Mar. Sci. Tech. Bull. (2024) 13(1): 102-110
e–ISSN: 2147–9666
info@masteb.com

dergipark.org.tr/en/pub/masteb
www.masteb.com
DOI: 10.33714/masteb.1441264

Marine Science and Technology Bulletin

PRENSIP
https://prensip.gen.tr/

RESEARCH ARTICLE

Impacts of Brent crude oil price fluctuations on global aquaculture production during World economic crises

Ümüt Yiğit[1]*

[1] *Çanakkale Onsekiz Mart University, School of Marine Technologies, Program of Underwater Technologies, 17020, Çanakkale, Türkiye*

ARTICLE INFO

Article History:
Received: 22.02.2024
Received in revised form: 29.03.2024
Accepted: 30.03.2024
Available online: 31.03.2024

Keywords:
Aquaculture volume
Brent petrol
Market value
Oil price
Economic crisis

ABSTRACT

This study evaluates the linkage between brent crude oil prices and volatility spillover on the global aquaculture volume -and values during world economic crises. Besides the main variable costs comprising feed expenses with over the half of total costs in aquaculture facilities, the energy expenditures are among the important operational costs that influence farm profits through feed costs overall, but also with direct effects in recirculating systems as electricity use. Findings in this study evidenced that global aquaculture volume and value is closely related to global brent crude oil price variations during the periods of crises, as a result of increase in production costs. The correlations between brent crude oil prices and percent changes in volume -or values of farmed fish covering the crises periods between 2008 and 2021 were highest as 0.798 (R=0.798134676) and 0.716 (R=0.715832960), respectively, which are close to zero "0", showing strong correlations between the investigated structures. However, no correlation was found between the investigated structures during the pre-crisis, post-crisis or inter-crisis periods. Over the last ten years, there were three periods when brent oil prices dropped remarkably, with interrelated effects on world aquaculture production volume or values with severe price dip following the brent oil trends. Hence, the results from this study reveal that any severe change in the energy sector will in turn hit the aquaculture industry with significant influences on both production volume -and values. Therefore, information regarding the interrelation of brent crude oil price variations and global aquaculture production provided in this study, may support building management strategies for sustainable fish farming business with foresights to world economic crises.

Please cite this paper as follows:

Yiğit, Ü. (2024). Impacts of Brent crude oil price fluctuations on global aquaculture production during World economic crises. *Marine Science and Technology Bulletin*, *13*(1), 102-110. https://doi.org/10.33714/masteb.1441264

* Corresponding author
E-mail address: umutyigit@comu.edu.tr (Ü. Yiğit)

Introduction

Energy resources are one of the most important factors affecting production that shape global economies. In developing economies with high external dependency for energy, the cost of production is directly affected by any fluctuation, especially in oil and its derivatives (Taghizadeh-Hesary et al., 2018). Crude oil has strong impacts on life and may influence the quality standards of people's life and livelihoods during imbalance of crude oil prices (Jahangir & Dural, 2018), because of its broad use of area such as the transportation industry, or production of all kinds of commodities, including food and animal production or agricultural activities. Energy resources are indispensably in use in all levels of industrial process. It has been stated that fluctuations in oil prices directly affect animal production (Fabiosa, 2009), or products obtained from animals, such as the butter prices and volatility influenced by the changes in oil prices (Bergmann et al., 2016). Also, strong linkages between agricultural commodity prices and oil prices in the U.S. were reported by McFarlane (2016) in their study conducted over long-term comprising two consecutive periods of 1999–2005 and 2006–2012. Similarly, López Cabrera & Schulz (2016) evaluated the price and volatility risks generated by the energy and agricultural commodity prices, and underlined that the variations in prices were closely related between energy -and agriculture commodities in Germany in long-term, and strong positive correlations were noted with severe shock effects on markets. This was also reported from Nigeria, where Nwoko et al. (2016) revealed a positive and significant short-term relation between oil price and food price volatility between 2000 and 2013. In another study, Al-Maadid et al. (2017), the relations between food and energy prices have been investigated and the authors underlined that there were strong relations between food and both oil prices. It has been reported that the food crises in 2006 and financial crisis in 2008 caused significant impacts on the volatility of the prices for food and oil. El Montasser et al. (2023) also evidenced strong relations between the presence of volatility in brent oil prices and agricultural commodities. Although investigations on the relationship between energy resources and agricultural activities or livestock sector has increased recently, it should be noted that this relationship is not unidirectional, many factors play a role in the interaction and there is a more complex connection than it seems (El Montasser et al., 2023). Unexpected developments, such as the recent Covid-19 pandemic, or events that started as a regional dispute between Russia and Ukraine but turned into a war in a short time, cause serious problems not only in the regional economies, but also in the inter-country trade network with severe shock waves on both developed or emerging economies worldwide. Despite the fact that a number of research efforts focused on the interrelation of brent crude oil prices with a variety of commodities and price volatilities, including agricultural commodities (López Cabrera & Schulz, 2016; McFarlane, 2016; Aye & Odhiambo, 2021), food production (Nwoko et al., 2016; Al-Maadid et al., 2017; Roman et al., 2020), and livestock production (Fabiosa, 2009), there is no published report available to our knowledge so far regarding the possible volatility spillover from brent crude oil price variations on global aquaculture activities, which is in a rapid expansion with remarkable growth over the last decades, providing an important share of the food demand of the growing world population.

