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PANDEMIC, WAR, INFLATION:
OIL MARKETS AT A CROSSROADS?

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ABSTRACT

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Abstract

The COVID-19 pandemic as well as the Russian invasion of Ukraine have had profound effects on the global energy landscape, with some of the longer-lasting effects still unfolding. This paper discusses how these events have reshaped the supply side of the global oil market by focusing on structural changes in each of the three main oil-producing countries. The demand side has responded to geopolitical developments by devising a set of policy tools to stabilize oil markets and counter inflationary pressures. In particular, the price cap policy was introduced to supplement the EU embargo on seaborne Russian oil exports, and record volumes of oil were released from government-controlled emergency stockpiles. The sources of oil price fluctuations associated with these events are also discussed, as is their role in the recent surge of inflation, with a particular focus on the heterogeneity in the pass-through of oil supply shocks within the Euro area.

1 Structural Changes in the Global Oil Market

The outbreak of the COVID-19 pandemic in early 2020 set in motion a sequence of structural changes in global energy markets, which were reinforced by the Russian invasion of Ukraine only two years later. These dramatic events reshaped the energy landscape considerably during the past three years with important repercussions for the macroeconomic environment and unprecedented policy responses.

Figure 1 shows the evolution of oil production for the world's three largest producers over the period 2018 to 2023. At the onset of the pandemic, when oil demand collapsed as a result of worldwide lockdowns, US production plummeted by almost three million barrels per day (mbpd) within two months. The steep fall in global oil demand also called for production cuts from OPEC+,[2] but Russia initially refused to cooperate with OPEC to stabilize oil prices, which triggered a price war between the two leading oil exporters, Russia and Saudi Arabia. The spike in Saudi oil production

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[2] OPEC+ is an informal alliance between OPEC member countries and 10 other oil-producing nations that was formed at the end of 2016, of which Russia is by far the most important participant given that it accounts for roughly 13% of global oil production.

in April 2020 is the punishment for Russia’s non-compliance. Saudi Arabia flooded an already oversupplied market with almost 2 mbpd of crude oil, which caused oil prices to crash. It was only at the end of April 2020 that OPEC+ reached an agreement to jointly reduce oil output by around 10 mbpd, equivalent to 10% of global production, to lift oil prices off the floor. After stabilizing at lower production levels in the second half of 2020, US and Saudi oil production took another hit during the second wave of lockdowns and travel restrictions at the start of 2021. Russia’s invasion of Ukraine on February 24, 2022, led to a drop in its oil output of about 1 mbpd, which was partially undone as Russia developed new export markets. After a strong recovery of Saudi production exceeding pre-pandemic levels, OPEC+ announced a supply cut of 2 mbpd in October 2022 in an attempt to stem oil prices which had fallen due to widespread recession fears caused by monetary tightening of the world’s major central banks. Saudi Arabia lowered oil production to 10 mbpd, which corresponds to its average supply before the pandemic. Neither US nor Russian oil output was back at pre-pandemic levels by February 2023.

These supply-side developments had profound impacts on the oil industry and market structure in each of the three oil-producing countries, as I will discuss next.

1.1 The US Shale Oil Sector

The market turmoil triggered by the coronavirus crisis and the Saudi-Russia oil price war has taken a major toll on the US oil industry. A lot of US oil companies had taken on excessive debt in the heyday of the shale oil revolution which had rendered them extremely vulnerable to price fluctuations. As a result, many shale drillers went bankrupt when oil prices plunged in April 2020. The subsequent massive supply cut by OPEC+ prevented a further contraction of the US shale sector.

Historically, US shale oil producers have been able to ramp up production in a short time span to take advantage of rising oil prices; but, in the aftermath of the COVID-19 pandemic, both physical constraints and corporate demands have diminished their responsiveness considerably. Physical impediments to raise oil output arose from supply chain bottlenecks during the recovery from the pandemic, which led to a shortage of important production inputs such as fracking sand, drilling equipment, and steel, among others. Given their relative scarcity, the costs for these inputs have also been rising, making it less profitable for oil companies to expand production. Other constraints that held back production growth in the shale patch were a lack of qualified workers and the difficulty to reverse prior shut-ins. The industry also faced several logistical barriers, such as limited pipeline capacity, that impaired the transportation of oil. While these factors are all temporary in nature and are getting resolved over time, the main reason for the slow return to pre-pandemic growth is the enduring pressure from investors to maintain capital discipline and to return cash in the form of dividends and share buybacks. In addition to the shift in priorities from new drilling to generating a steady stream of profits for shareholders, another factor that restrains investment in new productive capacity is the uncertain long-term perspective in view of the green transition and stricter climate policies, which investors fear could leave assets stranded.[3]

So far, it seems that US shale drillers do abide by the new corporate rules and remain committed to cutting costs, paying down debt, and generating returns for shareholders rather than increasing spending on exploration, drilling, and production in response to high oil prices. Figure 2, panel A, shows rig counts by major US shale oil plays, which are an important indicator of investment appetite. While the number of active rigs has been gradually returning to pre-covid levels, overall drilling activity has fallen by 7 percent since the beginning of 2023. This could mark the beginning of a slowdown of the US shale sector since shale producers have to keep drilling in order to maintain existing production levels. While the Permian, the biggest shale basin, seems to have plateaued, other plays show signs of a decline in drilling activity. Another indicator for future production, displayed in panel B, is drilled but uncompleted wells (DUCs), which can be viewed as working inventory that shale drillers can tap within a short time frame. Since the height of the pandemic, DUCs have been steadily declining in all major oil-producing regions before levelling off in early 2022. While the reduction in DUCs means more well completions, a stable inventory level in conjunction with decreasing drilling activity imposes limits on future oil production growth. These investment trends in physical productive capacity are reinforced by a wave of consolidations and acquisitions of smaller private operators in the shale patch by bigger public oil companies, which prioritize profit maximization over production expansion.

After years of boom-bust cycles, the US shale industry has shifted to a new business model that is more focused on creating shareholder value than on increasing market share, which is reflected in the ongoing stagnation of US oil production. This is a structural change that has redefined the role of US shale oil in global markets and is likely here to stay. So, neither policymakers nor consumers should count on the shale oil sector going back to its earlier swing-producer role.

1.2 OPEC under the leadership of Saudi Arabia

Since the US shale oil boom until before the pandemic, OPEC had to factor in the response of shale drillers when making its own production decisions. In particular, OPEC production cuts would be countered by a surge in US production in a continuous fight for market share between these two key players. This is much less of a concern in the post-COVID 19 era. With the new moderate-growth strategy of the US oil industry, the balance of power has shifted back in favor of OPEC(+) and its de-facto leader Saudi Arabia.

As a first step in this direction, Saudi Arabia took the leadership in coordinating the record production cut of 10 mbpd in the early stages of the pandemic in an effort to stem the freefall of oil prices as global demand contracted sharply (see also

[3] Investors also seem more concerned about ESG factors in the post-pandemic world and have a greater interest in de-carbonizing their portfolios.

Almutairi, Pierru, and Smith, 2023). As the economy reopened and oil prices rose back to pre-pandemic levels, OPEC+ agreed to unwind earlier cuts by gradually bringing back supply at an increasingly faster pace. One problem that became apparent as the group stepped up production increases was that several OPEC member countries were consistently underproducing and missing their quotas. Panel A of Figure 3 shows the difference between actual production and production targets for a subset of OPEC members from January 2019 to April 2023. Negative numbers indicate undershooting the output quota, while positive numbers indicate exceeding it. The two main West African producers, Angola and Nigeria, which together account for about 9% of total OPEC output, have consistently underperformed for the past two years due to years of under-investment and large maintenance work that got delayed by the pandemic. The failure to comply with production targets was particularly severe after the invasion of Ukraine when the oil market scrambled to make up for lost exports from Russia. In the early stages of the war, also Iraq and Kuwait were unable to raise output to agreed levels to help fill the supply gap. Only the United Arab Emirates produced above quota since the outbreak of the war, while Saudi Arabia remained right on target. Panel B tracks the evolution of OPEC's total spare production capacity over the period 2014-2023. After freeing up a lot of production capacity in the wake of the coordinated supply cut, spare capacity has declined steadily since then and is now back at pre-pandemic levels. While levels of unused capacity have been low by historical standards also before the pandemic crisis, the lack of sufficient OPEC spare capacity has become more concerning in this new setting where other major oil producers face enduring constraints for different reasons. In addition, most of the group's production buffer is accounted for by only two member countries, Saudi Arabia and UAE with extra capacity of about 1.5 mbpd and 1 mbpd, respectively. This together with the inability of some members to meet production targets points to a structural issue that limits OPEC's flexibility to balance the market and might exacerbate future market tightness.

As market conditions have eased over the past year, Saudi Arabia has repeatedly demonstrated its willingness to curb production to “stabilize” oil markets and keep prices in its preferred target range. However, the price effects of its most recent supply cut announcements have been rather short-lived and dominated by macroeconomic news of subdued global growth. Thus, Saudi Arabia's ability to push up oil prices in an environment of economic weakness seems increasingly limited.

1.3 Russia

The market for Russian crude oil is undergoing a fundamental transformation. In the immediate aftermath of the invasion of Ukraine, some of Russia's regular Western buyers refused to take delivery of its oil by imposing voluntary sanctions. This marked the beginning of a gradual redirection of global oil flows. As Europe turned away from Russian oil to buy more North Sea crudes from the UK and Norway, which were previously shipped to Asia, and increased imports from the US, Russia started re-routing its oil from Europe to Asia, developing a new export market in India, where it faces direct competition from Saudi Arabia and other Gulf producers. This change in composition of importing countries has led to a fragmentation of the export market for Russian crude into two geographic segments with their own price and demand dynamics, as I will discuss in greater detail in the next section (see also Babina et al., 2023).

Another significant repercussion of the ongoing war was the departure of several international energy companies including ExxonMobil, Shell, and BP, which is likely to create a technical knowledge gap with long-term consequences for Russian oil supply. Likewise, oilfield services firms such as Schlumberger, Halliburton, and Baker&Hughes, have withdrawn from Russia, which restricts its access to Western advances in drilling technology. This loss in technology transfer will hamper new field developments and efficiency improvements in oil extraction.

2 Policy Interventions

So far, I have highlighted important structural changes on the supply side of the crude oil market that were brought on by the pandemic and reinforced by the war in Ukraine. Other noteworthy developments that break with past tradition have happened in the policy arena.

In response to geopolitical events, in particular the Russian invasion of Ukraine, governments of major oil-importing nations devised a set of policy tools to promote stability in the global oil market, counter global inflationary pressures, and support households and firms by keeping crude oil and petroleum product prices in check. I will discuss two of them here.

2.1 The EU Embargo and the G7 Oil Price Cap

Oil-related sanctions are a standard tool of economic warfare and have been routinely applied to exert pressure on foreign governments in order to achieve certain geopolitical objectives or force compliance with international law.[4]

In response to the full-scale Russian invasion of Ukraine on February 24, 2022, several countries, including the US, Canada, and Australia, acted swiftly by imposing an outright ban on Russian imports of crude oil. In these countries, Russia accounts for only a small fraction of total oil imports. In contrast, given the EU's heavy reliance on Russian energy,[5] member countries reached an agreement to ban the majority of Russian oil imports only at the end of May 2022. The EU embargo was mainly directed at seaborne oil purchases which made up two-thirds of Europe's imports from Russia before the war, while sanctions on the remaining one-third delivered by

[4] For example, the United States currently has active economic sanctions imposed on three major oil-producing and exporting countries: Iran, Venezuela, and Russia. While the sanctions on Iran and Venezuela are geared toward suppressing crude oil trade, Russian sanctions in response to the invasion and occupation of Crimea in March 2014 were more narrowly targeted at barring oil companies' access to debt finance and production technologies; similarly, in response to the Crimean crisis, the European Council devised sanctions to restrict Russia's access to EU capital markets.

[5] Before the outbreak of the war, the EU was the destination for almost half of Russia's crude oil exports for a total of 2.3 million barrels per day according to the US Energy Information Administration.

pipeline were supposed to be phased in gradually, with the overall goal to cut Russian crude imports by 90% at the end of 2022 in an effort to undermine the primary source of war financing. To ensure its effectiveness, the seaborne oil embargo was to be supplemented by a ban on insuring oil tankers carrying Russian crude to prevent Russia from re-routing its oil to other regions. Denying Russia access to Western shipping insurance and other maritime services could have resulted in a loss of almost all seaborne Russian oil exports in the amount of around 3.5 million barrels per day or 4.3% of global oil production causing a spike in oil prices.[6]

To address concerns about supplies from Russia not reaching global markets and to mitigate the embargo-related market distortions and price impacts inherent in the provisions of the original EU sanction package, the price cap mechanism was proposed as a compromise by a coalition of countries led by the G7. The price cap policy stipulates that internationally recognized maritime transport services, including insurance, shipping, and brokering, are available for Russian cargoes only if the oil is sold at or below the price cap, which was set at $60 per barrel when the policy together with the EU oil embargo came into effect on December 5, 2022. This new policy tool thus serves a dual purpose: curtailing the revenue stream from oil sales, Russia's most important export product,[7] that is contributing to funding the war, while keeping Russian barrels flowing to ensure that the world market is well supplied.

