

Sectoral Heterogeneity in Exposure to Oil Price Shocks: Evidence from a Fixed-Effects Panel Analysis

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Abstract

This paper investigates how the exposure to oil price shocks differs across sectors, targeting airlines, oil producers and shipping companies. The analysis is based on a panel of listed companies with daily observations, including 28th of February 2026 (the start date of the Iran-US-Israel conflict). Fixed-effects regressions are generated, including Brent crude oil returns as main explanatory variable and S&P 500 index for capturing global market conditions. In order to complement the short-run analysis, the study develops an annual sector-level dataset (2007–2026), subsequently estimating one year ahead forecast regressions. The results emphasize sectoral heterogeneity in the exposure to oil price shocks of companies. The airlines industry reflects a significantly negative sensitivity to oil returns, once with the rise of fuel costs that decrease profitability. A negative trend is noticed in shipping companies, which hold higher bunker fuel expenses. By contrary, oil-producing businesses demonstrate a profitability increase, reacting with statistically significant positive sensitivity. These relationships remain consistent across the high frequency panel estimates, together with the longer horizon annual dynamics. By combining a fixed-effects panel approach with sector interaction terms, the empirical model allows the oil coefficient to differ from one industry to another.

Keywords

Oil price shocks; sectoral heterogeneity; airlines sector; oil producers; shipping industry; global market sensitivity

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Introduction

The shocks in oil price are a core factor in terms of financial and macroeconomic fluctuations, while not maintaining an even effect across industries. (Kang et al., 2020). It is well-known that industries focusing on the energy sector, like airlines, are oppositely harmed by oil price increases (Gong & Lin, 2021). Various sectors, such as shipping, lie in an intermediary position, since they are subjected to fuel costs and global market dynamics at the same time. Airlines, oil producers and shipping are the three main industries for which the current paper examines sectoral heterogeneity in exposure to the shocks of oil price. Hence, the article evaluates how oil price shocks propagate differently across these sectors. It also focuses on the importance of sector-specific analysis during periods of heightened volatility. The empirical design unites two complementary methods, the first being the estimation of fixed-effect panel regression, with daily company observations, that matches recent studies on how enterprises respond to oil price movements (Narayan & Gupta, 2015). The second method focuses on creating an annual industry-level framework, that contains regression analysis and a simple one-year-ahead forecast. Together, these two approaches provide an integrated overview of the propagation of oil price shocks through various industries, which is consistently reflected in recent findings (Baumeister & Hamilton, 2019).

As affirmed by Caldara & Iacoviello (2022), Antonakakis, Chatziantoniou & Filis (2020), geopolitical risk proved to be a major creator of oil price volatility. For this reason, the 2026 US-Israel-Iran conflict represents a natural experiment. Also, it is relevant for assessing heterogeneous sector reactions.

Understanding how each sector is affected truly matters for professionals, market participants and decision-makers, since aggregated models can mask the fact that sectors react in opposite directions (Kilian & Park, 2009). By capturing this heterogeneity directly, the article shows that not all industries are affected in the same manner and enhances the high importance of sector-level analysis during volatile times.

Relying on the mentioned considerations, the paper addresses the following research questions.

RQ1: How do oil price shocks influence the stock performance of airlines, oil producers and shipping companies?

RQ2: To what degree do industry differences explain why sectors react distinctly to oil price changes?

RQ3: Do the short-run sector reactions align with the long-run results and forecasted patterns?

