Excess Speculation and Position Limits: an analysis of the Volume-Volatility relations in Energy Futures Markets

joint with Matteo Manera and Ilaria Vignati

Fondazione Eni Enrico Mattei

21/07/2011

Introduction

- An excess of speculation, taking for granted that it exists (?), has two main effects:
    1. Energy prices away from fundamentals
    2. **Excessive Volatility**

- **Aims**

1. Analysis of the correlation between trading activity and volatility measures for crude oil, natural gas, heating oil and unleaded gasoline (daily futures prices, 1986-2010):
    i. Does excess speculation increase volatility?
    ii. Do measures of liquidity/depth help forecasting volatility?
    iii. Does excess speculation reduce market depth (i.e. volume needed to move prices by 1%)?

2. Position limits:
    i. What are them?
    ii. Are they useful?

What is excess speculation?

- Excess speculation: "*speculation which exceeds the need for liquidity by commercial handlers hedging price risk in derivatives markets*" (M. Greenbergerer, a former CFTC commissioner).

… an empirically useless definition: what is the threshold above which speculation becomes detrimental (e.g. below that threshold speculators provide liquidity)?

- How can we "measure" speculation?

1. "Realized data": use realized measures of trading activity such as open interest and volume (e.g. CFTC CoT data).
2. "Reverse engineering": define (an exhaustive set of) fundamentals and measure speculation as residuals (e.g. price dynamics we cannot explain with fundamentals)

Some Simple Economics of Volume, Volatility & News

- Traders buy and sell assets according to the information they have

- Prices, volatility and trading activity measures depend on the news that arrive into the market:

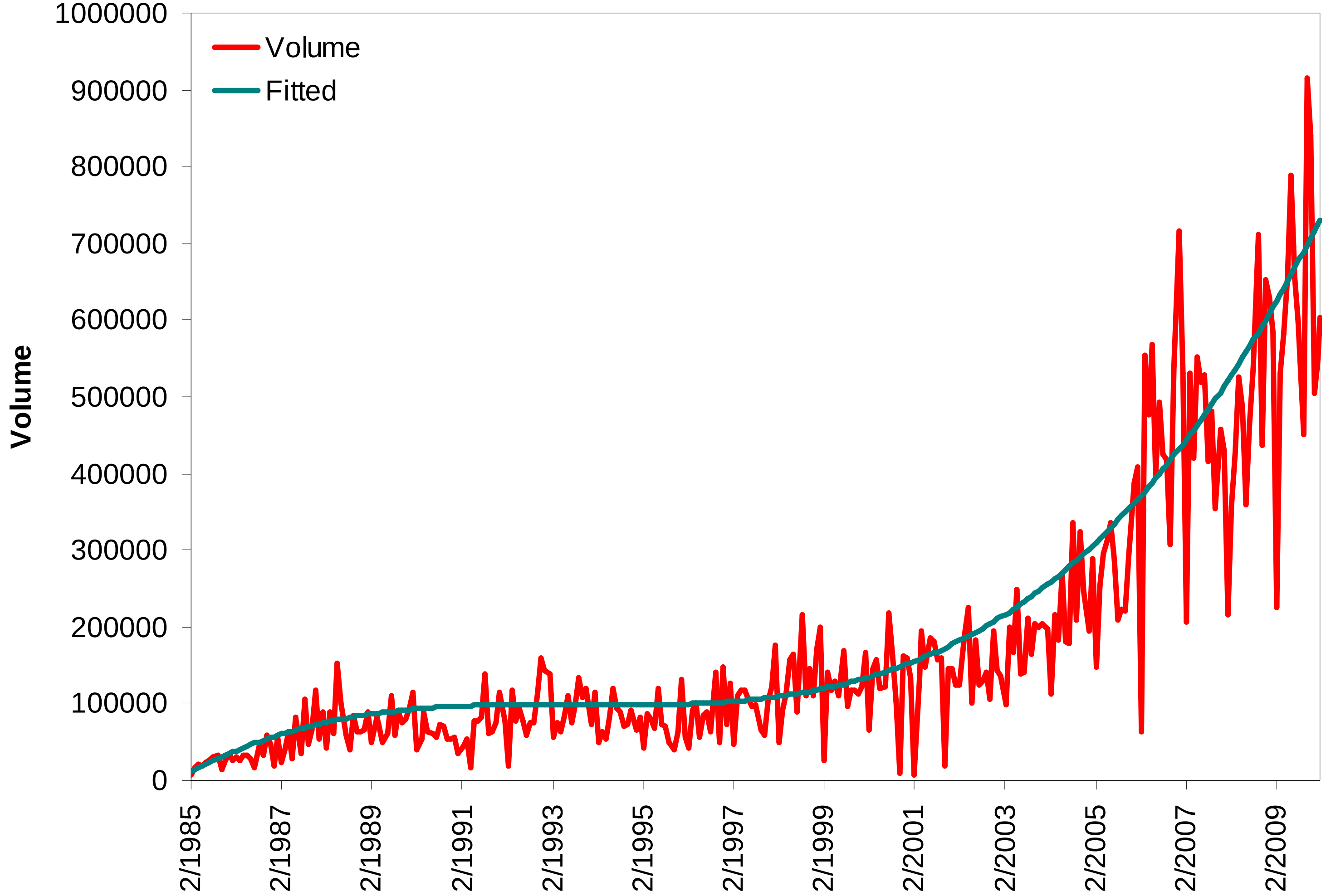
  - Good news: prices move upward

  - Bad news: prices move downward

above-average trading activity in the market as it adjusts to a new equilibrium

⇒ **Mixture of Distribution Hypothesis**: Volume & Volatility positively correlated because they depend on the same latent (mixing) variable, namely the information that flow into the market.

