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Design and Implementation of the Price Cap on Russian Oil Exports

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Basic economics teaches that price caps are bad – limiting the price of a good distorts demand and discourages producers from supplying the market. So why did the Biden Administration, led by Janet Yellen, the consummate economist, champion a price cap on oil from Russia after it invaded Ukraine in 2022? The answer is that this price cap, implemented for crude oil in December 2022 and oil products in February 2023, differs significantly from the standard cap discussed in introductory economics classes.

A standard price cap applies to all goods traded in a market. For example, in some countries there are price caps on bread for everyone or diesel for farmers or rent controls on housing. Such caps often lead to excess demand for the good and insufficient supply, and thus to shortages at the capped price. If prices are constrained, other non-price mechanisms, like first-come-first-served, are required to allocate the good. All too frequently, the result is empty bakery shelves or fuel shortages or difficulties finding housing.

This paper explains how the cap on Russian oil is different and describes its first six months in existence. We first provide background on Russian oil trade in Section I. Section II outlines the price cap policy, describing its goals, structure and enforcement. Section III explains how the current price cap on Russian oil differs from the much-criticized textbook price cap. Section IV describes some additional attributes of the policy and Section V describes some concerns raised before the policy was implemented. Section VI reviews key outcomes over the first six months

I. Background: Energy as a Double-edged Sword

On February 24, 2022, Russia invaded Ukraine, in a major escalation of an ongoing war. The United States, the European Union, and their allies immediately responded to this unprovoked and illegal aggression with a broad range of sanctions, including the freezing of Russian central bank reserves. These unprecedented actions, while damaging to Russia's economy, did not stop the war. Russian aggression continued, causing massive loss of life and damage to civilian infrastructure.

Russia's abundance in natural resources, primarily fossil fuels, is a double-edged sword, both for its government and for the rest of the world. On the one hand, energy exports are the most important source of revenue for the Russian state, which creates a vulnerability in case the revenues dry up. In the first nine months after its renewed invasion of Ukraine, when the energy sanctions were subject of intense debate but had not yet been implemented, Russia exported oil worth over $600 million per day.[2] Oil and petroleum products are also the country's single

[2] This is a conservative estimate based on multiplying 8 million barrels per day times an average "Urals discount" price of around $80 per barrel. (Russia's main crude oil product is the Urals blend.) See also "October update: EU fossil fuel payments to Russia in first fall below pre-invasion level in October," Centre for Research on Energy and Clean Air, CREA, https://energyandcleanair.org/october-update-eu-fossil-fuel-payments-to-russia-in-first-fall-below-pre-invasion-level-in-october/, for more detailed estimates by types of fossil fuel.

largest source of foreign exchange.[3] Revenues from fossil fuel exports, including crude oil, petroleum products, natural gas, and coal, funded around 45 percent of the Kremlin's budget before the war. Given the decline in other domestic and export sectors, fossil fuel exports – oil in particular – are now even more important to federal revenues.[4] Such high dependence of Russia on the energy revenues creates a powerful potential economic weapon for the governments in the West: curtailing the flow of money for oil and energy more broadly would significantly tighten Russia's budget constraint, especially in presence of other sanctions that limit the ability of the Russian state to borrow and save. This action not only could constrain what is feasible for Russia militarily in the short run, but it presumably should reduce the Kremlin's ability and incentive to invade neighboring nations.

On the other hand, the world economy relies on Russian energy exports. In 2021, before the war, Russia produced about 10.5 million barrels per day (mbpd) and exported almost 8 mbpd of crude oil and refined products, making it the world's single largest exporter of oil and product combined.[5] Of this total, just under 5 mbpd was crude oil, with 1.5-2 mbpd flowing through pipelines to the European Union, China, and countries that were formerly part of the Soviet Union.[6] Beyond oil, the European Union relied heavily on Russian natural gas exports. This dependence of the world economy on Russian energy exports, especially in 2022 as major economies confronted post-covid supply constraints and inflation was at a 30-year high, made energy exports a powerful economic weapon for Russia: threatening to limit production could drive prices higher, leading to economic hardship and possibly a softening stance of the West against the war. At the same time, the size of Russia's oil exports made the traditional instruments of international relations and economic warfare, such as outright embargoes on Russian energy exports, a lot riskier and more complex for Western governments. In short, Russia's dominance in world energy markets created a need for new solutions that could impose

[3] In 2022, Russia earned some windfall profits from manipulating the price of natural gas sold to Europe, but oil is expected by far to be Russia's largest potential source of foreign exchange revenue in 2023 and for the foreseeable future. In 2019, oil, petroleum products, and gas earned Russia $240 billion, with over half of that coming from sales to the EU; the rest of Russia's exports combined ($48.5 billion) amounted to less than the value of its gas exports ($51 billion); crude oil generated $122.2 billion and refined products accounted for $66.9 billion; see Korhonen and Simola (2022).

[4] Oil and natural gas "made up 45 percent of Russia's federal budget" in 2021; "Russia's War on Ukraine", https://www.iea.org/topics/russia-s-war-on-ukraine. Russia received high short-term profits from natural gas exports in 2022, primarily through exploiting its market power in Europe. For Russian fossil fuel revenues during 2022, see "Financing Putin's war: Fossil fuel exports from Russia in the first six months of the invasion of Ukraine," https://energyandcleanair.org/publication/financing-putins-war-fossil-fuel-exports-from-russia-in-the-first-six-months-of-the-invasion-of-ukraine/. In fall 2022, Russian federal government revenue was forecast at just over $500 billion for 2023, "Russia's PM sees budget deficit at 2% of GDP in 2023", Reuters, September 20, 2022, https://www.reuters.com/world/europe/russias-pm-sees-budget-deficit-2-gdp-2023-2022-09-20/, with a budget deficit of 2 percent of GDP.

[5] See "IEA Sees Russia Oil Output Nosediving in 2023 on Lack of Markets," November 15, 2022, https://www.bloomberg.com/news/articles/2022-11-15/iea-sees-russia-oil-output-nosediving-in-2023-on-lack-of-markets?leadSource=uverify%20wall. Total Russia oil exports in 2021 were 7.3 million bpd in Q1 2021, rising to 7.7 million bpd in Q4; from the IEA Monthly Oil Market Report, 16 March 2022, p.5.

[6] See "Oil Market and Russian Supply," IEA, February 2022, https://www.iea.org/reports/russian-supplies-to-global-energy-markets/oil-market-and-russian-supply-2

effective and sustained economic damage on an aggressor that happened to be a major energy exporter.

