Are Temporary Oil Supply Shocks Real?[1]

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Hurricanes disrupt oil production in the Gulf of Mexico because producers shut in oil platforms to safeguard lives and to prevent damage. We examine the effects of these temporary oil supply shocks for real economic activity in the U.S. We find no evidence that temporary oil supply shocks affect state-level employment or indirectly affect industrial production in sectors not immediately related to oil production. Temporary oil supply shocks appear to have minor price effects, mainly for gasoline prices and CPI inflation. We also find no effect on imports, exchange rates or the import price of oil. Our results suggest that oil reserves held by U.S. refiners are largely sufficient to absorb any temporary production disruptions.

Assessing the Economic Effects of Temporary Oil Supply Shocks

A classic question in energy economics is how oil supply shocks affect the broader economy. Measuring this effect is nontrivial because oil prices, oil production and economic conditions are interrelated and may be affected by common factors. In this paper, we investigate the effect of temporary oil supply shocks for U.S. economic activity using exogenous variation in U.S. oil supply that results from hurricane activity in the Gulf of Mexico.

We construct a series of exogenous and temporary oil supply shocks by combining data on the trajectory of hurricanes and the location of rigs in the Gulf of Mexico. Because oil rigs shut in production in anticipation of potential hurricane strikes, we use the month-on-month change in oil production in the Gulf for the month of the hurricane as our measure of the oil shock. We then investigate the effect of these shocks on various economic outcomes. Our key result is that temporary supply disruptions have short-lived effects on inflation, mainly for gasoline prices and the Energy CPI but no discernable effects on employment or industrial production beyond the directly affected areas and sectors. Overall, the shocks appear to be largely smoothed by oil inventories held by U.S. refiners.

Our findings contribute to an ongoing debate around the significance of oil supply shocks for various economic outcomes. One popular approach to identify oil supply shifts is via implementations of the structural vector autoregressive (SVAR) models of the global oil market (see, *e.g.*, Kilian, 2009; Kilian and Murphy, 2014; Baumeister and Hamilton, 2019). However, the outcomes of the models crucially depend on the assumption made about structural parameters. For example, SVARs which impose inelastic supply and elastic demand find small effects of oil supply shocks on U.S. GDP, whereas SVARs which impose more elastic supply or more inelastic demand find larger effects (Herrera and Rangaraju, 2020). Using quasi-experimental evidence, our results show temporary oil supply shocks have at most modest effects on the broader economy.

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Methodology

This paper exploits the fact that a significant fraction of U.S. oil production is located in the Gulf of Mexico, an area that is prone to hurricanes. As storms advance, oil platforms shut in production to safeguard lives and equipment. We construct oil supply shocks using monthly data from 1980M1 to 2019M12 on oil rig location and production in the Gulf of Mexico from the U.S. Bureau of Ocean and Energy Management. Following Brannlund *et al*. (2022), we combine this information with the National Oceanic and Atmospheric Administration's hurricane data to construct a hurricane indicator equal to 1 if a hurricane of category greater than or equal to 1 on the Saffir-Simpson scale passes within 500km of any oil producing lease in the outer continental shelf (OCS). We interact the hurricane indicator with the total change in OCS oil production for the corresponding month to obtain a series of temporary oil supply shocks.

