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Does “Paper Oil” Matter?

Energy Markets’ Financialization and Co-Movements with Equity Markets

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Does “Paper Oil” Matter?

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*This presentation reflects the opinions of its authors only and not those of the Bank of Canada, the U.S. Commodities Futures Trading Commission (CFTC), the Commissioners, or the authors’ colleagues upon the staffs of either institution.

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1. Background

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Background

- More investment money in commodity futures markets
  - Thousands of hedge funds, commodity index funds, etc.
  - Commodity assets under management (AUM)
- What could this development mean for…
  - Energy Price Levels?
  - Oil Market Volatility?
  - Cross-Market Linkages? → My focus today

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Background

"***As more money has chased*** *(...)* ***risky assets, correlations have risen.*** *By the same logic, at moments when investors become risk-averse and want to cut their positions, these asset classes tend to fall together.* ***The effect can be particularly dramatic if the asset classes are small—as in commodities.*** *(...) This marching-in-step has been described (...) as a '****market of one****'."*

The Economist, March 8, 2007.

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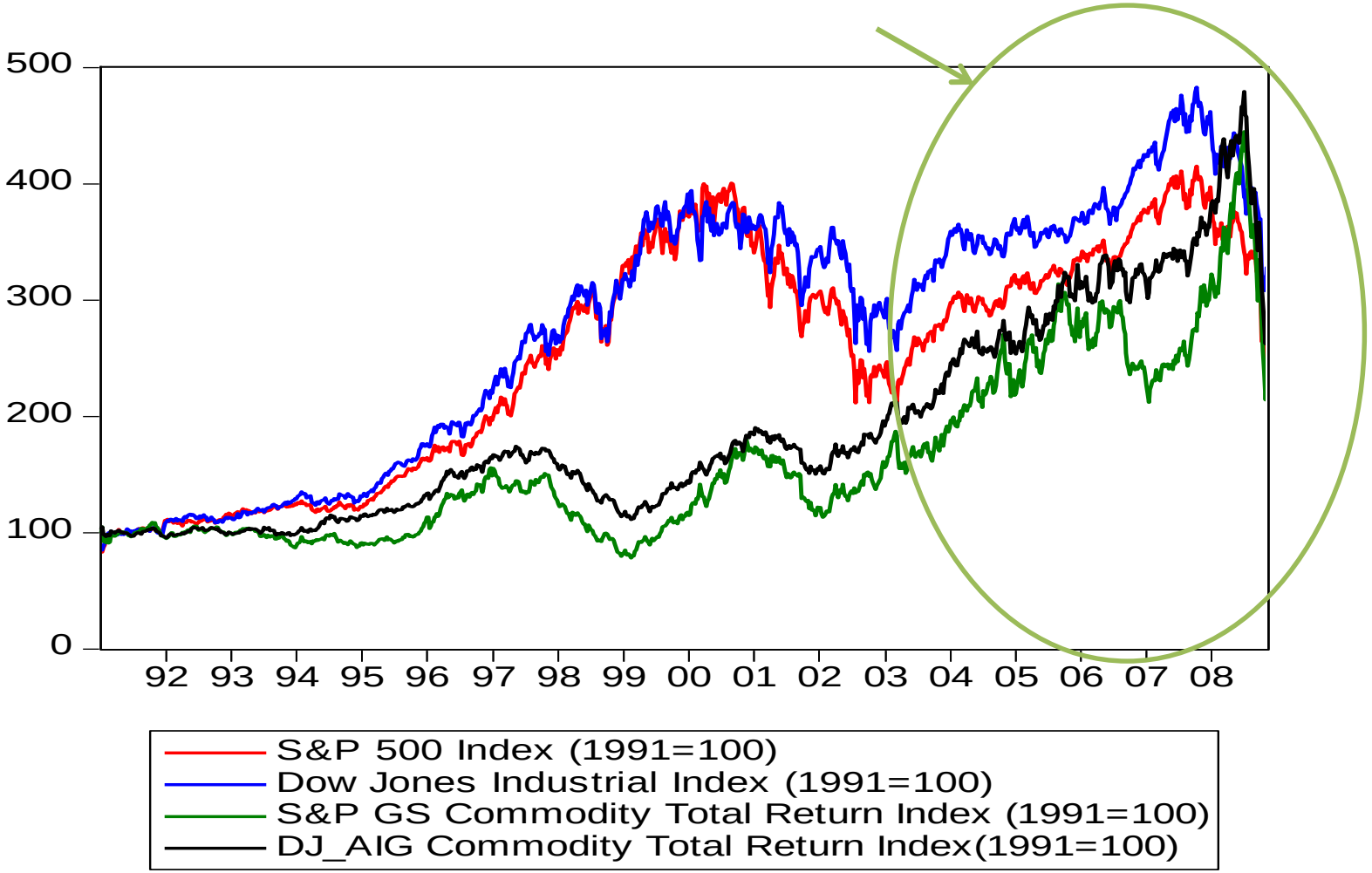
The “Marching in Step” Observers Had in Mind



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Outline of Today's Talk

- Provide evidence on Prices
  - Cross-market Linkages → Have returns on energy assets & equities started to move in sync?
- Provide evidence on Trading Activity
  - Who trades?
  - Cross-markets → Do more equity futures traders also trade commodity futures?
- Explain Linkages
  - Commodity fundamentals or Trading Activity?

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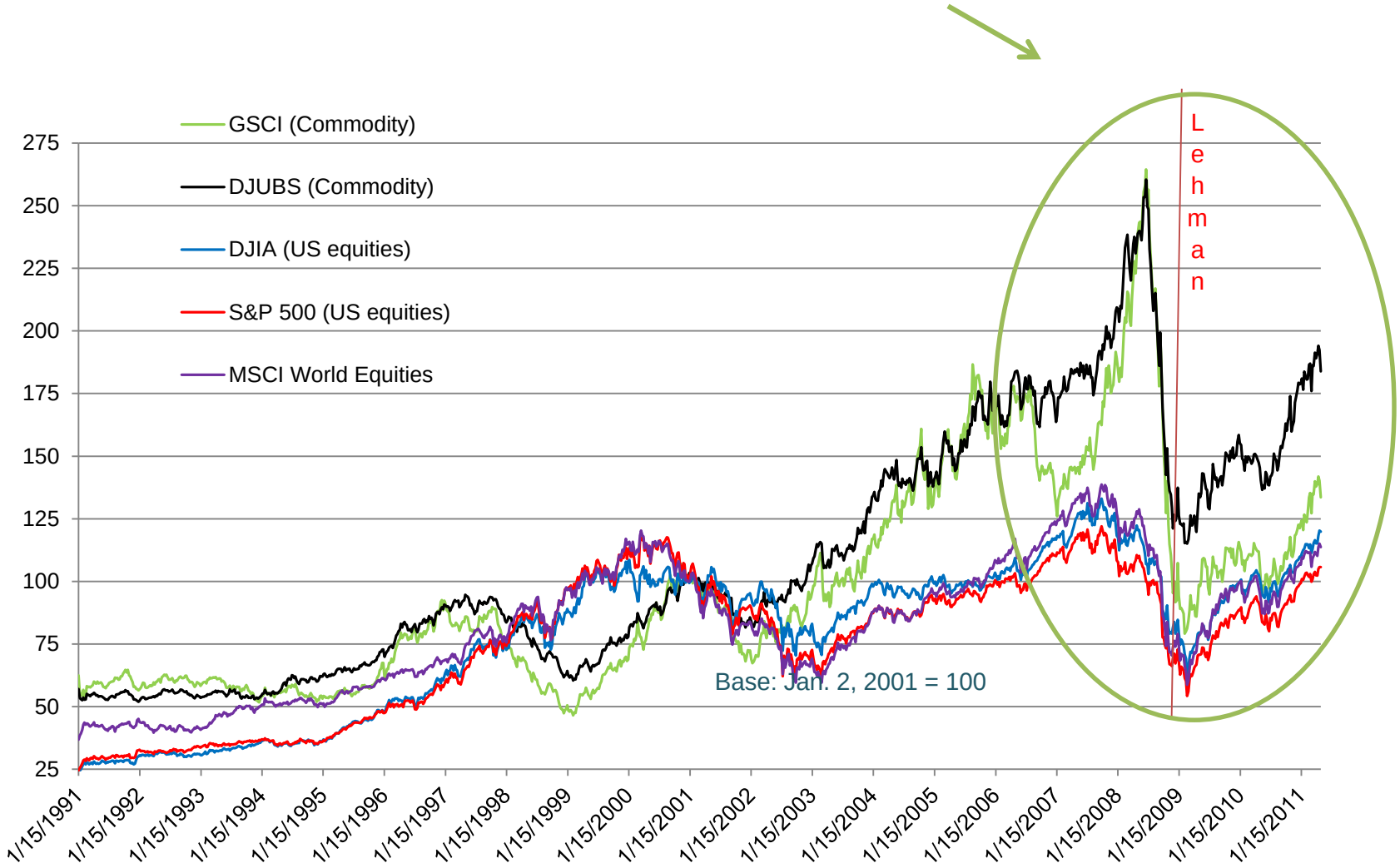
The “Marching in Step” – after Lehman



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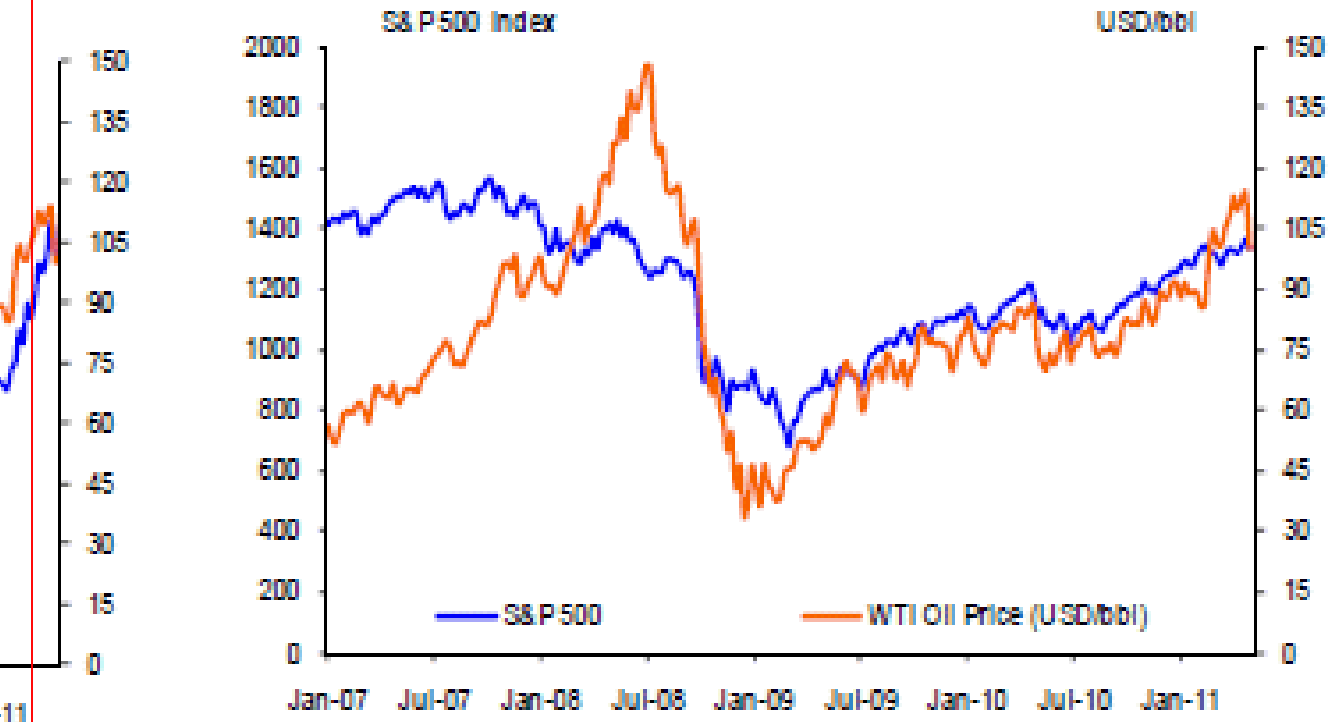
The "Marching in Step" – after Lehman

Figure 2: S&P 500 Index and oil prices



Source: Bloomberg Finance LP, Deutsche Bank

Source:
Deutsche Bank's
Global Commodities Daily, May 2011

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A "Market of One" – Really?

