

Quantifying the Speculative Component in the
Real Price of Oil:
The Role of Global Inventories

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Expectations and Speculative Oil Demand

- A natural economic definition of a speculator in the physical market is anyone buying crude oil not for current consumption, but for future use (Fattouh, Kilian and Mahadeva, forthcoming: EnJ).
- Speculative purchases of oil arise in the physical market for oil when the buyer is anticipating rising oil prices.
 - ⇒ A shift in expectations about future excess oil demand manifests itself as a shift in the demand for oil inventories, so these demand shocks are speculative demand shocks by construction.
- Kilian and Murphy (forthcoming: JAE) quantified this speculative demand using a structural model of the global oil market.

Structural Model of the Global Crude Oil Market

- VAR model based on data since 1973.2
 1. Percent change in global crude oil production
 2. Index of global real activity (business cycle index)
 3. Real price of oil
 4. Change in above-ground global crude oil inventories
- Four structural shocks:
 - Flow supply shock
 - Flow demand shock
 - Speculative demand shock
 - Other (idiosyncratic) oil demand shocks

1. Identifying Assumptions on Sign of Impact Responses

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

2. Bound on Impact Price Elasticity of Oil Supply:

Impact elasticity is positive, but near 0.

3. Bound on Impact Price Elasticity of Oil Demand:

$|\text{Impact elasticity}| < |\text{Long-run elasticity}|$

4. Dynamic Sign Restrictions

An unexpected flow supply disruption is associated with positive responses of the real price of oil for the first year; so are positive oil demand shocks.

Potential Caveat:
How Good Are the Crude Oil Inventory Data?

Kilian and Murphy (forthcoming: JAE):

1. External validation:

Model finds speculation for episodes when industry sources indicate that it existed (1979, 1986, 1990, 2002).

2. Model passes formal test for informational sufficiency:

Oil futures spread has no added predictive power.

This paper:

Are the key results robust to the use of alternative proxies for global above-ground crude oil inventories?

Alternative Approaches to Constructing Global Crude Oil Inventory Data

1. Kilian and Murphy (forthcoming: JAE) use EIA data:

$$(\text{Crude oil inventories})^{US} \times \frac{(\text{Petroleum inventories})^{OECD}}{(\text{Petroleum inventories})^{US}}$$

2. Energy Information Group (EIG):

Proprietary data on global crude oil inventories including:

Commercial Oil Stocks outside the OECD

Oil Stocks at Sea

Oil in Transit/Independent

Strategic Stocks

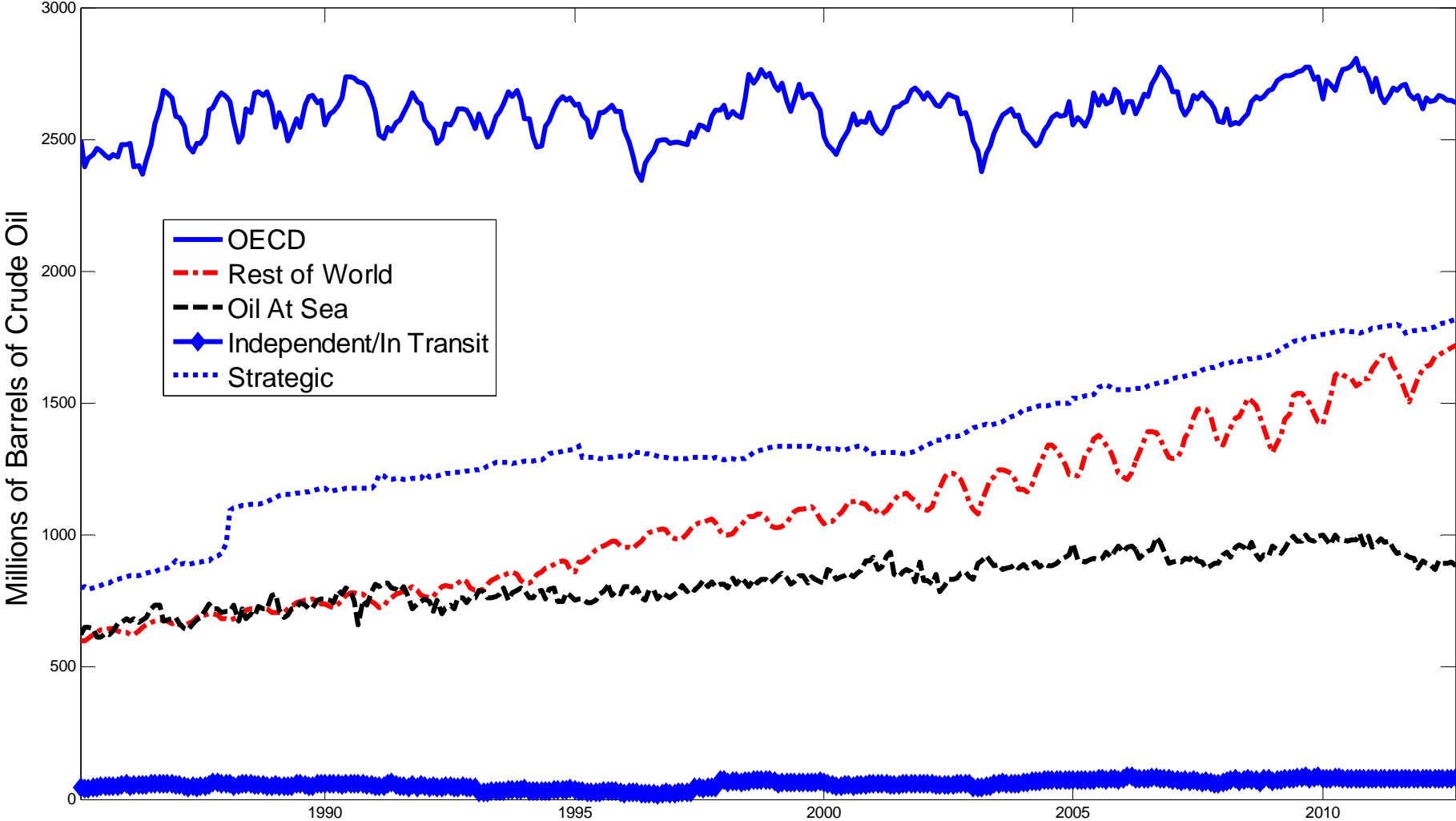
Caveat: Missing data are filled in using rules of thumb.

