Predatory or Sunshine Trading? Evidence from Crude Oil ETF Rolls

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Crude Oil ETFs

- Commodity investment in institutional portfolios.
  - Stoll and Whaley (2010): $174 billion.
  - Index funds: 24%; ETFs: 25%.
- Exposure via passive, long-only commodity futures.
  - Physicals incur storage and insurance costs.
  - Futures markets are liquid.
- ETF Roll strategy: Sell expiring contract and purchase contracts with more distant expiration days.

USO share price vs. Crude Oil

ETFs preannounce the Roll.

Roll Dates are projected and subject to change without notice. Roll Dates are the expected dates on which the composition of the Benchmark Futures Contract is changed or "rolled" by selling the near month contract and buying the next month contract. The change occurs over four days.

Roll Start	Roll End
November 4, 2011	November 9, 2011
December 6, 2011	December 9, 2011
January 6, 2012	January 11, 2012
February 7, 2012	February 10, 2012
March 6, 2012	March 9, 2012
April 9, 2012	April 12, 2012
May 8, 2012	May 11, 2012
June 6, 2012	June 11, 2012
July 6, 2012	July 11, 2012
August 7, 2012	August 10, 2012
September 6, 2012	September 11, 2012
October 8, 2012	October 11, 2012
November 2, 2012	November 7, 2012
December 5, 2012	December 10, 2012

ETF Roll activity is large (table 1)

	Front Contract on Roll Date			
Roll date	ETF Selling Activity (contracts)	Market Trading Volume (contracts)	ETF %	Market Trading Volume During Settlement
3/5/08	4,455	414,308	1%	16,756
4/8/08	5,632	307,800	2%	16,338
5/6/08	5,122	331,913	2%	11,933
6/6/08	8,779	508,749	2%	18,139
7/8/08	7,208	382,404	2%	15,378
8/6/08	6,289	307,994	2%	16,189
9/8/08	11,961	317,923	4%	18,581
10/7/08	9,119	342,917	3%	21,235
11/6/08	13,031	292,018	4%	6,756
12/5/08	23,725	327,140	7%	27,508
1/6/09	49,852	331,307	15%	9,145
2/6/09	67,882	518,382	13%	32,674
Sum	213,055	4,382,855	13%	210,632

Predatory trading?

Wall Street Journal, 3/6/2009:

"*Since the fund (USO) is so big, it is unable to switch in and out of contracts….without moving markets and giving speculators an opportunity to make bets on those moves.*"

"It's like taking candy from a baby and the candy comes out of returns of the investors in the fund."

Bloomberg, 7/22/2010:

"*Professional futures traders exploit the ETFs' monthly rolls to make easy profits at the little guy's expense…. They can buy the next month ahead of the big programmed rolls to drive up the price, or sell before the ETF, pushing down the price investors get paid for expiring futures."*

"I make a living off the dumb money…"

Predatory trading: Theory

Brunnermeier and Pedersen (2005), Carlin, Lobo and Viswanathan (2007), Schoneborn and Schied (2007).

- Traders are aware of the presence of a large liquidator.
- Profit by trading in the same direction as the liquidator and reversing the position after liquidation is complete.

Outcomes:

- Predators cause the security price to temporarily overshoot the long-term equilibrium.
- Liquidator earns lower proceeds.
- Lower price forces other traders into distress.

Example: LTCM, Amaranth, ENRON, AIG, Lehman.

Sunshine trading: Theory

Admati and Pfleiderer (1991), Schoneborn and Schied (2007)

Liquidator should preannounce trading intention if:

- credibly signal that trade is liquidity motivated.
- the trade size is large.

Outcomes:

- Increase market size by attracting natural counterparties and liquidity providers.
  - Competition among predators is beneficial.
- Lower the adverse selection component of trading costs.
- Liquidator achieves a more favorable price.

Our Contributions

Predatory or sunshine trading?

- Simple Model - How 'Market Resiliency' determines the strategic trader's optimal response.

Market quality on Roll and non-Roll days

- More Depth in limit order book + Tighter Spreads.

