

TIL6022 Project Group 18

How did oil prices affect logistics performance in The Netherlands between 2021 and 2023 ¶

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Introduction

As the third largest oil producer ([U.S Energy Information Administration, 2022](https://www.eia.gov/international/rankings/world) (<https://www.eia.gov/international/rankings/world>)), Russia has a big influence towards the global oil price. The geopolitical landscape, especially with the on-going war between Russia and Ukraine, has further strengthened this impact. On February 24, 2022, Russia announced special military action against Ukraine, and the Russia-Ukraine war broke out. As a result to the war, Ukraine imposed a ban on natural gas and oil exports in February 2024 ([Gas Transmission System Operator of Ukraine, 2022](https://tsoua.com/en/news/ukraine-stops-exporting-natural-gas/) (<https://tsoua.com/en/news/ukraine-stops-exporting-natural-gas/>)), followed by a number of sanctions by EU countries in response to Russia's war of aggression ([EU Sanction on Russia, 2022](https://www.consilium.europa.eu/en/policies/eu-response-ukraine-invasion/) (<https://www.consilium.europa.eu/en/policies/eu-response-ukraine-invasion/>)), intensifying the energy crisis in Europe and leading to fluctuated change in oil prices.

The Netherlands, as a key logistics hub in Europe and heavily dependent on fuel for its freight and transportation operations, was impacted by the fluctuating oil prices caused by these geopolitical developments. The main objective of this research is to see the impact and correlation between the change of oil prices on the logistics performance in the Netherlands before and after the Russia-Ukraine energy dispute in 2022.

Research Questions and Objectives

The main research question for this project is **how did oil prices affect logistics performance in The Netherlands between 2021 and 2023?**

Following are the sub research questions of this project:

1. How did the fluctuation in oil prices impact the total freight volume (ton) trend in the Netherlands between 2021 and 2023?
2. How did the fluctuation in oil prices impact the volume (ton) of freight transported in different transport modes in the Netherlands between 2021 and 2023?
3. How did the total export value (USD thousand) from the Netherlands to EU countries and total import value (USD thousand) from the EU countries to the Netherlands fluctuate in response to changes in oil prices between 2021 and 2023?

The objectives of this project are:

1. To visualize and examine the impact of oil price fluctuation on the changes in total freight volume (ton) in the Netherlands between 2021 and 2023.
2. To visualize, compare, and determine the correlation between oil price fluctuations and the volume of freight transported across different modes of transportation (air, rail, inland waterway, sea, and road) in the Netherlands between 2021 and 2023.
3. To visualize, sort, and compare the fluctuations in the total export value (USD thousand) from the Netherlands to five EU countries and total import value (USD thousand) from the five EU countries to the Netherlands fluctuate in response to changes in oil prices between 2021 and 2023.

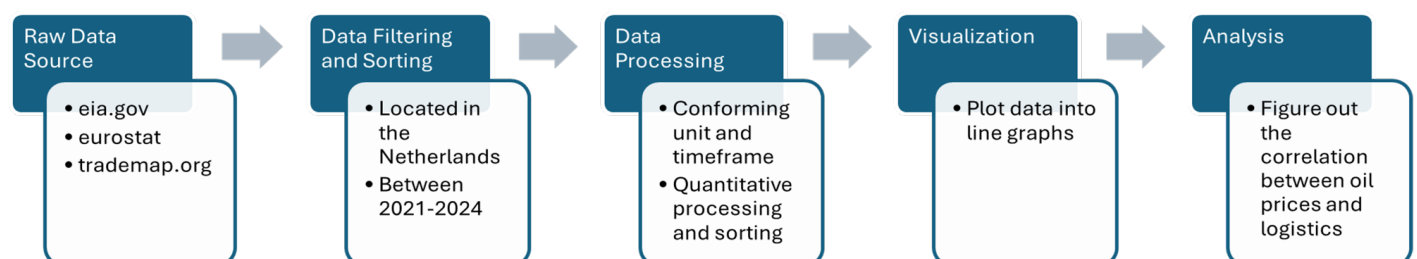
Timescale:

For conducting analysis, we use quarterly data from 2021 until 2023.

Spatial scale:

The analysis will focus on the Netherlands. The international trade data will focus on top 5 countries with highest trade value with the Netherlands.