- Büyükşahin, Haigh & Robe (JAI 2010):
  - Not so fast: Let's look at return correlations, not price levels
    - On average, return correlations between passive equity and energy investments used to be about zero (1991 to August 2008)
    - No secular increase in dynamic conditional correlations (DCC)
- General result?
  - Yes
    - True at daily, weekly & monthly frequencies
    - True regardless of index choice (GSCI or DJ-UBS; S&P or DJIA)
  - And yet…

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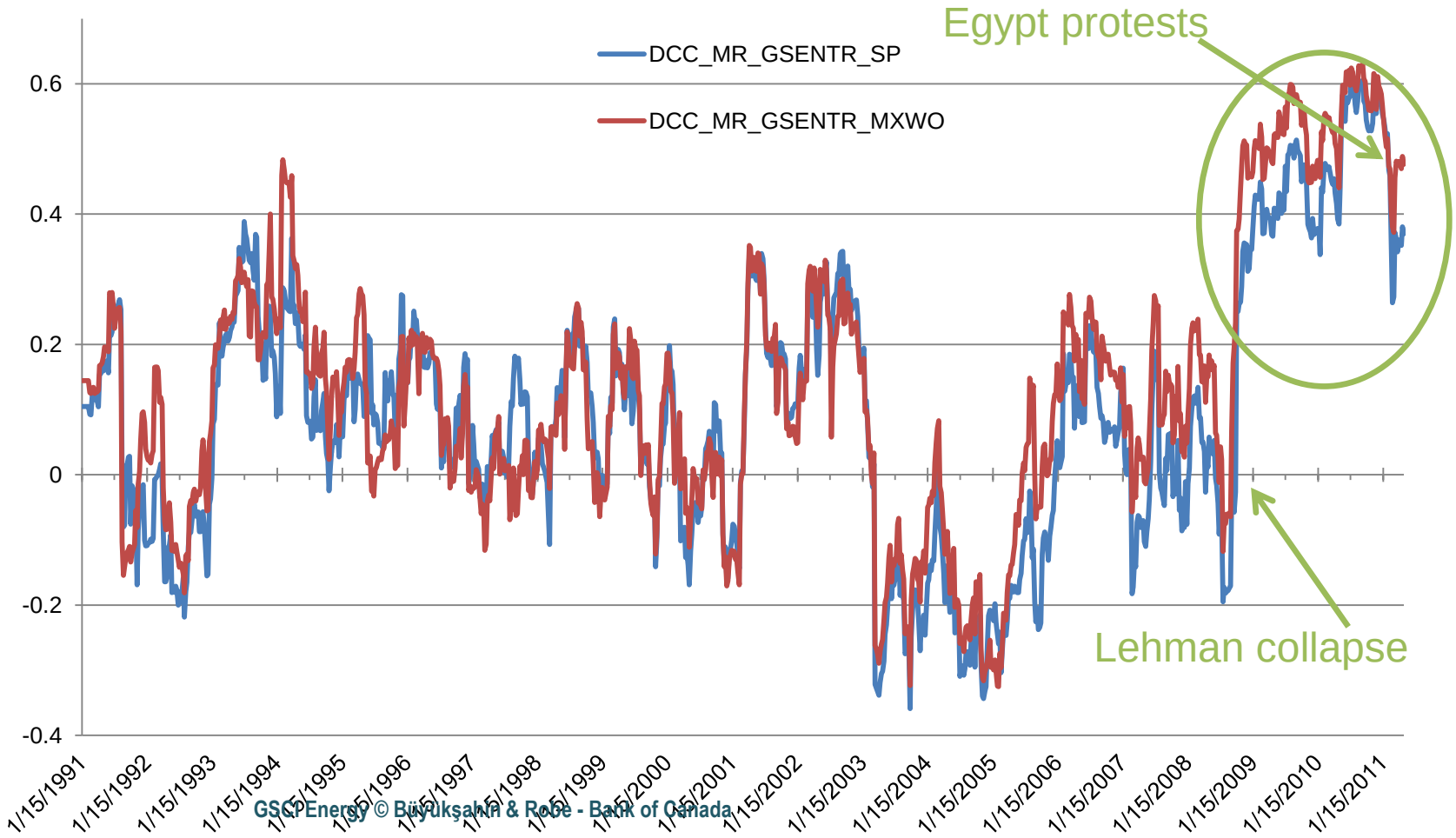
SP500 & GSCI Correlation (DCC), 1991-2011

- DCC estimates average about Ø, *but* fluctuate substantially over time



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Correlation Facts

- How confident are we of the correlation pattern:
  - Frequency?
    - Irrelevant – Similar patterns at daily, weekly & monthly frequencies
  - Specific to Oil?
    - No – Similar patterns for returns on diversified commodity portfolios
  - Does it matter how we estimate correlations?
    - Yes– Very different patterns with rolling correlations
  - What about cross-commodity correlations?
    - Differences – Ags and Livestock vs. industrial commodities
    - Similar – Post-Lehman behavior

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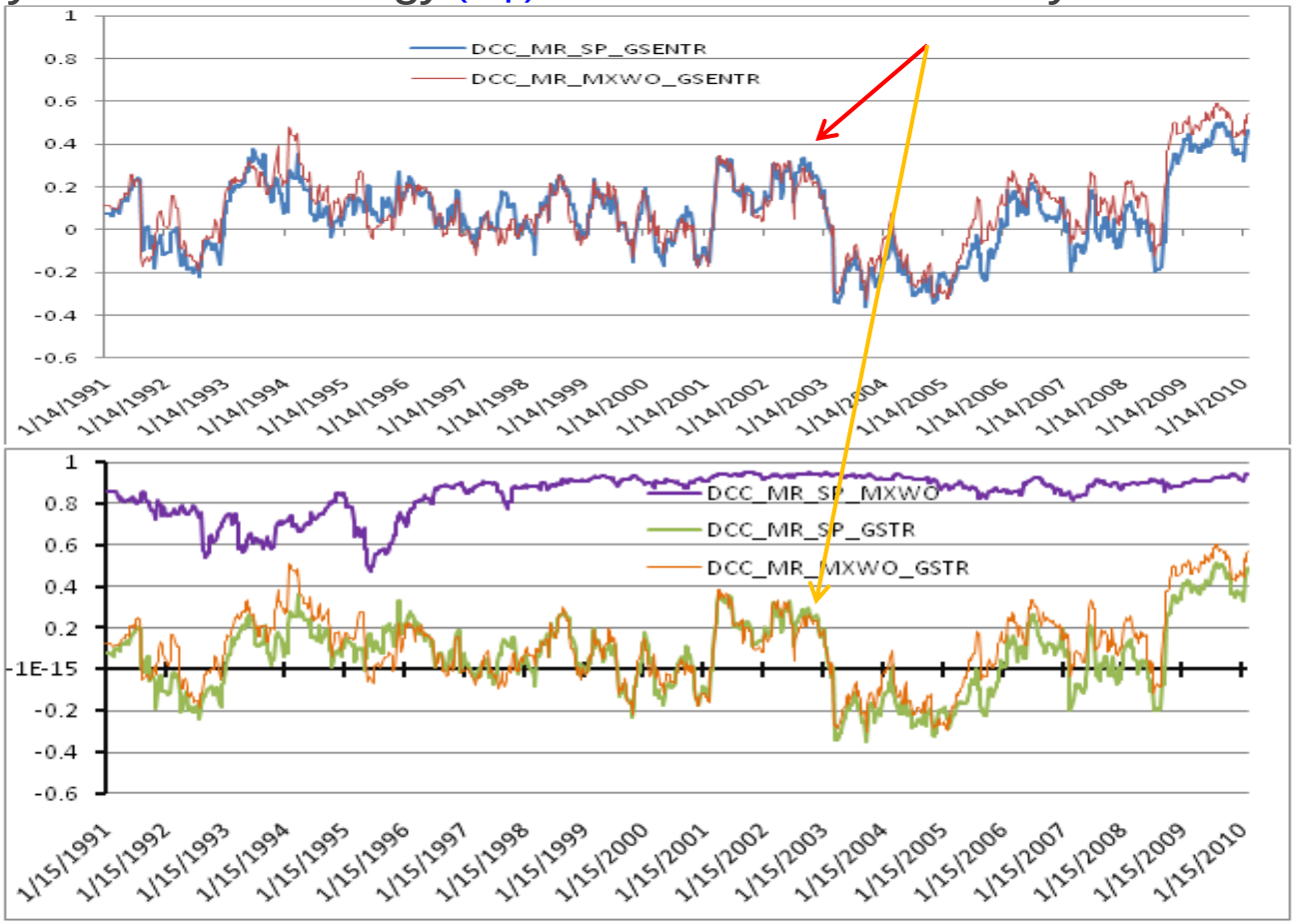
Equity Returns *vs*. Energy & Other Commodities

- Equity Returns *vs*. Energy (Top) *or* Diversified Commodity Portfolio



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DCC Analysis

- Dynamic Conditional Correlation (Engle, JBES 2002)
  - 2-stage estimation:
    - First stage : n univariate GARCH(1,1) estimates are obtained (simultaneously), producing consistent estimates of time-varying variances.
    - Second stage : The correlation part of the log-likelihood function is maximized, conditional on the estimated time-varying variances from the first stage.
  - Advantages:
    - Takes into account the time-varying nature of the relationship between equity and commodity returns
    - Accounts for changes in return volatilities

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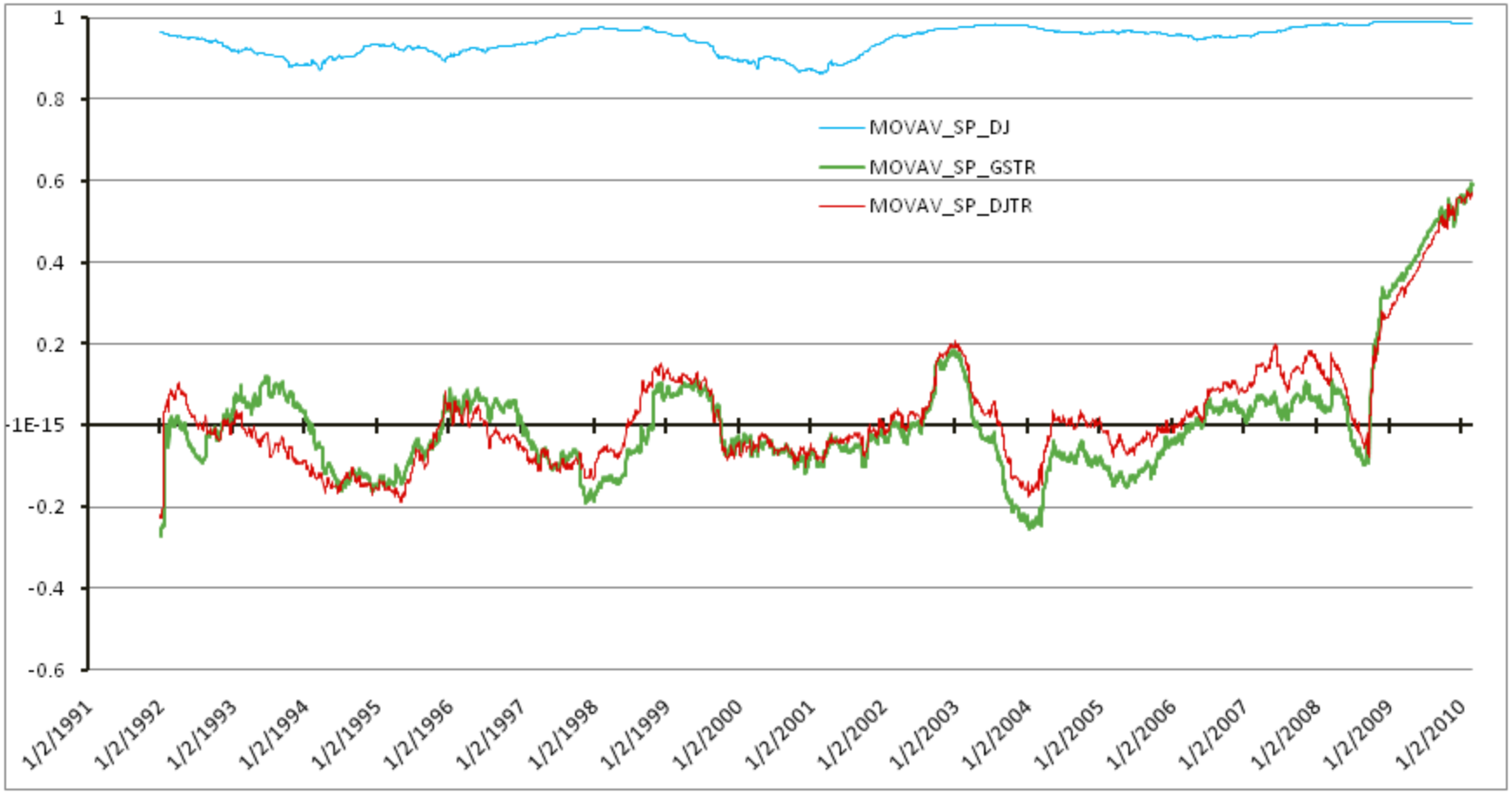
Without accounting for time-varying volatility…