Enforcing a coordinated price ceiling is basically equivalent to forming a buyer's cartel that limits the rents an oil-producing country can extract from exporting its resource (see, e.g., Wachtmeister et al., 2022). The effectiveness of a price cap mechanism hinges on the relative elasticity of supply and demand, or the ease with which buyers and sellers can adapt to the new market reality. In the case of Russia, infrastructure constraints for pipeline transportation to end-users or to ports and the dominant roles of the UK and the EU for the provision of international shipping services imply a rather inelastic supply curve.[8] The EU, traditionally the major consumer of Russian oil, has made great strides to wean itself off from Russian supplies and to diversify supply sources, suggesting that its oil demand is more elastic.[9] This difference in elasticities together with the level of the cap determines

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6 Based on the global oil market model of Baumeister and Hamilton (2019) presented in Section 3, Baumeister (2022) simulates the oil price path implied by this insurance-ban scenario and shows that oil prices would have jumped by more than $15 per barrel in the first month of its implementation and continued to rise by an additional $25 over a six-month period. Accounting for the tightness in other energy markets at the time and the resulting limited substitutability across energy sources, the price surge could have been as high as $25 on impact and $68 six months later. See also Baumeister and Hamilton (2023b) who conduct a case study of how a 50% cut in Russian production, which corresponds to a loss of more than 5 mbpd, would affect not only the oil price, but trigger an adjustment process of oil consumption decreases in the US, Europe, Japan and the rest of the world as well as production increases from Saudi Arabia and the rest of the world to jointly make up for that shortfall.

7 In the pre-invasion period, crude oil accounted for around 35% of Russian export revenues.

8 Johnson et al. (2023) provide evidence that Russia's supply curve is indeed highly inelastic and may even be downward sloping, which means that producers might find it beneficial to pump more oil when prices are declining. This can be explained by Russia's peculiar oil tax and export duty system which shields oil companies from global price fluctuations and provides incentives to increase production and exports regardless of the market price. In response to the introduction of the price cap, Russia has modified its method for calculating taxes on oil exports to prop up government revenue at the expense of oil companies.

9 Baumeister and Hamilton's (2023b) estimates of country-specific oil supply and demand elasticities show that European oil consumption is indeed more elastic than Russian oil supply.

the allocation of rents between seller and buyer. While the price cap, if rigorously enforced, reduces the rents earned by Russian oil producers, it is less clear who benefits from the redistribution of rents, as pointed out by Johnson, Rachel, and Wolfram (2023). What is clear is that a price cap confers bargaining power to buyers willing to engage in Russian transactions, which was highlighted as one of the beneficial aspects of the oil price cap policy when it was introduced (Yellen, 2022).

In the first couple of months after its implementation, there has been an active public debate about whether the price cap has achieved its intended goals. Such an assessment needs to speak to the following questions:

- Was the global oil market well enough supplied to prevent a price surge?
- Have Russian fossil fuel earnings and fiscal revenues declined meaningfully?
- Was the price cap successfully implemented and enforced?

Based on the currently available information, opinions on all these fronts differ. Hilgenstock et al. (2023) report that, based on official data, seaborne crude oil export volumes were down by about 12% in the first quarter of 2023 relative to average shipments since the outbreak of the war.[10] High-frequency data based on tracking vessels that originate from Russian ports in Figure 4, panel A, show that after an initial drop, exports by sea have been on the rise, exceeding pre-invasion levels. Seaborne export volumes have remained relatively stable and are higher on average than in the pre-price cap period, reaching a new high in the second quarter of 2023. What is also evident from the breakdown by destination is that the price cap has reinforced the redirection of Russian oil trade flows to new export markets that began shortly after the onset of the war, with China and India now being the top importers.

The overall production trend is less clear. While Johnson et al. (2023) note that Russia's oil production has increased somewhat in recent months, the latest numbers released by the US EIA project a decline of 550,000 barrels per day from February to June in line with the production cut announced in March 2023, with a flat trajectory until the end of the year. According to Bloomberg, the number of idled oil wells rose substantially in the first quarter of 2023, which is consistent with a reduction in oil production (Princeton Policy Advisors, May 11, 2023).

Since December 2022, daily Brent prices have been fluctuating consistently in the $70-$90 price range; thus, it seems that embargo-related supply changes were small enough to not have any material impact on global prices, which was likely helped by the macroeconomic headwinds that counteracted any supply-related upward tendencies of oil prices.

While global prices were not much affected, the EU embargo regime altered the price dynamics in different geographic locations. Even before the implementation of sanctions, the price differential between Brent and Russia's Western benchmark, Urals, which pre-invasion had not been more than a few dollars, had widened

[10] They also note that total crude oil exports have declined more than seaborne ones because most European countries no longer take delivery of Russian oil via the Druzhba pipeline.

considerably. Panel B of Figure 4 shows that, after the outbreak of the war, the Urals discount surged from below $5 to over $35 in April 2022 since traditional buyers shunned Russian oil, which exerted downward pressure on the reference price for its crude. This is supported by the decline in shipments in the months after the invasion in panel A. After stabilizing at a new level of just below $25 in the second half of the year, the price spread rose again after the introduction of the price cap. While this could be interpreted as success of the price cap policy, Hilgenstock et al. (2023) conduct a more nuanced analysis. Based on detailed customs data, they use prices charged for shipments departing from different Russian ports to provide evidence for price dispersion between market segments. They make the case that after losing their EU customer base due to the embargo, Russia had no choice but to offer steep discounts to find alternative buyers for shipments from the Baltic Sea and Black Sea ports to sustain export volumes, while no price adjustments were necessary for locations where the customer base had not shifted. For example, their calculations show that Indian buyers who replaced EU importers paid between $43-$45, which is substantially below the price cap level. While one could take this as evidence that buyers can leverage the price cap to impose steeper discounts, it rather reflects India's monopsony power in the post-embargo world independent of the price cap policy.[11] This interpretation is consistent with their finding that export prices for Russia's Pacific Ocean transactions never fell below the price cap.

The combined effect of lower prices and somewhat reduced overall export volumes, including pipeline delivery, led to a sharp decline in oil export earnings. Receipts from Russian crude oil shipments were down 35% in the first quarter of 2023 relative to the pre-embargo level (Hilgenstock et al., 2023). This fall in oil export income curtailed government revenue from mineral extraction and export duties by 23% compared to the annual average preceding the war (Johnson et al., 2023) and by 40% compared to the first quarter of 2022 (Rosenberg and Van Nostrand, 2023). Oil-related fiscal revenues would have even been lower had the Russian government not adapted its taxation system to the price-cap regime in April 2023 to increase its share of export earnings, shifting the financial burden onto oil companies (refer to, e.g., CREA (2023) for details).[12] In recent months, the narrowing of the discount for Urals (panel B) and the increase in shipping volumes (panel A) boosted oil export revenues (see Oil&Gas Journal, 2023), which together with higher tax rates will also benefit Russia's budget.

Another important dimension directly tied to government revenues is the level of the price cap. The initial ceiling of $60 seems overly generous and much higher than what is needed to incentivize Russia to continue supplying oil to global markets given that it vastly exceeds the marginal costs of production, which are estimated to fall in the range of $10 to $25 (see, e.g., Johnson et al., 2023; Wachtmeister et al.,

11 Part of the lower price can also be explained by higher shipping costs due to the longer sea voyage that have to be borne by the oil importer since quoted prices are on an FOB basis.

12 Rosenberg and Van Nostrand (2023) point out that this tax change will have longer-term consequences for the Russian oil sector since it deters companies from investing into exploration and development of new oil fields, which will diminish production capacity and limit oil production growth. This adds to the strains put on the industry by the departure of Western oil majors and oilfield services companies and the loss of access to their advanced technology, as discussed in Section 1.3.

2022; CREA, 2023). At the same time, the price cap is not far below current market prices which are hovering in the mid-$70s as a result of looser market conditions. This has led to calls to significantly lower the price cap to force greater economic losses on Russia (see Babina et al., 2022; Hilgenstock et al., 2023). For example, CREA (2023) estimates that Russian export revenues on seaborne oil could have been slashed by 37% had the price cap been set at $30.[13]

Some analysts have argued that the EU embargo and the price cap in particular have failed because Russia was able to find alternative buyers and maintain or even increase seaborne export volumes. The theoretical analysis of Johnson et al. (2023) shows that this outcome would be consistent with a price cap policy that covers almost all of a producer's export sales. Due to the geographical market segmentation discussed earlier, not all of Russia's oil exports are subject to the oil price cap, which also has important implications for its effectiveness (see, e.g., Hilgenstock et al., 2023; Johnson et al., 2023). In particular, it allows Russia to preserve some market power, which limits the scope for discounts in locations where the customer base has not changed (e.g., shipments directed to China). This two-tier system undermines the price cap mechanism and considerably weakens the effective enforcement of the policy. There is also mounting evidence for price cap evasion. For example, Hilgenstock et al. (2023) show that customs-based export prices from Pacific Ocean ports exceed the price cap even though Western shipping and insurance services are used for transportation. Another loophole in the EU embargo is the re-import of refined products obtained from Russian crude, which calls into question the overall effectiveness of sanctions.

The final verdict is still out there. But, if in the end it turns out that the price cap mechanism is deemed to have fulfilled its objectives, this new policy instrument has the potential to change the balance of power between producers and consumers in energy markets with implications lasting long after the war in Ukraine ends.

2.2 Releases from the Strategic Petroleum Reserve

Another stabilization mechanism to protect countries against sudden shortfalls of oil supply are government-owned emergency stockpiles of crude oil. For example, the Strategic Petroleum Reserve (SPR) in the US was established in the aftermath of the 1970s energy crises to promote energy security and mitigate the effects of unexpected oil supply disruptions.

While not a new policy instrument, the scale and duration of drawdowns from the emergency reserves in response to the strong economic recovery from the pandemic and the Russian invasion of Ukraine were unprecedented. The initial SPR sale of 50 million barrels was motivated by an oil supply imbalance that had arisen in the wake of the rebound from the pandemic as oil demand outpaced supply. The goal of this government intervention was to help lower energy prices for consumers and to give

[13] CREA also points out that the price cap coalition is in violation of its own rule to review the level of the cap every two months and adjust it such that it is 5% below the average market price for Russian oil.

the domestic oil industry more time to raise production levels. Shortly after the outbreak of the war in Ukraine, on March 1, 2022, the US Department of Energy committed to releasing 30 million barrels of crude oil from the SPR to ensure an adequate supply of petroleum. This SPR release was part of a coordinated effort among the 31 members of the International Energy Agency (IEA). Other IEA member countries collectively agreed to release an additional 30 million barrels of petroleum from their emergency stockpiles, bringing the total release to 60 million barrels. To put further downward pressure on energy prices, the US government authorized a second emergency sale of up to 180 million barrels in April 2022, of which 60 million barrels were part of another joint initiative with the IEA, whose members contributed the other half. The combined amount of 240 million barrels constituted the largest-ever release of crude oil from government-controlled stocks.

To put these numbers into perspective, it is useful to compare the most recent releases from the US SPR to releases during other historical episodes. For example, the emergency sale in the aftermath of the Iraqi invasion of Kuwait in August 1990 amounted to 17 million barrels as part of an international effort to minimize oil supply disruptions from the Gulf War. The fallout from the destruction of oil facilities in the Gulf of Mexico as a result of hurricanes Rita and Katrina in September 2005 was made up for by an SPR release of 15 million barrels. During the Arab Spring in 2011, the US in cooperation with the IEA released 30 million barrels each from their emergency stockpiles to compensate for losses of crude oil in Libya and several other oil-producing countries. None of these previous emergency sales comes even close to the massive drawdown that started in December 2021.

Figure 5 shows the rapid depletion of the US SPR over a period of 12 months from a high of 600 million barrels at time of the first release announcement to a record low of 372 million barrels in December 2022 when delivery of emergency sales was completed. This historically low inventory level, which only covers about 20 days of supply at current US consumption rates according to Reuters, has raised concerns about the lack of a sufficient supply buffer to manage a future energy crisis, making countries more vulnerable in the event of another emergency. There is no direct evidence on how much the additional volumes of crude oil from emergency reserves contributed to moderating price fluctuations and pushing oil and other energy prices down over this period which depends on overall market dynamics.

