

The Role of  
Inventories and Speculative Trading in the  
Global Market for Crude Oil

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# Competing Views of the Global Market for Crude Oil

1. Oil is an asset, the price of which is determined by desired stocks.

Shifts in the expectations of forward-looking traders are reflected in changes in the real price of oil and in changes in oil inventories.

2. The real price of oil is determined by shocks to the flow supply of oil and to the flow demand for oil.

⇒ Recently, there has been increasing recognition that both elements of price determination matter.

# Expectation Shifts in Oil Market Models

## Problem:

Traditional econometric models of oil markets are backward-looking.

Market expectations of future oil demand and oil supply are equated with econometric expectations in these models.

## Examples of Expectations Shocks

Supply side: New discoveries (Brazilian off-shore oil fields)

Anticipation of a War in the Middle East

Anticipation of “peak oil” effects

Demand side: Anticipation of a booming world economy

Anticipation of a major global recession

Anticipation of new energy-saving technologies

Both: Shifts in Uncertainty about Future Oil Supply

Shortfalls

# Why Is It So Difficult to Model Expectation Shifts?

- Expectations data are not available.
  - Expectations are nonlinear functions of observables.
- ⇒ Models of how expectations are formed are too complicated to be practical.

## Our Indirect Approach

- Speculative demand for oil manifests itself as demand for oil inventories.
  - ⇒ By including changes in oil inventories in an econometric model we are able to identify the effects of expectations shifts without explicit measures of expectations.
- Revisions to expectations shift the oil demand curve (conditional on past data) through changes in the demand for inventories, for a given oil supply curve.

# Structural Model of the Global Crude Oil Market

- Monthly data for 1973.2-2009.8:
  1. Percent change in global crude oil production
  2. Index of global real activity in deviations from trend
  3. Real price of oil
  4. Change in above-ground global crude oil inventories
- All variables are mutually endogenous.
- Two years worth of lags in model

## Four Shocks

1. Shock to the flow of crude oil production (“flow supply shock”)
2. Shock to the demand for crude oil driven by the global business cycle (“flow demand shock”)
3. Shock to the demand for above-ground oil inventories arising from forward-looking behavior (“speculative demand shock”)
4. Residual shock that captures all structural shocks not otherwise accounted for and has no direct economic interpretation (e.g., weather shocks, shocks to inventory technology or preferences, changes in SPR, technical constraints in refining).



# 1. Identifying Assumptions on Sign of Impact Responses

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	Flow Supply Shock	Flow Demand Shock	Speculative Demand Shock
Oil Production	-	+	+
Real Activity	-	+	-
Real Oil Price	+	+	+
Inventories			+

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NOTE: All sign restrictions involve weak inequalities.

## 2. Bound on Impact Price Elasticity of Supply

- Consensus: The impact price elasticity of oil supply is near zero.
- Grid of supply elasticity bounds:

$$\eta^{Oil\ Supply} \leq 0.025 \text{ (baseline)}$$

$$\eta^{Oil\ Supply} \leq 0.050$$

$$\eta^{Oil\ Supply} \leq 0.100$$

- Our main results are robust to using a bound as high as 0.1.

### 3. Bound on Impact Price Elasticity of Demand

- Standard demand elasticity measures equate the production of oil with the consumption of oil. The relevant elasticity measure instead is based on the sum of the flow of oil production and the depletion of oil inventories triggered by a negative oil supply shock.
- We restrict this impact *price elasticity of oil demand in use*:

$$-0.8 \leq \eta^{Oil Use} \leq 0$$

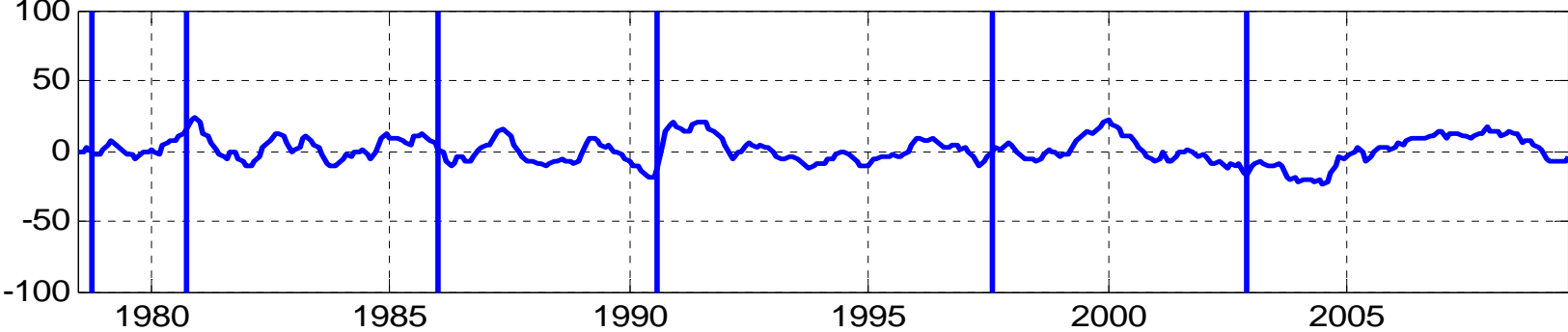
The lower bound is based on cross-sectional estimates of the long-run price elasticity of gasoline demand.

