of 790 thousand barrels per day in 2019. They subsequently declined to approximately 750 thousand barrels per day in 2020 and fell more sharply to about 680 thousand barrels per day in 2021. Exports then recovered to approximately 710 thousand barrels per day in 2022, declined again to around 690 thousand barrels per day in 2023, and increased to approximately 715 thousand barrels per day in 2024. These fluctuations reflect changes in global market conditions, production policies, and energy demand.

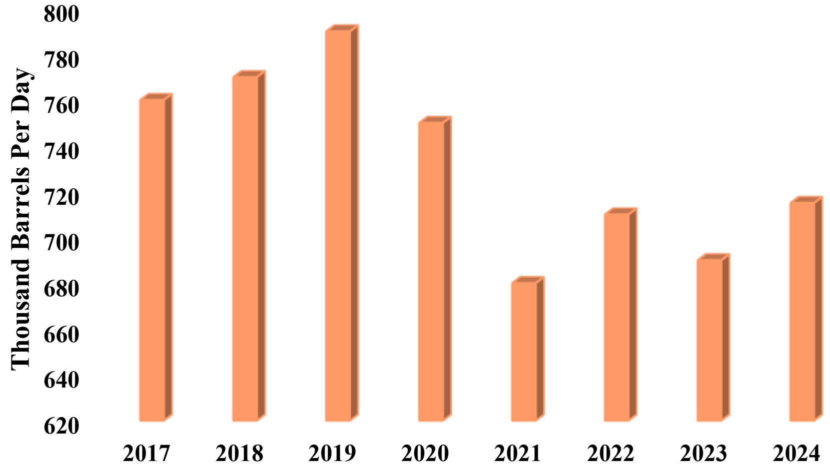

Figure 18

Qatar's crude oil and condensate exports from 2017 to 2024 (U.S. Energy Information Administration Report on the Qatar Oil Market (2025))

As shown in Figure 19, the geographic distribution of Qatar's crude oil and condensate exports in 2024 was heavily concentrated in Asian markets. China was the largest export destination, accounting for 27% of total exports, followed by South Korea at 20% and Singapore at 16%. Japan and the United Arab Emirates each accounted for 10%, while Taiwan and Thailand each represented 5%, other Asian countries 4%, and India 3%. This distribution highlights Qatar's strong dependence on East and Southeast Asian energy markets.

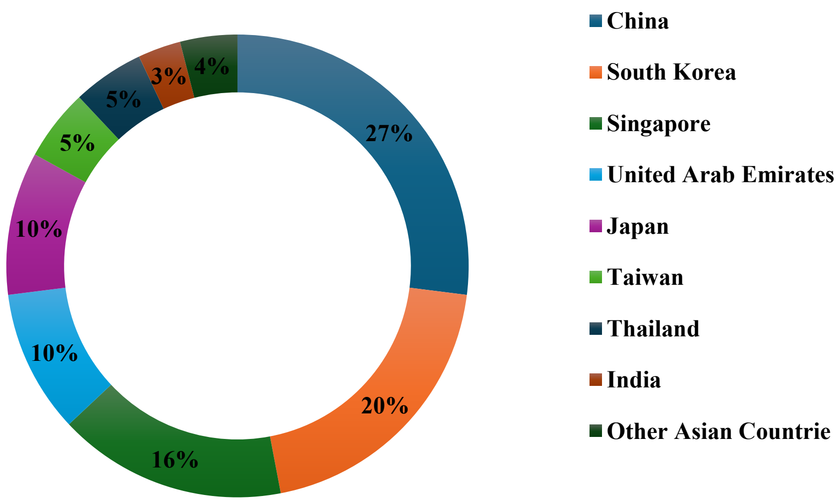

Figure 19

Qatar's crude oil and condensate exports by destination in 2024 (U.S. Energy Information Administration Report on the Qatar Oil Market (2025))

Following the closure of the Strait of Hormuz, when tanker passage became restricted to Iran and states authorized by it, Qatar's export channels, similar to those of other Persian Gulf producers, became severely disrupted. Nearly all of the country's crude oil, condensate, and petroleum product exports must transit the strait. Consequently, the additional capacity generated through the North Field expansion, together with Qatar's refining and gas-to-liquids capabilities, became effectively unavailable for export. Qatar was therefore compelled to reduce production or rely on limited storage capacity, leaving a substantial portion of its production and export capacity underutilized.

A production interruption occurs when disruptions in the Strait of Hormuz reduce the flow of crude oil and condensates to refineries and petrochemical facilities, temporarily shutting down part of the region's operational capacity. This effect is particularly severe in countries lacking alternative export routes, especially Kuwait, whose exports and a substantial share of refinery feedstock depend almost entirely on transit through the Strait of Hormuz. Under such conditions, even short-term interruptions in tanker traffic can significantly reduce refinery throughput and energy-intensive industrial activity. Previous incidents involving temporary feedstock shortages at major regional refineries illustrate this vulnerability, as such shortages resulted in immediate reductions in operational capacity. Overall, the closure or restriction of the strait threatens not only export flows but also the continuity of domestic production throughout the region.

Bahrain

Over the past several decades, Bahrain's oil production and export patterns have undergone distinct phases of stability, sharp increases, and repeated fluctuations. The available data reveal structural changes in production and export activity, periods of substantial market re-entry, and subsequent phases of gradual decline. The following section provides a detailed interpretation of these developments based on official data and an analysis of their evolution over time.

As shown in Figure 20, Bahrain's oil production remained at a very low and relatively stable level, with only minor fluctuations, from the mid-1990s until approximately 2009. During this period, daily production remained at only a few tens of thousands of barrels per day, with no pronounced upward or downward trend. Around 2010, however, the time series exhibits a sudden and substantial increase, with reported production rising abruptly to a much higher level. Rather than indicating a gradual expansion in physical production, such a discontinuity may reflect a change in reporting methodology or the inclusion of an additional production source, such as output from shared offshore fields, in the official statistics.

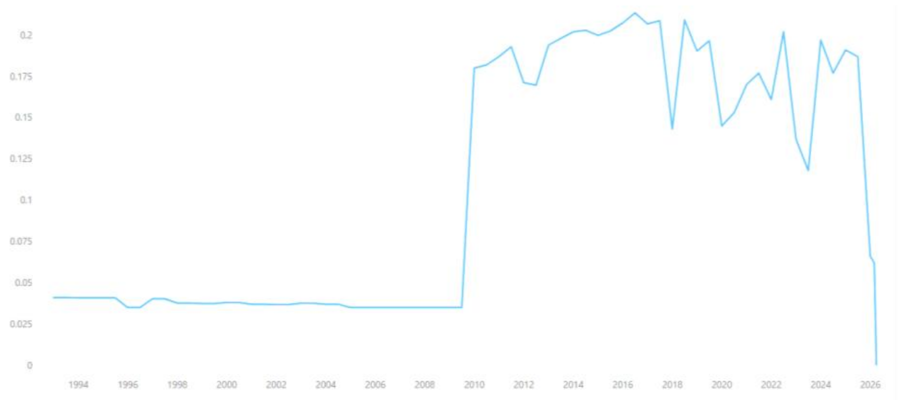

Figure 20

Bahrain's crude oil production in 2024 (U.S. Energy Information Administration Report on the Bahrain Oil Market (2025))

Following this increase, production stabilized at a higher level from 2010 onward, although the series continued to exhibit considerable volatility. These fluctuations, characterized by intermittent peaks and declines, may reflect factors such as maintenance activities, changes in field productivity, operational decisions, or broader market conditions. In the final years presented in the figure, this volatility persists, followed by an unusually sharp decline toward near-zero values as 2026 approaches. Such a pattern may indicate incomplete observations at the end of the reporting period, a discontinuity in the time series, or a visualization error rather than an actual cessation of production. Overall, Figure 20 indicates that Bahrain maintained low and stable oil production until 2009, transitioned to a substantially higher but more volatile production level after 2010, and exhibits anomalous end-of-series values that require further verification.

Figure 21 illustrates the trajectory of Bahrain's crude oil exports from 2014 to 2025, showing an initial period of negligible recorded activity, followed by a sharp increase, a phase of relative stability, and a subsequent gradual decline. In 2014 and 2015, reported export volumes were zero, which may indicate either an absence of recorded exports during those years or limitations in data reporting and registration. In 2016, however, exports increased sharply to approximately 131.9 thousand barrels per day, indicating Bahrain's substantial re-entry into the export market or a marked expansion in its capacity to supply foreign markets. This upward trend continued in 2017, when exports reached 154.8 thousand barrels per day, and peaked in 2018 at approximately 156.5 thousand barrels per day. Thus, the 2016–2018 period represents a phase of rapid export growth and the attainment of the highest levels shown in the figure.

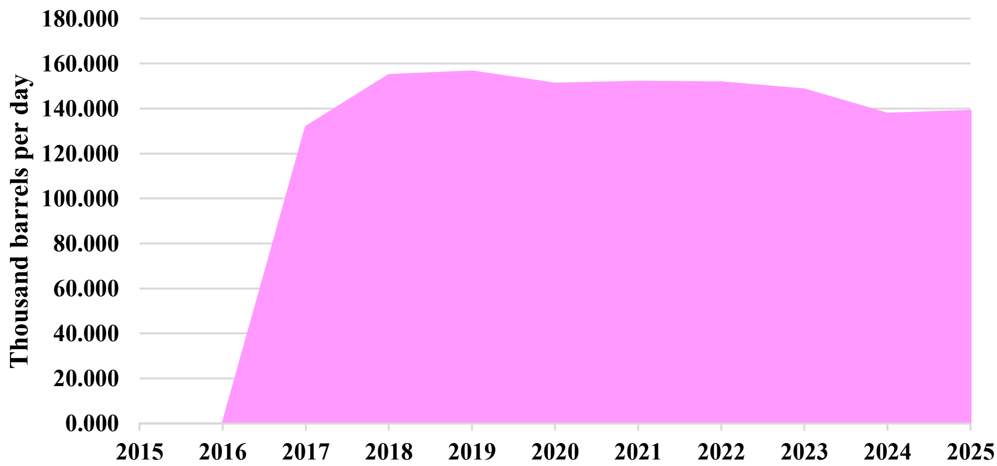

Figure 21

Bahrain's crude oil export from 2014 to 2025 (U.S. Energy Information Administration Report on the Bahrain Oil Market (2025))

Following the 2018 peak, exports declined slightly to approximately 155.8 thousand barrels per day in 2019 and then to 151.1 thousand barrels per day in 2020. From 2020 to 2022, export volumes remained relatively stable, fluctuating within a narrow range of approximately 151–152 thousand barrels per day. This pattern indicates that exports entered a period of relative stabilization following the initial decline. From 2023 onward, however, the downward trend became more pronounced, with exports falling to approximately 148.5 thousand barrels per day. The decline intensified in 2024, when exports decreased to approximately 137.8 thousand barrels per day, the lowest level recorded since the initial increase in 2016. Although a modest recovery to approximately 139.0 thousand barrels per day was projected for 2025, export volumes remained substantially below the levels observed during 2017–2023. Overall, the figure indicates that Bahrain's crude oil exports increased sharply after 2015, peaked in 2018, remained relatively stable for several years, and entered a sustained declining phase beginning in 2023.