In recent weeks, the US has initiated the process of replenishing the SPR with two consecutive purchase announcements. The plan is to buy back 12 million barrels by the end of this year with the first 3 million barrels already having been allocated and scheduled for delivery in August. Refilling the SPR creates additional demand for oil in a market environment that is torn between recession fears and subdued global growth and looming supply cuts and other supply-related uncertainties. The SPR purchases are likely to contribute to market tightening over the coming months and put a floor under oil prices.

3 Sources of Oil Price Fluctuations

To analyze how recent events have influenced fluctuations in oil prices, I use the model of the global market for crude oil proposed by Baumeister and Hamilton (2019) to quantify the relative importance of supply-side and demand-side developments. This model consists of four structural equations that describe the behavior of buyers and sellers in the oil market as well as the determinants of global growth. Buyers can purchase oil either for the purpose of consumption or inventory accumulation. The dynamic demand equation for consumption is given by:

$$q_t - \Delta inv_t = \beta_{qy} y_t + \beta_{qp} p_t + \boldsymbol{b}_d' \boldsymbol{x}_{t-1} + u_t^d$$

where q_t is the quantity of oil produced in a given month and Δinv_t is the change in oil stocks as a fraction of last month's production such that the difference yields the amount of oil consumed; y_t is real income and p_t is the real price of Brent crude oil with β_{qy} and β_{qp} measuring respectively the short-run income and price elasticities of oil demand. The dynamics are captured by $\boldsymbol{x}_{t-1} = (1, \boldsymbol{y}_{t-1}', \boldsymbol{y}_{t-2}', \ldots, \boldsymbol{y}_{t-12}')'$ with $\boldsymbol{y}_t = (q_t, y_t, p_t, \Delta inv_t)'$ and u_t^d is a consumption demand shock. Oil that is purchased but not consumed goes into storage which implies the following inventory demand equation:

$$\Delta inv_t = \gamma_1 q_t + \gamma_2 p_t + \boldsymbol{b}_{inv}' \boldsymbol{x}_{t-1} + u_t^{inv}$$

where changes in oil inventories, Δinv_t, are a function of current quantity produced and current price as well as past dynamics, and u_t^{inv} is an inventory demand shock. The decision of oil producers about how much oil to pump in any given month is characterized by a dynamic supply equation of the form:

$$q_t = \alpha_{qp} p_t + \boldsymbol{b}_s' \boldsymbol{x}_{t-1} + u_t^s$$

where α_{qp} is the short-run price elasticity of supply and u_t^s is a structural oil supply shock. Global real activity is contemporaneously determined by the real price of oil and past dynamics in the following way:

$$y_t = \alpha_{yp} p_t + \boldsymbol{b}_y' \boldsymbol{x}_{t-1} + u_t^y$$

with α_{yp} measuring the sensitivity of real income to oil price fluctuations and u_t^y being an economic activity shock. The model is estimated with Bayesian methods where the identifying assumptions are treated as prior information that is summarized in the form of probability densities which is then combined with information in the data to obtain estimates of the structural parameters.[14] The full set of priors as well as the sources of the data is described in Baumeister and Hamilton (2019).

Figure 6 shows the decomposition of the Brent price of crude oil into supply-side and demand-side drivers from 2020 to 2022. At the onset of the COVID-19 pandemic, oil prices collapsed reaching a trough of $18 per barrel in April 2022. The lift-off of oil

[14] For a non-technical introduction to the econometric methodology, please refer to Baumeister and Hamilton (2022); for a thorough treatment, please refer to Baumeister and Hamilton (2023a). Both papers use a model of the global oil market for illustration.

prices from their floor between April and August 2020 is due for 54% to supply cuts, mainly engineered by OPEC+ members, and for 46% to the return of oil demand. In the early stages of the recovery, as economies reopened from the pandemic-induced lockdowns, the bulk of the oil price increase of 67% between October 2020 and October 2021 is driven by a strong rebound in demand against supply tightness given that OPEC+ decided to return barrels to the market at a slower pace than previously anticipated. Between December 2021, when tensions between Russia and Ukraine became first apparent, and February 2022, high demand accounts for 80% of the 26% increase in the price of oil, while 20% can be attributed to difficulties on the supply side to bring oil production back online after earlier shut-ins. The Russian invasion of Ukraine that started on February 24, 2022, contributed to a further spike in oil prices hitting a peak of $123 per barrel in June 2022. Over this period, supply shocks contributed 62% to the 20% increase in oil prices. Since then, oil prices have come down by 32% in September 2022, which is largely due to an unexpected decrease in oil demand. This demand destruction is likely the result of growing fears of recession due to aggressive monetary policy tightening of central banks around the world. Between October and December 2022, oil prices declined by another 15%, which was counteracted by unexpected supply reductions that prevented prices from falling further. Since the beginning of 2023, the monthly Brent oil price has fluctuated in a narrow range of $75-$83 per barrel.

To get a better sense of the underlying drivers of the demand for crude oil, Table 1 provides a breakdown of the demand component into the contribution of shocks to economic activity, consumption demand, and storage demand over the various subperiods. In the first three phases of the surge in oil prices, the oil consumption demand shock accounts for the largest share of demand-side drivers, in particular during the re-opening period where it explains 77% of the oil price rise. In the post-invasion periods, the picture is more nuanced. During the run-up in oil prices in the first couple of months of the war in Ukraine, oil consumption demand shocks made a positive contribution of almost the same size as oil supply shocks, while inventory demand and economic activity shocks made small negative contributions. The latter could be the result of the initial interest rate increases by the Federal Reserve, which started in March 2022. Interestingly, when shocks to oil supply, consumption and storage demand exerted downward pressure on oil prices from June to September 2022, economic activity shocks stemmed the decline somewhat. In the last period from October to December 2022, all three demand shocks pushed oil prices lower.

4 The Role of Oil Price Shocks for Inflation

I now turn to assessing the relevance of different oil market shocks for inflation dynamics in both the United States and the Euro area. For this purpose, I augment the global oil market model of Baumeister and Hamilton (2019) with measures of headline inflation and inflation expectations following Aastveit, Bjørnland, and Cross (2023).[15]

4.1 Determinants of Recent Inflation Dynamics: A Comparison between the US and the Euro Area

When linking oil price fluctuations to inflationary pressures, it is useful to select as a starting date the point in time when inflation increased above and beyond the Federal Reserve's and ECB's inflation target given that we are interested in determining to what extent oil market shocks played a role in overshooting the target. In the US, the annual inflation rate had recovered back to pre-pandemic levels in February 2021 and was close to the 2% average inflation target, before taking off to heights not seen since the 1970s and early 1980s. In the Euro area, annual inflation seemed to have stabilized around the 2% target in the second quarter of 2021, but then started to soar above target from July 2021 onwards; I take June 2021 as the initial point since it marks the lowest level before inflation started its gradual ascent.

Table 2 reports the contributions of oil market shocks to consumer price inflation for the same subperiods that I previously considered for decomposing oil price dynamics except for the country-specific starting date for the first time period. Panel (a) shows that US headline inflation soared by 4.5 percentage points (pp) from 1.7% in February to 6.2% in October 2021. About one-third of this initial surge in inflation is due to demand shocks with oil consumption demand being the single most important contributor. A similar picture emerges in panel (b) for the Euro area where HICP inflation climbed 2.1 pp reaching 4% in October 2021. More than half of this rise in inflation is explained by demand shocks with 30% accounted for by economic activity and 70% accounted for by oil consumption. Oil supply shocks only play a minor role in both economies during this episode.[16]

In the three-month period between December 2021 and February 2022, inflation increased by another 0.8 pp and 0.9 pp in the US and the Euro area, respectively. While oil supply shocks are negligible, the contribution of demand shocks is twice as large in the Euro area accounting for 75% of the additional rise in inflation with the contribution evenly split between economic activity and consumption demand shocks.

In the aftermath of the invasion of Ukraine, war-induced oil supply shocks accelerate inflation in the US by 73% to its peak level of 8.9% in June 2022, with little role for demand shocks. Instead, in the Euro area oil supply shocks and demand shocks each contribute around 0.2 pp to the 1.2 pp increase in inflation; however, taking a closer look at the composition of demand shocks reveals that while oil consumption

[15] Please refer to Aastveit et al. (2023) for a discussion of the additional priors for the structural parameters in the equations for inflation and inflation expectations. I will use the same priors for the Euro area that they suggested for the United States.

[16] Oil market shocks do not account for all of the inflationary dynamics; the reason is that there are also shocks to inflation and inflation expectations in the empirical model, which are a composite of different factors that affect inflation such as other cost-push shocks due to supply-chain issues, for example. Since I cannot assign a clear structural interpretation to these shocks, I will not discuss them further.

and inventory demand shocks put considerable upward pressure on inflation, economic activity shocks tempered the overall contribution.

From June to September 2022, inflation starts coming down in the US, while it is still gaining pace in the Euro area. Close to 40% of the 0.7 pp decline in US inflation can be attributed with almost equal shares to oil supply shocks (0.15 pp) and demand shocks (0.12 pp). The breakdown of the demand shock into its underlying components shows that the strong downward pressures on inflation from consumption demand shocks were counteracted by positive economic activity shocks that kept inflation from falling further over this period. The primary driver of the further run-up of Euro area inflation by 1.3 pp are economic activity shocks, whose contribution is in part offset by both oil consumption and storage shocks, resulting in a joint contribution of demand-side shocks of only 0.29 pp.

In the last quarter of 2022, US inflation decreased by another 1.3 pp, half of which is explained by negative demand shocks stemming from all three components. Euro area inflation declined by 1.4 pp from its all-time high of 10.6% in October 2022. Oil market shocks are not the main source of inflation dynamics during this period with oil demand shocks accounting for -0.24 pp and oil supply shocks for a mere 0.02 pp.

These results are broadly in line with Bernanke and Blanchard (2023) who conclude that energy price shocks account for much of the increase in US inflation in late 2021 and the first half of 2022 based on a quarterly model of wage-price determination. However, they do not distinguish between demand-driven and supply-driven changes in energy prices and their separate roles for inflation dynamics. Gagliardone and Gertler (2023) trace the recent inflation surge to a combination of oil price shocks and accommodative monetary policy by the Federal Reserve using a quantitative New Keynesian model that features complementarities in the use of oil with both household consumption and firm production. They also do not decompose the contribution of oil price shocks into supply and demand sources. Corsello and Tagliabracci (2023) provide evidence that the direct and indirect effects of energy price shocks contributed roughly 60% to the run-up in Euro area inflation in the first nine months of 2022.

4.2 Dynamic Effects of Oil Supply Shocks on Inflation and Inflation Expectations

Among the different inflationary sources of oil price fluctuations considered thus far, concerns about oil supply disruptions have figured prominently ever since the outbreak of the war in Ukraine. Given that oil supply shocks not only lead to higher inflation but also depress economic activity (see, e.g., Baumeister, Peersman, and van Robays, 2010; Baumeister and Peersman, 2013; Baumeister and Hamilton, 2019; Bjørnland, 2022; Gagliardone and Gertler, 2023), they generate a trade-off between inflation and output stabilization for central banks. More generally, Bjørnland’s (2022) literature review points to an increased role for oil supply shocks based on several recent studies, which has important implications for studying their macroeconomic consequences, in particular in light of the war-induced energy supply cuts.

I use the same extended oil market model as above to quantify the magnitude and speed of pass-through of oil supply shocks to headline inflation and inflation expectations in the US and the Euro area. I consider two different measures for inflation expectations: a survey-based measure that reflects households' expected inflation for the next year and a market-based measure that reflects financial market participants' assessment of long-term inflation.[17]

Figure 7 shows the inflationary effects of a 10% increase in the real price of oil due to an oil supply disruption.[18] Both US and Euro area inflation jump up on impact by roughly similar amounts, reflecting the direct effect of the oil price rise on the energy component of headline inflation. Energy goods and services account for roughly 7.5% of overall US CPI, while energy receives a weight of about 9.5% in the Euro area consumption basket. US inflation rises steeply and reaches a peak of 0.4% after one quarter before gradually reverting back to baseline. In contrast, HICP inflation responds more slowly and it takes almost six months before inflationary pressures start to mount. The fact that Euro area inflation reaches its maximum effect of 0.3% only about a year after the shock and remains elevated for a prolonged period of time suggests an important role for second-round effects. Overall, the pass-through to headline inflation is much faster in the US, while inflationary consequences are relatively persistent in the Euro area.