Data Pipeline



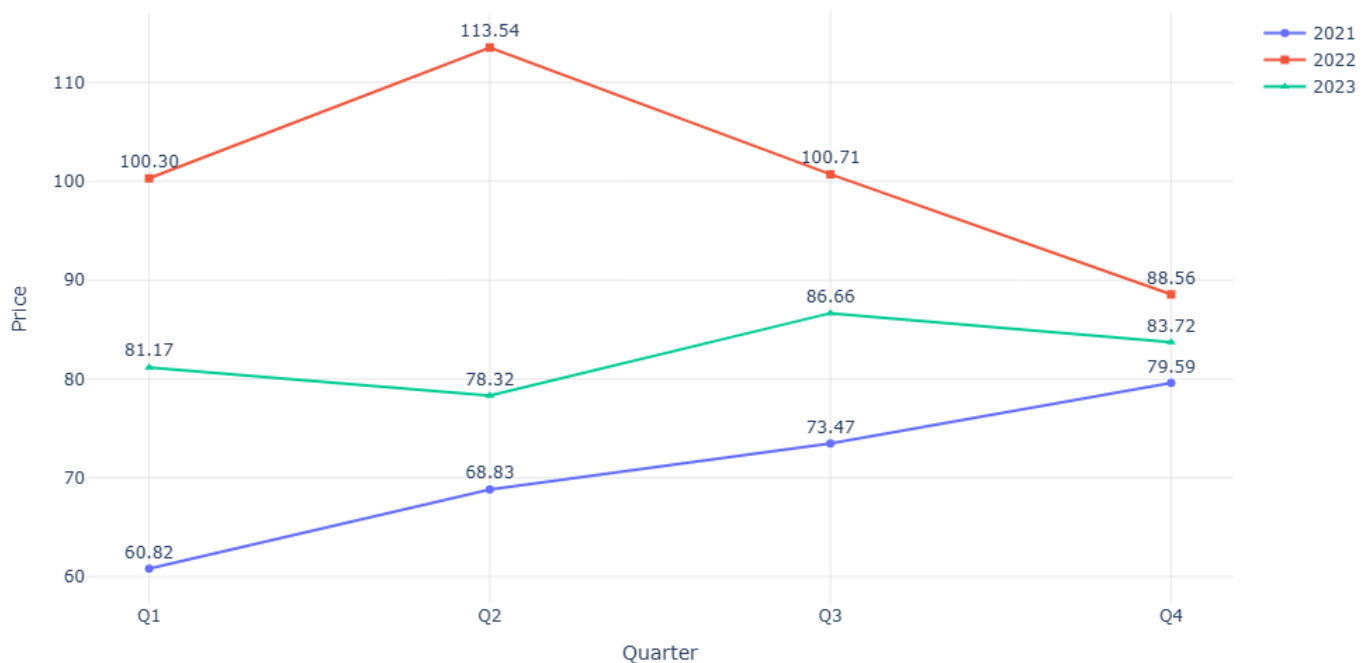
1. Oil Price Surge

Starting in 2021, oil prices showed a consistent upward trajectory, climbing steadily from USD 60.82 to USD 79.59, marking a significant 30.9% increase over the year. However, 2022 emerged as a particularly turbulent year with dramatic price fluctuations. Prices surged to a peak of USD 113.54 in Q2 2022, representing the highest point in the three-year period, before beginning a steady decline. This volatility is attributed to global supply chain disruptions, particularly supply losses and dislocations stemming from the Russia-Ukraine conflict, which significantly affected global oil prices during this period.

Moving into 2023, oil prices eased and the market showed signs of stabilization. This aligns with research by Huang et al. (2017), which found that geopolitical factors typically have only a short-term impact (approximately up to 10 months) on oil prices. While Q1 2023 prices (USD 81.17) were lower than the same period in 2022 (USD 100.30), they remained substantially higher than 2021 levels (USD 60.82), suggesting a new price threshold had been established.

The first half of the year (Q1-Q2) consistently showed significant price movements across years, while the latter half (Q3-Q4) typically exhibited more moderate changes, suggesting seasonal patterns in oil pricing.

Quarterly Oil Price Comparison (2021-2023)

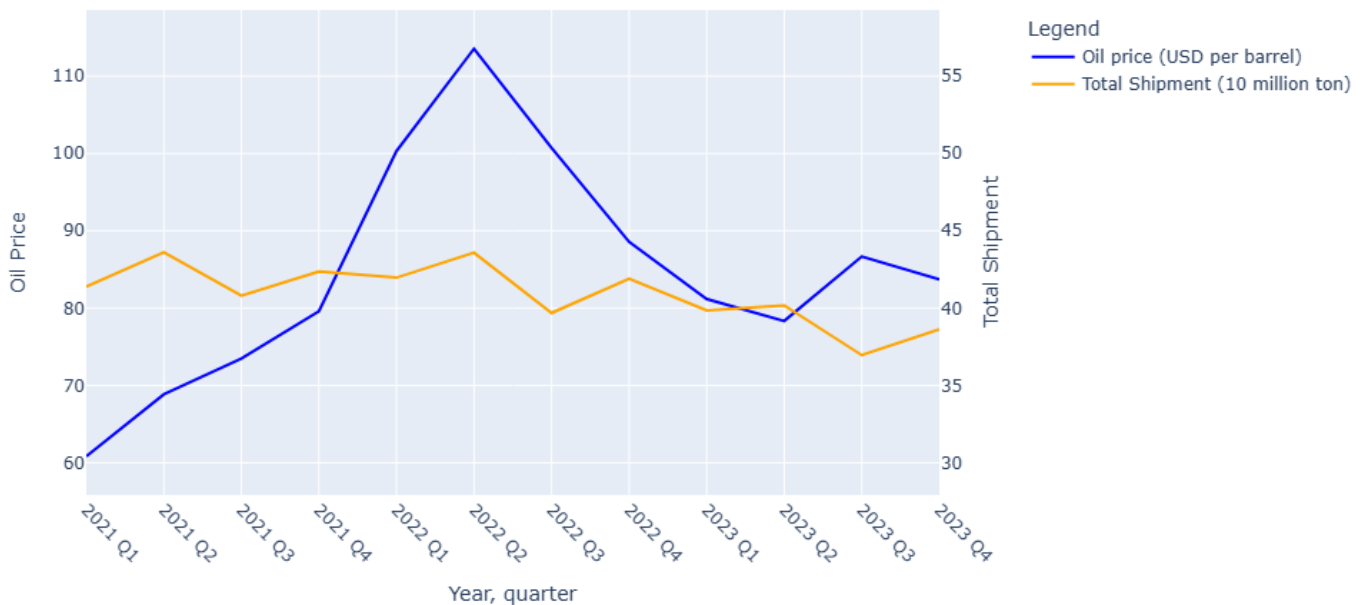


Oil price data is obtained from ([U.S Energy Information Administration, 2022](https://www.eia.gov/international/rankings/world) (<https://www.eia.gov/international/rankings/world>)), specifically for the Europe Brent Spot Price Free on Board (FOB) measured in USD Dollar per Barrel.