1. Review of the scientific literature

Globalization represents a series of profound transformations, that has enabled the evolution of world trade and the growth of international investments. In this global process, worldwide economies, markets, companies and businesses are integrated into the structure of the global economy (Bogoevici, 2025). As oil has been an essential energy source for ages, the effect of its price fluctuations on stock markets does not follow a uniform pattern. On the contrary, the fluctuations, or in other words the ups and downs, depend mainly on each of the economies' net positions in the global energy market (Wang et al., 2013). Higher oil prices are a driving force that supports stock markets by raising public revenues, promoting fiscal discipline and improving the national welfare state (Mukhtarov et al., 2019). Indeed, investors looking to invest in the oil and gas sector sometimes face complex or even industry-specific key performance indicators (KPIs). Besides, oil is still the world's most important energy source since it is crucial as an energy engine. The oil and gas industry is sometimes subject to supply shocks and unexpected risks that may have a significant impact on the demand of its products (Benabed & Gruenbichler, 2023; Benabed, 2024). According to Hugues and Zabbala (2023), supporting oil and gas operations could be relevant as a funding source for renewable and low-carbon energy development; thereby facilitating rather than hindering the energy transition. Thus, more investments in the oil and gas field require funds. Additionally, the volatility in crude oil prices has become a major risk factor for global financial markets, particularly since the appearance of commodities as an economic fuel, based on investment instruments and financial supplies (Civcir & Akkoc, 2021). In their paper, Salisu & Isah (2017) argue that higher interest rates are possible hedges and investment options focusing even on bonds that have become crucial and critical at the same time for the energy business and fossil fuels. Some of the investors' reactions to rising oil prices differ from their reactions to falling prices (negative shocks) in terms of direction, size and significance (Dhaoui et al., 2018). In some prior research on China, EU and India, Zhang and Ogura (2025) affirm that oil shocks and shortages generally create negative and lasting effects on stock markets. Other authors, such as Abraham Dakuma (2021), state that the energy transition may involve a larger transformation of the system, but specific fuel sources and technology will always remain crucial for companies' operations and strategic objectives in the global economy. Overall, the literature consistently highlights that oil price shocks produce asymmetric effects on industries. It also supports the need for sector-level analysis, a gap this paper addresses directly.

2. Research methodology

2.1 Data gathering and sample construction

The research method started from a related literature review and set research questions that helped structure the content and go further with the research results and analysis, with a coherent compatibility to the research field and what has been published in prior research by other authors.

It is well-known that Brent crude oil is used as the primary oil price benchmark for multiple reasons. Brent crude oil represents the global reference price for seaborne crude oil, widely used in practice and academic work and is especially relevant for companies with European and international exposure. West Texas Intermediate (WTI), in opposition, is more regionally oriented. Nevertheless, it is worth to be mentioned that Brent futures are highly liquid, offering reliable historical data. According to the U.S. Energy Information Administration (2023), Brent is the benchmark for pricing most of the global crude trade, around two-

thirds. In the empirical analysis there have been used Brent crude futures prices (Brent oil futures historical data from Investing.com website) for computing both daily and annual returns.

The sample consists of 16 publicly listed companies, classified into three sectors, as follows.

- Airlines: Air France–KLM, Lufthansa, Delta Air Lines, United Airlines, Ryanair ADR, Wizz Air;
- Oil producers: BP, Shell, Exxon Mobil, Chevron, ConocoPhillips, TotalEnergies, OMV Petrom;
- Shipping: Hapag-Lloyd, Mitsui O.S.K. Lines, Maersk.

The three sectors were chosen since they represent opposite channels of transmission: cost exposure (airlines), revenue exposure (oil producers) and mixed exposure (shipping). The dataset is built on the principle of always using each company's main listing in its home market, as affirmed by Baruch, Karolyi & Lemmon (2007). Adequate liquidity, correct currency denomination and full historical coverage are thus ensured. In the same time, distortions caused by lightly traded American Depositary Receipts (ADRs) or secondary listings can be avoided. More specifically, for the article BP and Shell have been extracted from the London Stock Exchange, TotalEnergies from Euronext Paris, Lufthansa from Xetra and Maersk from Nasdaq Copenhagen. Also, this decision is helpful for preventing missing data and measurement errors. The sample contains observations of around 60 days before 28 February 2026 (start date of the conflict) and 40 days after this date. This choice ensures data consistency and captures both pre-conflict market reactions and immediate post-event behaviour. This window allows early market reactions and immediate post-conflict changes.

2.2 Data sources and workflow

The dataset building involves two stages. Investing.com and Yahoo Finance were used for collecting historical price data for individual companies, Brent crude oil and the S&P 500 index. Data was then exported as CSV files and further processed in RStudio software. For the data cleaning process, the relevant variables (date and closing price) were kept. Daily returns were computed and temporal consistency ensured. Also, missing observations were removed. The data was later aggregated at sector level for further analysis. The automated workflow improved efficiency, reduced manual errors and ensured reproducibility, crucial for empirical financial research.