The price cap on Russian oil emerged as a policy to address that challenge.

II. The Goals and Structure of the Price Cap

The price cap has two main goals. First, it is an integral part of a broader sanctions package designed to reduce Russia's foreign exchange revenues and reduce its capacity to wage war in Ukraine. In general, sanctions are designed to limit government revenues and impose an appropriate degree of economic hardship on aggressor countries. Reducing the revenue from oil exports provides a key potential lever to reduce Russia's ability to wage war. Three potential effects were at play: lower foreign exchange revenue make it harder for Russia to defend its exchange rate, particularly given that most of its foreign currency reserves are frozen; less foreign cash per day will also reduce Russia's ability to buy weapons (including ammunition and drones) from other countries; and lower expected future federal government revenues will reduce the government's broader ability to finance and conduct war, including the local currency component (e.g., paying soldiers and domestic armaments suppliers).

The second goal of the price cap was to make it possible for Russian oil to stay on the world market in the face of an impending complete European Union (EU) embargo and services ban. In early May 2022, the European Union announced that it would ban imports of both Russian seaborne oil and refined products and ban the provision of EU-based services for shipments of Russian seaborne oil to non-EU countries.[7] Observers expected the United Kingdom, which was planning an import ban of its own, and other Western countries would follow the European Union. The European Union's import ban took effect on December 5, 2022, for crude oil and February 5, 2023, for petroleum products. Many analysts predicted that the EU embargo and services ban – if implemented without exceptions – would prevent Russia from exporting 1-2 mbpd of oil, potentially increasing oil prices significantly and, in turn, adding to global inflationary pressures.[8]

The price cap for Russian oil is implemented by G7 countries and allies, a group we will refer to as "the coalition." The coalition is best understood as a group of service providers—not a group of current Russian oil importers – because alongside the price cap, the coalition countries implemented embargoes on purchases of Russian oil. Crude oil tankers are large and can deliver their cargo to any suitable port, so since the invasion, Russia has steadily redirected its exports of crude by sea to China, and by mid 2022 was exporting over 1 mbpd to India, which was not previously a significant buyer of Russian crude.

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[7] This was part of the EU's sixth package of sanctions, agreed May 30-31: "Russia's War on Ukraine: Eu Adopts Sixth Package of Sanctions Against Russia," https://ec.europa.eu/commission/presscorner/detail/en/IP_22_2802.

[8] "Some 1 million barrels per day of Russian products and 1.3 million barrels per day of crude would have to find new homes due to the planned EU restrictions, according to the IEA estimates," https://www.bloomberg.com/news/articles/2022-08-11/iea-sees-russian-oil-output-down-20-when-eu-ban-takes-effect.

The cap is set as a specific price level measured in dollars per barrel of oil, meaning that it will not mechanistically vary with the price of world oil (e.g., the Brent benchmark price for crude oil).[9] In principle, the coalition may periodically reset the price cap, for example if world oil prices rise or fall dramatically – or based on Russian military actions. Thus far, however, the price cap has remained at the initial level of $60 per barrel for crude oil, and $45 and $100 for low- and high-quality refined petroleum products, respectively.[10]

Crucially, the cap applies to any purchase of crude oil exported by sea from Russia after December 5th, 2022, providing the purchase involves maritime, financial, or other services from any entity based in a coalition member's jurisdiction. After February 5, 2023, petroleum products were subject to equivalent caps. Crude oil exported by pipeline is exempt from the cap. Purchases that do not involve coalition services – e.g., a purchase by a Chinese trader carried on a Chinese ship to a Chinese refinery, paid in rubles through a Chinese bank, and insured by a Russian company – are not be subject to the price cap. The cap applies only until the point of the "first landed sale," meaning that sales while the oil is still on the water must adhere to the price cap, so long as they use coalition services.[11] Any refined products made from Russian oil in other countries is not subject to a price cap.

These design elements are a consequence of two important features of Russian oil exports. First, much of Russian oil is exported by sea. Second, pre-invasion, the western services played a major role in facilitating these exports. Thus, the western coalition are using the market power they have in the market for oil trade services, to exert pressure on the exporter.

More specifically, before the February 2022 invasion, about 90% of both crude oil and petroleum product exports that left Russia by sea were insured by companies in the European Union, a G7 country or Norway.[12] Crude exports via pipeline are effectively at capacity, so Russia cannot shift away from using ships.

In contrast to crude oil, none of Russia's petroleum product exports travel by pipeline and before the invasion, most were carried in specialized short-haul tankers to European markets.[13] Russia

[9] "G7 coalition has agreed to set fixed price for Russian oil," Reuters, November 4, 2022, https://www.reuters.com/world/exclusive-g7-coalition-has-agreed-set-fixed-price-russian-oil-source-2022-11-03/.

[10] Low-quality petroleum products, such as fuel oil and naphtha, typically trade at a discount to crude oil, while high-quality products, such as diesel and gasoline, typically trade at a premium to crude oil. See "The Price Cap on Russian Oil: A Progress Report," US Treasury, May 18, 2023, https://home.treasury.gov/news/featured-stories/the-price-cap-on-russian-oil-a-progress-report

[11] This was clarified by officials in early November: "G7 Russian oil price cap applies only to seaborne crude," Reuters, November 4, 2022, https://www.reuters.com/business/energy/g7-russian-oil-price-cap-applies-only-seaborne-crude-official-2022-11-04/.

[12] See "Tracking the impacts of EU's oil ban and oil price cap," CREA, updated regularly.

[13] For example, in 2021, China received 1.6-1.8 million barrels of crude per day from Russia, half via pipeline and half on ships, but no refined products (IEA, Monthly Oil Market Report, 16 March 2022, p.5).

has very little available on-shore storage for oil or refined products, so they can only produce what they can consume domestically or export.

The price cap is implemented via regulations on service providers in coalition countries. A company based in one of the coalition countries that knowingly provides services to a transaction involving seaborne Russian oil priced above the cap is engaging in conduct prohibited by their country's sanctions and would therefore face the appropriate national penalties.[14] A system of attestations, issued by trusted entities, is used to enforce compliance. For instance, if the transaction described above involving the Chinese refinery was insured by a UK-based entity that knew the price paid was above the cap (or should have known if the company had followed appropriate due diligence processes), then the UK insurer would be violating the UK's prohibition on providing services for oil purchases above the cap.[15] Coalition countries have established "safe harbors" for service providers who unknowingly provide services for oil purchased above the cap due to fraudulent or falsified information provided by their customers. Ultimately, since the price cap is a new tool, implementation and enforcement is a challenge. We discuss how these issues affect the economics of the problem below.

