Federal Reserve Bank of Dallas

The Impact of the 2022 Oil Embargo and Price Cap on Russian Oil Prices

Lutz Kilian, David Rapson and Burkhard Schipper

Working Paper 2401 **March 2024**

Research Department

https://doi.org/10.24149/wp2401

The Impact of the 2022 Oil Embargo and Price Cap on Russian Oil Prices*

Lutz Kilian†, David Rapson‡ and Burkhard Schipper§

March 20, 2024

Abstract

This paper documents the effect of the oil embargo and price cap on Russian oil exports in the wake of the Russian invasion of Ukraine in February 2022. We show that the embargo forced Russia to accept a $32/bbl discount on its Urals crude in March 2023 relative to January 2022, nearly half of which is directly attributable to the higher cost of shipping crude oil over longer distances, as Russia diverted much of its crude oil exports to India. Based on a calibrated model of global oil supply and demand, the remainder ($17/bbl) can be explained by increased Indian bargaining power. We also provide a similar analysis for the ESPO price discount on exports to China. In contrast, the price cap deprived Russia of the financial resources it spent on assembling a "shadow" fleet of tankers, but its effect on the Russian oil export price was negligible once the adoption of the price cap had facilitated the use of Western services to transport Russian oil to Asia.

Keywords: Russia, Oil, Sanctions, Embargo, Price cap

JEL Codes: F51, Q41, Q48

---

* We thank Kunal Patel for his expertise and extensive assistance with procuring some of the data, Dongkyu Kim for excellent research assistance, and Catherine Wolfram, Karl Dunkle Werner and Christopher Knittel for comments and insights. All opinions and errors are our own. The views expressed here are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Dallas or the Federal Reserve System.

† Lutz Kilian, Research Department, Federal Reserve Bank of Dallas, 2200 N Pearl Street, Dallas, TX 75201, and CEPR, (lkilian2019@gmail.com).

‡ David Rapson, UC Davis Economics Department, One Shields Ave, Davis, CA 95616 and Federal Reserve Bank of Dallas, 2200 N Pearl Street, Dallas, TX 75201, (dsrapson@ucdavis.edu).

§ Burkhard Schipper, UC Davis Economics Department, One Shields Ave, Davis, CA 95616 (bcschipper@ucdavis.edu).

1 Introduction

The Russian invasion of Ukraine in February 2022 prompted widespread voluntary restrictions on imports of Russian crude oil, which were replaced by a formal oil embargo in December 2022 and a cap on the fob price of Russian crude oil sold to countries not participating in the embargo.[1] The embargo, led by the U.S. and the European Union, dramatically reduced demand for Russian oil from traditional buyers, and caused global oil trade flows to be redirected. The main effects of the voluntary restrictions and formal embargo were twofold. First, by segmenting the market into buyers and non-buyers of Russian oil it increased the distance Russian oil was required to travel to reach the market and hence the transportation cost. This, in turn, created scarcity in the tanker market that raised the cost of shipping oil by sea for a given distance. Second, the embargo raised the bargaining power on India and China, the two remaining buyers large enough to absorb large quantities of Russian oil.

The price cap that was added by the G7 countries served both economic and political objectives. Importantly, it allowed the West to relax the ban on using Western shipping insurance and related financial services to transport Russian oil to third countries, which had been part of the EU's 6th sanctions package and was scheduled to go into effect in 2023. The fear was that this maritime services ban would cause a surge in global oil prices and a global recession. The price cap on Russian oil exports was a political concession made by the U.S. to European countries in order to ensure the flow of Russian oil to countries not participating in the embargo. It allowed countries not participating in the oil embargo to purchase Russian oil, but made it more difficult for those countries to import Russian crude valued above the price cap by restricting access to Western maritime services. Thus, the price cap was expected to undermine Russia's ability to finance its war through oil export earnings. While the initial price cap of $60 per barrel was intended to be adjusted periodically, as of early 2024, the cap has remained at $60, even as the global price of oil retreated from its high in mid-2022.

[1] The fob ("free on board") price of oil is what the seller receives per barrel sold. This excludes the cost of insuring and transporting the oil, which is borne by the buyer and, along with the cost of the oil itself, comprise the cif ("cost, insurance and freight") price.

A question of obvious policy interest is whether the embargo and/or the price cap reduced Russian oil export revenues or diverted Russian resources away from the war effort, and how this outcome was achieved. In this paper, we provide the first quantitative analysis of the economic channels through which these sanctions operate.[2] Our analysis distinguishes between the effects of the import restrictions and of the price cap. We document four key facts. First, the decline in Russian oil export revenues since January 2022 was achieved by reducing the Russian fob price of oil rather than the volume of Russian oil exports. Second, we estimate that roughly half of the Russian price discount arose from having to redirect Russian oil exports to more distant destinations. We find no evidence that the tanker insurance premium arising from the Ukraine war and the G7 price cap has been quantitatively important. Third, we calibrate a model of global oil supply and demand to demonstrate that the remainder of the Russian price discount can be explained by a modest increase in Indian and Chinese market power due to the segmentation of the oil market. Finally, while we acknowledge the important political role the price cap played in ensuring continued access to Western maritime services for Russian exports to Asia (which, in turn, had potentially important macroeconomic effects), we demonstrate that it had only a negligible effect on the Russian price discount. In particular, once the Russian fob price fell below the price cap in the first half of 2023, whether the price cap was enforced or not made no difference for the economic outcomes. Nor did the price cap prevent the average Russian fob price from rising above the price cap on the Pacific coast throughout, or from the Black Sea and Baltic Sea in the second half of 2023.

Our results are somewhat at odds with common perceptions about the efficacy of the price cap in reducing Russian oil revenues. The price cap policy was heralded by officials at the U.S. Department of the Treasury as "a new tool of economic statecraft" (Rosenberg and Van Nostrand (2023)) designed to achieve two goals: "First, to keep global energy markets well-supplied and avoid a price shock that would hurt the global economy... And second, to limit the Kremlin's ability to fund its illegal war in Ukraine" (Van Nostrand (2023)). We conclude that the first

[2] Babina et al. (2023) provide related evidence based on Russian customs data. However, their analysis can be difficult to reconcile with other data sources and ends in December 2022, before the oil embargo and price cap went into effect.

of these objectives was achieved by linking the price cap to the availability of maritime services for the transport of Russian oil to Asia. However, the effect on Russian resources available to wage war was limited to the funds the price cap caused Russia to spend on acquiring additional oil tankers.

Conditions under which the price cap would stabilize global oil prices while reducing Russian oil revenues are outlined in Johnson et al. (2024). These include the presence of an effective enforcement regime to ensure compliance by the Western tanker fleet, and the absence of a so-called "shadow fleet" of oil tankers that can operate at scale outside of the scope of the price cap. We present evidence that, to date, these conditions have not been met. We are not saying that the economic outcomes in 2023 would have been the same if the price cap had never been implemented. Our point is that the price cap effectively had served its purpose once the EU agreed to relax the maritime services ban, and did not materially contribute to the Russian fob price discount in 2023 in any other way.

This paper contributes to several strands of the literature. Our estimates of the effects of recent sanctions on Russian oil contribute to a growing literature on the economic costs of sanctions on countries initiating these sanctions (or "senders"), as in Besedeš et al. (2021), and on countries being targeted (see, e.g., Ahn and Ludema (2020) on "smart sanctions"). Our quantitative analysis of the price cap on Russian oil revenue builds on a recent theoretical work on how price caps can be used as a sanctions tool (e.g. Johnson et al. (2024)). Our conclusion that the price cap had little direct effect on the Russian fob price, but was important primarily because it persuaded the EU to abandon its general ban on maritime services for the transport of Russian oil, is consistent with the distinction between economic and political outcomes described in Felbermayr et al. (2021).[3] By documenting the importance of the transportation sector in resolving price differentials, we also complement Borenstein and Kellogg (2014), Kellogg and Sweeney (2023), Brancaccio et al. (2020) and others. Finally, we contribute to a literature quantifying the genesis and effects of supply and demand shocks in the global

[3]These and other studies in the sanctions literature are summarized in Morgan et al. (2023).

oil market (e.g., Kilian and Murphy (2014)).

The remainder of the paper is organized as follows. Section 2 documents how Russian crude oil exports and revenues have evolved since the invasion of Ukraine and shows that the evolution of Russian oil revenues has been driven by the fob price. Section 3 documents the evolution of the Russian fob price discount, and describes how this discount changed, as the oil embargo and oil price cap were imposed. In Section 4 we discuss how and to what extent rising transportation costs contributed to the Russian fob price discount. In Section 5, we present a calibrated model of global oil supply and demand that allows us to quantify each of the economic determinants of the price discount at which Russian oil trades in global markets. The model demonstrates that a modest degree of Chinese and Indian market power alone can explain the remainder of the Russian oil price discount. The concluding remarks are in Section 6.

2 Key Stylized Facts

Before we can build a model of the impact of the sanctions, it is necessary to understand the evolution of Russian oil trade and revenues since the invasion of Ukraine in early 2022. In this section, we provide a comprehensive assessment of the relevant facts, including an examination of the effects of the sanctions on Russian oil revenues. We also discuss the shadow fleet and the relationship between the oil prices that are relevant for our analysis.

January 2022 is a good starting point not only because it marks the point at which detailed monthly data for Russian oil exports and revenues become available, but also because at that point the risk of a Russian invasion still seemed low, so anticipatory effects of the invasion of Ukraine that took place in late February 2022 are not likely to be important.[4]

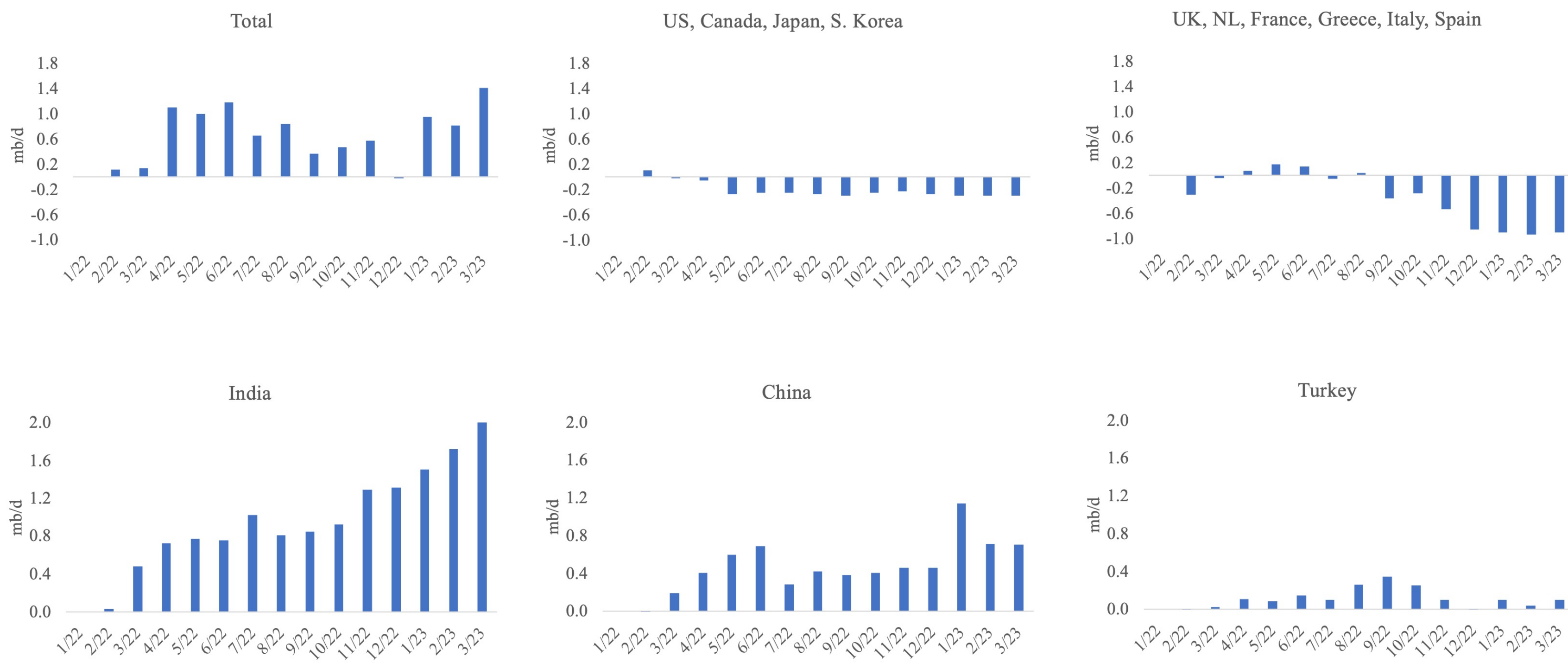
As of January 2022, Russian crude oil exports involved pipeline exports to China and to

[4]It was not that the Russian military build-up went unrecognized by Ukraine and the West, but that such build-ups were by no means unprecedented and could be interpreted as a bargaining tool designed to exert political pressure. In January, U.S. efforts still focused on de-escalation and deterrence. It was only in mid-February that the U.S. and other countries urged their citizens to leave Ukraine immediately, as the readiness of Russian forces increased.

Western Europe, as well as seaborne exports, mainly from ports in the Baltic Sea, the Black Sea and the Sea of Japan. In response to Russia's invasion of Ukraine in late February 2022, many countries curtailed their sea-borne imports of Russian crude oil. This happened well before the oil embargo and oil price cap were imposed in December 2022 (see Figure 1). As most European countries, the United States, Japan and South Korea reduced their seaborne imports from Russia, other countries including notably India, China and Turkey took advantage of the availability of Russian oil at discounted prices and substantially increased their seaborne imports of Russian crude.[5]

[5] In the case of China, these imports occurred on top of existing commitments to import Russian crude oil by pipeline. Because exports to Chinese by pipeline have not changed much, the increase in China's seaborne imports or Russian crude captures the change in overall Chinese imports.