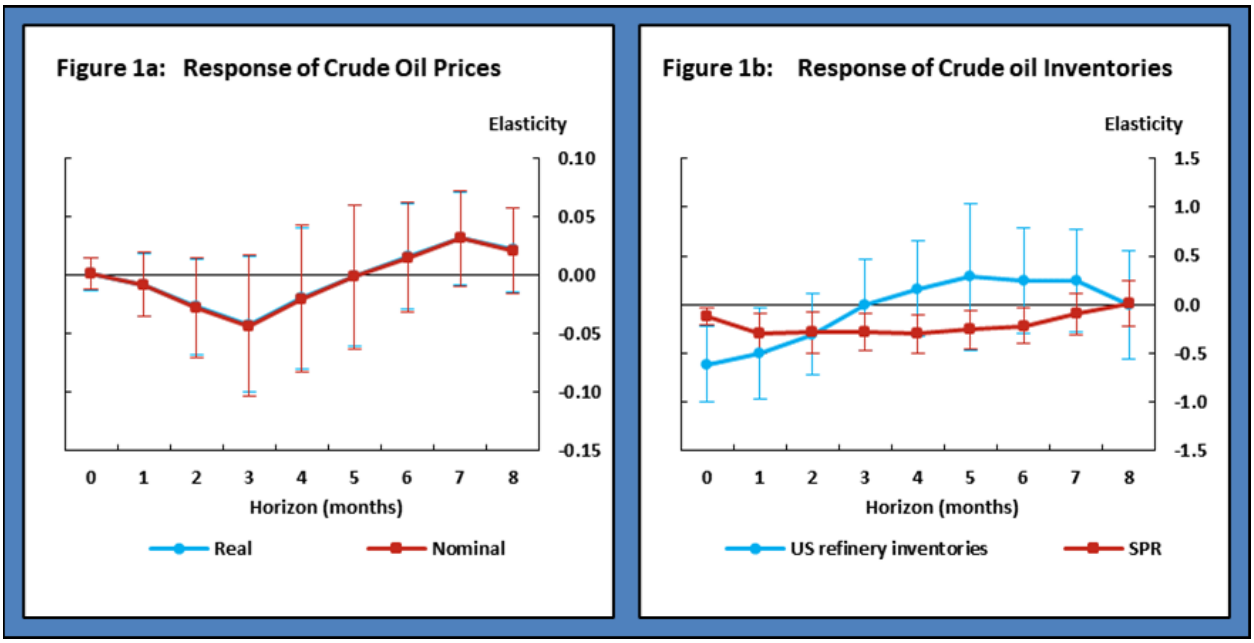
The shock measure attributes the entire change in OCS oil production for a month in which the area was affected to the hurricanes. Compared to alternative measures of shut ins, it allows us to obtain the total effect of hurricanes on the OCS production and to construct a long time series for our empirical analysis. Our first finding is that hurricanes often cause significant disruptions to U.S. oil supply. Some of the major storms in our sample, Hurricanes Katrina and Rita in 2005 and Gustave and Ike in 2008, lead to production shortfalls of roughly 20% of total U.S. oil production.

In a second step, we use a local projections econometric framework (Jordà, 2005) to estimate the effect of the shocks on various economic variables. Wherever possible, we focus on economic outcomes in areas outside of the Gulf of Mexico to avoid comingling our estimates with the direct impact of the hurricanes.

Effect of Temporary Oil Supply Shocks on the Oil Market and Macroeconomic Outcomes

Effect on oil market: We first consider whether the oil supply disruptions are reflected in the price of imported crude oil. Figure 1a presents the effects of the shocks on both the real and nominal price series, along with the whisker bars representing the 95 percent confidence intervals for the point estimates. None of the point estimates are significantly different from zero at any of the horizons up to 8 months from the oil supply shock, suggesting that there is no contemporaneous response of the price of imported oil to a transitory oil supply shock. Generally, the modest response of crude oil prices to supply shocks are more compatible with evidence obtained from SVAR models that impose a lower short-run supply elasticity (Herrera and Rangaraju 2020). It implies that identifying temporary oil supply shocks from oil prices is, at best, extremely difficult, at least for shocks localized to the U.S. For such shocks, even imposing a sign restriction on the short-run elasticity would seem to have little identifying power to differentiate the impulse responses at any horizon we consider. Another implication of the estimates is that there is little short-run change in U.S. demand for imported oil in response to a temporary oil supply disruption.

Figures 1a and 1b



One reason that there might be no demand response for imported crude from transitory oil supply shocks is that refineries smooth such shocks using crude oil inventories. We assess the impact of the oil supply shock for the oil inventories held by refineries and inventories held in the Strategic Petroleum Reserve (SPR). The estimated coefficients, presented in Figure 1b, can be interpreted as the portion of the oil supply shock smoothed by releases from these inventories. There is a statistically significant draw down of oil inventories in response to an oil supply shock both contemporaneously and one month after the shock. The point estimates are approximately 0.6 and 0.2 for commercial and SPR inventories, respectively, which suggests that the cumulative response is almost identical to the level of the shock. Overall, these results are consistent with the role of inventories for smoothing production disruptions

highlighted in theory of storage (see, *e.g.*, Working, 1949; Pindyck *et al*., 1994), as well as the empirical evidence in Kilian and Murphy (2014). They suggest that oil reserves held by U.S. refiners are largely sufficient to absorb temporary production disruptions.