- … we'd mis-estimate how much & when correlations change



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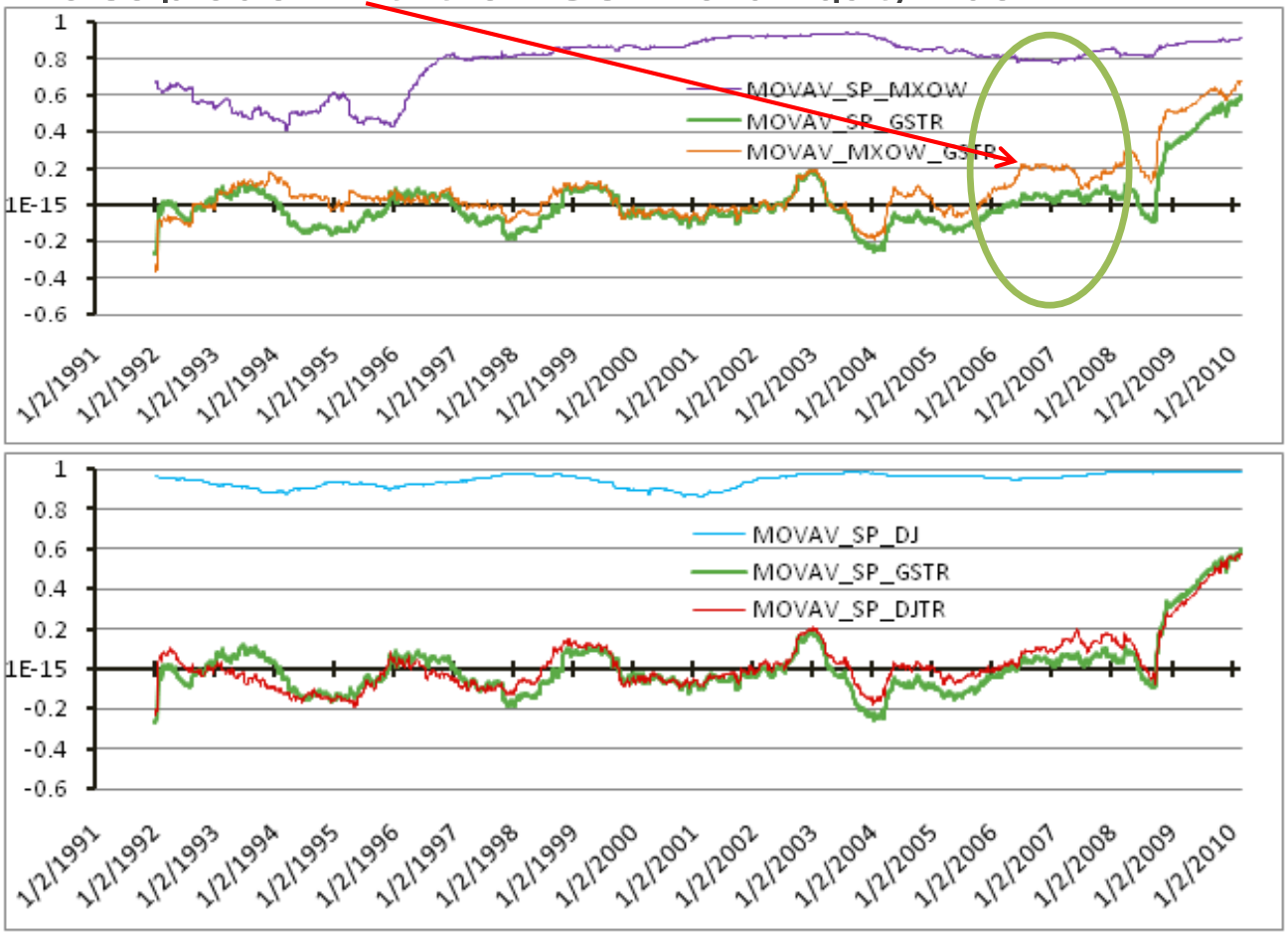
Without accounting for time-varying volatility…

- Even worse problem with the MSCI World Equity Index



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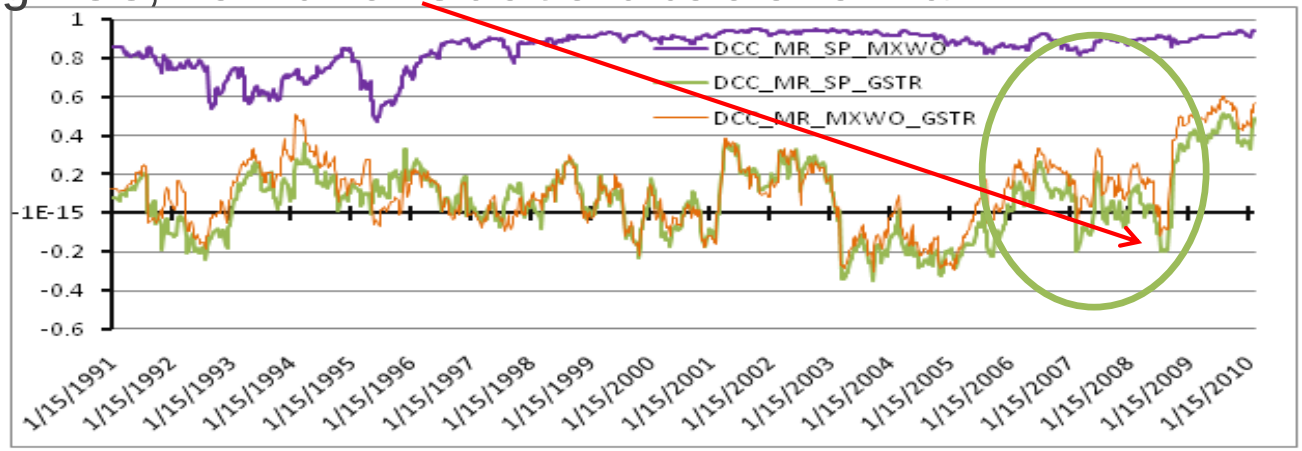
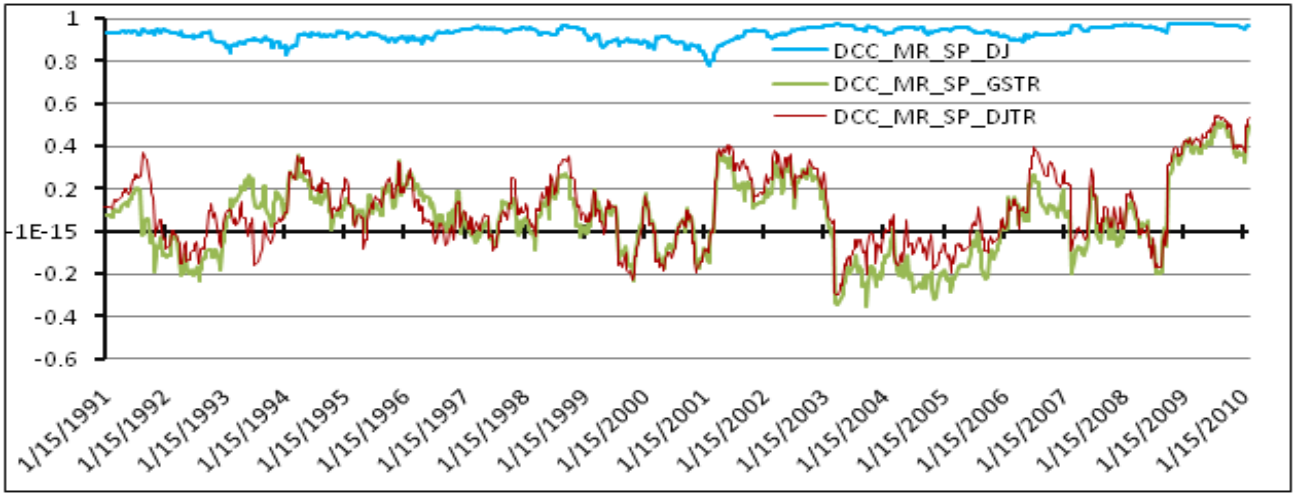
Vs. accounting for time-varying volatility…

- Using DCC, we find no *visible* trend before Lehman





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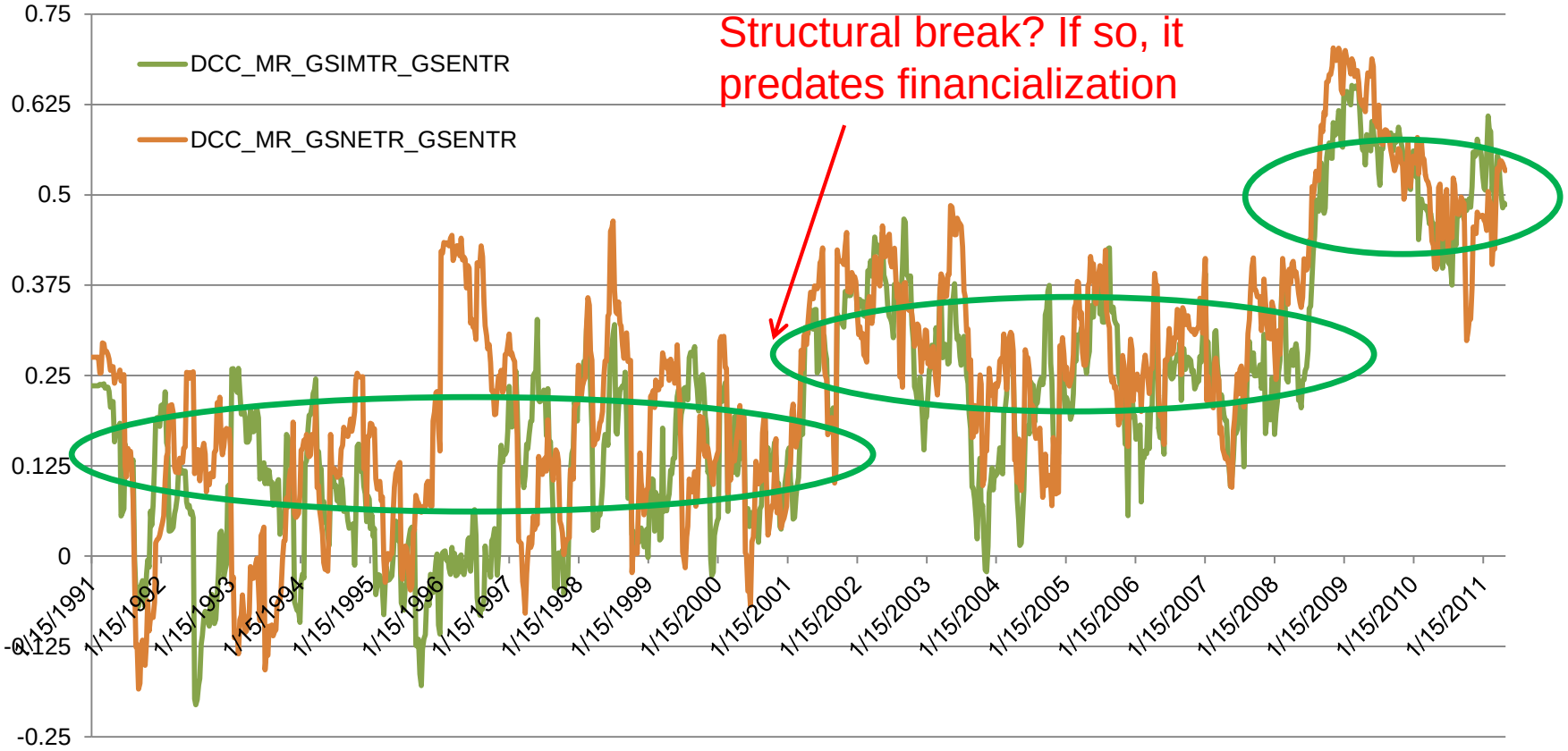
Cross-Commodity Correlations