2. Impact on The Netherland's Logistic Performance

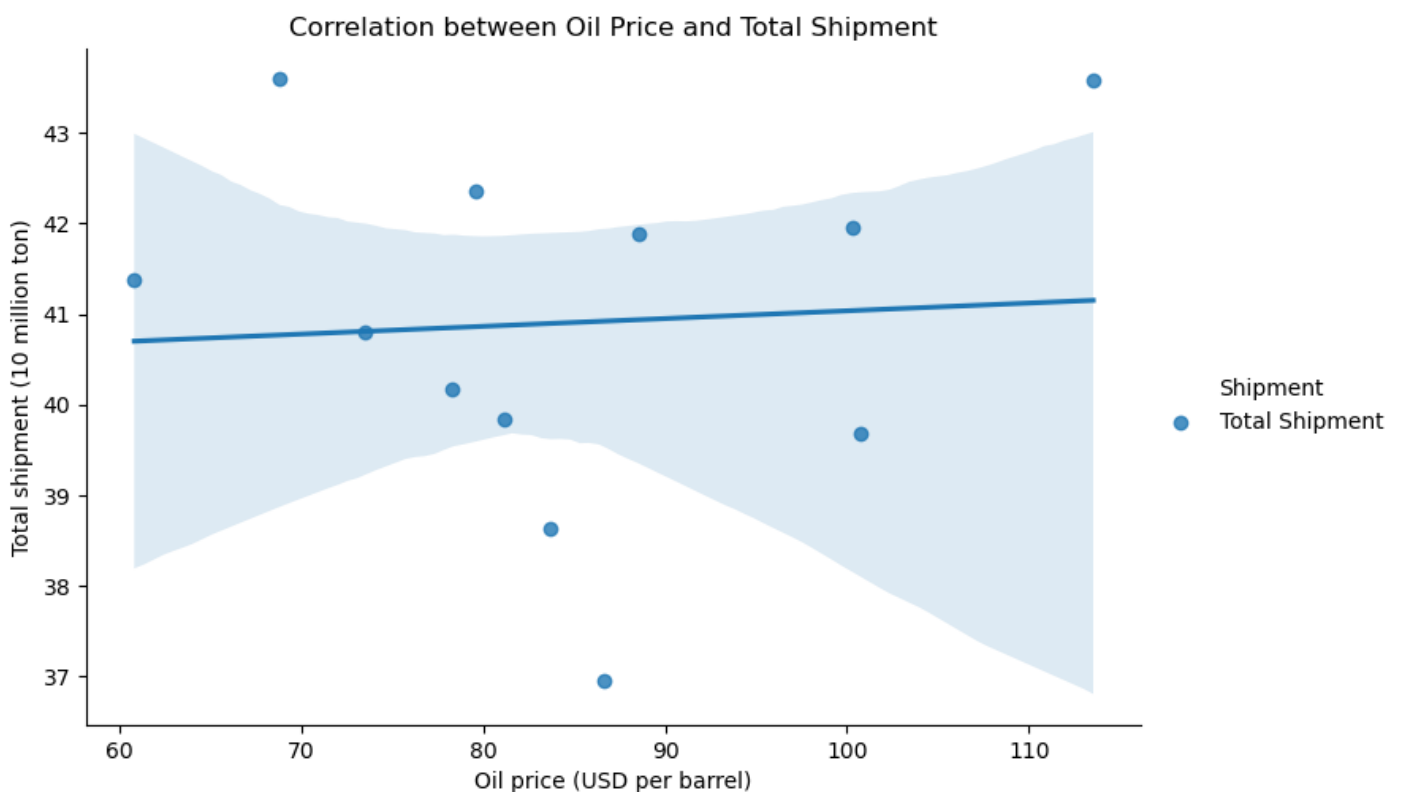
A. Oil Price and Shipment Quantity Trends from 2021 to 2023

Trend of Oil Price and Shipment Quantity from 2021 to 2023



Total shipment quantities exhibit much less volatility throughout the period. Shipment volumes remain relatively stable between 40 and 50 million tons, with a slight increase in 2021, followed by a small dip around Q2 2022—coinciding with the peak in oil prices. This suggests that higher oil prices may have a dampening effect on the total shipment quantity. However, the drop in shipment quantity is not as significant as the oil price fluctuations, suggesting that The Netherlands' trade demand remained robust and relatively inelastic to rising fuel costs. By 2023, shipment volumes recover, reflecting the market's adjustment to the new pricing environment.