Estimate the Resiliency of Crude Oil Futures Market.

- Price impact is fully reversed in 15 minutes.

Examine Strategic Trading surrounding Roll days

- Behavior consistent with Sunshine Trading

What explains ETF underperformance?

- Roll Cost + Cost-of-Carry

Data and sample

- **CFTC dataset:** All NYMEX crude oil futures trade, including floor and block trades, and Globex trades.
  - For each trade: trade type, price, volume, account number for buyer and seller
    - Number of active accounts during periods of interest.
    - Track inventory changes by accounts.
- **CME's dataset:** 5-level deep limit order book, bid-ask quotes, and CME Globex trades.
- **Commodity Research Bureau (CRB)** daily record of settlement prices, volume and open interest for each contract over January 1990 through November 2011.

Data and sample

WTI Crude Oil Futures contracts traded on NYMEX

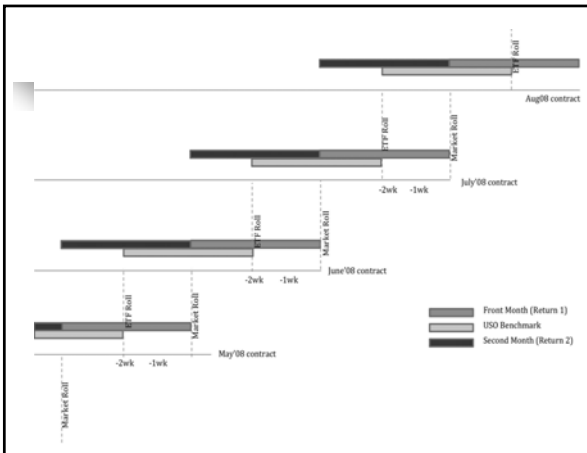
Daily settlement price: VWAP of trades between 2:28 PM and 2:30 PM ET.

Sample period: March 1, 2008 to February 28, 2009.

- 12 monthly roll dates.

Aggregate trading activity of **Eight ETFs** on Roll days.

- ETF Roll dates are public.
- Each month, define 'Roll date' as the single date with more than 90% of ETF monthly trading activity.
- Aggregate assets under management for sample ETFs increased from $0.63 billion in March 2008 to $4.66 billion in February 2009.



Activity is higher on Roll days (table 3)

Each measure is calculated for each minute of trading day.

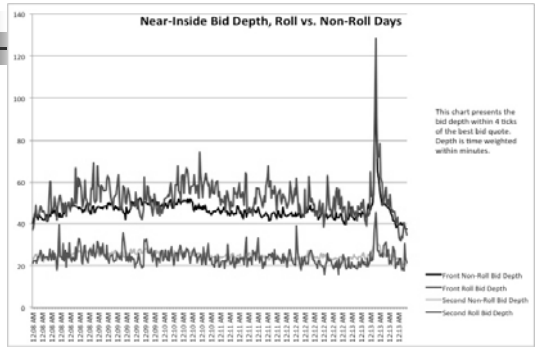
Compare market quality on Roll and non-Roll day for same minute. Report test of medians.

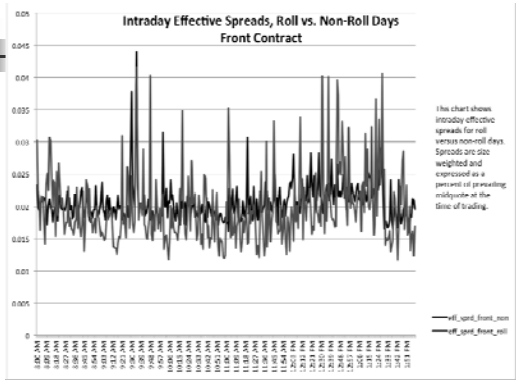
Trade imbalance = buyer- less seller-initiated volume (standardized)

