Investor Flows and the
2008 Boom/Bust in Oil Prices

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Investor Flows, Speculation, and Oil Prices

- The role of speculation (broadly construed) in the dramatic rise and subsequent sharp decline in oil prices during 2008?

- Many attribute these swings to changes in fundamentals of supply and demand, *within representative agent models.*

- At the same time there is mounting evidence of the "financialization" of commodity markets.

- Objective: investigate the impact of investor flows and financial market conditions on crude-oil futures prices.

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Heterogeneity and Investor Flows

- The prototypical dynamic models referenced in discussions of the oil boom (e.g., Hamilton (2009), Pirrong (2009)) have representative agent-types (producer, storage operator, commercial consumer, etc.).

- Moreover, they do not allow for learning under imperfect information, heterogeneity of beliefs, and capital market and agency-related frictions that limit arbitrage activity.

- As such, they abstract entirely from the consequent rational motives for many categories of market participants to speculate in commodity markets based on their individual circumstances and views about fundamental economic factors.

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Inferred Commodity Index Long Positions (Dash →) Against NYMEX WTI Futures (Solid ←)
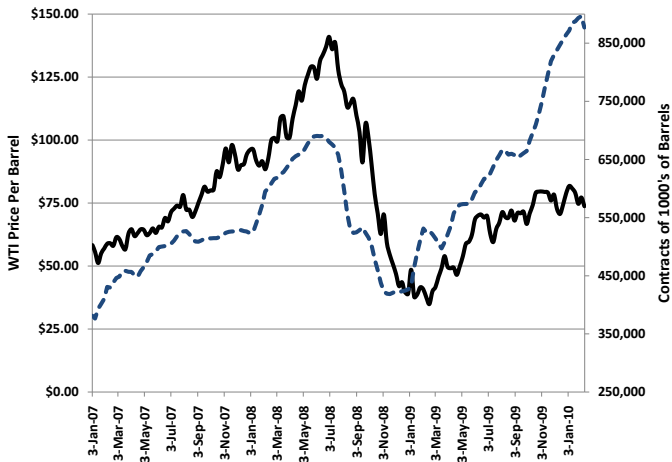
Financialization of Commodities: What Do We Know?

- Tang and Xiong (2011) show that, after 2004, agricultural commodities that are part of the GSCI and DJ-AIG indices became much more responsive to shocks to a world equity index, changes in the U.S. dollar exchange rate, and oil prices.

- Using proprietary data from the CFTC, Buyuksahin and Robe (2011) link increased high-frequency correlations among equity and commodity returns to trading patterns of hedge funds.

- Less formally, Masters (2009) attributes price movements to flows into crude oil positions by index investors.

- Mou (2010) documents substantial impacts on prices of the "roll strategies" employed by index funds– index investors bear large implicit transactions costs.

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Speculation and Booms/Busts in Commodity Prices

- Absent arbitrage opportunities and near stock-out conditions in a commodity market:

$$S_t = E_t^{\mathbb{Q}} \left[e^{-\int_t^T (r_s - \mathcal{C}_s)\, ds} S_T \right],$$

  - S_t denotes the price of crude oil S_t,
  - $\mathcal{C}_t$ denotes the convenience yield net of storage costs,
  - $E_t^{\mathbb{Q}}$ denotes the expectation of market participants under the risk-neutral pricing distribution.

- An implication of S_t drifting at the rate $(r_t - \mathcal{C}_t) S_t\, dt$.

- Additionally, the futures price for delivery of a commodity at date $T > t$ is related to S_T according to

$$F_t^T = E_t^{\mathbb{Q}} \left[S_T \right].$$

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The Futures-Spot Basis

- Rearranging these expressions gives

$$\frac{F_t^T}{S_t} = \frac{1 - Cov_t^{\mathbb{Q}}\left(e^{\int_t^T \mathcal{C}_s\, ds}, e^{-\int_t^T r_s\, ds}\frac{S_T}{S_t}\right)}{B_t^T\, E_t^{\mathbb{Q}}\left[e^{\int_t^T \mathcal{C}_s\, ds}\right]} - \frac{1}{B_t^T} \times Cov_t^{\mathbb{Q}}\left(e^{-\int_t^T r_s\, ds}, \frac{S_T}{S_t}\right),$$

where B_t^T denotes the price of a zero coupon bond.