In the aquaculture sector, especially in closed recirculating facilities and hatcheries, the energy factor comes to foreground in terms of electricity costs, while the share of energy use in the production of feed required for fish feeding is also significant. Hence, this study aimed to fill this gap by evaluating the interrelated nature or even the co-explosivity between Brent crude oil prices and the production level or sales value for the global aquaculture industry, that in turns may provide important foresights for farm managers to overcome future crisis periods with best aquaculture management strategies.

Material and Methods

Data Description

For the evaluation of interrelations between brent crude oil prices and aquaculture production in terms of volume and value, actual prices for both measures were used with the sample period between 2005 and 2021, covering the three global economic crises occurred in 2009, 2015 and 2020, that hit global economies of both developed and emerging countries. These three incidences were chosen to figure the two shock waves happened in five-years intervals over the past fifteen years by the dip price of brent crude oil, that remarkably affected the world aquaculture production and global aquaculture markets, overlapped and potentially showed a co-explosivity effect. Among the three severe price drops of brent crude oil, the shock wave in 2009 was called as "Housing market bubble" (Loo, 2020), the crisis in 2015 was called as "the oil shale revolution 2014-2015" (Mănescu & Nuño, 2015), whereas the third was the Great Lockdown (Panneer et al., 2022), that occurred in 2020 due to the recent Covid-19 pandemic. Data used in this study were retrieved from statistical data base of Statista (2023), and FAO (2023a, 2023b). Data for global aquaculture production volume and value represent the total sum of finfish aquaculture covering diadromous fishes + freshwater fishes + marine fishes. Plants and other aquatic animals are excluded.

The data for global finfish aquaculture production in volume and international trade values in $US covered the periods between 2005 and 2021, which were collected from online statistical query panels of FAO (2023a, 2023b), have been used in the equations given below, according to Yigit & Kusku (2022):

$$PIVOL\% = \frac{(PVOL(y2) - PVOL(y1))}{PVOL(y1)} \times 100$$

where,

PIVOL%: percent increase of production volume (tons)

PVOL(y2): production volume (tons) in year-2

PVOL(y1): production volume (tons) in year-1

$$PIVAL\% = \frac{(PVAL(y2) - PVAL(y1))}{PVAL(y1)} \times 100$$

where,

PIVAL%: percent increase of production value ($US)

PVAL(y2): production value ($US) in year-2

PVAL(y1): production value ($US) in year-1

The unit sales price for the global finfish aquaculture harvests were estimated via dividing the production values by production volumes using following equation provided by Yigit et al. (2023).

$$SPunit = \frac{PVAL}{PVOL}$$

where,

SPunit: unit sales price

PVAL: production value ($US)

PVOL: production volume (tons)

Description of the Interrelation Via Correlation and Statistical Analyses

With the mathematical estimations in this study, it was aimed to understand to which extent price changes for the brent crude oil and global aquaculture in both volume and value correlate positively with each other. Correlations were assessed for data covering the crisis periods, as well as no-crisis periods in order to understand the variations of coefficients with possible influences by crisis. In terms of timely perspective, the total span of years investigated in this study (2005-2021) was divided into period groups, following the reports of Al-Maadid et al. (2017), Vo et al. (2019), and Roman et al. (2020). The three period groups in this study were assessed as (a) no-crises and (b) crisis periods. Then, each of these periods were divided into three subperiods, where the no-crisis period group consisted of (i) 2005-2008 (pre-crisis period of the housing market bubble crisis in 2009), (ii) 2010-2014 (post-crisis period after 2009-crisis, pre-crisis period before the oil shale revolution in 2015), and (iii) 2016-2019 (post-crisis period after 2015-crisis, pre-crisis period before the Covid-19 pandemic crisis in 2020), while the crisis period group consisted of (i) 2005-2021 (all times combined with three world crisis in 2009, 2015, 2020), (ii) 2008-2021 (three world crisis periods combined with one year before and after the crisis), and (iii) 2009-2020 (three world crisis combined, covering the year of crisis only.