Market Quality	Roll		Non-Roll			Wilcoxon signed rank	
	Mean	Median	Mean	Median	Difference:	T-Stat	P-value
Trading Volume per Minute (contracts)							
- Front contract	855.4	716.4	648.0	580.7	207.4	12.4	(0.000)
- Second contract	402.3	283.9	273.7	239.8	128.7	8.4	(0.000)
Standardized Trade Imbalance							
- Front contract	-0.02	-0.02	0.01	0.01	-0.03	-1.82	(0.034)
- Second contract	0.00	0.01	0.00	0.00	0.01	0.31	(0.378)

More liquidity on Roll Day (table 3)

Market Quality	Roll		Non-Roll			Wilcoxon signed rank	
	Mean	Median	Mean	Median	Difference:	T-Stat	P-value
Quoted Spreads (in basis points)							
- Front contract	1.13	1.12	1.17	1.16	-0.04	-5.6	(0.000)
- Second contract	1.42	1.39	1.45	1.42	-0.03	-3.1	(0.001)
Near-inside Bid Depth (contracts)							
- Front contract	51.9	51.0	46.4	46.0	5.5	13.17	(0.000)
- Second contract	23.9	23.3	24.8	24.6	-1.0	-6.37	(0.000)
Near-inside Ask Depth (contracts)							
- Front contract	49.2	48.2	44.0	43.9	5.2	14.60	(0.000)
- Second contract	20.5	19.9	21.8	21.6	-1.3	-7.96	(0.000)
Liquidity Supplying Accounts (Number)							
- Front contract	874		681		193	2.23	(0.001)
- Second contract	167		153		14	0.39	(0.500)
Effective Spread (in basis points)							
- Front contract	1.96	1.83	2.06	2.01	-0.10	-5.64	(0.000)
- Second contract	2.29	2.06	2.39	2.32	-0.10	-4.60	(0.000)





A simple model of strategic trading

Three intervals: PRE, DURING, and AFTER.

- Each interval has N trading periods.

Liquidator: Quantity Q_L. Trade in DURING interval.

Monopolist **Strategic trader (ST)** chooses quantities to maximize profits (trade with or against in DURING interval)

- Trades sum to zero across three intervals.

Non-strategic traders (Non-ST) (natural counterparties), represented by the limit order book, absorb the liquidation.

Simplifying assumption: Liquidator and strategic traders (a) use market orders, and (b) trade at an even rate across N periods during any interval that they trade.

Model set-up follows Chap. 15 of Hasbrouck (2007).

Value (beg of period 't'): $V_{t-1} = V_0 + \lambda Q_{t-1}$ where $Q_t = \sum_{i=1}^{t} q_i$

Midpoint (beg of period 't'): $M_t = V_0 + \lambda Q_{t-1} + \gamma \theta A_{t-1}$ where $A_t = \sum_{j=0}^{t-1} \theta^j q_{t-j}$

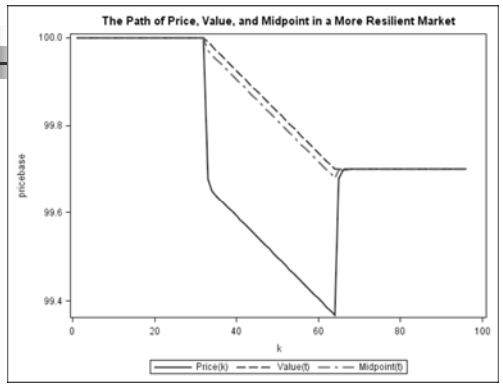
Traded price: $P_t = M_t + (\lambda+\gamma)\, q_t$

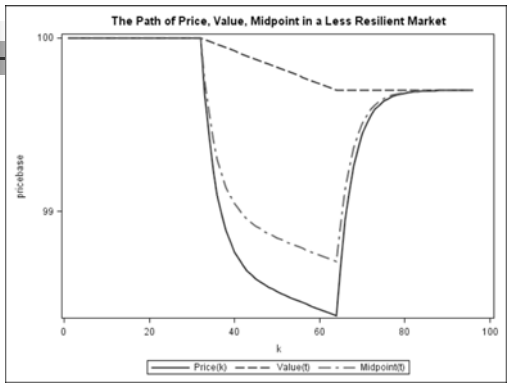
Resiliency parameter

If $\theta = 0$, fully resilient. The book refills instantaneously.