Figure 1: Russian crude tanker exports relative to January 2022 by key destinations (mb/d)



Source: TankerTracker.com and authors' calculations. Data from January 2022 through March 2023 normalized relative to January 2022 level, the month before the Russian invasion of Ukraine. All data shown are revised data as of May 2023, so cargoes with unknown destinations are largely accounted for.

India became the primary destination for Russian seaborne crude exports with Indian imports from Russia nearly three times China's seaborne imports in March 2023. India's low-cost imports from Russia partially substituted for higher-cost crude imports from the Middle East, West Africa and the United States, but mainly constituted additional Indian demand. Indian imports in part reflected an arbitrage opportunity whereby discounted crude from Russia is processed by Indian refineries and re-exported as refined products to the rest of the world at global prices, and in part allowed India to satisfy growing domestic demand. This caused the volume of Russian seaborne crude oil exports to India to increase markedly from January 2022 to March 2023 – and to persist at that level later in 2023.[6]

2.1 The evolution of Russian crude oil exports since January 2022

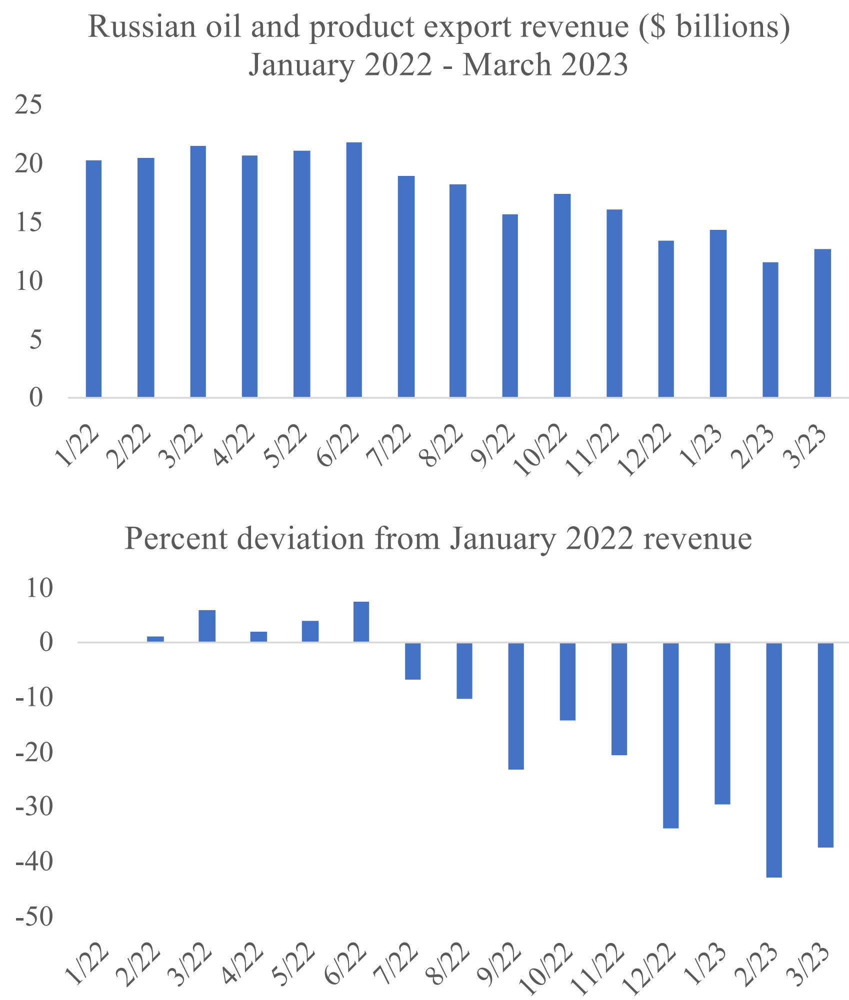
Russia not only successfully diverted its seaborne exports from Europe to Asia, but it also managed to offset the reduction in its pipeline oil exports to Europe, especially with the onset of the oil embargo. There is no question that the volume of Russian oil exports did not decline in the year following the invasion of Ukraine. In fact, according to our calculations, the overall volume of Russian crude exports increased within this time frame. Thus, the primary effect of the Russian invasion of Ukraine has been a redirection of oil trade flows rather than a reduction in oil trade.

2.2 The evolution of Russian crude oil revenues since January 2022

Policymakers have pointed to the fact that Russian oil and refined product export revenues in early 2023 were about 40% lower than before the invasion as evidence that the price cap is working (e.g., Rosenberg and Van Nostrand (2023)). Figure 2 shows that indeed the combined revenue from Russian crude oil and refined product exports by February 2023 had declined 43% below its January 2022 level, which is lower than in any previous month since the invasion started. It is important, however, to put this decline into context.

[6]The dip in Russian oil exports in December 2022 reflected unusually harsh weather at Russian ports in East Asia rather than the effect of sanctions.

Figure 2: Russian export revenue from crude oil and product exports since January 2022



Source: IEA OMR and authors' calculations

First, much of this price decline predated the imposition of the formal embargo and price cap. The incremental decline in Russian oil revenues in December 2022 was only 15% compared to November 2022, arguing against an important role for the sanctions. While the announcement of a possible price cap in June 2022 might have caused oil revenues to decline in anticipation of these sanctions, we will show in Section 3 that empirical evidence does not support this view.

Second, while the oil embargo only affects Russian crude oil exports, the price cap applies to Russian crude oil exports starting in early December 2022 and Russian exports of refined products starting in February 2023, with shipments already in transit exempted. Thus, it makes sense to analyze Russian crude oil exports separately from exports of refined products.

Third, some of the observed decline in Russian oil revenues may simply reflect the decline in global oil prices, as global demand weakened in the second half of 2022. Conversely, the surge in oil prices in the first half of 2022, which was already well underway before the invasion, clearly helped raise Russian oil revenues. This makes it harder to determine how effective the policy response to the invasion of Ukraine has been.

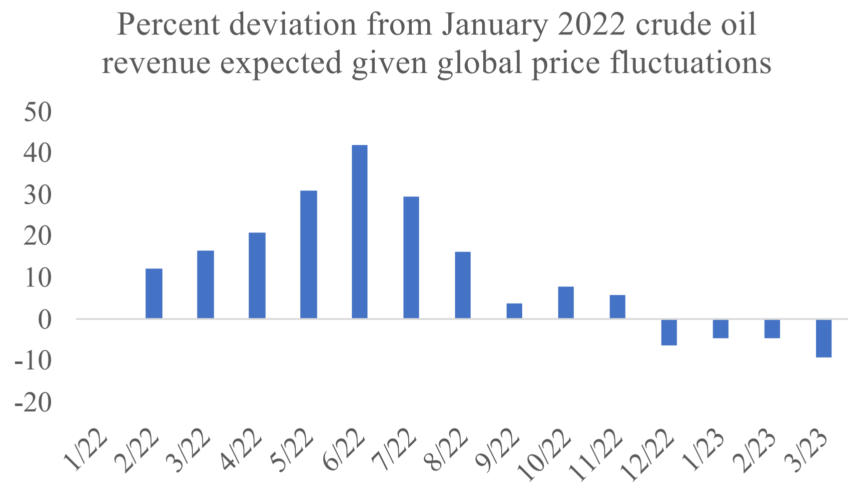
Figure 3 seeks to control for unrelated variation in the Russian export price of oil by constructing a counterfactual that holds constant the crude oil export volume at its January 2022 level, while extrapolating the Russian fob price of crude oil at the rate of growth of the spot price of Brent crude oil. The latter price is a widely used benchmark for the global price of crude. A strong case can be made that the evolution of the Brent price since mid-2022 mainly reflected fluctuations in global oil demand as well as oil supply decisions by oil producers other than Russia (see Section 3.1). To account for the temporary surge in the Brent price in March 2022, which was driven by the concern that Russia might withhold its oil from the global market, we remove this price spike from the Brent price series by linear interpolation. There is no indication that these concerns persisted beyond March.

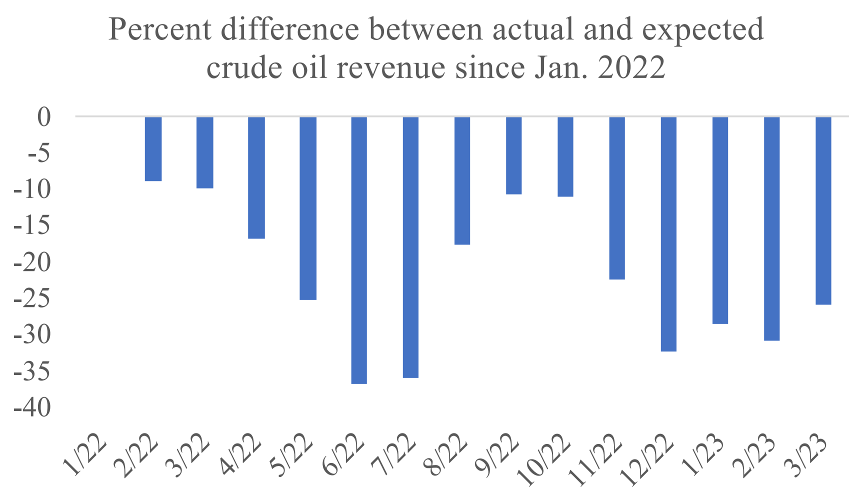
The upper panel of Figure 3 shows the evolution of Russian oil export revenues expected given the evolution of the global price of crude oil in the absence of the war. Allowing Russian exports to increase over time would not change this picture fundamentally.[7] The lower panel plots the difference between the actual Russian revenues from seaborne exports of crude oil in each month and the revenues expected even in the absence of any sanctions or voluntary import restrictions, given this path of the global price of oil.

Most importantly, from our point of view, Figure 3 illustrates that the effectiveness of the sanctions, as measured by oil revenues, reached its maximum already in June 2022 rather than

[7] In constructing this counterfactual, we ignore possible seasonality in Russian oil exports over the course of the year because this seasonality is difficult to estimate based on the available very limited monthly historical data for Russian seaborne oil exports.

Figure 3: Russian export revenue from crude oil since January 2022 controlling for global oil price fluctuations





Source: IEA OMR, Argus, Platts, Clipper, Bloomberg, Kpler and authors' calculations. We hold constant the volume of Russian oil exports in January 2022 and extrapolate the Russian fob price at the rate of growth of the Brent spot price, excluding the two price spikes in March 2022, which were caused by the Russian invasion.

in early 2023. The informal sanctions imposed right after the invasion of Ukraine were quite effective at reducing Russian revenues before being relaxed somewhat in the second half of 2022, perhaps in anticipation of a formal embargo. Voluntary import restrictions of selected countries alone created revenue shortfalls as large as 36% in mid-2022, compared to 32% in December 2023. Moreover, compared to November 2022, the average shortfall increased by only 7 percentage points on average after the formal oil embargo and price cap were imposed. This contrasts sharply with the 43% decline widely referred to by policymakers.

2.3 How Russian oil is priced

Global oil prices such as the Brent price of crude oil are only reference prices as opposed to transaction prices. The actual price paid for crude oil also depends on the type of crude oil and, most importantly, on the location where the oil is to be delivered. The price paid by the buyer differs from the price received by the oil producer, with the difference reflecting the costs of insurance and transportation in a competitive market. Russian oil export revenues depend on the fob price of Russian crude exports. The costs of shipping Russian oil to its final destination abroad are borne by the importer. The cif price paid by the importer exceeds the fob price by the costs of insuring the cargo and the freight costs of transporting the oil from the Russian export port to the importing sea port.

Abstracting from differences in the quality of the crude oil that may make crude oil more or less desirable from the point of view of a refiner, importers choose among alternative sources of crude oil based on the cif price at the import destination. Consider the example of a refinery in India that buys crude oil in global markets. If Russia wants to compete with other suppliers, it has to lower its fob price of oil to compensate the buyer for the additional insurance and transportation costs involved in delivering Russian oil from the Black Sea to India, for example, as opposed to crude oil from, say, the Persian Gulf. This means that having to redirect Russian crude oil exports from Europe to Asia raises the cost of transporting Russian crude oil and hence lowers the fob price that Russia can charge. Likewise, any insurance premia involved in moving Russian oil cargoes will lower the Russian fob price, increasing the wedge between the fob and cif price.

2.4 The evolution of the shadow fleet

Russia would not have been able to sustain its oil revenue without access to a variety of means of shipping its oil exports. The oil tanker fleet transporting Russian oil in 2023 consisted of oil tankers using Western maritime services subject to the price cap, tankers using these services fraudulently in violation of the price cap, and tankers not using Western maritime services at all. The latter are colloquially known as shadow tankers. Because these vessels are owned and insured in countries not implementing the price cap policy, they are not subject to sanctions. The Russian fob price is a weighted average of the prices of these shipments (including the fraudulent ones).

As discussed in Levi et al. (2023), there are hundreds of shadow tankers accounting for 37% of total Russian oil exports. There is little evidence, however, that these shadow tankers constitute a fleet coordinated by Moscow. The Russian state-owned shipping company Sovcomflot controls only 30% of the operating shadow tankers. Most of the remaining 70% is operated by tanker owners in other countries. Only one quarter of the tankers transporting Russian crude oil is owned and insured in countries that are not implementing oil sanctions against Russia.

To complicate matters, the continued reliance of many tankers in the shadow fleet on at least some Western maritime services has made them vulnerable to tightened U.S. sanctions, blurring the distinction between shadow tankers and tankers violating the price cap (see Kennedy (2023)). Throughout 2023, the enforcement of the price cap was sporadic at best. Since late 2023, there have been efforts to tighten the enforcement.