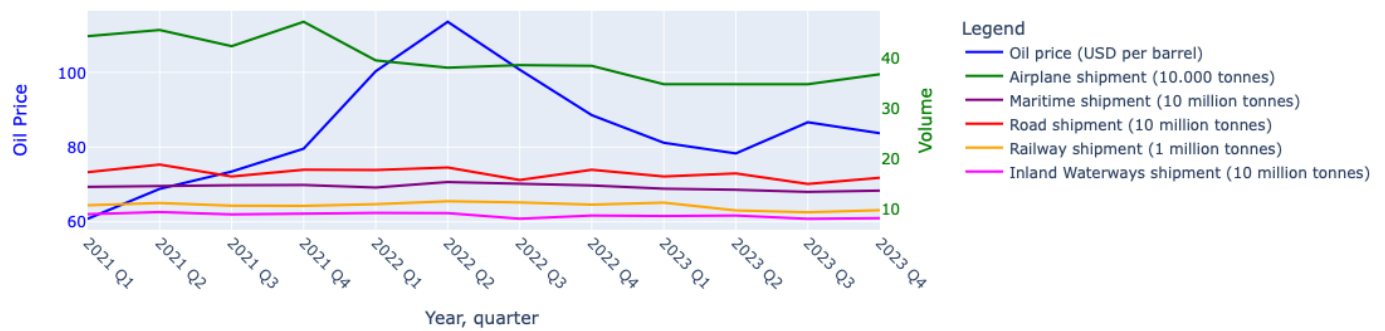
The scatter plot examining the relationship between oil prices and total shipment volumes reveals a weak positive correlation. The nearly flat line of best fit suggests that changes in oil prices have minimal direct impact on shipment volumes. The wide confidence interval (shown by the shaded area) indicates high uncertainty in this relationship. The scattered distribution of points and weak correlation suggest that total shipment volumes are likely influenced by multiple factors beyond oil prices alone. This could indicate that global shipping demand is relatively inelastic to oil price changes, or that other factors (such as contractual obligations, global demand, or supply chain constraints) may play more significant roles in determining shipment volumes. While there are some outliers in both higher and lower ranges of shipment volumes, there is no clear pattern indicating a strong dependency between oil prices and shipping quantities.



B. Oil Price and Volumes of Transport Modes Trends 2021 to 2023

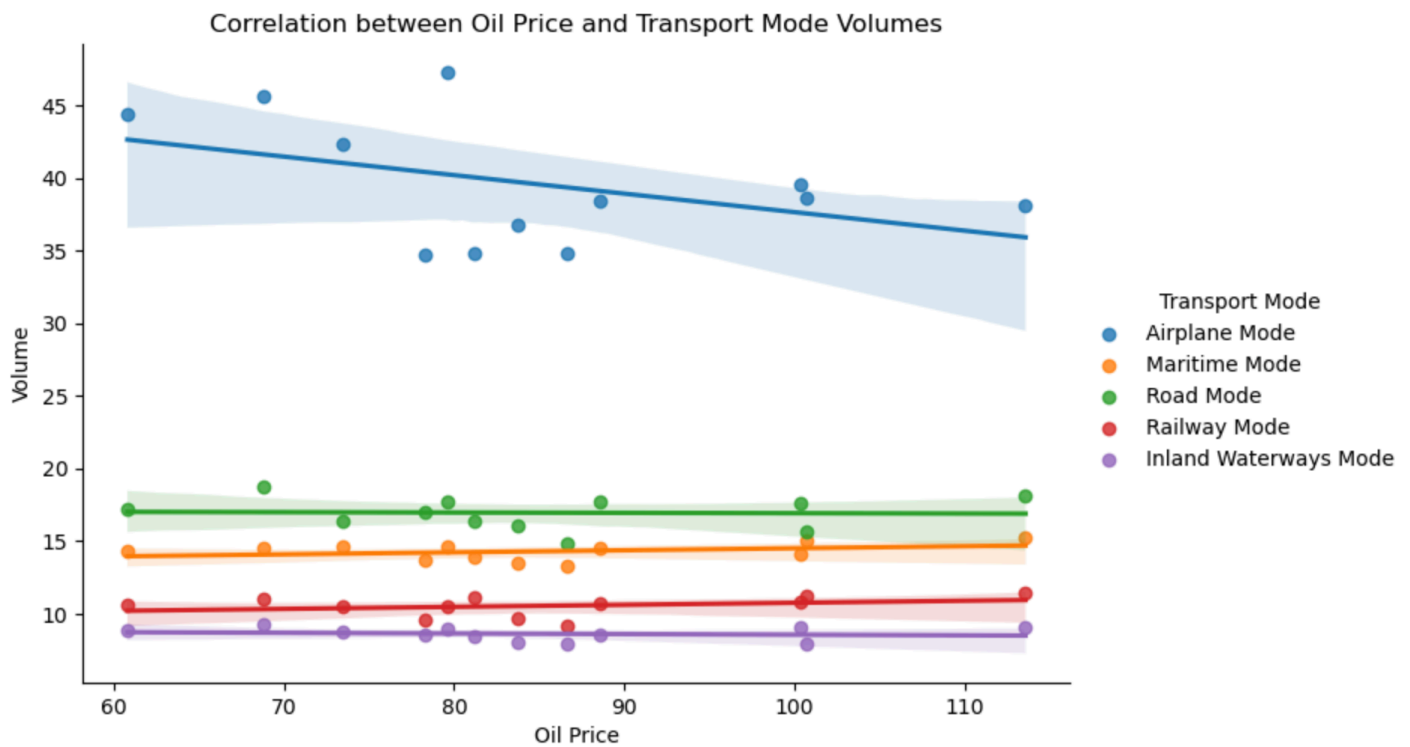
The graph illustrates the relationship between oil prices and transport volumes across different modes from 2021 Q1 to 2023 Q4. Among transport modes, Airplane Shipment shows the most noticeable fluctuations. It maintained relatively stable volumes around 40-45 units during 2021, but experienced a notable decline coinciding with peak oil prices in 2022. Some recovery and stabilization occurred in 2023, though at slightly lower levels than 2021. Maritime Shipment demonstrates stability throughout the period, with fluctuations between 130-150 million tonnes. The data shows little direct response to oil price changes, suggesting resilience in this transport mode. Road Shipment maintains a relatively stable pattern with slight variations, fluctuating between 160-190 million tonnes. Railway Shipment and Inland Waterways Shipment show the most stable patterns among all modes. Both demonstrate minimal fluctuations throughout the period and appear least affected by oil price volatility.