- If the covariance terms are negligible, then (approximately)

$$\frac{F_t^T - S_t}{S_t} \approx y_t^T\,(T - t) - \ln E_t^{\mathbb{Q}}\left[e^{\int_t^T \mathcal{C}_s\, ds}\right],$$

where y_t^T is the continuously compounded yield on a zero of maturity $(T - t)$ periods.

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Representative Risk-Neutral Market Participants?

- Most of the extant model-based interpretations of the oil price boom focus on:
  - representative risk-neutral producers and refiners, and
  - they arrive at similar expressions, but with
  - the expectation $E_t^{\mathbb{Q}}$ replaced by $E_t^{\mathbb{P}}$, the expectation of market participants under the historical distribution.

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  - they arrive at similar expressions, but with
  - the expectation $E_t^{\mathbb{Q}}$ replaced by $E_t^{\mathbb{P}}$, the expectation of market participants under the historical distribution.

- If refiners and investors are heterogeneous and:
  - risk averse or
  - they face capital constraints that lead them to behave effectively as if they are risk averse, and
  - different classes of investors hold different views about future oil-market fundamentals,

- then risk-premiums and forecast errors will impact futures and, thereby, spot prices.

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Accommodating Risk Premiums and Informational Heterogeneity

- Market risk premium: $RP_t^T \equiv \left(E_t^{\mathbb{Q}}[S_T] - E_t^{\mathbb{P}}[S_T] \right)$, $T > t$.

- For a short time interval $[t, \tau]$ over which r and $\mathcal{C}$ are approximately constant:

$$\frac{E_t^{\mathbb{P}}[S_\tau] - S_t}{S_t} - y_t^\tau \left(\tau - t \right) \approx \mathcal{C}_t \left(\tau - t \right) - RP_t^\tau.$$

- Thus, expected excess returns in the spot commodity market depend on both convenience yields and risk premiums.

- The same will in general be true of expected excess returns in the futures market, the percentage changes in the price of a future contract, adjusted for roll dates.

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Heterogeniety Version I:
Wealth-Weighted Futures Prices

- Suppose market participants hold different beliefs and have different purchasing powers.

- By analogy to Xiong and Yan (2010), if $\log S_t$ is an affine function of risk factors X_t that follow an affine process, then we expect futures prices to take a form similar to

$$F_t^T = \int_i \omega_i e^{a(T-t)+b_X(T-t)X_t+b_\theta(T-t)\theta_i},$$

  - ω_i is the wealth allocation of investor i,
  - θ_i summarizes investor i's beliefs about the state of the economy X_t.

- As beliefs and wealths change, so will the futures prices.

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Heterogeneity Version II:
Forecasting the Forecasts of Others

- Optimal when agents have different non-nested information sets. (Townsend (1983), Singleton (1987))

- Nimark (2009) abstracts from wealth distribution effects and focuses on agents' forecasting problem under log utility. In a bond market setting, the forward rate becomes:

$$f_t^n = \int_i E_{t,i} r_{t+n}\, di - \int_i E_{t,i} \left(r_{t+n} - \prod_{s=0}^{n-1} \int_i E_{t+s,i} r_{t+n} \right) + \nu_t.$$

- Note that the law-of-iterated expectations does *not* apply.
- Therefore, average expectations of investors' forecast errors effectively enter as a state variable.

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Implications for Commodity Pricing

- Surely participants in oil market held different views about economic growth, global demand and supply of oil, inventory positions domestically and in emerging economies, etc.

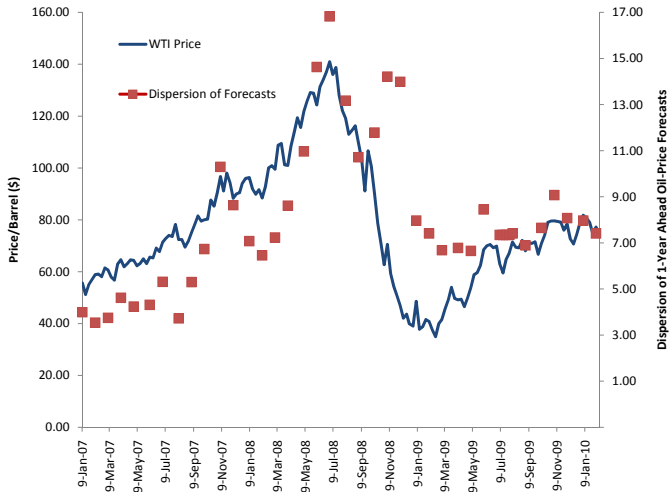- Consequently, averaging across investors will typically give