Oman

For decades, Oman's energy sector has been characterized by production capacity that substantially exceeds its steadily increasing domestic demand. This persistent surplus has reinforced the country's long-standing role as a major energy exporter, even as the relationship between hydrocarbon production and rising domestic consumption continues to evolve.

As shown in Figure 22, Oman's oil production remained consistently and substantially higher than domestic consumption between 1980 and 2024, reinforcing the country's position as a major oil-exporting nation. During the 1980s, production started from a relatively low base and followed a steady upward trajectory. This growth continued throughout the 1990s, bringing production close to 1 million barrels per day by the late 1990s and early 2000s. Following this peak, production entered a period of decline, with a more pronounced decrease during the mid-2000s, potentially reflecting natural field depletion, technical constraints, or changing market conditions. However, this decline was temporary. Production began to recover in the late 2000s and strengthened throughout the 2010s, reaching or exceeding 1 million barrels per day in several years. In the final years shown in the figure, production remained relatively high despite short-term fluctuations, reaching one of its highest levels around 2022 before declining slightly toward 2024.

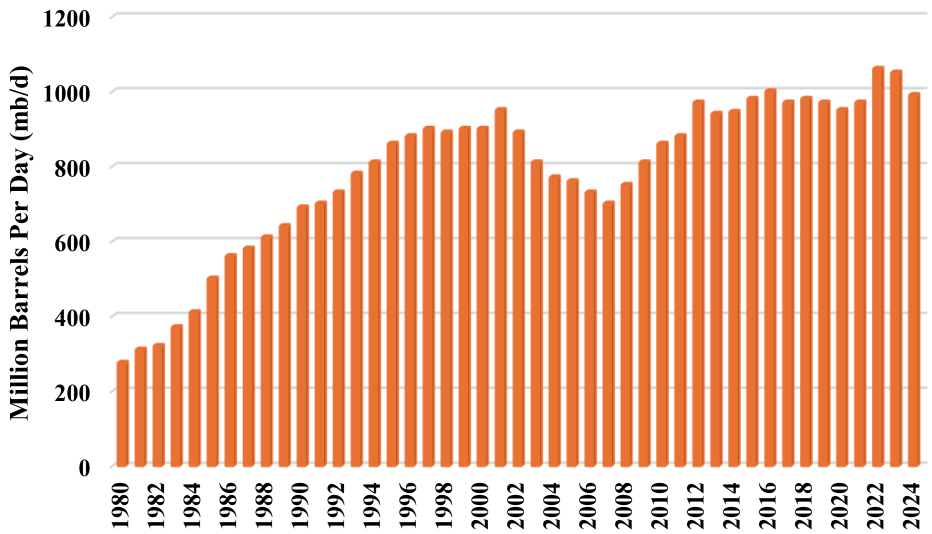

Figure 22

Oman's crude oil production and consumption from 1980 to 2024 (U.S. Energy Information Administration Report on the Oman Oil Market (2025))

In contrast, Oman's domestic oil consumption began at a very low level and increased gradually over the study period. Growth became more pronounced during the 2000s and accelerated further throughout the 2010s, with consumption reaching several hundred thousand barrels per day in recent years. This gradual increase can be attributed to population growth, industrial development, expansion of the transportation sector, and rising domestic energy demand. Despite this sustained growth in consumption, a substantial gap between production and domestic demand persisted throughout the entire period. Even during periods of declining production or increasing consumption, oil production remained several times higher than domestic requirements.

2.2. Supply and Pricing Channel for Crude Oil and Petroleum Products

The supply and pricing channel for crude oil and petroleum products is shaped by the interaction among production capacity, transportation routes, geopolitical risks, and the behavior of market participants. Any disruption to physical supply flows, particularly through strategic chokepoints such as the Strait of Hormuz, can increase geopolitical risk premiums, intensify price volatility, and redirect global trade flows. Consequently, a country's ability to sustain exports, manage transportation routes, and meet global demand plays a critical role in determining short- and medium-term price equilibrium. This channel therefore represents the linkage between physical supply conditions and financial market behavior in the energy sector.

The global oil market is highly sensitive to geopolitical risk, and even the prospect of a supply disruption can be rapidly reflected in oil prices. When regional tensions escalate or disruptions to Iran's oil exports emerge, the market incorporates a geopolitical risk premium into prices, effectively accounting for alternative supply scenarios. Figure 23 illustrates the oil price fluctuations associated with the U.S.–Israeli conflict against Iran.

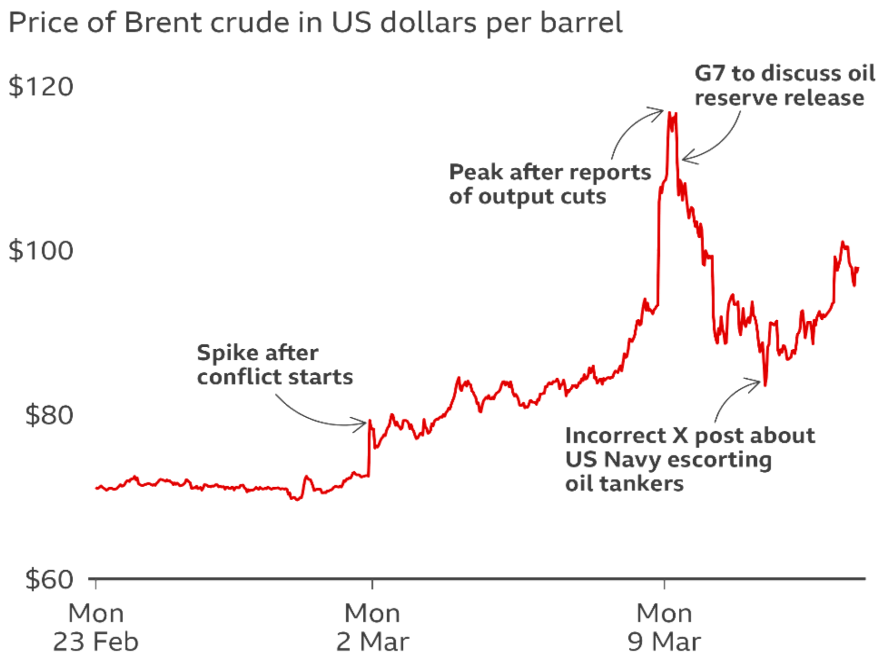

Figure 23

Oil price changes caused by the U.S.–Israeli war against Iran in March 2026 (Bloomberg, 2026)

In energy economics, the geopolitical risk premium refers to the portion of the oil price that reflects heightened uncertainty regarding the continuity of supply. As shown in Figure 24, when the probability of disruption along a critical route such as the Strait of Hormuz increases, the global market responds through a shift in the supply curve from S_1 to S_2, representing a reduction in effective supply and an increase in the equilibrium price. Conversely, heightened uncertainty may shift the demand curve for safe-haven assets such as gold from D_1 to D_2. These mechanisms, previously discussed in the theoretical framework, provide the analytical basis for understanding the response of global oil markets to geopolitical shocks affecting the Strait of Hormuz.

Figure 24

Oil price disturbances caused by the U.S.–Israeli war against Iran (Bloomberg, 2026)

In summary, any threat to or disruption of the Strait of Hormuz, given its critical role in the daily transit of crude oil and refined petroleum products, is perceived by the market as an anticipated reduction in supply, thereby increasing the risk premium in both futures and spot markets. Consequently, even before an actual decline in production or exports occurs, prices may rise rapidly through expectation-driven and behavioral mechanisms.

Under a scenario involving disrupted transit through the Strait of Hormuz, various supply-enhancing and demand-reducing factors may partially offset the resulting oil shortage. The interaction of these forces provides an overall perspective on the likely market equilibrium under crisis conditions. Figure 25 illustrates the balance between global oil supply and demand following the closure of the Strait of Hormuz.

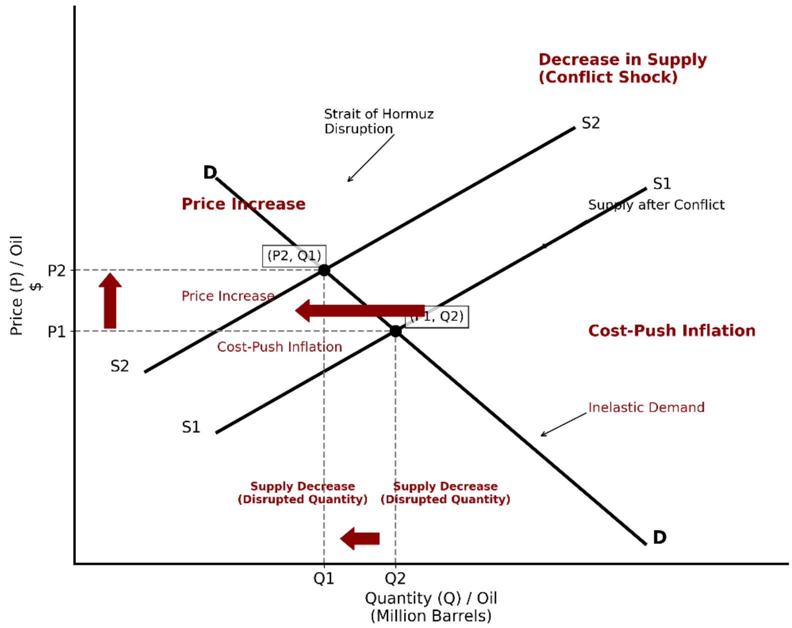

Figure 25

Global oil market supply shock

As illustrated in Figure 26, a reduction in crude oil supply through the Strait of Hormuz could be offset, at least temporarily and partially, by several operational measures that may moderate upward pressure on global oil prices. Under the most optimistic scenario, alternative pipeline routes in Saudi Arabia, the United Arab Emirates, and Iraq could transport approximately 5 million barrels per day without major time constraints, provided that the conflict does not extend to other strategic chokepoints. In addition, part of the shortfall could be covered by floating storage reserves, primarily associated with Iran, Russia, and Venezuela, with an estimated supply capacity of 1 million barrels per day for approximately 110 days, equivalent to about 110 million barrels in total.