The correlation coefficient range between minus one (-1) and one (1) indicate how the variations of the two evaluated parameters are related to each other. When the value obtained is close to "-1", this indicates a strong negative relation, which shows that the variables move in opposite directions, whereas a coefficient value close to "1" gives a strong positive relation between the variables, underlining a trend motion to the same direction. When the correlation coefficient is found as "0", this gives an indication that the trends of the two variables are not linearly related (Camp, 2019). The correlation coefficient between brent crude oil price volatilities and global aquaculture value has been investigated in the present study. Mathematical calculations were assessed by using a Microsoft Excel program for Mac MacBook Pro, macOS Big Sur (11.7.3), and the correlation coefficients were estimated by the following equation:

$$Correl\ (X,Y) = \frac{\sum(x - \bar{x})(y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sum(y - \bar{y})^2}}$$

where, $\bar{x}$ and $\bar{y}$ indicates the mean value of the sample for two different series, which were set as the brent crude oil price, global aquaculture value changes, and global aquaculture production volumes in this study.

Results

The main three severe price drops of brent crude oil occurred during the devastating crises in 2009, 2015, and 2020 are presented in Figure 1. The variations of average annual brent crude oil price, global finfish aquaculture production in volume and value, and the precent volatility rates over the previous year during the study period from 2005 to 2021 have been summarized in Table 1.

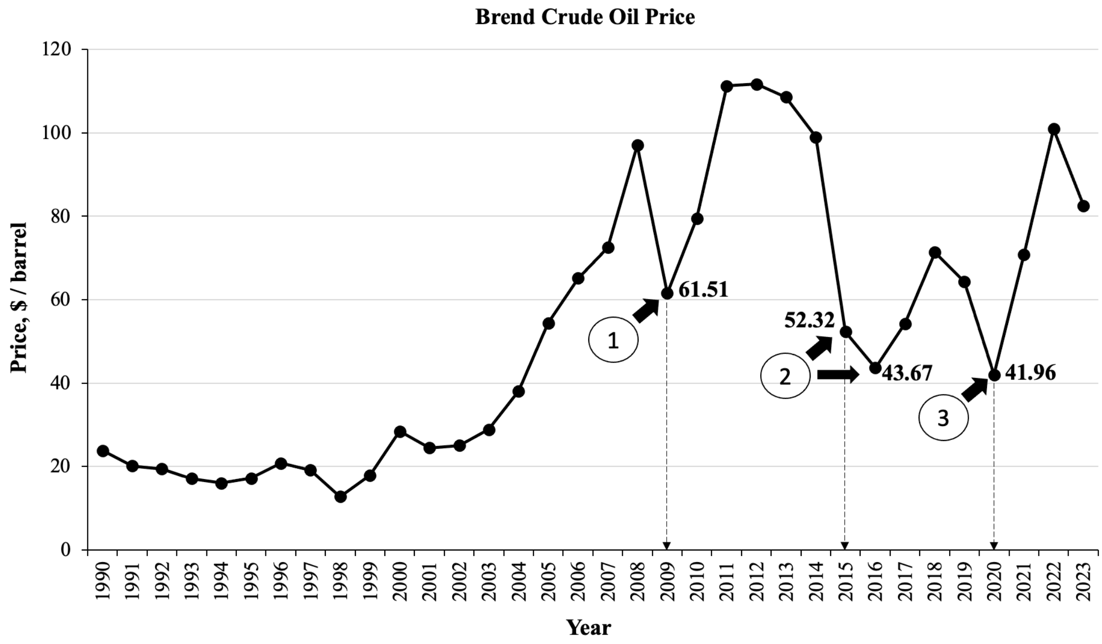

Figure 1. Variations in brent crude oil prices between 1990 and 2023. Price drops during the three global crises are noted with arrows. Year of brent crude oil crises indicated with vertical arrows. Figure produced using data provided by Statista (2023).

Table 1. Average annual brent crude oil price ($ per barrel), and global aquaculture sales average per kg fish and percent value changes between 2005 and 2021.