Insights from the EIG Inventory Data

The EIG data allow us to address some policy questions about potential changes in inventories in recent years:

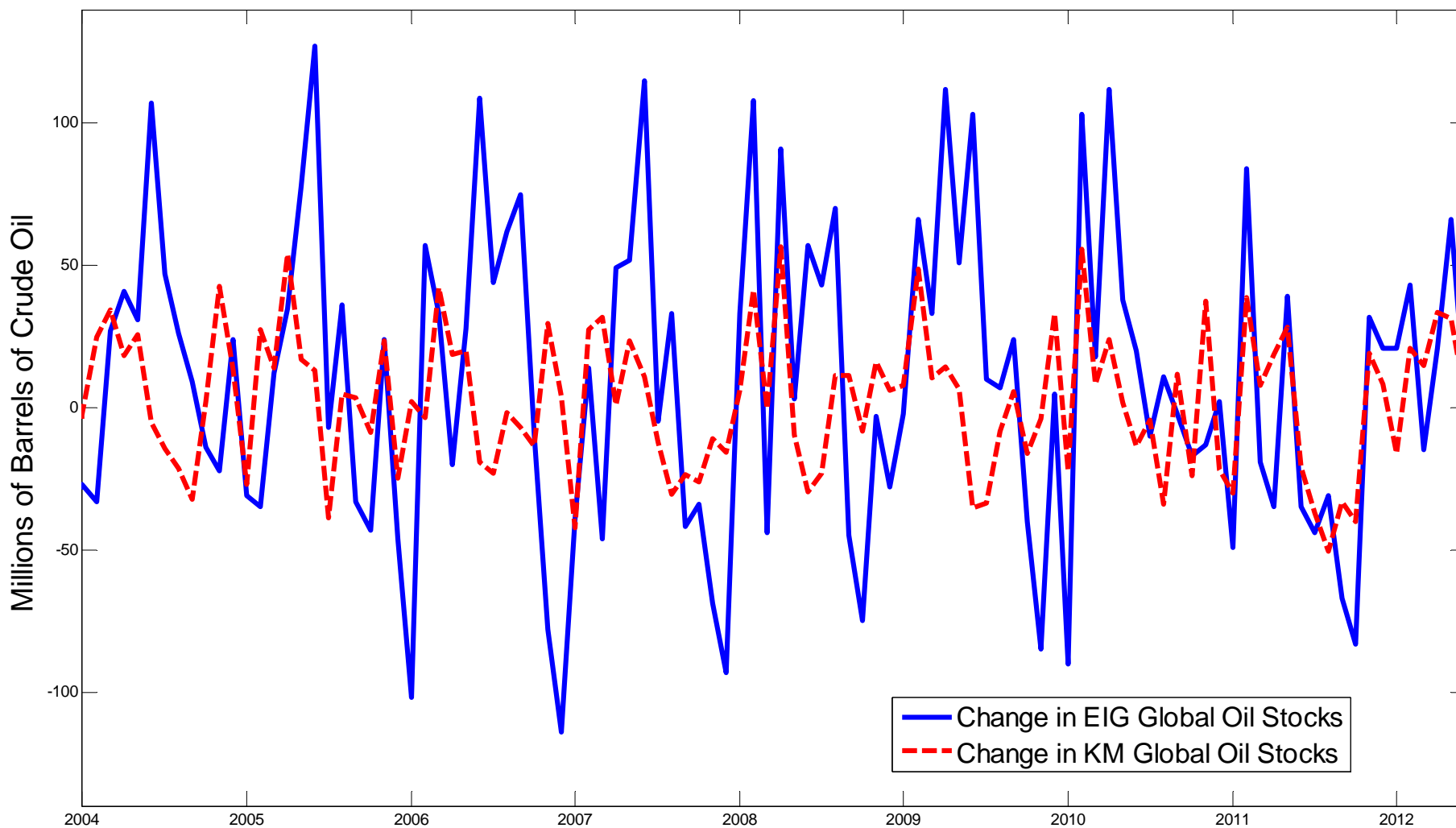
1. Have “financial investors” used tankers to stock oil in a way that does not enter national statistics?
2. Have emerging economies such as China accelerated their inventory building?
3. What about the creation of the Chinese SPR?
4. What about Iran’s decision to store oil on ships following the embargo decision?