- Same for Cross-Commodity correlations*? Not for Industrial Metals…*



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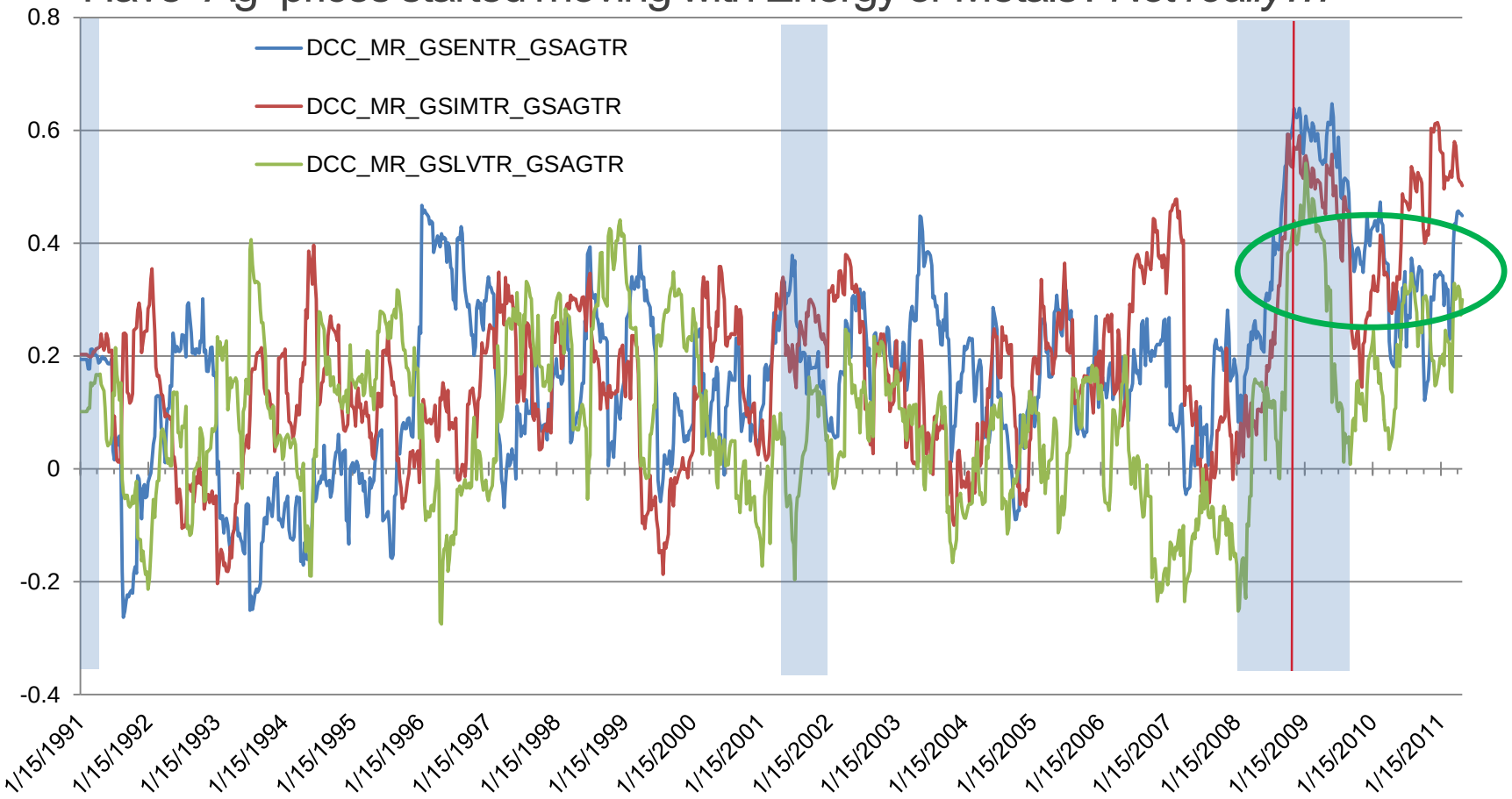
Cross-Commodity Correlations

- Have "Ag" prices started moving with Energy or Metals? *Not really…*



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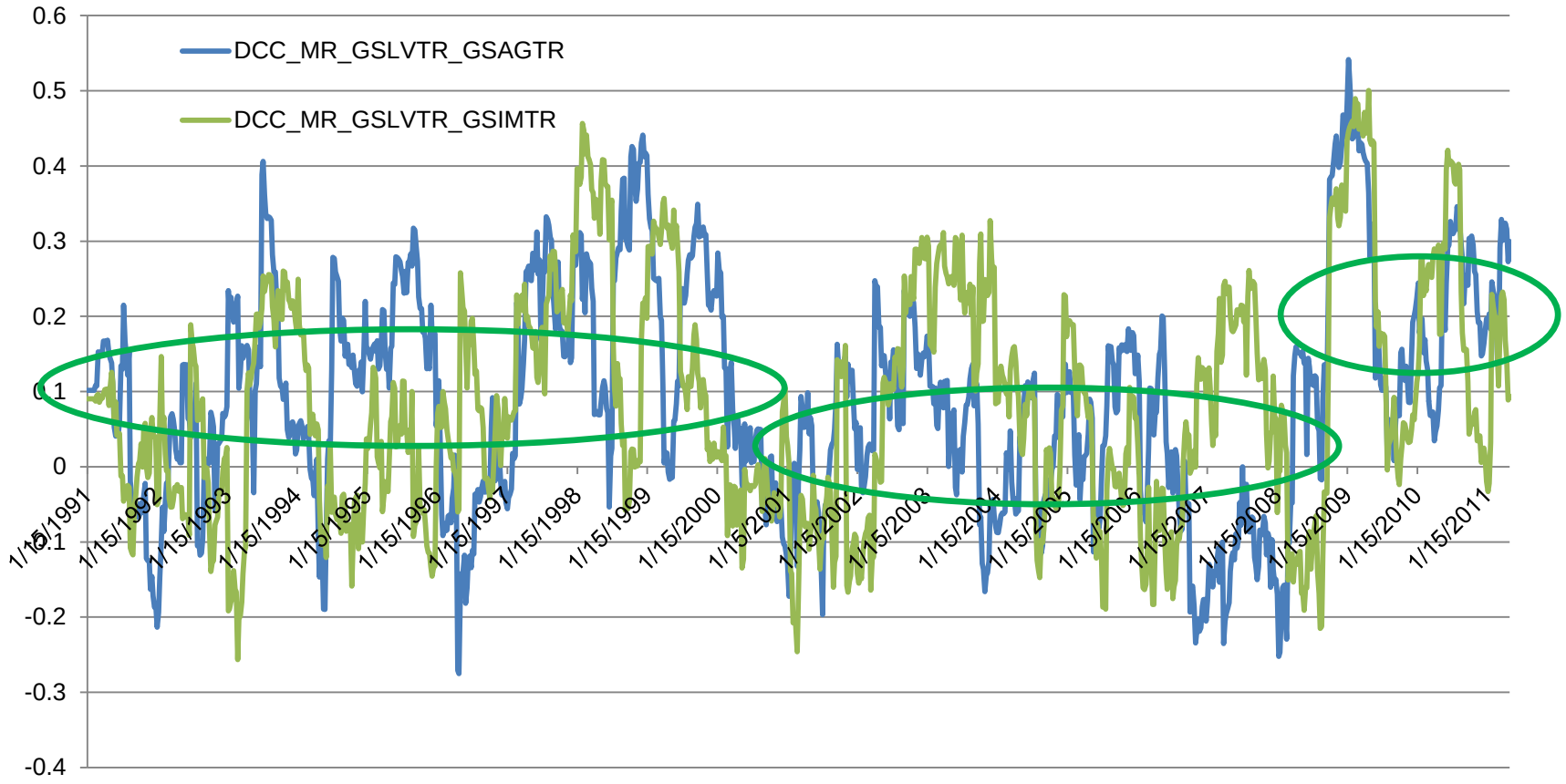
Cross-Commodity Correlations

- How about Livestock? *Quite the opposite…*



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This Paper

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Thinking about Commodity-Equity Linkages

- As the DCC graphs show…
  - Equity-energy DCC estimates do fluctuate substantially over time
    - Can we explain what (or who) drives them?
      - → Macroeconomic / physical fundamentals? Trading? Both?
  - Extreme-event correlations do exist (Shanghai Feb.'07, Lehman Sept.'08,…)
    - Does financial stress increase correlations?
    - How (through what channel) does stress affect distributions?
- Our focus
  - Equity-energy co-movements
    - Why?

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Related Finance Literature #1

- Does It Matter Who Trades?
  - Theoretical results
    - Arrival of less-constrained traders (value arbitrageurs) should reduce mispricing
      - e.g., Rahi & Zigrand (*RFS* 2009); Başak & Croitoru (*JFE* 2006)
    - Limits to arbitrage
      - Questions about such traders' behavior in periods of market stress
        - Leverage constraints, wealth effects, portfolio rebalancing needs, etc.
        - Kyle & Xiong (*JF* 2001), Gromb & Vayanos (JF 2001), Kodres & Pristker (*JF* 2002), Broner, Gelos & Reinhart (*JIE* 2006), Pavlova & Rigobon (*REStud* 2008), …
  - Our paper: empirical analysis, using commodity and equity markets

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What do we contribute to this first literature?

- Direct evidence that who trades matters for asset pricing
  - In general, difficult to test the theory
  - Unlike most authors, we have access to comprehensive daily data on
    - trader-level (i.e., individual) positions
    - each trader's main of business & underlying motive for trading (i.e., hedging or not)
    - over an entire decade (July 2000 to March 2010)
  - The composition of the open interest helps explain an important aspect of the joint distribution of commodity and equity returns

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Related Finance Literature #2

- Financialization of commodity markets
  - Vibrant debate on the impact of having more financial traders
  - Extant findings?
    - Energy futures risk premia given limits to arbitrage
      - » Acharya, Lochstoer & Ramadorai (2009, updated 2012), Etula (2010) ←→Hong & Yogo (2010)
    - Intra-market linkages (crude oil)
      - » Büyükşahin, Haigh, Harris, Overdahl & Robe (2011)
    - Cross-commodity linkages
      - » Stoll & Whaley (2010) ←→ Tang & Xiong (’10), Bicchetti & Maystre (’12)

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What do we contribute to this second literature?