What's going on?
Volume: Oil Futures (1985-2010)

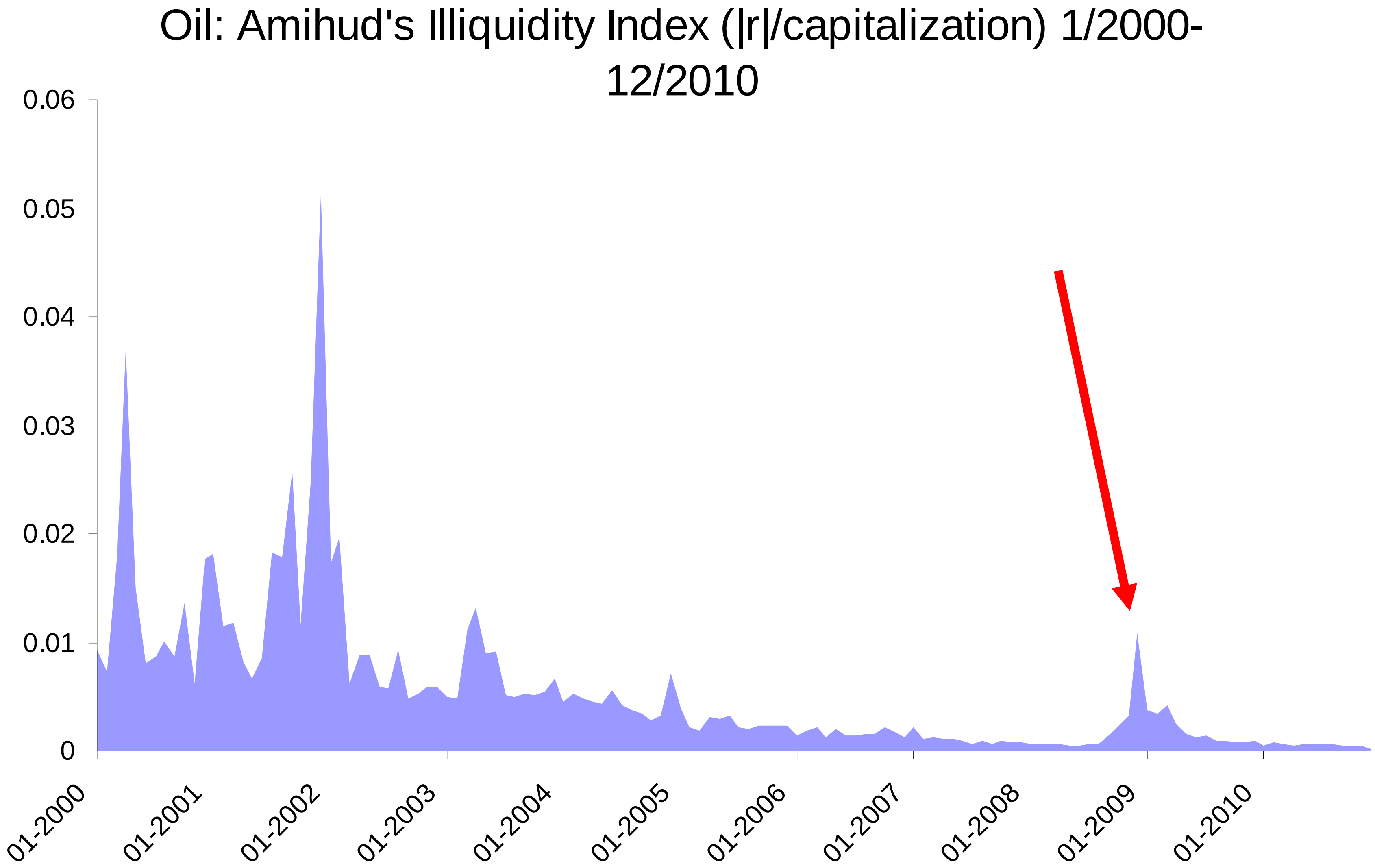


Oil market is getting more liquid…

Eni Enrico Mattei

What's going on?

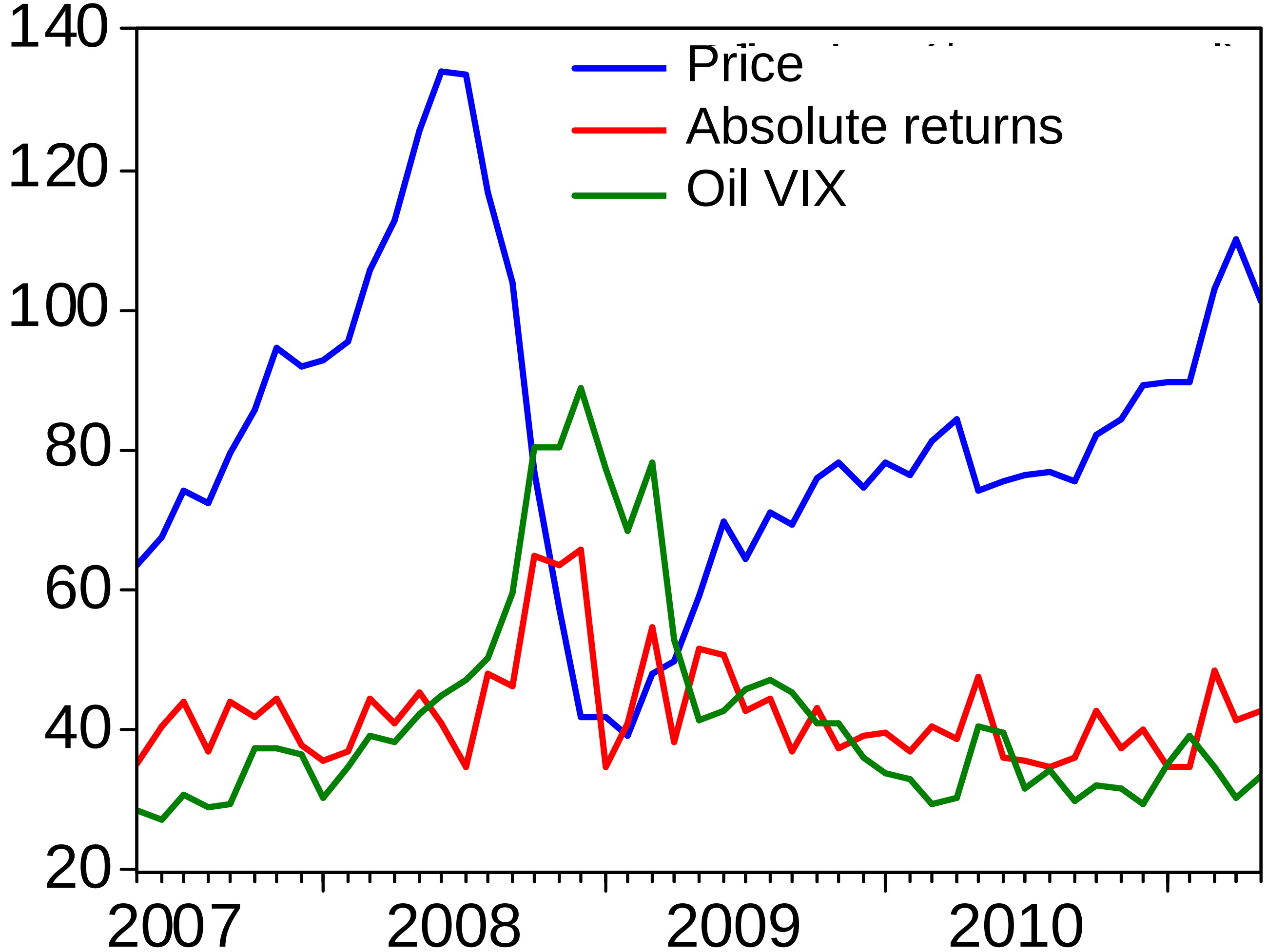
Illiquidity: Oil Futures (1/2000-12/2010)



Oil market is getting more liquid…

What's going on?

