The Rise of Refinery Margins[*]

Leonard Gregor[†], Justus Haucap[‡]

March 1, 2024

Work in Progress - Please do not circulate or cite without permission!

Abstract

In this explanatory paper, we investigate the pass-through rates of three exogenous cost shocks along the vertical chain in the retail and wholesale gasoline (diesel) market. The cost shocks of concern are an increase in crude oil prices after the Russian invasion of the Ukraine and a temporary reduction of energy taxes for gasoline (diesel). Lastly, we investigate the effect of the import ban of Russian Gasoline and Diesel. Using a unique data set from Germany that contains prices and quantities from all three vertical market levels: Crude oil, wholesale, and retail gasoline and diesel prices, we employ a difference in differences approach to estimate a causal effect of the exogenous cost shock on refinery and station margins. We find evidence that refinery companies in Germany pass through significantly more than 100% of the crude oil price increase to wholesale prices of gasoline and diesel. We also find suggestive evidence that the temporary reduction in energy taxes in the summer of 2022 was not fully passed through to consumers. Lastly, we find little evidence for significant changes in prices or quantities after the import ban of Russian Gasoline and Diesel.

1 Introduction

Compared to the GDP, corporate profits reached record levels over the past decade. Empirical studies have shown that this can be attributed to a significant increase in

market power and concentration (De Loecker et al., 2020). Therefore, understanding how and when firms pass on costs to consumers, as well as how they increase their price-cost margins is crucial. This paper aims to analyze the pass-through of costs in the German wholesale and retail gasoline (diesel) market, focusing on refinery and station margins.

Studying the pass-through of refineries, especially in the wake of cost shocks is interesting for multiple reasons. First, gasoline prices have been repeatedly under public scrutiny as multiple antitrust agencies have investigated the drivers for fluctuating retail gasoline prices, with mixed results. Market power and margins are, therefore, of significant interest. Second, many oil and refinery companies additionally reported record profits last year despite a difficult economic background. This is potentially problematic, as energy prices including oil prices have been a major driver of inflation.[1] Third, it is of general interest to investigate the effect of an unconventional fiscal policy, in order to evaluate it's efficiency. Fourth, we are investigating market behavior in times of crisis. This is important as prices already increased, in expectation of future supply problems. We show, however, that after the ban on Russian imports of Diesel and Gasoline, prices did not react as strongly as expected. Last, as energy costs including oil prices have been a major driver of inflation, it is important to know where inflation originates in order to respond appropriately

Our paper provides estimates of the pass-through of three exogenous cost shocks: The Russian invasion of Ukraine in February of 2022, which resulted in rising global energy prices, the begin of the import ban on Russian Diesel and Gasoline in February 2023 and a temporary energy tax break in the summer of 2022 in Germany.

We use a unique data set that contains prices from all three vertical market levels: crude oil, wholesale, and retail gasoline and diesel prices. The data set also includes wholesale prices from the harbors of Amsterdam, Rotterdam and Antwerp (ARA), which we use as a control group in our Difference and Difference analysis. Furthermore, we have access to quantity data on the wholesale level and refinery capacities.

Descriptive evidence shows that after the Russian invasion of the Ukraine, crude oil prices as well as gasoline and diesel wholesale and retail prices increased significantly in Europe. Wholesale and retail prices increased by at least three times the amount of the crude oil price increase, nearly tripling refinery margins. This effect is also long lasting. Even when crude oil prices decreased at the end of 2022 and 2023 wholesale prices stayed up and with it refinery margins. For the whole of 2022 and 2023 it seemed that gasoline and diesel prices were uncoupled from crude oil prices.

During the time of the tax break, these effects were even stronger, indicating that the tax break was not fully passed-through to consumers. Margins of gasoline retail stations,

---

[1]See: https://www.reuters.com/markets/europe/ecb-confronts-cold-reality-companies-are-cashing-inflation-2023-03-02/

however, did not change at all during the same time frame.

Our volume data indicates three things: First, consumption seems to be rather stable in the long term and is only slowly decreasing. There are, however strong seasonal effects. Second, demand went (especially) for Diesel went significantly up during the temporary tax break in Germany. Lastly, refineries plan on a long term basis. After the COVID pandemic, they lowered their capacity in Germany and where not able to increase it quickly after the Russian Invasion of Ukraine. Only in the beginning of 2023 were refineries able to increase capacity again to nearly pre-covid levels.

In a next step we employ a difference in difference approach to estimate the effect of all discontinuities on wholesale prices, confirming the results of our descriptive analysis. We find evidence that refinery companies in Germany passed through significantly more than the increase in crude oil prices to wholesale gasoline and diesel prices after the Invasion. Hence, they increased their margin. The difference and difference estimation can also confirm that refineries did not pass-through the whole tax rebate. Especially, when comparing wholesale prices in Germany and in the ARA region, it becomes apparent that price decreases were not passed through consumers in Germany. Lastly, we find evidence that the import ban on Russian Diesel and Gasoline increased wholesale prices in Germany, however not as much as the invasion.

Our paper contributes to the literature in two ways: First, our paper adds to the understanding on the way fuel prices react to changes in crude oil prices. This literature started with Bacon (1991) describing asymmetric price responses to changing input costs. Among others Lewis (2009); Ahmed et al. (2015); Gautier and Le Saout (2015) investigated the way crude oil price changes are passed through on to retail prices. These papers, however, did not account for multiple levels along the supply chain. Accounting for the whole vertical chain, was done for example by Farkas and Yontcheva (2019); Borenstein et al. (1992); Verlinda (2008). Furthermore, Li and Stock (2019) account for all three market levels, they differ in looking at the prices of bioethanol.

Second, this paper related to the literature that investigates the effect of tax changes on the retail gasoline market. There are a number of papers such as Freitas and Syga (2022); Bachmann et al. (2021); Clemens and Röger (2022); Dovern et al. (2022); Drolsbach et al. (2022) that estimate the pass-through of the temporary tax reduction in the summer of 2022. Unlike most of them we estimate the effect of the end of the tax reduction and therefore look at a tax increase. Our results contradict most of these papers, as they find a very high rate of tax pass-through to consumers, while we find a lower rate of the tax pass-through.

The rest of the paper is structured as follows: Section 2 summarizes the institutional background of the market. Section 3 presents our data set and shows first descriptive evidence. Section 4 presents our econometric analysis and results. Lastly, Section 5 concludes.

2 The German Gasoline Market

The Market for Gasoline in Germany was characterized by a high level of uncertainty since the Russian Invasion of Ukraine and subsequent global sanctions against Russia. This section, therefore discusses the vertical structure and price dynamics of the market for refined oil products in Germany.

This market is of major economic relevance, as in 2019 retail fuel sales alone were worth 92 billion Euro or approximately 3% of the German GDP. Moreover, fuel prices have significant effects on the rest of the economy, as they determine transport and travel costs (Montag et al., 2020).

In the following section we will describe the physical flow of crude oil from exploration, and transportation to the refinery process. We will also describe the distribution of refined products via storage facilities and wholesalers to gasoline stations and consumers. Furthermore, we will explain the market for crude oil procurement, the wholesale and retail markets for refined products and the pricing mechanisms in these markets.

Supply Chain

In Germany, imported crude oil mostly arrives in ships via the Rhine from the harbors of Amsterdam, Rotterdam, Antwerp and Hamburg at refineries. Some refineries also have a direct pipeline connection (Bundeskartellamt, 2022).