- We provide the first detailed evidence on financialization in a cross-section of energy markets
- We provide the first evidence of increased cross-market trading
- We show that some, not all, types of financial traders affect correlations
    - Hedge funds? Yep! Index traders? Nope!
- We show that hedge fund heterogeneity matters
    - Not all hedge funds drive cross-market correlations equally
    - Funds active in both equity and energy futures markets vs. others

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Trading Facts

Financialization of Energy Futures Markets

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A. Position Data

- Publicly available data: CFTC Commitments of Traders (COT) Reports (Weekly since 1990's)
  - Highly aggregated
    - All maturities are lumped together
    - Traders grouped in just 2 bins ("Commercials" vs. "Non-Commercials")
- vs. Our data: Large Trader Reporting System (LTRS)
  - End-of-day positions of every individual large trader (Daily)
    - Non-public, CFTC only
    - For every contract maturity
    - Every day from July 1, 2000 to February 26, 2010
  - Information on each trader's line of business

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Our Detailed Data: Main Sub-Categories *(Oil)*

- Non-commercials
  - Hedge Funds (includes Commodity Pool Operators (CPOs), Commodity Trading Advisors (CTAs), Associated Persons who control customer accounts, and other Managed Money traders)
  - Floor Brokers & Traders
  - Non-Registered Participants (Traders not registered under the Commodity Exchange Act (CEA); category includes non-MMT financial traders)
- Commercials
  - "Traditional"
    - Producers
    - Manufacturers (refiners, etc.)
    - Dealers (energy wholesalers, exporter/importers, marketers, etc.)
  - Commodity Swap Dealers (includes arbitrageurs and CITs)

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What Does our Additional Information Show?

- Importance of Financial Traders
  - Hedge Funds & Swap Dealers (incl. CITs) are up
- Heterogeneity within the Broad Categories
  - Good idea to break out Swap Dealers & Hedge Funds (2009)
  - Heterogeneity Extends to Use of Options
- Differential Growth at Near/Far Ends
  - E.g., 1-3 years OI now > 1-3 months OI back in 2000
- Differential Behaviors at Near/Far Ends
  - E.g., Swap Dealers: net long in nearby / net short in backdated

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Generalizing to all GSCI Commodities

- We would like
  - Detailed position data for futures contracts in GSCI Energy index
- Unfortunately
  - two contracts are non-US → no data (Gas oil and Brent)
  - Position data for RBOB gasoline are available only after 2006
- Bottom line
  - We have data WTI crude, Henry-Hub natural gas, No.2. heating oil
  - Weights:
    - Time-varying GSCI weights, scaled to account for "missing" contracts

Heating Oil	WTI Crude Oil	Natural Gas
10%	77%	13%

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B. Measurement Issues

- Traders' shares in short-term & long-term contracts
  - For each category of traders, we get
    - Share of the total open interest (all contract months)
    - Share of the open interest in first 3 contract months
- Speculators
  - Hedge funds? → Register with CFTC → detailed data
  - CITs (Commodity Index Traders)?
    - Detailed data at monthly (quarterly) frequency & only since 2010 (2008). → we proxy their market share by share of commodity swap dealers
    - Best we can do (Why?), but imperfect
      - » Approximation is better for short-term contracts (why?)
  - Overall importance?

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Measurement Issue: Speculative Activity

- Working's T (1960):
  - Goal: measure the extent to which speculative positions exceed the net hedging demand in a given futures market i
  - Formally:

$$WSIS_i = 1 + \frac{SS_i}{HL_i + HS_i} \; if \; HS_i \geq HL_i$$

$$WSIS_i = 1 + \frac{SL_i}{HL_i + HS_i} \; if \; HL_i \geq HS_i$$

where SS_i is the magnitude of the short positions held in the aggregate by all non-commercial traders; SL_i stands for all non-commercial long positions; and, HS_i stands for all non-commercial long positions and HL_i stands for all long hedge positions.

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C. Financialization in Pictures

- Overall speculation is up
  - From about 10% excess spec till 2002 to 35-50% after 2005
- Commodity Index Trading is Up
  - Swap Dealer positions account for about 35% of futures OI
- Hedge Funds are Up
  - From 5-10% of the futures OI till 2002 to 25-30% after 2005
- Cross-Market Trading is Up
  - Tripled since 2002
  - Pattern does not follow other hedge funds

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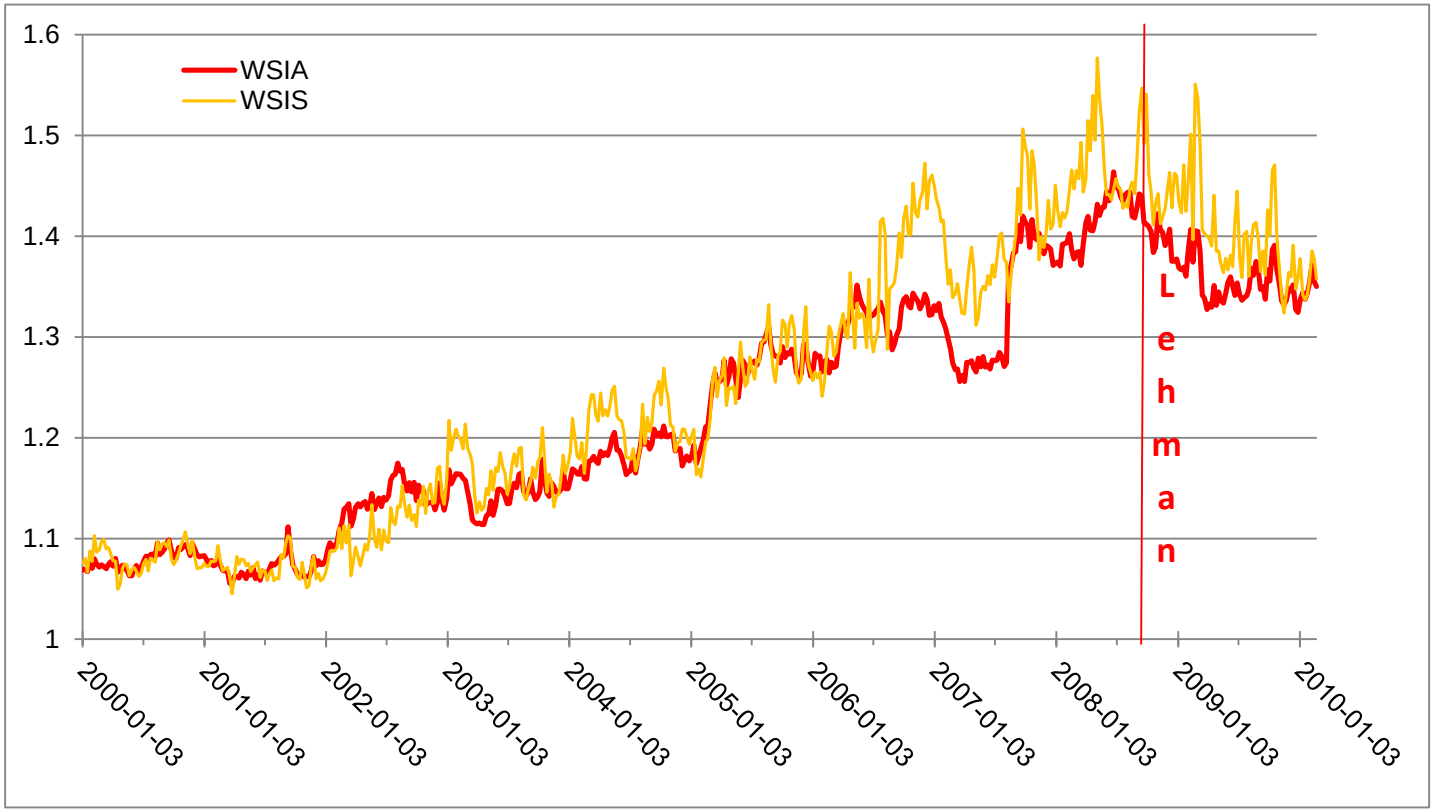
Energy Speculation

- Working's *T*, January 2000 to March 2010



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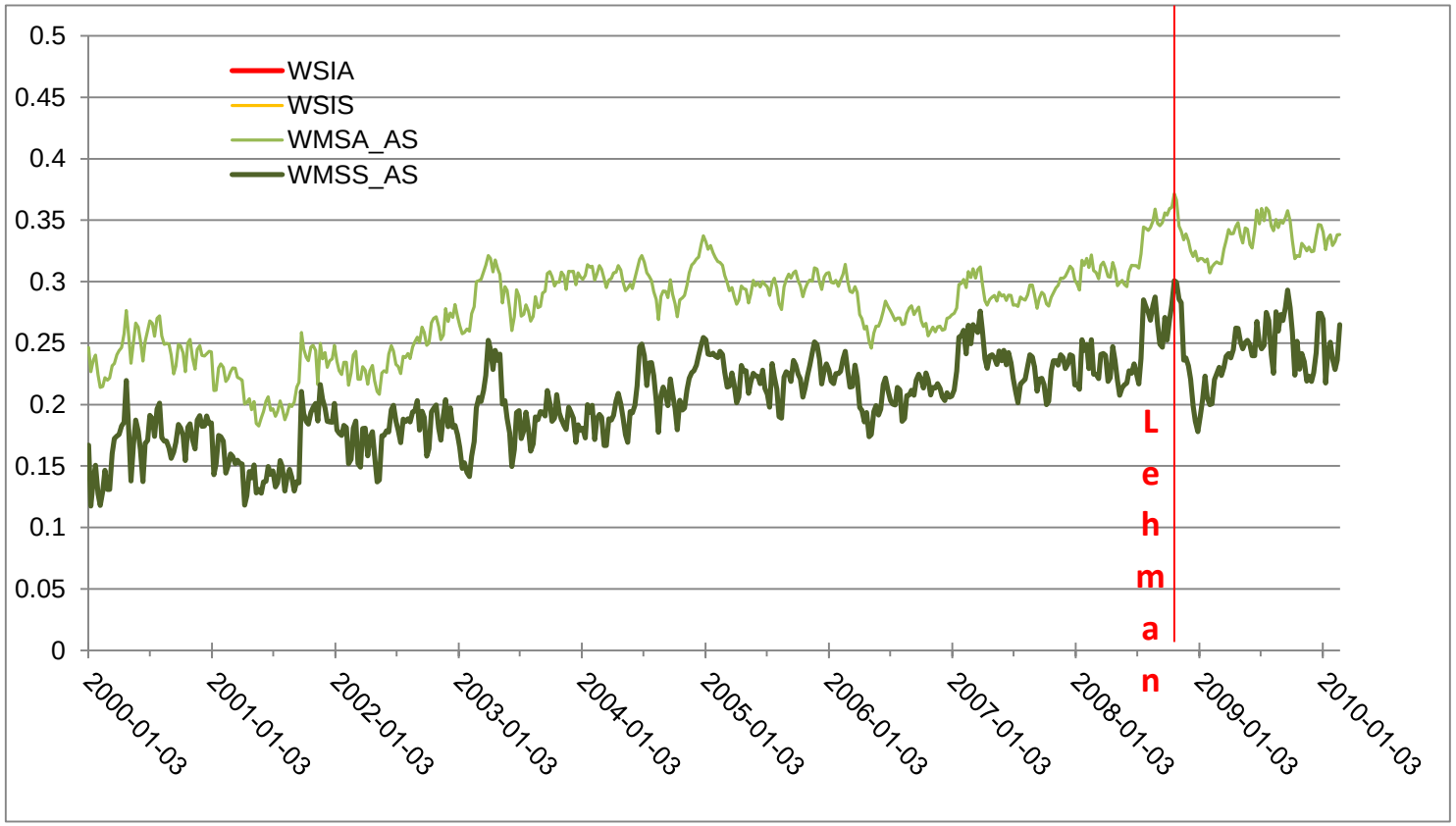
Swap Dealing & Commodity Index Trading