Oil Price & Volatility (2007/5-2011/5)

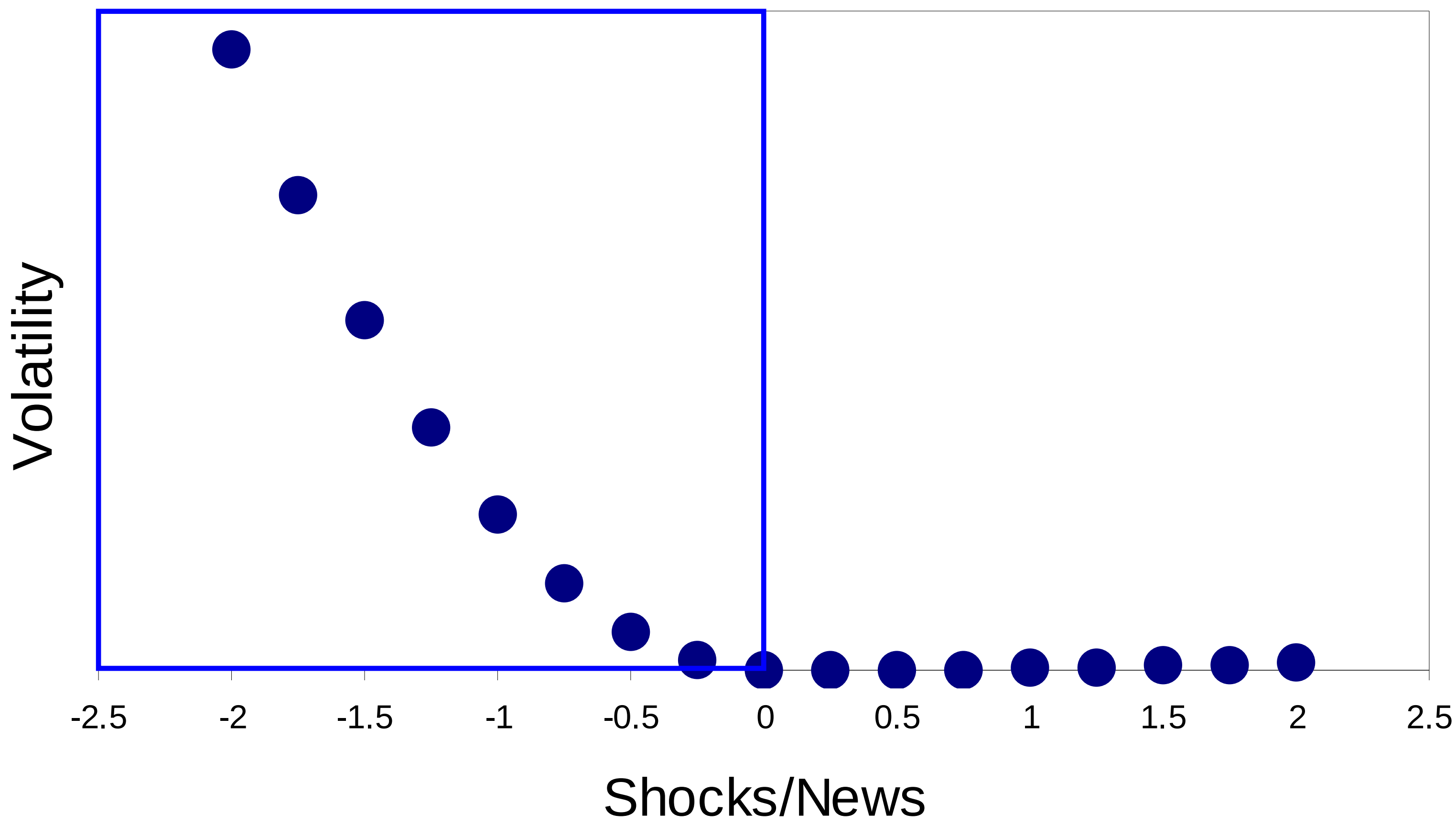


Contrary to popular wisdom prices and volume are increasing, but volatility is currently is decreasing…

What's going on?