3 Assessing the Effects of the Price Cap

The price cap was conceived by the U.S. Department of the Treasury as a response to widespread concerns that sanctions on Russia could inadvertently damage the global economy by dramatically reducing Russian oil flows and thereby increasing global oil prices. The price cap works by setting a cap of $60 on the fob price of Russian crude exported on tankers relying on Western insurance and related financial services after December 2022. Russian crude valued above this price cap can only be shipped on tankers not relying on Western maritime services. The intent was to make tankers unavailable to Russia, forcing Russia to lower its fob price and curtailing its crude export earnings while maintaining the overall supply in the global market. To the extent that Russia would evade the price cap by building a shadow fleet, the expectation was that this investment would constrain Russia's ability to finance the war.

The price cap had a multitude of potential effects. Some of these were related to political objectives, such as preserving the flow of oil in global markets by relaxing the EU ban on maritime services. Others were related to economic objectives, such as constraining the fob price of Russian oil exports and curtailing Russia's ability to finance its war effort. In addition, even the announcement of a possible price cap in June 2022 was thought, by some, to affect market expectations and hence the price of oil. In this section, we assess the empirical support for each of these effects, one at a time.

3.1 Financial costs to Russia

One of the most visible economic effects of the price cap has been to prompt Russia (and other players in this market) to assemble a shadow fleet of oil tankers not subject to the price cap. With the benefit of hindsight, creating a shadow fleet would have been unnecessary in early 2023, when the average fob price was below the price cap, because Russia could simply have relied on tankers using Western insurance. Presumably, Russia did not anticipate this outcome and instead expected to be forced to rely on a shadow fleet. Under such expectations, it made sense for Russia to acquire as many oil tankers as possible before the demand for tankers surged and tankers became more difficult to find in the market. Moreover, building a fleet takes time. Expanding the shadow fleet became even more important when the Urals fob price started exceeding the price cap in mid-2023. Thus, the case can be made that the price cap (or the expectation that the price cap would be binding) forced Russia to spend billions of dollars on assembling a shadow fleet.

However, there are countervailing arguments. As noted by Kennedy (2023), the core of this fleet is made up of the roughly 80 tankers belonging to Russia 's main state-owned shipping company, Sovcomflot. Sovcomflot was sanctioned by the EU shortly after the invasion of Ukraine, causing it to lose access to Western maritime services well before the price cap was implemented. These tankers becoming part of the shadow fleet thus cannot be attributed to the price cap.

In addition, the focus on the price cap ignores that Russia would have had to maintain a fleet of oil tankers even in the absence of the price cap, as commercial oil shipping in the Black Sea was curtailed by the expanding war with Ukraine. These tankers were needed to maintain the flow of Russian exports from the Black Sea to the Mediterranean Sea, where it could be transferred to other tankers or continue to its final destination. How important this motive was compared to that of circumventing the price cap is an open question.

Even more importantly, the Russian shipping company Sovcomflot only controls about 30% of the operating shadow tankers. The rest are operated by owners in other countries, so much of the cost of assembling the shadow fleet was not borne by Russia. Finally, the increase in the role of shadow tankers has been mainly driven by more voyages from Russia, rather than an increase in the number of shadow tankers (see Levi et al. (2023)).

In short, to the extent that Russia invested in additional oil tankers in response to the price cap, this diverted resources from the war effort. However, this fact does not detract from our point below that the price cap contributed little to the decline in the Russian fob price, conditional on the Western maritime services ban having been relaxed. It is the latter effect that we turn to next.

3.2 Distinguishing political and economic effects

There was a set of potential sanction policies for governments to choose from, ranging from an EU oil embargo (A) and a ban on Western maritime services for transporting Russian oil (B) to a price cap on Russian oil exports to third parties (C). The EU s 6th sanctions package, which was passed on June 3, 2022, included both the oil embargo and the ban on European maritime services for transporting Russian oil (A+B), whereas what has become known as the G7 price cap maintained the embargo, while relaxing the ban on Western maritime services by allowing their use for shipments below a given price (A+C).

In assessing the effects of these policies, one must distinguish between their economic effects and the political constraints that caused them to be adopted. It is conceptually possible to separately consider the economic effects of the embargo, transportation services restrictions, and the price cap, or any combination thereof. Indeed, it is necessary to understand what may have happened in certain counterfactual scenarios that were not implemented, since this is what will allow us to make informed decisions about future sanctions regimes. Our assessment of the sanctions' economic effects deliberately does not incorporate the political constraints policymakers operated under in 2022, because evaluating the effectiveness of sanction policies designed to satisfy specific political constraints can be misleading when thinking about future applications of sanctions. The same political constraints may not exist at that point.

The important role of political constraints in 2022 is illustrated by the chronology of events. The EU's 6th sanctions package included both an oil embargo and a ban on European services for transporting Russian crude oil with these restrictions intended to take effect by the end of 2022. After this package was passed in June 2022, U.S. Treasury officials, some market participants and some foreign governments became concerned that the European maritime services to be banned by the EU (and other countries such as Norway and the U.K.) were necessary for Russian oil to reach the global market.[8] The fear was that the global oil price would spike and there would be a global recession if these Russian barrels were eliminated from the global supply. One possible response would have been to reverse the ban on the use of European maritime services for Russian oil exports to third countries, but this option was considered politically infeasible, presumably because of the (incorrect) belief that Russia would be able

[8] Regional price differentials are common when transportation infrastructure is capacity constrained. One such example is discussed in Kellogg and Sweeney (2023) who study the impact of the Jones Act on U.S. fuel prices. Another instance of this phenomenon was documented by Borenstein and Kellogg (2014) who studied the interplay of crude oil and gasoline markets during the shale oil revolution. Similarly, one would expect frictions in maritime transportation to produce a glut in Russia and scarcity in the rest of the world, but on a much larger scale.

to sell its oil to countries in Asia at the global price. Instead, the price cap was introduced, which linked access to European maritime services to the Russian fob price in an effort to gain political support from EU members.

In what follows, we demonstrate that the effects of the chosen sanctions policy (A+C) on the Russian fob price could have been achieved via an alternative policy that removes the price cap component (A). We show that an embargo that allowed Russia to use Western maritime services would have had essentially the same effect on the fob price as an embargo that was coupled with a price cap that allows Russia restricted access to Western maritime services. This result implies that the price cap had little to no effect on the fob price, despite being politically expedient.

To evaluate the economic relevance of the price cap for the Russian fob price, consider two scenarios that we observe in the data for 2023: one where the fob price is below the price cap and another where it is above. When the Russian fob price is below the price cap, the price cap is non-binding and Western maritime services can be used irrespective of whether the price cap is enforced or not. When the Russian fob price exceeds the cap, this is evidence that either a) there are sufficient transportation services not requiring Western maritime services to deliver all (or at least most) Russian seaborne exports to the customers, or b) the price cap is not being enforced. In either of these cases, a very similar economic outcome would have been observed if policymakers decided to abandon the price cap going forward from that point. Thus, the main role of the price cap was to facilitate a political agreement not to enforce the EU's ban on maritime services. This conclusion is not surprising because, as we will show, the conditions identified by Johnson et al. (2024) for a price cap to constrain the fob price were not met in 2023.

3.3 Empirical evidence on the Russian fob discount

Given that Russian oil export volumes have not declined, as noted in Section 2, any reduction in revenues must have reflected a decline in the fob price of Russian crude. Figure 4 examines how this price evolved and how price discounts relative to the global price of oil have affected

Russian export earnings.[9] The fob prices of seaborne Russian crude are computed separately for Urals oil (Black and Baltic Sea) and ESPO oil (Pacific). The Urals fob price is a weighted average representing the average share of crude exported from the Baltic (41%) and Black Sea (16%) ports, respectively.[10]

There are two channels through which the price cap could have affected the Russian fob price. The most obvious would be a binding and well enforced price cap that yields Russian fob prices close to $60 per barrel. If Russian fob prices are below $60, the cap was set too high and is non-binding. If Russian fob prices are above $60, then the price cap ought to be binding but is either being circumvented fully or in part by the use of shadow tankers or is not being successfully enforced. Thus, the hypothesis that the price cap causes a reduction in the Russian fob price can be tested by observing the time series of Russian fob prices and their proximity to $60, at least when the price is below the price cap. Moreover, the fob price being substantially above the price cap at a mininum is evidence that the price cap has done little to reduce Russian oil revenues. The second potential channel through which the price cap could affect the Russian fob price is by altering expectations of market tightness in the global oil market in advance of the implementation of the price cap. We start by considering the first of these possibilities.

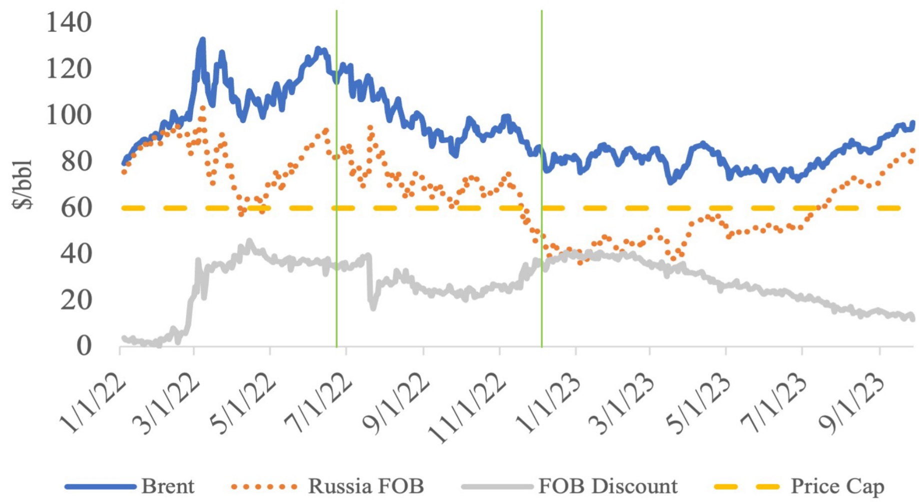
Global oil prices and the Russian fob price discount are both changing in response to market conditions for crude oil and for tankers. For example, the Brent price exceeded $120 per barrel in mid-2022 before falling into a range of $70-$100 per barrel thereafter. Figures 4(a) and 4(b) reveal several insights about the Russian fob price and, by extension, the effect of the price cap. First, the Russian fob price has been systematically lower than the Brent price, which is

[9]Our analysis draws on fob price data from the IEA, Platts and Argus for the ports of Primorsk (Baltic Sea), Novorossiysk (Black Sea) and Kozmino (Pacific Coast). There are no price data for the intermittent crude exports from Russia's Arctic ports. Prices may differ by port, reflecting differences in the quality of the oil exported as well as transportation costs. When price assessments for the same port and month differ across data providers, we average the prices.

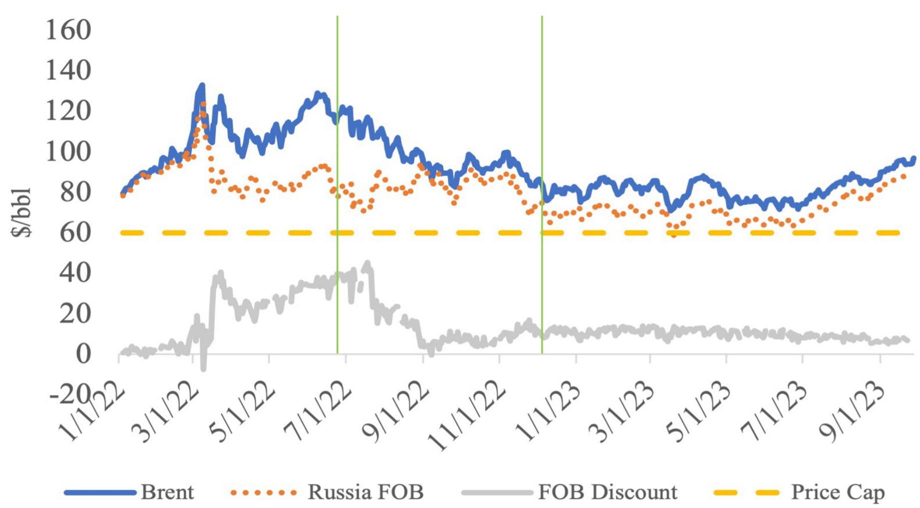
[10]In constructing the weights, we abstract from oil exports from Artic ports since these exports are comparatively small as a share of total Russian crude exports, take place only intermittently, and no fob price data for Arctic ports are being collected by Argus or Platts. It should also be noted that the share of Black Sea Russian crude exports is difficult to pin down since Kazakh oil that arrives in Russia by pipeline is also exported through the same port. Different data providers make different assumptions in that regard, but similar results are obtained under alternative assumptions.

Figure 4: Russian fob price discounts relative to Brent since January 2022

(a) Urals Crude



(b) ESPO Crude



Source: EIA, Argus, Platts, Clipper, Bloomberg, Kpler and authors' calculations. Green vertical lines are placed on June 28, 2022 (G7 leaders' communiqué) and December 5, 2022 (commencement of embargo and price cap) the reference price for crude oil in Western Europe. Second, while the Russian Urals fob price has at times been below the $60 price cap and at times above it, the ESPO fob price has been consistently above the price cap. Third, the Russian Urals fob price discount (relative to Brent) was between $20-$35 per barrel for most of 2022 and early 2023, but declined later in 2023. In contrast, the ESPO fob price discount has been stable with values near $5 to $15 since mid-2022.