Trend of Oil Price vs Volumes of Transport Modes 2021 to 2023



While oil prices experienced dramatic changes during this period, transport volumes were relatively stable overall. Airplane shipment showed some sensitivity to oil price spikes, while maritime, road, railway, and inland waterway transport exhibited greater resilience. This suggests that energy-efficient modes, such as rail and inland waterways has a possibly better ability to absorb or pass through fuel cost changes, underscore the importance of diversifying transport modes to ensure long-term resilience in the face of fluctuating energy cost.

To further support our claim, we examined the correlation between each transport mode's volume and oil prices with a scatter plot.



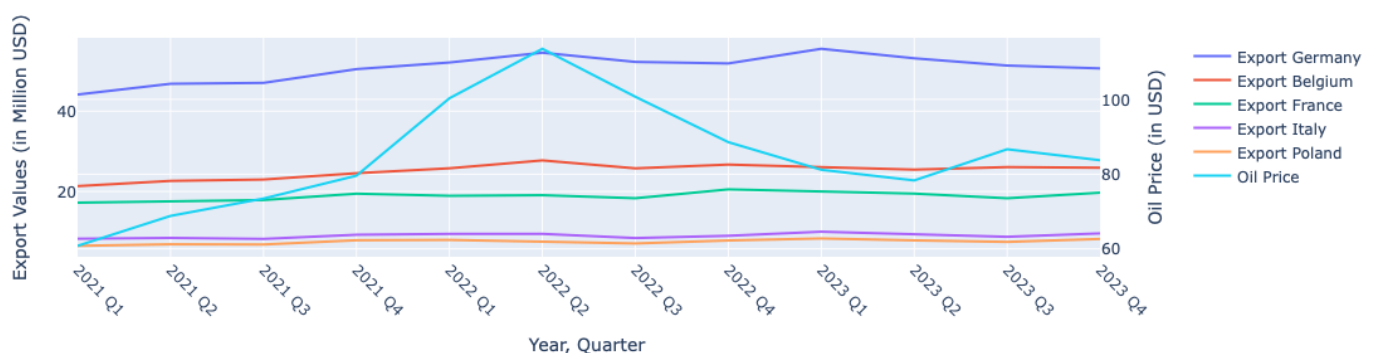
It can be seen that airplanes mode volumes has a negative correlation to the oil price, indicating that air cargo volume is indeed affected by oil price fluctuations. In contrast, other transport modes show minimal change, with Road and Inland Waterways mode appearing particularly flat while Railway and Maritime modes show a weak positive correlation. Air transport also shows the widest confidence intervals range, highlighting its sensitivity to oil price changes, whereas the confidence intervals for other transport modes show minimal impact from oil price fluctuations.

C. Export Values by Country and Price Over Time

	Quarter	Price	Export Germany	Export Belgium	Export France	Export Italy	Export Poland
0	2021 Q1	60.820000	44.117655	21.330007	17.206682	8.232882	6.464029
1	2021 Q2	68.830000	46.797432	22.626315	17.625687	8.438632	6.848701
2	2021 Q3	73.470000	47.022815	22.971691	17.868996	8.190615	6.796111
3	2021 Q4	79.590000	50.446783	24.537921	19.451189	9.228776	7.857002
4	2022 Q1	100.300000	52.094426	25.765264	18.914984	9.436756	7.941483
5	2022 Q2	113.540000	54.533106	27.722722	19.069949	9.441125	7.449511
6	2022 Q3	100.710000	52.237598	25.748810	18.312154	8.402710	7.057325
7	2022 Q4	88.560000	51.860825	26.689289	20.520986	8.964858	7.799943
8	2023 Q1	81.170000	55.508039	26.052519	19.919543	9.985542	8.299103
9	2023 Q2	78.320000	53.140635	25.434880	19.466554	9.420803	7.823181
10	2023 Q3	86.660000	51.333495	26.063645	18.305596	8.711629	7.439858
11	2023 Q4	83.720000	50.627033	25.902379	19.698186	9.562786	8.178079

Considering independently the total export value from the Netherlands of these five EU countries, it underscores the importance of proximity and economic integration in shaping export patterns. Countries that are geographically closer and have stronger infrastructural ties to the Netherlands, such as Germany and Belgium, tend to command higher total export values. The export patterns also highlight the role of major EU economies (Germany and France) as primary trade partners, with smaller or more distant markets (Italy and Poland) playing a secondary role in Dutch export strategy.