Year	BCOP * $/barrel	ΣPVOL** Tons	PIVOL % increase	ΣPVAL*** $, ×1000	PIVAL % increase
2005	54.38	27,949,129.8	-	39,424,645.9	-
2006	65.14	29,772,563.5	6.52	45,031,777.4	14.22
2007	72.52	31,572,500.5	6.05	56,487,942.5	25.44
2008	96.99	34,239,736.7	8.45	65,482,730.8	15.92
2009	**61.51**	**35,697,108.7**	**4.26**	**69,674,113.7**	**6.40**
2010	79.47	37,683,870.0	5.57	80,681,414.1	15.80
2011	111.26	39,385,612.1	4.52	94,937,258.5	17.7
2012	111.63	42,269,689.2	7.32	104,160,284.8	9.71
2013	108.56	44,863,659.3	6.14	115,747,156.0	11.1
2014	98.97	47,129,646.2	5.05	126,406,719.3	9.21
2015	**52.32**	**48,994,863.6**	**3.96**	**122,950,881.8**	**-2.73**
2016	43.67	50,978,555.5	4.05	132,105,854.9	7.45
2017	54.25	52,594,116.2	3.17	138,945,076.9	5.18
2018	71.34	54,436,545.0	3.50	140,537,402.4	1.15
2019	64.30	56,195,538.6	3.23	143,645,756.6	2.21
2020	**41.96**	**57,506,702.8**	**2.33**	**144,912,753.2**	**0.88**
2021	70.86	59,271,218.1	3.07	154,902,873.6	6.89

Note:
BCOP: brent crude oil price
ΣPVOL: global aquaculture production, total
PIVOL: global aquaculture production, percent increase over previous year
ΣPVAL: global aquaculture value, total
PIVAL: global aquaculture value, percent increase over previous year
*Statista (2023), **FAO (2023a), ***FAO (2023b)
The three shock waves of crises with brent crude oil price dips in 2009, 2015 and 2020 have been highlighted in grey color and bold numbers.

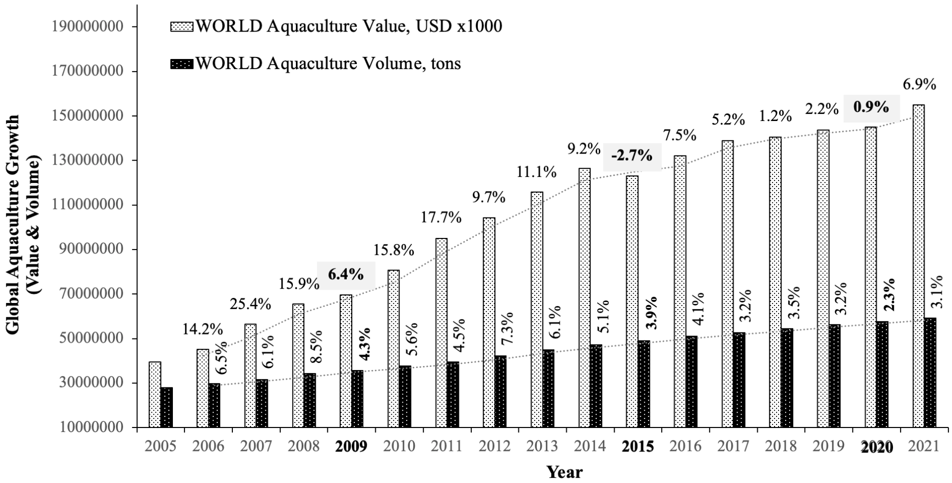

Figure 2. Global finfish aquaculture growth in value ($, x1000) and volume (tons) from 2005 to 2021, with indications of world crisis in 2009, 2015 and 2020. Values on bars present percent increase over previous year. Figure produced by statistical data provided by FAO (2023a, 2023b).

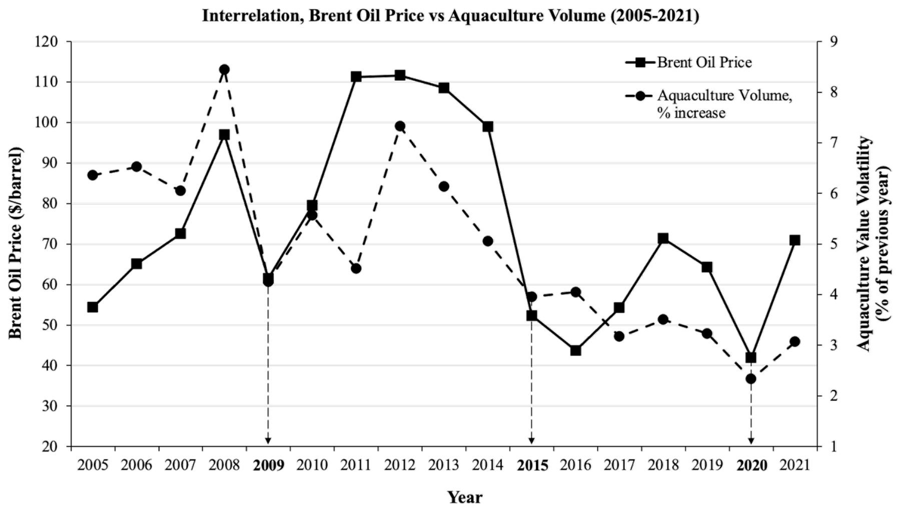

Figure 3. Superimposed illustration for the interrelation of brent crude oil price versus global aquaculture production volume between 2005 and 2021. Year of brent crude oil crises indicated with vertical arrows. Figure produced by statistical data provided by Statista (2023) and FAO (2023a, 2023b).