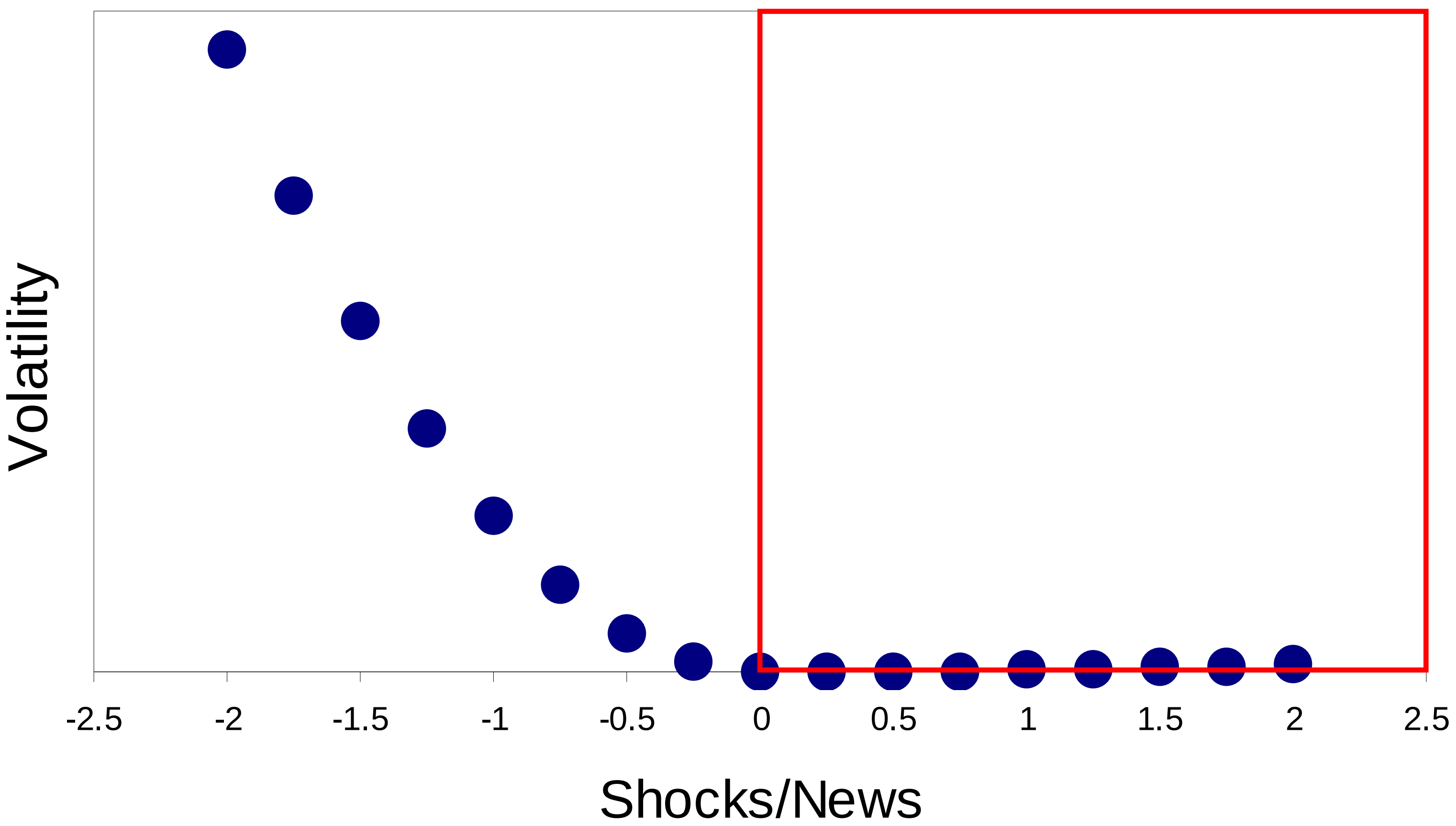
Good news is no news

News Impact Curve



Bad News: unexpected price decreases are positively correlated with volatility

News Impact Curve



Good news: unexpected price increases do not seem to be correlated with volatility

Measuring volatility and trading activity

Volatility

- Absolute returns
- Squared Range i.e. (rg = log(p^{max})-log(p^{min}))
  - High-Low Range
  - Open-Close-High-Low Range (overnight effects)

Trading activity

1. **Daily trading volume** (VOL) = number of contracts traded during a day (i.e. more trades, more speculation (?))

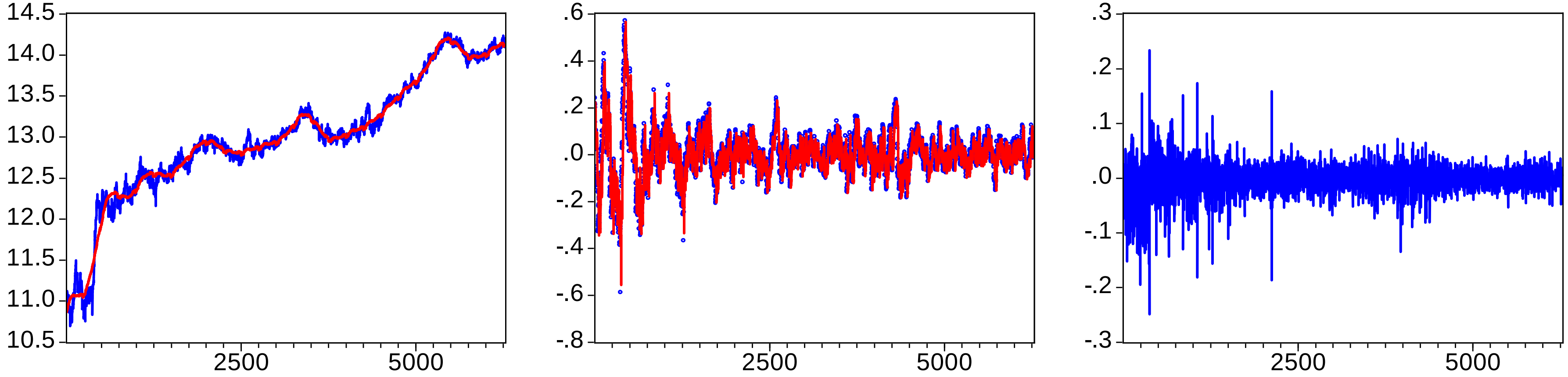
2. Scalping Index = Volume/Open Interest (OI):

- OI = no. of outstanding contracts (i.e. open or yet to be settled)
- OI ≈ hedging activities; agents whose investment horizon is longer than a day;
- VOL ≈ speculation; agents who close out their positions within the day;

⇒ VOL/OI ≈ relative importance of hedgers and speculators

Decomposing trading activity variables

Crude Oil : OI = T + E + U



(1) (2) (3)

(1) Raw series = Trend + Expected + Shocks

(2) De-trended series = Raw – Trend = Expected + Shocks

(3) Shocks = De-trended - Expected

Fondazione Eni Enrico Mattei

Time horizon and Empirical Strategy

The empirical strategy depends on how quickly we think that prices adjust to new information

(a) **Short Memory Approach**: impact of news is transitory, prices move quickly to the new equilibrium.

⇒ Correlation e Granger Causality.