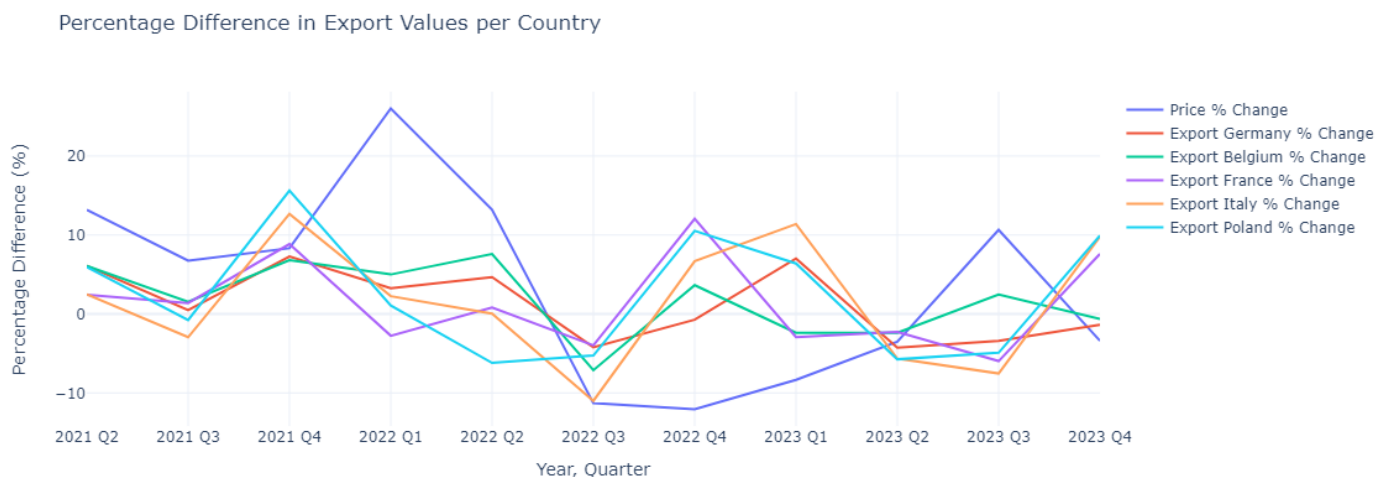
Export Values by Country and Price Over Time



The graph represents the notable yet complex impact of the oil price fluctuations to the export activities of the Netherlands with other five key EU countries - Germany, Belgium, France, Italy and Poland. In the first half of the examined period, as oil prices surged sharply from 113.54 in 2022 Q2, we observe a corresponding increase in export values from the Netherlands to all five countries. More specifically, export values to Germany rose from 44.12 thousand USD to 54.53 thousand USD, while Belgium and France experienced less dramatic increases during the same period. This implies that although higher oil prices leads to the rising costs, the demand for Dutch exports remained robust, likely fueled by strong economic recovery post-pandemic and resilient trade relationships.

Following the peak of oil prices in 2022 Q2, a decoupling effect becomes evident. While oil prices began to drop significantly after 2022 Q2, export values to most of the countries did not experience a similarly sharp decline. Instead, they remained relatively stable, especially in countries like Germany, where exports slightly dropped but stayed at high levels. For example, exports to Germany and Belgium settled at 50.63 thousand USD and 25.90 thousand USD respectively by 2023 Q4. It could suggest that once economies adapted to the high energy costs, export flows normalized and remained consistent. Despite falling oil prices, this stabilization represents the fact that other economic factors, such as demand, trade agreements, or industrial dependencies also play a significant role in shaping the export trends and even potentially buffering the impact of oil price changes.

Overall, the data shows that oil prices had an initial influence on export values, particularly during the price surge from 2021 Q1 to 2022 Q2, but as prices began to fall, the export values stabilized. This indicates that while oil prices can affect trade dynamics in the short term, the long-term demand for Dutch exports is resilient, and not solely dependent on fluctuations in oil prices. The sustained demand, especially from Germany, Belgium, and France, highlights the strength of economic ties and suggests that these countries were able to absorb the price shocks without significantly reducing their import.



We also examined the quarterly percentage changes and found some level of correlation between export values and oil price fluctuations, especially pronounced during the oil price spike in Q1 2022. The third quarter of 2022 proved particularly challenging, with several countries experiencing negative export growth as a result of rising oil prices. Recovery patterns differed among the countries, with some rebounding more quickly than others.

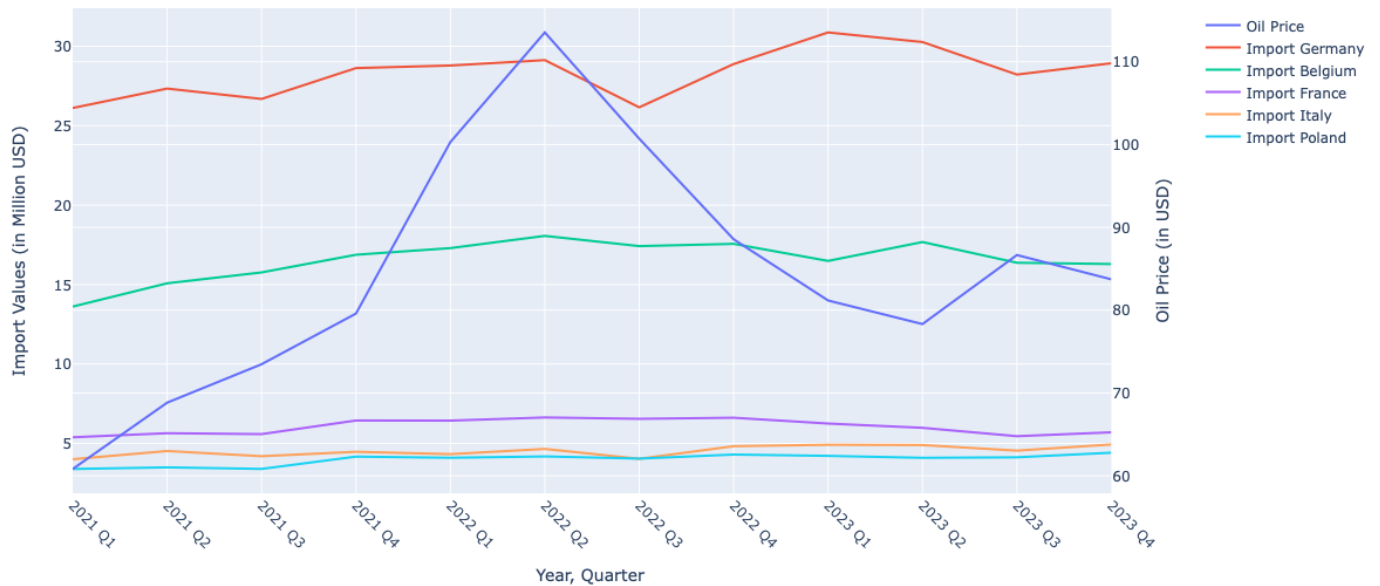
By late 2023, most countries showed moderate growth rates, indicating a stabilization in export performance. Notably, Poland, representing Eastern Europe, displayed higher volatility compared to Western European countries, possibly reflecting differing economic sensitivities to market conditions.