## 4. Dynamic Sign Restrictions

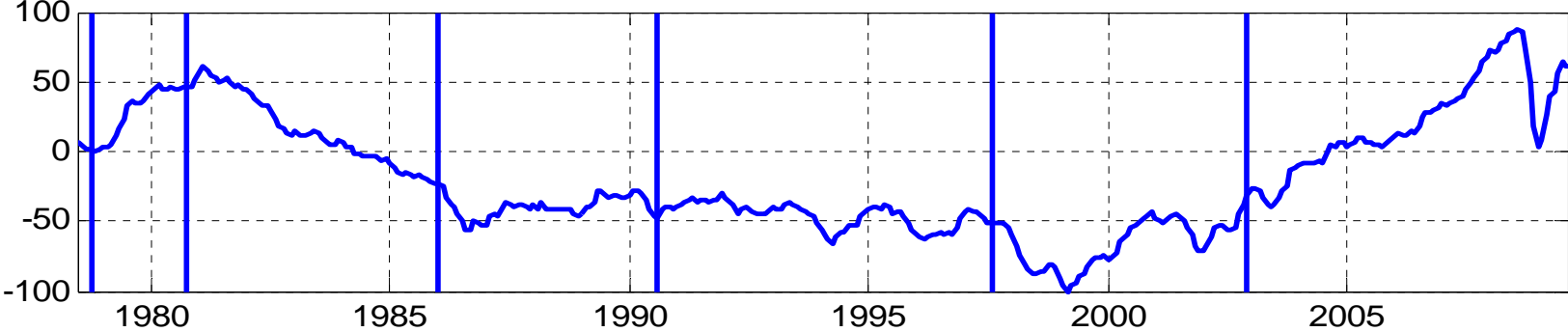
- For the first year after an unexpected oil supply disruption, the real price of oil must remain weakly positive, while global oil production and real activity must be remain weakly negative.

# Historical Decompositions for 1978.6-2009.8

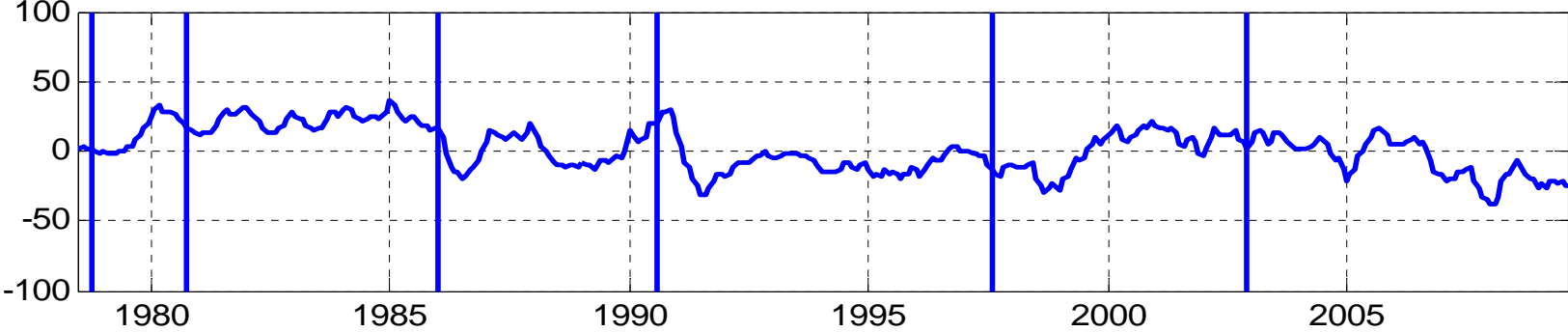
Cumulative Effect of Flow Supply Shock on Real Price of Crude Oil



Cumulative Effect of Flow Demand Shock on Real Price of Crude Oil



Cumulative Effect of Speculative Demand Shock on Real Price of Crude Oil



# Speculation without a Change in Oil Inventories?

- Hamilton (BPEA 2009): Possible if the short-run price elasticity of gasoline demand is zero.
- This elasticity is closely related to the short-run price elasticity of oil demand.

## Consensus view on short-run price elasticity of oil demand:

Hamilton (2009): -0.06.

Dahl (1993); Cooper (2003): -0.05, -0.07.

# Problems with the Consensus on the Demand Elasticity

- The identification of this parameter requires an exogenous shift of the oil supply curve along the oil demand curve.
- Much of the existing literature on estimating oil demand elasticities does not distinguish between oil demand and oil supply shocks.
- Standard reduced form approach suffers from downward bias. IV is infeasible, but our structural model provides an alternative.

## Posterior Probability Distribution of the Short-Run Impact Price Elasticity of Demand for Crude Oil

	$\eta^{Oil Production}$	$\eta^{Oil Use}$
16 <sup>th</sup> Percentile	-0.80	-0.54
<b>50<sup>th</sup> Percentile</b>	<b>-0.44</b>	<b>-0.26</b>
84 <sup>th</sup> Percentile	-0.23	-0.09

Related structural estimates:

Baumeister and Peersman (2009):  $\eta^{Oil Production} = -0.38$  (median)



# The Impact Price Elasticity of Gasoline Demand

A short-run model of the refinery market implies under empirically plausible assumptions that:

$$\eta^{Oil\ Use} \approx \eta^{Gasoline}$$

- ⇒ Median estimate of the short-run price elasticity of gasoline demand is -0.26.
- ⇒ With 84% probability greater in magnitude than -0.09.

Consensus view from reduced form:

Hughes, Knittel and Sperling (2008): Recently between -0.04 and -0.08

## What Explains the 2003-08 Oil Price Shock?

- No evidence that “peak oil” has been the cause.
- No evidence that OPEC was behind the oil price increase.
- No evidence that speculation by oil traders was responsible.
- Strong evidence that a booming world economy was the cause.

## Three Policy Conclusions

1. Increased regulation of oil traders will not keep the real price of oil down.
2. Increased domestic oil production in the U.S. will not lower the real price of oil materially.
3. Efforts to revive the world economy will cause the real price of oil to recover, creating a policy dilemma.

Only energy conservation and the development of alternative sources of energy will overcome this dilemma.