Tail events: A New Approach to Understanding Extreme Energy Commodity Prices

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Motivation

- Puzzle: Unprecedented + synchronized boom-bust cycle in energy prices
- Aim: Understanding the propagation mechanism
- Strategy: Looking at clusters of extreme energy price fluctuations
  - Extreme event or "exceedance"
    A week with large price fall or rise in one market, which are defined as the bottom or top 10% tail of the distribution
  - Cluster or "coexceedance"
    A week in which more than one market synchronously experiences extreme events

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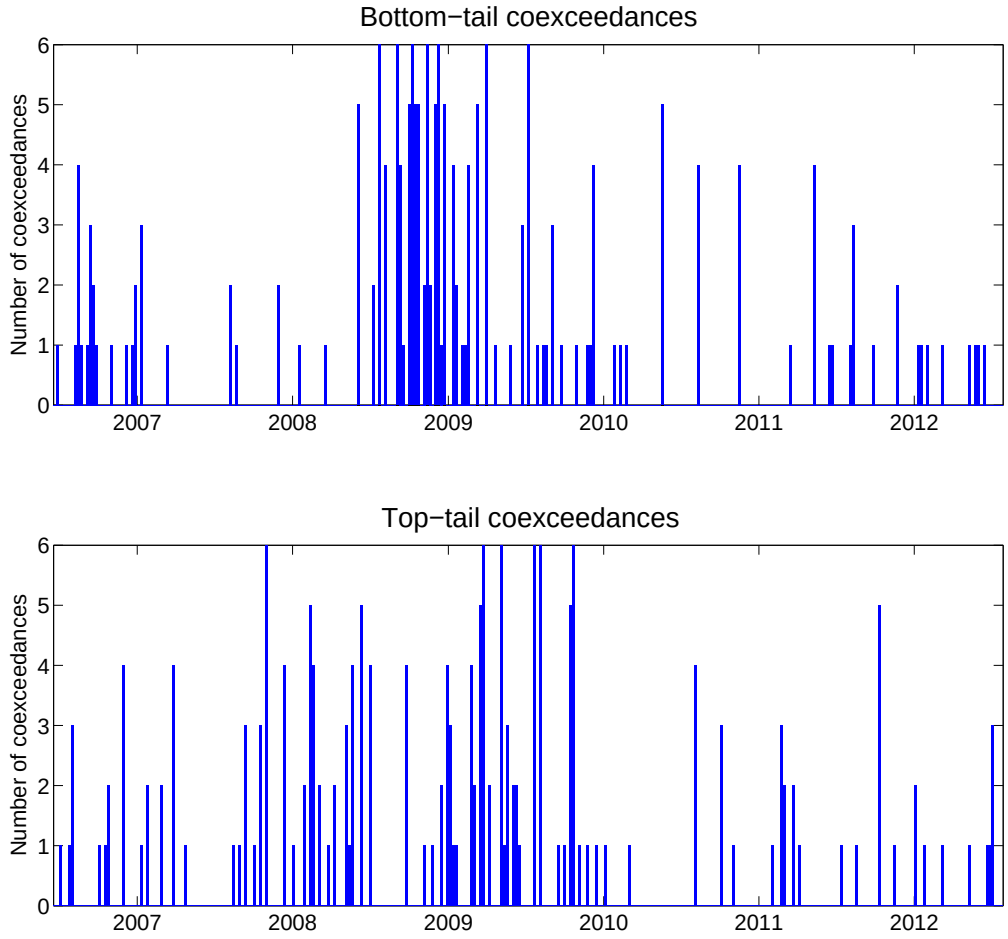
Clustering of extreme events



- Six energy markets: WTI crude oil, heating oil, gasoline, natural gas, Brent crude oil, gasoil

Research question

What explains the coincidence of extreme energy price innovations during the recent boom and bust cycle?

1. Can these tail events be explained by common supply and demand fundamentals?
2. Or is there evidence of an amplification mechanism caused by financial intermediaries?