If $0<\theta<1$, the book takes time to refill, and the temporary impact extends into future periods.

If $\theta = 1$, the temporary impact is never reversed, and thus is indistinguishable from permanent impact.





Model: Order flow and proceeds

PRE order flow: $Q_p = -\rho_p Q_L$

DURING order flow: $Q_d = -(1+\rho_d) Q_L$

AFTER order flow: $Q_a = Q_L(\rho_d + \rho_p)$

where positive values of ρ_p and ρ_d indicate strategic trading in the direction of liquidator.

Performance measures:

1. Maximize Liquidator's Proceeds: $LP = Q_L \overline{P}_d$.
2. Non-ST's Acquisition Costs: $AC = Q_L \rho_p \overline{P}_p + Q_L(1-\rho_d)\overline{P}_d - Q_L(\rho_p + \rho_d)\overline{P}_a$
3. ST's profits: $SP = Q_L\left[\rho_p(\overline{P}_p - \overline{P}_a) + \rho_d(\overline{P}_d - \overline{P}_a)\right]$

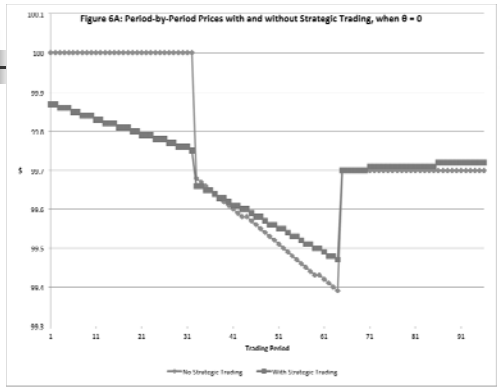
   $SP = Q_L^2\left[\rho_p^2(I_2 - 2I_0) + \rho_d^2(I_1 - 2I_0) + \rho_p\rho_d(I_2 - 2I_0) + I_1\rho_p + (I_1 - I_0)\rho_d\right]$

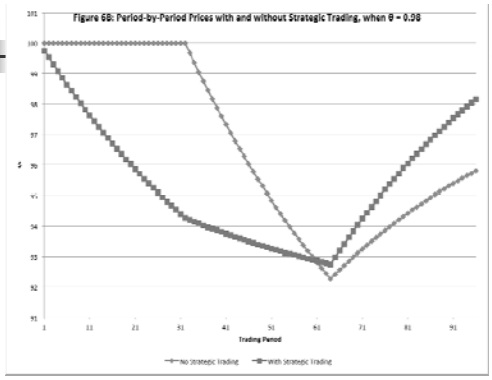
   solve for ρ_p^* and ρ_d^*
4. Extent to which price is distorted and subsequently reversed.

V_0=100; Q_L=20 units; N=32

Table 4: Numerical Outcomes from Closed Form Solutions -- Strategic Trading Around a Known 20 Unit Liquidation, Lambda = .015, Gamma = 0.5

	Base	Optimal Unconstrained Strategic Trading					
Theta	LP = AC	Pre	During	After	SP	LP	AC
0.00	1990.7	0.40	-0.33	-0.07	1.8	1991.4	1993.1
0.10	1990.0	0.38	-0.33	-0.05	1.8	1991.0	1992.8
0.20	1989.2	0.36	-0.33	-0.03	1.9	1990.6	1992.5
0.30	1988.1	0.34	-0.33	-0.01	2.0	1990.0	1992.0
0.40	1986.7	0.32	-0.34	0.02	2.2	1989.2	1991.3
0.50	1984.8	0.30	-0.34	0.04	2.4	1988.0	1990.4
0.60	1982.0	0.28	-0.34	0.06	2.8	1986.2	1989.0
0.70	1977.6	0.27	-0.34	0.07	3.5	1983.2	1986.7
0.80	1969.6	0.26	-0.34	0.08	4.8	1977.4	1982.2
0.90	1951.4	0.30	-0.36	0.06	8.1	1962.0	1970.1
0.92	1944.9	0.33	-0.37	0.04	9.6	1955.1	1964.7
0.94	1936.7	0.38	-0.38	0.00	12.1	1944.2	1956.3
0.96	1926.1	0.48	-0.41	-0.07	17.5	1923.8	1941.3
0.98	1912.2	0.74	-0.46	-0.28	36.2	1868.3	1904.4
1.00	1893.8	16.17	-0.33	-15.83	1648.5	-1401.1	247.4