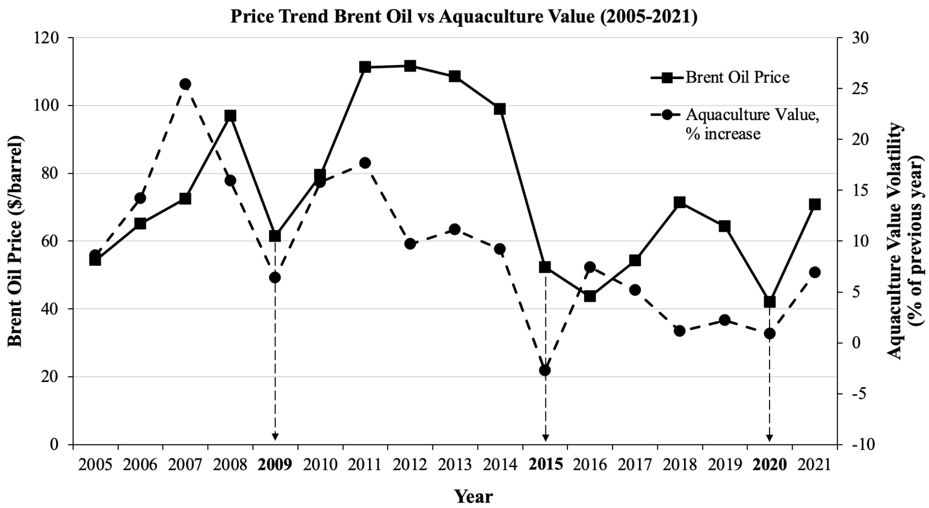

Figure 4. Superimposed illustration of brent crude oil price trend versus global aquaculture value volatility between 2005 and 2021. Year of brent crude oil crisis indicated with arrow. Figure produced by statistical data provided by Statista (2023) and FAO (2023a, 2023b).

Table 2. Correlation coefficients between brent crude oil prices and global aquaculture volume -and value volatilities during no-crisis and crisis periods.

Brent Crude Oil			
Crisis: NO	**Inter-crisis periods**		
	2005-2008[a]	**2010-2014[b]**	**2016-2019[c]**
GA-VOL	0.146297890	0.213407087	-0.569037484
GA-VAL	0.057705678	-0.252998166	-0.995184679
Crisis: YES	**Time of crisis periods**		
	2005-2021[d]	**2008-2021[e]**	**2009-2020[f]**
GA-VOL	0.566464994	0.730856035	0.790843781
GA-VAL	0.498279004	0.715832960	0.696991266

Note:

GA-VOL: global aquaculture volume

GA-VAL: global aquaculture value

No-crisis periods;

[a]2005-2008: before the housing market bubble crisis in 2009

[b]2010-2014: after 2009-crisis, before the oil shale revolution in 2015

[c]2016-2019: after 2015-crisis, before the Covid-19 pandemic in 2020

Crisis periods;

[d]2005-2021: all times combined with three world crises in 2009, 2015, 2020

[e]2008-2021: three world crisis periods combined with one year before and after the crisis [f]2009-2020: three world crisis periods combined covering the year of crisis only

Table 2 shows the results of Pearson's correlation with two main period groups with three divisions of subperiods in each group. Data in table reflect the relationship between brent oil price variations and both the percent volatility of both aquaculture volume -and value during the inter-crisis periods, that explains the "before, between and after" crisis terms (no-crisis periods).

Discussion

The results in this study evidenced no relationship with price variation in brent crude oil and global aquaculture volume or value during the no-crisis periods, since no correlation or even negative (-) correlation was found between brent oil price variations and percent volatility of both aquaculture volume -and value during the inter-crisis periods, that explain the "pre-crisis, between-crisis, and post-crisis" terms (no-crisis periods). This was in line with the report of Nazlioglu & Soytas (2011), who did not find any relationship between agriculture commodities and crude oil prices, which is an indication that during a no-crisis period, the brent oil price trend is not directly linked to the price of agricultural commodity. Also, Zhang et al. (2010) noted that the increase in crude oil prices have not direct linkage or relation to the food prices, but other factors influencing price volatilities may get in charge, such as demand shocks (Vo et al., 2019), that in turn may be coupled with a demand increase for crude oil according to Baumeister & Kilian (2014). In contrast to these reports with incompatible and even contradictive findings, there are clear evidences for significant linkages between food and oil prices during periods of crisis such as the food crisis in 2006, and financial crisis in 2008, that led to remarkable volatilities between their price series (Al-Maadid et al., 2017).