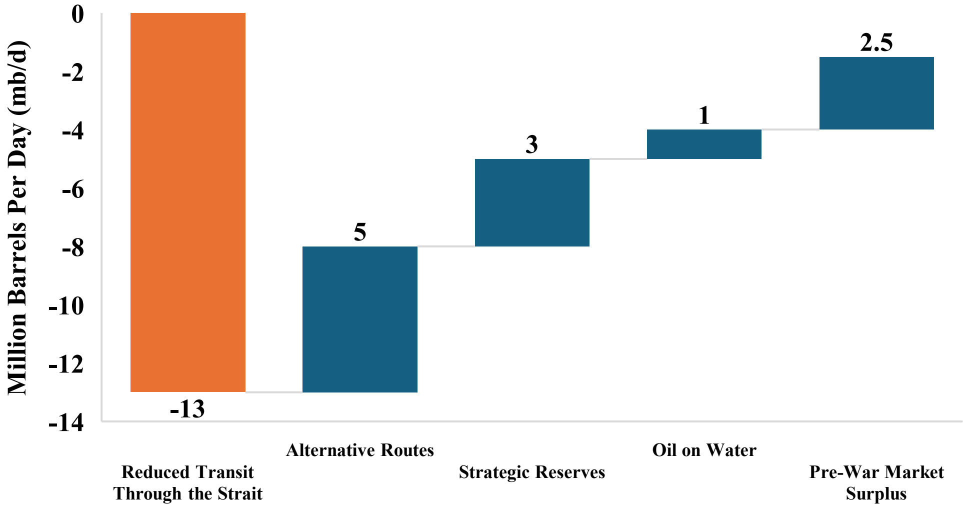

Figure 26

Crude oil supply–demand balance after closure of the Strait of Hormuz (U.S. Energy Information Administration, 2026; OPEC, 2026)

Moreover, the release of strategic petroleum reserves by member countries of the International Energy Agency (IEA) could add approximately 3 million barrels per day to the market for about 130 days, corresponding to a total volume of nearly 400 million barrels. Despite these compensating sources, estimates indicate that by the second month of the conflict, approximately 4 million barrels per day of crude oil that would normally transit the Strait of Hormuz could remain uncompensated. Even after accounting for a prewar supply surplus of approximately 2.5 million barrels per day, a residual shortage of about 1.5 million barrels per day could persist. During the first month of the conflict, compensating supply capacity would be even more limited, leaving approximately 160 million barrels of crude oil required by global markets unsupplied.

Escalating geopolitical risk in the Strait of Hormuz, through its effect on global oil and gas prices, would directly increase energy costs in advanced economies. Initially, these effects would emerge at the production level through higher input costs for firms and would subsequently be transmitted to consumers, particularly through higher fuel and transportation prices, thereby generating inflationary pressures. Under such conditions, central banks in the United States, Europe, and the United Kingdom would face a dual challenge: higher inflation would call for tighter monetary policy, while rising energy costs would simultaneously weaken economic activity. This combination would increase the risk of stagflation and complicate monetary policy decision-making.

As depicted in Figure 27, rising gasoline prices in the United States represent one of the fastest transmission channels through which an energy shock affects the consumer price index (CPI), owing to the substantial share of fuel expenditures in household budgets and their direct impact on transportation costs and related goods and services. Low-income households, which allocate a larger proportion of their income to energy expenditures, are particularly vulnerable to these effects. In Europe and the United Kingdom, greater dependence on imported energy and international oil and gas markets accelerates the transmission of a Strait of Hormuz shock to domestic inflation, thereby significantly increasing the cost of energy imports.

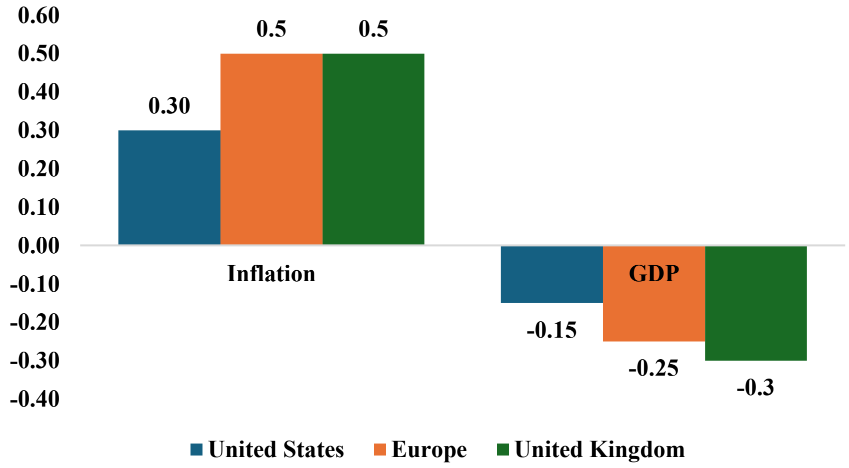

Figure 27

Strait closure and inflationary effects on the U.S., Europe, and the U.K. (Bloomberg Economics, 2026)

Ultimately, rising energy prices often become a politically sensitive domestic issue in these economies because the resulting inflationary pressures directly affect household budgets and the cost of living. Policy responses by governments and central banks generally focus on managing inflation expectations, stabilizing energy markets, and calibrating the pace of monetary tightening. Overall, a disruption in the Strait of Hormuz can simultaneously intensify inflationary pressures and weaken economic growth, thereby narrowing the margin for policy error in major economies.

Table 1

Possible scenarios

Scenario	Key assumption	Description	Oil flow status	Geopolitical risk level	Probable outcome
Extreme	Complete closure of Hormuz	Disruption or shutdown of the strait	Severe blockage of tanker passage	Very high	Strong supply shock and sharp surge in global oil prices
Risky	Severe but incomplete disruption	Halted Iranian oil exports	Decline in Iran's oil supply to the market	High	Rising oil prices and pressure on global energy markets
Baseline	Limited and periodic tensions	Continued oil flow amid geopolitical strains	Oil flow continues	Moderate	Price fluctuations without major supply interruptions
Probable	Controlled tension	Conditional passage of tankers for non-aligned states (subject to tolls)	Restricted tanker transit	Moderate to high	Additional transport costs and re-routing of trade flows

As shown in Table 1, under the baseline scenario, the continued flow of oil prevents extreme price increases. In supply-disruption scenarios, however, particularly those involving restrictions on regional oil flows, the likelihood of a substantial price surge increases significantly. The extreme scenario involves a severe supply shock accompanied by a sharp increase in oil prices. The risky scenario is characterized by the suspension of Iranian oil exports and a partial reduction in global supply. Under the baseline scenario, the primary effect is increased price volatility without major physical disruption to supply. In the probable scenario, controlled tanker passage combined with the imposition of transit fees increases transaction costs and alters established trade routes.

2.3. Oil and petroleum product reserves channel in the United States, Europe, and Asia

Within the framework of global energy security, strategic reserves of crude oil and petroleum products constitute a critical instrument for managing supply shocks and preventing abrupt price increases. In the event of a closure of the Strait of Hormuz and restrictions on tanker traffic, these reserves would function as a short-term buffer for major consuming regions. However, because strategic reserves are inherently finite, their capacity to stabilize markets would diminish if disruptions to Persian Gulf oil exports persisted, thereby increasing pressure on the global energy market.

As shown in Figure 28, the distribution of proven oil reserves is highly concentrated among a limited number of major producers. Venezuela ranks first with approximately 303 billion barrels, followed by Saudi Arabia with 267 billion barrels and Iran with 209 billion barrels, all of which hold substantial importance in global oil markets. Canada, with 163 billion barrels, Iraq with 145 billion barrels, the United Arab Emirates with 113 billion barrels, and Kuwait with 102 billion barrels occupy the next positions, followed by Russia with 80 billion barrels, the United States with 74 billion barrels, Libya with 48 billion barrels, and Nigeria with 37 billion barrels. These figures indicate that a substantial share of global proven oil reserves is concentrated in the Middle East and among a limited number of major producers in the Americas, underscoring their critical role in maintaining global supply balance and energy security.

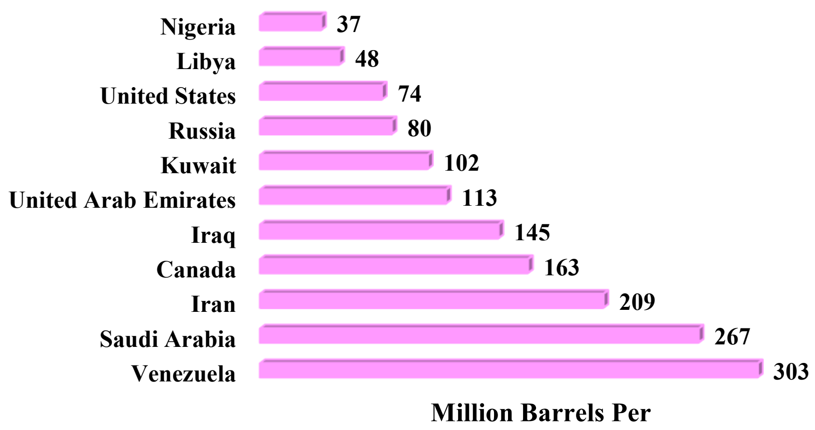

Figure 28

Largest holders of proven oil reserves in 2024 (U.S. Energy Information Administration, 2025; Razavi, 2025; Miz-e-Naft, 2025)

Following the unprecedented disruption of oil transit through the Strait of Hormuz and the resulting supply crisis, concerns have intensified regarding the adequacy and durability of emergency petroleum reserves. The United States, through its strategic petroleum reserve (SPR), can temporarily mitigate supply shortages and sharp price increases; however, given the finite capacity of the SPR, additional measures such as increased shale oil production, diversification of import sources, and demand management would also be required. Europe and Asia, despite maintaining strategic storage obligations, remain more vulnerable because of their dependence on imported refined petroleum products, particularly diesel, and constraints on refining capacity. This vulnerability is especially pronounced in countries such as Japan, South Korea, and India, which depend heavily on energy flows through the Strait of Hormuz. Although China may be comparatively better positioned because of its substantial petroleum reserves, these stocks can primarily absorb the initial supply shock. Sustained market stability would ultimately depend on the rerouting of trade flows and adjustments in global production and consumption patterns.