Household inflation expectations react more strongly on impact in the US but the initial rise fades quickly, whereas they build up more gradually in the Euro area. This difference in dynamics matters for monetary policy. The protracted response in the Euro area indicates that higher oil prices are getting more ingrained in expectations, which increases the risks of setting off a wage-price spiral. Long-run market-implied inflation expectations are less sensitive to oil supply shocks in both economies compared to short-run consumer inflation expectations, but they experience a small sustained increase of similar magnitude of around 0.03%. Thus, while long-run inflation expectations seem firmly anchored in both economies, households in Europe are more prone to significantly adjust their inflation expectations upward for some time in response to oil supply shocks.

4.3 Cross-country Differences in the Euro Area

The ECB's mandate to maintain area-wide price stability is complicated by the fact that individual Euro area member countries might react quite differently to oil supply

[17] For the US, I rely on the median 1-year-ahead inflation expectations from the Michigan Survey of Consumers and the 10-year expected inflation rate constructed by the Federal Reserve Bank of Cleveland; for the Euro area, I use the 1-year-ahead balance statistic for household inflation expectations from the European Commission consumer survey and the 5-year, 5-year forward inflation expectation rate from www.macrotrends.net.

[18] The solid blue lines are the median of the posterior distribution for any given horizon and the shaded areas represent 68% posterior credibility regions.

shocks. I next examine the pass-through of oil supply shocks for all 19 individual Euro area member countries.[19]

Pass-through is the result of direct and indirect mechanisms. Since households do not directly consume crude oil, the first stage of pass-through is reflected in oil-related products and other energy goods and services that are part of the consumer basket, whose price developments are summarized by HICP energy. Indirect inflationary pressures may arise because higher energy prices increase the costs of input factors and production for non-energy goods and services, which, if passed on to consumers, will show up in core inflation (see, e.g., Peersman and van Robays, 2009; Baumeister et al., 2010; Conflitti and Luciani, 2019). Given that oil price changes are highly visible, households might disproportionately react to them when forming expectations about future inflation. Higher inflation expectations can set in motion second-round effects via the wage-bargaining mechanism where workers try to make up for current and expected future decreases in purchasing power and via the price-setting mechanism where firms increase their mark-ups, both of which reinforce inflationary pressures (see, e.g., Peersman and van Robays, 2009; Wong, 2015; Bjørnland, 2022; Aastveit et al. 2023). The strength of such effects depends in large part on the credibility of monetary policy and the ability of the central bank to keep inflation expectations anchored. Another indirect transmission channel of oil supply shocks is consumer confidence, which can be considered an indicator of future household spending and thus captures demand-side effects that are likely to exert downward pressures on prices.

In addition to the country-specific responses of headline inflation, I focus on direct effects, cost effects, second-round effects, and demand effects of oil supply shocks. To trace out these dynamic effects, I estimate an internal instrumental variable vector autoregression (see Plagborg-Møller and Wolf, 2021), where the instrument is the global oil supply shock recovered from the oil market model of Baumeister and Hamilton (2019).[20]

Figure 8 displays the responses of each country to an oil supply shock that raises the real price of oil by 10% on impact. To get a sense of the differences in magnitude across countries, the panels on the left show the cross section of responses for a given horizon, where the selected horizon corresponds to the peak response of the Euro area (which is included as a reference point) except for energy price inflation. The countries are ordered from the largest to the smallest response. To gauge differences in dynamics, the panels on the right report the month of the maximum effect for each country.

Panel A quantifies the direct effect on the energy component of the consumer price index in the month when the oil supply shock hits. The size of the response depends

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[19] Note that I exclude Croatia given that it adopted the Euro only in January 2023.

[20] Besides the monthly oil supply shock, I include the real price of Brent crude oil in order to normalize the shock to lead to a 10% increase in oil prices on impact, as well as annual HICP inflation, HICP energy and core inflation from Eurostat, and measures of 1-year-ahead inflation expectations and consumer confidence from the European Commission survey. For most countries, data start in 1996M1, except for some of the smaller countries where data become available only later. All samples end in 2022M12. The VAR contains 12 lags and is estimated for each country separately using Bayesian methods.

on each country's share of oil-related products in the energy consumption bundle and the degree of substitutability of oil with other sources of energy. Oil price increases are immediately reflected in higher energy prices in all countries with the exception of Malta. The strength of the pass-through spans from 0.3% in Ireland to 1.5% in Greece with Luxembourg being a clear outlier with an impact response of 2.3%. The core countries are close to the Euro area value of 1.1%, which, given the weight of energy in the Euro area basket of around 9.5%, implies an impact effect on headline inflation of 0.1%, which is consistent with the result reported in Figure 7 (see also Figure 9). Given that oil prices remain elevated for some time after the shock, the maximum response of energy prices is reached in most countries after 11 months.

To evaluate to what extent firms pass this increase in their input costs on to final consumers, panel B shows the cross-country effects on core inflation which measures price changes in non-energy goods and services. The responses a year and a half after the shock are relatively tightly clustered around 0.15% except for the three Baltic countries where the cost channel is particularly strong. While the magnitude of same-horizon responses is rather similar across countries, there is considerable heterogeneity in the speed of transmission. Core inflation rises relatively quickly in one third of the Euro area countries reaching the peak within one year, while the pass-through is more protracted in the other countries.

The quantitative importance of second-round effects is assessed by the response of household inflation expectations in panel C. The sensitivity of inflation expectations to an oil supply shock varies greatly across member countries at the point in time when the Euro area response peaks. A handful of countries display only a modest reaction; however, these countries either reach their peak much earlier or later than the Euro area as a whole. In about half of the countries, inflation expectations show a strong response in the range of 0.2% and 0.4% despite having already passed the horizon of the maximum response. This suggests that supply-driven oil price increases exert a sizeable and prolonged effect on inflation expectations with important differences in cross-country dynamics. The dispersion in timing is relevant for the ECB in deciding about the appropriate pace of monetary tightening in light of the risk of a de-anchoring of inflation expectations.

Panel D examines the responses of consumer confidence as a proxy for the demand channel of oil supply shocks to gauge deflationary effects. An increase in oil and energy prices forces consumers to spend a larger share of their disposable income on energy needs given that energy demand is relatively price inelastic, which reduces spending on other goods and services. This discretionary income effect tends to be reinforced by households becoming more uncertain about their future as a result of the oil supply shock. Thus, a fall in consumer confidence is indicative of future spending cuts. Panel D shows that consumer confidence declines between 1% and 2% for most Euro area member countries but that the response is sluggish, except for Lithuania where confidence is hit hardest on impact; all other countries reach their trough in the second year after the shock, which might be linked to the persistence of the oil price response. This suggests that confidence of households is an important propagator of oil supply shocks which is likely to result in a confidence-induced decrease in spending which, in turn, eases inflationary pressures.

Taken together, there are considerable quantitative differences in the dynamic effects of oil supply shocks on energy and core inflation as well as inflation expectations and consumer confidence across Euro area countries. This cross-country heterogeneity in the relative strength of various transmission channels can arise from structural differences in individual member economies related to the energy mix, industry composition, and competitive environment. For example, Peersman and van Robays (2009), who look at various quarterly inflation indicators for a subset of Euro area countries after an oil supply shock, provide evidence that countries with formal wage indexation mechanism and high employment protection are more prone to display strong second-round effects. They also show that cross-country differences cannot be explained by the varying degree of oil intensity of member economies. Corsello and Tagliabracci (2023) note that a diverse set of national government policies such as energy tax reductions, subsidies, and other fiscal measures are another source from which differences in the timing and magnitude of pass-through might originate.

All these direct and indirect effects contribute to the overall inflation dynamics summarized in Figure 9. The left-hand-side panel illustrates the heterogeneity in the country-specific responses of headline inflation on impact which is driven by a combination of the pass-through of crude oil price increases to energy prices in each country, composition of the energy bundle, and the weight of the energy component in that country's consumer basket. For example, Luxembourg displays the strongest response of energy inflation, which together with an above-average share of energy in consumer expenditures translates into the strongest impact effect on headline inflation. For other countries, this link is stronger or weaker depending on the relatively larger or smaller weight of the energy component. Germany is a case in point where energy inflation increases by a little more than 1%, while headline inflation surges by almost 0.2% on impact reflecting Germany's greater consumption share of energy.

The right-hand-side panel reports the maximum response of headline inflation across member countries. The dispersion in the magnitude of the effects suggests important differences in the dynamics, which can be traced to differences in timing of second-round effects of rising energy prices. Take the four largest Euro area economies (Germany, France, Italy, and Spain) which contribute most to Euro area headline inflation. The fact that their maximum responses slightly exceed the Euro area peak indicates that they peak before or after Euro-area wide headline inflation.

The heterogeneous transmission of oil supply shocks in the Euro area poses important challenges for the effective conduct of monetary policy by the ECB.

5 Risk Assessment

I conclude with an assessment of possible upside and downside risks over the near term and their implications for the future path of oil prices.

Saudi Arabia's plan to reduce its output by 1 million barrels per day (mbpd) came into effect on July 1, 2023, amid a broader deal by OPEC and its allies to limit supply into 2024. At the same time, Saudi Arabia and Russia pledged to extend oil production cuts into August 2023 curbing supply by another 1 mbpd and 0.5 mbpd, respectively. I use the model described in Section 3 to simulate the price path implied by these supply reductions which amount to a withdrawal of 1.7% and 1.9% of global oil production in July and August 2023.[21] The black dashed-dotted line in Figure 10 shows that this tightening of supply pushes oil prices slightly above $90 per barrel over the next 12 months under the assumption that no further supply-side surprises happen after August.

In recent months, economic concerns about further tightening of monetary policy in the US and Europe to return inflation to target have been mounting. Higher interest rates increase borrowing costs for businesses and consumers, which could weaken economic activity and reduce oil demand. A useful historical precedent to mimic the current macroeconomic environment of high but declining inflation coupled with rising interest rates in the major advanced economies is the second tightening cycle during Volcker's chairmanship from July 1980 to January 1981. I feed the sequence of estimated oil consumption demand shocks for this historical episode[22] into the global oil market model as of June 2023 to gauge the oil price effects of lingering worries over a slowdown in the global economy as a result of continued interest rate hikes by central banks in the US and Europe. The black dotted line in Figure 10 shows the extent to which growing recession fears exert downward pressure on oil prices over the next year. In this hypothetical scenario, oil prices are expected to gradually decline to around $62 per barrel.

OPEC+ supply cuts and restrictive monetary policy have been pulling oil prices in opposite directions. If we assume that supply and demand concerns are equally important in determining oil prices going forward, we can combine both scenarios by assigning equal weight to them. In this case, the red line with dots in Figure 10 indicates that oil prices might continue to fluctuate in a relatively narrow range of $76 to $80 per barrel in the coming year.

There remain plenty of challenges and uncertainties both on the supply and the demand side of the global oil market and it remains to be seen how those play out over the medium term.

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21 A description of how to implement scenarios in structural VAR models can be found in Baumeister and Kilian (2014).

22 To ensure that this is not a US-specific scenario, I extend the shock sequence to March 1981, which is when the policy rate of the Bundesbank, which I take as a proxy for European monetary policy at the time, reached its peak.