Germany crucially depends on crude oil imports from other countries to supply its refineries. Only 2% of the German demand for crude oil can be covered by crude oil fields in Germany (Arbeitsgemeinschaft Energieverbrauch e.V., 2022). The primary source of crude oil refined in Germany between 2018 and May 2022 was Russia (about 30%), while each of the following countries provides about 10% of German crude oil imports: Norway, the United Kingdom, Kazakhstan and the U.S. All together, 33 countries export crude oil into Germany.[2]

Even though Germany imports crude oil from a number of countries, individual refineries are much more limited in their procurement, as crude oil from different regions of the world has different chemical compositions. Most refineries in Germany are, therefore, equipped to handle a blend (mix) of different crude oils. If a refinery has the appropriate facilities to process a certain type of crude oil, its configuration can be changed within weeks. However, building new facilities can take years and require significant investments. The actual refining process works as a joint product production. When refining oil, multiple products emerge: Apart from different types of fuel like gasoline, diesel, jet fuel and liquefied petroleum gas (LPG), they produce among others heating oil, lube oil, bitumen, and pre-products for the chemical and pharmaceutical industry. Refinery

---

[2]See: https://www.n-tv.de/wirtschaft/Woher-deutsches-Ol-und-Gas-kommen-article2674116.html

operators can only partially control the exact ratios of production, as these mainly depend again on the type of crude oil, facility and configuration of the individual refinery. This so-called crack spread can be adjusted to some degree to regional demand the refinery is facing. Like Bundeskartellamt (2022) we will assume that a refinery in Germany uses a 3-2-1 crack spread. This means that it produces two liters of diesel and one liter of gasoline from three liters of crude oil.

In the following, we will also assume that the market for fuels actually consists of two separate product markets for gasoline and diesel.[3] Consumers cannot easily switch between these two, as cars run on either diesel or gasoline and they must make a long-term commitment to either diesel or gasoline when buying a car. Therefore, diesel and gasoline has to be stored and transported in different facilities and can not be mixed. Generally, diesel consumption in Germany is higher than refinery production, while gasoline production is larger than consumption. Therefore, Germany exports, about 5 to 10% of its national gasoline production and imports a little less than 15% of its national diesel production. In 2019, nearly 15% of these imports came from Russia (Bundeskartellamt, 2022).

As transportation is a significant cost factor in the market, refineries and storage facilities are mostly located near rivers or canals (see Figure 4). Therefore, large quantities of crude oil and refined products are transported via ships. Furthermore, Figure 1 shows that markets are regional. 90 % of all gasoline (diesel) is sold within a 300 (350) km radius around a refinery. Moreover, wholesalers with storage facilities have a distribution function. They will be supplied with large quantities from ships and distribute refined products all over the country via trucks. Wholesalers mostly sell fuels to gasoline stations and large industrial consumers.

Only when loading the refined product on a truck will the government charge all fees and taxes.[4] When consumers refill their fuel tank at a gasoline station another 19% VAT is charged (Bundeskartellamt, 2022).

Product	70% of Sales	80% of Sales	90% of Sales
Diesel	ca. 200km	ca. 250km	ca. 350km
Gasoline	ca. 150km	ca. 200km	ca. 300km
Heating Oil	ca. 100km	ca. 150km	ca. 200km

Table 1: Sales of a refinery by geographical extent, according to Bundeskartellamt (2022)

---

[3]When we talk about gasoline in the following, we talk about E5, meaning gasoline with a 5% addition of bioethanol. E10 (with a 10% addition of bioethanol) and special types of fuel with a higher octane rating will be ignored in the following, as they have a market share of below 10%. See: `https://rp-online.de/leben/auto/news/luxus-sprit-viel-geld-fuer-nichts_aid-16895193`

[4]Namely: Energy taxes, CO2-emission tax, EBV fee (Erdölbevorratungsverband), THG Quota (Treibhausgasminderungsquote).

Market Structure

The markets for fuels have previously been under scrutiny by antitrust agencies in many different countries, mostly because the vertical market structure from crude oil exploration to gasoline stations is dominated by a few large companies. These companies are fully vertically integrated, meaning that they extract, transport, and refine crude oil as well as sell refined products in the wholesale and retail market.

Table 2 shows that four of the 12 companies which operate a refinery in Germany are fully vertically integrated, three operate from exploration to refining,[5] two operate refineries and gasoline stations and three companies only operate refineries.

Furthermore, these companies cooperate on different levels along the supply chain. First, they jointly own and operate refineries, pipelines and storage facilities. Second, even though these fully integrated companies could procure crude oil for their refineries and refined products for their gasoline stations from within their corporation, this is not the case. Due to the importance of transportation costs all companies also procure crude oil and refined products from other companies (Bundeskartellamt, 2022). Third, a system of swap agreements exists between most major companies. To reduce transport costs, these firms supply each others stations. About 25% of all fuel sold in Germany is contracted in this way.

Effectively, the structural market conditions are conducive to establish cooperative or collusive behavior. Moreover, independent refineries that are not vertically integrated are completely dependent on third parties for procurement. The same applies to independent wholesalers and gasoline stations, which are dependent on refineries for procurement (Bundeskartellamt, 2009).

Furthermore, potential competition on all three vertical levels is limited. A partial market entry would result in dependencies on existing market players, and market entry along all of the supply chain is associated with very large investment costs. Lastly, demand is very fragmented at the retail and wholesale stage and, therefore, there is no countervailing buyer power.

Pricing Mechanism

Generally, two types of contracts are used when trading crude oil and refined products: Long-term contracts and spot market transactions. Refineries, wholesalers and gasoline stations can buy crude oil and refined products in the short run on spot markets, with different delivery times. The most important spot market for Europe is the ARA region. Long-term contracts are usually negotiated in fall and run for the following year. These

---

[5]OMV has no gasoline stations in Germany anymore, but operates a refinery that supplies OMV's gasoline stations in Austria, Esso sold its network of gasoline stations in 2018 and Rosneft operates gasoline stations outside of Germany

contracts use price indexes by price information services as a benchmark. The involved parties will agree on certain discounts and surcharges depending on transportation costs, quality, quantity, and so on. These price indexes in turn are based on spot market prices. For example, the market for refined products in Germany is an open spot market. The price information service Argus Media gathers information from market participants throughout the day and calculates a market price. Argus states that they *"are informed by information received from a wide cross-section of market participants, including producers, consumers and intermediaries. Argus reporters engage with the industry by proactively polling participants for market data. Argus will contact and accept market data from all credible market sources including front and back office of market participants and brokers. Argus will also receive market data from electronic trading platforms and directly from the back offices of market participants. Argus will accept market data by telephone, instant messenger, email or other means."* Even though Argus also publishes real-time data, after the market closes they will publish a so-called end of day-value. As prices can vary significantly over the day, according to Argus, this is supposed to represent the price on the open spot market during the day, as reporters verify all transactions of the day.[6]

This end-of-day value is the price benchmark for many long-term contracts, trading gasoline and diesel. Usage of the contract type varies between companies. Some companies only use long-term contracts for procurement while others almost exclusively use spot market transactions for procurement (Bundeskartellamt, 2021).

3 Data and Descriptive Evidence

In this section, we turn to the empirical analysis. We begin by describing our data set and then present descriptive evidence on the pass-through of German refineries.

3.1 Data

Our dataset contains prices for all three market levels, as described in the section before. We have data on prices for the crude oil market as well as the wholesale and retail market for refined products.

First, like Bundeskartellamt (2022) we use the daily "ICE Brent 1-minute month" indicator from Argus Media. This quote from the "London Intercontinental Exchange" represents the daily settlement price at 16:30 London Time for future contracts with delivery in the month after next. This price quota is highly relevant, as trading volumes are high and it is not limited to a regional market, like a spot price.

As described in the previous section, the wholesale market for refined products in Germany is an open spot market. Unfortunately no data from a commodity exchange is publicly

---

[6]See: https://www.argusmedia.com/-/media/Files/methodology/argus-omr-fuels.ashx

available. Hence, we use data from the price information service Argus Media. Argus publishes daily data for eleven price regions within Germany for e5, e10 and diesel fuels. In contrast to the crude oil data, this data includes the highest, lowest, mean and volume adjusted mean price for each day. Argus Media also reports quantity data for each of the eleven regions. They report the quantity of all transactions received as an interval, broken down by each of the eleven regions. Furthermore, we also use ARA spot market prices for gasoline and diesel from "Refinitiv Datastream" as a comparison to German wholesale prices. Refinitic Datastream also reports capacities from all German refineries, which includes the technical capacity of the refinery, as well as the capacity that is online and in use.