Global Commercial and Strategic Stocks of Crude Oil: 1985.1-2012.8



SOURCE: *Energy Intelligence Group* (EIG). Reproduced with the permission of EIG.

Change in Global Crude Oil Stocks: 2003.12-2012.5



SOURCE: *Energy Intelligence Group* (EIG) and *Kilian and Murphy* (KM) based on EIA data.

Differences from Kilian and Murphy (JAE) Model

We estimate two versions of the model. One with EIG data and one with KM data. We backcast the EIG data analogously to the KM data.

Other differences:

1. Sample updated until 2012.5.
2. Slight tightening of the identifying assumptions.
3. The real price of oil is measured in exact percent deviations from the mean (rather than in log deviations).

How We Summarize the Results

Sign-identified VAR models generate many admissible solutions and these solutions may differ.

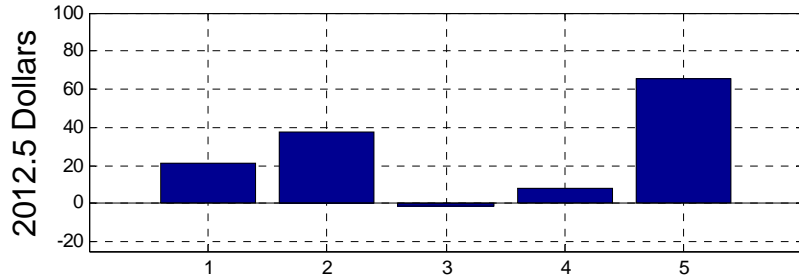
- Our first pass of the data is to search for the model that has a price elasticity of oil demand in use closest to the elasticity estimate of -0.26 reported in Kilian and Murphy (forthcoming: JAE).
- The paper also reports sensitivity analysis.

Key Policy Question:

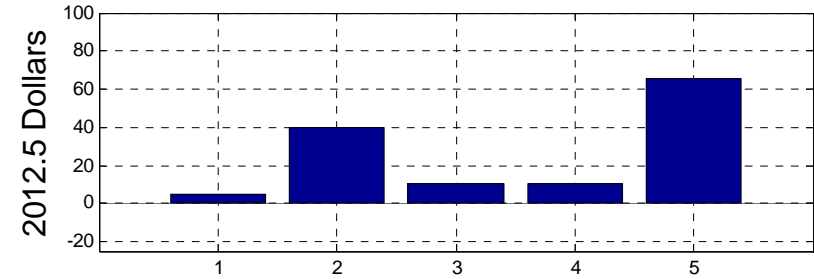
- How many dollars of the inflation-adjusted real price of oil must be attributed to each shock?
- Answering this question requires some changes in the representation of the model estimates.
 - ⇒ We introduce two new summary statistics that have not been used in this literature before.
 - ⇒ In implementing these statistics it is essential to compute exact percentages rather than relying on log approximations.