III. How Is the Price Cap on Russian Oil Different from Standard Price Caps?

The price cap on Russian oil differs from a standard price cap in several important ways. First, it only caps the price received by one supplier – Russia. Oil markets are global, and crude oil is regularly shipped long distances, e.g., from Russia to India or from Saudi Arabia to Japan. This means that shocks to demand and supply anywhere in the world can impact the global market price for oil. As discussed above, Russia is a major supplier to world consumers, accounting for about 8% of world supply and more than 12% of exports (see BP Statistical Review of World Energy 2022). Since the cap only applies to Russian oil, it does not affect the incentives of firms in other countries to produce and export oil, and it does not distort the prices that final consumers pay for oil on the global market. (See Section A of the Appendix for a graphical treatment.)

Fundamentally, the cap shifts revenues away from the sanctioned entity – effectively the Kremlin in this case – towards the purchasers of resources at the cap. Oil customers – for example, refineries in India – can buy crude oil below the benchmark price in the global market. This offers a free profit, or arbitrage opportunity. It is important to stress that this is a feature and not a bug: as long as the oil reaches the global market and the revenues accruing to the sanctioned country are limited, the goals of the cap are met. For customers, complying with the price cap is incentive compatible. The potentially large profit opportunities for the buyers of Russian crude

[14] For a more discussion regarding how the cap will be enforced, see this commentary: "OFAC issues guidance on implementation of G7 price cap on Russian crude oil and petroleum products," Hogan Lovells, 19 September 2022, https://www.engage.hoganlovells.com/knowledgeservices/news/ofac-issues-guidance-on-implementation-of-g7-price-cap-on-russian-crude-oil-and-petroleum-products.

[15] See this summary of UK legislation, from the UK Treasury: https://www.gov.uk/government/news/uk-government-bans-services-enabling-the-transport-of-russian-oil, which notes: "Insurance is one of the key services that enables the movement of oil by sea, particularly protection and indemnity (P&I) insurance which relates to third-party liability claims – the UK is a global leader in the provision of P&I cover, writing 60% of global cover".

mean that the purchasers seek Russian oil, so that it is effectively rationed. Note that this arrangement does not require that the purchasing entities or their home countries – e.g., India – officially commits to the price cap. This makes the instrument implementable without an explicit consent from all the buyers. This is a key advantage of the cap over other instruments such as tariffs, which would require explicit commitment at a governmental level. However, oil importing countries may decide to tax away some of those economic rents or find some other way to share the benefits with ultimate consumers of fuel. We discuss this further below and in the appendix.

The second reason why this price cap is different from the standard caps is that Russia is an inframarginal producer, meaning that its marginal costs of extracting and transporting oil for export are considerably below market clearing prices. This reflects both Russia's luck – the country is endowed with oil that is inexpensive to extract (although analysts suggest reserves of inexpensive oil are dwindling) – and the fact that oil markets are far from perfectly competitive, meaning that the market price is above all suppliers' marginal costs.[16] OPEC+, the coalition of large oil exporters (the original members of OPEC plus Russia and several smaller producers), regularly meets to orchestrate agreements among members to restrict output in order to buoy prices.[17]

Because Russia is an inframarginal supplier, there is room to set a price cap above the country's marginal cost and still significantly below world prices. If the price cap level is set sufficiently above Russia's marginal costs, it has the economic incentive to sell at the cap rather than withhold oil that it cannot sell without coalition country services. These incentives are sharpened by the financial and trade constraints facing the Russian state, in part due to the financial and trade sanctions implemented alongside the price cap by the coalition. If these constraints mean that the contemporaneous flow of revenues are particularly important to Russia, it might face incentives to increase production when prices are capped, to offset the negative revenue impact (Johnson, Rachel, and Wolfram, 2023).

[16] According to a pre-invasion presentation by Rosneft to investors, its upstream margins were positive in early 2020, even though the onset of the COVID-19 pandemic pushed world oil prices down towards $20 (see slide 11 in https://www.rosneft.com/upload/site2/document_cons_report/Q42021_Results_ENG_final.pdf, which is the presentation accompanying full year financial results). Some estimates suggest a marginal cost of production for established Russian oil fields may even be under $10 per barrel (Hausmann 2022).

[17] OPEC currently has thirteen member countries: five on the Persian Gulf (Iran, Iraq, Kuwait, Saudi Arabia, and UAE), seven are in Africa (Algeria, Angola, Republic of the Congo, Equatorial Guinea, Gabon, Libya, and Nigeria), and one in Latin America (Venezuela); https://www.opec.org/opec_web/en/. Ten other countries, including Russia, join that group to form OPEC+: https://www.weforum.org/agenda/2022/11/oil-opec-energy-price/.
According to the US Energy Information Agency, https://www.eia.gov/energyexplained/oil-and-petroleum-products/where-our-oil-comes-from.php, "Together, the OPEC members at the beginning of 2020 held about 71% of the world's total proved crude oil reserves, and the OPEC members in 2021 accounted for about 37% of total world crude oil production."

IV. Additional Attributes of the Russian Oil Price Cap

In addition to reducing Russian export revenue while keeping oil on the market, the price cap on Russian oil has several additional features. First, while the price cap only directly applies to purchases of Russian oil that use services from coalition countries, it also likely provides negotiating power to oil importers that continue to buy Russian oil above the cap without using those services. As long as there are market imperfections – e.g., perhaps the markets are segmented to some extent, so that buyers have some monopsony power – reducing the attractiveness of Russia's "outside option" through capping prices will further empower the monopsonist buyers that purchase oil outside of the price cap regime.

Second, it is important to weigh the price cap relative to alternatives. In the past, oil sanctions have involved embargos, which make it illegal for anyone in one country to buy from the embargoed country. For instance, from 2017, the Trump Administration began to impose sanctions on oil exports from Venezuela. But Russia is a much larger oil exporter than Venezuela.[18] An all-out embargo on Russian oil would have much larger implications for world oil markets and thus for global inflation. For example, if the EU embargo prevents 2 mbpd from reaching the market, reasonable assumptions suggest that oil prices could spike by at least $20 per barrel which, at the end of 2022, would have represented more than a 20% jump from 2021 average prices.[19] A broader embargo would lead to much larger price spikes.[20]

The other problem with an embargo would be that, like many laws and rules, it is likely that it would be flouted in part, i.e., there will be "leakage" around the edges. If Russia sells some oil outside the embargo, it could make more money per barrel on the oil it can sell, since removing the regular supply of its oil from the market is likely to drive up world prices. It is even possible that Russia would earn more revenue after an embargo than it would without an embargo.[21]

The price cap, by contrast, hurts Russia while providing a benefit to countries that can access lower-priced Russian oil than they could without the sanctions. This makes it less likely that

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[18] In 2017, before the US imposed sanctions, Venezuela produced about 1 million barrels of crude per day; https://www.eia.gov/international/analysis/country/VEN. By August 2020, this had fallen to 360,000 b/d.