Resiliency of NYMEX Crude Oil Market

Separate parameters on Roll vs. non-Roll days.

Front versus Second month contract.

Models based on (a) 5-second interval with 60-lags and (b) 1-second interval with 75 lags.

- Results robust to 10-second and 30-second intervals.

$$P_t - M_t = \alpha + \gamma \sum_{j=t-k}^{t} \theta^{t-j} q_j + \lambda \sum_{j=t-k}^{t} q_j^* + \varepsilon_t$$

Permanent impact based on order-flow surprise (Madhavan et al (1997), Huang and Stoll (1997), Sadka (2006)).

Implemented using NYMEX order data.

Resiliency estimates (table 5)

	Number of observations	alpha (α)	Lambda (λ)	Gamma (γ)	Theta (θ)	R^2
Panel B: Time interval = 1 second; Lags = 75						
Front Contract: Full sample	5,261,609	25.84	0.051	0.038	0.976	53.64%
Non-Roll Days	4,047,759	19.180	0.052	0.036	0.975	53.28%
Roll	237,349	53.110	0.050	0.063	0.990	64.35%
Difference		33.930 ***	-0.002 ***	0.027	0.015 *	
p-value		(0.00)	(0.00)	(0.12)	(0.07)	
Second Contract: Full sample	5,184,068	-7.410	0.076	0.070	0.994	16.46%
Non-Roll Days	3,987,888	-8.792	0.075	0.060	0.993	17.44%
Roll	213,335	36.440	0.143	0.182	0.996	9.48%
Difference		45.232 ***	0.069 ***	0.122	0.004	
		(0.00)	(0.00)	(0.18)	(0.77)	

Discussion of resiliency results

Front month is more liquid than second month.

Evidence of Market Stress on Roll days:

- Temporary impact is larger and Market is less resilient.

Permanent price impact is positive on Roll days:

- Other informed traders may prefer to trade during the Roll.
- Roll day impact is smaller for front month.

Reconciling estimates of θ

5-second model yields front month θ= 0.959

- Proportion of TI that persists after 1 min: $0.959^{12} = 0.605$.
- After 5 min = 0.081; After 15 min = 0.0005.
- Crude Oil Futures market is resilient.

Numerical illustrations: 32 intervals per period ≈ 15 min / trading day. All θestimates yield resiliency < 0.3 at a 15 minute interval.

Strategic traders around the Roll (table 6)

Based on CFTC trader account-level data

Three intervals: BEFORE [Day -3, Roll Day (9 AM)]; AFTER [Roll Day (5 p.m.), Day +3]; DURING is rest.

Identify strategic trader accounts:

$[|\text{Net inventory change}|/\text{Total Activity}]_{ROLL} < 25\%$

Classify each account into one of twelve trading strategies

- Liquidity provision: ST1-ST5; Predatory: ST8 – ST12.

Strategic volume: The account's round trip volume around the roll. Aggregate strategic volume for each strategy.

Normalized strategic volume: [strategy volume – complementary volume] on Roll and non-Roll windows.