2.3 Panel structure

Based on the core dataset there is built a firm-level panel with daily frequencies. Inside it, each cross-sectional unit corresponds to a single company and the time dimension is measured in trading days, so depending if it is a working or non-working day. All the 16 selected companies are grouped into three sectors (airlines, oil producers and shipping), with the dependent variable being the daily stock return of firm i at time t . The fixed-effects panel regression is estimated using these daily observations in order to assess the oil price sensitivity in terms of stock returns. The key explanatory variable is the daily return on Brent crude oil.

2.4 Regression specification

The baseline specification is a fixed-effects model:

$$R_{i,t} = \alpha_i + \beta \cdot OilRet_t + \gamma \cdot MktRet_t + \varepsilon_{i,t} \quad (1)$$

where:

$R_{i,t}$ = daily return of company i at time t

α_i = company fixed effect, capturing time-invariant traits (business model, cost structure, geography)

$OilRet_t$ = daily return on Brent crude oil

$MktRet_t$ = daily return on the S&P 500 index (market control)

β (oil coefficient) = common sensitivity to oil price changes

γ (market coefficient) = common sensitivity to market movements

$\varepsilon_{i,t}$ = error term, capturing all other shocks not explained by oil or market returns (micro-level events, noise)

This model assesses how daily oil price fluctuations affect company-level stock returns while controlling for market movements and firm-specific traits. Sector dummies interacted with oil returns capture sectoral heterogeneity, showing different oil sensitivity across industries, with airlines as the baseline category.

The extended model is:

$$R_{i,t} = \alpha_i + \beta_1 \cdot OilRet_t + \beta_2 \cdot MktRet_t + \gamma_1(OilRet_t \cdot OilProducer_i) + \gamma_2(OilRet_t \cdot Shipping_i) + \varepsilon_{i,t} \quad (2)$$

where:

β_1 = oil sensitivity for airlines (baseline)

γ_1 = difference in oil sensitivity between oil producers and airlines

γ_2 = difference in oil sensitivity between shipping and airlines

Hence, oil sensitivity for each sector transforms into: Airlines: β_1 ; Oil Producers: $\beta_1 + \gamma_1$; Shipping: $\beta_1 + \gamma_2$. The fixed-effects regression specification answers RQ1 by measuring how daily oil price fluctuations affect organizations' stock returns.

2.5 Interpretation of coefficients

The firm fixed effect (α_i) captures all characteristics that are invariable over time, such as business models and cost structures. The oil price coefficient (β) measures sensitivity to oil price changes: negative for cost-exposed sectors (airlines) and positive for oil producers. The market coefficient (γ) captures exposure to systematic risk, while the error term ($\varepsilon_{i,t}$) reflects the idiosyncratic shocks on the market.

3. Results and discussion

3.1 Fixed-effects panel regression

The fixed-effects findings present sharp, economically relevant differences across sectors, Figure no. 1.

t test of coefficients:

	Estimate	Std. Error	t value	Pr(> t)
Oil_Return	-0.312579	0.058225	-5.3684	9.785e-08

Market_Return	0.509585	0.198801	2.5633	0.01051
*				
Oil_Return:SectorOilProducer	0.559952	0.059312	9.4408	< 2.2e-16

Oil_Return:SectorShipping	0.427713	0.072493	5.9001	4.904e-09

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Figure no.1. T-test of coefficients

Sector interaction terms allow the oil price coefficient to be different from one industry to the other, treating airlines as the reference category. The estimated coefficients are:

- Oil_Return (baseline for airlines): -0.31 ($p < 0.001$)
- Oil_Return $\times$ OilProducer: +0.56 ($p < 0.001$)
- Oil_Return $\times$ Shipping: +0.43 ($p < 0.001$)
- Market_Return: +0.51 ($p = 0.0105$)