- Overall *vs*. Near-dated Swap Dealer Positions (% of OI), 2000-2010



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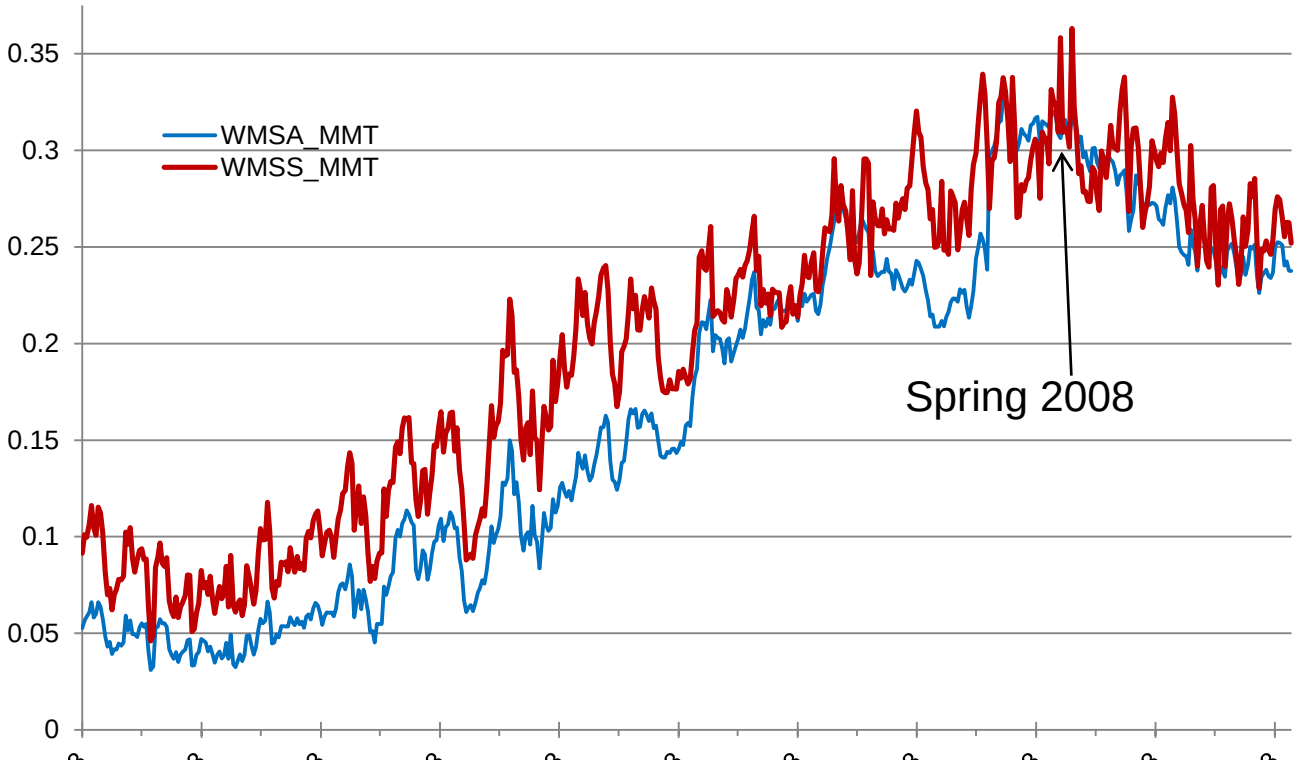
Hedge Funds *and* Cross Traders

- Hedge funds' share of Energy Futures Open Interest, 2000 to 2010



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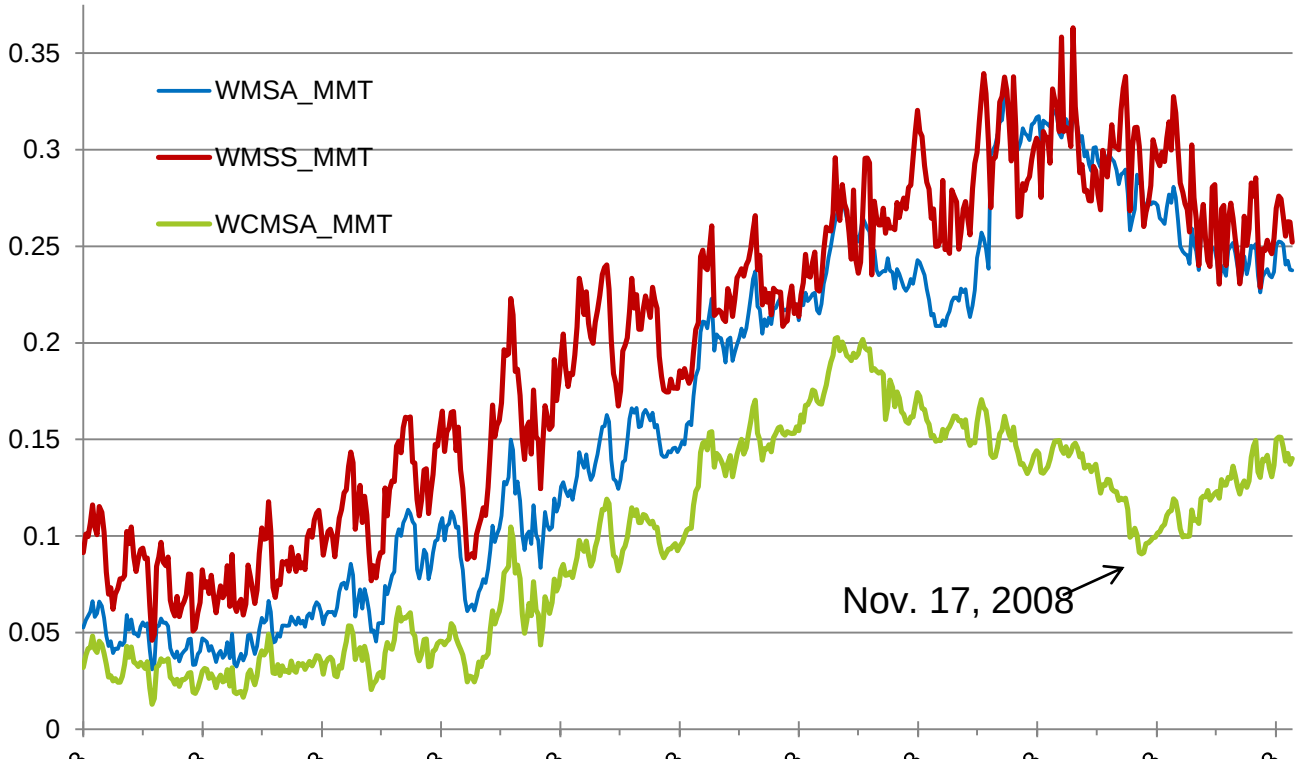
Hedge Funds *and* Cross Traders

- Hedge funds that Trade both Energy and Equity Futures, 2000-2010



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What Drives Correlations:
Trading Activity *or* Fundamentals?

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Does Trader Identity Matter?

- Does the composition of trading activity (i.e., who trades) matter for asset pricing?
  - Theoretical reasons to believe trader identity matters
- Who is a "candidate" for enhancing linkages?
  - Traditional commercial traders, Long-term investors, etc.? → Unlikely
  - Hedge funds? → More likely
    - Enter/exit markets frequently
    - trade across markets to exploit perceived mis-pricings/opportunities
      - » Levered + subject to borrowing limits/wealth effects + value-arb across markets

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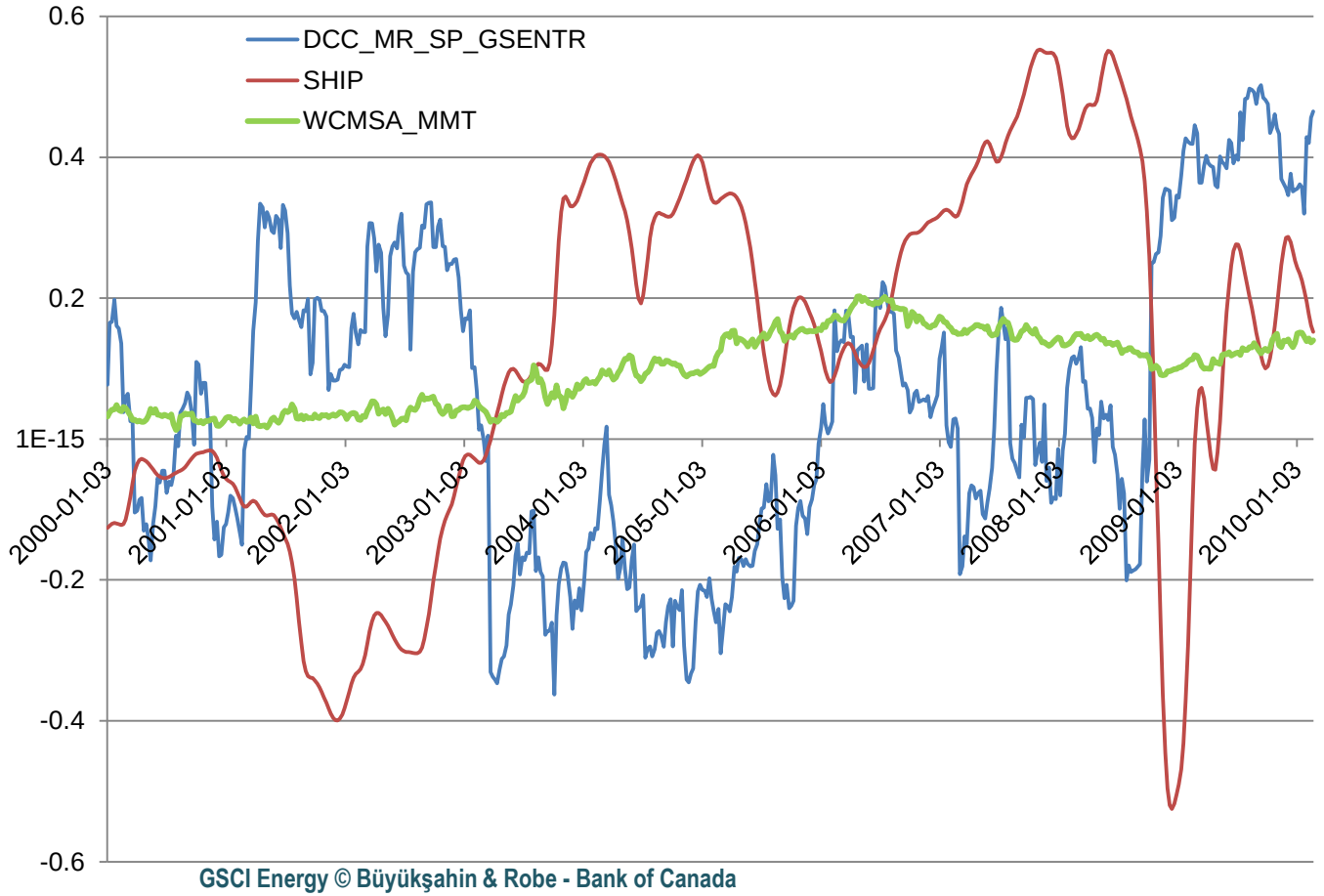
More Speculators → Ever Higher DCC?

- Cross-mkt trading should be the best candidate: *Does a graph hint at it?*



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Fundamentals?

- Macroeconomic fundamentals
  - Inflation?
  - Business cycles / economic climate?
    - Measurement
      - » US economic activity?
        - ❖ ADS *(Aruoba-Diebold-Scotti, JBES 2009)*
      - » World economy?
        - ❖ SHIP – Real economic activity index (Kilian, AER 2009)?
        - ❖ LPI (non-exchange-traded commodity price index)?
- Energy-market fundamentals
  - Spare crude oil production capacity?