According to data from the International Energy Agency (2026), as illustrated in Figure 29, the capacity of national emergency oil reserves to cover domestic demand varies considerably across countries. Japan, with 208 days of coverage, and South Korea, with 200 days, maintain the highest levels. They are followed by Germany with 130 days, the United Kingdom with 124 days, France with 117 days, and Spain with 98 days. By comparison, the Philippines maintains reserves equivalent to 60 days of demand, Australia 49 days, Malaysia 30 days, Indonesia 20 days, and India only 11 days. Under International Energy Agency requirements, member countries are required to maintain emergency oil stocks equivalent to at least 90 days of net oil imports. Given the high dependence of many Asian economies on Middle Eastern oil, disruptions affecting strategic routes such as the Strait of Hormuz can place particularly severe pressure on their energy security and, more broadly, on global oil markets.

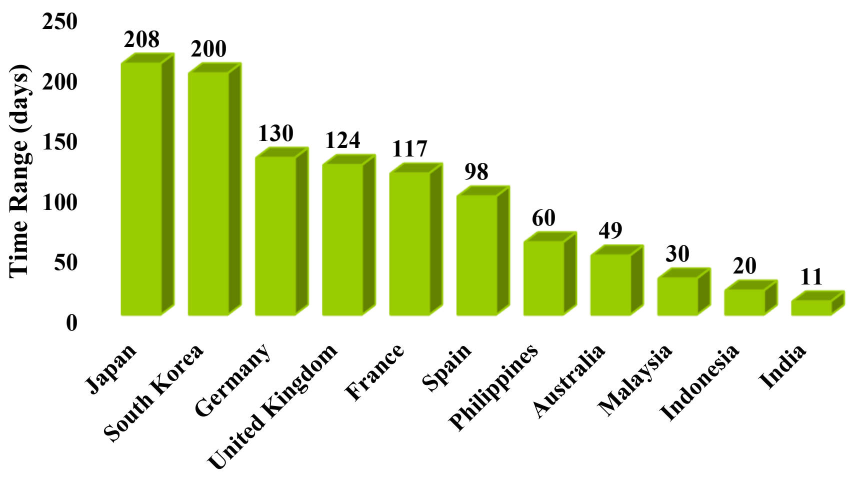

Figure 29

Duration of countries' emergency oil reserves in days (International Energy Agency, 2026)

According to Bloomberg (2026), Indian refineries purchased approximately 60 million barrels of discounted Russian crude oil for April delivery, at prices USD 5–15 per barrel below global benchmarks. This volume is comparable to India's imports in the current month but nearly double the volume imported in February. Following the issuance of a U.S. sanctions waiver, competition for Russian crude cargoes intensified, and several tankers previously destined for China were rerouted to India. At the same time, Russian offshore inventories declined by more than 20 million barrels, equivalent to more than 2 million barrels per day, during the first half of March. Analysts estimated that Russia could once again become India's largest crude oil supplier in March (Bloomberg, 2026).

As illustrated in Figure 30, following the closure of the Strait of Hormuz, the principal export route for Middle Eastern oil, regional producers have been forced to store increasing volumes of crude oil domestically. Iraq, constrained by limited storage capacity, has already reduced production, while JPMorgan estimates that Saudi Arabia and the United Arab Emirates may also be compelled to implement similar production cuts within several weeks. The combined available storage capacity of Saudi Arabia, the United Arab Emirates, Kuwait, and Iraq is estimated at approximately 100 million barrels, equivalent to about one-third of their total storage capacity, although less than 80% of this volume is considered practically usable.

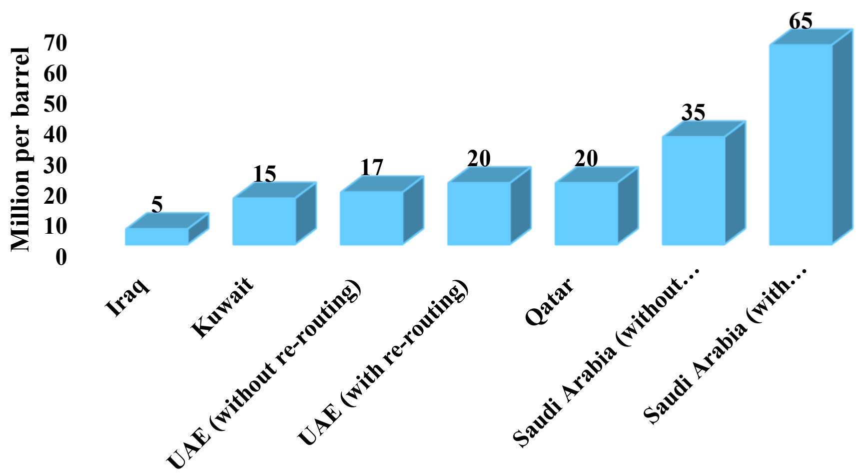

Figure 30

Rapid filling of middle eastern oil storage following the closure of the Strait of Hormuz (Bloomberg, 2026)

In Saudi Arabia, the Juaymah terminal and four of the six storage tanks at Ras Tanura are reportedly already full. Analysts estimate that Persian Gulf producers could reach full storage capacity in less than four weeks, although the use of alternative export routes could extend this period by approximately one week. Meanwhile, oil prices in London exceeded USD 85 per barrel and, despite reports of Iran–U.S. peace negotiations, stabilized at approximately USD 82 per barrel. If regional production declines further, the resulting supply constraints could intensify global inflationary pressures.

2.4. The channel of Trump's tweets and signals affecting the oil market

Major political and military developments in the Middle East generated substantial fluctuations in crude oil prices between October 2023 and June 2025. As illustrated in Figure 31, successive episodes of geopolitical tension, ranging from the Hamas attack on Israel to Israeli strikes on Iran's nuclear facilities and statements by U.S. President Donald Trump, were associated with sharp increases or declines in oil prices. This pattern demonstrates the rapid and substantial influence of regional security crises and political signaling on global oil market dynamics.

As shown in Figure 31 and Table 2, the energy market is highly sensitive to regional geopolitical tensions. On October 9, 2023, when markets reopened following the Hamas attack on Israel, Brent crude oil prices increased by approximately 5%. Tensions escalated further on April 1, 2024, when Iran accused Israel of carrying out an attack in Damascus and subsequently responded with more than 300 drones and missiles. Regional instability intensified further following the assassination of Ismail Haniyeh, the political leader of Hamas, in Tehran on July 31, 2024, and the explosions involving pagers and walkie-talkies in Lebanon on September 17, 2024. These developments were followed by the killing of Hezbollah leader Hassan Nasrallah in an Israeli strike on Beirut, further heightening geopolitical tensions.

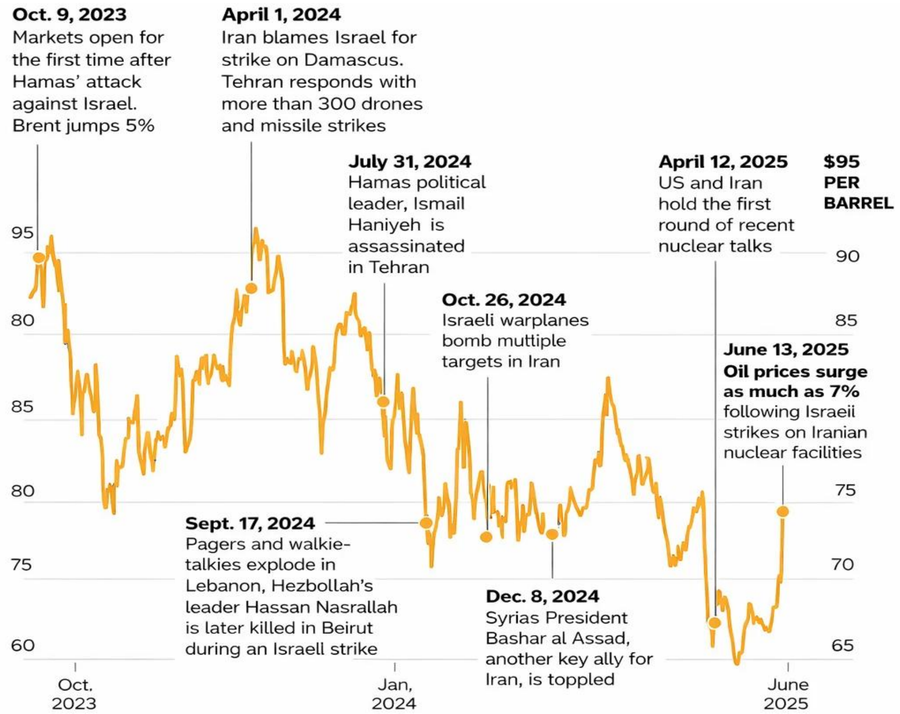

Figure 31

Oil price fluctuations in response to geopolitical from October 9, 2023 to June 13, 2025 (Bloomberg, 2025)

In addition, on October 26, 2024, Israeli fighter jets struck several targets inside Iran, and on December 8, 2024, Syrian President Bashar al-Assad was overthrown. Despite subsequent diplomatic efforts, including the first round of recent U.S.–Iran nuclear negotiations on April 12, 2025, Israeli attacks on Iran's nuclear facilities on June 13, 2025, once again unsettled global energy markets, causing oil prices to increase by as much as 7%. Overall, these developments demonstrate that escalating conflict in the Middle East can directly increase volatility and exert substantial upward pressure on global oil prices.

With the outbreak of the U.S.–Israeli war against Iran and the escalation of conflict in the Middle East in March 2026, the global oil market, particularly Brent crude oil futures, became highly sensitive to President Trump's statements, speeches, and social media posts. Escalating regional tensions and Iran's political threats concerning the Strait of Hormuz, including proposals to keep the strait closed or reopen it only upon the payment of transit fees, further increased oil market volatility and exerted upward pressure on prices. Figure 29 illustrates how military developments and political signaling can directly influence global energy security and oil market dynamics.