Since there is a lack of research on the spillover of crude oil prices into aquaculture production volume -or values, earlier investigations on a variety of food and agriculture commodities have been compared with the findings in this study regarding global aquaculture impacts. A number of researchers have pointed on the increasing crude oil prices as a strong reason for significant shock effects on agricultural markets. For example, El Montasser et al. (2023) reported that the relationship between crude oil and agricultural commodity is a complex issue that is linked to a variety of factors, however the authors underlined that the linkage between crude oil and agricultural commodities increased drastically during the global 2007-2008 food crisis and the recent Covid-19 pandemic crisis, which was in agreement with Du et al. (2011), who reported volatility spillovers from crude oil prices to the prices of agriculture commodities during the post-crisis period of 2006. Also, Nazlioglu et al. (2013) underlined that there was no risk transmission between crude oil and agriculture commodity prices during the pre-crisis period, but the oil market volatility showed a spillover into the agricultural markets during the post-crisis period. In contrast to these reports, findings in the present study showed evidence that the correlation coefficients for the evaluated structures of brent crude oil price and volatility spillover on global aquaculture volume -or value had no linkage in the pre-crisis or post-crisis periods during the three crises encountered in 2009, 2015, or 2020. However, at the time of the crises, the correlation coefficients increased in the positive direction close to one "1", underlining a strong relationship between brent crude oil price changes and the volatility of both global aquaculture volume -and value, with highest coefficients of 0.731-0.791, and 0.697-0.716 during the periods covering all three severe crises occurred in 2009, 2015, and 2020. Similar findings were also addressed by Roman et al. (2020) with high correlation coefficients between prices of oil and food indices. The results of this study with crisis-driven volatility spillover of crude oil prices into global aquaculture volume -and value, is also in close agreement with the report of Fabiosa (2009), who noted negative correlation coefficients between crude oil and grain prices, but the relationship increased during the ethanol bloom period, with elevated correlation coefficients from -0.117 to 0.876 for corn, from 0.182 to 0.909 for soymeal, and from -0.252 to 0.834 for distiller soluble dried grains. The correlation between crude oil and feed prices increased from a weak correlation of 0.020 to 0.890 during the ethanol bloom period between 2005-2008, that severely influenced the feed costs and as a consequence the livestock sector was affected during the crisis period.

Over the last fifteen years, three main crises were observed globally with five-years intervals that severely affected economies of developed as well as emerging economies of world countries. Among the three severe price drops of brent crude oil, the shock wave in 2009 was called as "Housing market bubble" (Loo, 2020), the crisis in 2015 was called as "the oil shale revolution 2014-2015" (Mănescu & Nuño, 2015), whereas the third was the Great Lockdown (Panneer et al., 2022), that occurred in 2020 due to the recent Covid-19 pandemic. In 2009, the average annual price of brent crude oil dropped suddenly to 61.51 $/barrel from its peak of 96.99 $/barrel in its history. After the recovery of 2009 crisis, it peaked again to the highest level of 111.63 $/barrel, that declined slightly to 108.56 $/barrel and 98.97 $/barrel over the following two years and suddenly dropped to 52.32 $/barrel in 2015 and 43.67 $/barrel in 2016. Political instabilities in certain countries or regional conflicts such as the Russia-Ukraine conflict, that turned to a flame of war by February 20th, 2014, limiting the world food trade routes and lowered food security around the globe (Ben Hassen & El Bilali, 2022). Russia's economy is most dependent on the energy sector, however, the sharp decline in global oil prices in 2014 brought the price of a barrel of oil down 60% from the $100 band, resulting in a severe dip in 2015. Mănescu & Nuño (2015) analysed the collapse in oil prices in the second half of 2014 and underlined that the sudden drop of the price was mainly because of unexpected supply shocks by the energy industry, which was in agreement with Baffes et al. (2015), who also noted that supply shocks were more responsible than the demand shocks in the decline of brent crude oil prices occurred late 2014. An increasing trend was seen thereafter which averaged around 70 $/barrel in the years of 2018-2019. However, a similar sudden decline was seen again in 2020 during the Covid-19 pandemic crisis, with a hit to its lowest rate of 41.96 $/barrel (Statista, 2023).

Based on earlier investigations evaluated above, fluctuations in crude oil prices are strongly related to commodity prices that affect operational costs through the production stages and consequently increase the prices of goods that is delivered to the consumers. Hence, it is advisable that political instabilities in certain countries especially those with high food supply for the global markets need strong attention to develop rapid solutions immediately in order to hinder any possible food security problems in the world.