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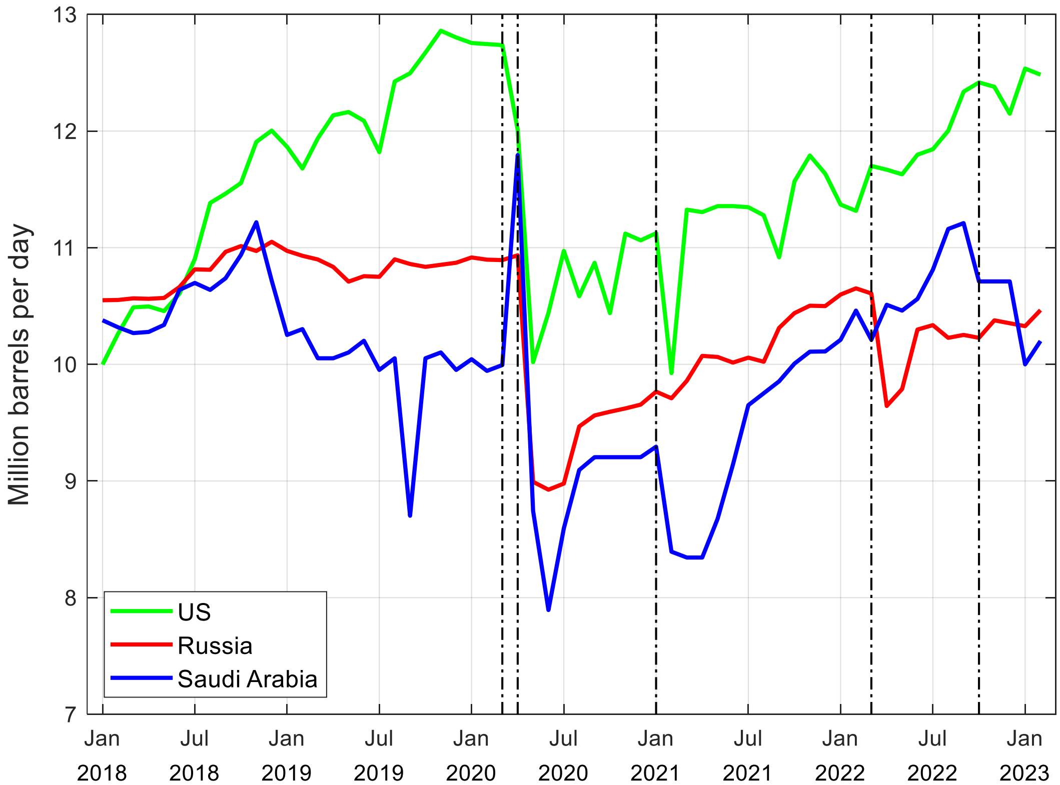
Figure 1. Production developments of the three main oil producers, 2018-2023

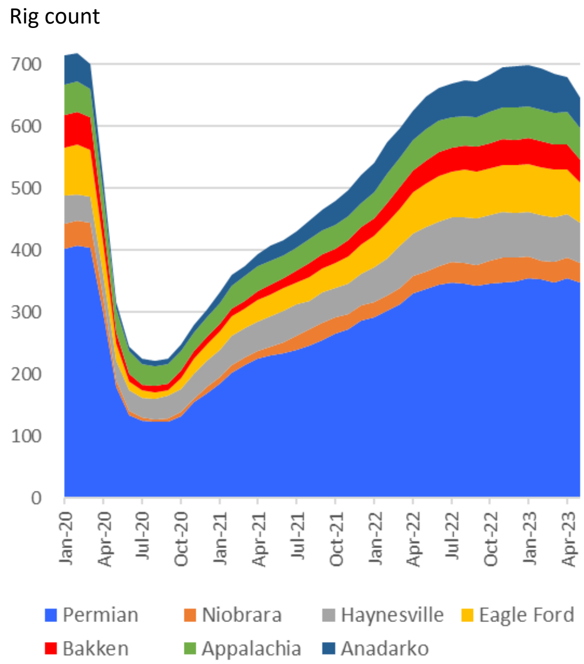


Source: US EIA

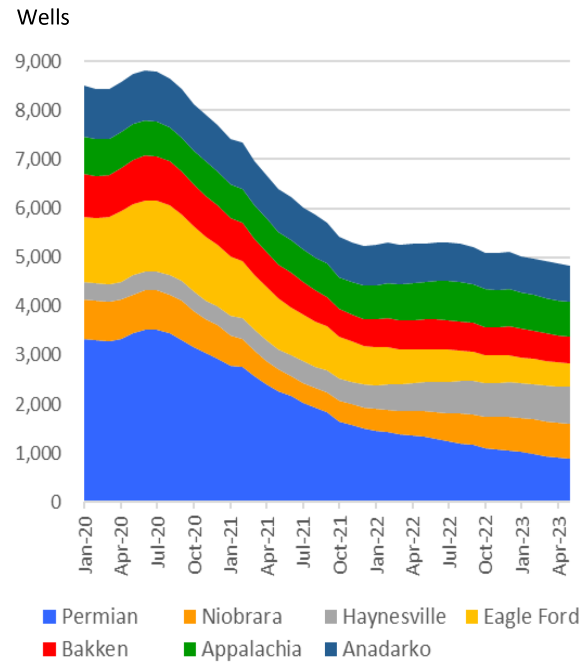
Notes: The black dashed-dotted lines refer to the following events: OPEC+ price war and demand collapse from COVID-19 pandemic (March 2020), OPEC+ agreement of production cuts (April 2020), second wave of lockdowns (January 2021), Russian invasion of Ukraine (February 2022), OPEC+ announcement of production cuts (October 2022).

Figure 2. Indicators of the US shale oil industry

Panel A: Rig counts disaggregated by shale oil plays



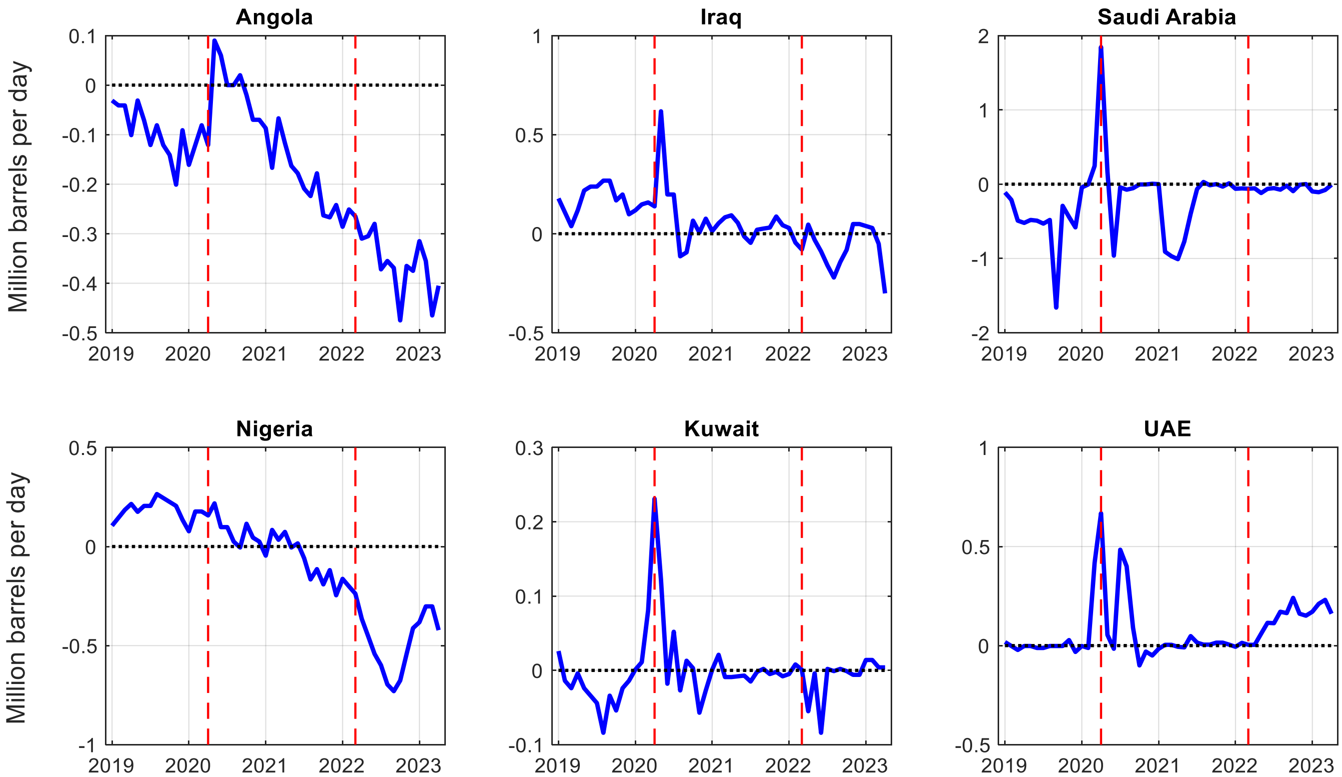
Panel B: Drilled but uncompleted wells



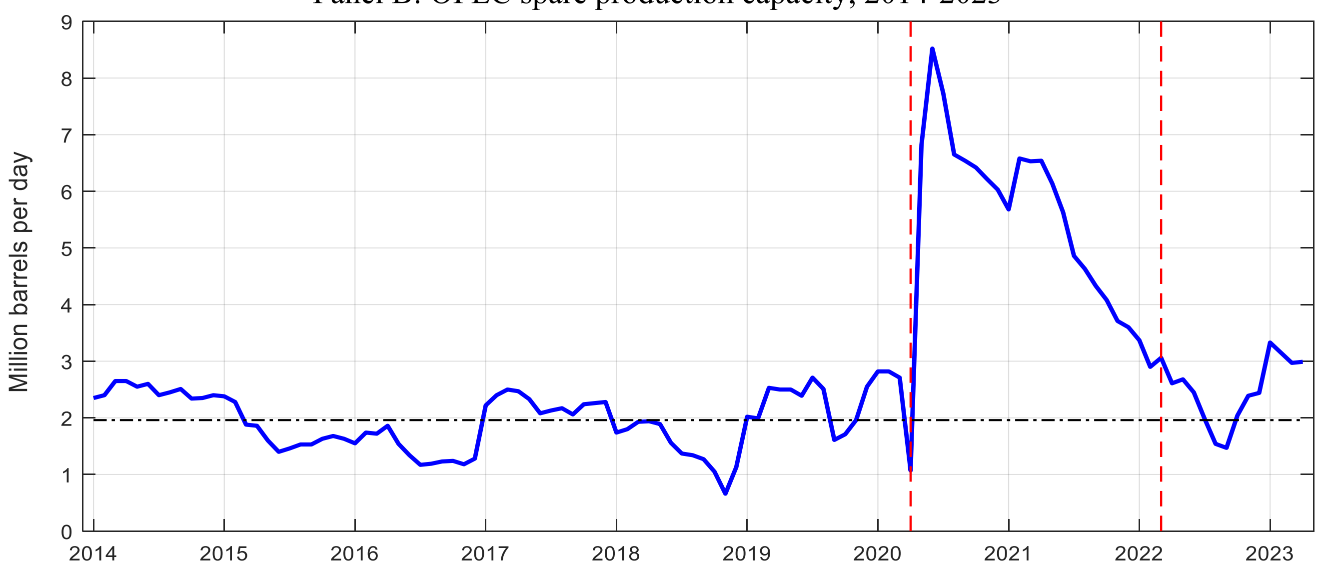
Source: US EIA Drilling Productivity Report

Figure 3. Oil production indicators for OPEC member countries

Panel A: Monthly over- and underproduction in selected OPEC member countries



Panel B: OPEC spare production capacity, 2014-2023

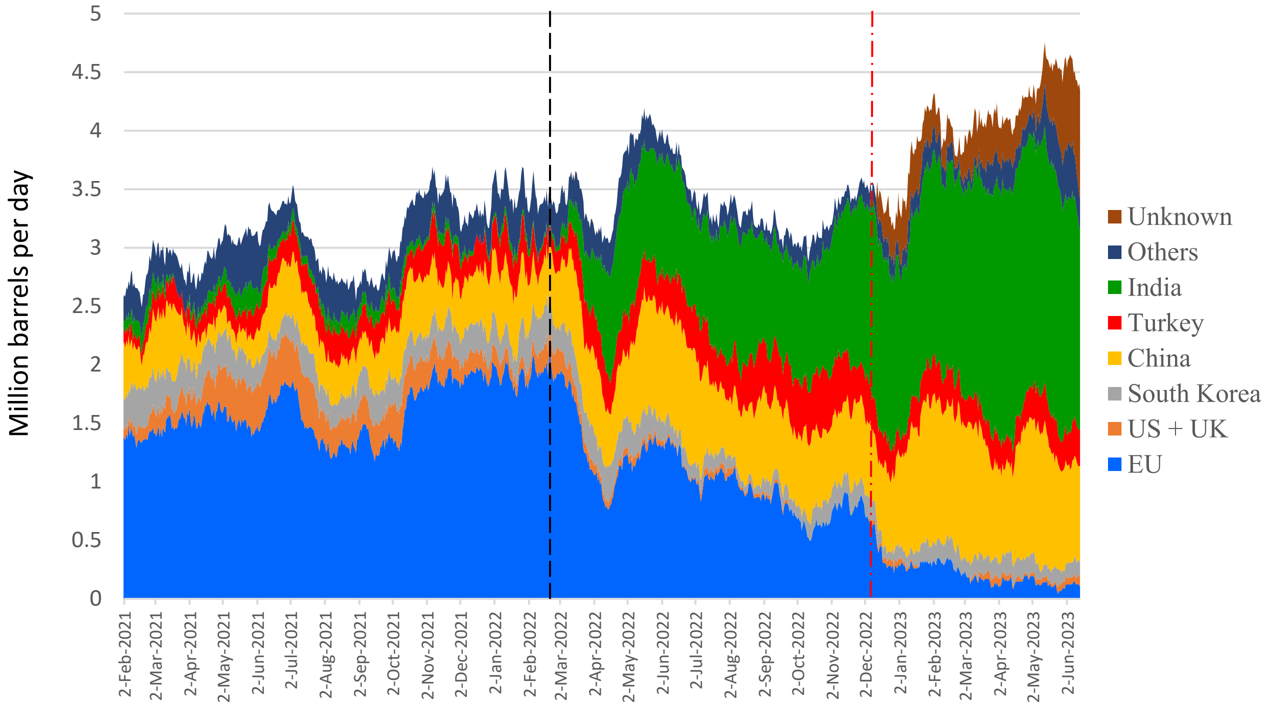


Source: Bloomberg (panel A), US EIA (panel B)