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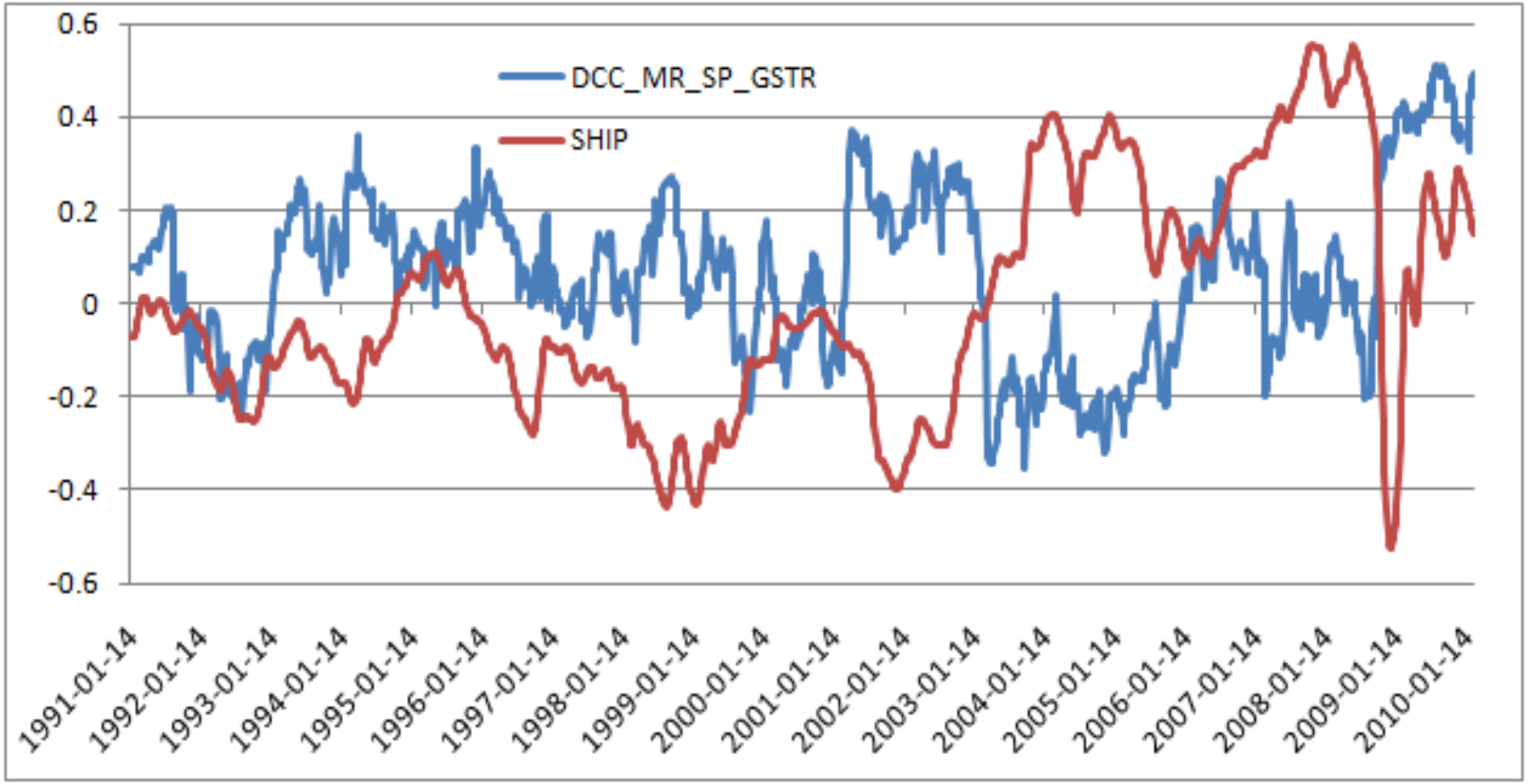
a. Worldwide Economic Activity & DCC

- Figure 3: SHIP negatively related with DCC after 1997?



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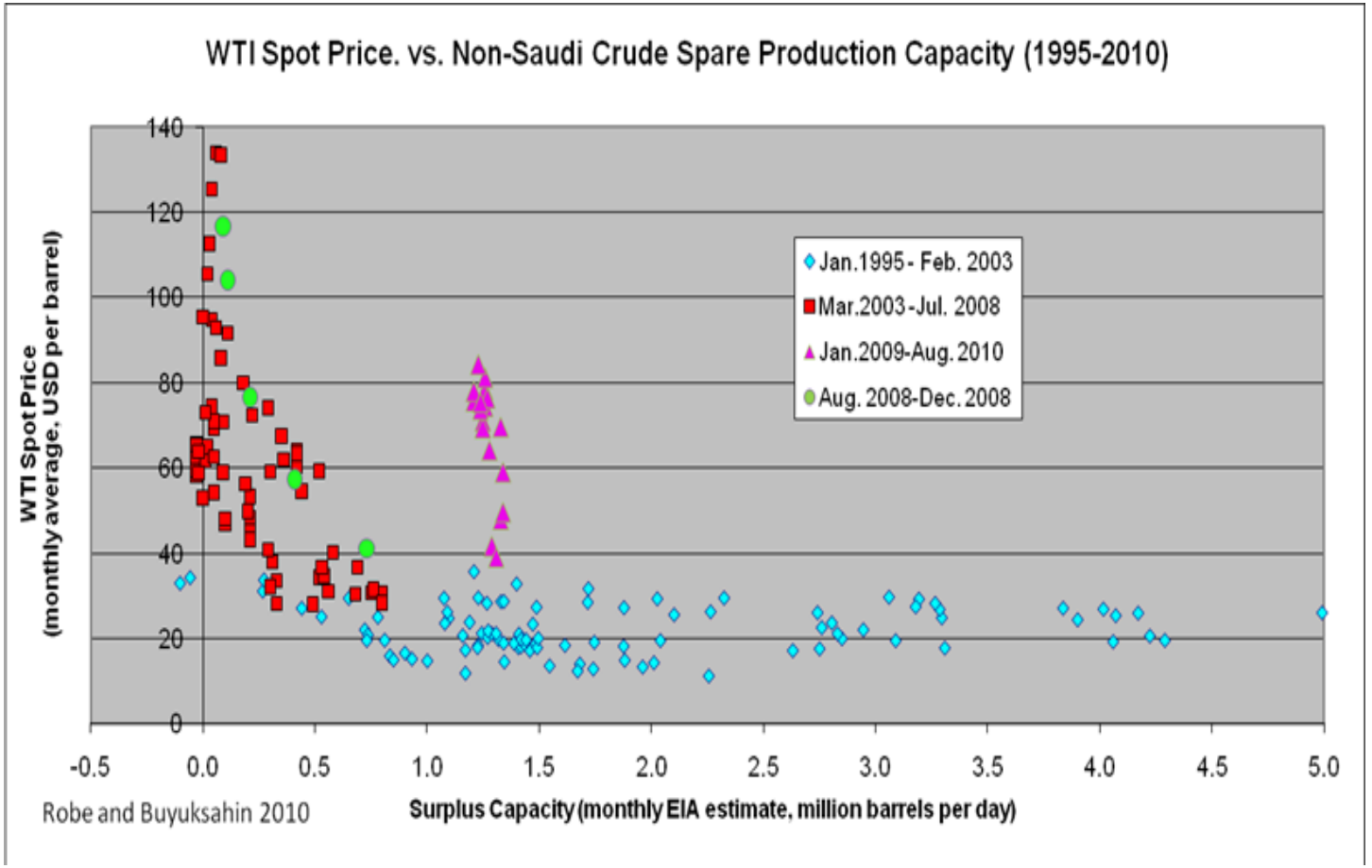
b. Worldwide Oil Demand/Supply Balance

- Figure 4: SPARE



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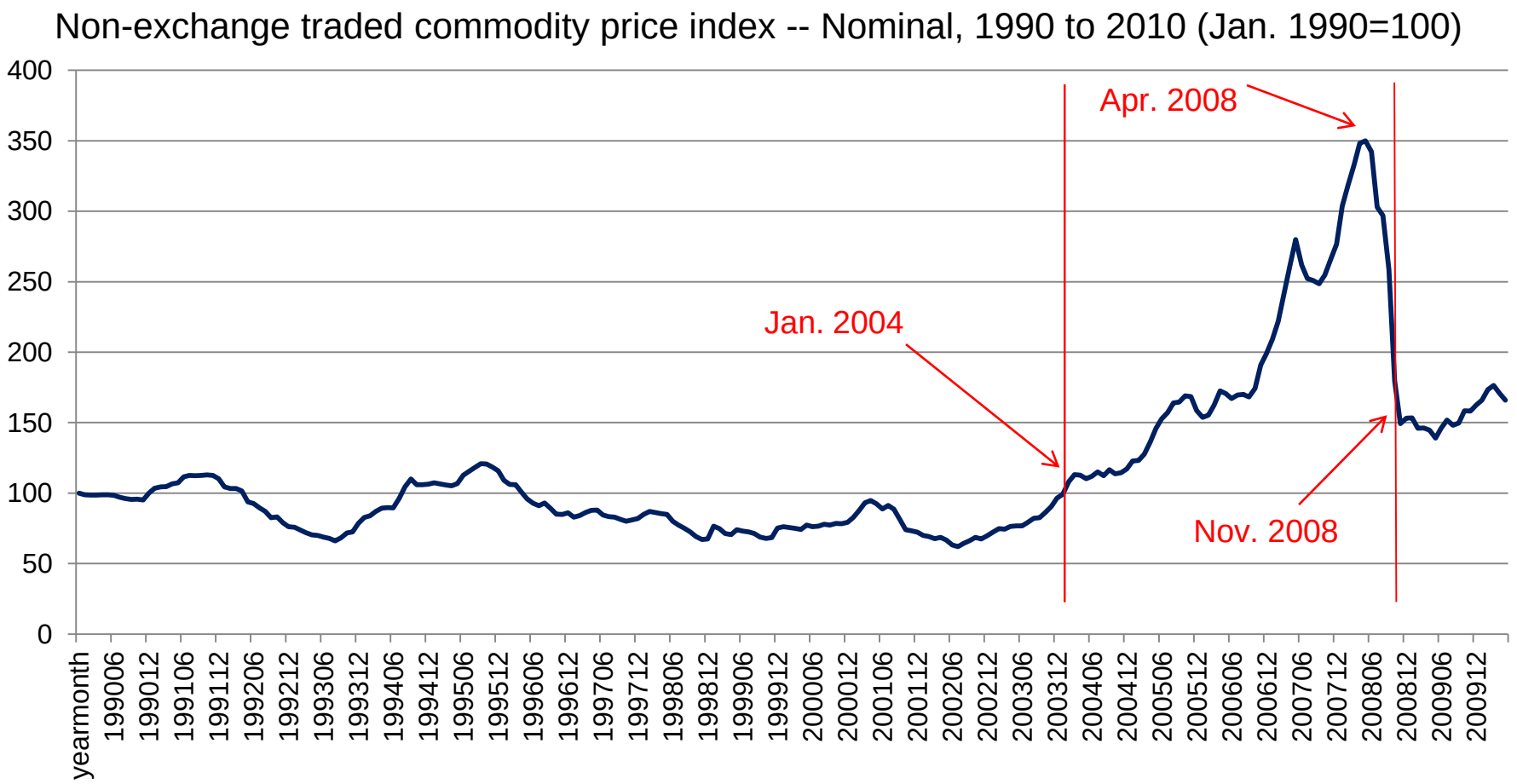
c. Commodity-Demand Shock in 2004



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Market Stress?