The correlation structure between brent crude oil and global aquaculture prices volatility has increased dramatically in the present study, during the main three economic crisis in 2009, 2015, and 2020, which is in line with earlier reports on grain prices as discussed above. The depreciation in the aquaculture sector coincides with the downward trend in brent oil prices observed in 2009, 2015 and 2020. The decrease of aquaculture value during the crises could be explained by the cessation of purchases from Russia, but on the other hand, reduced prices could also be linked to the efforts of melting the stock in hand as a result of high-volume production as a challenge to encourage the sales immediately after the shock wave and closure of borders that was also the case during the lock-downs of Covid-19 pandemic period. The sharp decline in crude oil prices due to the recent Covid-19 pandemic crisis, together with the significant variations in global economies in the last decade, resulted an even more careful evaluation of the effects of crude oil, as an important indicator for food securities (Xu et al., 2020). The slow move of economic recovery after the pandemic can be linked to the nature of the Covid-19 that hit many countries, including emerging countries and developed economies. Despite the strong measures, the spread of the Covid-19 virus affected all sectors and consumers, with slow-down of various production facilities, that eventually reduced the need and consumption of oil, which in turn resulted in an over-supply of crude oil. This was also the case for the global aquaculture production volume, which indeed continued with increasing quantities during the pandemic period from 2019 to 2020. However, the percent increase of price in 2020 over the previous year of 2019 was less than the normal trend in the pre-crisis period of the Covid-19 virus. This again, similar to the case for the over-supply in crude oil, the global aquaculture production led to an over-supply of aquaculture harvest from fish farms, as a result of the lock downs and chain cut of the trade flow due to limited border passages in most countries during the Covid-19 pandemic. This again shows the sensitively close tides of intercontinental trade linkage in the world.

Conclusion

Considering that variations in brent crude oil price influence global aquaculture value during crises, the diversification of the energy consumption in the aquaculture industry could be an important measure for the slow-down of shock waves and volatility spillover from crude oil price into aquaculture values. Both renewable and non-renewable energy sources, like solar energy in hatcheries, and current -or wind energy resources in offshore cage farming systems can be combined for the improvement of food security, that is much dependent on fossil fuels. Further, in the context of policy efforts for reducing foreign dependency on energy sources, the interrelation of brent crude oil price variations and volatility spillover on global aquaculture enterprises need more attention and is encouraged in future investigations.

Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

Funding

Not applicable.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

Al-Maadid, A., Caporale, G. M., Spagnolo, F., & Spagnolo, N. (2017). Spillovers between food and energy prices and structural breaks. *Journal of International Economics, 150*, 1–18. https://doi.org/10.1016/j.inteco.2016.06.005

Aye, G. C., & Odhiambo, N. M. (2021). Oil prices and agricultural growth in South Africa: A threshold analysis. *Resources Policy, 73*, 102196. https://doi.org/10.1016/j.resourpol.2021.102196

Baffes, J., Kose, M. A., Ohnsorge, F., & Stocker, M. (2015). *The great plunge in oil prices - causes, consequences, and policy responses*. Policy Research Note No.1, World Bank.

Baumeister, C., & Kilian, L. (2014). Do oil price increases cause higher food prices? *Economic Policy, 29*, 691–747. https://doi.org/10.1111/1468-0327.12039.

Ben Hassen, T., & El Bilali, H. (2022). Impacts of the Russia-Ukraine war on global food security: towards more sustainable and resilient food systems? *Foods, 11*, 2301. https://doi.org/10.3390/foods11152301

Bergmann, D., O'Connor, D., & Thummel, A. (2016). An analysis of price and volatility transmission in butter, palm oil and crude oil markets. *Agricultural and Food Economics, 4*, 23. https://doi.org/10.1186/s40100-016-0067-4

Camp, K. M. (2019). The relationship between crude oil prices and export prices of major agricultural commodities. *Beyond the Numbers: Global Economy, 8*(7) (U.S. Bureau of Labor Statistics, April 2019). Retrieved on January 14, 2024, from https://www.bls.gov/opub/btn/volume-8/the-relationship-between-crude-oil-and-export-prices-of-major-agricultural-commodities.htm

Du, X., Yu, C. Y., & Hayes, D. J. (2011). Speculation and volatility spillover in the crude oil and agricultural commodity markets: A Bayesian analysis. *Energy Economics, 33*(3), 497-503. https://doi.org/10.1016/j.eneco.2010.12.015

El Montasser, G., Belhoula, M. M., & Charfeddine, L. (2023). Co-explosivity versus leading effects: Evidence from crude oil and agricultural commodities. *Resources Policy, 81*, 103331. https://doi.org/10.1016/j.resourpol.2023.103331