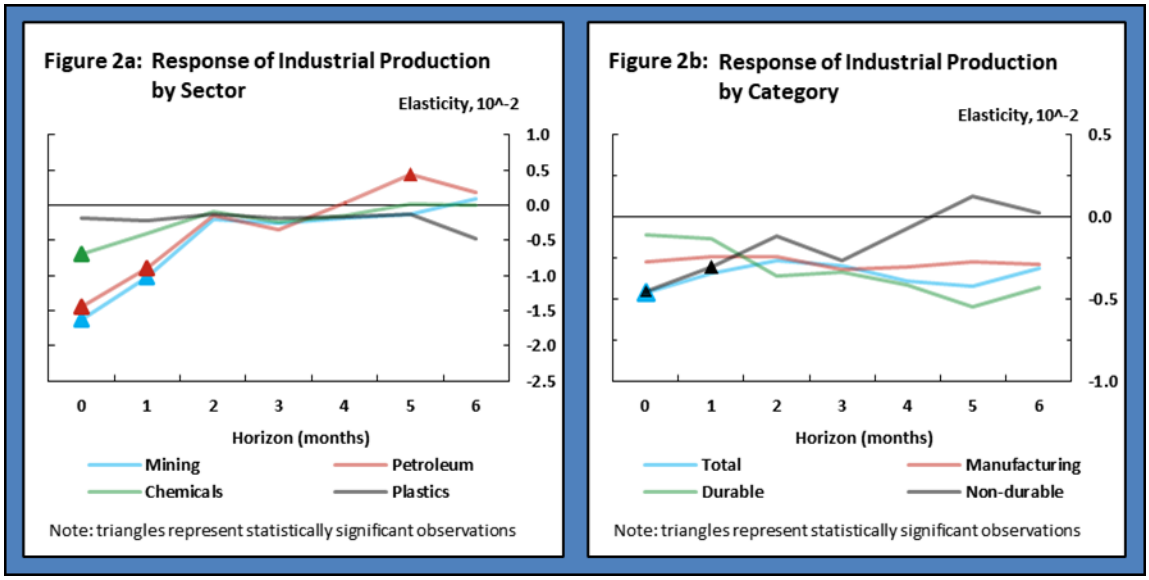
Roughly 40 percent of U.S. oil production is refined into gasoline, suggesting that a quantity shock in U.S. crude oil could still impact gasoline production. We find that gasoline prices in cities connected to Gulf refiners, such as Chicago, Boston and New York, tend to rise on impact and 1 month after the shock with a 10 percent increase in the supply shock leading to roughly a 0.3 percent rise in gasoline prices in both months. Cities which are not closely linked to oil production in the Gulf, such as West Coast cities, rise only in the following month by about 0.3 percent. Cost pressure from increased inventory drawdowns may explain the changes in gasoline prices. Substitution to Canadian energy products seems to play no role, as we do not find any significant effects on real Canadian energy exports or the Canadian dollar.

A potential concern with these results is that oil prices are largely determined by refinery demand and that our impulse responses might confound damage to refineries or pipelines with the impact of the hurricane shut-in production shock.[2] In our sample, there are two periods where hurricanes caused substantial disruption to refineries and pipelines: Hurricanes Katrina and Rita in September 2005; and Hurricanes Gustav and Ike in September 2008. We show that the results are robust to excluding these hurricanes, suggesting that our results are not driven by simultaneous disruptions of the refining sector but rather reflect the response to temporary crude oil production shocks.

Effect on macroeconomic outcomes: We next turn to the question of whether oil supply shocks affect the broader U.S. economy. Our interest is not whether hurricanes affect economic activity, but whether disruptions to oil supply caused by hurricanes affect economic activity.

We first examine the effect of oil supply shocks on production in the U.S. using disaggregated industrial production data. The response of industrial production differs by sector. Figure 2a on the next page shows that industries that directly measure oil extraction or usage, such as Mining, Petroleum and Chemicals decline on impact and remain depressed in the month following the shock. A 10 percent increase in the supply shock causes a decline of about 0.15 percent in Mining and Petroleum and less in Chemicals in that month.