D. Import Values by Country and Price Over Time

	Year, Quarter	Price	Import Germany	Import Belgium	Import France	Import Italy	Import Poland
0	2021 Q1	60.820000	26.110000	13.610000	5.390000	4.000000	3.390000
1	2021 Q2	68.830000	27.340000	15.080000	5.640000	4.520000	3.490000
2	2021 Q3	73.470000	26.680000	15.760000	5.580000	4.190000	3.390000
3	2021 Q4	79.590000	28.630000	16.880000	6.440000	4.470000	4.170000
4	2022 Q1	100.300000	28.790000	17.290000	6.430000	4.320000	4.100000
5	2022 Q2	113.540000	29.130000	18.060000	6.630000	4.650000	4.180000
6	2022 Q3	100.710000	26.160000	17.420000	6.550000	4.030000	4.040000
7	2022 Q4	88.560000	28.880000	17.560000	6.620000	4.820000	4.300000
8	2023 Q1	81.170000	30.870000	16.490000	6.250000	4.910000	4.210000
9	2023 Q2	78.320000	30.270000	17.680000	5.980000	4.900000	4.090000
10	2023 Q3	86.660000	28.220000	16.370000	5.450000	4.550000	4.130000
11	2023 Q4	83.720000	28.930000	16.290000	5.700000	4.930000	4.410000

When examining the total import value to the Netherlands from these five EU countries individually, it highlights how economic integration significantly influence import trends. Similar to export value, countries that are geographically closer to the Netherlands and have stronger infrastructure connections, like Germany and Belgium, generally account for higher import values. This pattern also emphasizes the importance of major EU economies, such as Germany and France, as key trade partners, while smaller or more distant markets, like Italy and Poland, play a lesser role in the Dutch import strategy.

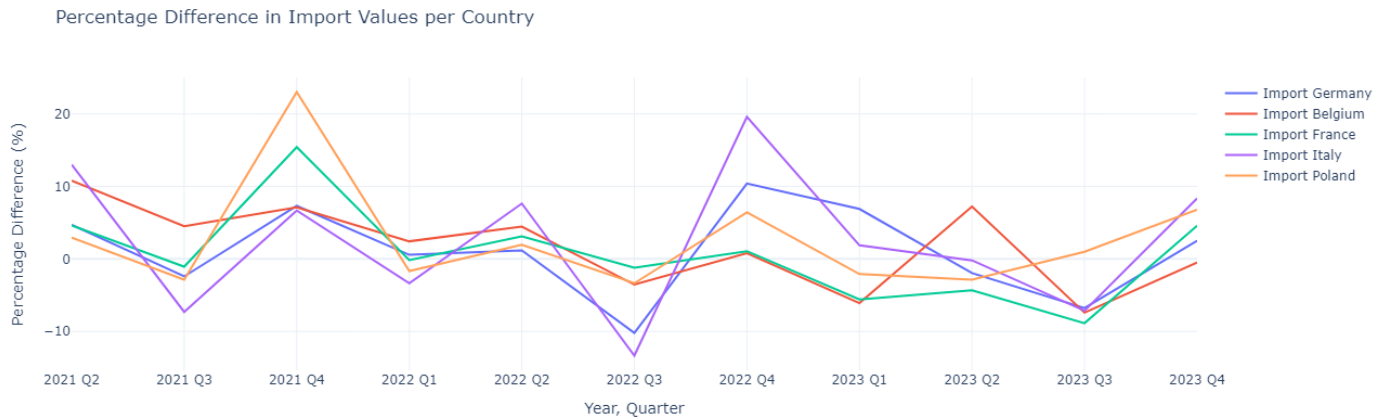
Import Values by Country and Oil Price Over Time



The data shows significant trends in import values to the Netherlands from five EU countries over the quarters from 2021 to 2023. In 2021, Germany emerged as the leading importer with values starting at 26.11 million USD in Q1 and gradually increasing to 28.63 million USD by Q4. Belgium followed with an initial value of 13.61 million USD in Q1, which rose steadily to 16.88 million USD in Q4. France's imports ranged from 5.39 million USD to 6.44 million USD, while Italy and Poland had lower values, starting at 4.00 million USD and 3.39 million USD respectively, with slight increases through the quarters.

In 2022, the overall import values showed a marked increase, particularly for Germany and Belgium. Germany's imports reached 28.79 million USD in Q1, with minor fluctuations throughout the year, peaking at 28.88 million USD in Q4. Belgium's imports saw a steady growth from 17.29 million USD in Q1 to 17.56 million USD in Q4. France's import values remained relatively stable, while Italy and Poland also showed modest increases, with values around 4.32 million USD for Italy and 4.10 million USD for Poland in Q1, and slight improvements by Q4.

By 2023, import values continued to reflect the established trends, with Germany leading at 30.87 million USD in Q1 and slightly decreasing to 28.93 million USD by Q4. Belgium's imports maintained a strong position at around 16.49 million USD in Q1, and fluctuated slightly throughout the year. In contrast, France, Italy, and Poland displayed more stable yet lower import values, with France's imports peaking at 6.62 million USD in Q4. Overall, the data illustrates a concentrated import pattern, where Germany consistently leads, while other countries like Belgium show significant contributions but at lower levels.