To the extent that the objective of the price cap was to deprive Russia of financial gains from high global oil prices, this policy clearly has not been successful, given that the average Russian fob price has substantially exceeded $60 since mid-2023. One may object that the fob prices in Figure 4 incorporate shadow fleet shipments and that the price of Russian oil shipped on tankers using Western insurance is lower than the average fob price. All this really says, however, is that the price cap has been of limited relevance for the fob price because Russia has been able to use oil tankers not relying on Western insurance (or tankers operating in violation of the price cap).

Nor does the price cap help explain why the average Urals fob price dropped far below $60 in the first half of 2023. In the first half of 2023, importers of Russian oil had the same access to Western maritime services as they would have had if all restrictions on maritime services had been removed. It is in this sense that the price cap policy was effectively a policy of circumventing the EU services ban. If some Russian exports were actually constrained by the price cap, while others were not, one would have expected the average fob price to be above the price cap by construction.

These conclusions raise at least two questions: 1) If the price cap was not effective, why was the Russian fob price so far below the global price in early 2023? Sections 4 and 5 present an intuitive explanation that centers around increased shipping costs and the increased market power of India and China, Russia's main remaining customers. 2) How did the Russians circumvent the price cap when the Russian fob price moved above the cap in the second half of 2023? One answer to the latter question is the shadow fleet of oil tankers that operates without Western services and is therefore not covered by the price cap. As of December 2023 this fleet comprised several hundred vessels. Bloomberg estimates that more than 70% of 2023 Russian seaborne cargoes were loaded onto ships that were not subject to the rules imposed under the price cap (see Nightingale et al. (2023)). Similarly, analysts at Argus estimate that much of the Russian seaborne exports relied on vessels not covered by Western insurance. The other answer is that the price cap was not rigorously enforced in 2023, allowing shipping companies to move Russian oil in violation of the price cap, while using Western maritime services. This point is important because the absence of a shadow fleet and strict enforcements are the key conditions required for a price cap policy to work (see Johnson et al. (2024)).

How much the price cap facilitated the flow of oil from Russia compared to a general ban on Western maritime services for transporting Russian crude oil is less clear. If more than 70% of Russian seaborne cargoes in 2023 were transported on tankers not subject to the price cap, as estimated by Bloomberg, only roughly a quarter of Russian oil exports was subject to the price cap. This suggests that only about 1 mb/day of Russian oil exports were ever at risk of being disrupted in the absence of the price cap. The actual number may have been even lower to the extent that shipping companies ostensibly satisfying the price cap rules evaded sanctions by submitting fraudulent paperwork. Nor is it clear that, in the absence of the price cap, Russia could not have used alternate means of transportation.

Proponents of the price cap sometimes suggest that the success of this policy must be judged against the counterfactual of the dramatic surge in the global oil price that would presumably have resulted if all maritime services had been banned, as originally stipulated in the 6th EU sanctions package. The concern at the time was that several millions of barrels of Russian oil were at risk of being removed from the global market before the price cap. What this argument overlooks is that, according to our back-of-the-envelope calculation above, at most about 1 mb/day of Russian oil exports would have been disrupted, given the ability of Russia to draw on a large shadow fleet of tankers not requiring Western maritime services. Furthermore, the size of the shadow fleet is endogenous. Tankers are sold into the shadow fleet to arbitrage differentials in ship value that arise from sanctions, thereby dampening the effects of the sanctions themselves (similar to dynamics described in Brancaccio et al. (2020) and Kellogg and Sweeney (2023)). At least with the benefit of hindsight, a good case can be made that a shortfall of this magnitude would have been manageable, as long as Saudi Arabia was willing to compensate for this shortfall by reducing its voluntary production cuts. Moreover, there is no evidence that the oil market in 2022 was particularly concerned about a possible lack of access to maritime services causing a shortage of oil and higher global oil prices. Had such concern existed, we would have seen a sharp response in the price of oil to the 6th EU sanctions package dated June, 3, 2022. Figure 4 shows that no discernible response occurred.[11]

3.4 Did the oil market anticipate the price cap?

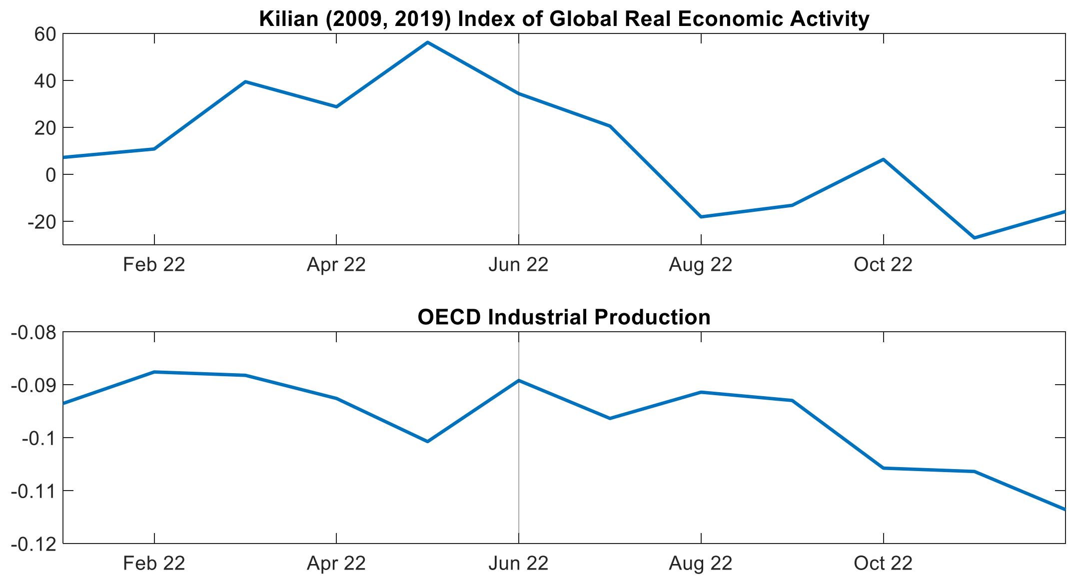
As noted earlier, another channel through which the price cap could have reduced the global price of oil is by shifting down oil price expectations well before its implementation. In this section, we examine this hypothesis and find no support for this channel. On June 28, 2022, world leaders at the G7 summit discussed for the first time an EU study of the feasibility of a price cap on Russian oil. In the G7 Leaders' Communiqué, they welcomed "the decision of the European Union to explore with international partners ways to curb rising energy prices, including the feasibility of introducing temporary import price caps where appropriate" (page 5). At question is how market participants viewed this statement, which influences the appropriate counterfactual against which to estimate the impact of the price cap.

If market participants viewed the G7 statement as a commitment to pursuing the price cap, and held the belief that such a policy would increase global supply (relative to the pre-announcement baseline), then one would expect oil prices to have fallen through the expectations channel (see Kilian and Murphy (2014)). That price decline could itself be attributable to the price cap, calling into question our earlier interpretation of the price decline being driven

[11] The Brent price remained stable at $125 on the day after this announcement. It temporarily peaked one week after the announcement at $128, before resuming the decline that had started on June 8. Even if one were willing to attribute this delayed increase to the EU announcement, it stands to reason that the reaction to a likely removal of several millions of barrels of Russian oil from the market would have been more than $3, so we can safely rule out that explanation. Nor would allowing for the market to anticpate this announcement explain this puzzle.

by a slowing global economy and unrelated oil supply shocks. Although the G7 wording fell far short of a commitment to a price cap, this hypothesis is worth investigating.

Figure 5: Indicators of Global Economic Activity in Commodity Markets



Source: Haver, FRED. The vertical line marks June 2022, the month of the G7 summit. OECD industrial production has been linearly de-trended.

As shown in Figure 4, the decline in the Brent price started 20 days before the G7 summit, on June 8, 2022, and there is no visual sign that the trend decline changed with this announcement. What about oil price expectations shifting around the time of the announcement? Such shifts should be reflected in the term structure of oil futures prices, even acknowledging the likely presence of a risk premium. If the oil price expected at the end of 2022 fell in response to news about a possible oil price cap, one would expect to see a downward shift in the futures price, especially for the December contract. Instead, the entire Brent futures curve (including the price of the December contract) shifted up on June 28 (or for that matter on June 29) relative to June 27, the day before the announcement. This evidence again argues against the view that the G7 announcement drove down the price of oil.

3.5 An alternative explanation of the decline in the price of oil

What about the alternative that demand for oil in the second half of 2022 declined substantially relative to the first half? There are several pieces of evidence consistent with this interpretation. One such indication is that the broad-based index of primary commodity prices compiled by the IMF peaked in mid-2022. It is widely accepted that such indices are proxies for fluctuations in global demand (see Kilian and Zhou (2018)). This evidence is broadly consistent with the evolution of the Kilian index of global real activity (see Kilian (2009), Kilian (2019)) that was designed to capture fluctuations in activity related to markets for industrial commodities (see Figure 5). This index leads fluctuations in real output by one month. It reached its peak in May 2022, ending a long expansion that started in 2021, when the Covid pandemic fizzled. The peak in May is followed by a sustained decline in the second half of 2022. Cruder proxies for variation in global real activity in commodity markets such as the OECD industrial production index also indicate a substantial slowing of the global economy in the second half of 2022, with a peak in June, at the same time as the price of oil. Thus, a plausible interpretation is that the upward trend in the Brent price in the first half of 2022 reflected strong and growing demand (with departures from this trend explained by the initial market response to the Russian invasion of Ukraine), while the trend decline in the second half of 2022 mainly reflected slowing demand for oil related to macroeconomic conditions rather than expectations of the oil price cap.

3.6 Other anticipatory effects of the price cap on the Brent price

There is another possible argument for why the anticipation of the price cap may have mattered for the global oil price. This argument is that as of June 2022 there was a large premium in the price related to fears of a disruption of Russian oil supplies to the global market. This "fear premium" was alleviated only by the announcement that there might be a price cap at the end of the June. Thus, the apparent decline in global oil demand was not driven by the business cycle, but by the price cap.

This hypothesis does not appear to fit the data, however. Oil inventories persistently increased after after June 2022 (see Johnson et al. (2024), Figure 6). This increase is inconsistent with a reduction in storage demand driven by lower oil price expectations because such a reduction should have lowered oil inventories. Thus, the inventory data provide no support for the hypothesis that the price cap was responsible for much of the decline in the Brent price in the second half of 2022 because it assuaged market fears about an oil supply disruption. Nor is there evidence of systematic destocking after the implementation of the price cap started in December 2022. An increase in oil inventories is consistent, however, with a persistent reduction in the flow demand for oil driven by a slowing global economy, as documented in Figure 5 (see Kilian and Murphy (2014)).

Moreover, the narrative about higher oil supply expectations does not fit the data on the global business cycle in Figure 5. If there had been a substantial decline in the oil price driven by expectations of higher global oil supplies after June 2022, this should have stimulated the economy and raised global real activity. The steady decline in global real activity after June 2022 is difficult to reconcile with this hypothesis. In contrast, our alternative explanation that the oil price decline in the second half of 2022 reflected a slowing of global economic activity is consistent with the real activity data.

Finally, there is clear evidence of a fear premium driving the oil price away from its trend in March 2022 (see Figure 4). This premium reflected anxiety about possible disruptions of global oil supplies, as widely discussed in the press. Subsequently, however, the oil price reverted to the upward trend it had been on at the beginning of the year, casting doubt on the existence of a large fear premium in mid-2022 or later in 2022.

4 The Effect of Higher Insurance & Transportation Costs

We now turn our attention to shipping insurance and transportation costs. Prior to 2022, Europe was the primary destination for Russian crude. After the EU and other countries curtailed their oil imports from Russia, Russia was forced to sell its crude to more distant buyers, an effect that can be thought of as "market segmentation" (more on this below). Shipments to more distant destinations raised both the cost of insurance and the cost of transportation. As the distance over which the Russian oil has to be transported increases, not only the variable cost of shipping (such as crew costs, fuel costs, and insurance costs) increases, but tankers are spending longer at sea, reducing the effective size of the tanker fleet. Moreover, the need to partially replace Russian pipeline exports of crude to Europe by seaborne exports to Asia added to the scarcity of tankers. This is expected to raise tanker rates even if there is no change in insurance rates, but even more so to the extent that insurance premia responded to the war and/or sanctions. Thus, to remain competitive, Russia was forced to offer a larger price discount compared to the Brent price of oil. The magnitude of this discount reflects the tanker insurance premium and the transportation cost premium which we seek to quantify next.

4.1 The tanker insurance premium

The cost of insuring oil tankers carrying Russian crude depends not only on the distance travelled, but also on the availability of insurance from non-Western providers and on whether the tanker passes through a war zone. Tanker insurance costs reflect the cost of insuring the cargo of crude oil as well as the cost of insuring the tanker itself, also known as hull insurance. There is an insurance premium when tankers travel through a war zone. For example, in 2019, after six oil tankers had been attacked in the Persian Gulf, the cost of insuring crude oil cargoes from the Middle East rose tenfold to reach 0.4% of the price of crude oil, reaching 25 cents of the Brent price of $64.30 per barrel at the time (see Tobben (2019)). As far as insurance for the tanker itself is concerned, a plausible war risk premium might be two percent of the market value of the empty vessel for seven days of coverage. Therefore, for a tanker worth $100 million transiting the war zone, the war insurance premium would be two million dollars. Assuming a cargo of two million barrels of oil, this amounts to a one dollar increase in the price per barrel. The combined increase in insurance costs in this example is associated with little more than a $1 increase in the price per barrel of oil. This illustrates that the cost of oil tanker insurance tends to be negligible relative to the price of crude oil, even under war-like conditions.

