Oil Price Shocks
Precautionary Demand in Crude Oil Market

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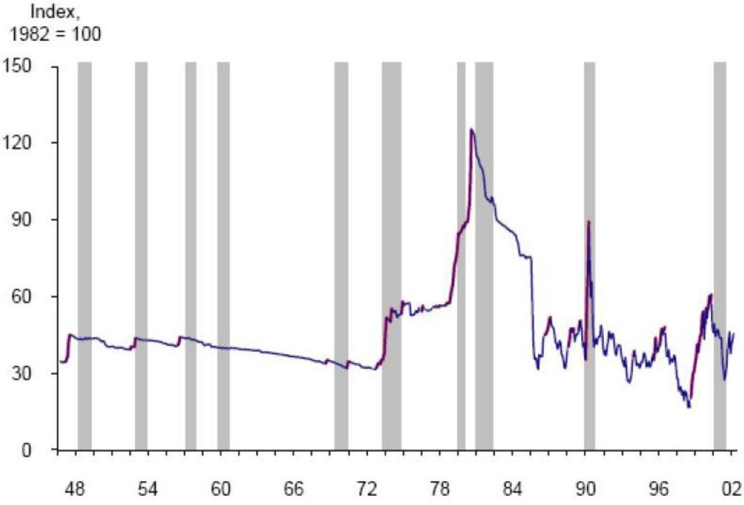
Motivation

Nine of ten recessions in the United States were preceded by a sharp rise in the price of oil.

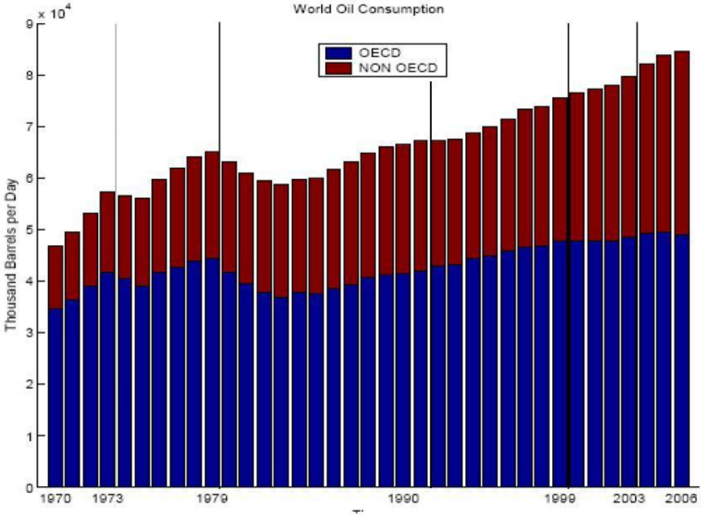


Literature Review

- A large number of studies tried to establish theoretical links to prove that oil prices were responsible for the recessions, periods of in ation and reduced economic growth.
- Traditional literature on energy economics gives central role to exogenous political events in modeling the oil market: Oil supply disruptions.
- However, more recent studies (Barsky and Kilian (2004), Kilian (2009), Blanchard and Gali (2007), Campolni (2007)) takes a different stand and provides arguments in favor of reverse causality from macroeconomic variables to oil prices: Aggregate demand or foreign TFP shock.
- These studies helped to understand differences between oil prices shocks and their macroeconomic implications in 70s and 2000s.

Literature Review

Closer look to the history: 70s vs 90s



Literature Review

- Existing literature is almost silent about this fact.
- Only Kilian (2010), using structural VAR model of the global crude oil market points out the role for precautionary demand in crude oil market.
- Besides, he claims that it is less the physical supply disruptions than the increased precautionary demand for oil triggered by increased uncertainty about future oil supply shortfall is driving price of oil.
- What is the intuition?

The Source of Shocks: Why are they important?

- Different shocks can cause different macroeconomic dynamics.
- While, an unexpected oil supply disruption causes a small and temporary effect on real oil price and real economic activity, unanticipated oil market-specific demand increases have an immediate, large and persistent effect on those variables.
- Hence, it is important to understand the nature of the shocks before formulating policy responses.
- There is highly positive correlation between commodity prices and real interest rates.

Contribution

- Based on these findings, I propose to build a theoretical model to explore macroeconomic consequences of precautionary demand motives in crude oil market.
- First step is to simulate the effects of demand shocks in oil market on macroeconomic variables, such as GDP and inflation.
- We build on the analysis of oil price and monetary policy undertaken by Leduc and Sill (2004) and Carlstom and Fuerst (2006).
- These papers employs DSGE models, where monopolistically competitive firm use exogenously priced oil in their production process.
- Our novelty is to introduce cash market and storage market (Pindyck (2001), Kilian and Alquist (2008)) for oil, where firms can buy oil futures to offset energy uncertainty.

Contribution

- Second step is to analyze the role for alternative monetary policies in amplifying or dampening the economy's response to oil price shocks.
- Under new specification for the source of these shocks, we may expect to have different policy proposals compared with the existing literature.

The Model

- Sticky-price business-cycle model with representative household, representative final good producer and a continuum of intermediate goods producers.
- Oil is used as an input by monopolistically competitive intermediate goods producers.
- Firms buy physical oil in cash market and futures in financial market.
- Inventory dealers store the oil and sell forward contracts or futures.
- Following Pindyck (2001) futures and spot prices interact in the market for storage through the convenience yield of the commodity.