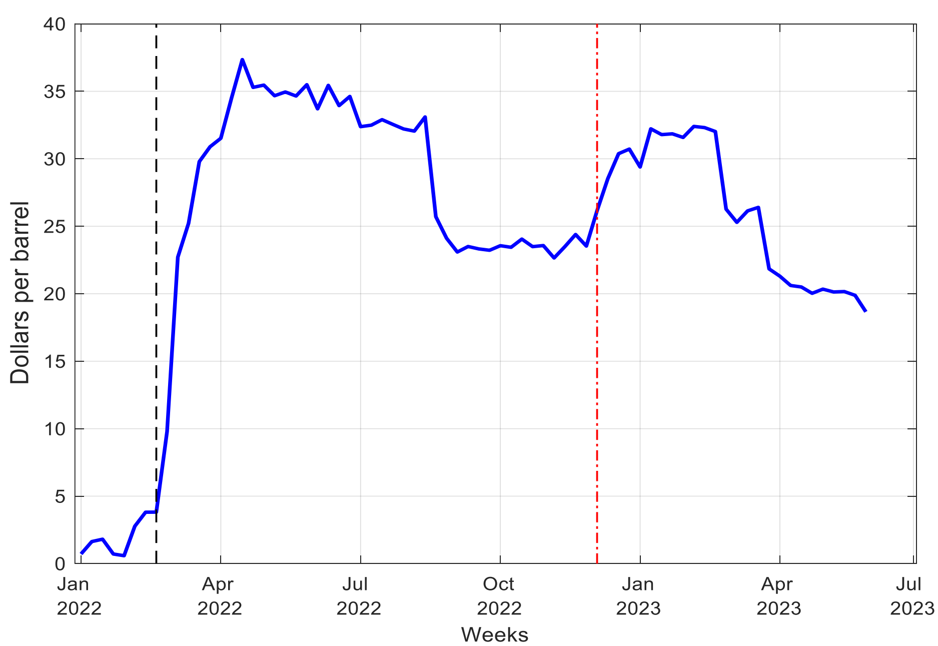
Notes: In panel A, negative numbers indicate undershooting the production quota, while positive numbers indicate overshooting it. In panel B, the black dashed-dotted line indicates the average spare capacity before the pandemic (1.96 mbpd). In both panels, the first red dashed line refers to the time of the OPEC+ production cut agreement (April 2020) and the second red dashed line to the Russian invasion of Ukraine (March 2022).

Figure 4. Russian Oil Export Activity and Price Differentials

Panel A: Russian seaborne shipments of crude oil by destination



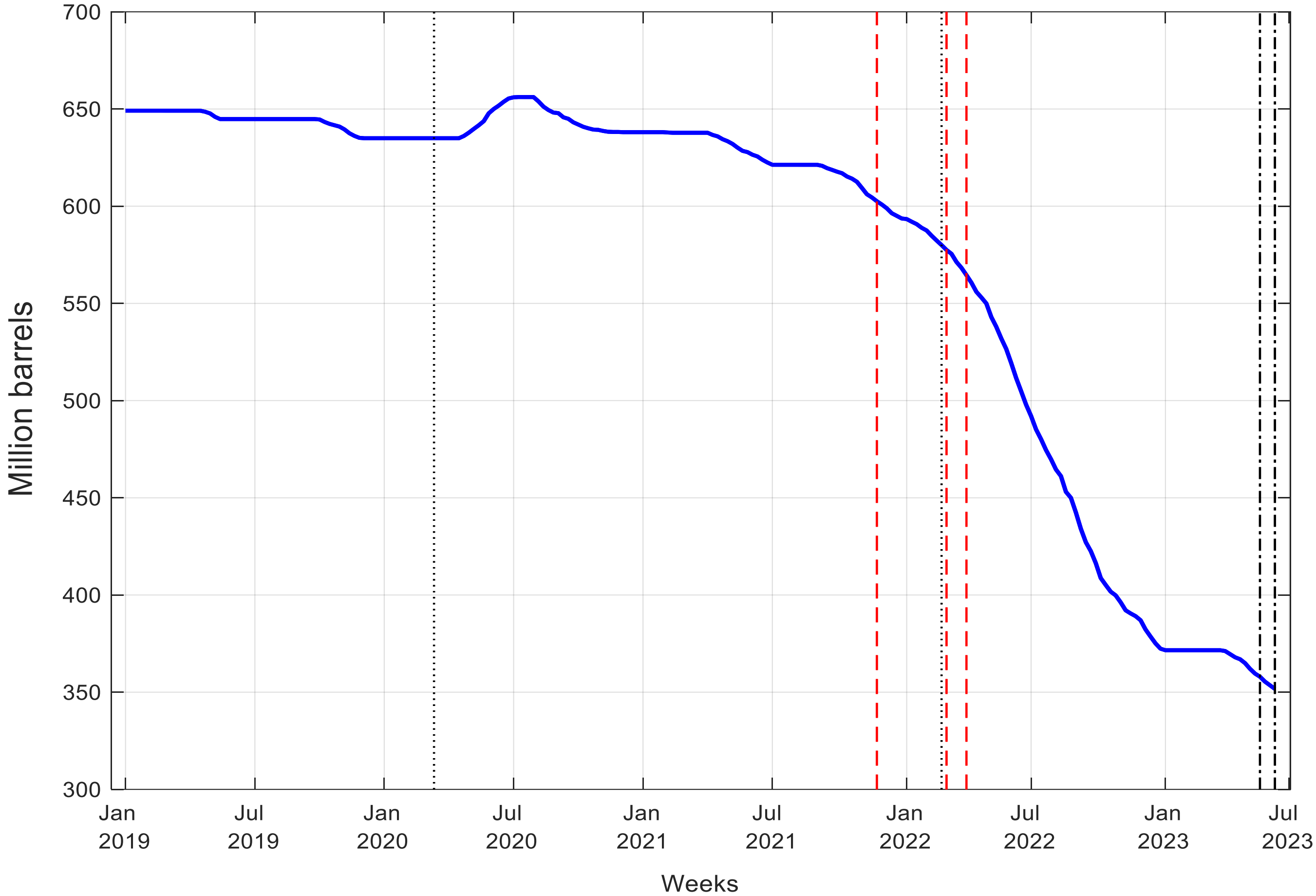
Panel B: Weekly average price discount of Russian benchmark Urals relative to Brent



Source: CREA (panel A), US EIA and Neste (panel B)

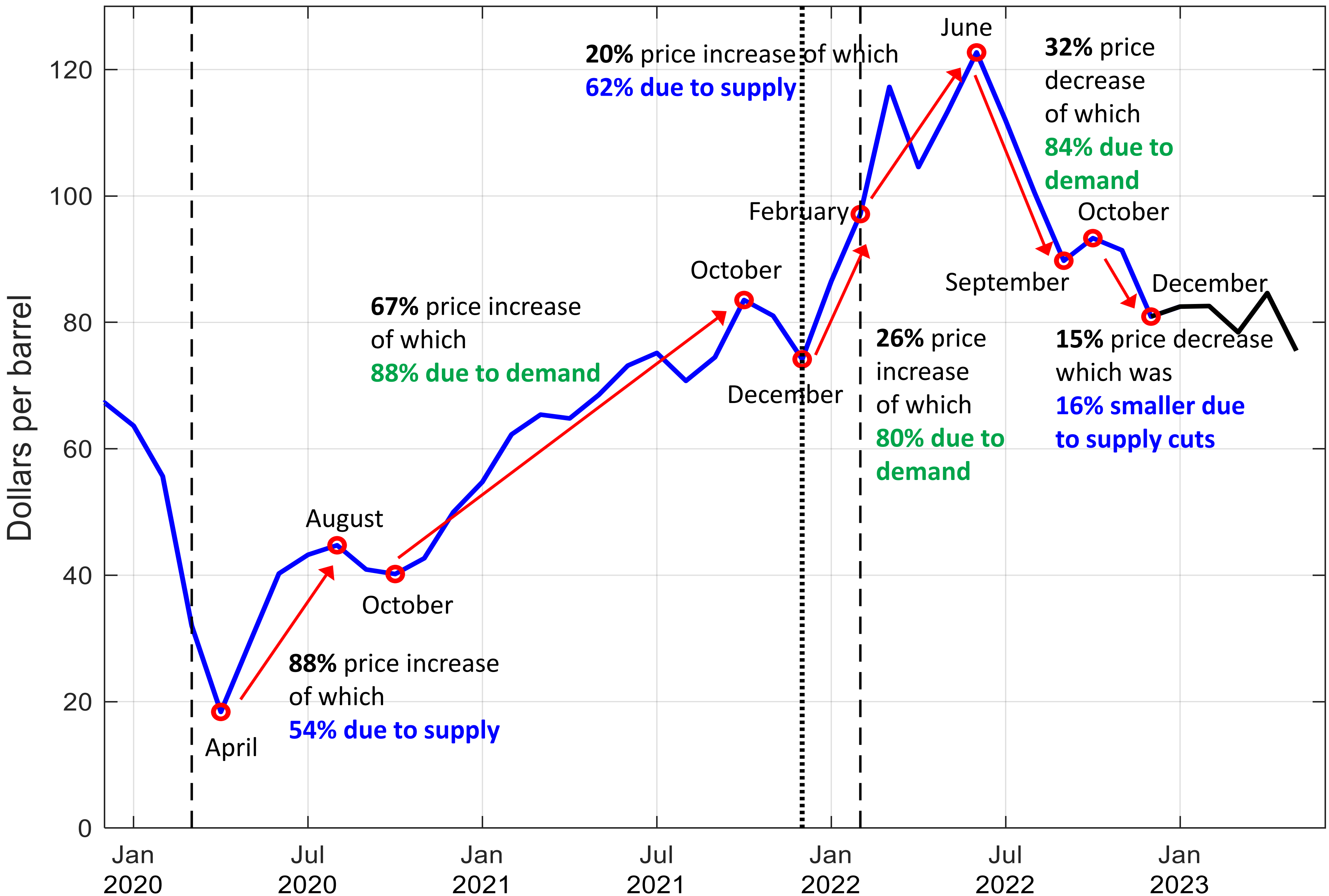
Notes: In panel A, shipments are 30-day moving averages and volumes are converted from metric tons to barrels by applying a factor of 7.33. In both panels, the dashed black line refers to the start of the war in Ukraine, and the red dashed-dotted line refers to the start of the EU oil embargo and the price cap policy.

Figure 5. Weekly Stocks of Crude Oil in the US Strategic Petroleum Reserve, 2019-2023



