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

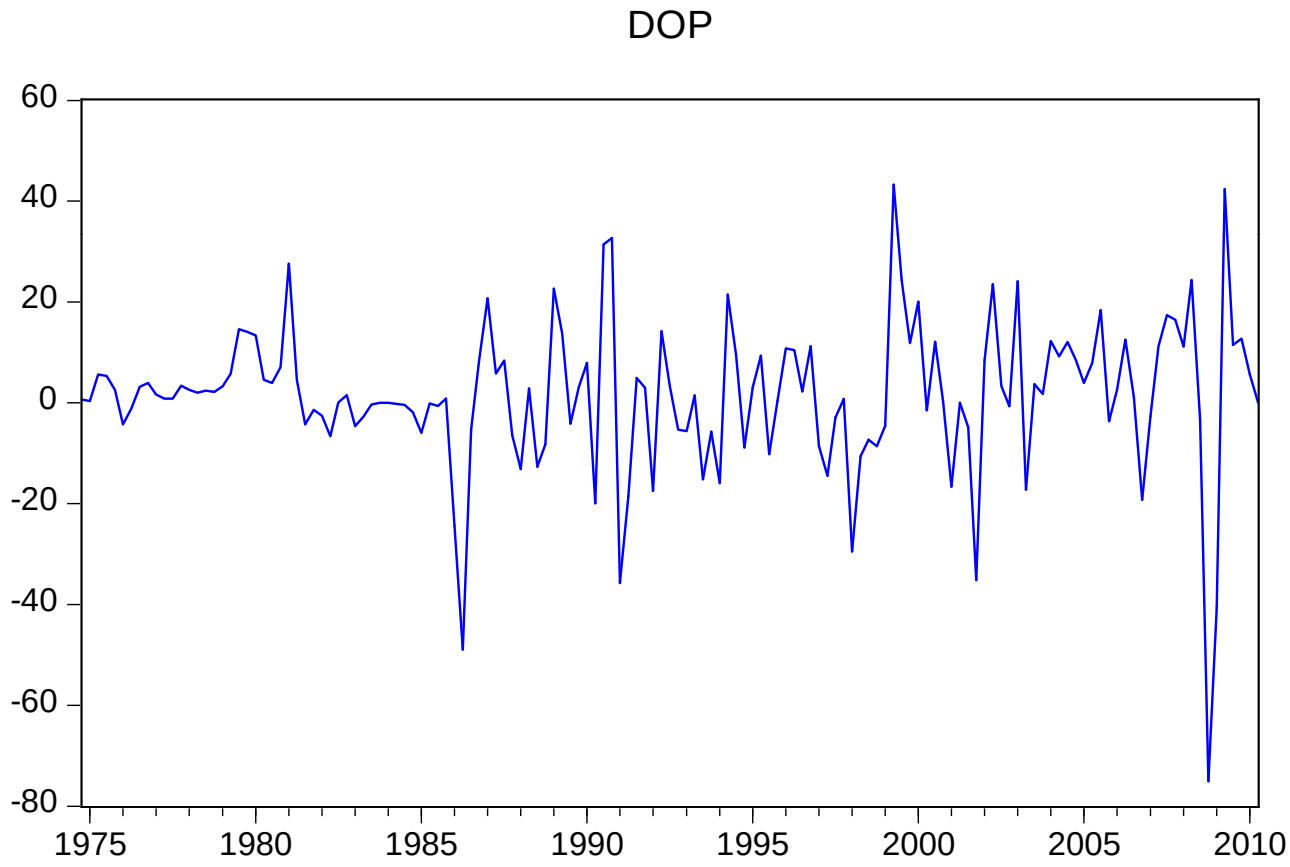
A few of many results

- 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)