A similar surge in hull insurance premia took place in 2022, as the invasion of Ukraine unfolded and even neutral oil tankers operating in the Black Sea were increasingly at risk. Saul (2022) reports that the hull insurance rate for tankers in the Black Sea for a 7-day period increased from 0.025% before the invasion to between 1% and 5% after the invasion. This puts the hull insurance for an Aframax tanker at between $0.88/barrel and $4.38 per barrel. By April 2022, the hull insurance premium for a $50 million, five-year old tanker hauling a standard one million-barrel Russian cargo was about $5/barrel (see Koh et al. (2022)). By May 2022, hull insurance premia for oil liftings from the Black Sea had increased four-fold compared to before the invasion (see Paris (2022)). Information on cargo insurance premia is harder to come by, but tends to be an order of magnitude smaller, as illustrated by the earlier Middle Eastern example. According to Reuters, the war risk premium for vessels in the Black Sea increased by 20% in early 2023 (Ollett and Bhattacharjee (2023); Saul (2023)).

These insurance premia, however, only apply to Russian crude exports from the Black Sea which account for only 16% of all Russian oil tanker exports. The remaining 84% of Russian oil tanker exports from Baltic, Arctic and Pacific ports were not affected by this development. A further unrelated increase in insurance premia likely took place after the imposition of the price cap in December 2022. While the price cap does not prevent tankers from carrying Russian cargo to third countries, to the extent that some insurance providers withdrew from the market rather than becoming involved in verifying the price cap, it arguably may have raised the cost of obtaining Western maritime insurance for tankers carrying Russian oil under the price cap exemption. Argus reported that tanker insurance costs, after the imposition of the price cap, were expected to increase by 4 percent in 2023 (see Ollett and Bhattacharjee 2023). Not only is this increase quite modest, suggesting that the tightening of the insurance market may be ignored, but these higher rates do not apply to all tankers carrying Russian oil.

Oil cargoes that are actually (or ostensibly) sold below the fob price cap of $60 per barrel in early 2023 accounted for nearly 60% of all tankers carrying Russian oil cargoes, according to

Nightingale et al. (2023).[12] This does not necessarily mean that the cost of insurance increased for the remaining 40% of tankers carrying Russian oil, however. For example, many of the tankers operating in the Black Sea do not rely rely on Western insurance, and it seems quite plausible that the alternative insurance providers active in this market charge less than Western insurance companies because the coverage of these contracts is likely to be lower and payouts are less certain. This is certainly the case for the state-owned Russian tanker fleet.

Non-state-owned oil tankers operating in violation of the price cap also have access to Russian maritime insurance. While this insurance is arguably less comprehensive than its Western counterpart, it is accepted by Denmark for passage through the Denmark Strait, by Turkey for passage through the Bosporos Strait, and by Egypt for passage through the Suez Canal. Moreover, there is no evidence of a war risk premium for Russian owned tankers operating from the Black Sea, and, to the extent that foreign tankers move crude oil from the Black Sea in violation of the embargo, they often take delivery of Russian cargoes outside of the Black Sea by ship-to-ship transfer, obviating the need to pay a war insurance premium.

While information about the insurance market for Russian oil cargoes is fragmentary, it is clear that the added cost of insuring Russian oil cargoes and insuring oil tankers crossing the Black Sea is small on average relative to the price of crude oil in global markets. Thus, we will abstract from changes in oil tanker insurance costs in the analysis below. It should be noted that this situation may change, if the price cap is lowered or if its enforcement is tightened, but our concern in this paper is with understanding the data through 2023.

4.2 The transportation cost premium

A natural approach to evaluating the increase in transportation costs caused by having to ship Russian crude oil over longer distances is to compare the fob discount for Russian crude in January 2022, before the invasion, to the discount in March 2023. This task is complicated by

[12] In practice, shippers are expected to provide the paperwork establishing whether the price cap is violated or not with refineries paying the cif price. The price of oil actually paid to Russian producers is susceptible to manipulation, since unscrupulous shippers can easily inflate the cost of shipping thereby lowering the implied fob price of the cargo.

the fact that standard Russian fob price series for Urals crude oil were discontinued, as trading on traditional routes from the Baltic and from the Black Sea ceased in 2022. In contrast, the fob price series for trade with India emerged only in early 2023 and is not available farther back in time. As to the oil trade between Russia and China, the data are even more fragmentary.

Table 1: Discount on Russian fob price as of January 2022 (U.S. Dollars per Barrel)

Russian fob export price	Price discount relative to		
	Argus Urals cif Rotterdam	Argus North Sea Dated	Brent Spot
Argus Urals Primorsk (Baltic Sea)	1.29	2.39	1.80
Argus Urals Novorssiysk (Black Sea)	0.87	1.97	1.38
Argus ESPO Kozmino (Pacific)	-	2.11	1.52
Platts Urals Primorsk (Baltic Sea)	2.45	3.55	2.96
Platts Urals Novorssiysk (Black Sea)	2.58	3.68	3.09
Averages Urals Primorsk (Baltic Sea)	1.87	2.97	2.38
Average Urals Novorssiysk (Black Sea)	1.72	2.82	2.23

Notes: The cost of insurance and freight adds almost $2 to the price, taking the Rotterdam cif price for Urals oil as the benchmark, which controls for the quality of the oil. North Sea Dated is a benchmark for a different type of crude. The additional quality difference is reflected in a larger discount of near $3. North Sea Dated is more representative for the price of oil in the Atlantic Basin than Brent, which is included as one among several benchmarks in North Sea Dated.

Nevertheless, we can glean some information from the price data. Table 1 reports the difference between the fob price for Russian Urals crude and the cif price for the Urals crude in Rotterdam, one of the major destinations for Russian crude in Western Europe, in January 2022, before the invasion. Focusing on Urals crude helps control for differences in the quality of the oil. The cost of insurance and freight adds almost $2 per barrel to the price, implying a discount of $2 on the fob price.[13] Using North Sea Dated instead (a recently introduced new benchmark that is more accurate than Brent), the discount is near $3, which reflects the fact that the quality of North Sea Dated oil differs from that of Urals oil.

Table 2 focuses on data for March 2023, about one year after the invasion of Ukraine, when trade patterns had changed and the Rotterdam price series had been discontinued. It shows

[13] After January 2022, there is a growing gap between Brent/North Sea Dated and Rotterdam cif that is not related to the quality of the oil, but apparently customers' unwillingness to buy this oil at any price. Of course, the interpretation of cif Rotterdam also becomes murky, when there is (almost) no trade. The Rotterdam series stops in December 2022.

Table 2: Discount on Russian fob price as of March 2023 (U.S. Dollars per Barrel)

Russian fob export price	Price discount relative to		
	Argus Urals cif India	Argus North Sea Dated	Brent Spot
Argus Urals Primorsk (Baltic Sea)	17.19	33.83	33.97
Argus Urals Novorssiysk (Black Sea)	17.65	34.30	34.43
Argus ESPO Kozmino (Pacific)	-	10.76	10.90

Notes: The fob price discount has grown by $15, taking the Indian cif price as the benchmark. The latter price is available only starting in March 2023. Similar Urals cif prices for China are not available, as China is mainly importing ESPO oil from Asian ports.

a discount of $17 for Russian shipments of Urals crude from the Baltic Sea or the Black Sea to India, which had replaced Rotterdam as one of the primary destinations. Given that the rising cost of insurance is negligible, as discussed in Section 4.1, this evidence suggests that of the $34 -$2 = $32 increase in the discount relative to Brent for oil exported from Black Sea and Baltic Sea ports about $15 reflected the increase in transportation costs associated with redirecting oil exports from Europe to Asia. This evidence suggests that the remaining $17 are likely to reflect the market power that India exercises in the Urals market as the only remaining large buyer of this oil. Not only is this explanation plausible, given that we already ruled out the possibility that the price cap has non-negligible effects on the fob price discount, but the calibrated model of the oil market discussed in Section 4 shows that even a modest degree of market power implies a reduction in the price discount of the magnitude documented here.

In contrast, the fob discount for Russian oil exported from Kozmino on the Pacific coast is $11 per barrel. In the year preceding the invasion of Ukraine, the spread of Kozmino ESPO fob prices over the North Sea Dated price averaged $1.44 per barrel, suggesting a drop in the ESPO fob price by $12 since the invasion. To the extent that much of the oil from Pacific ports is shipped to China, the result that the overall effect on the price discount is smaller than for India is not surprising since the shipping distances are not much greater than those to Japan or South Korea and insurance costs have not materially changed. While we do not have the necessary data to decompose the $12 increase in the ESPO discount further, it would be surprising if the transportation cost increased by more than a few dollars, so much of the increase in this discount is likely to reflect the growing market power of China in the ESPO market.[14]

Table 3 summarizes what we have learned about the economic determinants of Russian price discounts. First, the importance of higher insurance costs is likely to be negligible, as alternative low-cost insurance providers have filled the void left by Western insurance companies and Russian oil increasingly is shipped on tankers whose ownership cannot be traced easily, making enforcement difficult. In addition, lower global oil prices starting in late 2022 took much of the bite out of the oil price cap, allowing Western companies to participate in the Russian oil trade more easily in the first half of 2023. Second, our estimate of the added transportation cost of $15 per barrel for shipping Russian oil to India rather than Western Europe is substantial, as is the tentative $17 estimate of the effect of India's higher market power. Third, our $12 estimate of the combined effect of higher transportation costs and Chinese market power, while smaller, is still substantial. The latter estimate obviously has to be taken with a grain of salt, given that the price data for China's ESPO imports are likely less reliable.[15] While our data do not allow us to decompose the effects of higher transportation costs and China's higher market power in the ESPO market, Section 4 re-examines the economic determinants of the Russian fob discount more formally through the lens of a calibrated model of the global oil market, allowing us to corroborate and refine the evidence in Table 3.

4.3 The shipping risk premium

In the discussion so far, we attributed the increased wedge between fob and cif prices in March 2023 to the higher transportation costs associated with shipping Urals oil over longer distances and to the rise in tanker rates from the reduction in the effective size of the tanker fleet. As

[14] The increase in the discount relative to Brent and North Sea Dated is also consistent with the fact that some of the oil shipped from Kozmino was destined for countries such as India that traditionally did not import oil from Kozmino and that now ship oil over longer distances. Those shipments, however, account for only a small fraction of Russian oil exports from Kozmino.

[15] For example, China also imports Russian crude from Artic, Baltic and Black Sea ports. There is every reason to believe that the latter trade is subject to an even larger transportation cost premium than Russian oil trade with India, because the distances are substantially greater. However, there are no data for these routes that would allow us to quantify these costs.

Table 3: Quantifying the economic determinants of
Russian fob price discounts in March 2023

Determinants	India	China (ESPO)
Rise in insurance premia	≈ $0	≈ $0
Rising shipping distance	$15	} $12
Rising market power of importers	$17	

Notes: Authors' calculations described in text.

noted by Kennedy (2023), however, there is another possible explanation of rising transportation costs. The argument is that the price cap created a risk premium for companies involved in shipping Russian oil in violation of the price cap, which was reflected in higher transportation costs. One interpretation of the data on transportation costs for Urals crude oil is that this risk premium was high in early 2023 and came down in the second half of 2023, as evaders of the price cap became less concerned that they would be caught and sanctioned. Kennedy (2023) also makes the case that the risk premium may have risen again after the U.S. Treasury started tightening the enforcement of the price cap in October 2023.

One obvious challenge with this argument is that, if there is a shipping risk premium in transportation costs, it is not observable, making it difficult to establish that the risk premium moved as conjectured and that it is quantitatively important. However, we can deduce that the decline in the Russian fob price below the price cap in the first half of 2023 could not possibly be explained by such a risk premium because, as soon as the fob price falls below the price cap, the risk of being sanctioned and therefore the risk premium goes to zero. This means that the existence of a risk premium would have implied that the fob price is bounded from below by the price cap of $60. It clearly was not in March 2023, and the increase in the shipping distance for Urals oil between January 2022 and March 2023 explains why.

While we do not formally examine what happened in the second half of 2023, when the Russian fob price systematically exceeded the price cap, there is no indication of a quantitatively important shipping risk premium in the second half of 2023 either. In fact, analysis by Hilgenstock et al. (2023) suggests that the effective compliance with the price cap was poor.

There is general agreement that the risk of violators of the price cap being caught was low at this point and that violations of the price cap had become widespread. Indeed, it was this fact that prompted the U.S. Treasury to attempt to tighten the enforcement of the price cap in October 2023.

Nor is there evidence that the risk premium has become quantitatively important since October 2023. Not only has there been no substantial change in the Russian fob price discount, but the Urals discount, which also includes the transportation cost, declined to about $10 in the second half of 2023 and in early 2024, which by itself argues against the emergence of a large risk premium. Thus, it remains to be seen whether tightened enforcement of the price cap will change this situation in 2024. We will return to this point in the conclusion. For now we focus on explaining the evolution of the price discount between January 2022 and March 2023.

5 Model and Results

The goal is to describe the simplest model that allows us to analyze and compare data from January 2022 and March 2023. March 2023 is a natural point of comparison as the sanctions on Russian crude and product exports imposed in December 2022 had taken full effect by March. We seek to quantify three effects in sequence. First, a "supply and demand effect" that reflects changing business cycle conditions in the global market for crude oil as well as exogenous changes in the supply of oil from other producers. Second, given the segmentation of the crude oil market after the invasion of Ukraine and the rerouting of Russian crude exports, we allow a "transportation cost effect" to increase the cost of insurance and freight due to more crude oil being shipped by tankers rather than by pipeline, longer shipping routes, and the Black sea port Novorossiysk being close to a war zone. Third, the "market power effect" allows India and China to exercise partial monopsonistic market power in their respective segmented markets for Russian crude oil.