Lastly, we use retail prices from the German market transparency unit for fuels. Since 2014 gasoline stations in Germany are obliged by law to report every price change to the market transparency unit within five minutes. The unit, therefore, provides real-time access to virtually all price changes at retail gasoline stations. We obtain historic data from the price comparison website `www.tankerkoenig.de`, which provides all historic prices from the market transparency unit for fuels. Furthermore, they include characteristics of gasoline stations in Germany including name, brand, address, geographic coordinates, and opening times of the station. Our analysis includes a large data set, starting on the 1 January 2015 and ends on the 31 December 2023. Within this time frame, we investigate three exogenous discontinuities, namely the beginning of the Russian invasion of Ukraine on 24 February 2022 and the actual start of sanctions on Diesel and Gasoline on the 5 February 2023. Additionally, the so-called "fuel rebate" ("Tankrabatt") also falls within this time frame. In reaction to continuously high gasoline retail prices, Germany, among other countries in Europe, introduced a temporary energy tax reduction for gasoline and diesel. For gasoline (diesel), the energy tax rate is reduced by 29,55 (14,04) cents/liter (c/L) from 65,45 (47,04) c/L to 35,9 (33) c/L. This discontinuity began on 1 June 2022 and was limited until the 31 of August.

Both discontinuities within our data are both an input price shock for Diesel and Gasoline and a supply shock for Diesel as Russia was not only responsible for 13% of the global crude oil production, but also the fourth largest Diesel producer in the world. Therefore, crude oil and Diesel prices increased, substantially.

Using data on gasoline station characteristics, which includes geographic coordinates, we match each gasoline station in Germany with one of the eleven regions of the Argus wholesale data. In a next step we construct daily retail price averages for each of the eleven regions. In order to compare German wholesale prices with prices from Amsterdam, Rotterdam, Antwerp (ARA), we deduct all taxes and fees from German retail and wholesale prices. From retail gasoline (diesel) prices we deduct 19% value-added tax, and all taxes and fees we deduct from wholesale gasoline (diesel) prices. This is namely 65,45 (47,04) c/L in energy taxes, 7 (8) c/L in carbon taxes in 2021 and 8,4
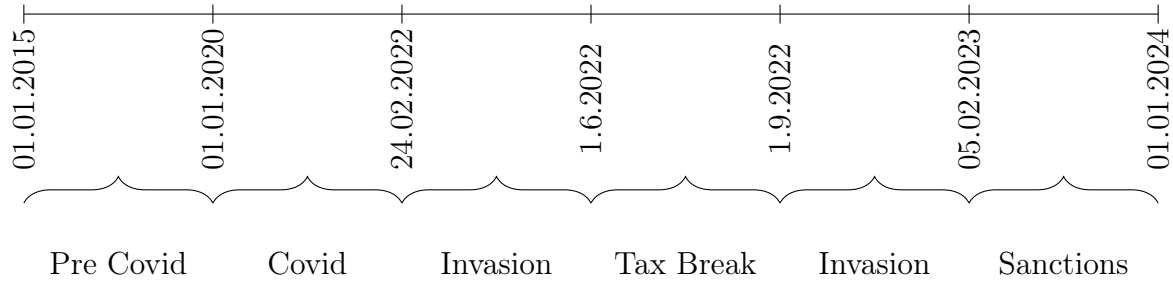
Figure 1: Timeline of events

(9,4) c/L in 2022, and 2.7 (3) c/L in fees for the "Erdölbevorratungsverband" (EBV). Furthermore, we calculate one daily average retail and wholesale price for the whole of Germany to be able to compare the general price development within Germany over time.

Descriptive Evidence

Before estimating the refinery pass-through, this section studies the refinery margins over time and between different markets.

First, figure 1 shows a time line of all events and our respective naming of time intervals. Figure 2 shows the development of absolute crude oil, wholesale and retail gasoline (diesel) prices, as well as the discontinuities described before. The black dotted lines mark the Russian invasion of Ukraine and the ban on Russian Diesel and Gasoline imports into Europe. The Grey lines mark the beginning and the end of the temporary reduction in energy taxes in Germany.

From 2015 to 2020 gasoline, diesel and crude oil prices have been relatively stable. However, all prices have been quite low at the beginning of the COVID-pandemic and recovered during 2021. After 24 February 2022 a remarkable spike in prices becomes evident. This spike is significantly more pronounced for wholesale and retail prices than it is for crude oil prices. Also, the increase in diesel prices is more pronounced than the increase in gasoline prices. Over the course of the year 2022 and 2023, crude oil prices returned to pre-war levels, while, the spread between crude oil prices and wholesale prices does not fully close. Notably, the spread between gasoline and crude oil decreases first, still in 2022, but stays above pre-war levels. The spread between Diesel and crude oil decreases in the first half of 2023, but also stays above pre-war levels.

During the whole time frame the retail margin, the spread between retail and wholesale prices, stays remarkably constant. The spread between wholesale and crude oil prices, however, increases significantly after the Invasion. It nearly doubles during 2022 and stayed significantly above pre-war levels during 2023 and 2024. These results are confirmed by figure 6 in the Appendix. It can easily be seen that the station margins are nearly

constant, while refinery margins increased dramatically after the invasion. Also the within 2022 and 2023 the margins stay above pre-war levels.

Figure 7 shows the difference between the average wholesale gasoline (diesel) price in Germany and the ARA spot market price. Generally, the difference between prices is larger for diesel than it is for gasoline prices. This seems to be true for the whole time series, thus even before the invasion began. Generally, the price difference between German and ARA wholesale prices is rather stable over the time period before the invasion. As the price volatility after the Russian invasion increases, no clear effect on the spread between ARA and German wholesale prices can be distinguished. It can, however be seen that the spread increases during the time of the temporary tax reduction and that the spread is larger in 2023 and 2024.

Figure 3 first shows volume data from Argus Media in m3 per day. This is the quantity that Argus Media collected during one specific day. It has to be noted, that long-term changes in the Argus quantity data might originate from changes within their network of companies that report prices to Argus. In the short term it seems that Diesel quantities are very volatile and seasonal. Looking at our three discontinuities it can be seen that shortly before the Russian invasion to Ukraine demand decreased, which might be due to seasonal effects. However, after the invasion demand increased, probably because businesses stocked up on Diesel. A significant increase in demand can also be seen during the time of the tax break. Demand than decreased before the import ban on Russian Diesel and increased after the ban came into place, for reasons unknown. When looking at changes in the demand for Gasoline, it can be seen that reported quantities are generally on a much lower level and much less volatile. However, effects during the tax break can be seen.

Figure 3 also shows the technical and actual online capacity of refineries in Germany for every given day. The difference between both numbers is that refineries often do not work at full capacity due to maintenance and repairs. After a phase of high production in German refineries, lots of capacity was reduced during the Covid pandemic, because demand was a lot lower. After the invasion, this disinvestment stopped, as prices were higher. With the beginning of the sanctions, it can be seen that refineries invested into capacity, therefore the capacity online went down, but when it went up again, total capacity was higher.

