

Forecast Real Oil Price Using Structural Vector Autoregressions

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- ① Motivation
- ② Model and Data
- ③ Historical Decompositions
- ④ Forecast Scenarios

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Main Question

- ① **What is the effect of supply and demand shocks in the oil market on oil price?**
 - Example : What is the supply shock in the increase of oil prices in the period 2020-2022?
- ② **How will oil prices change based on a conditional scenario?**
 - Example: If we know the future path of oil supply.
 - Example: The effect of another Asian crisis on flow demand.
 - Example: The effect of shutting down Iranian oil production.

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Structural Model of the Global Crude Oil Market

- Baumeister and Hamilton (AER 2019) Monthly VAR(12) reduced-form model for 1974.1-2022.4:
 - Percent change in global crude oil production
 - Index of global real activity
 - Real price of crude oil
 - Change in above-ground global crude oil inventories

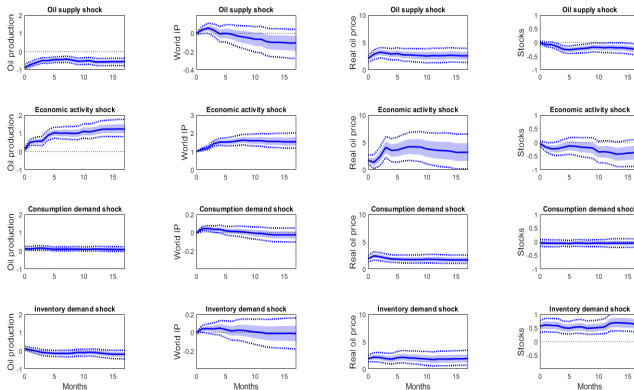
$$B_0 y_t = \alpha + B_1 y_{t-1} + \dots + B_p y_{t-p} + \omega_t$$

$$y_t = \beta + B_0^{-1} B_1 y_{t-1} + \dots + B_0^{-1} B_p y_{t-p} + B_0^{-1} \omega_t$$

$$u_t = B_0^{-1} \omega_t$$

- The model is structural in that the elements of w_t are mutually uncorrelated .

Impulse Response Function



Analysis based on the structural model

- Determine drivers of past oil price fluctuations
 - Historical decomposition
 - Cumulative change over extended historical periods
 - Counterfactual paths for the real price of oil
 - Forecast Error Variance Decomposition
- Assess sensitivity of baseline forecast to hypothetical scenarios

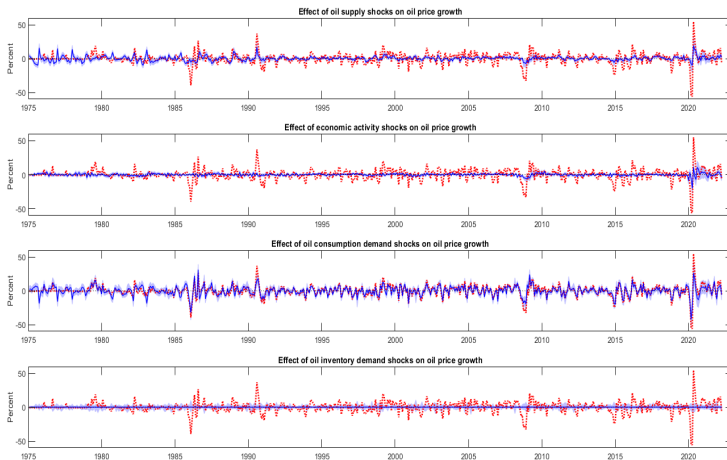
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Historical Decomposition

- The structural moving average representation of the estimated model allows us to decompose past fluctuations in the real price of oil into orthogonal components corresponding to different oil demand and oil supply shocks:

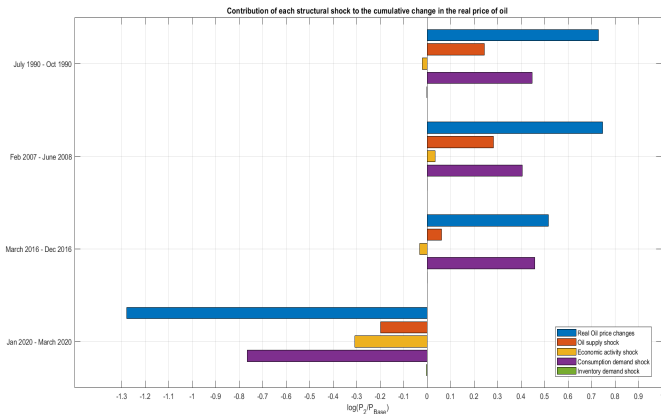
$$y_t = \sum_{i=0}^{\infty} \theta_i \omega_{t-i} \approx \sum_{i=0}^{t-1} \theta_i \omega_{t-i}$$