Contribution to Cumulative Change in Real Price of Oil by Structural Shock

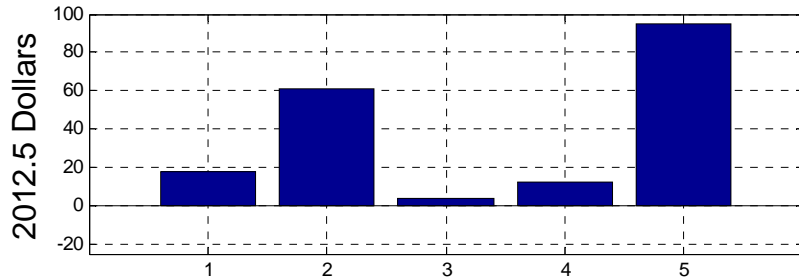
Model based on Original Inventory Proxy
2003.1-2012.5



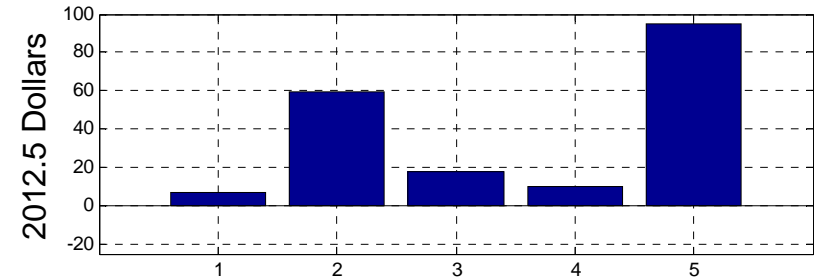
Model based on EIG Inventory Proxy
2003.1-2012.5