Fabiosa, J. F. (2009). The impact of the crude oil price on the livestock sector under a regime of integrated energy and grain markets. *Agricultural & Applied Economics Association 2009 AAEA & ACCI Joint Annual Meeting*, USA. https://doi.org/10.22004/ag.econ.49240

FAO. (2023a). *Statistical Query Panel - Global aquaculture production (Quantity)*. FAO Fisheries and Aquaculture Division [online]. Retrieved on July 10, 2023, from https://www.fao.org/fishery/statistics-query/en/aquaculture/aquaculture_quantity

FAO. (2023b). *Statistical Query Panel - Global aquaculture production (Value)*. FAO Fisheries and Aquaculture Division [online]. Retrieved on July 10, 2023, from https://www.fao.org/fishery/statistics-query/en/aquaculture/aquaculture_value

Jahangir, S.R., & Dural, B.Y. (2018). Crude oil, natural gas, and economic growth: Impact and causality analysis in Caspian Sea region. *International Journal of Management and Economics, 54*(3), 169–184. https://doi.org/10.2478/ijme-2018-0019

Loo, A. (2020). *2008-2009 Global Financial Crisis: The Great Recession*. Economics, Retrieved on July 02, 2023, from https://corporatefinanceinstitute.com/resources/economics/2008-2009-global-financial-crisis/

López Cabrera, B., & Schulz, F. (2016). Volatility linkages between energy and agricultural commodity prices. *Energy Economics, 54*, 190–203. https://doi.org/10.1016/j.eneco.2015.11.018

Mǎnescu, C. B., & Nuño, G. (2015). *Quantitative effects of the shale oil revolution*. European Central Bank Working Paper Series, No: 1855. Retrieved on January 22, 2024, from https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1855.en.pdf

Nazlioglu, S., Erdem, C., & Soytaş, U. (2013). Volatility spillover between oil and agricultural commodity markets. *Energy Economics, 36*, 658-665. https://doi.org/10.1016/j.eneco.2012.11.009

Nazlioglu, S., & Soytas, U. (2011). World oil prices and agricultural commodity prices: Evidence from an emerging market. *Energy Economics, 33*, 488–496. https://doi.org/10.1016/j.eneco.2010.11.012.

Nwoko, I.C., Aye, G.C., & Asogwa, B.C. (2016). Effect of oil price on Nigeria's food price volatility. *Cogent Food Agriculture, 2*(1), 1146057. https://doi.org/10.1080/23311932.2016.1146057

Panneer, S., Kantamaneni, K., Akkayasamy, V. S., Susairaj, A. X., Panda, P. K., Acharya, S. S., Rice, L., Liyanage, C., & Pushparaj, R. R. B. (2022). The great lockdown in the wake of COVID-19 and its implications: Lessons for low and middle-income countries. *International Journal of Environmental Research and Public Health, 19*, 610. https://doi.org/10.3390/ijerph19010610

Roman, M., Górecka, A., & Domagała, J. (2020). The linkages between crude oil and food prices. *Energies, 13*, 6545. https://doi.org/10.3390/en13246545

Statista (2023). *Average annual Brent crude oil price from 1976 to 2023*. Retrieved on July 01, 2023, from https://www.statista.com/statistics/262860/uk-brent-crude-oil-price-changes-since-1976/

Taghizadeh-Hesary, F., Rasoulinezhad, E., & Yoshino, N. (2018). *Volatility linkages between energy and food prices: Case of selected Asian countries*. ADBI Working Paper 829. Retrieved on January 16, 2024, from https://www.adb.org/sites/default/files/publication/411176/adbi-wp829.pdf

Vo, D. H., Vu, T. N., Vo, A. T., & McAleer, M. (2019). Modeling the relationship between crude oil and agricultural commodity prices. *Energies, 12*, 1344. https://doi.org/10.3390/en12071344

Xu, S., Du, Z., & Zhang, H. (2020). Can crude oil serve as a hedging asset for underlying securities? Research on the heterogenous correlation between crude oil and stock index. *Energies, 13*, 3139. https://doi.org/10.3390/en13123139

Yigit, Ü., & Kusku, H. (2022). Comparison of production trends in Japan with long history in aquaculture and challenging success of Türkiye as a fairly new country in fish farming. *Marine Reports, 1*(2), 99-109. https://doi.org/10.5281/zenodo.7393998

Yigit, Ü., Yigit, M., Ergün, S., Sanver, F., & Taylor, N. (2023). Competitive economic trends of steelhead farming in Türkiye and Norway. *Marine Reports, 2*(1), 16-25. https://doi.org/10.5281/zenodo.8050627

Zhang, Z., Lohr, L., Escalante, C., & Wetzstein, M. (2010). Food versus fuel: What do prices tell us? *Energy Policy, 38*(1), 445–451. https://doi.org/10.1016/j.enpol.2009.09.034