Historical Decomposition for Real Oil Price



Decomposing the Cumulative Change in the Real Price of Oil

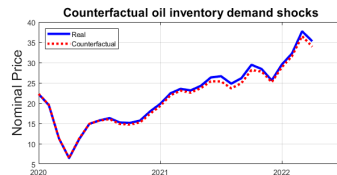
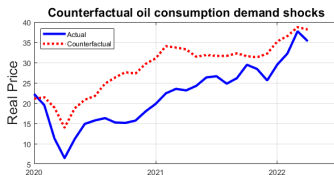
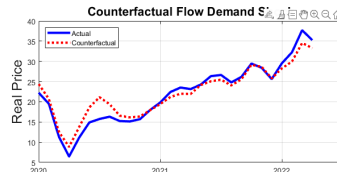
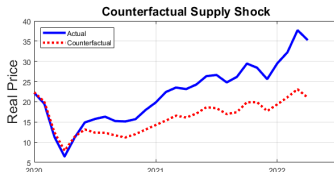
- Contribution of each structural shock to the cumulative change in the real oil price in dollar terms



Counterfactual Path

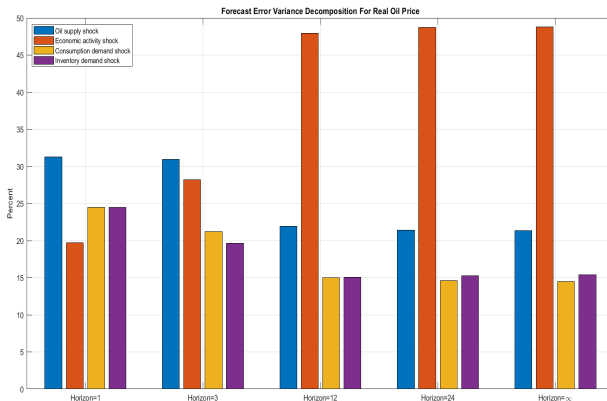
- It characterizes the evolution of the real price of oil from 2020 to 2022 based on the global oil market

Historical counterfactuals for the Real WTI price 2020 to 2022



Forecast Error Variance Decomposition

- The practically important question that the structural VAR model can answer is how much of the forecast error variance at any horizon is accounted for by each structural shock



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Forecast Scenarios

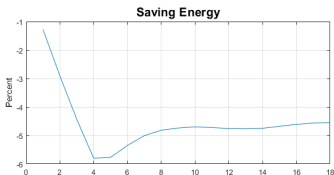
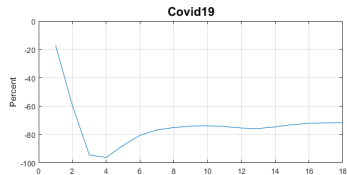
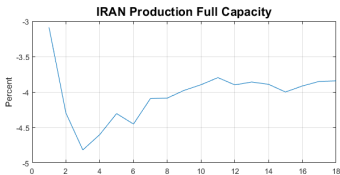
- **Iran at Full Capacity** : This corresponds to an increase in global crude oil production of 1.2 percent.
- **Covid-19** : The coronavirus crisis was affecting on oil markets is particularly severe because it was stopping people and goods from moving around, dealing a heavy blow to demand for transport fuels
- **Saving Energy** : Immediate actions in advanced economies can cut oil demand by 2.7 million barrels a day in the next 4 months.
- **Russian Production Shortfall** : EIA estimates production of Russian liquid fuels is set to reach 9.3 million barrels a day in the fourth quarter of 2023 from 11.3 million in the first quarter of this year.

Forecast Scenarios

- **Iran 1979** : The growing influence of Islamic Revolution and the hostage crisis in Iran led to increasing tension in the Middle East.
- **Iraq 1990** : This scenario can be motivated by focusing on the surge in consumption demand that occurred preceding and following the invasion of Kuwait in August of 1990
- **Russian invasion of Ukraine** : This sharp rise in crude oil prices reflects increased geopolitical risk and uncertainty regarding how announced and potential future sanctions may affect global energy markets
- **Global economic development** : This scenario asks how a further unexpected surge in the demand for oil like the one that occurred during September 2007-June 2008 would affect the real price of oil.