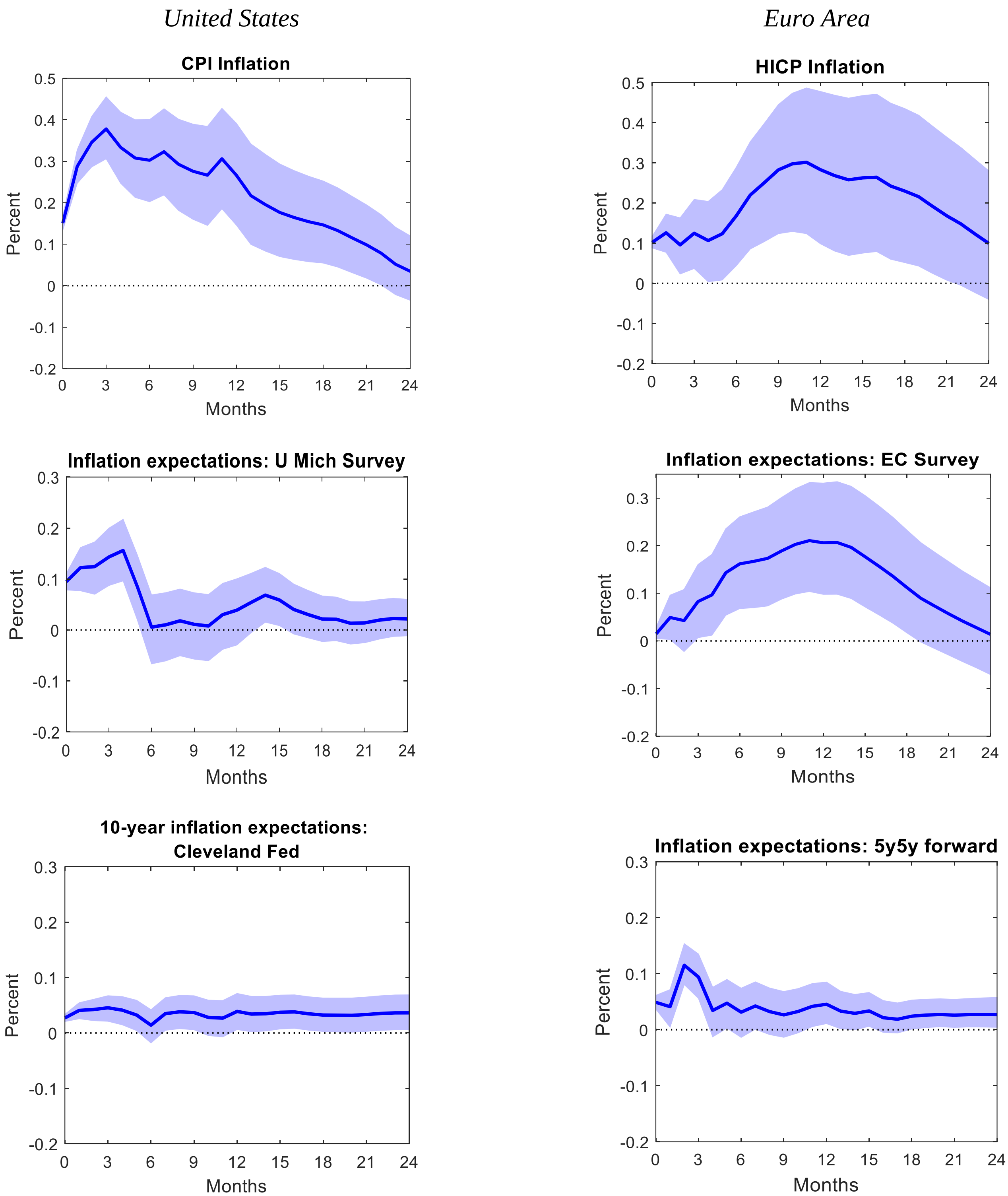
Source: Weekly Petroleum Status Report (US EIA)
Notes: The black dotted lines indicate the start of the pandemic-related lockdowns (March 12, 2020) and the Russian invasion of Ukraine (Feb 24, 2022); the red dashed lines indicate the announcements of the Biden administration for SPR releases on November 23, 2021, March 1, 2022, and April 1, 2022; the black dashed-dotted lines indicate the announcements of the Biden administration for SPR purchases on May 15, 2023, and June 9, 2023.

Figure 6. Drivers of Oil Price Fluctuations, 2020-2022



Source: Global oil market model of Baumeister and Hamilton (2019) updated to include data until December 2022.
Notes: The blue line is the nominal price of Brent crude oil that is part of the analysis, whereas the black line refers to the most recent observations. The first dashed line indicates the start of covid-related lockdowns. The dotted line indicates the start of growing tensions between Russia and Ukraine and the second dashed line the Russian invasion of Ukraine.

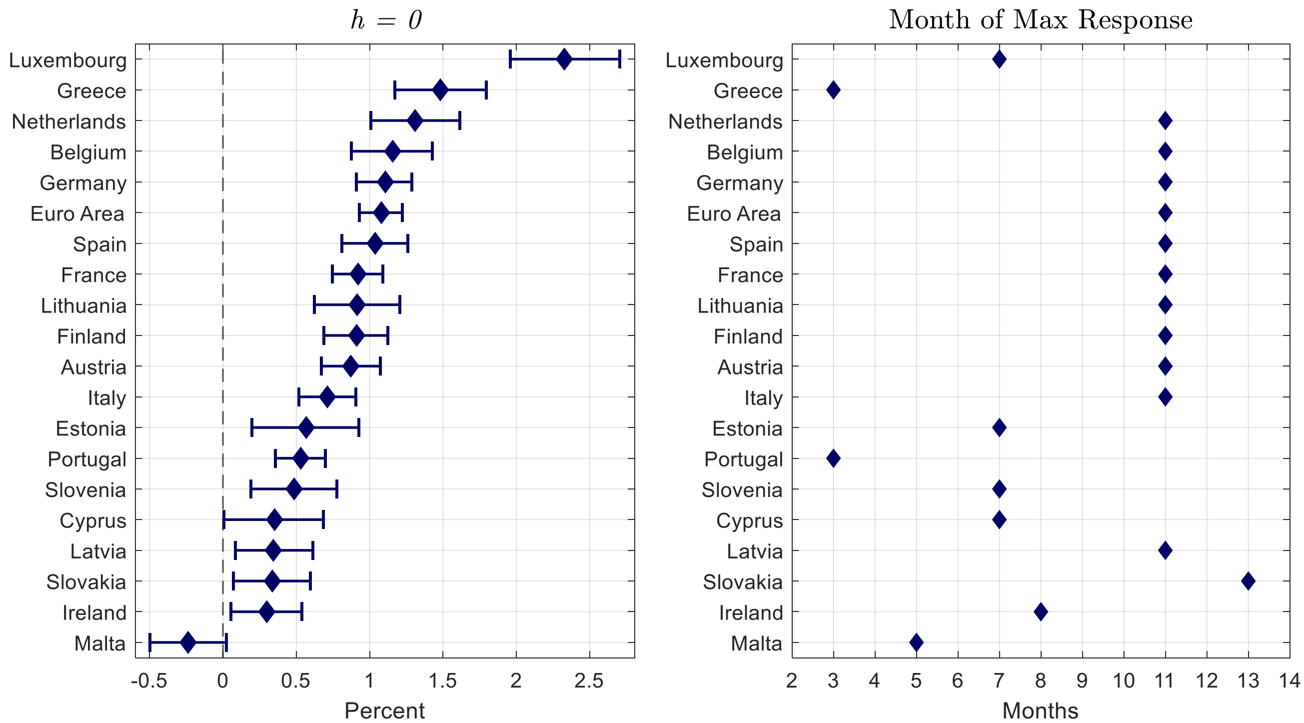
Figure 7. Inflationary effects of a 10% increase in oil prices due to an oil supply shock



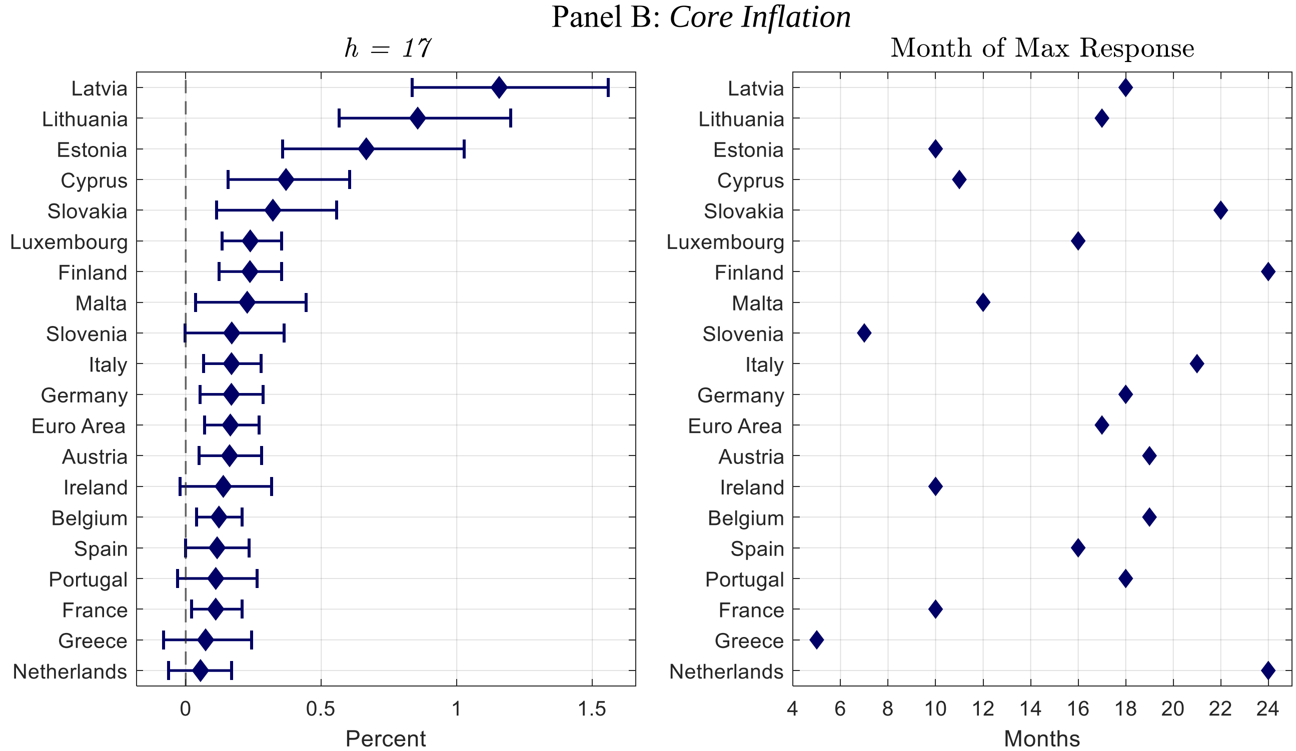
Notes: The blue lines are the posterior medians and the shaded areas correspond to 68% posterior credibility sets.

Figure 8. Cross-country differences in the channels of transmission of a 10% increase in oil prices due to an oil supply shock