Table 3 shows generally that prices on all three vertical levels increased significantly after the Russian invasion of Ukraine. While crude oil prices only increased by 25 c/L, wholesale prices for gasoline (diesel) in Germany increased by 36 (55) c/L. In the ARA region wholesale Gasoline (Diesel prices increased by 31 (46) c/L. Subsequently, the refinery margin also increased significantly by about 10 (30) c/L. This suggests that
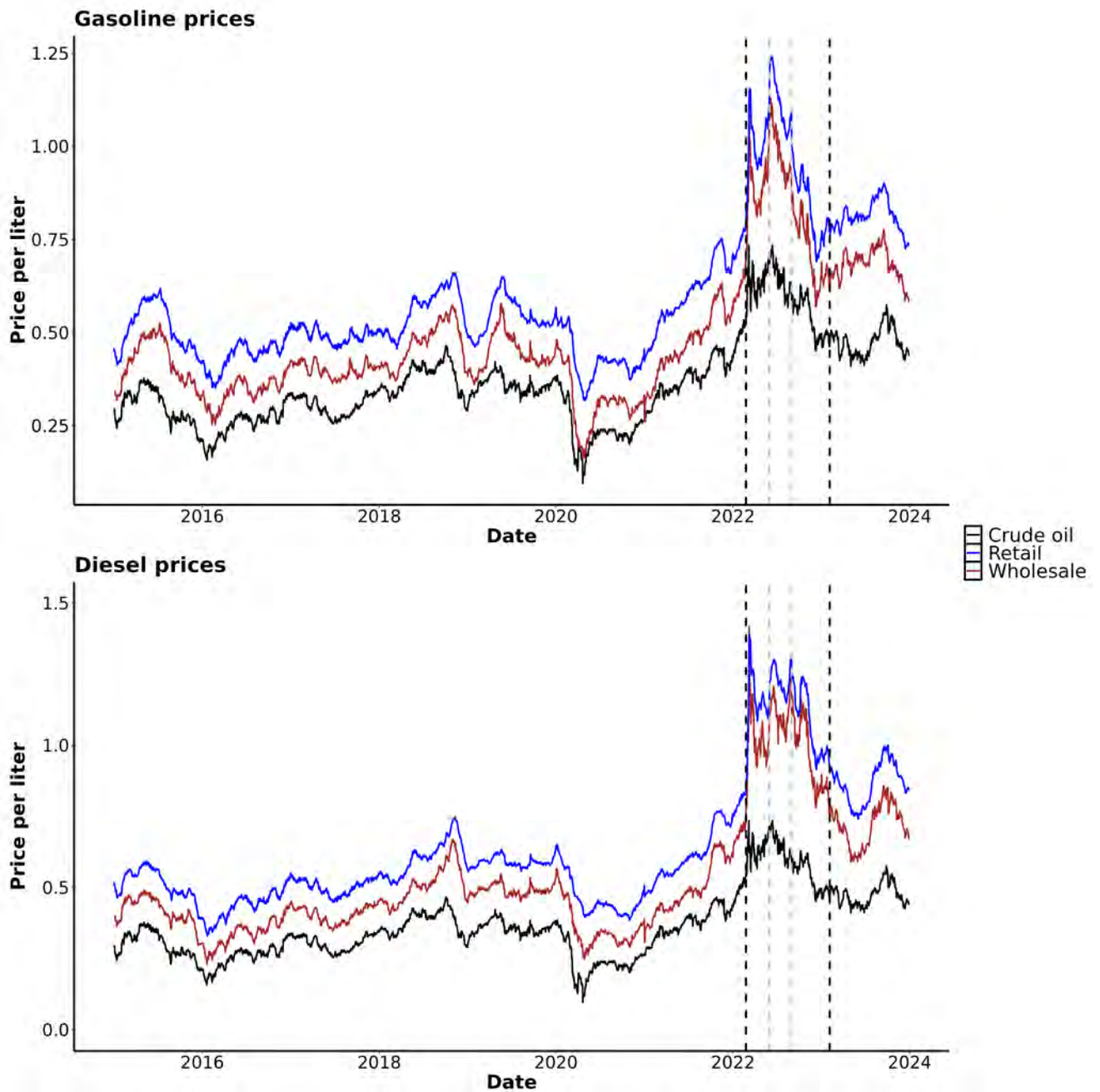
Figure 2: Crude oil, diesel and gasoline prices on the wholesale and retail market

refineries were able to pass-through more than 100% of the crude oil price increase and increase their profits. Refinery margins were even higher in the time of the tax break in Summer 2023. After the import ban against Russian Gasoline and Diesel margins decreased, but are still significantly above pre-war levels. In contrast, when refineries would sell their Diesel and Gasoline in the ARA regions, margins would be significantly lower.

Table 3 also shows that prices during the temporary tax reduction are higher than after. This is mainly because crude oil prices were higher during the temporary tax reduction than after. The ARA spot market prices for gasoline and diesel confirm this. It is,
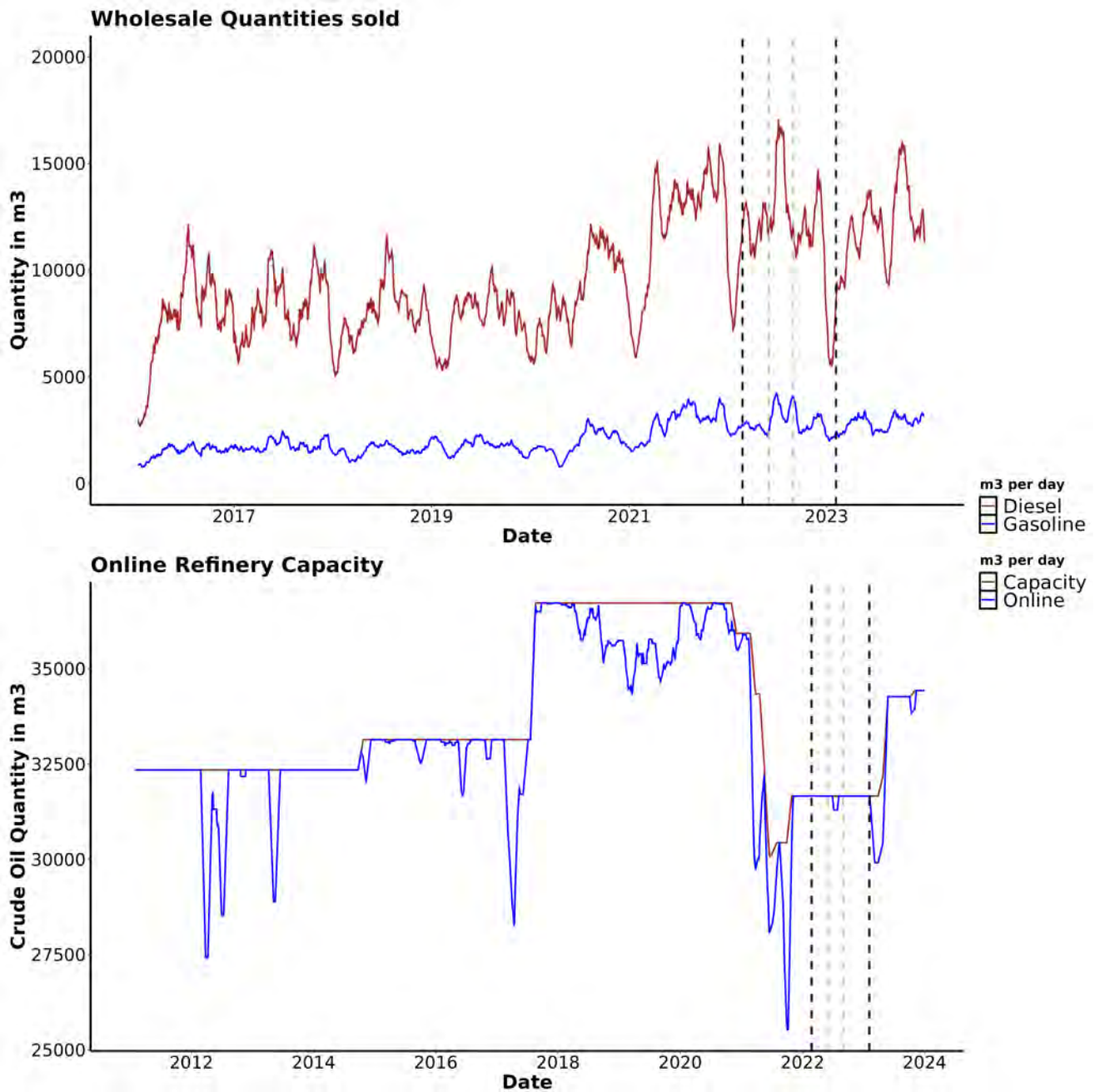
Figure 3: Quantities of Diesel and Gasoline sold according to Argus Media and Refinery Capacity

however, remarkable that refinery margins are still higher during the temporary tax reduction than after. This suggests that refineries might not have passed through the whole tax reduction to consumers. Stations again only passed through the temporary reduction in wholesale prices and their margins did not change.