Airlines show a negative and statistically significant sensitivity to oil price changes ($\beta_{\text{Airline}} = -0.31$, $p < 0.001$), demonstrating their increased exposure to fuel costs. This aligns with Gong & Lin (2021), who affirm that fuel price increases reduce airline profitability. Oil producers indicate a positive and significant relationship with oil price movements ($\beta_{\text{OilProducer}} = -0.3126 + 0.55995 = +0.2474$, $p < 0.001$), with revenues increasing when oil prices rise. This pattern is in line with Narayan & Gupta (2015). As for the shipping area, there is displayed a more moderate and less precisely estimated response ($\beta_{\text{Shipping}} = -0.3126 + 0.42771 = +0.1151$, $p < 0.001$), highlighting an intermediate exposure. Across all industries, the market coefficient ($\gamma = 0.51$) is positive. This implies stock returns move with broader market conditions. Overall, the results confirm pronounced sectoral heterogeneity in the propagation of oil price shocks. These asymmetric responses are consistent with the broader literature. They show that oil price shocks are transmitted differently across industries, according to their cost and revenue exposure (Kang et al., 2020; Kilian & Park, 2009).

3.2 Visual evidence of sectoral heterogeneity

In order to complement the regression analysis, two visuals are included to depict the sector-specific structures from the dataset, Figure no. 2.

- (a) Daily stock returns by sector

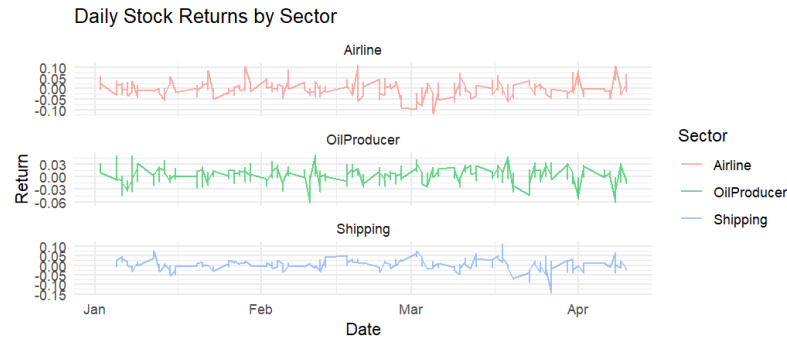


Figure no. 2. Daily stock returns by sector

As it can be noticed, the plot of daily stock returns by sector shows clear variations in volatility and direction across industries, Figure no. 3.

(b) Relationship between oil returns and stock returns by sector

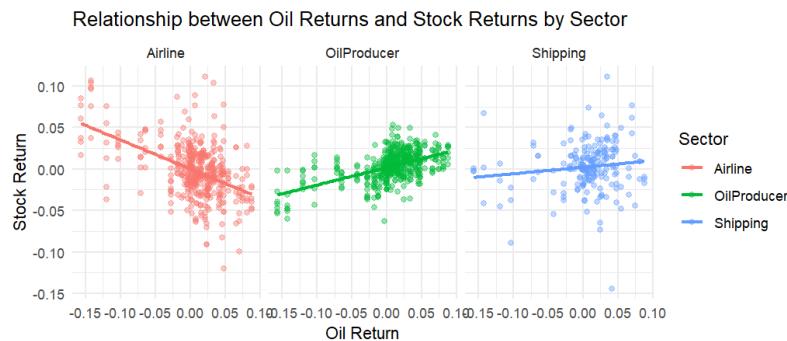


Figure no. 3. Relationship between oil returns and stock returns by sector

These patterns align closely with the estimated regression coefficients and confer sectoral heterogeneity evidence. The scatterplots mainly display: a clearly negative slope for airlines, a positive association for oil producers and a mild positive one for shipping companies. In this sense, a direct contribution is brought in answering RQ2: it can be visually confirmed that sectors behave distinctly to oil price shocks. Airline sector is oppositely affected, oil producers benefit, while shipping firms occupy an intermediate position. In economic terms, this has the following meaning: a 1% increase in oil prices decreases airline returns by 0.31 percentage points and increases oil producer returns by 0.25 percentage points, showing a mechanism of asymmetric transmission. These differences in the visuals reflect the sector-specific patterns found in recent empirical studies. They also emphasize that oil shocks generate heterogeneous stock market reactions (Antonakakis et al., 2020; Baumeister & Hamilton, 2019).