- 1. Financial Stress?
  - Financial stress should matter – evidence on extreme linkages:
    - » Bond-equity returns extreme linkages in G-5 countries
    - » International equity market correlations increase in bear markets
    - » Commodity-equity linkages went up in Fall 2008
  - Our measure: TED Spread
    - » Robustness: VIX
- 2. Hedge fund / Spec activity / Cross-market trading?
- 1+ 2: Do these effects interact?

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What Really Matters?

ARDL Regressions

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B. Explaining Commodity-Equity DCC

- Regress the DCC estimate on…
  - …trader position data
    - Each trader category entered separately
      - Short-dated (≤ 3 months) *vs*. Far-dated (> 3 months) positions
    - All traders in a category *vs*. only energy-equity cross-market traders
  - …real-sector variables
  - …market stress proxies

- Technical issue
  - Some series are I(0), others I(1); also, endogeneity?
    → ARDL model, Pesaran-Shin (1999) approach
    → Lagged values of variables to deal with AC and endogeneity

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Fundamentals Matters:

Economic Activity, Stress, Lehman

The long-run model

AR Model Estimated

$A(L)DCC\_MR_t = \beta_1(L)SPARE_t + \beta_2(L)UMD_t + \beta_3(L)TED_t + DUM_t$

$R^2 = 0.96$ $F(8,495) = 1524$ $DW = 2.03$ $Log\text{-}L = 867.34$

Solved static long run equation

$DCC\_MR_t = -0.1891 + 0.0977(SPARE_t) + 0.0851(UMD_t) + 0.2074(TED_t) + 0.4214(DUM_t)$

(-0.0677) (0.0328) (0.0511) (0.0918) (0.1073)

WALD test $x^2(4) =$ 33.3559 [0.0000] **

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Fundamentals Matters:

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Dynamic Analysis of Lag Structure: Modelling DCC

	Lag		
Variables	0	1	Σ
Constant	-0.0104	0.0000	-0.0104
DCC_MR	-1.0000	0.9450	-0.0552
SPARE	0.0043	0.0011	0.0054
UMD	0.0014	0.0033	0.0047
TED	0.0180	-0.0066	0.0114
DUM	0.0233	0.0000	0.0233

Test on the significance of each variable

Variable	F(n.,d.)	Value	Prob.	Unit Root t-test
Constant	F(1,495)	8.1175	[0.0046] **	
DCC_MR	F(1,495)	5014.5	[0.0000] **	-4.1366*
SPARE	F(2,495)	3.2283	[0.0405] *	2.5386
UMD	F(2,495)	1.9403	[0.1448]	1.7990
TED	F(2,495)	3.9766	[0.0194] *	2.6464
DUM	F(1,495)	9.8673	[0.0018] **	3.1412

Tests on the significane of each lag

Lag	F(n.,d.)	Value	Prob.
1	F(4,495)	1267.1	[0.0000] **

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Fundamentals Matters:

Economic Activity, Stress, Lehman

An Error Correction Model for DCC

Variable	Coefficient	JHCSE
Constant	0.0324	0.0020
ΔDCC_{t-1}	-0.0145	0.0429
$\Delta SPARE_t$	0.0152	0.0401
$\Delta SPARE_{t-1}$	-0.0123	0.0415
ΔUMD_t	0.0017	-0.0013
ΔUMD_{t-1}	0.0007	0.0014
ΔTED_t	0.0165	0.0214
ΔTED_{t-1}	-0.0025	0.0130
ECM_{t-1}	-0.0556	0.0169
$R^2 = 0.06$	$F(8,495) = 4.108$	
$\sigma = 0.044$	$DW = 2$ $RSS = 0.94$	

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Who Trades Also Matters (Control for Trading)

The long-run model

AR Model Estimated

$$A(L)DCC\_MR_t = \beta_1(L)SPARE_t + \beta_2(L)UMD_t + \beta_3(L)TED_t + \beta_4(L)WMSS\_MMT_t + \beta_5(L)WMSS\_AS_t + \beta_6(L)WMSS\_TCOM_t + \beta_7(L)INT\_TED\_MMT_t + DUM_t$$

$R^2 = 0.96$ $F(16,487) = 805$ $DW = 2.06$ $Log\text{-}L = 884.7$

Solved static long run equation

$$DCC\_MR_t = \underset{(1.078)}{-2.5629} + \underset{(0.0321)}{0.1171}(SPARE_t) + \underset{(0.0345)}{0.0585}(UMD_t) + \underset{(0.4275)}{1.3518}(TED_t) + \underset{(1.549)}{5.1680}(WMSS\_MMTt) + \underset{(1.656)}{0.9074}(WMSS\_AS_t) + \underset{(1.387)}{2.8491}(WMSS\_TCOM_t) - \underset{(1.416)}{4.2037}(INT\_TED\_MMT_t) + \underset{(0.0925)}{0.4509}(DUM_t)$$

WALD test $x^2(8) =$ 73.7788 [0.0000] **

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Dynamic analysis of lag structure

	Lag		
Variables	0	1	Σ
Constant	-0.2000	0.0000	-0.2000
DCC_MR	-1.0000	0.9220	-0.0778
SPARE	-0.0151	0.0242	0.0091
UMD	0.0013	0.0033	0.0046
TED	0.2120	-0.1070	0.1050
WMSS_MMT	0.6770	-0.2740	0.4020
WMSS_AS	-0.1110	0.1820	0.0706
WMSS_TCOM	0.1250	0.0967	0.2220
INT_TED_MMT	-0.7150	0.3880	-0.3270
DUM	0.0351	0.0000	0.0351

Test on the significance of each variable

Variable	F(n.,d.)	Value	Prob.	Unit Root t-test
Constant	F(1,487)	5.7611	[0.0168] *	
DCC_MR	F(1,487)	3914.0	[0.0000] **	-5.2814 *
SPARE	F(2,487)	5.1959	[0.0059] **	3.1479
UMD	F(2,487)	1.9725	[0.1402]	1.7804
TED	F(2,487)	13.5610	[0.0000] **	3.3786
WMSS_MMT	F(2,487)	8.0264	[0.0004] **	3.2183
WMSS_AS	F(2,487)	0.6349	[0.5305]	0.5545
WMSS_TCOM	F(2,487)	2.1108	[0.1222]	2.0535
INT_TED_MMT	F(2,487)	12.2770	[0.0000] **	-3.0917
DUM	F(1,487)	15.4660	[0.0001] **	3.9327

Tests on the significane of each lag

Lag	F(n.,d.)	Value	Prob.
1	F(8,487)	511.83	[0.0000] **

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An error correction model

Variable	Coefficient	JHCSE
Constant	0.0250	0.0020
ΔDCC_{t-1}	-0.0267	0.0464
$\Delta SPARE_{t}$	0.0087	0.0440
$\Delta SPARE_{t-1}$	-0.0302	0.0441
ΔUMD_{t}	0.0013	0.0013
ΔUMD_{t-1}	0.0002	0.0013
ΔTED_{t}	0.2130	0.1019
ΔTED_{t-1}	0.0522	0.0560
$\Delta WMSS\_MMT_{t}$	0.7061	0.2650
$\Delta WMSS\_MMT_{t-1}$	0.3259	0.2068
$\Delta WMSS\_AS_{t}$	-0.1156	0.1522
$\Delta WMSS\_AS_{t-1}$	0.0369	0.1772
$\Delta WMSS\_TCOM_{t}$	0.1314	0.1372
$\Delta WMSS\_TCOM_{t-1}$	0.0238	0.1571
$\Delta INT\_TED\_MMT_{t}$	-0.7083	0.3386
$\Delta INT\_TED\_MMT_{t-1}$	-0.1999	0.2048
ECM_{t-1}	-0.0791	0.0173

$R^2 = 0.13$ $F(16,487) = 4.639$

$\sigma = 0.042$ DW = 2.01 RSS = 0.87

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Cross-Trading Hedge Funds Matter

The long-run model

AR Model Estimated

$$A(L)DCC\_MR_t = \beta_1(L)SPARE_t + \beta_2(L)UMD_t + \beta_3(L)TED_t + \beta_4(L)WCMSA\_MMT_t + \beta_5(L)WCMSA\_AS_t + \beta_6(L)INT\_TED\_CMMTA_t + DUM_t$$

$R^2 = 0.96$ $F(14,489) = 925$ $DW = 2.08$ $Log\text{-}L = 885.028$

Solved static long run equation

$$DCC\_MR_t = \underset{}{0.2299} + \underset{(0.4065)}{0.1268}(SPARE_t) + \underset{(0.0370)}{0.0566}(UMD_t) + \underset{(0.0374)}{1.0007}(TED_t) + \underset{(0.3666)}{3.8594}(WCMSA\_MMTt) - \underset{(1.360)}{3.7826}(WCMSA\_AS_t) - \underset{(1.570)}{6.8718}(INT\_TED\_CMMTA_t) + \underset{(2.880)}{0.3756}(DUM_t)$$

WALD test $x^2(7) =$ 65.1266 [0.0000] **

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Dynamic analysis of lag structure

	Lag		
Variables	0	1	Σ
Constant	-1.0000	0.9270	-0.0729
DCC_MR	0.0168	0.0000	0.0168
SPARE	-0.0113	0.0206	0.0092
UMD	0.0012	0.0029	0.0041
TED	0.1970	-0.1240	0.0729
WCMSA_MMT	1.1800	-0.8970	0.2810
WCMSA_AS	-0.4550	0.1800	-0.2760
INT_TED_CMMTA	-1.5500	1.0500	-0.5010
DUM	0.0274	0.0000	0.0274

Test on the significance of each variable

Variable	F(n.,d.)	Value	Prob.	Unit Root t-test
Constant	F(1,489)	3818.5	[0.5818]	
DCC_MR	F(1,489)	0.3037	[0.0000] **	-4.8564 *
SPARE	F(2,489)	5.2796	[0.0054] **	3.1907
UMD	F(2,489)	1.5676	[0.2096]	1.6016
TED	F(2,489)	12.508	[0.0000] **	3.2762
WCMSA_MMT	F(2,489)	8.6470	[0.0002] **	3.1016
WCMSA_AS	F(2,489)	3.2507	[0.0396] *	-2.1928
INT_TED_CMMTA	F(2,489)	10.540	[0.0000] **	-2.7496
DUM	F(1,489)	7.3070	[0.0071] **	2.7031

Tests on the significane of each lag

Lag	F(n.,d.)	Value	Prob.
1	F(7,489)	564.7	[0.0000] **

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An error correction model

	Coefficient	JHCSE
Constant	-0.0110	0.0020
ΔDCC_{t-1}	-0.0379	0.0424
$\Delta SPARE_t$	0.0065	0.0432
$\Delta SPARE_{t-1}$	-0.0219	0.0436
ΔUMD_t	0.0014	0.0013
ΔUMD_{t-1}	0.0004	0.0013
ΔTED_t	0.1905	0.1017
ΔTED_{t-1}	0.0301	0.0450
$\Delta WCMSA\_MMT_t$	1.1795	0.4120
$\Delta WCMSA\_MMT_{t-1}$	0.5366	0.3830
$\Delta WCMSA\_AS_t$	-0.4599	0.2775
$\Delta WCMSA\_AS_{t-1}$	0.1642	0.2662
$\Delta INT\_TED\_CMMTA_t$	-1.4891	0.8019
$\Delta INT\_TED\_CMMTA_{t-1}$	-0.2810	0.8470
ECM_{t-1}	-0.0744	0.0173

$R^2 = 0.13$ $F(14,489) = 5.264$

$\sigma = 0.042$ DW = 2.01 RSS = 0.87

Conclusion

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Findings

- "Co-movements"
    - Time variations in correlations, but no upward trend till crisis
    - Extreme-events analysis: commodity umbrella leaks
- "Speculation" in cross-section of energy paper mkts
    - Increase in speculation + hedge fund activity + cross-mkt activity
- Impact of hedge funds in energy markets
    - Hedge fund activity helps link markets
    - Market stress matters, too
    - Interaction – contagion through wealth effects?
- Information on OI composition is payoff-relevant
    - CFTC decision to disaggregate more