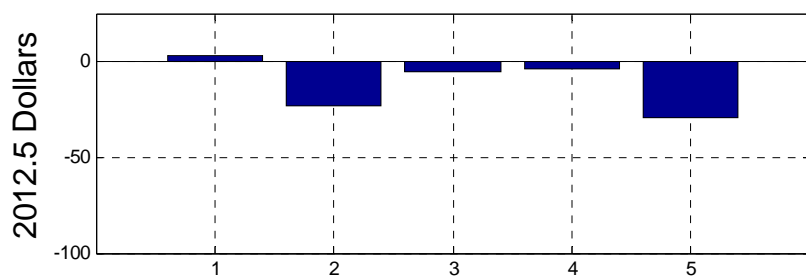
2003.1-2008.6



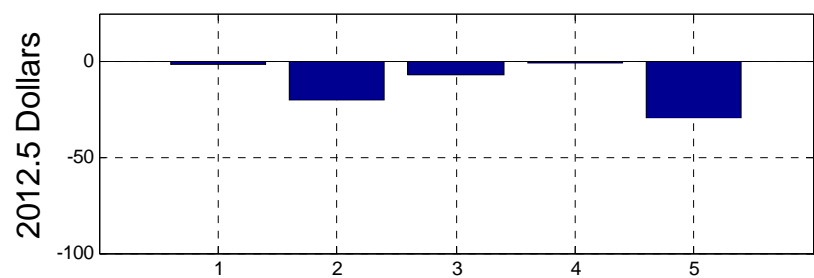
2003.1-2008.6



2008.6-2012.5



2008.6-2012.5

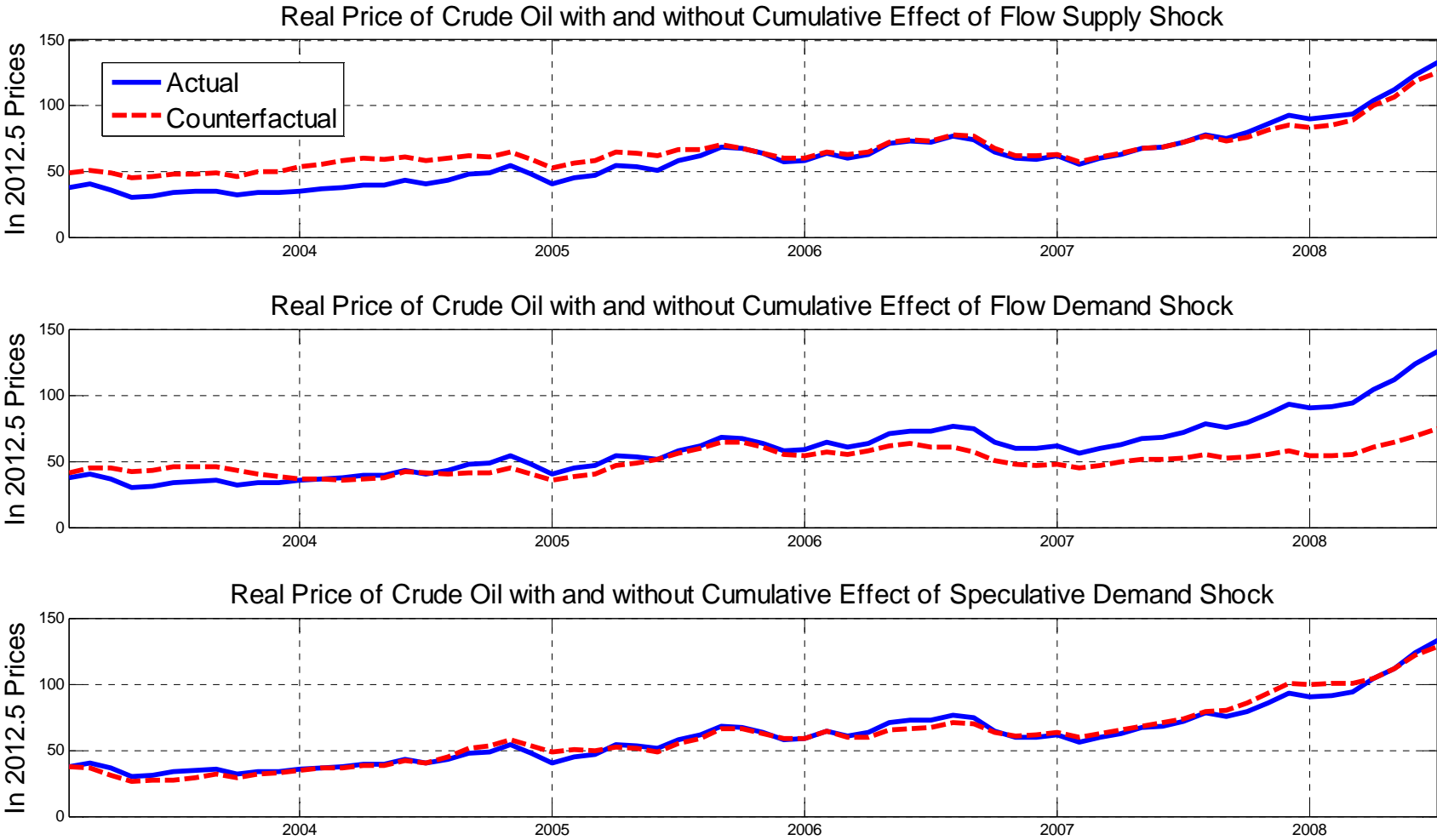


NOTES: Model with the price elasticity of oil demand in use closest to -0.26. 1 = flow supply shock; 2 = flow demand shock; 3 = speculative demand shock; 4 = other demand shock; 5 = observed cumulative change in real price.