$$\frac{\int_i E_t^{i\mathbb{P}}[S_\tau] - S_t}{S_t} - y_t^\tau \left(T - t\right) \approx \tilde{\mathcal{C}}_t \left(T - t\right) - \tilde{RP}_t^\tau + \mathcal{E}_t^\tau,$$

where i indexes investors and $\mathcal{E}_t^\tau$ captures the effects of forecast errors and/or limits to arbitrage.
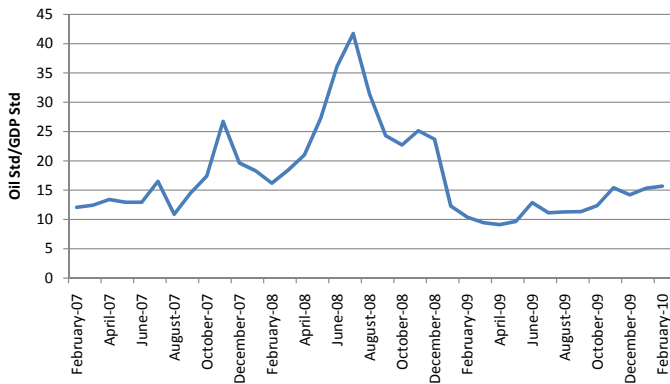
- Expect projections of realized "excess returns" to potentially capture aspects of all of these ingredients?

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Disagreement and Prices in Oil Markets

Relative Disagreement about Oil Prices and Global (G7 + BRIC) GDP Growth

New Evidence on Investor Flows and Oil Prices

- **RSPn** and **REMn**: the n-week returns on the S&P500 and the MSCI Emerging Asia indices, respectively.

- **IIP13**: the thirteen-week change in the imputed positions of index investors in millions, computed using the same algorithm as in Masters (2009).

- **MMSPD13**: the thirteen-week change in managed-money spread positions in millions, as constructed by the CFTC.

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More Conditioning Variables

- **REPOn**: the n-week change in overnight repo positions on Treasury bonds by primary dealers.

- **OI13**: the thirteen-week change in aggregate open interest.

- **AVBASn**: the n-week change in basis averaged across the maturities $\{1, 3, 6, 9, 12, 15, 18, 21, 24\}$ months.
  - The basis is a proxy for convenience yield– more later.

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Linear Projections

$$ERmM_{t+n}(n) = \mu_{nm} + \Pi_{nm}X_t + \Psi_{nm}ERmM_t(n) + \varepsilon_{m,t+n}(n),$$

- $ERmM_t(n)$: realized excess return for an n-week investment horizon on a futures position that expires in m months.

- X_t is the set of predictor variables.

- Weekly data over the sample period September 12, 2006 through January 12, 2010.

- Robust standard errors allowing for heteroskedasticity and serial correlation.

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Projections of 1-Week Excess Returns

