REGIONAL OIL PRODUCTION AND ECONOMIC IMPACTS DUE TO HURRICANES MAKING LANDFALL IN THE US GULF COAST REGION

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Section 1: Overview

The US Gulf Coast is an important oil-producing and refining region but is vulnerable to hurricanes. Namely, landfalling storms can cause temporary refinery shutdowns or physical damage to infrastructure, reducing production. For example, in 2017 Hurricane Harvey caused the shutdown of approximately 2.2 million barrels per day of refining capacity, or roughly 25% of regional capacity and 12% of US total capacity[1]. Also, the number of severe hurricanes making landfall in the US Gulf Coast area has increased since the 2000s [2]. Recent studies indicate that there has been a global increase in tropical cyclone severity and further increases are projected to be likely in the future [3,4].

Hurricanes bring economic losses and take a long time to recover. North Atlantic hurricanes in 2005 caused an $8 billion loss of Gross domestic product (GDP) due to the maximum sustained wind speed[5]. Research found that hurricanes typically caused damage to the local economy rather than the national economic growth rate[6]. Hurricanes Katrina and Rita caused a loss of approximately $8.28 billion, with 92% of that in the Gulf states[7]. Besides the Gulf Coast area, damages in Central America and the Caribbean were substantial as well[8]. After Hurricane Iniki (1992), it took 18 years for Kauai's economy to recover fully[9].

The focus of this study is on the effects of hurricanes on regional US production and markets involved with crude oil refining, mainly focusing on refiner gasoline and diesel production. Specifically, we focused on the impacts on refinery gasoline and diesel production and consumption, as well as crude oil, gasoline, and diesel prices and stocks, using data from multiple storms. The impacts of hurricanes' landfalls on consumers' and producers' surplus are also evaluated.

Section 2: Theoretical framework, data, and research approach

A hurricane making landfall in one principal producing and excess supply region will likely have a multi-regional impact. For illustrative purposes, we analyze such a case using a simple two-region graphical economic model as standardly used in interregional trade [10,11]. In that model, a supply shift due to a hurricane in one region will impact trade with, markets and supplies in other regions.

To estimate hurricane landfall impacts we need data identifying time periods of hurricane landfalls and data on production, prices, stocks, and consumption. For hurricane landfalls, we used the US National Oceanic and Atmospheric Administration (NOAA) (2022), US Department of Energy (DOE) (2016) and US Energy Information Administration (EIA) (2021) data to identify those landfalling between 2002 to 2021 in the Gulf Coast that were identified as affecting the energy sector. For the energy items of interest, EIA releases weekly data by petroleum administration for defense districts (PADD) on many of the characteristics we wanted to examine [14]. In particular, weekly regional data on PADD level refinery net gasoline and diesel net production, diesel and gasoline stocks, and prices of diesel and gasoline. We also obtained weekly data on the crude oil West Texas Intermediate (WTI) spot price and national gasoline and diesel sales to consumers.

The research approach has three main parts. Since the data contains both trend and seasonal components, we first remove those using additive time series models. Then, to estimate the persistent effects of hurricane landfall, we use a finite distributed lag model following Demirhan et al. (2020). Given the above findings regarding changed prices and production, the question arises of who gains and who loses. To investigate this we turn to an analysis of welfare in the form of consumers' and producers' surplus[16]. We estimate the changes in revenue minus the changes in operating costs and crude oil costs as the producers' surplus. Then, we sum up this over the weeks where effects occur after a landfall. To investigate the cost we follow the change in price times average quantity formula developed by Hicks (1942) and estimate the welfare change for consumers.

Section 3: Research results

For refiner production, only the Gulf Coast region (PADD 3) shows an effect after the landfall week, and gasoline net production has been affected longer than diesel net production. For product stocks and crude oil stocks, there are lags in some of the regions outside of PADD 3. Hurricane landfalls have a negative impact on gasoline stocks in PADDs 1 and 3 which last for three weeks. For product prices, we find the impacts in all PADDs last at least five weeks including crude oil prices remaining high for 4 weeks. For national consumption, impacts on gasoline last 1 week after hurricane landfall while the effects we find for diesel are limited to the landfall week.

The Gulf Coast is the main region affected with an immediate reduction of 145 and 147 thousand barrels per day of gasoline and diesel. The hurricane impacted gasoline production for over 8 weeks. In the first two weeks after the hurricane strike, it continues to cut production, after that, production slightly rebounds. Then, the total gasoline production reduction is 364 thousand barrels which corresponds to a 2% reduction from average production within the same period. The diesel production decreased 753 thousand barrels which is about 4% less than the average diesel production without the hurricane strike. Effects in the other PADDs are small and generally insignificant although there is a small significant increase of gasoline production in the PADD 2 Midwest region. We also find positive effects of the Texas winter storm and COVID-19 on diesel production in the Gulf Coast region.

For crude oil prices, we find using the West Texas Intermediate price that the price increase is about three cents per gallon in the landfall week and 0, 3, 7, and 5 cents/gallon for the next four weeks. For gasoline prices in PADDs 1-3, we find the prices increase by more than 10 cents per week. For PADD 4 and 5 there is still a positive effect, but it is smaller. For diesel, there are also significant price increases with the largest ones in PADDs 1-3.

Ultimately, a $2.90 billion gain across all the PADDs for the producers' surplus over the 8 weeks. For consumers, a landfalling hurricane leads to a $2.28 billion (0.8%) consumer surplus loss over the seven weeks. Adding total consumers' surplus losses to total net revenue change gives a net welfare gain of $0.62 billion.

Section 4: Conclusions

Energy facilities along the US Gulf Coast are vulnerable to hurricanes. This study explores the economic impact of hurricanes on oil industry-related markets not only in the US Gulf Coast region but also in other US regions. We find the effects of Gulf Coast hurricane landfalls on crude oil spot prices, regional diesel and gasoline prices, crude oil usage at refineries, and diesel, gasoline, and crude oil stocks. Changes in refinery activity and prices are then used to estimate changes in producers', consumers', and total surplus. Increases in retail gasoline and diesel prices for all regions are found. We find that the impacts of a hurricane are persistent, and the length of the impact varies by region and item. We also find that the markets in the Gulf Coast or PADD 3 exhibit the largest impact among US regions.

In terms of impacts, although refinery activities are most impacted in the Gulf Coast region, retail prices increase in all regions and persist for more than five weeks. Without considering physical damage, producers in the oil industry end up with a positive total producers' surplus charge of about $2.90 billion due to the output price increases outweighing the increase in input (crude oil) costs. Consumers experience a loss of $2.28 billion due to retail price increases and little decreases in quantity demanded. A hurricane landfall in PADD 3 brings a gain of $0.62 billion for the total welfare change. From a dynamic view, during the hurricane landfall week, producers in all regions experience losses. This is because all suffer the disruption in crude oil use plus higher prices. After the landfall week, producers' surplus increases in all PADDs except PADD 3, and consumers' surplus changes become more negative. Over what we find to be an eight-week impact period, producers ultimately gain, and consumers lose.

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