To this end, we calibrate our model to market data for January 2022 and March 2023, which allows us to recover several unobservables. These include the counterfactual prices and quantities with and without the three effects in question, and a measure of the market power of the major buyers in the Urals and ESPO markets in March 2023. The main assumptions of the model are (1) a competitive and globally integrated market for crude oil before the sanctions; (2) (piece-wise) linear demand and supply functions; and, (3) a segmented market for crude oil after the curtailment of Western demand for Russian crude oil. In particular, we assume that Urals crude is mainly traded with India and ESPO crude is mainly traded with China, allowing both countries some degree of monopsony bargaining power with Russia. Their residual demand is aggregated with the rest-of-the-world demand and met by the supply of non-Russian crude oil in a competitive market.

5.1 The "before sanctions" model

Let p be the fob market price per barrel of crude oil. For simplicity, we assume that the aggregate supply function is linear and takes the form $s(p) := c + kp$ with $c, k > 0$. The supply of crude oil by Russia (R) is a fraction $\rho \in (0, 1)$ of aggregate supply such that $s_R(p) := \rho s(p)$. Let $t \geq 0$ denote the cost of insurance and freight per barrel of crude oil, so $p + t$ represents the CIF price. We assume that global demand is piece-wise linear,

$$d(p+t) := \min\{\ell - m(p+t), b\} \text{ with } \ell, b, m > 0. \tag{1}$$

The kink and vertical "leg" reflects the global refinement capacity b. The demand by China (C) and India (I) is $d_C(p) := \gamma_C d(p)$ and $d_I(p) := \gamma_I d(p)$, where $\gamma_C, \gamma_I \in (0, 1)$ are fractions of global demand with $\gamma_C + \gamma_I < 1$. The combined demand by all net oil importers other than China and India (O) is denoted by $d_O(p) := (1 - \gamma_I - \gamma_C) d(p)$.

We assume that prior to the invasion of Ukraine, market participants were price takers in the short run. Although Russia, China, and India are non-negligible in the sense that their absence could affect prices, oil-consuming countries compete in a Bertrand fashion for crude oil. This assumption is justified as long as global supply does not reach global refinement

Table 4: Model Input and Data

Variable	Unit	Model Input	Data
Price elasticity of aggregate demand $e_D(p^* + t)$		-0.20	Kilian (2022) -0.20
Price elasticity of aggregate supply $e_S(p^*)$		0.05	Kilian (2022) 0.05
January 2022			
Market FOB price p^*	US$/b	86.74	Argus North Sea Dated 87.10
			Argus Urals FOB Primorsk 84.71
			Argus Urals FOB Novorossiysk 85.13
			Argus ESPO Blend FOB Kozmino 84.99
CIF-FOB markup t	US$/b	1.23	Argus CIF Rotterdam Urals 86.00
Russia's quantity $s_R(p^*)$	b/d	4,296,445	4,296,445
Other producers' quantity $s_P(p^*)$	b/d	22,592,069	22,592,069
Total quantity q^*	b/d	26,888,514	26,888,514
India's quantity $d_I(p^* + t)$	b/d	3,558,958	3,558,958
China's quantity $d_C(p^* + t)$	b/d	6,598,794	6,598,794
Other buyers' quantity $d_O(p^* + t)$	b/d	16,730,762	16,730,762
March 2023			
World market FOB price p_W^*	US$/b	78.29	Argus North Sea Dated 78.29
Urals FOB price p_U^* (quantity-weighted mean of Argus)	US$/b	44.35	Argus Urals FOB Primorsk 44.46
			Argus Urals FOB Novorossiysk 44.00
ESPO FOB price p_E^*	US$/b	67.53	Argus ESPO Blend FOB Kozmino 67.53
CIF-FOB World market markup t_W	US$/b	2.54	BDTI Increase Jan 2022/March 2023 2.07
CIF-FOB Urals markup t_U	US$/b	17.46	CIF-FOB Urals Primorsk - India 17.35
			CIF-FOB Urals Novorossyk - India 17.81
CIF-FOB ESPO markup t_E	US$/b	5.00	
Other producers' quantity $s_P(p_W^*) = q_W^*$	b/d	26,479,186	26,479,186
Other buyers' quantity in the world market $d_O(p_W^* + t_W)$	b/d	17,247,474	17,247,474
India's quantity from Russia $d_I(p_U^* + t_U) = q_U^*$	b/d	2,097,165	2,097,165
China's quantity from Russia $d_C(p_E^* + t_E) = q_E^*$	b/d	1,925,150	1,925,150
Other buyer's quantity from Russia	b/d	0	1,061,671
Russia's quantity	b/d	4,022,315	5,083,986
India's quantity in the world market $d_I(p_W^* + t_W) - q_U^*$	b/d	2,381,596	2,381,596
China's quantity in the world market $d_C(p_W^* + t_W) - q_E^*$	b/d	6,850,116	6,850,116

capacity.[16] The equilibrium fob price p^* is determined competitively by $s(p^*) = d(p^* + t)$. Global demand at the equilibrium price must equal global supply.

5.2 Calibration of the "before sanctions" model

The model is calibrated as shown in Table 4. The price elasticities of demand and supply of crude oil are based on a recent survey of oil demand and supply elasticities in Kilian (2022). The market price p^* is set equal to the quantity-weighted mean of Argus fob prices. Russian oil exports account for 4,296,445 b/d of the $q^* = 26,888,514$ b/d total of worldwide oil exports in

[16]If any country with positive net demand were to credibly withhold part of their demand, other countries *together* would be able to absorb the freed-up supply without exceeding the refining and storage capacity in the rest of the world. Similarly, if Russia or any other supplier individually withholds supply, other suppliers and storage can make up the shortfall. Under these assumptions, a competitive market is a reasonable approximation of reality in the short run.

January 2022 (or 15%).[17] Finally, we assume that exports via the Druzba pipeline are sold at the Urals Primorsk fob price and exports on the ESPO Daqing pipeline are sold at the ESPO Blend Kozmino fob price. About 67% of Russian exports are seaborne, 18% go through the Druzba pipeline, and 15% through the ESPO Daqing pipeline. This yields a quantity-weighted mean fob price of $p^* = 86.74$ \$ per barrel.

We calibrate the model as follows: Since $e_D(p^*) = \frac{\frac{\Delta q}{q^*}}{\frac{\Delta p}{p^*+t}}$, the slope of the aggregate demand function is $-m = e_D(p^*)\frac{q^*}{p^*+t}$. The intercept of the aggregate demand function is then $\ell = q^* + m(p^* + t)$, where the observed prices and quantities are assumed to equal the equilibrium prices and quantities. Similarly, we derive the slope and intercept of the aggregate supply function from the price elasticity of supply in equilibrium and the equilibrium price and quantity. Finally, the fraction Russia's supply relative to total supply and the fractions of India's and China's demand relative to aggregate demand are derived by straightforward calculations. This parameterization corresponds to the second column in Table 5.

5.3 The "after sanctions" model

The sanctions have two main components: First, a coalition of net oil importers curtailed its demand for Russian crude oil. This created a segmented market for crude oil with only India and China buying large quantities from Russia and other net oil importers purchasing crude from other suppliers. Second, a price cap of \$60 per barrel was imposed on all shipments of Russian crude oil insured by Western insurance. Given the evidence presented in Section 3 that the price cap is either non-binding or binding but unenforced throughout, we exclude it from our calibrations, although it can be shown that our results would be robust to allowing for an empirically plausible fraction of exports being subject to the price cap.

We assume that the market is segmented into three markets: one possibly imperfectly competitive market for Russian Urals and India, one possibly imperfectly competitive market for

[17] All data for seaborne exports come from tankertracker.com. Data on the ESPO Daqing pipelines come from the OPEC Monthly reports. Data on the Druzba pipelines are from Eurostat as reported by Bruegel. The latter have been converted from metric tonnes into barrels using a factor of 7.3122. We assume 31 days per month for the month of January.

Russian ESPO Blend and China, and one competitive market for the residual demands of both China and Russia, the demand by the rest-of-the-world, as well as the supply by producers other than Russia. This segmentation, which reflects geographic proximity and actual crude oil trade flows, helps explain why neither India nor China necessarily have full monopsony power in the markets for Urals and ESPO, respectively. India imports mainly Russian Urals crude from the Baltic Sea and Black Sea ports, whereas China imports mainly the ESPO Blend from Pacific ports.[18]

Because of the market segmentation, there are now three prices in the model. We denote the per barrel fob prices for Urals, ESPO, and rest-of-the-world by p_U, p_E, and p_W, respectively. Supply and demand functions are defined as before (with intercepts and slopes now calibrated to the March 2023 data in Table 3) except that Russia's supply is now split into the supply of Urals and the supply of ESPO crude, respectively. We define $s_U(p) := \rho_U s(p)$ and $s_E(p) := \rho_E s(p)$ as Russia's supply functions for Urals and ESPO, respectively, with $\rho_U, \rho_E \in (0,1)$ and $\rho_U + \rho_E < 1$. The combined supply by producers (P) other than Russia is $s_P(p) := (1 - \rho_U - \rho_I)s(p)$.

The cost of insurance and freight in the markets for Urals and ESPO crude exports and in the (rest-of-the) world market are denoted by t_U, t_E, and t_W, respectively. Equilibrium fob prices (p_U^*, p_E^*, p_W^*) for all three markets are given by

$$\alpha_I s_U(d_I^{-1}(s_U(p_U^*)) - t_U) = s_U(p_U^*), \tag{2}$$

$$\alpha_C s_E(d_C^{-1}(s_E(p_E^*)) - t_E) = s_E(p_E^*), \tag{3}$$

$$s_P(p_W^*) = d_O(p_W^* + t_W) + d_I(p_W^* + t_W) - q_U^* + d_C(p_W^* + t_W) - q_E^* \tag{4}$$

where $q_U^* = s_U(p_U^*)$ and $q_E^* = s_E(p_E^*)$. The α factors in equations (2) and (3) represent the degree of monopsony bargaining power of India and China in the markets for Urals and ESPO, re-

[18]This pattern seems to be driven by the vast distance between the Baltic Sea and China. Even though there exists a connection between the Druzba and ESPO pipeline system, pipeline capacity constraints have forced Russia to exports its Urals crude by sea.

spectively. Recall that in a monopsonistic market, the monopsonist would maximize consumer surplus by considering the point where the marginal cost of purchasing equals marginal gross consumer surplus. In a linear setting, the curve representing the marginal cost of purchasing is twice as steep as the supply curve. Thus, with full monopsony power we have $\alpha = \frac{1}{2}$. On the other hand, in competitive equilibrium without any monopsony power, we have $\alpha = 1$. In other words, the smaller α, the larger is the monopsony power of the buyer.

To understand the composition of the inverse demand functions and the supply functions in equations (2) and (3), recall that the monopsonist withholds demand compared to the competitive equilibrium. Thus, the monopsonist has strict positive excess demand at the monopsonistic price. The effective price for the satisfied monopsonistic demand can be computed by plugging in the supply at the monosponistic price into the inverse demand function. That is, $d_I^{-1}(s_U(p_U^*))$ is the effective price that determines India's demand in the market for Urals. Thus, if the α's were equal to $\frac{1}{2}$, equations (2) and (3) are just an alternative way of writing marginal purchase cost equals to marginal gross consumer surplus. If the alphas are equal to 1, then the effective price is the CIF price. The CIF price minus the cost of insurance and freight is the fob price. This explains why the transport costs appear on the l.h.s. of equations (2) and (3). See Appendix A for a detailed derivation of equations (2) and (3).

Note that the r.h.s. in equilibrium condition (4) represents the combined *residual* demand obtained by aggregating the *residual* demand of China and India with the demand from the rest of the world. Our assumption is that India and China first feast on Russian crude oil and then go to the world market to satisfy their residual demand.[19]

The segmented market equilibrium is illustrated schematically in Figure 6. For this illustration, we set cost of insurance and transportation to zero in all markets in order to not complicate the graphs any further. The left-most chart illustrates the outcome with market power α_I in the Russian-Indian market for Urals. Note that after satisfying demand q_U^*, India has a residual

[19] This assumption would be violated, for example, if their demand in the world market were largely determined by long-term purchasing contracts for crude oil, in which case there would be limited room for them to act in the spot market.

Figure 6: Illustration of a Segmented Market Equilibrium (p_U^*, p_E^*, p_W^*)

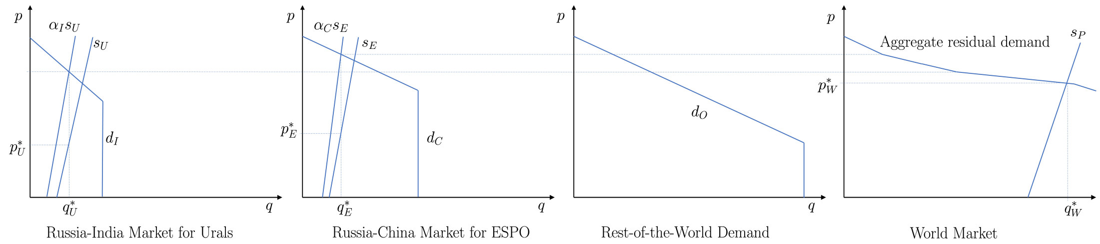


Table 5: Calibration Results

	January 2022	March 2023
Increased Transportation Costs	No	Yes
Market Power	No	Yes
p^*	86.74	78.72
q^*	26,888,514	30,569,355
k	30,999	19,416
c	24,199,663	29,040,888
m	67,244	76,469
ℓ	32,803,987	36,683,227
ρ_U	n.a.	0.07
ρ_E	n.a.	0.06
ρ	0.16	0.13
γ_I	0.13	0.15
γ_C	0.25	0.29
α_I	n.a.	0.87
α_C	n.a.	0.83

demand function depicted to the right of q_U^* in the left-most chart. Similarly, the second chart illustrates the outcome with market power α_C in the Russian-Chinese market for ESPO. Again, after satisfying demand q_E^*, China has a residual demand function depicted to the right of q_E^*. The third chart depicts the demand function of buyers other than India and China. The right-most chart aggregates the residual demand functions from the first two charts and the demand function of the third chart into an aggregate residual demand function. It also depicts the supply by producers other than Russia and the resulting competitive market equilibrium p_W^* in that market.