(b) **Long Memory Approach**: impact of news is not transitory, it takes time before prices move to the new equilibrium

⇒ Empirical tests based on methods for long-memory time series (i.e. fractionally integration)

H_0: volume and volatility have the same degree of fractional integration

i.e. volume and volatility depend on a latent process with long memory (i.e. news)

A look at the long memory approach

	Crude Oil					Heating Oil				
		H_0: d=0	H_0: d=1				H_0: d=0	H_0: d=1		
	d	H_1: d>0	H_1: d<1	H_0: $d_{\|r\|} = d_j$	H_0: $d_{\|rg\|} = d_j$	d	H_1: d>0	H_1: d<1	H_0: $d_{\|r\|} = d_j$	H_0: $d_{\|rg\|} = d_j$
Abs. Ret.	0.26	12.83	-36.64	-	-	0.24	12.09	-37.78	-	-
Range	0.26	13.25	-38.19	-	-	0.28	13.68	-35.88	-	-
Volume	0.18	8.49	-37.73	6.89	**6.44**	0.09	4.17	-41.27	26.87	38.57
E Volume	0.43	18.16	-23.87	31.30	30.80	0.31	13.53	-30.38	**4.89**	**1.12**
U Volume	-0.06	**-3.02**	-51.34	131.00	127.65	-0.09	**-4.05**	-50.41	131.58	153.56
OI	0.78	32.75	-9.04	291.48	296.58	0.77	31.69	-9.52	269.00	228.40
E OI	0.79	32.50	-8.61	297.05	296.88	0.75	30.16	-10.27	240.87	202.07
U OI	-0.03	**-1.43**	-48.16	103.23	106.05	-0.11	**-5.38**	-52.55	146.91	168.05
Volume/OI	0.12	5.10	-38.76	22.93	21.96	0.11	5.07	-39.09	18.91	28.85
E (Volume/OI)	0.37	14.81	-25.23	12.10	12.02	0.34	15.02	-28.78	11.59	**4.91**
U (Volume/OI)	-0.13	-5.61	-50.13	168.79	164.88	-0.07	**-3.07**	-47.59	112.75	132.65
	Unleaded Gasoline					**Natural Gas**				
		H_0: d=0	H_0: d=1				H_0: d=0	H_0: d=1		
	d	H_1: d>0	H_1: d<1	H_0: $d_{\|r\|} = d_j$	H_0: $d_{\|rg\|} = d_j$	d	H_1: d>0	H_1: d<1	H_0: $d_{\|r\|} = d_j$	H_0: $d_{\|rg\|} = d_j$
Abs. Ret.	0.20	9.46	-37.65	-	-	0.20	9.51	-37.33	-	-
Range	0.27	13.34	-35.93	-	-	0.28	13.31	-34.93	-	-
Volume	0.24	11.15	-36.13	**1.50**	**1.48**	0.23	10.02	-34.01	**0.70**	**2.55**
E Volume	0.52	22.02	-20.46	107.21	63.18	0.38	16.22	-26.45	35.22	11.58
U Volume	-0.04	**-2.05**	-50.78	74.43	124.47	-0.02	**-0.80**	-46.47	57.27	96.46
OI	0.78	32.59	-9.37	327.33	261.02	0.83	32.19	-6.59	361.80	273.14
E OI	0.77	32.15	-9.85	317.08	250.69	0.81	31.48	-7.19	341.55	257.15
U OI	-0.07	**-3.12**	-49.24	79.48	135.51	-0.02	**-0.75**	-43.83	49.30	86.01
Volume/OI	0.15	6.64	-38.97	**3.51**	18.13	0.20	8.50	-34.85	**0.05**	6.82
E (Volume/OI)	0.40	16.90	-25.46	41.60	16.79	0.27	11.95	-32.12	**5.33**	**0.02**
U (Volume/OI)	-0.07	**-3.49**	-50.53	90.79	144.74	-0.01	**-0.33**	-45.35	52.60	89.69

The short memory approach

- The long memory approach suggests that both trading activity and volatility depend on a long-memory latent process (i.e. news).

- Short Memory Approaches
  - Note: now we consider trading activity measures as proxies for the mixing variable (i.e. news)

  1. Estimate a bivariate VAR and test for Granger causality between trading activity and volatility measures.
  2. Estimate a univariate Multiplicative Error Model for different volatility proxies augmented with (lagged) trading activity measures.

Granger Causality

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
	VO → RA	VO → RGRS	VO → RGP	RA → VO	RGRS → VO	RGP → VO
Gasoline	21.469 (0.001)	19.253 (0.083)	21.710 (0.017)	22.380 (0.000)	36.156 (0.000)	36.558 (0.000)
Heating Oil	10.981 (0.089)	11.371 (0.044)	45.847 (0.000)	29.751 (0.000)	2.804 (0.730)	7.831 (0.251)
Natural Gas	16.421 (0.006)	20.155 (0.001)	27.235 (0.000)	35.951 (0.000)	6.802 (0.236)	34.416 (0.000)
Crude Oil	28.716 (0.000)	47.332 (0.000)	51.035 (0.000)	28.304 (0.000)	9.165 (0.241)	21.332 (0.019)
	H_0: VOI does not Granger cause volatility			H_0: volatility does not Granger cause VOI		
	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI
Gasoline	17.229 (0.004)	23.454 (0.024)	31.847 (0.000)	11.564 (0.041)	29.072 (0.004)	25.668 (0.004)
Heating Oil	12.091 (0.060)	10.263 (0.068)	45.391 (0.000)	30.506 (0.000)	1.411 (0.923)	4.707 (0.582)
Natural Gas	15.866 (0.007)	16.878 (0.005)	28.113 (0.000)	30.574 (0.000)	5.834 (0.323)	28.621 (0.000)
Crude Oil	24.971 (0.002)	44.236 (0.000)	45.755 (0.000)	23.927 (0.002)	5.784 (0.565)	16.677 (0.082)

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
	VO → RA	VO → RGRS	VO → RGP	RA → VO	RGRS → VO	RGP → VO
Gasoline	21.469 (0.001)	19.253 (0.083)	21.710 (0.017)	22.380 (0.000)	36.156 (0.000)	36.558 (0.000)

Feeback: volume GC volatility and vice versa

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
Natural Gas	16.4[illegible] (0[illegible]5)	20.155 (0.001)	27.235 (0.000)	[illegible].951 ([illegible]00)	6.802 (0.236)	34.416 (0.000)
Crude Oil	**28.716 (0.000)**	47.332 (0.000)	51.035 (0.000)	**28.304 (0.000)**	9.165 (0.241)	21.332 (0.019)

	H_0: VOI does not Granger cause volatility			H_0: volatility does not Granger cause VOI		
	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI
Gasoline	17.229 (0.004)	23.454 (0.024)	31.847 (0.000)	11.564 (0.041)	29.072 (0.004)	25.668 (0.004)
Heating Oil	12.091 (0.060)	10.263 (0.068)	45.391 (0.000)	30.506 (0.000)	1.411 (0.923)	4.707 (0.582)
Natural Gas	15.866 (0.007)	16.878 (0.005)	28.113 (0.000)	30.574 (0.000)	5.834 (0.323)	28.621 (0.000)
Crude Oil	**24.971 (0.002)**	44.236 (0.000)	45.755 (0.000)	**23.927 (0.002)**	5.784 (0.565)	16.677 (0.082)