Strategy	Trading Pattern (relative to ETF)			Front month			Second month			Complement strategy
	Before	During	After	Before	During	After	Before	During	After	
ETF*				none	sell	none	none	buy	none	
ST 1	against	against	with	buy	buy	sell	sell	sell	buy	ST 12
ST 2	none	against	with	none	buy	sell	none	sell	buy	ST 11
ST 3	with	against	against	sell	buy	buy	buy	sell	sell	ST 10
ST 4	with	against	none	sell	buy	none	buy	sell	none	ST 9
ST 5	with	against	with	sell	buy	sell	buy	sell	buy	ST 8
ST 6	against	none	with	buy	none	sell	sell	none	buy	ST 7
ST 7	with	none	against	sell	none	buy	buy	none	sell	ST 6
ST 8	against	with	against	buy	sell	buy	sell	buy	sell	ST 5
ST 9	against	with	none	buy	sell	none	sell	buy	none	ST 4
ST 10	against	with	with	buy	sell	sell	sell	buy	buy	ST 3
ST 11	none	with	against	none	sell	buy	none	buy	sell	ST 2
ST 12	with	with	against	sell	sell	buy	buy	buy	sell	ST 1

Table 6, Panel B.

Panel B: Normalized Strategic Volume Regressions	(1)	(2)	(3)	(4)	(5)	(6)
Front Month Contract						
Intercept	-306	-52	-851	368	3	-244
t(Intercept)	-0.86	-0.76	-2.14	4.07	0.01	-1.48
Roll_day	-2122	166	2805	254	-222	-1154
t(PAT_day)	-1.91	0.78	2.26	0.90	-0.26	-2.25
FEB6	-777	402	4479	-418	2766	4165
t(FEB6)	-0.21	0.57	1.10	-0.45	0.98	2.47
Second Month Contract						
Intercept	-89	28	-396	-79	102	-83
t(Intercept)	-0.42	0.44	-1.52	-0.87	0.59	-0.59
PAT_day	-1560	-43	2111	-49	-78	50
t(PAT_day)	-2.37	-0.22	2.59	-0.17	-0.14	0.11
FEB6	1277	2678	-1005	1402	957	76
t(FEB6)	0.59	4.11	-0.38	1.51	0.54	0.05

Trade types (table 2)

	Front Month			
Trade Type	ETF Trading Activity	% of ETF	Market Trading Activity	% of Market
Option on Future			112,690	0.2%
Option Spread Ratio			225,767	0.3%
Option Spread Conversion			152,450	0.2%
Exchange For Physical			171,631	0.2%
Crack Spread			2,045,089	2.9%
Crack Cross			108,081	0.2%
Trade-at-settlement	15,870	7.2%	3,485,249	4.9%
Cabinet	14,966	6.8%	352,729	0.5%
Block Trade	56,670	25.7%	906,990	1.3%
Block TAS Trades	130,951	59.5%	401,856	0.6%
Regular Outright	219	0.1%	45,032,772	63.7%
Intra-Commodity Spread	1,239	0.6%	14,987,761	21.2%
Regular Outright Cross			1,821,314	2.6%
Intra-Commodity Spread Cross			643,962	0.9%
Other	314	0.1%	255,111	0.4%
Total	220,229	100%	70,703,452	100%

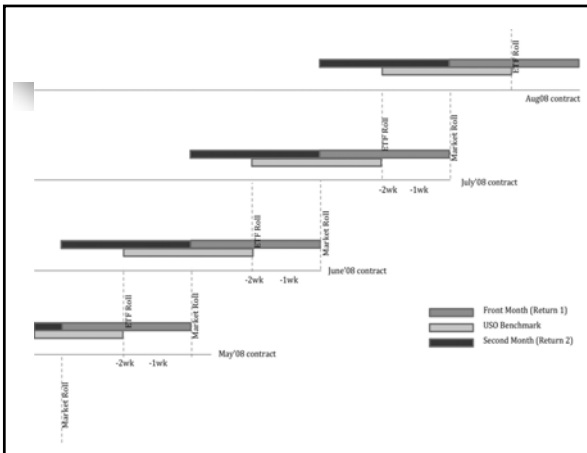
Imputed cost of ETF Roll (table 7)

Did the ETF Roll affect settlement price on Roll day?