Over the whole time frame, margins of gasoline stations are surprisingly stable. The margins of gasoline stations do not change after the Russian invasion of Ukraine or during the temporary tax reduction and also not after the import ban against Russian Diesel and Gasoline. Therefore, stations only passed through the increase in wholesale prices as

their margins remained stable.

Our volume indicators are harder to interpret, we assume that the increase in Volume sold between COVID and PreCovid is based upon the fact that Argus has more companies reporting prices and quantities over time, so more of the market is shown in this data. Remarkably the demand for Diesel and Gasoline increased significantly during the tax break, probably due to the fact that companies stocked up. This might also be the reason why the time frame "Invasion" shows no increase in demand. Figure 1 shows that the invasion time frame goes from the Invasion until the sanctions and leaves out the time frame of the tax break. When companies stocked up on refined product, they bought less after the tax break, lowering the mean of "Invasion". The volume sold stays also stable after the import ban came into effect.

Refinery capacity is largely stable over time, it decreases after the COVID pandemic, when demand decreased and therefore refineries planned to lower capacity on a longer term basis. Therefore, capacity is lower after the Invasion and during the tax break. After sanctions came into place, capacity increased again. Probably refineries planned to increase capacity when prices were high after the invasion.

4   Empirical Strategy and Results

The previous section presented evidence of significant changes in refinery margins after the Russian invasion that had a long lasting effect. We showed that refinery margins even increased during the temporary tax break. Since then margins decreased, but are still above pre-war level. Especially when compared to the ARA region. We also showed that station margins are largely unaffected by any exogenous shock.

Empirical Strategy

In this section, we employ a difference in differences approach to infer the causal effect of the Russian invasion of Ukraine, the temporary tax reduction and the ban on Russian Diesel and Gasoline imports on wholesale prices:

$$P_{it} = \beta_0 + \beta_1 Germany_i + \beta_2 Shock_t + \beta_3 DID_{it} + \beta_4 X_{it} + \varepsilon_{it} \tag{1}$$

In our model we regress the wholesale Diesel and Gasoline price on a constant β_0, an identifier between the German mean and ARA price $Germany_i$, an identifier for our three Shocks $Shock_t$ the interaction between both identifiers DID_{it}, a vector of control variables X_{it} and an error term ε_{it}. The control variables include the daily price for a liter of Brent Crude oil, the refinery capacity that is online at any given day

Results

Table 4 confirms the descriptive results from above. Wholesale prices increase significantly after the Russian invasion of Ukraine. Diesel (Gasoline) prices increase by about 7 (0.5) c/L after controlling for Crude oil prices. Diesel (Gasoline) wholesale prices are always about 6 (4) ct/L more expensive in Germany, than they are in the ARA region. The DiD parameter, however, shows us that the wholesale price for Diesel (Gasoline) in Germany is about 6 (4) c/L more expensive after the Invasion compared to before, compared to the ARA region. These effects are not only very stable over different estimations, but also highly significant and economically relevant.[7] As expected wholesale prices increase significantly with Crude Oil prices. All other control variables do not have any effect.

The results shown in table 5 are not as clear as in the table 4. This was to be expected, as the ban on Russian Diesel and Gasoline imports was pronounced long before. Compared to the ARA region, Diesel (Gasoline) wholesale prices in Germany are about 1 (3) c/L more expensive after the ban was effective. However, this effect is unfortunately not stable over different regressions. Also the effect of the Sanctions parameter itself changes the sign. Control variables are as above.

Lastly, table 6 shows the effect of the temporary tax reduction. Unsurprisingly wholesale prices for Diesel (Gasoline) are 13-14 (11-15) c/L more expensive during the tax break. This effect is not only statistically significant and largely stable over different estimations, but it also increases, when comparing to the ARA price region. This suggests that global Diesel and Gasoline prices were decreasing during the temporary tax break in Germany, but wholesale prices in Germany were not decreasing. This increases margins of German refineries even further.

5   Conclusion

In conclusion, this paper investigates the pass-through of three exogenous cost shocks, namely the Russian Invasion of Ukraine, a temporary tax reduction in Germany and the ban of Russian Diesel and Gasoline imports into Europe, on the whole vertical chain of Diesel and Gasoline production. First, we show that retail gasoline station margins stay constant and margins are more volatile on the refinery level. Second, we find evidence that refinery margins nearly tripled after the Invasion. This also has a long lasting effect. Since 2022, refinery margins did not return to pre-invasion levels. This effect is only reinforced by the temporary tax break, which is in contrast to most of the literature. Compared to that, the actual ban on Russian Diesel and Gasoline imports did not have a strong price effect.

---

[7]Note that we measure in prices per Liter. A 100 Liter Diesel (Gasoline) purchase is 6 € (4 €) more expensive.

Furthermore, we have access to quantity data and observe that demand stays rather constant in the long-term. On exception of this is the tax break in summer 2022, that significantly increases demand for Diesel and Gasoline.

References

Ahmed, Atil, Amine Lahiani, and Duc Khuong Nguyen, "Asymmetric and Nonlinear Pass-Through of Crude Oil Prices to Gasoline and Natural Gas Prices," 2015.

Arbeitsgemeinschaft Energieverbrauch e.V., "Energieverbrauch in Deutschland im Jahr 2021," 2022.

Bachmann, Rüdiger, Benjamin Born, Olga Goldfayn-Frank, Georgi Kocharkov, Ralph Luetticke, and Michael Weber, "A Temporary VAT Cut as Unconventional Fiscal Policy," 2021, *No. 21-23.*

Bacon, Robert W., "Rockets and feathers: the asymmetric speed of adjustment of UK retail gasoline prices to cost changes," *Energy Economics*, 1991, *13* (3), 211–218.

Borenstein, Severin, Adrian Colin Cameron, and Richard J. Gilbert, "Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes?," 1992, *4138.*

Bundeskartellamt, "Sektoruntersuchungh Kraftstoffe - Abschlussbericht Mai 2011," 2009.

_ , "Markttransparenzstelle für Kraftstoffe-Jahresbericht 2021," 2021.

_ , "Ad-hoc Sektoruntersuchung: Raffinerien und Kraftstoffgroßhandel (Zwischenbericht)," 2022.

Clemens, Marius and Werner Röger, "Temporary VAT Reduction During the Lockdown," 2022, *1944.*

Dovern, Jonas, Johannes Frank, Alexander Glas, Lena Müller, and Daniel Perico, "Estimating Pass-Through Rates for the 2022 Tax Reduction on Fuel Prices in Germany," 2022, *no. 9963 (2022).*

Drolsbach, Chiara, Maximilian Maurice Gail, and Phil-Adrian Klotz, "Pass-Through of Temporary Fuel Tax Reductions: Evidence from Europe," 2022, *no. 2022, 39.*

Farkas, Richárd and Biliana Yontcheva, "Price transmission in the presence of a vertically integrated dominant firm: Evidence from the gasoline market," *Energy Policy*, 2019, *126*, 223–237.

Freitas, Dimitra and Simon Syga, "35 Cent weniger für Benzin und 17 Cent weniger für Diesel: Der Tankrabatt ist angekommen," *Ifo Dresden berichtet*, 2022, pp. 13–18.

Gautier, Erwan and Ronan Le Saout, "The Dynamics of Gasoline Prices: Evidence from Daily French Micro Data," *Journal of Money, Credit and Banking*, 2015.