[19] These are roughly the magnitudes discussed by market analysts; "IEA Sees Russia Oil Output Down 20% When EU Ban Takes Effect," Bloomberg, August 11, 2022, https://www.bloomberg.com/news/articles/2022-08-11/iea-sees-russian-oil-output-down-20-when-eu-ban-takes-effect.

[20] For example, if the short-run demand elasticity is 0.1 and supply is perfectly elastic in the short run, meaning that markets clear on the demand side, a 2 mbpd reduction in Russian exports would reduce global supply by 2%. The demand elasticity assumption implies a 20% price increase is required for markets to clear.

[21] Some readers may counter that clearly Russia couldn't make *more* money with an embargo or they would have reduced exports on their own. But this logic neglects that there are uncertain outcomes resulting from reduced Russian exports. In other words, it is possible that even if expected profits are higher, Russia may be risk averse and unwilling to take the risk that profits would fall. The Russian government may also be concerned about the long-run costs of shutting down and reopening oil wells; there is a range of views among experts on how difficult or costly this would be.

there will be pressure to remove the sanctions over time. (Note that the EU and other coalition countries are not importing Russian oil in 2023 and beyond, but they benefit from the price cap because world prices will be lower than they would be without it.)

The total windfall gain for refiners in developing countries could be large, depending on the price cap relative to world prices. For example, 5 mbpd could generate between $50 million and several hundred million in additional profits, every day, depending on how the price cap relates to global benchmark prices. These amounts are significant relative to the cost of oil and government budgets in many countries.[22] Developing countries could use the resulting revenue (e.g., from taxing the windfall profits of local oil refiners) to subsidize consumers who are paying higher food prices due to the Russian invasion. This would be their policy choice.

The price cap represents a novel approach to sanctions. Typically, sanctions ban the trade of a good, imposing costs on both the sanctioned and the sanctioning countries. By contrast, the price cap limits the price of a good that uses services provided by a particular set of (western) companies. Further, the cap can be adjusted up or down as the coalition decides to tighten or loosen sanctions.

V. Concerns and Criticisms

There was plenty of bluster from Russia in reaction to the price cap proposal, and some prominent western voices have also expressed skepticism. We now offer an assessment of how the policy has fared against these mixed expectations.

A. *Possible Russian Shut-In*

Before the price cap was implemented, a central concern was that Russia would refuse to export oil at capped prices, effectively turning the price cap into an embargo. In July 2022, JP Morgan's commodity desk predicted that oil prices would spike to over $350 per barrel when Russia refused to sell into the price cap.

This concern was compounded by the strategically positioned threats from the Russian leadership about their willingness to withhold oil in response to the price cap. For example, Deputy Prime Minister Alexander Novak announced in early October 2022 that the price cap was "unacceptable" saying that, "if the price cap is introduced and we can't redirect the oil to other markets, we will cut our production by as much as needed." (see Bloomberg, October 5,

[22] India consumes about 5 million barrels of oil per day ("India's daily petroleum consumption growing faster than global average," Hindustan Times, October 12, 2022, https://www.hindustantimes.com/business/indias-daily-petroleum-consumption-growing-faster-than-global-average-puri-101665762596340.html#:~:text=Union%20minister%20of%20petroleum%20and,growth%20rate%20of%20around%201%25). At a world price of $100, that is $500 million per day. If half of this daily oil consumption comes from Russian oil in 2023 (up from about 1 mbpd from Russia currently) and if the price cap is set (hypothetically) at $50 per barrel, that would save India $125 million per day or $45 billion per year. Total Indian federal government spending in 2021 was about $360 billion.

2022).[23] It is useful to think carefully about the incentives that have so far mitigated against this type of response.

First, Russia's economic incentives to sell oil to non-coalition countries below the price cap depend on the level at which the price cap is set. With the cap set at $60 – well above even the highest estimates of the marginal cost of extraction, which different studies put in the region of $10-20 per barrel (see footnote 17) – there is plenty of revenues to be made by selling oil.

Russia's decision then involves trading off two effects: the more oil it sells at the cap, the more revenue it earns from those sales. But keeping oil off the market could drive up prices and may increase the revenue Russia earns on its remaining non-capped sales. This trade-off is mediated by the size of the shadow fleet, as this determines how much oil can be sold at elevated prices in the event of a shut-in. To the extent that the rapid expansion of Russia's own tanker and insurance capacity has proven difficult, this share has perhaps proved too limited to be worthwhile. As the shadow fleet capacity is expanded over time, the balance could tilt in favor of a shut in.

To illustrate the relationship between the price cap and the size of the shadow fleet, consider the following simple framework.

An oil rich state has access to own transport and services capacity to export κ amount of oil each period (that is, κ is the capacity of the 'shadow fleet'). Production above κ, if any, is exported using outside – or western -- services (in the current context, UK insurance and Greek tankers). Facing a binding price cap $\bar{p}$ on all exports that use western services, the producer chooses between two distinct options: whether to shut-in production – i.e., reduce output and exports to κ and sell the κ amount at world prices, or instead continue to export unchanged quantities. In our simple static setting the optimal choice picks the option with higher profits. Profits from oil sales in two scenarios are:

1. Russia shuts in production so that it exports κ outside of the price cap regime:

$$\pi_{shut-in} = \kappa \cdot (p_w(\kappa) - c)$$

   where $p_w(\cdot)$ denotes the world oil price as a function of Russia's output (specified in more detail below), and c is the marginal cost of production.

2. Russia does not shut in, in which case it sells κ outside of the price cap regime and the rest at the price cap:

$$\pi_{noshut-in} = \kappa \cdot (p_w(y) - c) + (y - k) \cdot (\bar{p} - c)$$

[23] "Russia Says Oil-Price Cap May Cause Temporary Output Cut," Bloomberg, October 5, 2022, https://www.bloomberg.com/news/articles/2022-10-05/russia-s-novak-says-oil-price-cap-may-cause-temporary-output-cut

where y is the output before the introduction of the cap (which we take as given).