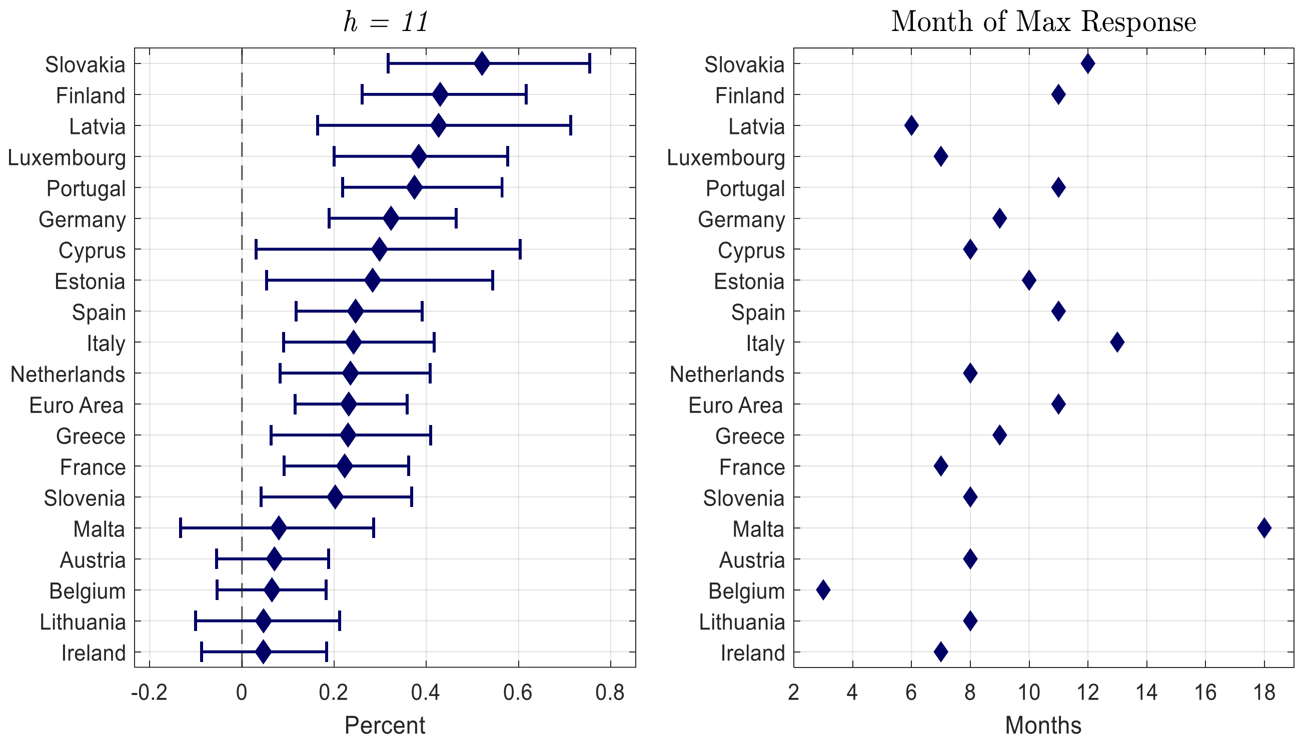
Panel A: *Energy Inflation*



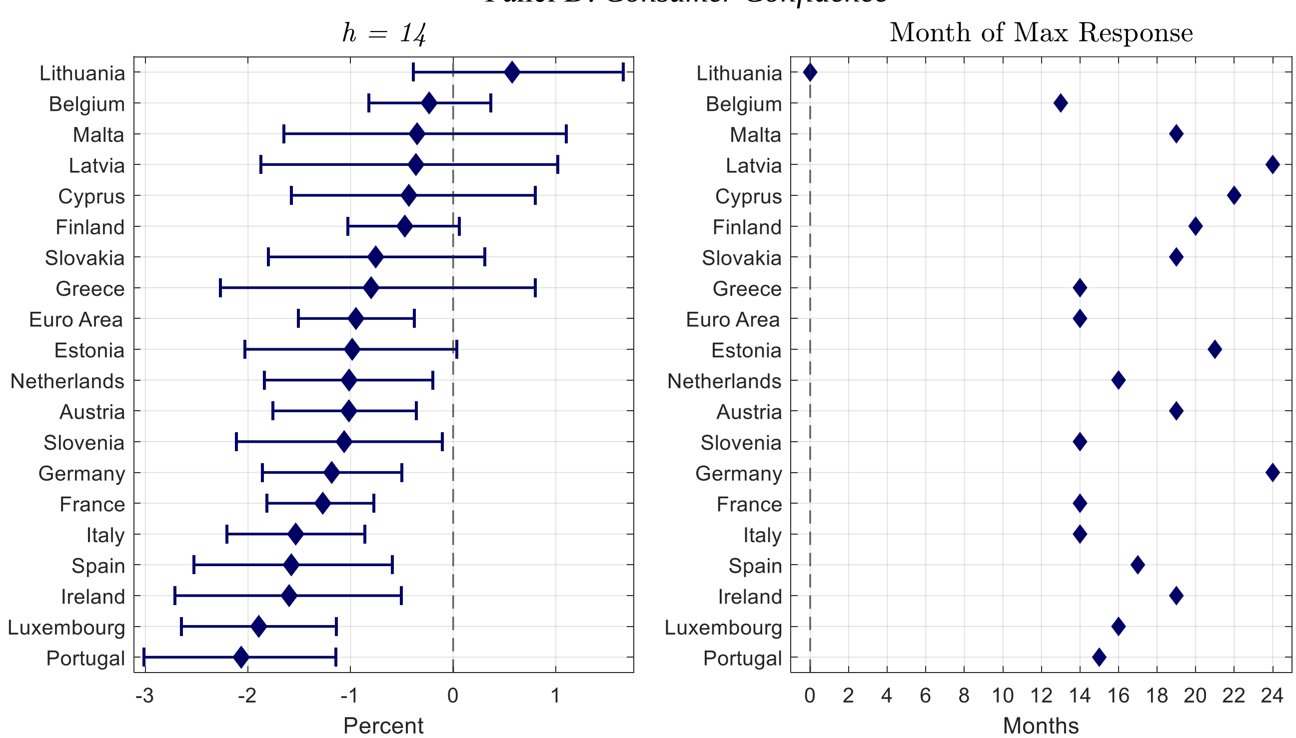
Panel B: *Core Inflation*



Panel C: *Consumer Inflation Expectations*

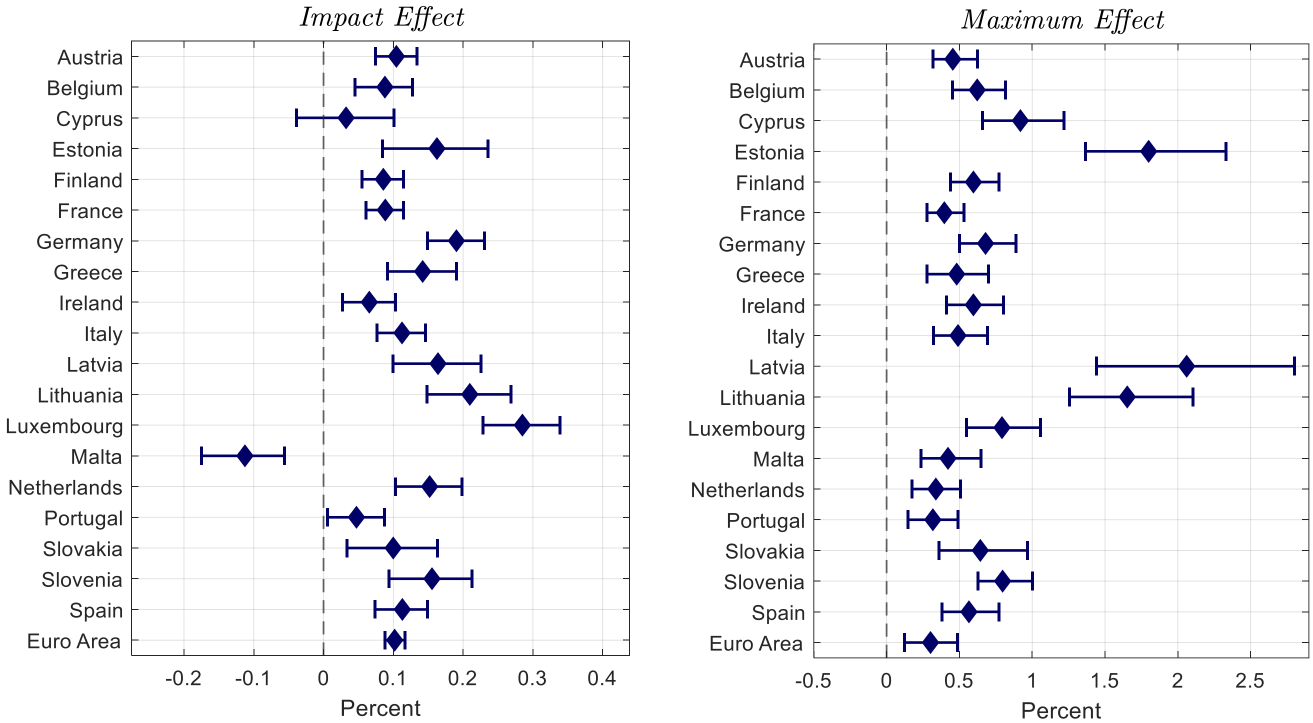


Panel D: *Consumer Confidence*



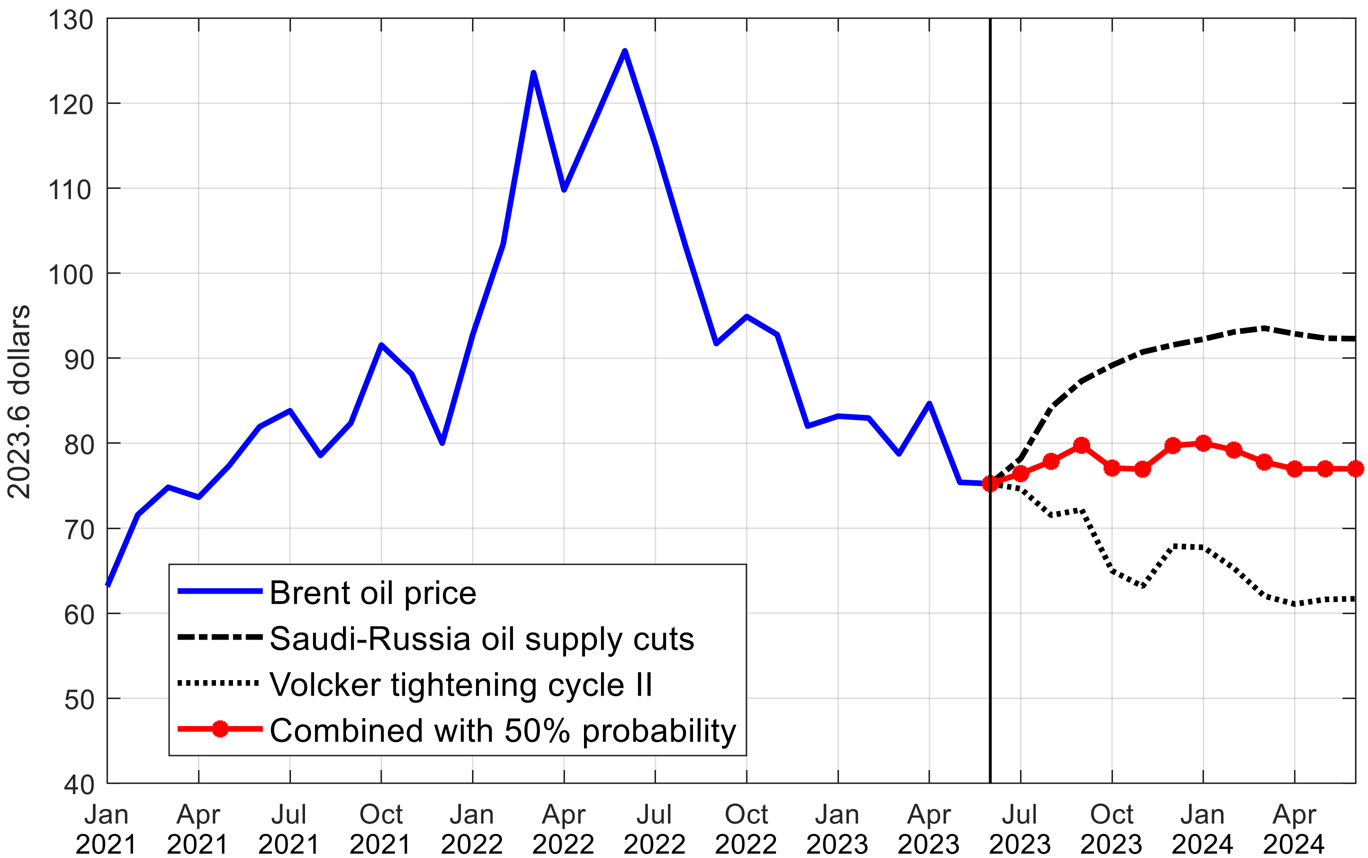
Notes: Error bars represent 68% posterior credible sets. The selected horizon corresponds to the maximum response of the Euro area except for energy price inflation where the impact effect is chosen.

Figure 9. Cross-country responses of headline inflation to a 10% increase in oil prices due to an oil supply shock



Notes: Error bars represent 68% posterior credible sets.

Figure 10. Scenario Analysis as of June 2023



Notes: The black dashed-dotted line indicates the price path implied by the Saudi oil production cut of 1 million barrels per day and 0.4 million barrels per day by other OPEC members in July 2023 and the Saudi-Russia oil production cut of 1.5 million barrels per day announced for August 2023; the black dotted line indicates the price path implied by the historical oil consumption demand shock sequence related to the second Volcker tightening cycle between July 1980 and January 1981 when inflation was falling and extended to March 1981 when the Bundesbank reached its peak policy rate; the red line with dots indicates the combined price path of both scenarios where each scenario receives equal weight.

Table 1. Sources of Oil Price Fluctuations since the Start of the Pandemic

Time period	*Actual real oil price growth*	*Oil supply shock*	*Economic activity shock*	*Oil consumption demand shock*	*Oil inventory demand shock*
	(1)	(2)	(3)	(4)	(5)
April-Aug 2020	87.7	47.8	10.8	24.6	0.8
Oct 2020-Oct 2021	67.1	10.2	6.8	51.9	-2.1
Dec 2021-Feb 2022	25.7	5.0	5.6	15.0	0.1
March 2022-June 2022	19.9	12.4	-3.2	11.0	-1.3
June 2022-Sept 2022	-31.9	-4.3	1.2	-25.0	-2.8
Oct 2022-Dec 2022	-14.6	2.2	-2.3	-11.4	-1.8

Notes: This decomposition is derived from the global oil market model of Baumeister and Hamilton (2019) updated to include data until December 2022.

Table 2. Contribution of oil market shocks to consumer inflation dynamics during 2021-2022

Time period	Actual change in inflation	Contribution of		Breakdown of contribution of demand shocks into		
		oil supply shocks	*demand shocks*	economic activity	oil consumption	oil inventories
	(1)	(2)	(3)	(4)	(5)	(6)
	(a) United States					
Feb-Oct 21	4.5	0.10	1.42	0.13	1.24	0.05
Dec 21-Feb 22	0.8	0.03	0.31	0.12	0.17	0.01
March-June 22	0.4	0.29	0.06	0.03	0.03	0.00
June-Sept 22	-0.7	-0.15	-0.12	0.27	-0.37	-0.02
Oct-Dec 22	-1.3	0.05	-0.58	-0.27	-0.23	-0.07
	(b) Euro Area					
June-Oct 21	2.1	-0.06	1.11	0.26	0.78	0.07
Dec 21-Feb 22	0.9	0.03	0.69	0.37	0.37	-0.05
March-June 22	1.2	0.20	0.22	-0.14	0.31	0.05
June-Sept 22	1.3	-0.08	0.29	0.52	-0.18	-0.05
Oct-Dec 22	-1.4	0.02	-0.24	-0.09	-0.10	-0.05

Notes: The units are percentage points. The inflation measure is the annual percent change in the consumer price index for all urban consumers: all items (CPI) for the US and the harmonized index of consumer prices (changing composition) for the Euro Area.