As shown in Figure 32 and Table 3, the outbreak of war in the Middle East on March 1, 2026, triggered profound changes in the region's geopolitical landscape and global energy markets. In this context, Iran's closure of the Strait of Hormuz and its restrictions on oil transit for the United States, Israel, and their allies underscored Iran's critical role in global energy markets.

Table 2

Oil price fluctuations based on political and diplomatic events (Bloomberg, 2025)

Date	Event
October 9, 2023	Markets reopen following the Hamas attack on Israel; Brent crude oil prices rise by 5%.
April 1, 2024	Iran accuses Israel of carrying out an attack in Damascus and subsequently responds with more than 300 drones and missiles.
July 31, 2024	Ismail Haniyeh, the political leader of Hamas, is assassinated in Tehran.
September 17, 2024	Pagers and walkie-talkies explode in Lebanon; Hezbollah leader Hassan Nasrallah is subsequently killed in an Israeli strike on Beirut.
October 26, 2024	Israeli fighter jets strike several targets inside Iran.
December 8, 2024	Bashar al-Assad, President of Syria and a key ally of Iran, is overthrown.
April 12, 2025	The United States and Iran hold the first round of renewed nuclear negotiations.
June 13, 2025	Following Israeli attacks on Iran's nuclear facilities, oil prices rise by as much as 7%.

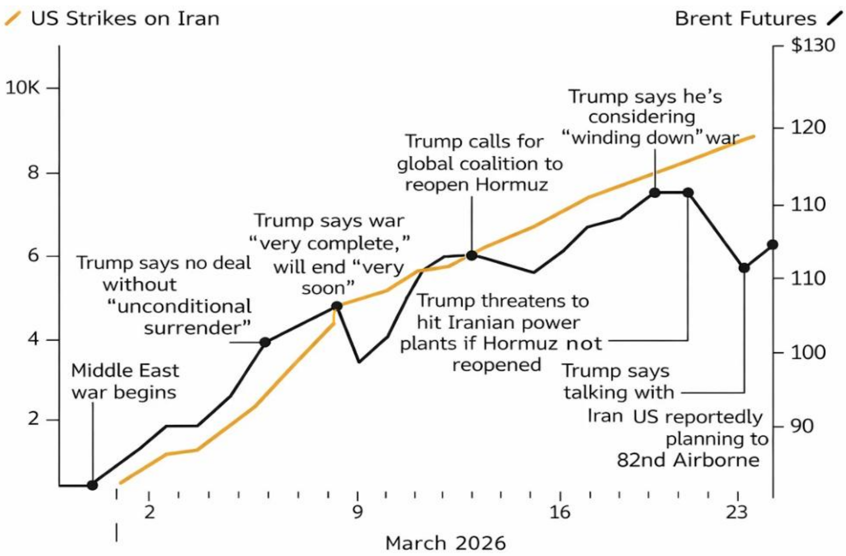

Figure 32

Oil price fluctuations following the start of the U.S.–Israeli attack on Iran in March 2026 (Bloomberg Economics, 2026; U.S. Department of Defense, 2026; U.S. Central Command, 2026; Chosun, 2026)

Despite President Trump's threat on March 9, 2026, to target Iran's power plants if the Strait of Hormuz were not reopened, as well as his call on March 12, 2026, for the formation of an international coalition to reopen the strait, Iran maintained control over this strategic chokepoint and focused on preserving oil exports for itself and its allies.

Furthermore, although President Trump stated on March 6, 2026, that the war was "very complete" and would end "very soon," he later announced on March 16, 2026, that discussions with Iran were underway and stated on March 22, 2026, that he was considering "ending the war." Meanwhile, reports on March 20, 2026, that the United States planned to deploy paratroopers from the 82nd Airborne Division indicated a further escalation of military tensions.

Overall, this period was characterized by escalating tensions, diplomatic initiatives, and military developments in the Middle East, all of which directly influenced global oil supply conditions and price dynamics.

Table 3

Oil price fluctuations following the U.S.–Israeli attack on Iran in March 2026 (Bloomberg, 2026; U.S. Department of Defense, 2026; U.S. Central Command, 2026; Chosun, 2026)

Date	Event
March 1, 2026	Beginning of the Middle East war
March 3, 2026	Trump states that no agreement is possible without “unconditional surrender.”
March 6, 2026	Trump says the war is “very complete” and will end “very soon.”
March 9, 2026	Trump threatens to target Iran’s power plants if the Strait of Hormuz is not reopened.
March 12, 2026	Trump calls for a global coalition to reopen the Strait of Hormuz.
March 16, 2026	Trump says he is in talks with Iran.
March 20, 2026	Reports indicate the United States plans to deploy paratroopers from the 82nd Airborne Division.
March 22, 2026	Trump states he is considering “ending” the war.

2.5. The channel affecting the physical and paper oil markets

The oil market operates through two interconnected layers: the physical market, in which crude oil and refined petroleum products are directly traded, and the paper market, which comprises futures, options, and other hedging instruments used primarily for price discovery, expectation formation, and risk management. A closure of the Strait of Hormuz would intensify the interaction between these two layers, as an initial shock driven by uncertainty and speculation in the paper market could rapidly transmit to the physical market through emerging supply shortages. The resulting inflationary and recessionary pressures in the physical economy could then feed back into the paper market through declining asset prices and market indices. This feedback mechanism represents a significant source of systemic risk in the modern global economy, with the potential to produce lasting changes in global wealth distribution and capital flows. Table 4 illustrates the transmission channels through which a Strait of Hormuz-related shock could propagate across both market layers.

As shown in Table 4, the geopolitical shock caused by disruption in the Strait of Hormuz first emerges in the paper market, where traders incorporate the shock into financial expectations through higher war-risk premiums, increased volatility, and rising futures prices, even before any material change in physical supply occurs.

If uncertainty persists, these financial pressures gradually transmit to the physical market over the medium term. Shipping routes become longer or more costly, insurance and transportation expenses increase, refineries adjust their crude sourcing strategies, and spot prices subsequently begin to follow movements in the paper market, albeit with some delay.

Over the long term, sustained disruption or uncertainty can generate more persistent structural effects. The shape of the futures curve may change, risk spreads may remain elevated, trade routes and long-term contracts may be reorganized, and investment in strategic reserves and alternative energy transportation infrastructure may increase.

Thus, a shock originating in the Strait of Hormuz, although initially reflected as an immediate financial signal, can gradually propagate into the physical market and ultimately develop into a structural and systemic transformation of the global energy supply chain.

Table 4

Scenario: the transmission channel of the Hormuz shock to the physical and paper oil markets

Time horizon	Paper (financial) market	Spillover to physical market	Price & operational outcomes	Structural/systemic features
Short term (hours to days)	Surge in war-risk premium; increased volatility; rise in short-term futures prices; higher insurance costs	Extremely limited transmission; no significant change in actual supply	Immediate rise in futures prices; higher war-risk insurance rates; precautionary stockpiling by companies	A shock that is entirely expectation-driven and financial; dependent on real-time signals and news
Medium term (weeks to months)	Persistent risk premium; futures curve stabilizes at higher levels; changes in hedging strategies	Delivery delays; longer routes; higher transport costs; physical market begins to follow paper pricing	Increase in spot prices; higher costs for Asian importers; adjustments to short-term contracts	Transition of the shock from financial to real; emergence of sustained uncertainty; pressure on refineries
Long term (months to years)	Stabilization of risk spreads; changes in futures-curve structure	Reconfiguration of trade patterns; investment in strategic reserves; possible rerouting of shipping lanes	Higher and more stable prices; revised long-term contracts; increased structural costs	Formation of systemic effects: capital reallocation, strengthening of alternative routes, restructuring of the market

2.6. Channels affecting tankers and oil transportation corridors

The Strait of Hormuz is a narrow maritime passage between Iran and the Arabian Peninsula that connects the Persian Gulf to the Gulf of Oman and the Arabian Sea. As one of the world's most critical energy transportation routes, it serves as the principal export corridor for crude oil and natural gas from Saudi Arabia, the United Arab Emirates, Kuwait, Qatar, Iraq, Bahrain, and Iran. Owing to the ongoing conflict, vessel traffic through the strait has been almost completely halted, placing severe pressure on global energy trade.

In 2025, approximately 25% of global seaborne oil trade passed through the Strait of Hormuz. Alternative export routes remain extremely limited. Only Saudi Arabia and the United Arab Emirates possess operational crude oil pipelines capable of bypassing the strait, with a combined capacity estimated at approximately 3.5–5.5 million barrels per day. By contrast, countries such as Iran, Iraq, Kuwait, Qatar, and Bahrain remain almost entirely dependent on the Strait of Hormuz for exporting the majority of their crude oil.

In 2025, approximately 80% of the crude oil and refined petroleum products transiting the Strait of Hormuz were destined for Asian markets. During the same year, more than 110 billion cubic meters of liquefied natural gas also passed through the strait. Approximately 93% of Qatar's LNG exports and 96% of the UAE's LNG exports were transported through this route, collectively accounting for nearly one-fifth of global LNG trade. As shown in Figure 33, no viable alternative route currently exists that can accommodate LNG volumes of this magnitude. In 2025, nearly 90% of the LNG transiting the Strait of Hormuz was exported to Asia, supplying more than one-quarter of the region's total LNG imports, while slightly more than 10% was destined for Europe.