Key Policy Question: 2003.1-2008.6

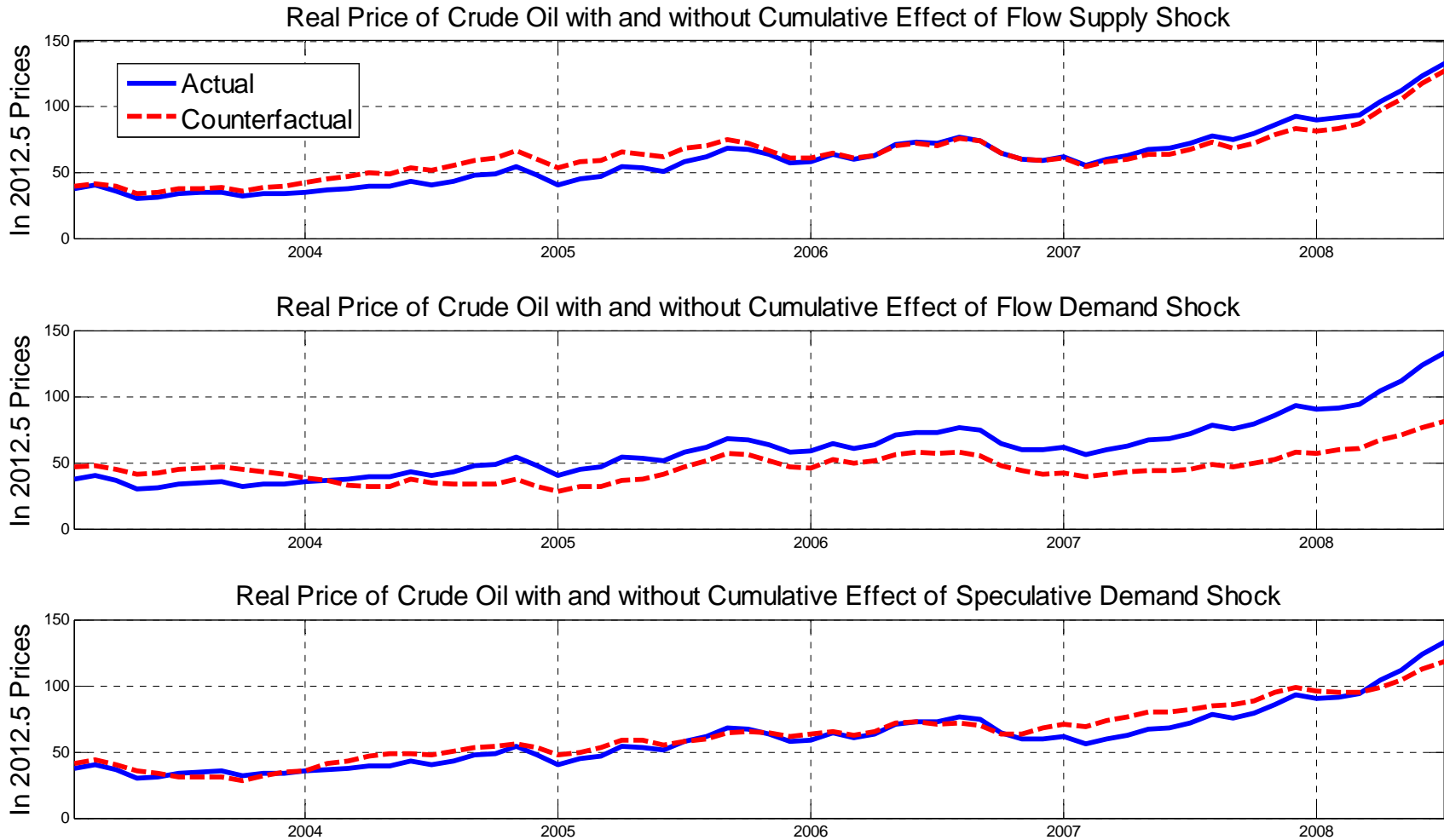
- What caused the Great Surge in the real price of oil from 2003 until mid-2008?
 1. How large was the “speculative element” in the price of oil?
 - Speculation by oil producers?
 - Speculation by oil consumers?
 2. Does the “peak oil” hypothesis help explain the price of oil?
 3. What is the role of unexpected flow demand?

Counterfactuals for Price of Oil in 2012.5 Dollars based on Original Proxy: 2003.1-2008.6



NOTES: The counterfactuals show the evolution of the real price of oil in 2012.5 dollars in the absence of the structural shock in question. If the counterfactual exceeds the actual, for example, the shock in question lowered the real price of oil.

Counterfactuals for Price of Oil in 2012.5 Dollars based on EIG Proxy: 2003.1-2008.6

