Discussion of:
Forecasting the Price of Oil

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What they do ...

• Extensive survey of research and analysis of oil-price forecasting models
• Lots of forecast model comparisons
  – Different definitions of oil prices, both nominal and real, different sample periods
  – Different forecast horizons, different forecasting models
• For practitioners, this paper is an important reference
A few of many results

• Post-1973, global activity measures help predict oil prices (Granger-causality)
  – Monetary aggregates
  – Non-oil commodity prices
  – Global production indexes
  – Bilateral exchange rates of commodity exporters

• For forecasting, there is really no gain from using futures prices – (which is what we use for our forecasts)
  – Survey forecasts perform poorly as well

• For short horizons, VAR, AR, ARMA models improve on no-change forecasts (but generally not by much)
Do Oil Prices Forecast Real GDP?

- Many studies say yes, provided a nonlinear specification is used.
- Authors suggest that for one-quarter ahead, not much evidence for a role for oil prices.
- Multi-period forecasts do seem to improve if oil enters forecast equation in a nonlinear way.
- Seems to be a bit of a controversy – Hamilton (2010) argues oil prices do improve one step ahead forecasts of real GDP.
Diff log PPI Crude Petroleum

DOP

36-Month Net Oil Price Increase

NET3YPPI

Real GDP Growth by Vintage

![Real GDP Growth by Vintage](chart.png)
Testing For Nonlinearity

- Estimate by OLS

$$\Delta y_t = \alpha + \sum_{i=1}^{p} \phi_i \Delta y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \sum_{i=1}^{p} \gamma_i \tilde{x}_{t-i} + \varepsilon_t$$

- With

$$\tilde{x}_t = \max \{0, x_t - \max \{x_{t-1}, \ldots, x_{t-12}\}\}$$

- Here $y_t$ is real GDP and $x_t$ is the PPI for crude petroleum (nominal)
## Exclusion Test for Net Oil Price Variable

*(pvals)*

<table>
<thead>
<tr>
<th>Data Vintage</th>
<th>1974Q1-2007Q4</th>
<th>1951Q4-2007Q4</th>
<th>1974Q1-2010Q2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008Q1</td>
<td>0.0044</td>
<td></td>
<td>0.0017</td>
</tr>
<tr>
<td>2008Q3</td>
<td>0.0045</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009Q3</td>
<td>0.0020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010Q3</td>
<td>0.0024</td>
<td></td>
<td>.0039</td>
</tr>
</tbody>
</table>
Net oil price increase exclusion tests

• What if the federal funds rate is added to the forecast equation?

\[ \Delta y_t = \alpha + \sum_{i=1}^{p} \phi_i \Delta y_{t-i} + \sum_{i=1}^{p} \beta_i x_{t-i} + \sum_{i=1}^{p} \gamma_i \tilde{x}_{t-i} + \sum_{i=1}^{p} \delta_i R_{t-i} + \epsilon_t \]

• For sample 1974q4 to 2007q4 p-value for \( \gamma_i = 0 \) is \( .034 \)
• For sample 1974q4 to 2010q2 p-value falls to 0.001
• Maybe it is not just the Fed reacting to oil prices
One-Step Ahead Forecast Comparisons
(RMSEs for 2008Q1 to 2010Q2)

\[ \Delta y_t = \alpha + \sum_{i=1}^{p} \phi_i \Delta y_{t-i} + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \sum_{i=1}^{p} \gamma_i \tilde{x}_{t-i} + \varepsilon_t \]

<table>
<thead>
<tr>
<th>Include Net Oil Price Increase?</th>
<th>Estimation sample period 1974Q4 - 2007Q4</th>
<th>Estimation Sample Period 1951Q1 – 2007Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>1.23</td>
<td>1.28</td>
</tr>
<tr>
<td>Yes</td>
<td>0.91</td>
<td>0.79</td>
</tr>
<tr>
<td>AR(4) model</td>
<td>1.26</td>
<td>1.33</td>
</tr>
</tbody>
</table>
Model Fit Without Net Oil Variable
Model Fit With Net Oil Variable

![Graph showing model fit with net oil variable](image-url)
Table 18a: MSPE Ratios of Nonlinear Dynamic Models Relative to the AR(4) Benchmark Model
Cumulative U.S. Real GDP Growth Rates