Lewis, Matthew S, "Temporary wholesale gasoline price spikes have long-lasting retail effects: The aftermath of Hurricane Rita," *The Journal of Law and Economics*, 2009, *52* (3), 581–605.

Li, Jing and James H. Stock, "Cost Pass-Through to Higher Ethanol Blends at the Pump: Evidence from Minnesota Gas Station Data," *Journal of Environmental Economics and Management*, 2019, pp. 1–19.

Loecker, Jan De, Jan Eeckhout, and Gabriel Unger, "The Rise of Market Power and the Macroeconomic Implications*," *The Quarterly Journal of Economics*, 01 2020, *135* (2), 561–644.

Montag, Felix, Alina Sagimuldina, and Monika Schnitzer, "Are Temporary Value-Added Tax Reductions Passed on to Consumers? Evidence from Germany's Stimulus," 2020, *DP15189*.

Verlinda, Jeremy A, "Do rockets rise faster and feathers fall slower in an atmosphere of local market power? Evidence from the retail gasoline market," *The Journal of Industrial Economics*, 2008, *56* (3), 581–612.

A   Appendix
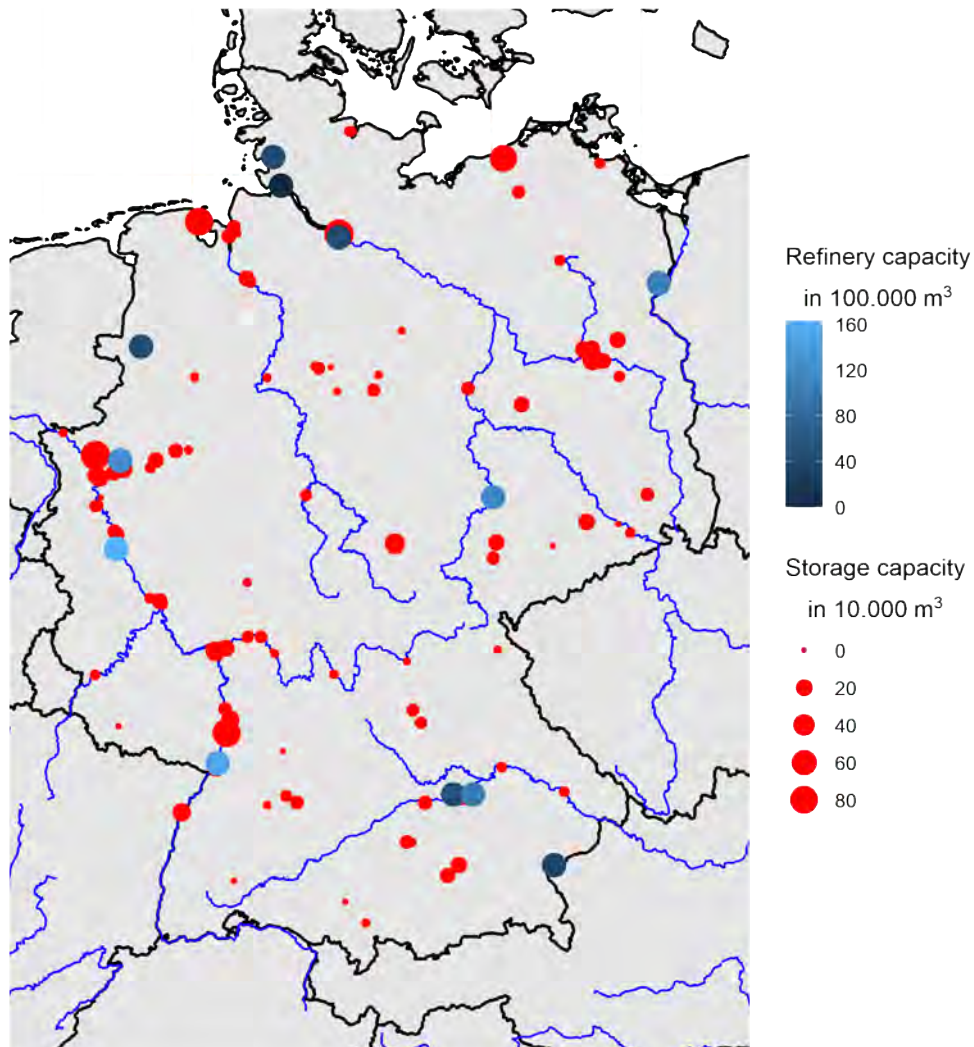
Figure 4: Map of refineries and storages throughout Germany
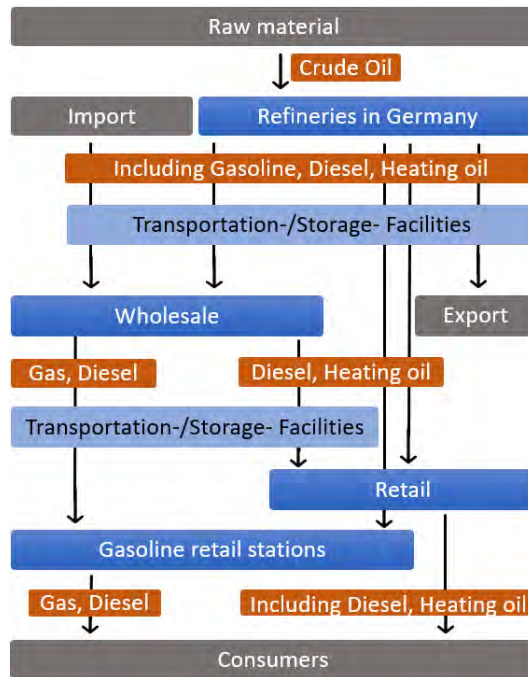
Figure 5: Vertical structure of the market for fuel, figure according to Bundeskartellamt (2022)

Company	Level of vertical integration	Refineries
BP	Fully integrated	Gelsenkirchen Lingen
Shell	Fully integrated	Rheinland MiRO (partially) PCK (partially)
Total Energies	Fully integrated	Leuna
ENI	Fully integrated	Bayernoil (partially) PCK (partially)
Rosneft	From exploration to refinery	PCK (partially) MiRO (partially) Bayernoil (partially)
OMV	From exploration to refinery	Burghausen
Esso	From exploration to refinery	MiRO (partially)
Philipps66	Refinery and gasoline stations	MiRO (partially)
Oilinvest Group	Refinery and gasoline stations	Holborn Europa
Varo Energy	Only Refineries	Bayernoil (partially)
Gunvor	Only Refineries	Ingolstadt
Klesch	Only Refineries	Heide

Table 2: Companies active in German fuel production, table according to Bundeskartellamt (2022)