Proportional Roll cost = Cost of [sell front + buy second]

$= \ln(F_{2T}/F_{1T}) - \ln(F_{2B}/F_{1B}) = S_T - S_B$

Benchmark is	Mean Cost	Std. Error	t-stat	P-value
1 Day Prior	0.0980	0.0696	1.41	0.1639
2 Days Prior	0.1559	0.0857	1.82	0.0736
3 Days Prior	0.1754	0.1150	1.53	0.1320
4 Days Prior	0.1602	0.1046	1.53	0.1306
5 Days Prior	0.2107	0.0981	2.15	0.0355
6 Days Prior	0.2340	0.1012	2.31	0.0239
7 Days Prior	0.2861	0.1107	2.58	0.0120
8 Days Prior	0.2743	0.1383	1.98	0.0515
9 Days Prior	0.3190	0.1651	1.93	0.0578
10 Days Prior	0.2075	0.2724	0.76	0.4490



Why does USO underperform crude oil?

Spot investors incur the interest cost of carrying inventory, storage and insurance costs and earn convenience yield.

Cost of carry $S_t = \frac{\ln(F_t(m)/F_t(n))}{(m-n)}$

Spot Risk Premium = Spot Price/Expected Spot Price(S_t)

$$U_{t+1} = \ln\left[\frac{P_{t+1}}{P_t e^{S_t}}\right]$$

Daily Spot return: $\ln\left[\frac{P_{t+1}}{P_t}\right] = U_t + S_t$

Daily Futures return: $\ln\left[\frac{F_{t+1}(m-1)}{F_t(m)}\right] = \ln\left[\frac{P_{t+1}e^{S_{t+1}(m-1)}}{P_t e^{S(m)}}\right]$ → $\ln\left[\frac{F_{t+1}(m-1)}{F_t(m)}\right] = U_t + (m-1)\Delta S$

- Spot outperform futures in contango markets.
- Futures return does not depend on S_t but on ΔS.

Table 8: CRB dataset

Table 8: Average Implied Spot and Futures Returns

	4/10/06 to 10/20/11		1/1/00 to 4/9/06		1/1/90 to 12/31/99		1/1/90 to 10/20/11	
	Days	1393	Days	1564	Days	2510	Days	5467
Variable	Mean (x250)	T-stat	Mean (x250)	T-stat	Mean (x250)	T-stat	Mean (x250)	T-stat
Appreciation in Implied Spot Price (S(t)+U(t))	3.98%		15.45%		1.14%		5.95%	
Cost of Storage (term slope S(t))	16.20%	21.73	-7.57%	-11.97	-3.55%	-6.27	0.33%	0.85
Expost Spot Premium (U(t))	-12.22%	-0.68	23.02%	1.49	4.69%	0.37	5.62%	0.65
Futures Return 1	-8.94%	-0.51	26.02%	1.79	2.41%	0.21	6.27%	0.77
Futures Return 2 U(t)+[(M-1)*ΔS)	-9.71%	-0.60	25.37%	1.86	5.24%	0.52	7.19%	0.98
Futures Benchmark Return	-14.11%	-0.85	20.80%	1.46	4.84%	0.45	4.58%	0.60
Benchmark less Return 1	-5.17%	-1.19	-5.22%	-2.17	2.43%	0.90	-1.69%	-0.94
Benchmark less Return 2	-4.40%	-2.65	-4.57%	-2.82	-0.40%	-0.15	-2.61%	-1.92
USO ETF Return	-12.79%	-0.80						

Conclusion

We study trading strategies, liquidity and price patterns surrounding rolls by eight ETFs designed to track crude oil.

- Net roll activity by ETFs is economically significant.
- Evidence based on limit order book depth, spread measures and number of liquidity providing accounts increased competition from liquidity providers on Roll days.
- We find evidence that oil futures markets are indeed resilient.
- For the range of resiliency parameters that we estimate, our model predicts that sunshine trading will dominate.
- Our analysis of trader-accounts based on CFTC data support a strategy where traders provide liquidity on Roll day and shift selling pressure to the preceding day.
- Overall, we find evidence in support of Sunshine Trading and little evidence that ETFs are hurt by preannouncing the roll.