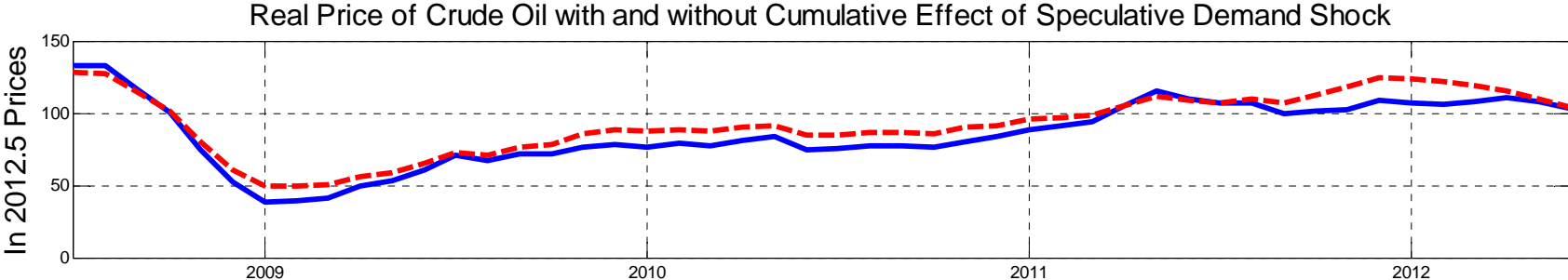
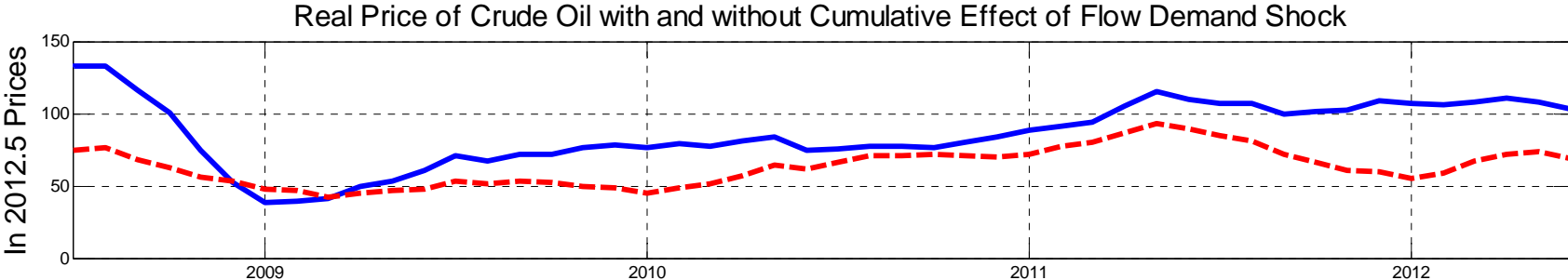
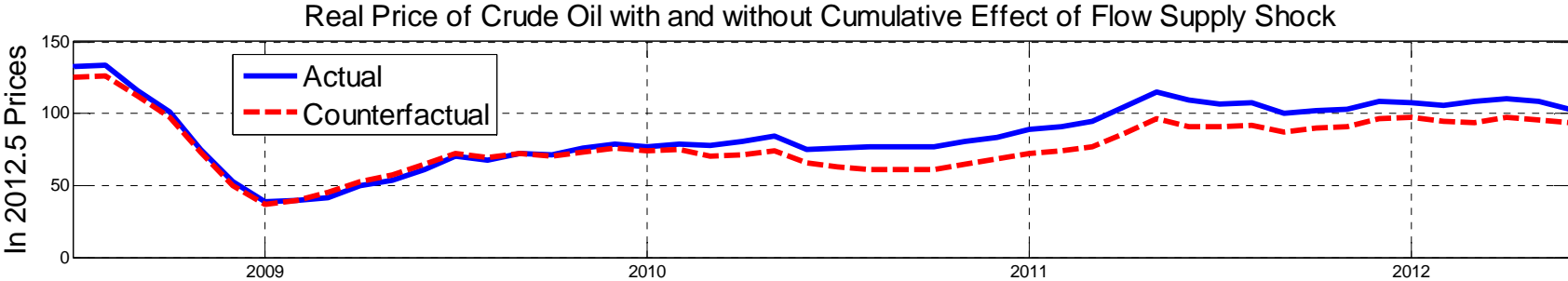


NOTES: If the counterfactual exceeds the actual, for example, the shock in question lowered the real price of oil.