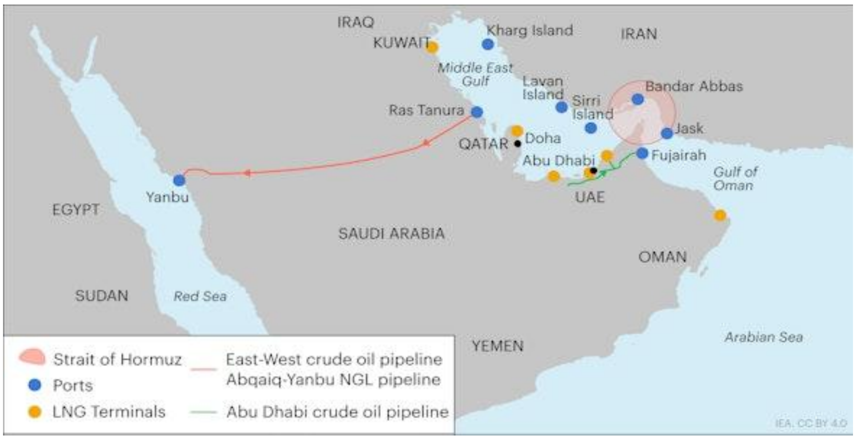

Figure 33

Alternative routes (International Energy Agency analysis based on Kpler data, 2026)

As shown in Figure 34, the majority of oil transported from the Persian Gulf is destined for Asian markets. China receives approximately 4.6 million barrels per day, followed by other Asian countries at approximately 2.6 million barrels per day and India at approximately 1.2 million barrels per day. By contrast, other regions receive substantially smaller volumes, with Europe receiving approximately 0.6 million barrels per day, the Americas 0.5 million barrels per day, and Africa 0.2 million barrels per day. This distribution demonstrates that demand for oil transiting the Strait of Hormuz is predominantly driven by Asian economies. Consequently, any restriction on transit through the strait would have its most immediate and substantial effects on Asian energy markets, while Europe, the Americas, and Africa would face comparatively lower direct exposure.

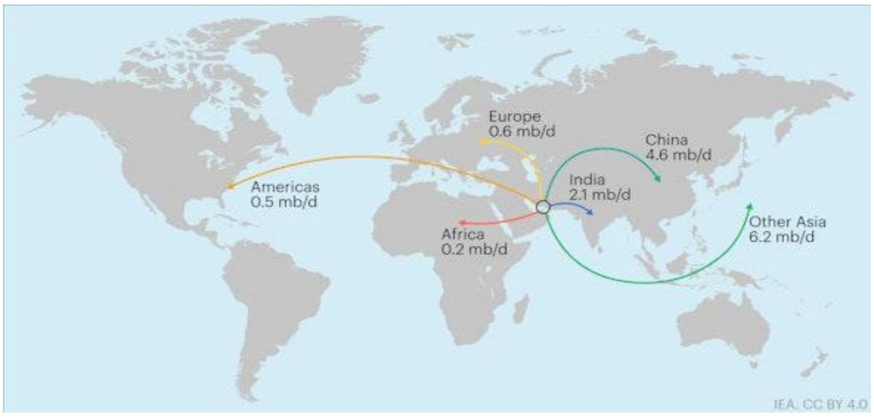

Figure 34

Crude oil exports passing through the Strait of Hormuz to Asian markets in 2025 (International Energy Agency analysis based on Kpler data, 2026)

Before the war, approximately 120–130 vessels transited the Strait of Hormuz each day. However, following the outbreak of the U.S.–Israeli war against Iran and the subsequent closure of the strait, most tankers exited the region rather than entering it. Oil transportation through the strait effectively declined to near-zero levels, with some days recording only two to four vessel transits, all of which occurred with Iran's authorization, as shown in Figure 35.

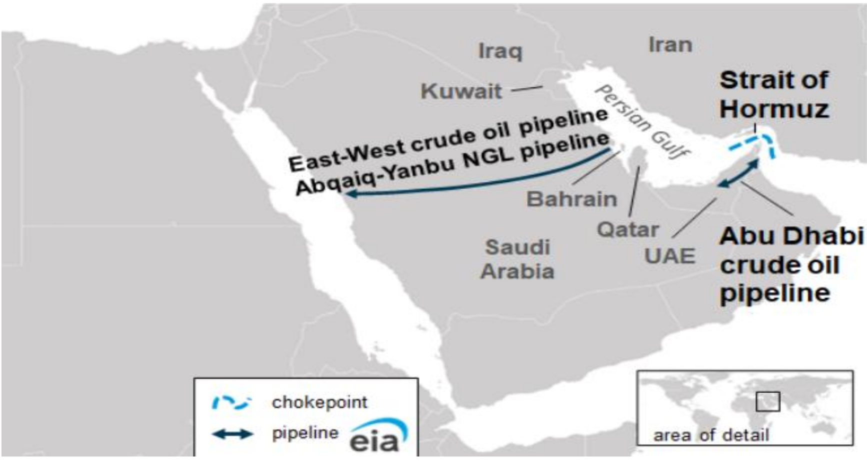

Figure 35

Volume of tanker traffic and oil transit through the Strait of Hormuz (Bloomberg, 2026)

As shown in Figure 36, this development indicates that Iran effectively controls maritime transit through the Strait of Hormuz, with more than 95% of normal vessel traffic having been eliminated.

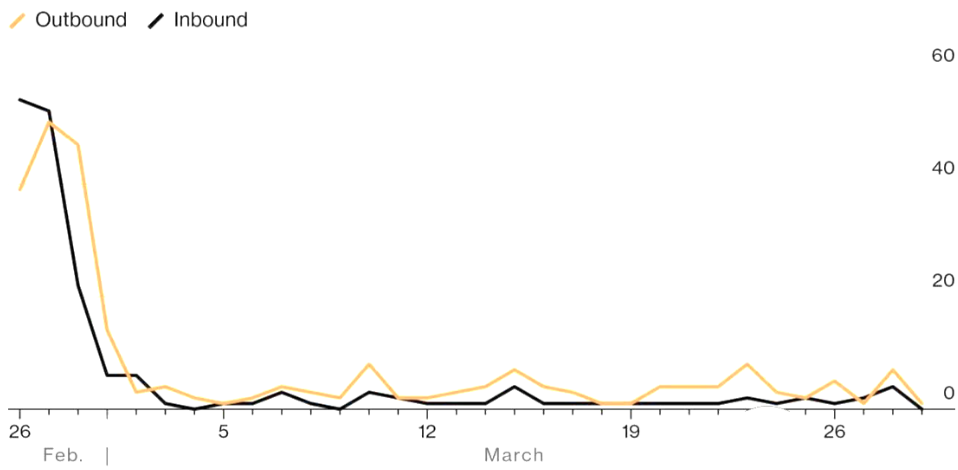

Figure 36

Shipping traffic in the Strait of Hormuz from February 26, 2026 to 26 March 2026 (Bloomberg, 2026; VesselTracking, 2026; MarineTraffic, 2026)

As shown in Figure 36, commercial vessel traffic, which ranged from approximately 45 to 50 ships per day in late February based on combined inbound and outbound movements, declined sharply following the recent developments and reached near-zero levels in early March. From approximately March 5 to March 29, daily traffic remained predominantly within the range of zero to five vessels, representing a decline of more than 90% relative to previous levels.

This sharp contraction is consistent with a scenario in which maritime transit is restricted following the closure of the Strait of Hormuz and the imposition of fees or other conditions on passing vessels, particularly if transit is permitted only for specific routes or selected countries while remaining restricted for others. Under such circumstances, the majority of commercial traffic, which previously involved dozens of vessels per day, effectively ceases, leaving only a limited number of ships operating within tightly controlled corridors. This situation has significant implications for regional energy flows, maritime transportation, and international trade.

As shown in Figure 37, following statements and social media posts by the U.S. President claiming that the Strait of Hormuz was "open," three container vessels of different nationalities attempted to proceed toward the designated corridor for authorized transit. However, after receiving warnings from Iran, the vessels altered course and withdrew. Iran has stated that the Strait of Hormuz is currently considered closed and that any unauthorized transit will be met with a firm response. It has further emphasized that vessels originating from or destined for ports in countries supporting U.S. or Israeli military actions will not be permitted to transit the strait, regardless of their final destination or selected corridor.

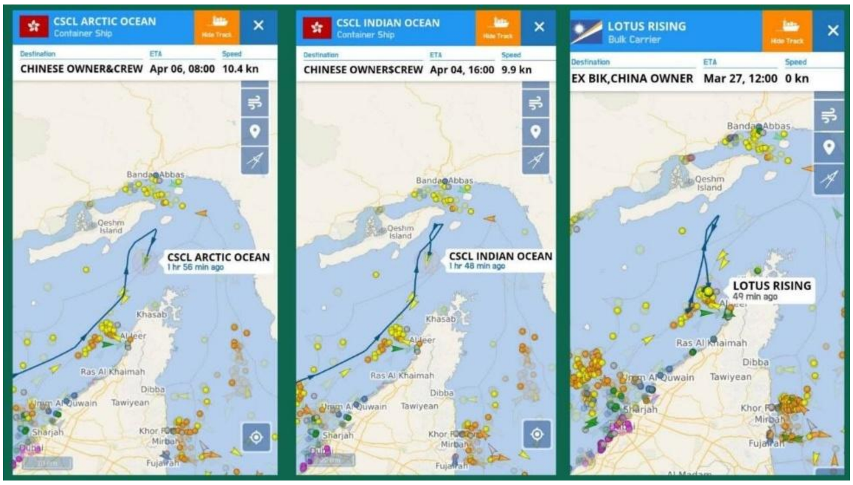

Figure 37

The absence of vessel traffic in the Strait of Hormuz (MarineTraffic, 2026)

2.7. Channel affecting oil insurance companies: tanker and cargo insurance

The marine insurance industry constitutes a critical but often less visible component of global energy trade, as oil tankers generally require valid hull and machinery insurance, cargo insurance, and third-party liability and environmental coverage before commencing commercial voyages. Although the Joint War Committee of the Lloyd's of London market already classifies the Strait of Hormuz region as a high-risk area, a full closure of the strait would fundamentally alter the marine insurance risk environment and impose substantial financial pressure on insurance and reinsurance companies.

The effects of this shock can be examined across three sequential time horizons. Table 5 presents the principal scenarios through which the closure of the Strait of Hormuz may affect tanker insurers, cargo insurers, and reinsurers.

As shown in Table 5, the closure of the Strait of Hormuz places the maritime insurance chain under increasing and cumulative pressure. In the short term, a sudden multifold increase in war-risk premiums, combined with the suspension of new policy issuance, creates an immediate constraint on tanker mobility and disrupts maritime traffic and energy flows.

As the crisis persists into the medium term, this pressure extends from primary insurers to the reinsurance market. Extremely large risks arising from the potential seizure or destruction of tankers may exceed the risk-absorption capacity of reinsurers. Combined with rising vessel idle costs and congestion along alternative routes, these conditions impose substantial financial burdens on shipowners, insurers, and reinsurers.