Following Johnson, Rachel, and Wolfram (forthcoming), we parametrize the $p_w(\cdot)$ function as follows:

$$p_w(y) = p_N \cdot \left(1 - \psi + \psi \frac{y}{y_N}\right)^{-\epsilon},$$

where $\psi \in [0,1]$ is the producer's share in global oil production, y_N is its reference level of output that it would produce if it did not use market power (so that $\frac{y}{y_N}$ provides a sense to which the producer reduces output -- uses market power -- in normal times), ϵ is the inverse of the elasticity of world demand for oil, and p_N is a constant (which can be interpreted as a hypothetical price that would prevail in the world market if Russia had no market power).

This formulation follows from a simple framework in which the producer has market power in equilibrium, and the degree of that power depends on the size of the producer (as well as the elasticity of demand). If the producer is small -- ψ is close to zero – world price is insensitive to producer's actions and is equal to p_N. Similarly, if world demand is very elastic – ϵ is close to 0 -- the producer is not able to affect global prices much.

We parametrize this framework and calculate profits under the two options – shut in or not -- as a function of κ relative to current production levels y. That is, we explore how profitability of the two options changes with the capacity to bypass the price cap.

We set ψ =0.1, c=\$15 , $\epsilon = 10$, reflecting Russia's share in global oil exports, the middle of the range of estimates for the marginal cost, and assuming that world demand is inelastic in the short term, with demand elasticity of 1/10. This calibration of the elasticity is within a range of short-term (about a year out) empirical estimates, and implies that a cessation of Russian production would see world prices of \$250 per barrel. Given these parameters, we use the model in Johnson, Rachel and Wolfram (2023) to compute $\frac{y}{y_N}$. With a very inelastic supply that we assume, the producer exerts significant market power: we estimate that $\frac{y}{y_N}$ is around 0.4. Finally, we set p_N at a level that is consistent with world prices around \$73 a barrel.

With this parametrization, Figure 1 shows profits under the shut in and no shut-in options, as a function of κ. We consider three price cap levels: the current \$60, as well as \$45 and \$30.

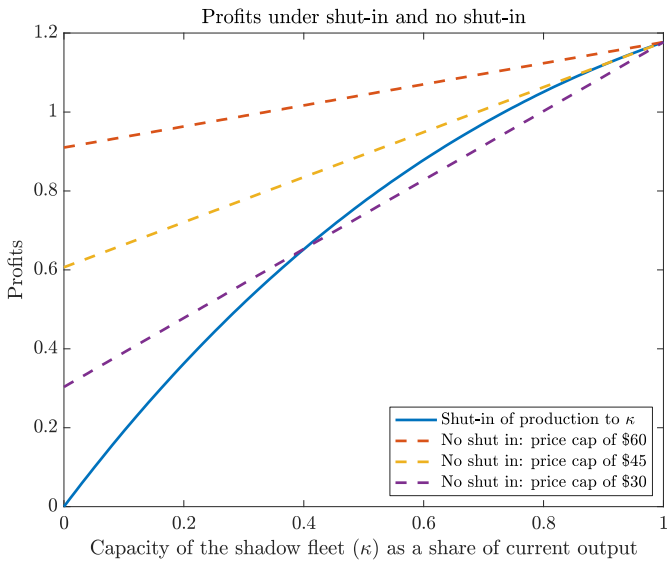

FIGURE 1: Profits in the shut-in and no-shut-in scenarios

To understand the Figure, consider how the schedules align with common sense at the two extremes. When $\kappa = 0$, shut in of production is complete, and Russia no longer sells any oil, making zero profit in the shut-in case. Under no shut-in, Russia sells all its oil at the cap, making positive profits (since the caps are all above marginal cost) that depend positively on the level of the cap. When $\kappa = 1$, the cap is irrelevant as Russia can sell all of its oil outside of the cap regime (thus the three no-shut in schedules coincide at this point). Moreover, in this case there is nothing to shut in, so that the shut-in schedule coincides with the no shut-in schedules as well. Note also that the no-shut-in dashed lines slope upward since the greater is κ, the more the exporter can sell outside of the cap regime, raising profits (since all price caps are binding – are below the market price -- in this exercise).

The main takeaway from this analysis is that, for the parameter values we have assumed, shut in is never profitable when the cap is $60 or even when it is $45. It could be profitable if the cap was lowered to $30 and if the shadow fleet could carry more than 40% of Russian exports. This is despite a rather inelastic demand that we have assumed, giving the producer a lot of market power and ability to exert a significant impact on global prices. Another takeaway is that there is little hope for Russia to make significantly more money by shutting in – even under the $30 cap and a large κ, the shut-in profits are only marginally above the profits that result from unchanged sales.

This trade-off is also informed by the expectations about the response from other oil producers, notably OPEC. A decline in Russian production on the order of 1-2 mbpd of oil could be offset by ramping up production across other OPEC members, which would offset the intended price effect. This potential response is consistent with the expectation that leading OPEC members would not tolerate prices well above their target ranges (e.g., fearing that such prices will further accelerate investments in green technology).

B. *Other Concerns*

One early criticism was that the U.S., EU, and allies would not be able to agree to implement a price cap. This has proved ill-founded, as the cap was implemented on the schedule agreed by the EU in its 6th sanctions package of June 2022: the cap on crude oil became effective on December 5, 2022, and the twin caps on petroleum productions became effective on February 5, 2023.

There has also been a concern that coalition-based services will not be essential to ship Russian oil in 2023 (equivalent to a high κ.in the framework above), either because entities currently based in the coalition will shift elsewhere (e.g., to the UAE) or companies in non-coalition countries will step in to provide any needed services (e.g., companies from China or Russia itself). [24] For example, if the entire "Greek-owned" shipping fleet had re-registered in Dubai, that would have made it easier for Russia to make sales without coalition services – and the European Union would need to think about how to treat sanctions evasion on such a scale. Russia has direct access (through its own ownership and other non-western vessels) to approximately one-quarter of the ships it needs to move its oil, and while we have seen some efforts to purchase or otherwise re-register western tankers, Russia is finding it difficult to build up "shadow fleet" rapidly enough in the near term. [25]

Another criticism ostensibly appeals to basic economic principles and argues that a price cap on Russian oil leads to excess demand, not for oil in general but for Russian oil specifically. As with any good with excess demand, an alternative allocation mechanism is required to determine which importers get access to the Russian oil. Critics contend that Russia might be able to recoup some of its lost oil revenues through this allocation process, for example by selling the rights to buy its inexpensive oil. A similar argument suggests that importers have an incentive to pay a bit more than the price cap in order to convince Russia to sell them additional inexpensive oil, effectively cheating on the collective agreement to pay Russia a lower price by making side payments to Russia.