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
	VO → RA	VO → RGRS	VO → RGP	RA → VO	RGRS → VO	RGP → VO
Gasoline	21.469 (0.001)	19.253 (0.083)	21.710 (0.017)	22.380 (0.000)	36.156 (0.000)	36.558 (0.000)
Heating Oil	10.981 (0.089)	11.371 (0.044)	45.847 (0.000)	29.751 (0.000)	2.804 (0.730)	7.831 (0.251)
Natural Gas	16.421 (0.006)	20.155 (0.001)	27.235 (0.000)	35.951 (0.000)	6.802 (0.236)	34.416 (0.000)
Crude Oil	**28.716 (0.000)**	47.332 (0.000)	51.035 (0.000)	**28.304 (0.000)**	9.165 (0.241)	21.332 (0.019)
	H_0: VOI does not Granger cause volatility			H_0: volatility does not Granger cause VOI		
	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI

Feedback: result robust to the trading activity measure we use

	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI
Natural Gas	15.866 (0.00[illegible])	16.878 (0.005)	28.113 (0.000)	[illegible]574 (0[illegible]0)	5.834 (0.323)	28.621 (0.000)
Crude Oil	**24.971 (0.002)**	44.236 (0.000)	45.755 (0.000)	**23.927 (0.002)**	5.784 (0.565)	16.677 (0.082)

… however when considering more efficient volatility proxies results are supportive of the MDH: VO Granger Causes Range

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
	VO → RA	VO → RGRS	VO → RGP	RA → VO	RGRS → VO	RGP → VO
Natural Gas	16.421 (0.006)	**20.155 (0.00[illegible]**	27.235 (0.000)	35.951 (0.000)	**[illegible].802 ([illegible]236)**	34.416 (0.000)
Crude Oil	28.716 (0.000)	**47.332 (0.000)**	51.035 (0.000)	28.304 (0.000)	**9.165 (0.241)**	21.332 (0.019)
	H_0: VOI does not Granger cause volatility			H_0: volatility does not Granger cause VOI		
	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI
Gasoline	17.229 (0.004)	23.454 (0.024)	31.847 (0.000)	11.564 (0.041)	29.072 (0.004)	25.668 (0.004)
Heating Oil	12.091 (0.060)	**10.263 (0.068)**	**45.391 (0.000)**	30.506 (0.000)	**1.411 (0.923)**	**4.707 (0.582)**
Natural Gas	15.866 (0.007)	**16.878 (0.005)**	28.113 (0.000)	30.574 (0.000)	**5.834 (0.323)**	28.621 (0.000)
Crude Oil	24.971 (0.002)	**44.236 (0.000)**	**45.755 (0.000)**	23.927 (0.002)	**5.784 (0.565)**	**16.677 (0.082)**

Granger Causality

The same results hold for the other commodities

	H_0: VO does not Granger cause volatility			H_0: volatility does not Granger cause VO		
Heating Oil	10.981 (0.089)	**11.371 (0.044)**	**45.847 (0.000)**	29.751 (0.000)	**2.804 (0.730)**	**7.831 (0.251)**
Natural Gas	16.421 (0.006)	**20.155 (0.001)**	27.235 (0.000)	35.951 (0.000)	**6.802 (0.236)**	34.416 (0.000)
Crude Oil	28.716 (0.000)	**47.332 (0.000)**	51.035 (0.000)	28.304 (0.000)	**9.165 (0.241)**	21.332 (0.019)

	H_0: VOI does not Granger cause volatility			H_0: volatility does not Granger cause VOI		
	VOI → RA	VOI → RGRS	VOI → RGP	RA → VOI	RGRS → VOI	RGP → VOI
Gasoline	17.229 (0.004)	23.454 (0.024)	31.847 (0.000)	11.564 (0.041)	29.072 (0.004)	25.668 (0.004)
Heating Oil	12.091 (0.060)	**10.263 (0.068)**	**45.391 (0.000)**	30.506 (0.000)	**1.411 (0.923)**	**4.707 (0.582)**
Natural Gas	15.866 (0.007)	**16.878 (0.005)**	28.113 (0.000)	30.574 (0.000)	**5.834 (0.323)**	28.621 (0.000)
Crude Oil	24.971 (0.002)	**44.236 (0.000)**	**45.755 (0.000)**	23.927 (0.002)	**5.784 (0.565)**	**16.677 (0.082)**

Other results and some conclusion

- Multiplicative Error Models deliver positive and statistically significant coefficients associated to (lagged) trading activity measures, which is supportive of the MDH.

- Some conclusions:
  - Trading activity has increased through time
  - Volatility is counter-cyclical
  - Volatility and trading activity in energy futures markets are positively correlated
  - Volatility is Granger caused by trading activity only if we consider volatility proxies that are more efficient than absolute returns

Fondazione Eni Enrico Mattei

A look at the "market depth"

- **"Market Depth"** (Kyle, 1985 and Bessembinder-Seguin, 1993): flow of money which is necessary to move prices by 1%.

- Estimate a model for returns and volatility augmented with (expected and unexpected) volume and open interest

- The coefficient associated to unexpected volume in the volatility equation provides an estimate of the "**market depth**".

A look at the “market depth”

1985-2010

	"MARKET DEPTH" ESTIMATES
	Capital required to move futures prices by 1% (million $)
GASOLINE	369.377***
HEATING OIL	423.301***
NATURAL GAS	301.832***
CRUDE OIL	297.165***

2004-2006

	"MARKET DEPTH" ESTIMATES
	Capital required to move futures prices by 1% (million $)
GASOLINE	345.178***
HEATING OIL	497.340***
NATURAL GAS	395.352***
CRUDE OIL	347.167***

2007-2010

	"MARKET DEPTH" ESTIMATES
	Capital required to move futures prices by 1% (million $)
GASOLINE	476.844***
HEATING OIL	627.278***
NATURAL GAS	175.709***
CRUDE OIL	332.978***

Fondazione
Eni
Enrico Mattei

Position limits

- **Position Limits (PLs)** are caps on the open interest (i.e. number of contracts) that derivative traders can hold.
- PLs on energy commodities have not been applied yet, but are under discussion since the aftermath of the financial crisis and are required under the Dodd-Frank Wall Street Reform Act (2010).
- **Pros**: PLs should limit market concentration and hence reduce the influence of speculators on prices.
- **Cons**:
  - PLs are ineffective (e.g. exemptions granted to swap dealers would have not limited the impact of “2 big 2 fail” institutions)
  - PLs reduce liquidity
  - PLs can bias the information content of prices

Evaluating Position Limits

- CFTC will set Position Limits as a function of yearly average open interest.