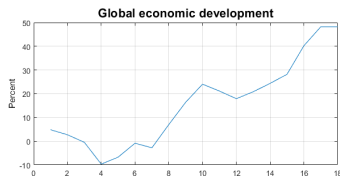
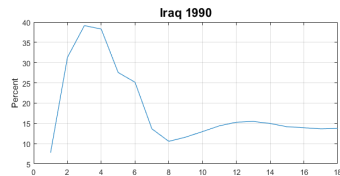
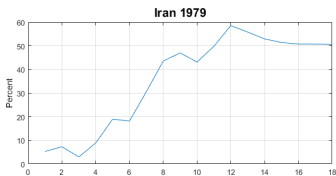
Response Function To Forecast Scenarios

Forecast Scenarios for the Real WTI: Percent Deviations from Baseline Forecast

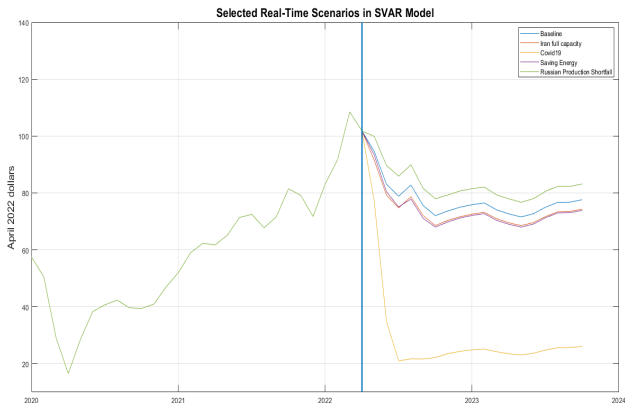


Response Function To Forecast Scenarios

Forecast Scenarios for the Real WTI: Percent Deviations from Baseline Forecast



Forecast Scenarios For Real WTI



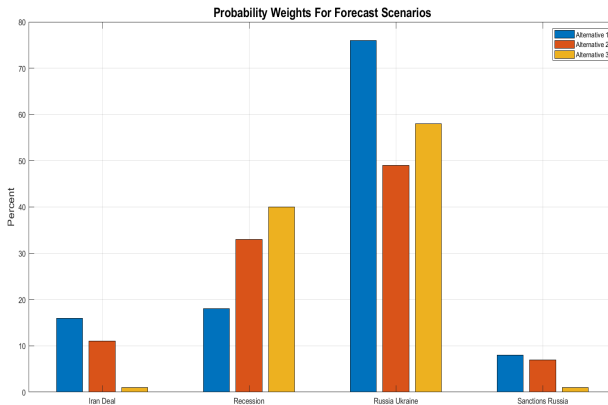
Forecast Scenarios For Real WTI



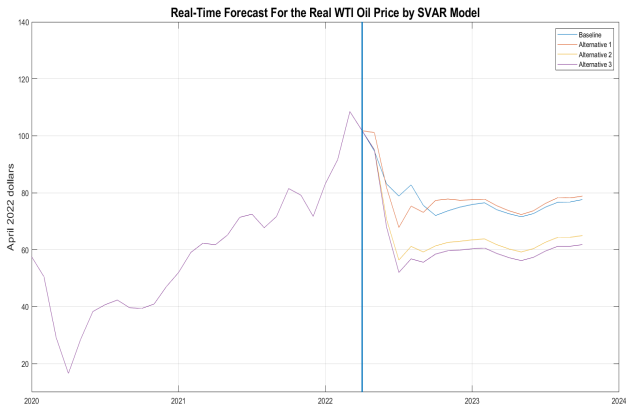
Probability Weights for Forecast Scenarios

- Use **Searching Google** to illustrate the relationship between alternative scenarios.
- For illustration we consider four specified words Iran Deal , Recession , Russian Ukraine and Russia Sanctions for 3 Alternatives:
 - Alternative 1: Some of the best news agencies such Reuters and Bloomberg.
 - Alternative 2: All of websites.
 - Alternative 3: Searching Google Trends.

Probability Weights for Forecast Scenarios



Real-Time Forecast For WTI Oil Price



Thanks!