From the quarterly percentage changes, Germany, Belgium, and France display more stable trends, with smaller percentage differences over time. Belgium's import growth gradually increases in the latter half of 2023, while France's import values remain relatively steady with minor fluctuations. This variation among countries could be attributed to differences in economic conditions and external factors influencing each country's trade dynamics. By the end of 2023, most countries show converging trends toward moderate growth rates, suggesting a potential stabilization in import performance across these European countries.

Discussion

This research highlights the interconnectedness of geopolitical events, oil prices, and the logistics performance of a nation with a highly developed transport and trade infrastructure like the Netherlands. The volatility in oil prices, largely driven by the Russia-Ukraine conflict, had an immediate yet varied impacts on different sectors within the Dutch logistics performance. Notably, while oil price fluctuations are a significant factor, the data suggests that the Dutch logistics performance is resilient to a limited extent

The findings indicate that while some transport modes, such as airplanes, are more sensitive to oil price changes, other modes—especially rail and inland waterways—appear more resilient, likely due to higher energy efficiency and stability in their operational costs. The analysis of export and import values shows the depth of economic integration between the Netherlands and its key EU trade partners. The trade stability with Germany, Belgium, and France, despite fluctuating energy costs, emphasize the strength of these economic relationships.

The research also underscores the limitations of relying solely on oil prices as a determinant of logistics performance. The weak correlation between total shipment volumes and oil prices, coupled with the observed oil prices and export/import values over time, suggests that other macroeconomic factors, such as global demand cycles, supply chain constraints, and regional trade policies, play substantial roles. While this study provides insights into the impact of oil prices on logistics in the Netherlands, it is limited by the assumption of *ceteris paribus*, which may oversimplify the complex interdependencies within global trade networks.

Datasets

- Crude oil prices:
 - Cushing, OK WTI Spot Price FOB (Dollars per Barrel)
<https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rwtc&f=m>
[\(https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rwtc&f=m\)](https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rwtc&f=m)
 - Europe Brent Spot Price FOB (Dollars per Barrel)
<https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RB RTE&f=M>
[\(https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RB RTE&f=M\)](https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RB RTE&f=M)
- Air transport: Air transport of goods by country
https://ec.europa.eu/eurostat/databrowser/view/avia_gooc_custom_13108978/default/table?lang=en
[\(https://ec.europa.eu/eurostat/databrowser/view/avia_gooc_custom_13108978/default/table?lang=en\)](https://ec.europa.eu/eurostat/databrowser/view/avia_gooc_custom_13108978/default/table?lang=en)
- Inland waterway transport: Goods transport by inland waterways
https://ec.europa.eu/eurostat/databrowser/view/iww_go_qnave_custom_13109022/default/table?lang=en
[\(https://ec.europa.eu/eurostat/databrowser/view/iww_go_qnave_custom_13109022/default/table?lang=en\)](https://ec.europa.eu/eurostat/databrowser/view/iww_go_qnave_custom_13109022/default/table?lang=en)
- Maritime transport: Sea transport of goods
https://ec.europa.eu/eurostat/databrowser/view/mar_go_qm_custom_13109050/default/table?lang=en
[\(https://ec.europa.eu/eurostat/databrowser/view/mar_go_qm_custom_13109050/default/table?lang=en\)](https://ec.europa.eu/eurostat/databrowser/view/mar_go_qm_custom_13109050/default/table?lang=en)
- Railway transport: Goods transport by rail
https://ec.europa.eu/eurostat/databrowser/view/rail_go_quartal_custom_13109085/default/table?lang=en
[\(https://ec.europa.eu/eurostat/databrowser/view/rail_go_quartal_custom_13109085/default/table?lang=en\)](https://ec.europa.eu/eurostat/databrowser/view/rail_go_quartal_custom_13109085/default/table?lang=en)
- Road transport: Goods transport by road
https://ec.europa.eu/eurostat/databrowser/view/road_go_tq_tott_custom_13109107/default/table?lang=en
[\(https://ec.europa.eu/eurostat/databrowser/view/road_go_tq_tott_custom_13109107/default/table?lang=en\)](https://ec.europa.eu/eurostat/databrowser/view/road_go_tq_tott_custom_13109107/default/table?lang=en)
- International Trade (import and export) <https://www.trademap.org/Index.aspx>
[\(https://www.trademap.org/Index.aspx\)](https://www.trademap.org/Index.aspx)

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<https://doi.org/10.1016/j.jpolmod.2019.12.005> (<https://doi.org/10.1016/j.jpolmod.2019.12.005>)

Huang, S., An, H., Wen, S., & An, F. (2017). Revisiting driving factors of oil price shocks across time scales. *Energy*, 139, 617-629. <https://doi.org/10.1016/j.energy.2017.07.158> (<https://doi.org/10.1016/j.energy.2017.07.158>)

Contribution Statement

Adi Putra Rukmananda: Background research, Oil Price and Shipment Quantity Trends visualisation, data modelling

Anh Tran: Background research, Export Values by Country and Price Over Time visualisation, data analysis

Fakhrinanisa Islah Birru: Background research, Import Values by Country and Price Over Time visualisation, data analysis

Rifan Fauzan Ghofir: Background research, Oil Price and Volumes of Transport Modes Trends visualisation, data modelling

Wilona Septyola Br Surbakti: Background research, Conceptualisation, Oil Price Surge visualisation, data analysis, data modelling

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