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Real Refiners’ Acquisition Cost for Imported Crude Oil</th>
<th>Nominal Refiners’ Acquisition Cost for Imported Crude Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unrestricted Model (20)</td>
<td>Exogenous Model (21)</td>
</tr>
<tr>
<td></td>
<td>Mork Increase Hamilton Net Increase</td>
<td>1 Year 3 Year</td>
</tr>
<tr>
<td>1</td>
<td>1.50 1.59 1.26</td>
<td>1.50 1.60 1.26</td>
</tr>
<tr>
<td>2</td>
<td>1.52 1.70 1.16</td>
<td>1.51 1.69 1.16</td>
</tr>
<tr>
<td>3</td>
<td>1.40 1.69 1.10</td>
<td>1.39 1.67 1.10</td>
</tr>
<tr>
<td>4</td>
<td>1.41 1.78 1.11</td>
<td>1.40 1.76 1.10</td>
</tr>
<tr>
<td>5</td>
<td>1.42 1.90 1.25</td>
<td>1.38 1.88 1.26</td>
</tr>
<tr>
<td>6</td>
<td>1.40 1.66 1.19</td>
<td>1.36 1.63 1.19</td>
</tr>
<tr>
<td>7</td>
<td>1.41 1.47 1.13</td>
<td>1.36 1.43 1.12</td>
</tr>
<tr>
<td>8</td>
<td>1.43 1.33 1.07</td>
<td>1.36 1.30 1.05</td>
</tr>
</tbody>
</table>

NOTES: The benchmark model is an AR(4) for U.S. real GDP growth. The nonlinear dynamic models are described in the text. Boldface indicates gains in accuracy relative to benchmark model. The exogenous model suppresses feedback from lagged real GDP growth to the current price of oil. No tests of statistical significance have been conducted, given the computational cost of such tests.
Actual GDP Growth vs. Predicted

![Graph showing actual GDP growth vs. predicted GDP growth from 2007Q1 to 2010Q2. The graph indicates significant fluctuations over the period, with actual growth generally below predicted growth, especially during 2008-2009.]
Takeaways

• Appears that oil prices help to forecast real GDP growth, even one step ahead, for this data and sample period
• The nonlinearity seems to be important
• Where does the 3 year net oil price increase variable come from? Not a structural construct. Forecasters should worry a bit about that
Yet another forecasting technology

• It might be interesting to forecast oil prices using a more structural approach
  – Allows the forecasters to investigate how identified shocks (technology, markups, policy etc) affect the time path of oil prices

• One could start by writing down and estimating a structural model with a meaningful oil sector
  – Time and resource intensive
  – Identification problems in large models
  – but probably the preferred way to go, in the long run
Could use an existing DSGE model to forecast non-modeled variables

- An example is the methodology in Schorfheide, Sill, and Kryshko (2010)
- Researcher starts with an estimated structural model:
  \[ S_t = T(\hat{\theta})S_{t-1} + R(\hat{\theta})\varepsilon_t \]
- Measurement:
  \[ y_t = D(\hat{\theta}) + Z(\hat{\theta})S_t + v_t \]
Supplement the structural model with an auxiliary model

- Researcher is interested in forecasting a non-modeled variable $x_t$
- Assuming that $x_t$ is not a state variable, can project it on the model’s non-redundant states $\tilde{S}_t$

\[
x_t = \alpha_0 + \alpha_1 \tilde{S}_{t|t} + \eta_t
\]
\[
\eta_t = \rho_x \eta_{t-1} + \nu_t \quad \nu_t \sim N(0, \sigma_\eta)
\]

- A log linear approximation to agent decision rules in a larger model
Estimate the auxiliary model using Bayesian methods

- Choose prior for $\alpha, \rho_x, \sigma_\eta$ and estimate using Gibbs sampler
- Forecast by projecting structural model state variables and auxiliary equation forward
- Allows for analysis of how structural shocks feed through to the forecast, and generating impulse response functions
- Note that the auxiliary variable is not helping you estimate the DSGE model
What Does AKV Suggest?

• Oil prices have a significant endogenous component, so this might work
• There is probably feedback from oil prices to structural model states, but it seems to be a complicated and nonlinear relationship
• But it probably would not work that well using a structural model estimated for, say, the U.S. economy.
  – Global factors are more in play for oil price determination
  – Then there is always the issue of how to choose priors
Summary

• A great reference for those interested in forecasting oil prices ...

• ... And in thinking about the oil/macroeconomy relationship