The factor that these arguments overlook is the services ban: making side payments to Russia is tantamount to violating the price cap. Companies that knowingly do this are subject to enforcement measures. An importer considering paying Russia more must weigh the costs of (1) missing out on the opportunity to get inexpensive capped Russian oil and (2) incurring the costs of potential enforcement. Thus, while we cannot rule out that there may be some side payments

[24] There was also some concern that oil could be transported in some deeply disguised fashion. But all tankers loading in Russia are tracked by various expert services, such as tankertracker.com. Ship to ship transfers at sea are possible, but these can also be monitored, including using satellite photos. The origin of financial and insurance services supporting these shipments is also generally known. The main question for enforcement remains whether the oil in question was or will be sold at a price no greater than the cap.

[25] The purchase of most western ships is financed by loans from banks. These lenders require the ship owners to have adequate insurance, and they do not generally accept Russian or Chinese insurance as adequate. The typical term for this financing is 15 years and most tankers have a useful life of only 20 years. Consequently, the global stock of unmortgaged ships is limited. (Craig Kennedy, private communication.)

to Russia, they are unlikely to be large enough to significantly affect the cap's effectiveness. In general, however, more research is needed to answer the question of who benefits from the revenues that the price cap takes away from Russia.

Probably the most common critique of the price cap was that other countries would not join the coalition. But, as we explained above, the price cap coalition was not designed to include importers – it is a coalition of service providers. Companies that import Russian oil can decide on a trade-by-trade basis whether to use coalition member services and buy Russian oil at the price cap. In addition, a central design element of the price cap approach is that it increases the bargaining power of all importers of Russian oil. Of course, some companies in countries like India or China might choose not to exercise that bargaining power – this is their decision. But companies in those countries do not currently pay the world price of oil to Russia – they pay world prices minus the "Urals discount". The price cap essentially helps to lock in that discount.

In addition to weighing economic incentives, Russia is making a geopolitical calculus. The benefits of sales under the price cap go to countries it has historically courted, including India, China and countries in sub-Saharan Africa and Latin America.

In addition, given the current Kremlin rhetoric, the content of its propaganda, and its longer-term cultivation of bellicose domestic attitudes, it remains to be seen whether Russia will remain a major global oil producer. At its peak, the Soviet Union produced almost 12 million barrels of oil per day, but by the mid-1990s, Russia produced only around 6 million barrels.[26] Given that the world is seeking to invest further in renewables and reduce fossil fuel consumption, Russia may think twice before further encouraging countries to shift away from Russian oil.

Conversely, over time the EU and some other coalition countries are likely to increase their investments in non-Russia sources of energy, including renewables, liquified natural gas from elsewhere, and nuclear power. If Russia cuts production by more in 2023, that will strengthen the incentives to accelerate this energy transition. Russia's future as a major energy supplier already looks bleak, but will its government really want to hasten the day when the world no longer needs what Russia produces.

[26] Kazakhstan is the largest ex-Soviet oil producer, after Russia; it currently exports about 1 million barrels per day. The subsequent rebound in Russian oil production was made possible largely by oil field services and technology provided by western companies.

VI. Outcomes in early 2023

In contrast to any dire predictions, setting a price cap on Russian oil at $60 per barrel seems to have had four broad effects. First, the Kremlin's oil-related revenues have fallen by 49% compared to the March to November 2022 period and 23% compared to the January 2021 to January 2022 period. Specifically, the blue vertical bars in Figure 2 reflect Russian government revenue from the mineral extraction and export taxes by month. The orange bars reflect averages during the pre-war, post-war and pre-price cap and post-price cap period (see also, Babina et al., 2023).

Second, Russia's oil production has if anything increased (see the grey line in Figure 2). Third, the advent of the EU embargo (for crude in December and refined products in February) did not result in a spike in world oil prices. Fourth, most western service providers have remained engaged in the Russia trade. Data from CREA suggest that about 60% of crude oil shipments and 75% of product shipments from Russia's ports in April 2023 were covered by insurers from the EU, G7 or Norway.

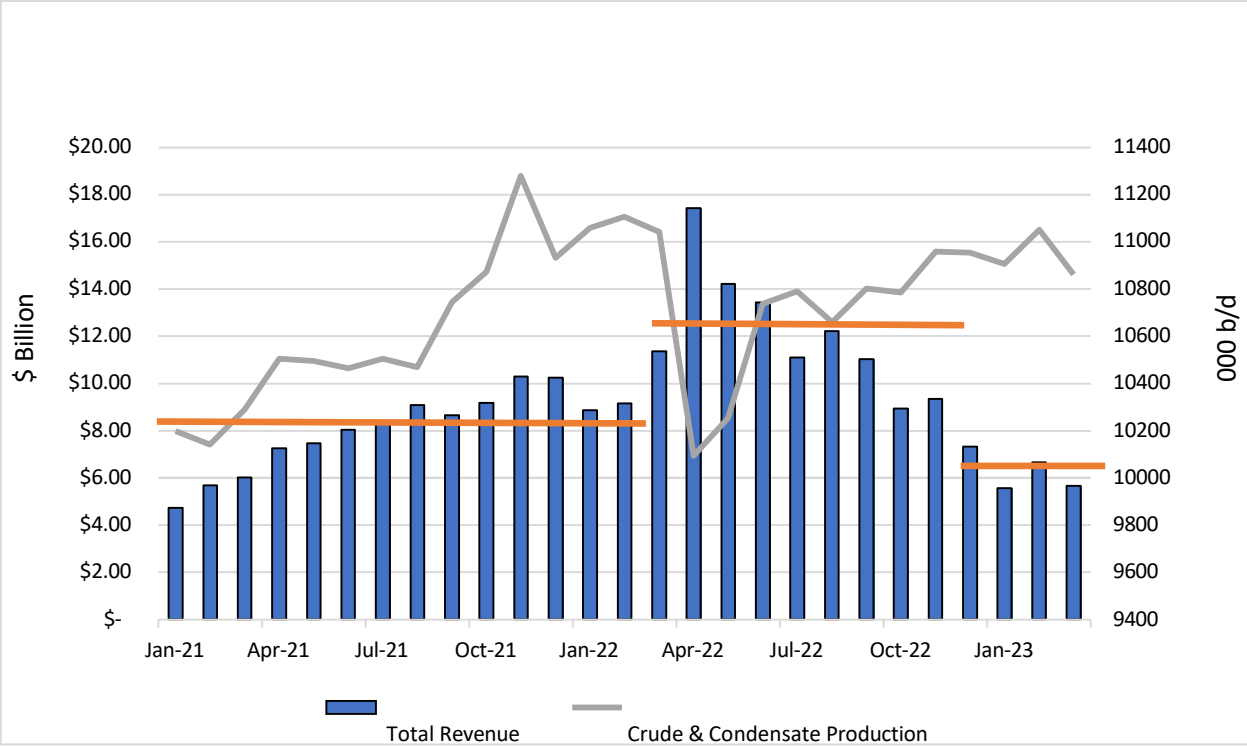

FIGURE 2: Russian oil output and revenue, 2021-23

Still there are lingering and legitimate concerns. Contrary to initial expectations, the oil price cap has not been lowered. The lack of a credible threat to lower the cap further affects Russian actions and also the willingness of other countries to trade with them.