Over the long term, the structural inability of private insurance markets to absorb persistent geopolitical risks may create the need for government intervention, including the establishment of sovereign risk-management funds or government-backed insurance schemes. Such intervention could transform the marine insurance market from a predominantly private system into a hybrid public–private framework, thereby increasing the role of governments in safeguarding energy security and maintaining the continuity of global trade flows.

Table 5

Scenario: the impact of a Strait of Hormuz closure on oil insurance companies

Time horizon	**Main events and mechanisms**	**Impact on insurance & reinsurance markets**	**Operational consequences for tankers**	**Systemic implications for the energy chain**
Short term (hours to days)	Sudden, multi-fold surge in war-risk premiums; possible halt in issuing new policies	Sharp increase in war-risk insurance rates; non-renewal of some policies; insurers become risk-averse	Higher transit costs; temporary suspension of tanker movements; immediate disruption of passage through Hormuz	Instant disruption to the energy supply chain; higher freight costs and market volatility
Medium term (weeks to months)	Pressure shifts to the reinsurance market; rise in risks exceeding USD 100 million	Reduced reinsurance capacity; higher retrocession rates; potential rejection of certain claims	Increase in vessel idle time; prolonged delays in ports and along alternative routes; heavy operational costs	Intensified financial pressure on shipowners and traders; cost pass-through to final energy prices
Long term (months to years)	Private markets become incapable of managing chronic, large-scale risks	State intervention and creation of sovereign funds; issuance of government or quasi-government insurance	Relative stabilization of traffic under state-backed coverage; gradual return of fleets	Structural transformation of the insurance market; emergence of a public-private model; expanded state role in ensuring energy security

3. Research methodology

This study evaluates the predictive performance of multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) models, specifically using the VECH specification, to analyze export and import dynamics. First, a concise overview of the MGARCH framework is provided. Subsequently, the backtesting procedures used to assess the forecasting performance of the model are described.

3.1. Overall approach

This study adopts a qualitative analytical approach grounded in structural scenario planning, a method well suited to issues characterized by high uncertainty, substantial complexity, and strong dependence on geopolitical variables, such as developments surrounding the Strait of Hormuz. Within this framework, the key variables and underlying drivers are first identified, including global oil and gas trade flows, the capacity of alternative transportation routes, maritime and military security conditions, the responses of financial and energy markets, and the degree of dependence of Asian importers on Persian Gulf oil. Using documentary analysis, market data, and expert assessments from the energy sector, the interrelationships among these variables are examined (Jamshidian and Zhu, 1996; Ramirez et al., 2015).

To complement the qualitative scenario-based assessment, this study also employs a multivariate GARCH model using the VECH representation. This extension enables the analysis to capture time-varying volatility and dynamic co-movements among multiple energy and financial indicators simultaneously. In particular, the VECH-GARCH specification is useful for modeling the conditional covariance matrix of shocks across markets, thereby providing a more rigorous statistical basis for identifying volatility transmission, spillover effects, and interdependence among variables potentially affected by geopolitical shocks in the Strait of Hormuz. Given the complexity of the multivariate framework, the VECH approach provides a structured representation of the lower triangular portion of the conditional covariance matrix and facilitates estimation of evolving variance–covariance dynamics over time. By integrating structural scenario planning with multivariate GARCH estimation, the study seeks to combine strategic qualitative insights with quantitative evidence on market volatility under alternative geopolitical conditions.

3.2. Data Collection Framework

The data used in this study were collected through extensive library and documentary research using secondary databases maintained by internationally recognized institutions. To ensure a high degree of validity and reliability, the dataset was compiled from the official repositories of the Organization of the Petroleum Exporting Countries (OPEC), the International Energy Agency (IEA), the U.S. Energy Information Administration (EIA), and the Federal Reserve Bank of St. Louis (FRED). The analysis is conducted at a monthly frequency and covers the period from 2000 to 2026. This timeframe was selected to capture long-term historical trends, major market shifts, and forward-looking projections, with particular emphasis on structural changes and volatility associated with actual or potential disruptions in the Strait of Hormuz.

3.3. Variables and Indicators Examined

The following key indicators were selected as the principal variables for the Persian Gulf countries examined in this study, namely Iran, Saudi Arabia, the United Arab Emirates, Iraq, Bahrain, Oman, Kuwait, and Qatar. The variables incorporated into the multivariate framework include:

- **Energy prices:** Used to capture fluctuations in global energy markets and supply-side shocks.
- **Gross domestic product (GDP):** Used as a primary indicator of global and regional economic growth.
- **Trade indicators:** Total exports and imports are included to evaluate changes in trade flows and trade balances.
- **Capital market index:** The S&P 500 is used as a benchmark for global financial market sentiment and investor responses to geopolitical uncertainty.

By synchronizing these macroeconomic, trade, energy, and financial variables at a monthly frequency, the study establishes a robust empirical foundation for analyzing volatility spillovers and dynamic interdependencies within the energy–economy nexus under conditions of geopolitical stress.

3.4. Analytical Technique: Multivariate GARCH Model and Scenario Analysis

From a theoretical perspective, extending the univariate generalized autoregressive conditional heteroskedasticity (GARCH) model of Bollerslev (1986) ($GARCH(p, q)$) to the multivariate setting is conceptually straightforward. As in the univariate $GARCH(p, q)$ case one may allow Σ_t to depend on past observations $\varepsilon_{t-i}, i = 1, \dots, q$, and covariance matrices $\Sigma_{t-j}, i = 1, \dots, p$. In the multivariate framework, however, the number of potential dependencies increases rapidly, making unrestricted specifications difficult to estimate empirically. For a comprehensive review of multivariate GARCH models, see Bauwens et al. (2006).

Let $VECH\ (\cdot)$ operator denote the transformation that stacks the elements on and below the main diagonal of an (N×N) symmetric matrix into an (N(N+1)/2)-dimensional vector. Using this operator, the general multivariate GARCH model can be expressed as follows:

$$vech(\Sigma_t) = c + \sum_{i=1}^{q} A_i vech(\varepsilon_{t-i}\varepsilon'_{t-i}) + \sum_{j=1}^{p} B_j vech\left(\Sigma_{t-j}\right) \quad (1)$$

In the so-called VEC representation, A_i and B_j are parameter matrices each containing $(N^*)^2$ parameters, whereas the vector c contains N^* coefficients. It should be noted that even in the simplest case, $N = 2$ and $p = q = 1$, 21 parameters characterize the model. To obtain tractable models for in empirical applications, it is usually necessary to impose parameter restrictions on the VEC model in below Equation. We assume that all eigenvalues of the matrix have modulus smaller than one:

$$\sum_{i=1}^{q} A_i + \sum_{j=1}^{p} B_j \quad (2)$$

Under this condition, the vector process ε_t is covariance stationary, with unconditional covariance matrix Σ.

Another component of the analytical framework employed in this study is scenario-based modeling. Given the inherently unpredictable nature of geopolitical shocks, scenario-based sensitivity analysis is used to estimate their potential impacts under alternative conditions. Table 6 presents four plausible scenarios and evaluates their potential effects on global oil supply and price fluctuations.

Table 6

Analytical technique: scenario analysis (research findings)

Scenario	Description
Baseline scenario	Continuation of current conditions and conventional capacity growth.
Partial/controlled disruption scenario	Imposition of tolls or strict inspections in the strait.
Supply shock scenario	Complete closure of the Strait of Hormuz due to regional military tensions.
Full-scale war scenario	Assessment of the effects of attacks on infrastructure and export terminals (such as Ras Tanura and Basra).

4. Results and discussion

4.1. Stationary test

The functional form of the augmented Dickey–Fuller (ADF) stationarity test is presented in the following equation, and the corresponding test results are reported in Table 7. The ADF unit root test is used to examine the stationarity of the variables. As shown in Table 7, at the level $I(0)$, the probability values for most variables exceed the 5% significance level. Therefore, the null hypothesis of a unit root cannot be rejected, indicating that these variables are nonstationary in levels. However, after taking the first difference $I(1)$, the probability values for all variables fall below 0.05. Accordingly, the null hypothesis is rejected, confirming that all variables become stationary after first differencing.

$$\Delta y_t = \alpha + \beta . t + \gamma y_{t-1} + \sum_{i=1}^{p-1} \delta_i \, \Delta y_{t-i} + \varepsilon_t \quad (3)$$

Table 7

Stationary test for variables

Variable	$I(0)$ Probability	$I(1)$ Probability
Export	0.6420	0.000
Import	0.0734	0.000
GDP	0.0814	0.000
Energy-price	0.0648	0.000
S&P500	0.9967	0.0000

4.2. Optimum lag length

According to the statistical results in Table 8, the optimal lag length is two. All model selection criteria, including the Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan–Quinn criterion (HQ), consistently identify lag 2 as the optimal specification, as indicated by the minimum criterion values marked with asterisks in the corresponding row.

Table 8

Optimum lag length

Lag	HQ	SC	AIC
0	18.68195	18.71855	18.65756
1	2.251366	2.470933	2.105001
2	–0.279334*	0.123206*	–0.547670*
3	–0.126946	0.458566	–0.517254
4	0.072296	0.840781	–0.439982
5	0.270780	1.222238	–0.363469

4.3. MGARCH-VECH model

The estimation results of the MGARCH-VECH model provide important insights into how trade flows, specifically imports and exports, respond to external shocks associated with energy markets and geopolitical instability in the Strait of Hormuz (See Table 9). Given the Strait of Hormuz's role as a major global chokepoint for energy transit, the energy price variable serves as a key transmission channel through which regional shocks affect international trade.

4.3.1. Import sensitivity to energy shocks

The results indicate a statistically significant and positive relationship between energy prices and imports (coefficient = 3.616624, ($p < 0.01$)). This finding suggests that geopolitical tensions in the Strait of Hormuz that generate increases in global energy prices may lead to an immediate rise in the value of imports. This effect can be attributed to higher transportation costs and inflationary pressures on imported goods, indicating that the domestic economy is highly vulnerable to supply chain disruptions originating from the Strait of Hormuz.