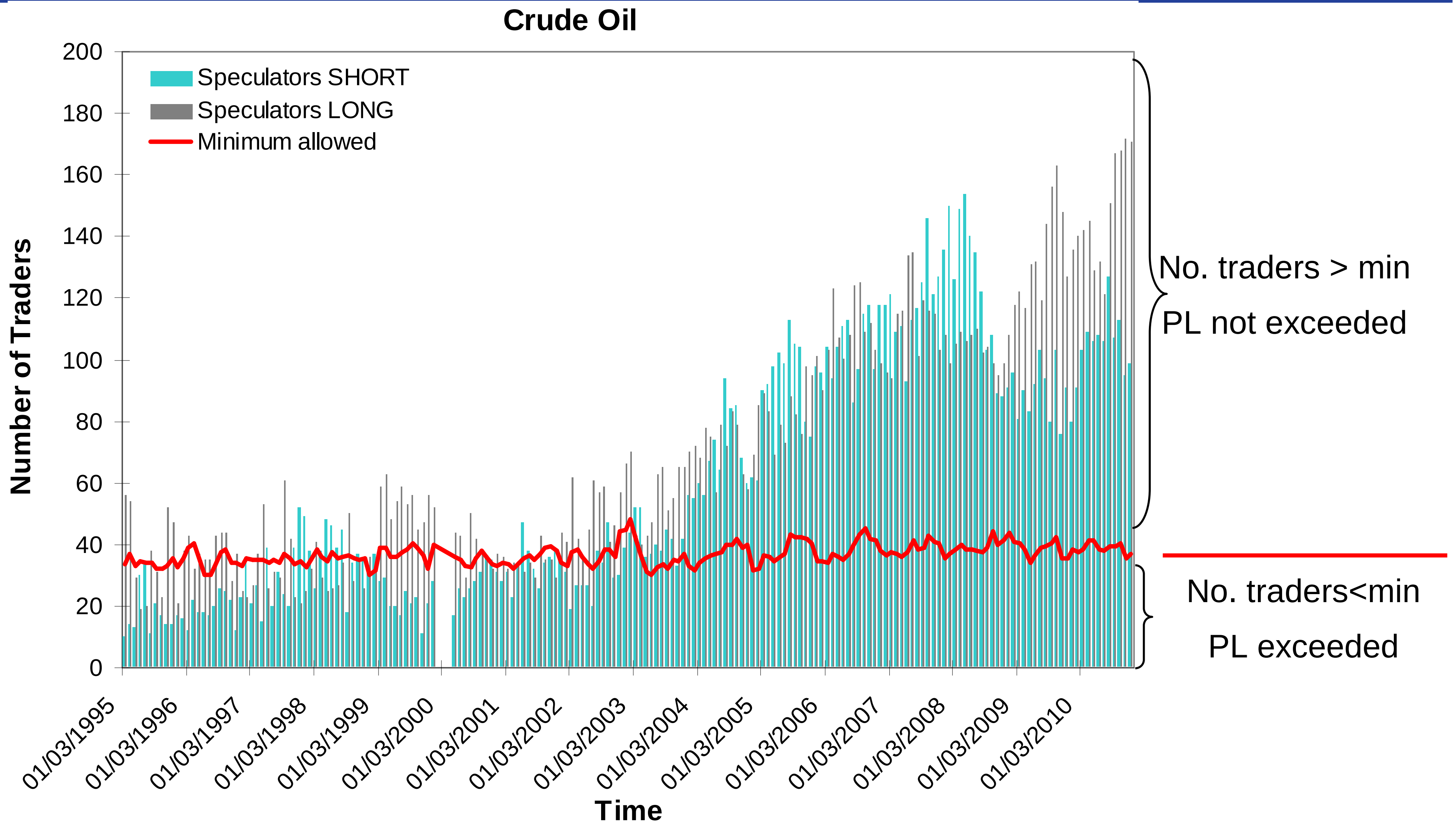
- PLs are expressed as no. of contracts a trader can hold

- Then OI/PLs = Min. no. traders s.t. PLs are not violated

- CFTC provides data on the no. of traders in the following categories:
  - Commercial Traders (i.e. Hedgers)
  - Non-Commercial Traders (i.e. Speculators)