According to market reports, the Urals discount may have declined in the past few months, so now Russian oil prices are closer to the $60 cap. At the same time, and likely related, there are increasing concerns that some traders are not being honest about the attestation process – leading to proposals to tighten safeguards.

There is also concern that, given recent changes in the Russian tax system, government revenue from oil sales may again be increasing.[27]

VII. Conclusion

The price cap on Russian oil reflects a novel approach to sanctions and the world is just beginning to understand its impacts on Russian oil revenues, geopolitical alignments, and oil trade. For example, in the months before it was implemented, reports suggested that the prospect of the price cap likely led Russia to offer crude oil at a cut-rate to importers in Indonesia.

In addition, without a price cap, EU sanctions would likely have taken millions of barrels of the market daily and thereby increased pressure on global prices. Oil traders, oil service providers, analysts, journalists, and sanctions officials will watch these developments carefully, but one thing is sure: economic incentives are powerful and given the large dollar volumes at play in the oil markets, it is particularly crucial to understand how they might shape decisions going forward.

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Appendix

The Appendix provides more technical details on several of the economic concepts discussed in the main text. Section A depicts the standard price cap and a price cap on Russian oil graphically. Section B considers additional policies that could constrain Russia's oil export revenues, including an embargo and a tariff, and compares them to a cap.

A Graphical Representation of Price Caps

Figure A1 provides a graphical representation of a standard price cap. In a market equilibrium, the price is equal to P^{eq} and the quantity demanded is Q^{eq}: supply equals demand. If policymakers cap prices at P^{cap} the quantity producers are incentivized to provide, $Q^{s,cap}$, is below the quantity that consumers would like to consume at that price, $Q^{d,cap}$, resulting in a shortage equal to the difference between $Q^{d,cap}$ and $Q^{s,cap}$. Because $Q^{d,cap}$ is greater than $Q^{s,cap}$, an alternative, non-price mechanism must be used to allocate the goods.

Figure A2 represents the price cap on Russian oil. We assume, for simplicity, that Russian suppliers are represented by the supply curve between points A and B. Note that this implies that Russian suppliers' costs are more similar to one another's than to the costs of suppliers in other countries. The figure implies that some of the suppliers in other countries are less expensive than Russia, represented by the supply curve below point A, and some are more expensive than Russia, represented by the supply curve above point B. The figure also implies that all of Russia's supply is infra-marginal, consistent with the real world.

Since the price cap only applies to Russian oil, and assuming that the price cap does not distort the amount of oil that Russia supplies, the equilibrium price seen by consumers and other producers is unchanged. Russia's losses relative to a world with no price cap are depicted by the red box. Russian suppliers continue to earn some profit, depicted by the blue trapezoid.

Figure A2 also abstracts from the fact that world oil markets are not perfectly competitive, so the equilibrium price is higher than would be suggested by the intersection of demand curve and a supply curve that simply tracks producers' marginal cost. Because OPEC+'s actions drive prices above marginal costs, Russia's rents are higher, and part of the revenues that the price cap removes (red box in Figure A2) are these non-competitive rents.

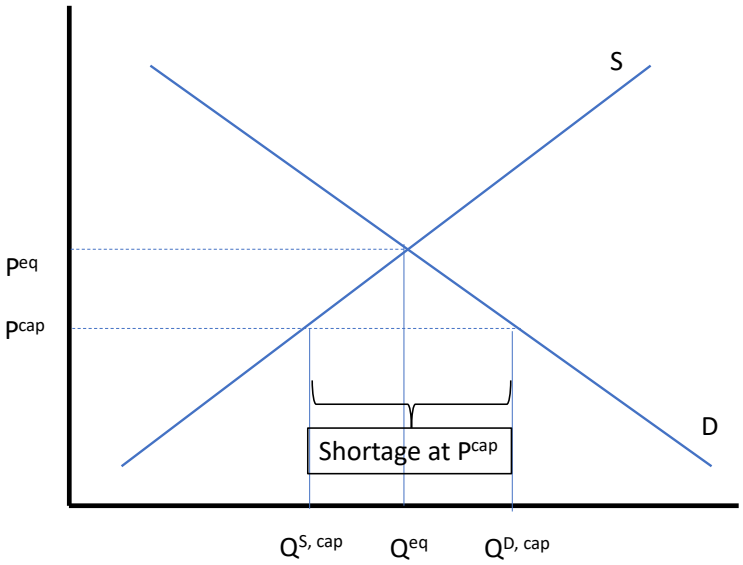

Figure A.1: Econ-101 price cap and the associated quantity shortage

Figure A.2: Price cap on the price of Russian oil

B Price Caps and Tariffs on Russian Oil

Economic theory suggests several ways to curtail Russia's oil revenues: most often mentioned are an embargo, a tariff, and a price cap. This appendix illustrates how these measures relate to each other; it then briefly outlines an example with a kinked supply curve, whereby Russia supplies an unalterled amount of oil to the market as long as the ongoing price that it receives allows it to make positive profits.

A tariff has several implementation advantages over a price cap. For one, importing countries could collect revenues from the tariff, which could be used to finance reconstruction in Ukraine, subsidize domestic fiscal measures necessitated by the war (such as subsidies for energy consumers) or anything else the domestic government wanted. Also, if all importers of Russian oil imposed the same tariff, the flow of Russian oil would not change. Under the current scheme, particularly with the EU embargo, ships carrying Russian oil will need to take much longer voyages to get the oil to buyers, slightly increasing the cost in global oil markets and straining shipping. With uniform tariffs, there would be no extra shipping costs.