Punchline: Boom-bust process is related to the financialization of commodity futures markets

Theories and transmission channels I

1. Real demand channel: Sharp rise and fall in demand for energy – mainly from China and other emerging economies – are important unexpected shocks
   $\rightarrow$ Hamilton (2009); Kilian (2009)

- Baltic Dry index, MSCI Emerging Market index, US dollar index, 3-month T-bill

Theories and transmission channels II

2. Financial demand channel: boom and bust caused by the increasing flow of money from financial participants into energy futures markets
   $\rightarrow$ Liu, Qiu and Tang (2011)
   - financial demand distorts commodity prices
   - in/out flow of speculative money exacerbates price volatility
   - correlations increase if different commodities are subject to correlated financial demand

- net long position changes of two types of traders provided by the US CFTC: managed money traders (hedge funds) and swap dealers (index traders)

Theories and transmission channels III

3. Liquidity channel: Reductions in funding liquidity lead to adverse trading and funding liquidity spirals which lead to coincident poor performance
   $\rightarrow$ Brunnermeier and Pedersen (2009)
   - shocks force financial players to liquidate their holdings in several markets at the same time
   - liquidation can amplify shocks and cause commonality in price fluctuations across different markets

- TED spread, changes in net repo volume (and credit spread)

Data

- Weekly energy futures data from June 2006 to July 2012
- Six energy commodities included in S&P GSCI: WTI crude oil, heating oil, gasoline, natural gas, Brent crude oil, gasoil
  - Weekly returns by rolling over from nearest to second nearest futures contract (Gorton et al., 2013)
- Pre-filtering of raw returns by VAR model containing common risk factors
  - aggregate market factors: S&P 500, USD, short rate, yield spread, credit spread
  - commodity-specific factors: futures basis, hedging pressure

Empirical strategy

- Estimate the conditional probability that a tail event (exceedance/coexceedance) on a given date occurs
- Multinominal logit regression model
  - Dependent variable: i tail event categories

$$\begin{cases} 0 & \text{Base case: if NO extreme event is observed} \\ 1 & \text{ONE case: if 1 extreme event is observed} \\ 2 & \text{LOW case: if 2 or 3 markets experience extreme event} \\ 3 & \text{HIGH case: if 4 or more markets experience extreme event} \end{cases}$$

  - $\Pr(\textit{tail event}_i) = f\left(\begin{array}{c} \textit{Real demand channel variables} \\ \textit{Financial demand channel variables} \\ \textit{Liquidity channel variables} \\ \textit{Control variables} \end{array}\right)$

Selected results

	Bottom tails		Top tails	
	(1)	(2)	(3)	(4)
Real Demand Channel Variables				
Baltic *(ONE)*	-0.03*	-0.04**	0.01	0.02
Baltic *(LOW)*	-0.06***	-0.05**	0.03	0.04
Baltic *(HIGH)*	-0.02	-0.02	0.01	0.01
Emerging *(ONE)*	-0.06	-0.04	0.02	0.03
Emerging *(LOW)*	-0.03	-0.01	0.07	0.07
Emerging *(HIGH)*	-0.01	-0.09	-0.02	0.06
Financial Demand Channel Variables				
Hedge funds *(ONE)*		-0.10***		0.06*
Hedge funds *(LOW)*		-0.12***		0.10**
Hedge funds *(HIGH)*		-0.12**		0.18***
Index trader *(ONE)*		-0.02		0.03
Index trader *(LOW)*		-0.06		0.09
Index trader *(HIGH)*		-0.11		0.14*
Liquidity Channel Variables				
TED spread *(ONE)*		0.09		-0.04
TED spread *(LOW)*		0.57*		0.53
TED spread *(HIGH)*		1.15***		0.41
Repo volume *(ONE)*		0.00		-0.01
Repo volume *(LOW)*		-0.00		-0.00
Repo volume *(HIGH)*		0.01		-0.00
Pseudo R^2	0.05	0.13	0.01	0.08

Selected results: only fundamental factors

	Bottom tails		Top tails	
	(1)	(2)	(3)	(4)
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Selected results: adding non-fundamental factor

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	(1)	(2)	(3)	(4)
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Repo volume *(ONE)*		0.00		-0.01
Repo volume *(LOW)*		-0.00		-0.00
Repo volume *(HIGH)*		0.01		-0.00
Pseudo R^2	0.05	**0.13**	0.01	**0.08**