3.3. Hypotheses testing

All hypotheses are tested at the 5% significance level ($\alpha = 0.05$). For each sector, the null hypothesis states that changes in oil price have no effect on stock returns, while the alternative hypothesis mentions that oil price changes significantly affect returns. Sectoral heterogeneity is assessed through the significance of the interaction terms.

H1 - Airlines (baseline sector)

H₀: $\beta_1 = 0$ Oil price changes have no effect on airline stock returns.

H₁: $\beta_1 \neq 0$ Oil price changes significantly affect airline stock returns.

Result: The null hypothesis is rejected at the 1% level ($\beta = -0.31$, $p < 0.001$), meaning that increases in oil prices are associated with a statistically significant decline in airline stock returns.

H2 - Oil Producers

H₀: $\beta_1 + \gamma_1 = 0$ Oil price changes have no effect on oil-producer stock returns.

H₁: $\beta_1 + \gamma_1 \neq 0$ Oil price changes significantly affect oil-producer stock returns.

Result: The null hypothesis is rejected at the 1% level ($\beta + \gamma_1 \approx 0.25$, $p < 0.001$), showing that rises in oil prices reflect a statistically significant increase in oil producer stock returns.

H3 - Shipping

H₀: $\beta_1 + \gamma_2 = 0$ Oil price changes have no effect on shipping stock returns.

H₁: $\beta_1 + \gamma_2 \neq 0$ Oil price changes significantly affect shipping stock returns.

Result: The null hypothesis is rejected at the 1% level ($\beta + \gamma_2 \approx 0.12$, $p < 0.001$), denoting that increases in oil prices have a positive, more moderate, statistically significant growth in shipping stock returns.

H4 - Sectoral Heterogeneity

H₀: $\gamma_1 = \gamma_2 = 0$ All sectors react the same to oil price changes.

H₁: At least one $\gamma \neq 0$ At least one sector reacts differently to oil price changes.

Result: The null hypothesis is rejected at the 1% level ($p < 0.001$), suggesting significant differences of sensitivity to oil price changes across sectors

3.4. Extended annual analysis

3.4.1 Construction of annual sector returns

To complement the high-frequency analysis, the dataset is aggregated to annual frequency, using the same daily data. Annual returns per company are computed based on the change between the first and last observed price from a certain year:

$$R_{i,year} = \frac{P_{i,end} - P_{i,start}}{P_{i,start}} \quad (3)$$

where:

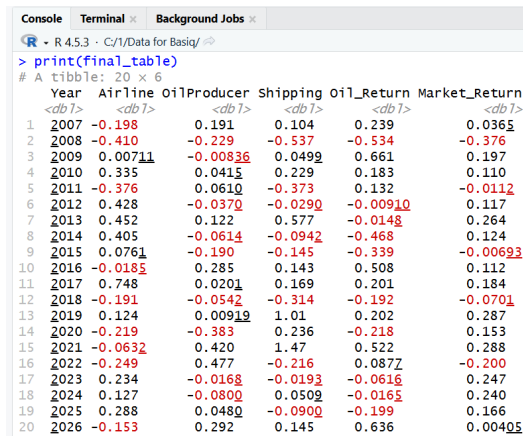
$R_{i,year}$ = annual return of company i , expressed as a percentage change over the year

$P_{i,start}$ = the first recorded price of company i in that year (start-of-year price)

$P_{i,end}$ = the last recorded price of company i in that year (end-of-year price)

$P_{i,end} - P_{i,start}$ = total price change during the year.