Key Policy Questions: 2008.6-2012.5

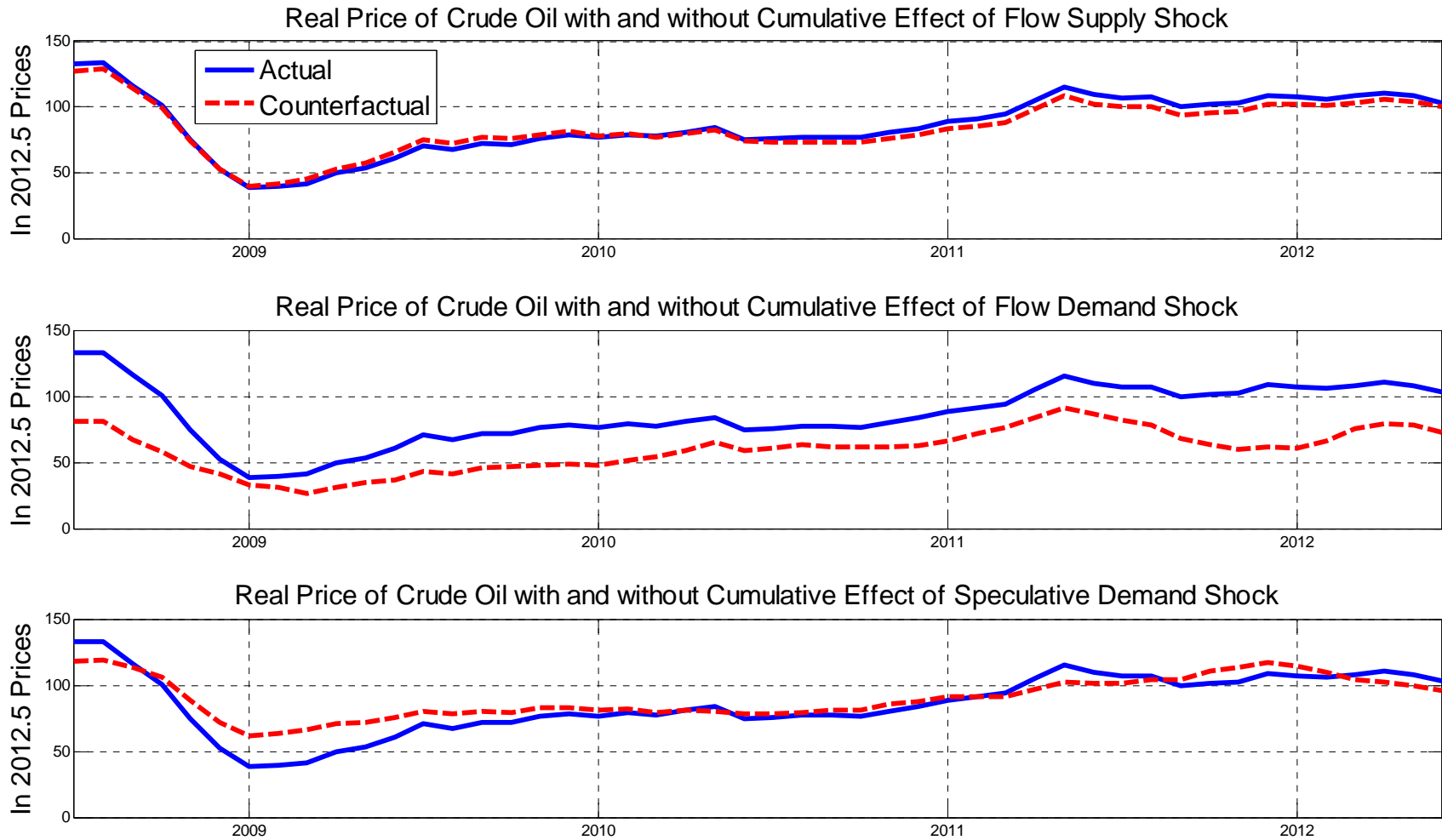
- What were the effects of the Libyan Crisis of 2011?
- Has the EU's decision to institute an oil embargo against Iran raised oil prices?
- Have positive flow supply shocks associated with “unconventional oil” helped lower the real price?
- Is there a greater psychological element in the real price of oil compared with earlier years?

Counterfactuals for Price of Oil in 2012.5 Dollars based on Original Proxy: 2008.6-2012.5



NOTES: If the counterfactual exceeds the actual, for example, the shock in question lowered the real price of oil.

Counterfactuals for Price of Oil in 2012.5 Dollars based on EIG Proxy: 2008.6-2012.5



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Conclusions

1. Flow demand shocks account for as much as 61 dollars of the 95 dollar increase in the real price of oil between 2003 and mid-2008. Flow supply and idiosyncratic demand shocks add between 17 and 30 dollars (depending on the inventory specification).

2. There is evidence of speculative demand raising the price in mid-2008 by between 5 and 14 dollars, depending on the inventory specification, but no evidence of speculative demand pressures between early 2003 and early 2008.

Episodes of increased speculative demand in the physical market for crude oil do not line up at all with increases in measures of the participation of financial investors in oil futures markets (see Fattouh, Kilian, and Mahadeva, forthcoming: EnJ)

3. There is evidence that the Libyan crisis in 2011 shifted expectations in oil markets, resulting in a price increase of between 3 and 13 dollars (depending on the inventory specification).
4. With regard to tensions with Iran in 2012, the implied price premium ranges from 0 to 9 dollars.
5. There is no indication that higher demand for strategic oil inventories from China (or for that matter storage of oil on tankers in recent years) played an important role determining global oil inventories or the real price of oil after 2009.
6. Between 20 and 23 dollars of the 29 dollar decline in the real price of oil since its peak in mid-2008 is accounted for by flow demand shocks compared with between -2 and +3 dollars explained by flow supply shocks.