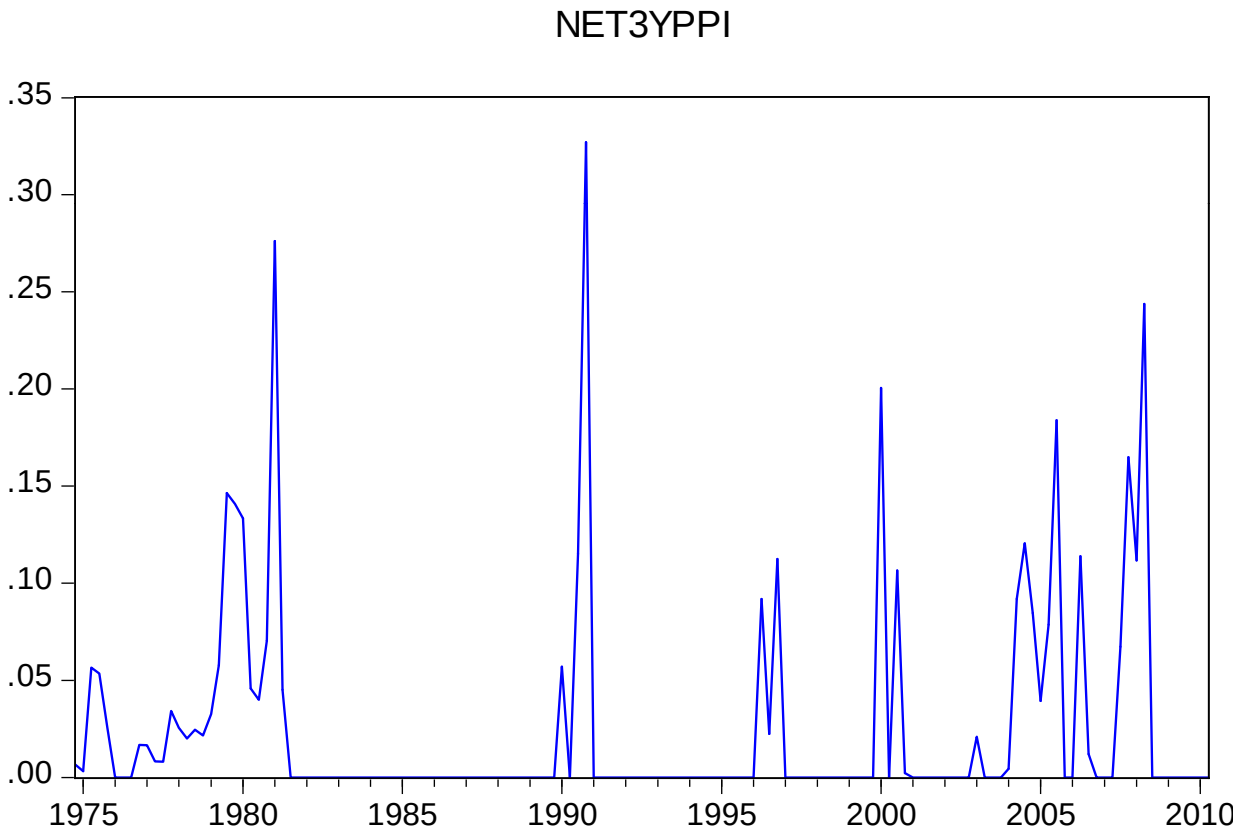
Do Oil Prices Forecast Real GDP?