5.4 Calibration of the "after sanctions" model

This model cannot be calibrated directly because the price elasticities discussed earlier relate to a competitive equilibrium in the global market. The price elasticities associated with outcomes in the segmented markets may differ. Hence, we cannot use standard price elasticity estimates to calibrate the slopes and intercepts of the demand and supply functions in the segmented markets.

To wit, we construct a counterfactual aggregated market that would have emerged without sanctions. We then assume that the price elasticities hold in the competitive equilibrium of that counterfactual aggregated market. This allows us to compute the slopes and intercepts of global demand and supply, given the competitive equilibrium of the counterfactual aggregated market. We know that if we were to disaggregate demand and supply of that counterfactual market into segmented markets, then it should fit our data on the segmented markets allowing for some degree of monopsony power on part of India and China. These arguments yield a system of equations whose solution determines the competitive equilibrium in the counterfactual aggregate market along with the market share of Russian Urals and ESPO as well as India's and China's market shares. This competitive aggregate model without sanctions serves as a useful benchmark. Importantly, it helps determine the degree of monopsony bargaining power of India and China in the segmented markets, as measured by their respective α. Appendix A describes this calibration in more detail.

5.5 Discussion of model results

Table 5 presents the parameters of the models calibrated using January 2022 and March 2023 data. The latter model allows for sanctions-related mechanisms, such as increases in the cost of shipping Russian crude oil to its destination and in the market power of India and China, reflecting the segmentation of the oil market. Table 6 compares selected oil prices, the volume of Russian crude oil exports by destination, and other important quantities before and after

Table 6: Crude Oil Prices and Russian Crude Oil Quantities Before and After Sanctions

	January 2022		March 2023		**Overall change**	
Increased Transport Costs	No		Yes			
Market Power	No		Yes			
Crude Oil Prices	US$/b		US$/b		US$/b	% change
Model						
Market FOB price p_W^*	86.74		78.29		-8.45	-9.74%
Urals FOB price p_U^*	86.74		44.35		-42.39	-48.87%
ESPO FOB price p_E^*	86.74		67.53		-19.21	-22.15%
Actual data						
Argus North Sea Dated	87.10		78.29		-9.42	-10.81%
Argus Urals FOB Primorsk	84.71		44.46		-40.25	-47.52%
Argus Urals FOB Novorossiysk	85.13		44.00		-41.13	-48.31%
Argus ESPO Blend FOB Kozmino	84.99		67.53		-17.46	-20.54%
Russian Crude Oil Quantities	b/d	% share	b/d	% share	b/d	% change
Model						
Russian export	4,296,445		4,022,315		-213,542	-4.97%
Indian import from Russia	0	0.00%	2,097,165	52.14%	2,097,165	n.a.
Chinese import from Russia	1,215,255	28.29%	1,925,150	47.86%	709,895	58.42%
Others import from Russia	3,081,190	71.71%	0	0.00%	-3,081,190	-100.00%
Actual data						
Russian export	4,296,445		5,083,986		787,541	18.33%
Indian import from Russia	0	0.00%	2,097,165	41.13%	2,097,165	n.a.
Chinese import from Russia	1,173,765	27.32%	1,925,150	37.87%	751,385	64.01%
Others import from Russia	3,122,680	72.68%	1,061,671	20.88%	-2,061,009	-66.00%

Notes: For the March 2023 model, we omitted quantities of Russian crude oil imported by countries other than India and China so as to match our stylized segmented markets model assumption. This explains the differences between the model export data and the actual data in March 2023.

the sanctions.[20] Our calibrated models closely match the changes in prices and quantities in the actual data, with Russian Urals crude receiving $44/bbl in March 2023, as compared to the benchmark global price of $78/bbl. The world market price of crude oil declines by 10% in the model, close to the 11% decline observed in the actual data.

Having demonstrated that our model can approximately reproduce the market conditions before and after the sanctions, in Table 7 we quantify each of the three economic mechanisms underlying this change: (1) shifts in supply and demand that are unrelated to the sanctions, (2) the embargo-induced increase in transportation costs, and (3) the increase in Chinese and Indian market power caused by the embargo.

The global benchmark oil price in March 2023 was $8.45 lower than in January 2022, an effect the model attributes primarily to shifts in global supply and demand that are unrelated to the sanctions and that did not materially change the direction of Russian crude oil exports compared to January 2022. The fact that the calibrated model does not predict a large effect of supply and demand shifts on the global price of oil (or for that matter on Russian export prices) from January 2022 to March 2023 is consistent with the oil market having returned to some degree of normalcy at this point, following the surge and then decline in global oil demand in 2022.

The model also reflects a dramatic shift in the destinations of Russian crude oil exports, as the EU embargo and related import restrictions segmented the oil market. As the distance over which Russian oil had to be shipped increases sharply, so does the transportation cost. This rise in transportation costs causes about half of Russian crude oil exports to be shifted to India, which traditionally had imported no Russian oil at all (see Table 7). At the same time, Chinese crude imports from Russia increase by 63%. Russian oil imports to the rest of the world drop sharply.

This reallocation has little effect on global crude oil prices, consistent with the global export

[20] Recall that there is no market segmentation in January 2022. To match the data, we force India's import from Russia to zero and satisfy India's entire demand by other suppliers. In return, China and other countries are assumed to take up the supply by Russia. Overall India's and China's share of demand and Russia's share of export matches the data.

Table 7: Decomposition of the Effects of Sanctions on Prices and Russian Export Flows

	Overall Change		**Supply & Demand Effect**		**Transportation Costs Effect**		**Market Power Effect**	
Crude Oil Prices	US$/b	%	US$/b	%	US$/b	%	US$/b	%
Market FOB price p_W^*	-8.45	-9.74%	-8.02	-9.25%	-0.81	-0.93%	0.38	0.44%
Urals FOB price p_U^*	-42.39	-48.87%	-8.02	-9.25%	-15.72	-18.12%	-18.65	-21.50%
ESPO FOB price p_E^*	-19.21	-22.15%	-8.02	-9.25%	-3.26	-3.76%	-7.93	-9.14%
Russian Crude Oil Quant.	b/d	%	b/d	%	b/d	%	b/d	%
Russian export	-274,130	-6.38%	-213,542	-4.97%	-25,420	-0.59%	-35,168	-0.82%
Indian import from Russia	2,097,165	n.a.	0	0.00%	2,122,564	n.a.	-25,399	-1.20%
Chinese import from Russia	709,895	58.42%	-40,606	-3.34%	760,270	62.56%	-9,769	-0.80%
Others import from Russia	-3,081,190	-100.00%	-172,936	-5.61%	-2,908,254	-94.39%	0	0.00%

volume remaining roughly constant and Russia being forced to absorb the cost of shipping the oil to farther destinations. Table 7 shows that the Russian Urals fob price, p_U^*, would have dropped by \$16/bbl due to the transportation cost increase alone, neglecting the change in Indian market power. The ESPO fob price would have dropped by \$3/bbl in the absence of a change in China's market power.

Finally, consider the "market power" channel. While the curtailment of Western demand for Russian crude oil explains the large shifts in imports of Russian crude oil seen in the actual data, it does not help explain the price differentials for Russian crude oil relative to the world market prices observed in the data. This requires taking into account changes in India's and China's market power. Table 7 quantifies the extent of monopsony power of India and China in their respective markets for Urals and ESPO oil. The degrees of monopsony power are endogenously determined in the model calibrated to the March 2023 data. As expected, in the model both India and China withhold demand in order to wield their market power.[21]

[21] It may seem counterintuitive at first sight that China and India were "withholding" some of their demand for Russian oil, when China and India *increased* their imports of Russian oil over this period. The point here is that "withholding" means that India and China could have absorbed an even larger amount of oil from Russia than they did in the end, but chose not to. In other words, the relevant reference point is the oil market in March 2023 after accounting for both supply and demand effects and the transportation cost increases caused by sanctions-related market segmentation.

As a result, we see the prices for Urals and ESPO oil and the world market price diverge in the model, much like in the actual data. The rest-of-the-world market price increases slightly by less than 1% due to the larger residual demand of India and China because these countries withhold some demand from Russia in order to exert some degree of market power. At the same time, the fob prices for Urals and ESPO crude oil decline substantially, as India and China exercise their partial monopsony power in those markets. The Urals price drop by an additional \$19 and the ESPO price by an additional \$8. Thus, as in the actual data, transportation costs only account for about half of the observed price decline in the Urals fob price. The remainder is explained by India's market power. For the discount in ESPO oil prices, in contrast, market power is more important than transportation costs, consistent with the arguments in Section 4. The effect of India's and China's market power on export quantities is negligible compared to the effect of higher transportation costs.

It is noteworthy how close the price effects of the transportation cost and market power effects in Table 7 are to the back-of-the-envelope calculations in Table 3. Both approaches yield a combined increase in the Urals price discount of \$ 34. Based on the price data, the transportation cost was estimated to be \$ 15 compared to \$ 16 in the calibrated model. The market power effect was estimated to be \$ 17 compared to \$ 19 in the calibated model. The overall effect on the ESPO price of \$ 12 in the data is also similar to the \$ 11 in the calibrated model. While we were unable to parse the effect of higher transportation costs and higher market power on the ESPO fob price in the empirical section, the calibrated model helps answer that question. It assigns \$ 3 to the added transportation cost and \$ 8 to China's higher market power.

This result does not require an implausibly high degree of market power. Table 5 shows that the parameters governing the monopsony power of India and China are, respectively, $\alpha_I = 0.87$ and $\alpha_C = 0.83$, which means that their monopsony power is similar and in the intermediate range. Full monopsony power would have implied α equal $\frac{1}{2}$ and no monopsony power α equal 1.[22] The result that both India and China have only *partial* monopsonist bargain-

[22]It appears that China has slightly more monopsony power in the ESPO market than India in the Urals market, which is surprising given that prices in the Urals market are much lower than prices in the ESPO market. However,

ing power in the Urals and ESPO markets, respectively, may be due to the fact that in reality both compete to some extent with each other for Russian oil in both markets despite the vast shipping distances between the Baltic Sea and China as well as the Pacific port of Kozmino and the West Coast of India. It might also be due to the fact that – unlike under our simplifying modeling assumption – other countries like Turkey and the UAE have at times competed for Russian oil. Finally, it might be due to the fact that the Urals and ESPO pipeline system is connected, if only imperfectly.[23]

What the decomposition in Table 7 shows is that the observed changes in oil prices and export quantities between February 2022 and March 2023 are predicted by a combination of shifts in global demand and supply unrelated to the sanctions and international restrictions on imports from Russia including the EU embargo, leaving no role for the G7 price cap in explaining the data. This finding is consistent with and reinforces our earlier conclusion based on the data alone that the gap between world oil prices and Russian fob prices cannot be attributed to the G7 price cap.

6 Conclusions

A central question for policymakers has been whether the EU oil embargo and G7 price cap is working, and, if so, what components of these sanctions have proved effective and why. We provide evidence that the sanctions reduced Russian oil export revenues by 26% compared to the revenues that would have been expected in March 2023 given the global price of oil. Our analysis shows that the success of these sanctions in reducing Russian oil export revenues owes more to the voluntary import restrictions in 2022 and the oil embargo than to the G7 price cap.

we should not read too much into these small differences because α is a measure of monopsony power only when considering each market in isolation. In practice, India and China also interact with the (rest-of-the) world market and their monopsony power has an indirect effect on the world market through their residual demand.

[23] An alternative measure of the respective bargaining power of Russia, India and China is their threat-point, which is shutting down their respective segmented market. Either Russia or India may threaten unilaterally to shut down the Urals market, while either Russia or China may threaten unilaterally to shut down the ESPO market. Our model suggests that sizable effects on market prices in the world market from such actions. Neglecting transportation costs, the world market price would increase to $95.59 and $94.17 per barrel with either the Urals or ESPO market shut down, respectively. World market prices would increase by 24% or 22% relative to prices without market power if the Urals or the ESPO market were shut down, respectively.

While our analysis shows that the effects of the price cap on the Russian fob price have been negligible conditional on the West making available some maritime services for the transport of Russian oil to Asia, we are not saying that the economic outcomes in 2023 would have been the same if the price cap had never been implemented. The price cap may have induced Russia to expand its shadow fleet but, otherwise, it effectively had served its purpose once the EU agreed to relax the maritime services ban. It did not materially contribute to the Russian fob price discount in 2023 beyond this fact. This distinction is at odds with common perceptions of the success of the oil price cap and matters for the design of future sanction policies because it suggests that a price cap is not an essential component of sanctions packages in general.

Instead, we explained that Russia was forced to lower its fob price, as it diverted its crude oil exports to India and China, to accommodate the higher cost of shipping crude oil over longer distances. Moreover, as an oil export revenue-maximizer, Russia had no choice but to acquiesce to India's and China's insistence on lower prices for Russian crude, given the rising market power of the only remaining major importers of Russian crude. A calibrated model of the global oil market demonstrates that increased transportation costs and a modest amount of market power can explain the discounts that Russia was offering on its fob price relative to the global price of oil. This evidence suggests that the oil embargo (and related import restrictions) were ultimately responsible for lowering the Russian fob price.

The implications of this calibrated model closely match those of a back-of-the-envelope calculation based on detailed data for Russian fob prices, cif prices in selected importing countries, and commonly used oil trading benchmarks. We showed that the evolution of the Russian fob price for Urals crude in the first half of 2023 is not consistent with a binding price cap. We also showed that the price cap appears to have done little to curtail Russian oil revenues in the second half of 2023. Moreover, the insurance premium, through which the price cap would affect oil trade, does not, at present, appear quantitatively important, nor does the shipping risk premium compensating shippers in violation of the sanctions for the possibility that they may be caught.