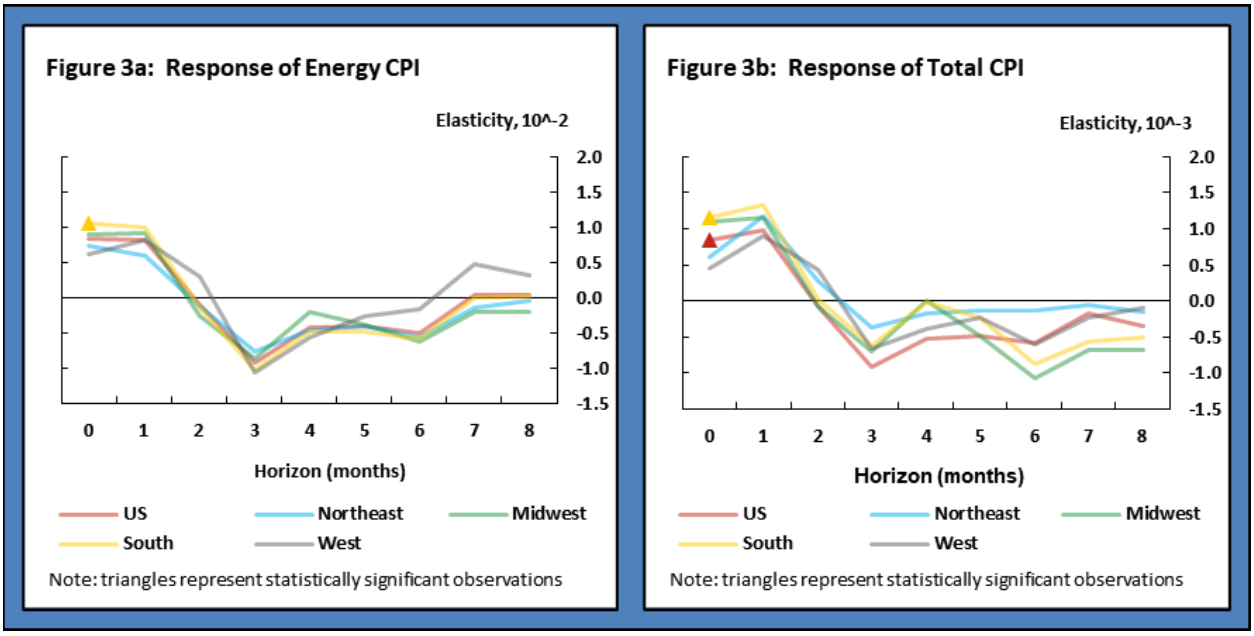
Figures 2a and 2b



Total and Non-Durable Industrial Production decline on impact and one month after the shock due to the direct impact of the shock (Figure 2b). Other sectors do not show a response to the temporary oil supply shocks. Overall, this suggests that oil supply shocks are localized to their industry and do not broadly affect U.S. aggregate production. The conclusion is consistent with evidence from a separate exercise, in which we find no effect on state-level unemployment up to 6 months outside the directly affected states in the Gulf regions.

Although there is little evidence that temporary oil supply shocks propagate to sectors of the economy not directly affected, one might expect that a reduction in industrial production in selected sectors would increase prices. We investigate this hypothesis by examining the impact of the shocks on inflation. Indeed, Figures 3a and 3b on the next page show significant impacts of these shocks on Energy CPI and Total CPI at the 1-month horizon for all U.S. regions. The point estimates are small – a 10 percent increase in the shock causes a 0.1 percent increase in the Energy CPI on impact and less on Total CPI. Non-energy CPI is unaffected for all regions.

Figures 3a and 3b



The evidence supports the conclusion that oil supply shocks are transitory and localized to a narrow subset of industries directly involved in oil production. Broader effects for the U.S. economy are effectively nominal shocks to prices and, even here, appear to be both muted and transitory.

Conclusion

We have used a quasi-random weather event, hurricanes, which lead to production shut-ins at offshore oil platforms in the Gulf to investigate the effect of oil supply shocks. We show that these hurricane events are associated with lower oil production in the Gulf and that the magnitude of these production changes can account for up to 20 percent of U.S. production. We analyze the effects of these oil supply shocks for oil prices, gasoline prices, employment, industrial production and international trade and finance. Overall, we find no evidence that temporary oil supply shocks have real effects for broader U.S. economic activity, while the nominal effects are modest and short-lived.

Endnotes

Dr. Ellwanger presented on this topic at the JPMCC's 5th Annual International Commodities Symposium during the "Economics of Energy Markets" session on August 15, 2022. The symposium, in turn, was co-organized by Professor Jian Yang, Ph.D., CFA, the J.P. Morgan Endowed Chair and JPMCC Research Director at the University of Colorado Denver Business School and Dr. Thomas Brady, the CoBank Executive Director of the JPMCC.

1 The views expressed in this article are solely those of the authors and no responsibility for them should be attributed to the Bank of Canada.

2 Kilian (2010) and Kilian and Zhou (2020) argue for the importance of U.S. refinery demand for crude oil prices, particularly the impact of hurricanes on Gulf Coast refineries.

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