- 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

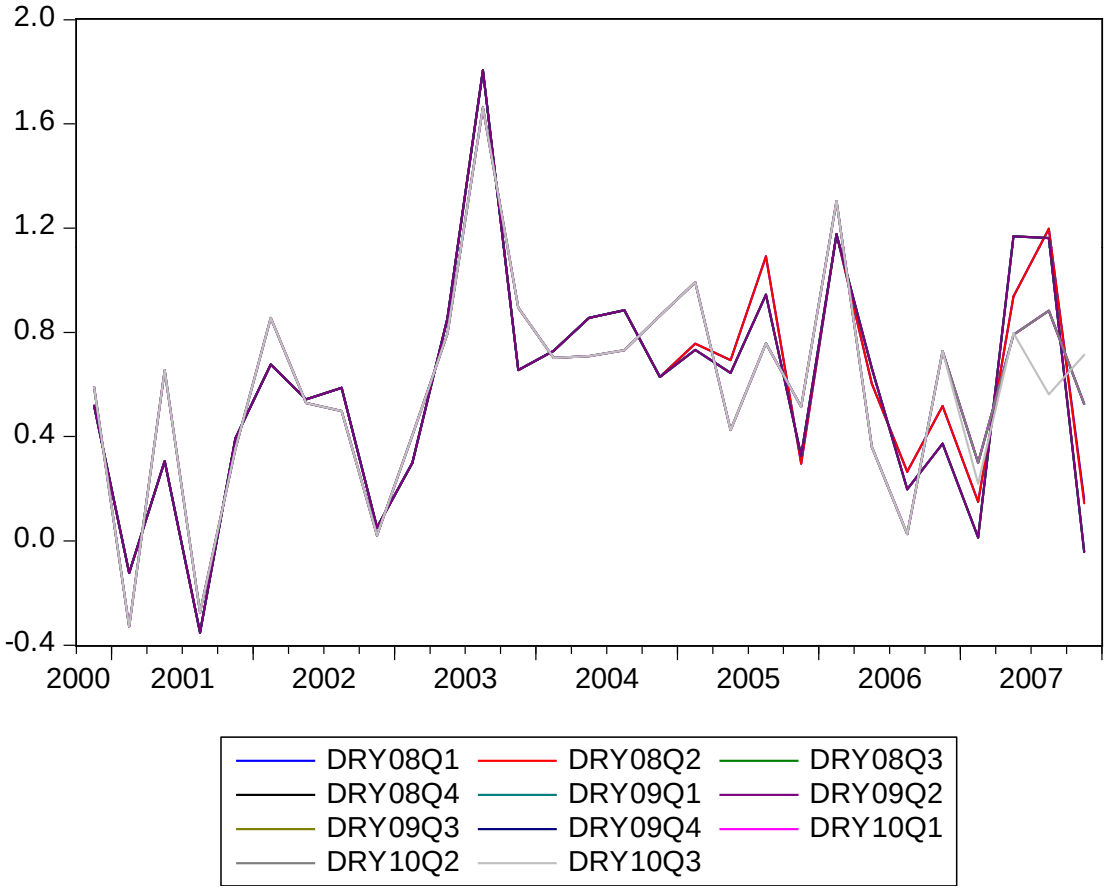
Diff log PPI Crude Petroleum



36-Month Net Oil Price Increase



Real GDP Growth by Vintage



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)

Data Vintage	1974Q1-2007Q4	1951Q4-2007Q4	1974Q1-2010Q2
2008Q1	0.0044	0.0017	
2008Q3	0.0045		
2009Q3	0.0020		
2010Q3	0.0024		.0039