Table 9

Results of MGARCH-VECH model

Variable	Coefficient	Probability
Constant	53.20413	0.5536
GDP	–16.72500	0.0277
S&P500	47.07502	0.0000
Energy-price	3.616624	0.0000
Constant	–306.7283	0.0000
GDP	27.27592	0.0000
S&P500	17.35416	0.0000
Energy-price	–0.025930	0.0000
	Variance equation coefficients	
Variable	**Coefficient**	**Probability**
C (9)	39.53271	0.0000
C (10)	0.488185	0.5852
C (11)	1.029493	0.0000
C (12)	0.826946	0.0000
C (13)	0.382512	0.0010
C (14)	0.515652	0.0003
C (15)	0.037506	0.4799
C (16)	–0.149822	0.4256
C (17)	0.069611	0.6069

4.3.2. Export vulnerability and competitiveness

Conversely, the energy price variable has a statistically significant negative effect on exports (coefficient = −0.025930, ($p < 0.01$)). This finding highlights an important vulnerability: as energy prices increase in response to instability or perceived geopolitical risk in the Strait of Hormuz, domestic production and maritime transportation costs also rise. These higher costs can reduce the international competitiveness of national exports and contribute to a contraction in export volumes. The negative coefficient therefore underscores the dual role of the Strait of Hormuz: although it serves as a critical artery for international trade, disruptions to this route can impose substantial additional costs on the export sector.

4.3.3. Synergistic effects with global markets

The high statistical significance of the S&P 500 index in both equations (($p = 0.0000$)) further indicates that the trade sector is sensitive not only to regional energy shocks but also to global investor sentiment. Because the Strait of Hormuz is a focal point of global energy security, disruptions in this region may simultaneously contribute to increased volatility in the S&P 500 and higher energy prices, thereby generating compounded adverse effects on the trade balance.

$$Import = C(1) + C(2)^{*}GDP + C(3)^{*}S\&P500 + C(4)^{*}Energy - price \tag{4}$$

$$Export = C(5) + C(6)^{*}GDP + C(7)^{*}S\&P500 + C(8)^{*}Energy - price \tag{5}$$

The MGARCH-VECH variance analysis reveals a pronounced asymmetric volatility structure between imports and exports. Import volatility is characterized by a high degree of persistence, indicating a strong GARCH effect, whereas the export sector exhibits comparatively greater stability. Importantly, the statistically significant covariance terms, C13 and C14, suggest that geopolitical risks associated with the Strait of Hormuz act as a common source of volatility across trade variables. Any disruption to this strategic maritime chokepoint may therefore generate a synchronized uncertainty shock that affects the overall trade balance, as reflected in the significant co-movement coefficients. The high persistence observed in import variance further suggests that the economy requires a relatively long period to absorb and recover from trade-related uncertainty arising from energy price fluctuations or regional geopolitical instability.

4.4. Granger causality test

The Granger causality analysis confirms that the trade sector is strongly interconnected with global energy and financial markets (See table 10). Most notably, the unidirectional causality from energy prices to imports highlights the vulnerability of the national trade balance to energy-related shocks, which are often associated with changes in the security conditions of the Strait of Hormuz. Furthermore, the bidirectional causality between energy prices and gross domestic product indicates a substantial degree of energy dependence within the economy. These findings suggest that disruptions in the Strait of Hormuz do not affect energy prices in isolation but may instead trigger broader systemic responses across GDP and trade flows, thereby creating a complex network of interconnected economic consequences.

4.5. Likelihood contribution test

The likelihood contribution test results confirm the overall robustness and adequacy of the estimated MGARCH-VECH model (Figure 38). Although the model maintains a stable fit throughout most of the sample period, the identified downward spikes correspond to specific episodes of extreme volatility, likely associated with major global economic crises and geopolitical developments affecting the Strait of Hormuz region. These findings indicate that the model is sufficiently sensitive to structural shocks while remaining statistically reliable for analyzing the long-term relationships between energy prices and trade dynamics.

- The 2008–2010 period corresponds to the global financial crisis.
- The 2020–2022 period coincides with the COVID-19 pandemic and the subsequent disruptions in global energy markets.
- In the context of the Strait of Hormuz, these outliers frequently coincide with periods of heightened geopolitical tension or extreme energy price volatility, both of which can substantially affect the model's residual structure.

Table 10

Granger casualty test results

Null hypothesis	**Probability**
Exports do not Granger-cause imports.	0.1933
Imports do not Granger-cause exports.	0.4193
Energy prices do not Granger-cause imports.	6.E-06
Imports do not Granger-cause energy prices.	0.7847
The S&P 500 does not Granger-cause imports.	0.0734
Imports do not Granger-cause the S&P 500.	0.5642
Gross domestic product does not Granger-cause imports.	0.0002
Imports do not Granger-cause GDP.	0.0283
Energy prices do not Granger-cause exports.	0.2545
Exports do not Granger-cause energy prices.	0.4078
The S&P 500 does not Granger-cause exports.	0.0233
Exports do not Granger-cause the S&P 500.	0.0085
GDP does not Granger-cause exports.	0.3019
Exports do not Granger-cause GDP.	0.9037
The S&P 500 does not Granger-cause energy prices.	0.0033
Energy prices do not Granger-cause the S&P 500.	0.4907
GDP does not Granger-cause energy prices.	0.0012
Energy prices do not Granger-cause GDP.	0.0138
GDP does not Granger-cause the S&P 500.	0.0965
The S&P 500 does not Granger-cause GDP.	0.5771

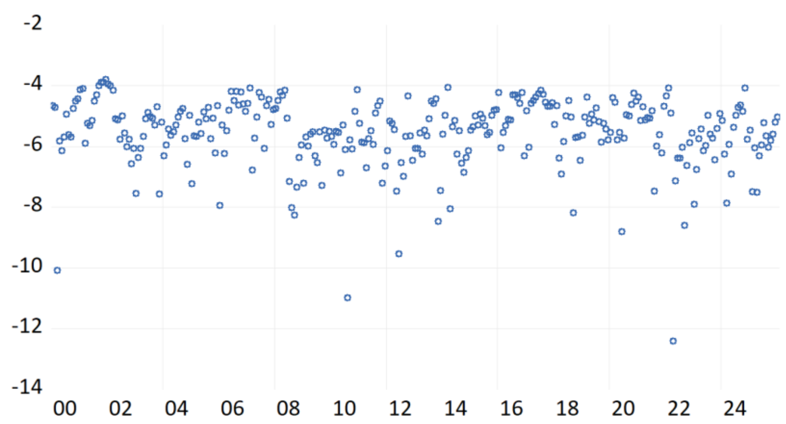

Figure 38

Log-likelihood contribution

5. Conclusions

The empirical findings from the MGARCH-VECH model and Granger causality tests, combined with the strategic analysis of maritime logistics, underscore the indispensable role of the Strait of Hormuz in maintaining global economic stability. The statistical evidence confirms that trade flows, particularly imports, are highly sensitive to fluctuations in energy prices, which constitute a primary transmission channel through which regional geopolitical shocks affect the broader economy. The Granger causality results reveal a significant bidirectional relationship between energy prices and gross domestic product, indicating that disruptions in the strait may not merely generate temporary price increases but can also trigger broader systemic economic contractions. This conclusion is further supported by the high persistence of volatility identified in the variance equations, reflecting a strong GARCH effect and suggesting that, once a shock occurs in this strategic maritime chokepoint, its destabilizing effects on trade and production may persist for an extended period, thereby making the recovery process slower and more costly.

Beyond the energy sector, the risks associated with the Strait of Hormuz extend to critical global commodity supply chains. As a major transit route for more than 30% of global urea trade and substantial volumes of ammonia, phosphate, and sulfur, the strait plays an important role in global food security and chemical industries. Furthermore, the transit of nearly 8% of global aluminum through this route exposes industrial manufacturing and green energy technologies to regional geopolitical instability. The sensitivity of the MGARCH model to historical shocks, as demonstrated by the likelihood contribution test, further confirms that global markets respond sharply to such vulnerabilities.

Importantly, the effects of a closure or restriction of the Strait of Hormuz extend beyond maritime trade and can disrupt the internal energy production cycles of exporting countries. The empirical relationship between energy prices and trade capacity highlights a potentially destabilizing feedback mechanism: as export routes become restricted, storage facilities may reach capacity, forcing producers to reduce or suspend output from refineries and oil fields. This process not only reduces national export revenues but also creates a supply deficit in global markets, thereby exerting further upward pressure on energy and commodity prices.

Thus, disruption of a single strategic transit route can generate a chain reaction affecting production, refining, transportation, storage, and downstream industrial activity. By disturbing the balance among production, storage capacity, and export flows, such a disruption places substantial pressure on regional logistical systems. The consequences extend beyond the economies of Persian Gulf producers to the stability of global energy and commodity markets. Strategic recommendations for mitigating these risks are presented in Table 11.

Table 11

Strategic recommendations

Strategic area	Recommendation	Rationale and objective
Energy corridor management	Develop and strengthen alternative regional pipeline routes (bypassing the Strait of Hormuz)	Reduce dependence on Strait of Hormuz for oil and gas exports; increase the resilience of the energy supply chain
Energy diplomacy	Establish regional mechanisms for managing maritime and energy crises	Lower geopolitical tensions and prevent large-scale disruptions to energy trade
Maritime security	Design a maritime traffic management system and secure corridors for vessel passage	Preserve a minimum flow of energy trade and reduce risks for shipping companies
Strategic reserves management	Increase and coordinate strategic oil and gas reserves in consuming countries	Provide a buffer against supply shocks and extreme price volatility
Market diversification	Expand long-term energy contracts and diversify export and import routes	Reduce the risk of dependence on a single route or market
Storage infrastructure	Expand oil and refined product storage capacity in both producing and consuming countries	Manage supply surpluses during crises and prevent production shutdowns
Market monitoring and information systems	Create joint systems for monitoring maritime traffic and energy data	Improve market transparency and enable rapid policy responses to geopolitical developments

Nomenclature

ADF	Augmented Dickey–Fuller
ADNOC	Abu Dhabi National Oil Company
AIC	Akaike information criterion
COVID	Coronavirus disease
FRED	Federal Reserve Bank of St. Louis
GARCH	Generalized autoregressive conditional heteroskedasticity
GDP	Gross domestic product
HQ	Hannan–Quinn criterion
IEA	International Energy Agency
JCPOA	Joint Comprehensive Plan of Action
LNG	Liquefied natural gas
MGARCH	Multivariate generalized autoregressive conditional heteroskedasticity model
MGARCH-VECH	Multivariate GARCH-VECH representation
OPEC	Organization of the Petroleum Exporting Countries
SC	Schwarz criterion
SPR	Strategic petroleum reserve
WTI	West Texas Intermediate

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