On the other hand, the price cap has one key political economy advantage over a tariff: it does not require explicit cooperation by governments. Many governments took a wait-and-see approach to the price cap. They were unwilling to commit to it given that it is a novel approach and appeared to conclude that it was not worth antagonizing Russia by formally agreeing to it. If the price cap had ended up not being implemented, these countries would be antagonizing Russia without gaining the benefit of low-priced Russian oil. By contrast, the price cap can be effective without formal government action. For example, the Indian government can stay silent on the cap and individual importers in India can decide whether to negotiate a price that is at or below the price cap level.

To begin the analysis, we need to specify how the tariff or price cap will be operationalized. Policymakers face several design choices. For example, either could be implemented as a fixed number (dollars per barrel) or as a percent of an existing price. We consider tariffs first, and then price caps.

A fixed %-tariff on Russian oil could mean different things, depending on what the % is applied to. Let us define three tariff types:

1. type-x: tariff is the % of the prevailing world price P^{WORLD}.
2. type-y: tariff is the % of the price that Russia receives P^{RUS} (note this is the way tariffs are usually specified in economics / international trade).
3. type-z: tariff is the % of the pre-tariff world price P^{NOW}, which is the current price

The three tariffs are of course related. We first write down how the prices that Russia gets and the recipients countries pay relate to each other under the three tariffs:

$$P^{RUS} = (1 - x)P^{WORLD} \tag{1}$$

$$P^{WORLD} = P^{RUS}(1 + y) \tag{2}$$

$$P^{RUS} = P^{WORLD} - z \cdot P^{NOW}. \tag{3}$$

For example, the first equation says that Russia gets $1 - x$ percent of whatever is the prevailing oil price in the world market. Combining equations (1) and (2), and (1) and (3), we get

$$y = \frac{x}{1 - x} \tag{4}$$

$$z = x \cdot \frac{P^{WORLD}}{P^{NOW}} \tag{5}$$

Equation (4) shows that there is a one-to-one (non-linear) mapping between x and y. Equation (5) shows that tariff z is a scaled version of x, where the scaling factor is endogenous and depends on what happens to the price of oil in the future, relative to the price on which the z tariff is based.

An example. Just as an example, consider the 90% tariff that Ricardo Hausman proposed.[1] This was the x-type tariff. The equivalent tariff calculated on the price that Russia actually receives (a y-type tariff) is $0.9/0.1 = 900\%$.

What does Russia actually get? Note that for a fixed % tariffs considered so far, P^{RUS} is endogenous and depends on what happens to the world price P^{WORLD}.

Consider now a price cap policy, and assume that this policy fixes the price Russia gets as some level: $P^{RUS} = \hat{P}$. From equations (1) - (3), such a price cap can be implemented through – or is

[1] https://www.project-syndicate.org/commentary/case-for-punitive-tax-on-russian-oil-by-ricardo-hausmann-2022-02

equivalent to – all of the three tariff types as follows:[2]

$$\hat{x} = 1 - \frac{\hat{P}}{P^{WORLD}} \tag{6}$$

$$\hat{y} = \frac{P^{WORLD}}{\hat{P}} - 1 \tag{7}$$

$$\hat{z} = \frac{P^{WORLD} - \hat{P}}{P^{NOW}}. \tag{8}$$

Note that all three tariffs that implement the price cap are variable: fluctuations in $P^{WORLD}(t)$ will translate into fluctuations in $\hat{x}(t), \hat{y}(t), \hat{z}(t)$: fixing the price results in a variable tariff; fixing a tariff results in a variable price.

An embargo. A full embargo can be thought of as an extreme version of a tariff (or equivalently, a price cap). Suppose that Russia will leave the oil in the ground if the price is equal to or lower than $\bar{P}$. Then the embargo can be implemented with the following tariffs:

$$\bar{x} \geq 1 - \frac{\bar{P}}{P^{WORLD}}$$

$$\bar{y} \geq \frac{P^{WORLD}}{\bar{P}} - 1$$

$$\bar{z} \geq \frac{P^{WORLD} - \bar{P}}{P^{NOW}}.$$

An example: the case with vertical-and-kinked Russian supply. A useful benchmark case that may also be quite realistic is that Russia's supply curve is kinked: it is completely inelastic up to $\bar{P}$, and supply drops to zero at or below $\bar{P}$ (Figure B.1).[3] We only consider a simple two-country setup here. The analysis in Appendix A above instead considers a global market.

[2] An alternative would be to implement the price cap via rationing. Since this is an inefficient strategy, we do not consider it here.

[3] Why is this realistic? In early 2020, when the average price of oil fell to $20 per barrel, Russia supplied almost as much oil as it did when the price averaged $110. This is because the cost of producing and distributing Russian oil is low. Russia's onshore storage options are limited, so any export reduction would mean oil wells need to be shut down. In some older oil fields, this would lead to immediate and permanent decline in productive capacity, particularly as Russia is cut off from advanced drilling technology for the foreseeable future.

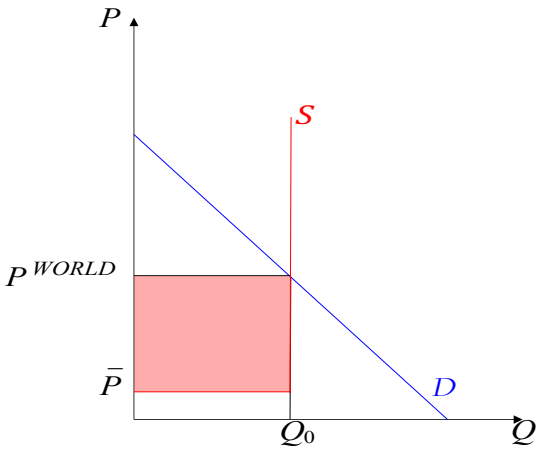

Figure B.1: The price cap when Russian supply is kinked.
Note: Current price and quantity normalized to 1.

For concreteness, suppose Russia's supply will be roughly unchanged as long as the price which it sells at is \$15 or higher. Consider a policy of caping the price of oil that Russia gets at $\hat{P} = \$60$. Under our assumptions, at such a price Russia will supply unchanged quantity of oil to the market. Assuming the world oil is at roughly \$73 when the policy is implemented, this price cap is then equivalent to the following tariffs, calculated under the assumption that the world price of oil remains roughly constant at \$73 per barrel:

$$\hat{x} = 1 - \frac{60}{73} = 18\% \tag{9}$$

$$\hat{y} = \frac{73}{60} - 1 = 22\% \tag{10}$$

$$\hat{z} = 1 - \frac{60}{73} = 18\%. \tag{11}$$