Net oil price increase exclusion tests

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

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

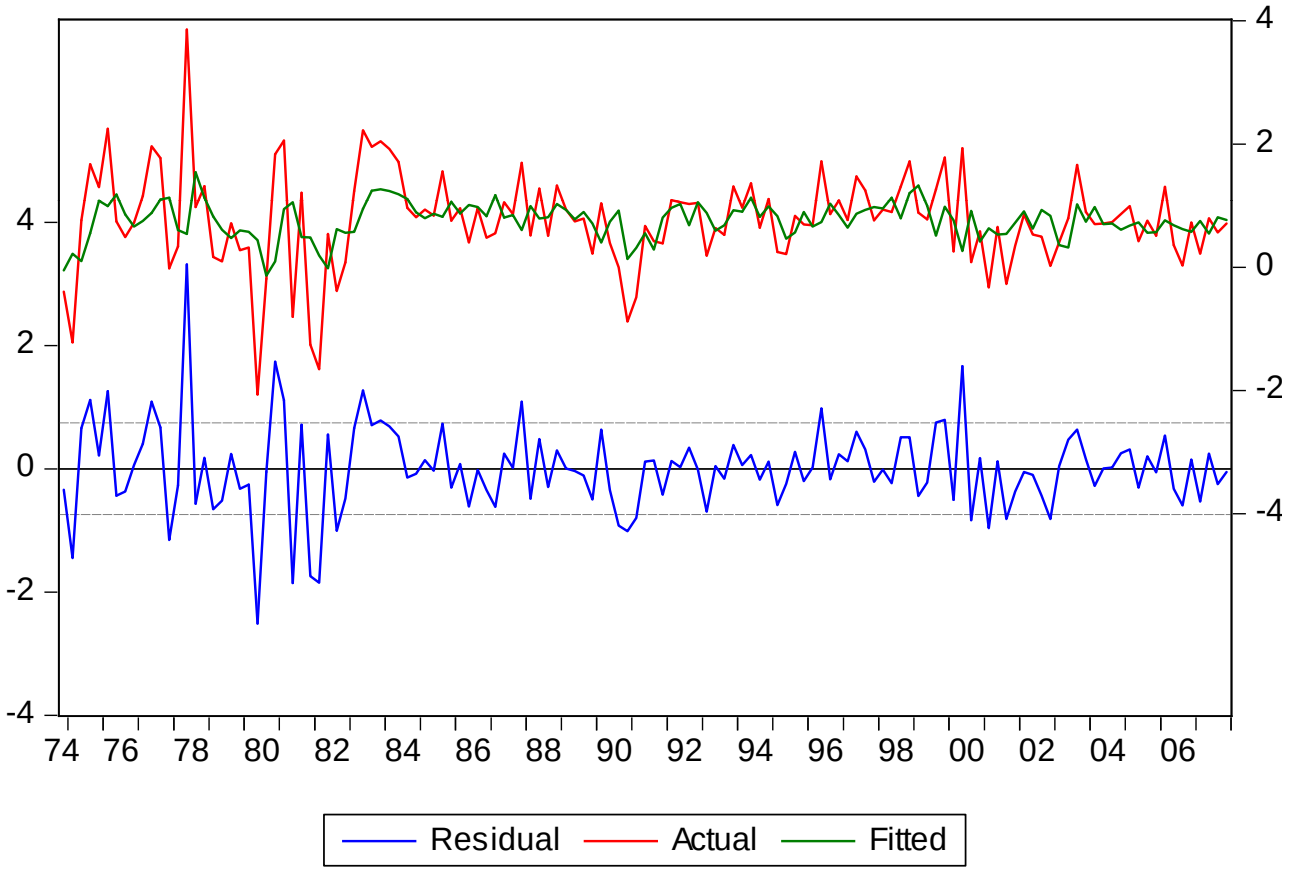
- For sample 1974q4 to 2007q4 p-value for $\gamma_i = 0$ is .034
- For sample 1974q4 to 2010q2 p-value falls to 0.001
- Maybe it is not just the Fed reacting to oil prices

One-Step Ahead Forecast Comparisons
(RMSEs for 2008Q1 to 2010Q2)

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

Include Net Oil Price Increase?	Estimation sample period 1974Q4 - 2007Q4	Estimation Sample Period 1951Q1 – 2007Q4
No	1.23	1.28
Yes	0.91	0.79
AR(4) model	1.26	1.33