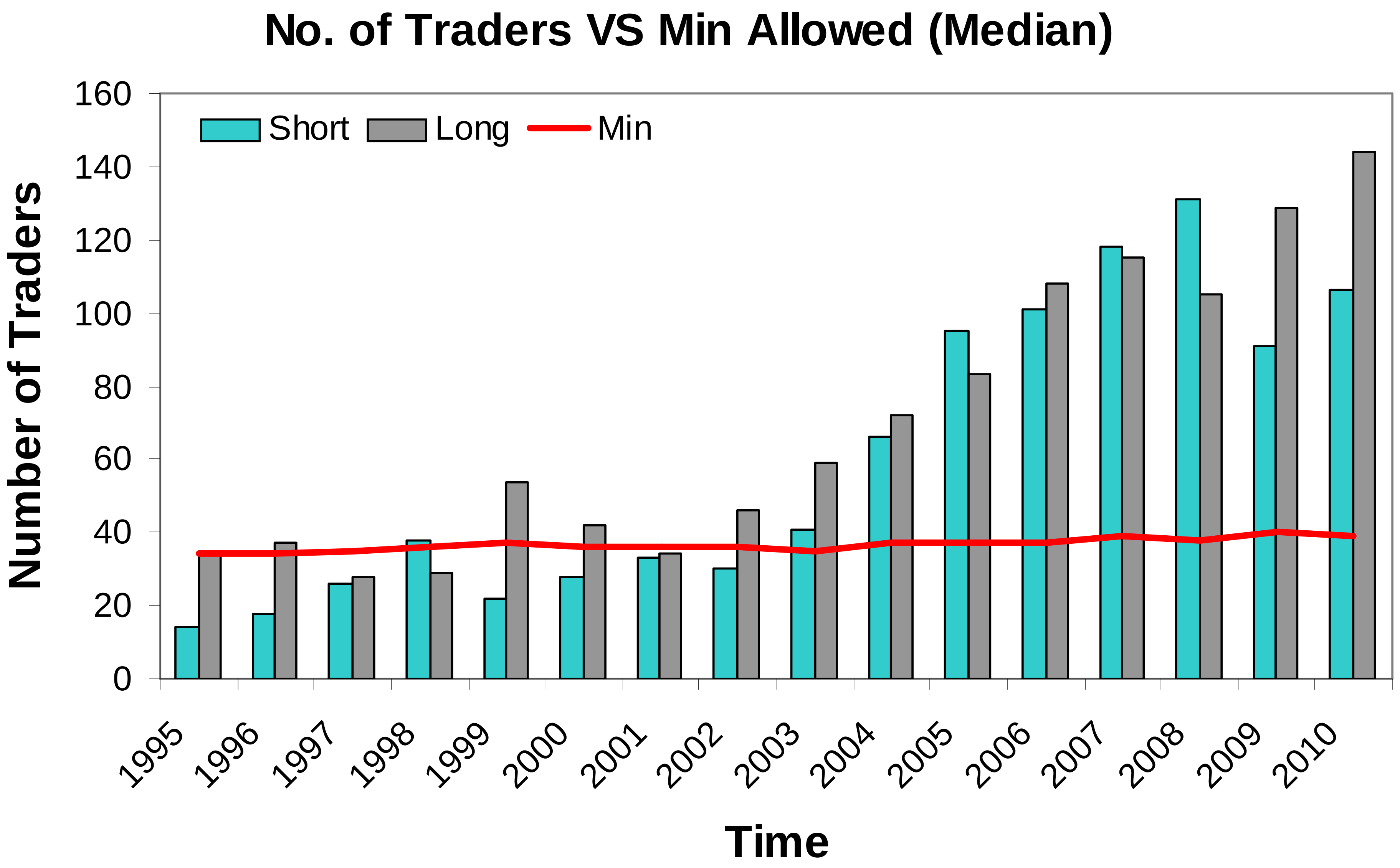
- Moreover we have information on the nature of their position:
  - Long: those who buy contracts
  - Short: those who sell contracts

Oil: no. of non-commercial traders VS min allowed by PLs



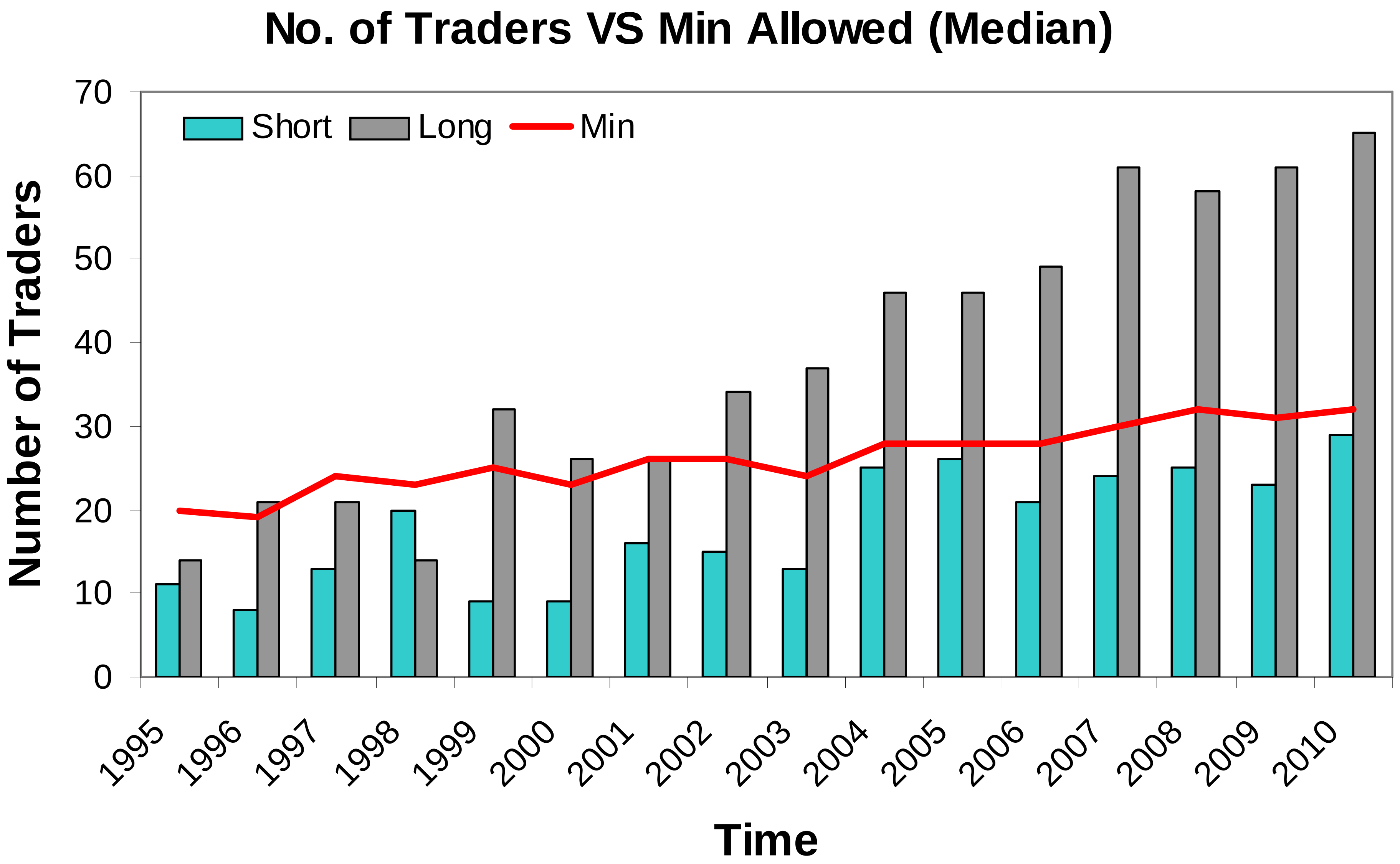
Minimum = OI/PL = Min no. non-commercial traders necessary to comply with PL

Crude Oil



No. of Traders VS Min Allowed (Median)
Short
Long
Min
Number of Traders
0
20
40
60
80
100
120
140
160
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Time

Gasoline



No. of Traders VS Min Allowed (Median)
Number of Traders
70
60
50
40
30
20
10
0
Short
Long
Min
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Time