Evaluating the effect of the price cap requires distinguishing between its important political contribution of allowing those transporting Russian oil access to Western services, and its direct economic effects. The latter primarily took the form of causing Russia to increase the size of its tanker fleet, although we discussed several reasons why some of this increase may have been caused by factors other than the price cap. The announcement of a potential price cap in June 2022 does not appear to have altered global oil prices, nor does it appear to have altered beliefs about future oil prices as measured by oil futures prices. Indeed, such an effect would seem inconsistent with the decline in global real activity in the second half of 2022 and the fact that oil inventories persistently increased in the second half of 2022. Nor did they decline after the implementation of the price cap started in December 2022.

Our model provides evidence that the price discount on Russian oil in March 2023 was mainly due to the import restrictions culminating in the EU oil embargo, which were reflected in a rise in transportation costs and in India's and China's market power. As long as the oil embargo continues to be enforced and these market conditions remain unchanged, one would expect the price discount to persist. The fact that the price discount on Urals oil has steadily declined since March 2023, as shown in Figure 4, raises the question of what has changed.

While a formal examination of this period is beyond the scope of this paper, in our view, the erosion of the Russian fob discount since March 2023 is likely explained by several changes in market conditions. For starters, Russian seaborne crude oil exports declined by 20% between March 2023 and November 2023, the most recent date for which accurate data on bilateral oil trade flows exist. This decline arguably reflected in part Russia's commitment to OPEC+ production restrictions and in part the lower efficiency of Russia's oil industry. As less oil was being exported by sea, the demand for oil tankers fell and so did the cost of transporting crude. The reduction in seaborne transportation costs in turn helps explain the lower Russian fob price discount.

The fall in Russian oil exports may also have been driven by lower demand from India. From March to November 2023, India reduced its demand for Russian oil by 13%. This was not a consequence of the threat of G7 sanctions, but likely caused by some combination of lower domestic demand for oil, limits to oil storage, and a reduction in India's ability to re-export refined products profitably. There was no material decline in China's oil demand for Russian oil over the same period. Finally, Russia has also become more adept at bypassing embargo restrictions by disguising the origin of its oil exports, which reduces the market power that was previously enjoyed by India and China, as does the recent increase in Turkey's oil imports from Russia. Turkey's imports doubled between March and November. Much of this oil finds its way into Europe directly or indirectly, undermining the oil embargo.

While it is conceivable that tightening the enforcement of the price cap could substantially improve its effectiveness, such measures are not likely to stem the flow of ESPO crude from Russia to China short of imposing secondary sanctions on Chinese companies, which does not seem politically feasible. There is more scope for reducing the size of the shadow fleet supplying Urals oil to India. However, at least initially, the second phase of the price cap launched in October 2023, in an effort to enhance compliance and to increase the costs to Russia of using the shadow fleet, has had little effect on the fob price discount for Russian Urals oil. The discount was $9 at the end of September 2023. As of the end of February 2024, the discount was virtually unchanged at $8, with the Urals price of $75 remaining well above the price cap of $60.

References

Ahn, Daniel P and Rodney D Ludema, "The sword and the shield: The economics of targeted sanctions," *European Economic Review*, 2020, *130*, 103587.

Babina, Tania, Benjamin Hilgenstock, Oleg Itskhoki, Maxim Mironov, and Elina Ribakova, "Assessing the Impact of International Sanctions on Russian Oil Exports," *Available at SSRN*, 2023.

Besedeš, Tibor, Stefan Goldbach, and Volker Nitsch, "Cheap talk? Financial sanctions and non-financial firms," *European Economic Review*, 2021, *134*, 103688.

Borenstein, Severin and Ryan Kellogg, "The Incidence of an Oil Glut: Who Benefits from Cheap Crude Oil in the Midwest?," *The Energy Journal*, 2014, *35* (1), 15–34.

Brancaccio, Giulia, Myrto Kalouptsidi, and Theodore Papageorgiou, "Geography, transportation, and endogenous trade costs," *Econometrica*, 2020, *88* (2), 657–691.

Felbermayr, Gabriel, T Clifton Morgan, Constantinos Syropoulos, and Yoto V Yotov, "Understanding economic sanctions: Interdisciplinary perspectives on theory and evidence," *European Economic Review*, 2021, *135*, 103720.

Johnson, Simon, Lukasz Rachel, and Catherine Wolfram, "A Theory of Price Caps on Non-Renewable Resources," Working Paper 2024.

Kellogg, Ryan and Richard L Sweeney, "Impacts of the Jones Act on US Petroleum Markets," Working Paper 2023.

Kennedy, Craig, "Dangerous Waters. How far will OFAC go in sanctioning Russia's shadow trade?," 2023. Available at: `https://navigatingrussia.substack.com/p/dangerous-waters`.

Kilian, Lutz, "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market," *American Economic Review*, 2009, *99* (3), 1053–1069.

— , "Measuring Global Real Economic Activity: Do Recent Critiques Hold up to Scrutiny?," *Economics Letters*, 2019, *178*, 106–110.

— , "Understanding the Estimation of Oil Demand and Oil Supply Elasticities," *Energy Economics*, 2022, *107*, 105844.

— **and Daniel P Murphy**, "The Role of Inventories and Speculative Trading in the Global Market for Crude Oil," *Journal of Applied Econometrics*, 2014, *29* (3), 454–478.

— and Xiaoqing Zhou, "Modeling fluctuations in the global demand for commodities," *Journal of International Money and Finance*, 2018, *88*, 54–78.

Koh, Ann, Alaric Nightingale, and Bloomberg, "The Cost of Insuring Merchant Ships Sailing to the Black Sea is up as Much as 10% During Ukraine Invasion," 2022. Available at: `https://fortune.com/2022/04/08/merchant-ships-insurance-costs-10-percent-black-sea-ukraine-invasion/`.

Levi, I., P. Katingas, L. Myllyvirta, and K. Hemalatha, "Shedding Light on Shadow Tankers. Who Transports Russian Oil 18 Months into the Invasion?," 2023. Available at: `https://energyandcleanair.org/wp/wp-content/uploads/2023/09/CREA_Russias-shadow-tankers_09.2023.pdf`.

Morgan, T Clifton, Constantinos Syropoulos, and Yoto V Yotov, "Economic sanctions: Evolution, consequences, and challenges," *Journal of Economic Perspectives*, 2023, *37* (1), 3–29.

Nightingale, A., J. J. Lee, and A. Longley, "How Russia Punched an $11 Billion Hole in the West's Oil Sanctions," 2023. Available at: `https://www.bloomberg.com/news/articles/2023-03-30/russia-still-reliant-on-western-insurance-for-half-oil-shipments#xj4y7vzkg`.

Nostrand, Eric Van, "Remarks by Acting Assistant Secretary for Economic Policy Eric Van Nostrand on the Second Phase of the Price Cap on Russian Oil at the Brookings Institution," 2023. Available at: `https://home.treasury.gov/news/press-releases/jy1815`.

Ollett, John and Sheel Bhattacharjee, "Tanker Insurance Premiums to Rise in 2023," 2023. Available at: `https://www.argusmedia.com/en/news/2410024-tanker-insurance-premiums-to-rise-in-2023`.

Paris, Costas, "Ship-Insurance Premiums for Russian Oil Liftings Up 400%," 2022. Available at: `https://www.wsj.com/livecoverage/russia-ukraine-latest-news-2022-03-15/card/ship-insurance-markets-see-premiums-for-russian-oil-liftings-up-400--bJpfWdHNcyweWnoPOFkA`.

Rosenberg, Elizabeth and Eric Van Nostrand, "The Price Cap on Russian Oil: A Progress Report," *U.S. Department of the Treasury*, 2023.

Saul, Jonathan, "Insurance Costs of Shipping through Black Sea Soar," 2022. Available at: https://www.reuters.com/business/insurance-costs-shipping-through-black-sea-soar-2022-02-25/.

__ , "Black Sea Shipping Rates Rise as Reinsurers Cut Cover," 2023. Available at: https://www.reuters.com/article/ukraine-crisis-shipping-insurance/black-sea-shipping-rates-rise-as-reinsurers-cut-cover-idUSL8N33Q2WD.

Tobben, Sheela, "Insurance for Middle East Oil Shipments Soars to More Than $500,000," 2019. Available at: https://www.insurancejournal.com/news/international/2019/06/25/530400.htm.

A Appendix: Calibration of the "After Sanctions" Model

This appendix provides further details on the "After Sanctions" Model and its calibration. First, we derive equation (2). Assume first that India has full monopsony power. Then India chooses the quantity of Urals imports to maximize her gross surplus minus cost:

$$\max_{q \in \mathbb{R}_+} \left(\frac{d_I^{-1}(0) - d_I^{-1}(q)}{2} q + d_I^{-1}(q) q - (s_U^{-1}(q) + t_U) q \right).$$

The first two terms are India's gross consumer surplus. The last term are the import costs.

Expand and simplify this expression to obtain

$$\max_{q \in \mathbb{R}_+} \left(\frac{1}{2} \left(d_I^{-1}(0) q + d_I^{-1}(q) q \right) - s_U^{-1}(q) q - t_U q \right).$$

The first-order condition is

$$\frac{1}{2} \left(d_I^{-1}(0) + d_I^{-1}(q_U^*) + \frac{\partial d_I^{-1}(q_U^*)}{\partial q} q_U^* \right) = s_U^{-1}(q_U^*) + \frac{\partial s_U^{-1}(q_U^*)}{\partial q} q_U^* + t_U, \tag{5}$$

which is India's marginal gross consumer surplus equals India's marginal cost.[24]

India's inverse demand and Russia's inverse supply of Urals crude oil are, respectively,

$$\begin{aligned} d_I^{-1}(q) &= \frac{\ell}{m} - \frac{1}{\gamma_I m} q \\ s_U^{-1}(q) &= -\frac{c}{k} + \frac{1}{\rho_U k} q. \end{aligned}$$

Thus, the l.h.s. of equation (5) becomes

$$\begin{aligned} \frac{1}{2} \left(d_I^{-1}(0) + d_I^{-1}(q_U^*) + \frac{\partial d_I^{-1}(q_U^*)}{\partial q} q_U^* \right) &= \frac{1}{2} \left(\frac{\ell}{m} + \frac{\ell}{m} - \frac{1}{\gamma_I m} q_U^* - \frac{1}{\gamma_I m} q_U^* \right) \\ &= d^{-1}(q_U^*), \end{aligned}$$

[24]We use ∂ in place of d to avoid confusion with the demand function.

and equation (5) is equivalent to

$$\begin{aligned} d^{-1}(q_U^*) - t_U = s_U^{-1}(q_U^*) + \frac{\partial s_U^{-1}(q_U^*)}{\partial q} q_U^* \\ = -\frac{c}{k} + \frac{1}{\rho_U k} q_U^* + \frac{1}{\rho_U k} q_U^* \\ = -\frac{c}{k} + 2\frac{1}{\rho_U k} q_U^*, \end{aligned}$$

which after some algebra is equivalent to

$$\begin{aligned} \frac{1}{2}\rho_U \left(c + k \left(d^{-1}(q_U^*) - t_U\right)\right) = q_U^* \\ \frac{1}{2} s_U(d^{-1}(q_U^*) - t_U) = q_U^*. \end{aligned}$$

Using $q_U^* = s_U(p_U^*)$, we obtain

$$\frac{1}{2} s_U(d^{-1}(s_U(p_U^*)) - t_U) = s_U(p_U^*).$$

When India has no market power, the effective price $d^{-1}(s_U(p_U^*))$ must equal the competitive cif price. In this case, $d^{-1}(s_U(p_U^*)) - t_U = p_U^*$ is the competitive fob price for Urals oil, and

$$s_U(d^{-1}(s_U(p_U^*)) - t_U) = s_U(p_U^*)$$

must hold. Thus, for any degree of market power $\alpha_I \in \left[\frac{1}{2}, 1\right]$, equation (2) holds:

$$\alpha_I s_U(d^{-1}(s_U(p_U^*)) - t_U) = s_U(p_U^*).$$

Equation (3) can be derived analogously.

The system of equations is given by equations (2) to (4) and

$$\rho_U s(p_U^*) = q_U^* \tag{6}$$

$$\rho_E s(p_E^*) = q_E^* \tag{7}$$

$$s(p^*) = d^*(p^* + t) \tag{8}$$

together with the identities

$$-m = e_D(p^*)\frac{q^*}{(p^* + t)} \tag{9}$$

$$k = e_S(p^*)\frac{q^*}{p^*}, \tag{10}$$

given the data realizations in the lower part of Table 4 and $p^* \geq 0$.

Solving for the unknowns $\{p^*, q^*, \gamma_I, \gamma_C, \rho_U, \rho_E, \alpha_I, \alpha_C\}$ also determines parameters m, ℓ, k, and c. Note that (p^*, q^*) is the competitive equilibrium in the counterfactual market without sanctions. The parameter t is the cost of insurance and freight in the counterfactual market without sanctions, which we assume to equal the costs prevailing in January 2022. We set t_U (the cif-fob Urals markup), t_E (the cif-fob ESPO markup), and t_W (the cif-fob markup in the rest of the world for the segmented market in March 2023), to the values stated in Table 4. The parameter solutions $\gamma_I, \gamma_C, \rho_U$, and ρ_E should be understood as the "true" but unobservable market shares of India, China, Urals, and ESPO, respectively, in the competitive equilibrium of the counterfactual market without sanctions. The results of the calibration are shown in the third column of Table 5.