Figure 6: Diesel and Gasoline station and refinery margins

Figure 7: Wholesale prices for Diesel and Gasoline in Germany and the ARA region

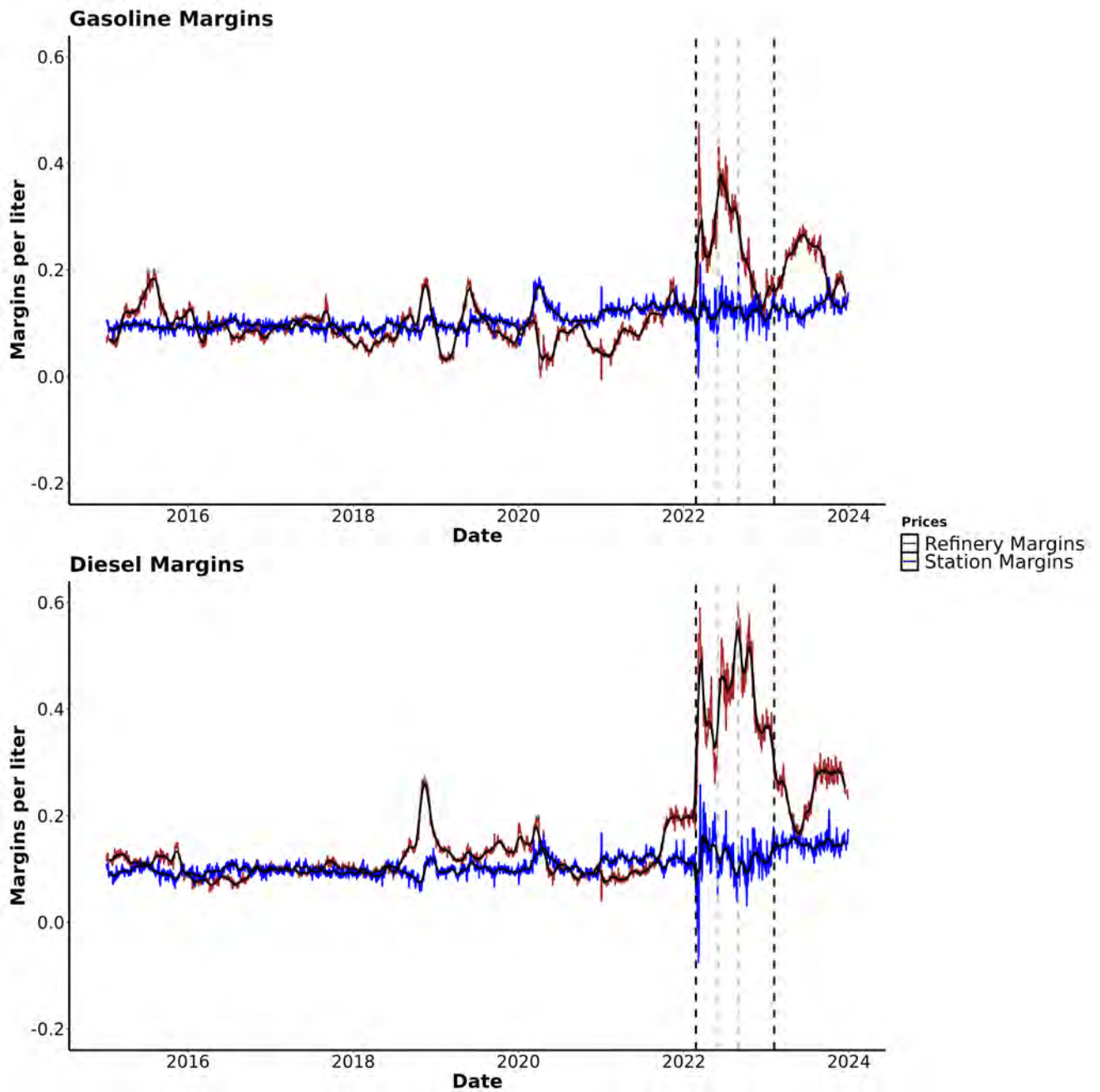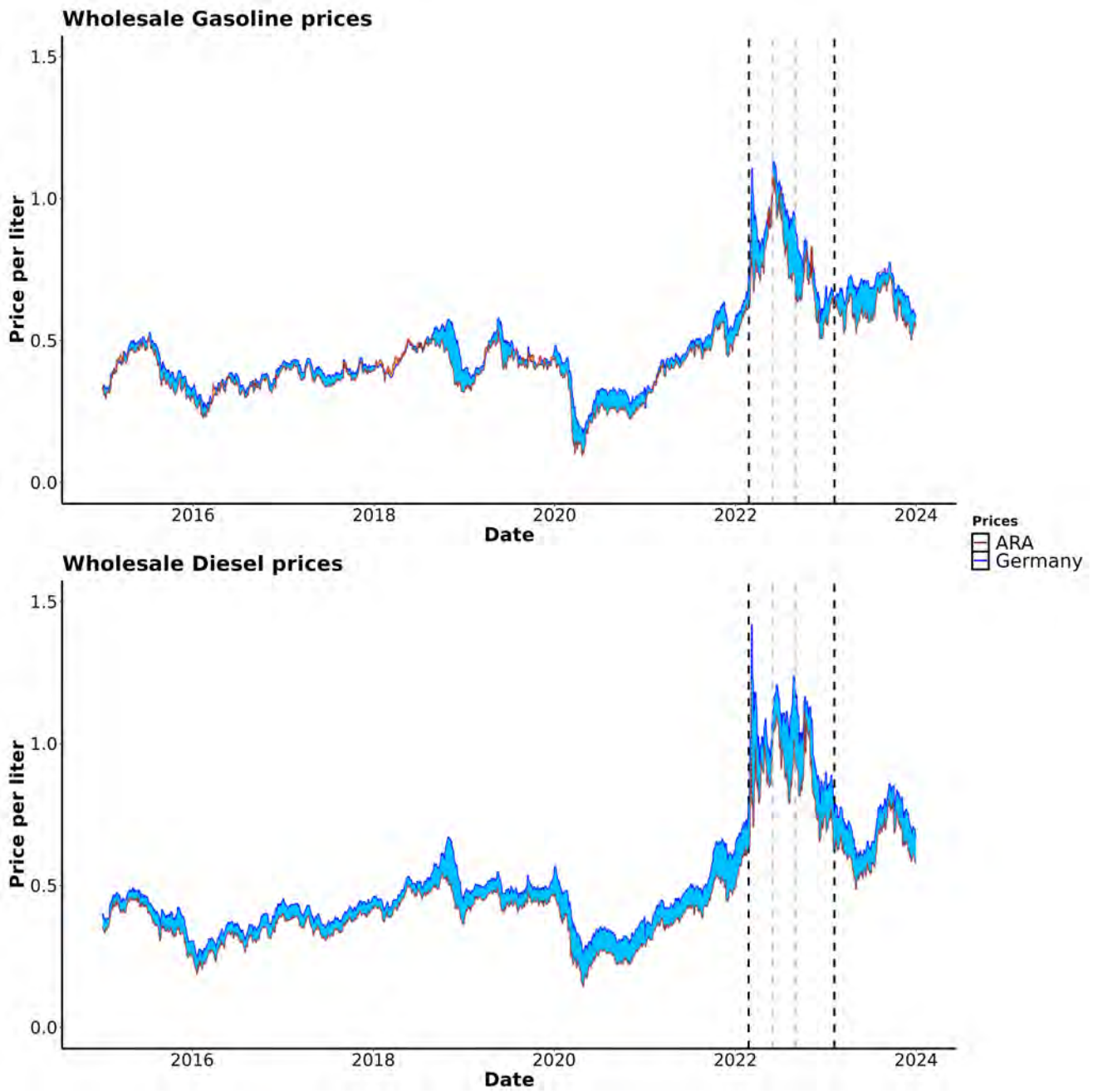|	Pre Covid	Covid	Invasion	Tax rebate	Post Sanctions
Observations	1822	785	254	92	330
Crude Oil	0.32	0.32	0.57	0.65	0.47
	(0.06)	(0.10)	(0.07)	(0.04)	(0.04)
A. Wholesale Prices					
Gasoline	0.42	0.41	0.78	0.99	0.68
	(0.06)	(0.12)	(0.12)	(0.07)	(0.04)
Diesel	0.43	0.44	0.98	1.12	0.72
	(0.08)	(0.12)	(0.12)	(0.06)	(0.07)
Gasoline (ARA)	0.40	0.37	0.71	0.88	0.61
	(0.06)	(0.13)	(0.12)	(0.13)	(0.05)
Diesel (ARA)	0.39	0.36	0.85	0.97	0.64
	(0.07)	(0.11)	(0.12)	(0.09)	(0.08)
B. Retail Prices					
Gasoline	0.51	0.53	0.90	1.12	0.81
	(0.06)	(0.12)	(0.12)	(0.07)	(0.04)
Diesel	0.53	0.55	1.10	1.23	0.87
	(0.08)	(0.12)	(0.12)	(0.05)	(0.07)
C. Refinery Margins					
Gasoline	0.10	0.09	0.21	0.34	0.21
	(0.03)	(0.03)	(0.06)	(0.04)	(0.04)
Diesel	0.11	0.12	0.41	0.47	0.24
	(0.03)	(0.04)	(0.09)	(0.06)	(0.04)
Gasoline (ARA)	0.08	0.05	0.13	0.23	0.14
	(0.03)	(0.03)	(0.06)	(0.09)	(0.04)
Diesel (ARA)	0.07	0.04	0.28	0.32	0.17
	(0.02)	(0.03)	(0.08)	(0.06)	(0.05)
D. Station Margins					
Gasoline	0.10	0.12	0.12	0.13	0.13
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Diesel	0.10	0.11	0.12	0.11	0.15
	(0.01)	(0.02)	(0.04)	(0.03)	(0.01)
E. Cost of Freight					
Gasoline	143.67	111.87	242.40	358.56	192.65
	(98.85)	(42.45)	(96.26)	(204.33)	(42.88)
Diesel	159.52	118.43	266.49	398.24	210.06
	(112.04)	(48.14)	(109.18)	(231.76)	(48.64)
F. Volume sold in Germany					
Gasoline	1642.49	2411.21	2539.96	3746.20	2871.49
	(731.77)	(1079.67)	(801.14)	(1125.97)	(900.28)
Diesel	7874.81	10681.27	10942.72	14143.48	12106.86
	(3897.90)	(4225.34)	(4172.33)	(4688.09)	(3408.20)
G. Refinery Quantities					
Capacity	34897.66	34241.80	31660.73	31660.73	33709.16
	(1791.97)	(2614.82)	(0.00)	(0.00)	(1079.33)
Online	34263.40	33336.40	31660.73	31541.83	33252.43
	(1876.47)	(3382.95)	(0.00)	(387.37)	(1796.76)

