Discussion of “What Do We Learn from the Price of Crude Oil Futures?”
by
Ron Alquist and Lutz Kilian

Ana María Herrera

Michigan State University

What is this paper about?

- Existing literature suggests <u>expectations about future oil prices</u> play an important role on the oil price-macroeconomy relationship.

- Common view expressed by central banks (Federal Reserve, ECB), policy institutions (IMF), and sometimes oil analysts: crude oil futures are good predictors of future oil prices.

- … but, are they?

What Do We Learn from the Price of Crude Oil Futures?

1. There is little evidence that the price of oil futures helps to predict future oil prices
   a. Futures prices are less accurate predictors of the price of oil than a simple no-change forecast at most horizons.
   b. Spread models are less accurate than the no change forecast.
   c. Forecast efficiency is rejected (even though $\hat{\alpha} \approx 0$ and $\hat{\beta} \approx 1$).
   d. Futures prices are not unbiased predictors of oil prices (although the bias is small).

What Do We Learn from the Price of Crude Oil Futures?

2. What explains the large MSPE of futures-based forecasts?

- Large variability of futures prices about the spot price due to the presence of a *convenience yield.*

- Theoretical model shows that uncertainty in the supply of oil can lead for large fluctuations in the basis.

- Precautionary demand for crude oil leads to changes in the basis.

CAREFUL!: The information content of crude oil futures might not be that great!!

Are oil futures good predictors of future oil prices?

There are three (really two) parts of the paper:

1. Two-country, two-period general equilibrium model of oil futures and oil spot markets

2. Forecasting accuracy of futures-based and other forecasting models

3. Back to the model: the effect of uncertainty in oil supply (reserves ?).

A Roadmap for this Discussion

1. Forecasting and why <u>some</u> models might not beat the no-change forecast

2. General Equilibrium Model of Oil Futures and Oil Spot Markets and possible extensions

3. Back to Forecasting: one comment

Why do crude futures seem a natural option?

- Futures prices are frequently used as measures of markets expectations:
  - Interest rates: Fed funds futures as predictors of future Funds rate (Krueger and Kuttner,1996; Sarno, Thornton and Valente, 2005)
  - Exchange rates: Forward currency rates as efficient forecasts of the future spot rate (Fama, 1984; Flood and Rose, 2000; …)

Forecasting: are futures an obvious candidate?

- Studies on futures prices usually start from the arbitrage free or cost-of-carry model in which prices are represented as:

$$F_t = S_t e^{(r+u-d)(T-t)}$$

where

F_t: futures price at time t

S_t: spot price at time t

r: risk-free interest rate

u: storage cost

d: convenience yield

T-t: time to expiry of futures contract

- Because storage costs and convenience yields are not observable, most studies focus on speculative market efficiency…

$$S_t = \alpha + \beta F_{t-i} + \varepsilon_t$$

Futures and the convenience Yield

For speculative market efficiency to hold:

1. Convenience yield needs to be constant over time
   - That is "*the flow of services that accrues to an owner of [the] physical commodity [oil] but not to an owner of a contract for future delivery of the commodity*" <u>does not vary with economic conditions</u>!!
   - <u>Alquist and Kilian</u>: uncertainty in the supply of oil results in changes in the convenience yield and undermines the predictive ability of oil futures prices.
   - <u>Alternatively</u>: one may think about introducing uncertainty in the demand for oil. Litzenberger and Rabinowitz (1995) show that introducing uncertainty leads to strong backwardation in equilibrium.

Futures and storage costs

For speculative market efficiency to hold:

2. Storage cost should be constant over time:
   - Average storage costs may vary over time as the composition suppliers/wells changes.
   - Alquist and Kilian: storage takes the form of inventories held be the US *above the ground.*
   - Additionally: One could think about underground storage and what drives the production decision of Saudi Arabia.

Forecasting: Futures as a starting point

Alquist and Kilian find little evidence that the price of oil futures helps to predict future oil prices

Table 2: 3-Month Ahead Recursive Forecast Error Diagnostics

$\hat{S}_{t+3\|t}$	MSPE (p-value)	Bias	MAPE (p-value)	Success Ratio (p-value)
S_t	19.560	0.435	3.099	N.A.
$F_t^{(3)}$	19.038 (0.347)	0.631	3.172 (0.920)	0.479 (0.648)
$S_t\left(1+\hat{\alpha}+\hat{\beta}\ln(F_t^{(3)}/S_t)\right)$	24.217 (0.870)	0.253	3.610 (0.990)	0.407 (0.996)
$S_t\left(1+\hat{\beta}\ln(F_t^{(3)}/S_t)\right)$	22.826 (0.983)	0.804	3.541 (0.998)	0.407 (0.992)
$S_t\left(1+\hat{\alpha}+\ln(F_t^{(3)}/S_t)\right)$	22.090 (0.747)	0.315	3.365 (0.965)	0.397 (0.998)
$S_t\left(1+\ln(F_t^{(3)}/S_t)\right)$	19.036 (0.348)	0.649	3.176 (0.920)	0.479 (0.648)

Adding interest rates

- Hotelling Principle (1931) suggests:
  - Net price of an exhaustible resource should rise over time at the rate of interest

$$S_t - x_t = (S_0 - x_0)e^{rt}$$

where

S_t: spot price

x_t: extraction cost per unit

  - <u>Alquist and Kilian</u>: Interest rates may be informative about future oil prices.

Adding interest rates

- Hotelling's model is derived under certainty and perfect competition.

- Uncertainty $\Rightarrow$ endogenous convenience yield $\Rightarrow$ Backwardation as a result from optimal decision of producers (Litzenberger & Rabinowitz, 1995)

- Imperfect competition: Almoguera and Herrera (2007) find that:
  - On average the oil market is better characterized by Cournot competition with a competitive fringe
  - Switches between non-cooperative and cooperative behavior took place with collusion resulting in 29% increase in oil prices and 12% decrease in oil production.

Adding interest rates

Alquist and Kilian find no statistical evidence that the Hotelling forecasting model is superior to the no-change forecast in MSPE and MAPE.

	MSPE (p-value)	Bias	MAPE (p-value)	Success Ratio (p-value)
$S_t(1+i_{t,3})$	19.811 (0.715)	0.167	3.111 (0.632)	0.541 N.A.
$S_t(1+i_{t,6})$	34.906 (0.713)	0.382	4.509 (0.708)	0.557 N.A.
$S_t(1+i_{t,12})$	65.285 (0.480)	1.439	6.018 (0.804)	0.582 N.A.

Mapping the forecasting results into the model

Modeling choices:

- Uncertainty oil Saudi Arabia's oil endowment
- Underlines importance of the convenience yield
- Yet, shocks here are by nature supply shocks, demand shocks are ruled out

2. Inventories are held above ground by the U.S.

- Leads to precautionary demand
- Yet, most inventories of oil are held underground in the form of reserves

3. Oil is used in production of goods

- Leads to precautionary demand
- Production function is strictly concave, which rules out lumpiness

Two Last Comments about Forecasting

- Evidence of changes in forecasting accuracy of using futures across samples, maybe suggest an unstable environment

- What if the idea floating in the back of the policy makers mind was that volatility in futures has predictive power for economic activity