Household

$$\max_{C_t, L_t, B_t} E_0 \; \Sigma_{t=0}^{\infty} \; \beta^t \; [\log C_t - \frac{L_t^{1+\phi}}{1+\phi}]$$

subject to

$$P_t C_t + B_t = R_{t-1} B_{t-1} + w_t P_t L_t + r_t^k P_t \bar{K} + \pi_t^f$$

Final Good Producers

$$\max_{y_t(i)} \; P_t Q_t - \int_0^1 P_t(i) Q_t(i) di$$

where

$$Q_t = [\int_0^1 Q_t(i)^{\frac{\epsilon-1}{\epsilon}} di]^{\frac{\epsilon}{\epsilon-1}}$$

Intermediate Goods Producers

- Continuum of firms
- Calvo price setting: $1-\theta$ fraction does profit maximization, θ can do only stick the old price, $P_t(i) = P_{t-1}(i)$.

Production

$$Q_t(i) = A_t K_t^{\alpha_k} L_t^{\alpha_l} O_t^{\alpha_o}$$

$$\pi_t^f(i) = P_t(i)Q_t(i) - w_t P_t L_t(i) - r_t^k P_t K_t(i) - P_t^o O_t^o$$

Financial Market Operation

$$\max_{X_t} E_0 \Sigma_{t=0}^{\infty} \left(\frac{1}{1+r}\right)\left[\frac{P_{t+1}^o}{P_{t+1}} X_t - \frac{F_t X_t}{P_{t+1}}\right]$$

- F_t: futures price at t for $t+1$
- X_t: # of futures contracts

Inventory Dealers

$$\max_{I_{t+1}} \; E_0 \Sigma_{t=0}^{\infty} (\frac{1}{1+r})^t [(\frac{F_{t-1}}{P_t} - p_t^o) I_t + p_t^o I_t - p_t^o I_{t+1} + g_t(I_{t+1}, \sigma_{\epsilon_t})]$$

$$E_t[\frac{1}{1+r}\frac{F_t}{P_{t+1}}] = p_t^o - g_1(I_{t+1}, \sigma_{\epsilon_t})$$

- $g_1(I_t, \sigma_\epsilon^2) > 0$
- $g_{11}(I_t, \sigma_\epsilon^2) < 0$
- $g_{12}(I_t, \sigma_\epsilon^2) > 0$
- $\lim_{I_t \to 0} \; g_1(I_t, \sigma_\epsilon^2) = \infty$

Oil Supply

- Oil exporting country is an endowment economy.
- In each period, it receives a random oil endowment $\tilde{\omega}_t$.

$$\tilde{\omega}_{t+1} \sim N(\omega, \sigma^2_{t+1})$$

where

$$\sigma^2_{t+1} = \lambda \sigma^2_t + \epsilon_t$$

- It acts as a price-taker in spot market for oil and uses revenues to buy consumption goods from final good procuders.

$$P_t C^F_t = P^o_t \tilde{\omega}_t$$

Qualitative Results

- The Effect of Uncertainty on Spot Price

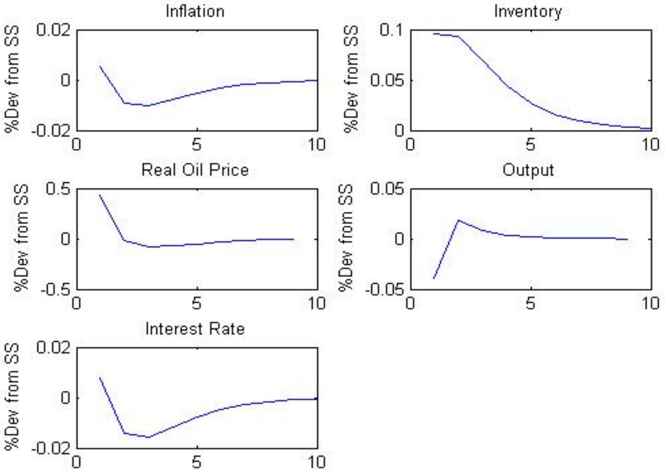
$$\underbrace{Q'(\tilde{\omega}_t - \Delta I_t)}_{p_{o,t}} = E_t[\underbrace{Q'(\tilde{\omega}_{t+1} - \Delta I_{t+1})}_{p_{o,t+1}}] + g_1(I_t, \sigma_{\epsilon_t})$$

- Add monetary Policy

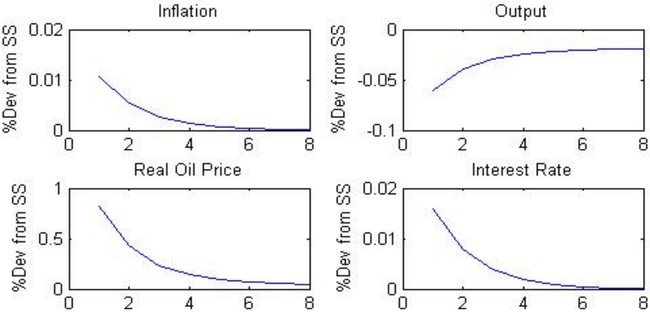
$$R_t = \phi_\pi(\pi_t - \pi^*) + \phi_y \hat{y}_t$$

- Run experiments for alternative policies
- Solve for the optimal monetary policy

Preliminary Results-1



Preliminary Results-2



Conclusion

- Uncertainty about future oil supply overshoots spot price of oil today.
- The effect is transmitted to the spot price through the level of inventory.
- Monetary policy can intervene to discourage the storage by increasing interest rates.
- Optimal monetary policy?