Net prices in EUR per liter, Quantities in m3 per day, standard deviation in parenthesis

Table 3: Summary statistics

	Wholesale Diesel Prices			Wholesale Gasoline Prices		
Invasion	0.419***	0.072***	0.073***	0.251***	0.005**	0.005**
	(0.011)	(0.004)	(0.003)	(0.006)	(0.002)	(0.002)
Germany	0.061***	0.061***	0.061***	0.030***	0.030***	0.030***
	(0.004)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)
DID	0.066***	0.066***	0.066***	0.041***	0.041***	0.041***
	(0.015)	(0.005)	(0.004)	(0.009)	(0.003)	(0.003)
Brent Price		1.567***	1.475***		1.324***	1.316***
		(0.007)	(0.007)		(0.006)	(0.007)
Volume		−0.00000	0.00000***		0.00001***	0.00000***
		(0.00000)	(0.00000)		(0.00000)	(0.00000)
Online			0.00000***			−0.00000***
			(0.00000)			(0.00000)
Freight			0.0002***			0.00000
			(0.00001)			(0.00001)
Constant	0.435***	−0.115***	−0.168***	0.405***	−0.050***	0.003
	(0.003)	(0.003)	(0.010)	(0.003)	(0.002)	(0.009)
N	5,844	5,840	5,840	5,844	5,840	5,840
R^2	0.394	0.943	0.952	0.417	0.942	0.942
Adjusted R^2	0.393	0.942	0.952	0.416	0.942	0.942
Residual Std. Error	0.164	0.051	0.046	0.131	0.041	0.041
	(df = 5840)	(df = 5834)	(df = 5832)	(df = 5840)	(df = 5834)	(df = 5832)
F Statistic	1,263.406***	19,128.500***	16,628.850***	1,390.557***	18,953.830***	13,622.660***
	(df = 3; 5840)	(df = 5; 5834)	(df = 7; 5832)	(df = 3; 5840)	(df = 5; 5834)	(df = 7; 5832)

*p < .1; **p < .05; ***p < .01

Table 4: DiD of Wholesale Diesel and Gasoline Prices before and after Russian invasion compared to ARA prices

	Wholesale Diesel Prices			Wholesale Gasoline Prices		
Sanctions	0.230***	0.020***	−0.029	0.218***	0.047***	−0.070***
	(0.007)	(0.003)	(0.022)	(0.006)	(0.003)	(0.018)
Germany	0.023***	0.055***	0.053***	0.009***	0.035***	0.031***
	(0.004)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
DID	0.520***	0.139***	0.141***	0.346***	0.034***	0.031***
	(0.011)	(0.005)	(0.005)	(0.009)	(0.004)	(0.004)
Brent Price		1.609***	1.484***		1.299***	1.281***
		(0.009)	(0.010)		(0.008)	(0.009)
Volume		−0.007***	−0.001		0.026***	0.012
		(0.002)	(0.002)		(0.008)	(0.008)
Online			−0.00000***			−0.00000***
			(0.00000)			(0.00000)
Freight			0.0002***			0.202***
			(0.00001)			(0.077)
Constant	0.438***	−0.123***	−0.074***	0.427***	−0.038***	0.096***
	(0.003)	(0.003)	(0.012)	(0.002)	(0.003)	(0.010)
N	6,566	3,742	3,304	6,566	3,202	2,830
R^2	0.355	0.939	0.946	0.308	0.937	0.940
Adjusted R^2	0.354	0.939	0.946	0.308	0.937	0.939
Residual Std. Error	0.163	0.051	0.048	0.137	0.041	0.039
	(df = 6562)	(df = 3736)	(df = 3296)	(df = 6562)	(df = 3196)	(df = 2822)
F Statistic	1,202.083***	11,553.170***	8,251.136***	973.510***	9,516.871***	6,263.959***
	(df = 3; 6562)	(df = 5; 3736)	(df = 7; 3296)	(df = 3; 6562)	(df = 5; 3196)	(df = 7; 2822)

*p < .1; **p < .05; ***p < .01

Table 5: DiD of Wholesale Diesel and Gasoline Prices before and after the ban of Russian imports compared to ARA prices

	Wholesale Diesel Prices			Wholesale Gasoline Prices		
Tax	0.585***	0.129***	0.139***	0.494***	0.114***	0.153***
	(0.011)	(0.005)	(0.005)	(0.010)	(0.005)	(0.004)
Germany	0.024***	0.053***	0.049***	0.010***	0.034***	0.028***
	(0.004)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)
DID	0.513***	0.158***	0.182***	0.338***	0.038***	0.069***
	(0.010)	(0.005)	(0.005)	(0.008)	(0.004)	(0.004)
Brent Price		1.532***	1.379***		1.275***	1.186***
		(0.009)	(0.009)		(0.008)	(0.008)
Volume		−0.009***	−0.006***		0.027***	−0.024***
		(0.002)	(0.002)		(0.007)	(0.007)
Online			−0.00000**			−0.00000***
			(0.00000)			(0.00000)
Freight			0.0002***			−0.203***
			(0.00001)			(0.064)
Constant	0.445***	−0.094***	−0.051***	0.435***	−0.027***	0.108***
	(0.003)	(0.003)	(0.010)	(0.002)	(0.003)	(0.008)
N	6,566	3,742	3,304	6,566	3,202	2,830
R^2	0.466	0.947	0.956	0.396	0.940	0.958
Adjusted R^2	0.466	0.947	0.956	0.396	0.940	0.958
Residual Std. Error	0.148	0.048	0.043	0.128	0.040	0.032
	(df = 6562)	(df = 3736)	(df = 3296)	(df = 6562)	(df = 3196)	(df = 2822)
F Statistic	1,911.421***	13,484.580***	10,291.810***	1,434.531***	10,065.220***	9,216.795***
	(df = 3; 6562)	(df = 5; 3736)	(df = 7; 3296)	(df = 3; 6562)	(df = 5; 3196)	(df = 7; 2822)

*p < .1; **p < .05; ***p < .01

Table 6: DiD of Wholesale Diesel and Gasoline Prices before and after the temporary tax reduction compared to ARA prices