Model Fit Without Net Oil Variable



Model Fit With Net Oil Variable

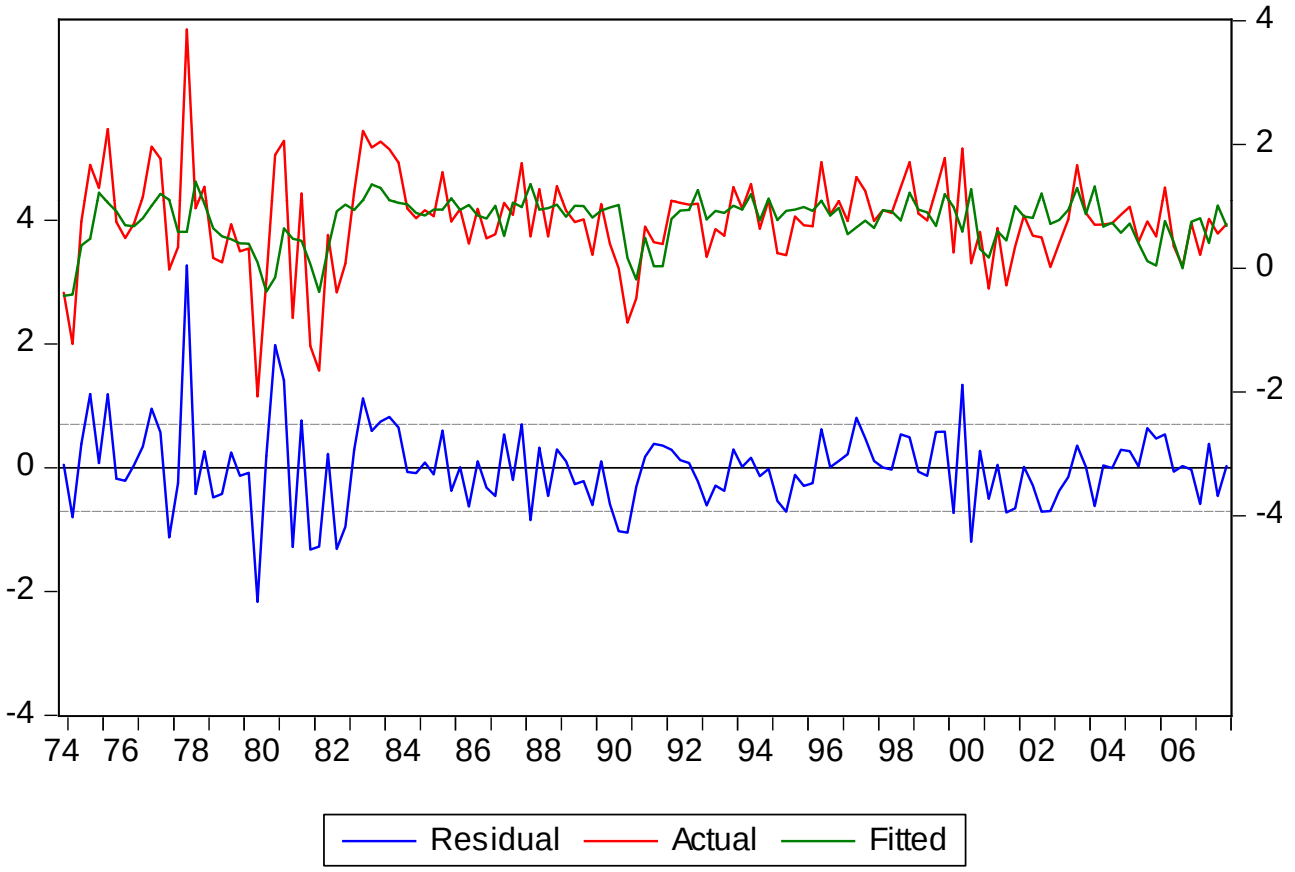


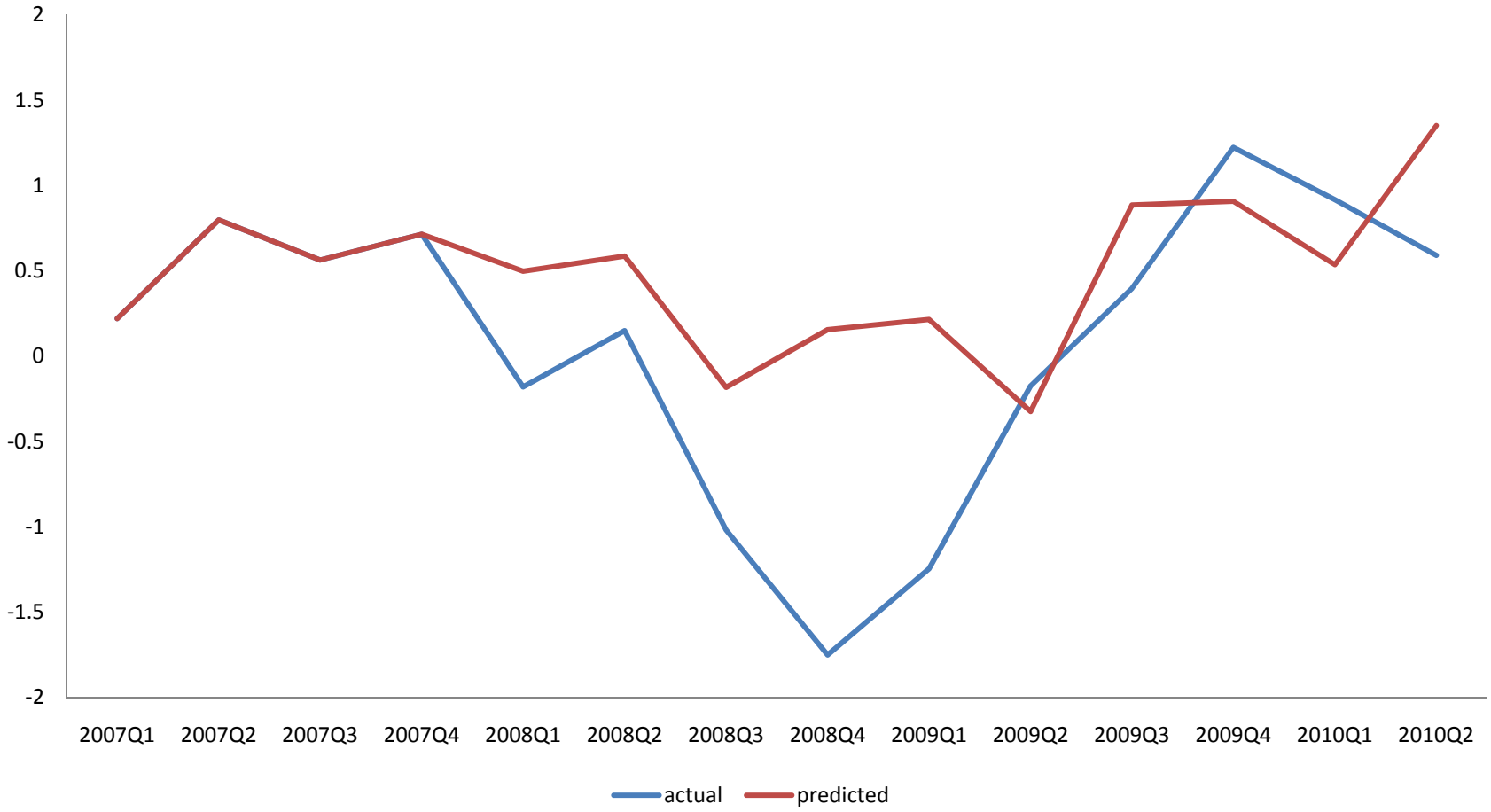
Table 18a: MSPE Ratios of Nonlinear Dynamic Models Relative to the AR(4) Benchmark Model
Cumulative U.S. Real GDP Growth Rates

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

	Nominal Refiners' Acquisition Cost for Imported Crude Oil					
	Unrestricted Model (20′)			Exogenous Model (21′)		
Horizon	Mork Increase	Hamilton Net Increase		Mork Increase	Hamilton Net Increase	
		1 Year	3 Year		1 Year	3 Year
1	1.38	1.46	1.32	1.37	1.46	1.31
2	1.36	1.47	1.01	1.35	1.45	1.01
3	1.25	1.45	**0.92**	1.24	1.43	**0.92**
4	1.25	1.50	**0.92**	1.24	1.47	**0.91**
5	1.26	1.67	1.10	1.23	1.65	1.10
6	1.25	1.50	1.10	1.21	1.47	1.09
7	1.25	1.35	1.07	1.21	1.31	1.05
8	1.26	1.23	1.03	1.21	1.20	1.01

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



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 $\tilde{S}_t$

$$x_t = \alpha_0 + \alpha_1 \tilde{S}_{t|t} + \eta_t$$

$$\eta_t = \rho_x \eta_{t-1} + \upsilon_t \qquad \upsilon_t \sim N(0, \sigma_\eta)$$

- 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