These firm-level returns are then averaged within each sector to obtain sector-level annual returns. The resulting dataset is merged with annual oil price returns and yearly S&P 500 returns, Figure no. 4.



```

Console Terminal Background Jobs
R - R 4.5.3 - C:/I/Data for Basiq/
> print(final_table)
# A tibble: 20 x 6
  Year Airline OilProducer Shipping Oil_Return Market_Return
<dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 2007 -0.198 0.191 0.104 0.239 0.0365
2 2008 -0.410 -0.229 -0.537 -0.534 -0.376
3 2009 0.00711 -0.00836 0.0499 0.661 0.197
4 2010 0.335 0.0415 0.229 0.183 0.110
5 2011 -0.376 0.0610 -0.373 0.132 -0.0112
6 2012 0.428 -0.0370 -0.0290 -0.00910 0.117
7 2013 0.452 0.122 0.577 -0.0148 0.264
8 2014 0.405 -0.0614 -0.0942 -0.468 0.124
9 2015 0.0761 -0.190 -0.145 -0.339 -0.00693
10 2016 -0.0185 0.285 0.143 0.508 0.112
11 2017 0.748 0.0201 0.169 0.201 0.184
12 2018 -0.191 -0.0542 -0.314 -0.192 -0.0701
13 2019 0.124 0.00919 1.01 0.202 0.287
14 2020 -0.219 -0.383 0.236 -0.218 0.153
15 2021 -0.0632 0.420 1.47 0.522 0.288
16 2022 -0.249 0.477 -0.216 0.0872 -0.200
17 2023 0.234 -0.0168 -0.0193 -0.0616 0.247
18 2024 0.127 -0.0800 0.0509 -0.0165 0.240
19 2025 0.288 0.0480 -0.0900 -0.199 0.166
20 2026 -0.153 0.292 0.145 0.636 0.00405

```

Figure no. 4. Yearly sectoral return patterns and their relationship to oil price rises, 2007–2026

During the 2007–2026 period, the annual sector averages indicate clear long-run patterns: airlines usually experience negative returns in the years in which oil price drastically increases, while oil producers benefit and shipping firms occupy a middle position. Additionally, these patterns mirror the relationships identified in the short-run panel analysis.

3.5. Annual regression and one-year-ahead forecast

3.5.1 Annual regression model

The annual regression and one-year-ahead forecast evaluate the persistence of cross-sector sensitivities over time and provide the empirical grounding for addressing RQ3. For each sector s , the following model is estimated:

$$Return_{s,t} = \alpha_s + \beta_s \cdot Oil_Return_t + \gamma_s \cdot Market_Return_t + \varepsilon_{s,t} \quad (4)$$

The corresponding R code is:

```
lm_airline <- lm(Airline ~ Oil_Return + Market_Return, data = annual_table)
lm_oil <- lm(OilProducer ~ Oil_Return + Market_Return, data = annual_table)
lm_shipping <- lm(Shipping ~ Oil_Return + Market_Return, data = annual_table)
```

The annual regression confirms the heterogeneous sectoral sensitivities to oil price changes, as follows:

- Airlines: $\beta_s < 0$ -> negative oil sensitivity;
- Oil producers: $\beta_s > 0$ -> positive oil sensitivity;
- Shipping: β_s small and positive -> moderate, indirect exposure; $\gamma_s > 0$ for all sectors -> positive market sensitivity.

Despite the presence of a reduced number of yearly observations, the consistency between daily and yearly estimates strengthens the robustness of the findings. This pattern across frequencies aligns with long-run evidence, that oil price shocks have lasting, sector-dependent impacts on financial markets (Caldara & Iacoviello, 2022).

Conclusion

This paper provides clear evidence of sectoral heterogeneity in the response of stock market to oil price shocks. Using a fixed-effects panel model with interaction terms, the analysis emphasizes that airlines are negatively affected by rising oil prices, advantages are brought for oil producers and shipping firms display a reduced, but positive sensitivity. These patterns are consistent with prior studies showing that cost-exposed sectors react adversely to oil increases (Broadstock & Filis, 2014), while oil-related industries with revenue exposure benefit from higher prices (Civcir & Akkoc, 2021). The results confirm that sectors do not react uniformly, so these differences should be recognized when evaluating commodity price shocks. Ignoring sector differences may lead to wrong conclusions and misleading results, as illustrated by the insignificant oil coefficient. The consistency between the short-run panel estimates and the longer-run annual regression also aligns with wider evidence that oil shocks generate persistent, sector-dependent effects (Kang et al., 2020). The findings are especially relevant during periods of geopolitical tension, such as the conflict between Iran and United States, when oil price volatility increases. Future research may extend the analysis to longer time horizons, additional sectors or alternative energy price measures. Additionally, it could include volatility indicators, structural breaks or alternative energy benchmarks, such as natural gas or refined products.

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