Selected results: financial demand channel

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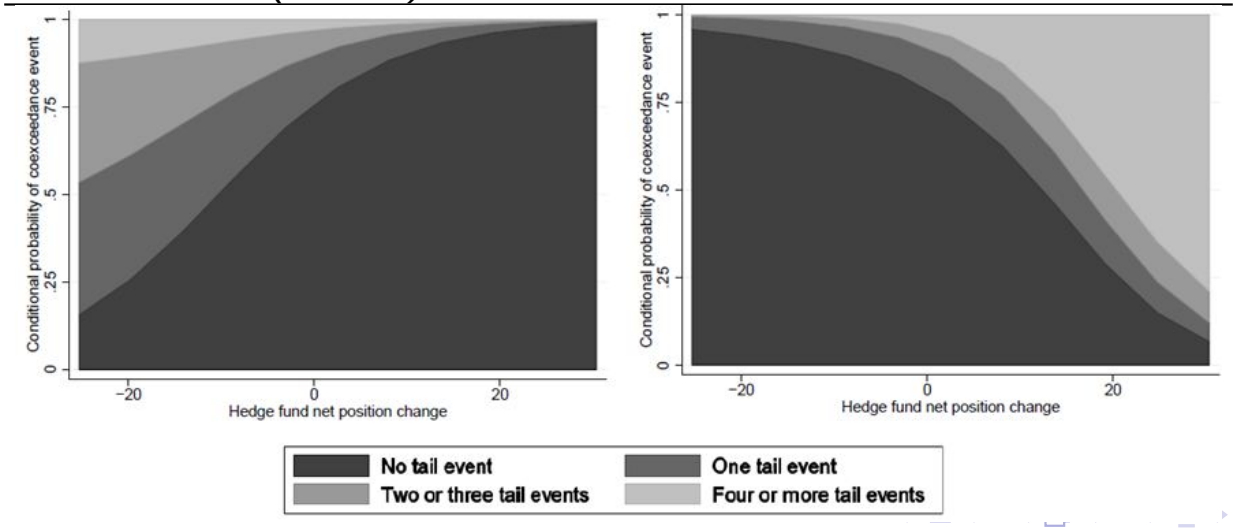

Selected results: liquidity channel

	Bottom tails	
	(1)	(2)
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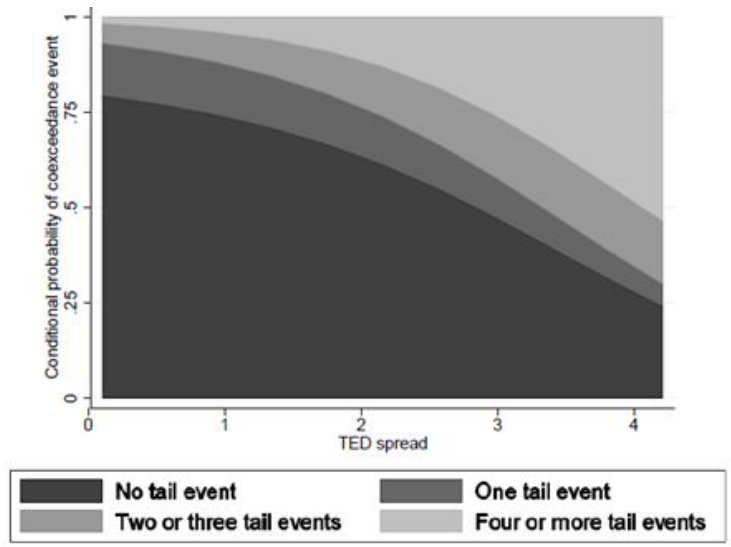

Predictability of tail events

- Robustness analysis: re-estimate the multinominal logit models using lagged explanatory variables:
  - pseudo-R^2 of 7% and 5% is much smaller
  - lagged TED spread still has positive and significant coefficients
  - lagged trading positions of hedge funds and index traders are insignificant
    - May reflect that energy futures prices rapidly incorporate information
    - Tail events are not predictable by positions of financial traders
    - Results should not necessarily be interpreted as contemporaneous positions changes causing extreme price changes

Implications and Discussion

- Clustering of tail events cannot be exclusively explained by market fundamentals
- Instead, evidence that non-fundamental factors (combination of liquidity + financial demand channel) gain economic relevance and coincide with significant cross-market spillovers
- Provides empirical support to recent policy efforts to regulate commodity derivatives markets
- But
  - Only sufficiently large position changes amplify market movements
  - No evidence that trading positions predict extreme price events
  - Aggregated position data (publicly provided by CFTC) may be imprecise

Thank you!