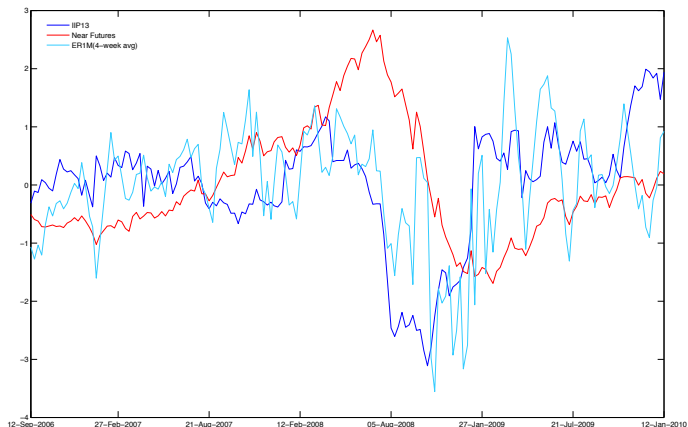| Contract	RSP1	REM1	REPO1	IIP13	MMSPD13	OI13	AVBAS1	R_{Lag}	Adj R^2
1	0.332	-0.342	-0.201	0.272	0.357	-0.103	-4.165	-0.219	0.27
	(1.44)	(-2.44)	(-2.89)	(3.51)	(4.36)	(-2.17)	(-6.26)	(-2.05)	
3	0.361	-0.242	-0.170	0.218	0.284	-0.082	-3.661	-0.152	0.27
	(1.99)	(-2.02)	(-2.76)	(3.71)	(4.43)	(-1.87)	(-6.48)	(-2.10)	
6	0.391	-0.261	-0.150	0.197	0.245	-0.072	-3.022	-0.105	0.25
	(2.35)	(-2.27)	(-2.64)	(3.49)	(4.14)	(-1.74)	(-5.59)	(-1.62)	
9	0.424	-0.275	-0.142	0.187	0.222	-0.067	-2.551	-0.090	0.24
	(2.67)	(-2.46)	(-2.58)	(3.45)	(3.95)	(-1.73)	(-4.72)	(-1.40)	
12	0.437	-0.283	-0.133	0.179	0.202	-0.064	-2.141	-0.075	0.22
	(2.84)	(-2.60)	(-2.49)	(3.42)	(3.83)	(-1.73)	(-3.97)	(-1.14)	
18	0.430	-0.286	-0.119	0.166	0.174	-0.058	-1.657	-0.054	0.20
	(2.99)	(-2.79)	(-2.35)	(3.42)	(3.61)	(-1.72)	(-3.13)	(-0.75)	
24	0.412	-0.287	-0.107	0.157	0.159	-0.053	-1.329	-0.046	0.18
	(2.98)	(-2.87)	(-2.21)	(3.46)	(3.40)	(-1.67)	(-2.60)	(-0.59)	
36	0.378	-0.294	-0.093	0.145	0.144	-0.048	-0.981	-0.033	0.16
	(2.85)	(-2.99)	(-2.05)	(3.52)	(3.02)	(-1.60)	(-2.10)	(-0.40)	

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Projections of 4-Week Excess Returns

Contract	RSP4	REM4	REPO4	IIP13	MMSPD13	OI13	AVBAS4	R_{Lag}	Adj R^2
1	0.023	0.246	0.097	0.987	0.972	-0.447	-1.33	-0.229	0.38
	(.061)	(1.22)	(1.39)	(4.36)	(6.95)	(-3.91)	(-.688)	(-2.04)	
3	-0.137	0.342	0.038	0.927	0.934	-0.374	0.121	-0.279	0.41
	(-.521)	(2.36)	(.564)	(4.54)	(7.03)	(-3.36)	(.095)	(-2.59)	
6	-0.200	0.351	0.015	0.880	0.833	-0.338	0.539	-0.271	0.39
	(-.783)	(2.58)	(.237)	(4.32)	(6.71)	(-3.22)	(.452)	(-2.33)	
9	-0.216	0.330	0.015	0.846	0.756	-0.322	0.707	-0.254	0.37
	(-.854)	(2.52)	(.248)	(4.30)	(6.40)	(-3.21)	(.611)	(-2.10)	
12	-0.222	0.312	0.017	0.811	0.689	-0.306	0.782	-0.238	0.36
	(-.886)	(2.48)	(.295)	(4.25)	(6.11)	(-3.14)	(.693)	(-1.92)	
18	-0.219	0.276	0.023	0.744	0.588	-0.278	0.776	-0.211	0.33
	(-.902)	(2.36)	(.432)	(4.20)	(5.60)	(-2.97)	(.726)	(-1.68)	
24	-0.213	0.250	0.029	0.687	0.531	-0.255	0.706	-0.190	0.31
	(-.915)	(2.30)	(.571)	(4.15)	(5.34)	(-2.83)	(.701)	(-1.49)	
36	-0.212	0.237	0.036	0.613	0.480	-0.236	0.412	-0.175	0.28
	(-.993)	(2.43)	(.787)	(4.06)	(4.95)	(-2.78)	(.454)	(-1.37)	

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Growth in Investor flows ($IIP13$) and the Four-week MA of the 1-week Futures Return ($ER1M$)

Risk Premiums/Expectational Factors or Convenience Yields?

- $ERmM$ depend in general on risk premiums, expectational factors, and convenience yields.

- Independent evidence on risk premiums: project $(S_\tau - F_t^\tau)$ $(\tau > t)$ onto information in investors' information set.

- The adjusted R^2 in the projection of $S_{t+4} - F_t^{t+4}$ onto the conditioning variables X_t (for the monthly horizon) is 0.39.

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- Only $IIP13$ and $MMSPD13$ enter with statistically significant coefficients $\Rightarrow$ impacting commodity prices through risk premiums or speculative expectational terms?

- Emerging market equity returns and open interest shaped the futures curve, but not so much spot market risk premiums.

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