
Reflexivity in financialized commodity futures markets. The role of information

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Based on the joint work:

V. Filimonov, D. Bicchetti, N. Maystre and D. Sornette

“Quantification of the High Level of Endogeneity and of Structural Regime Shifts in Commodity Markets”

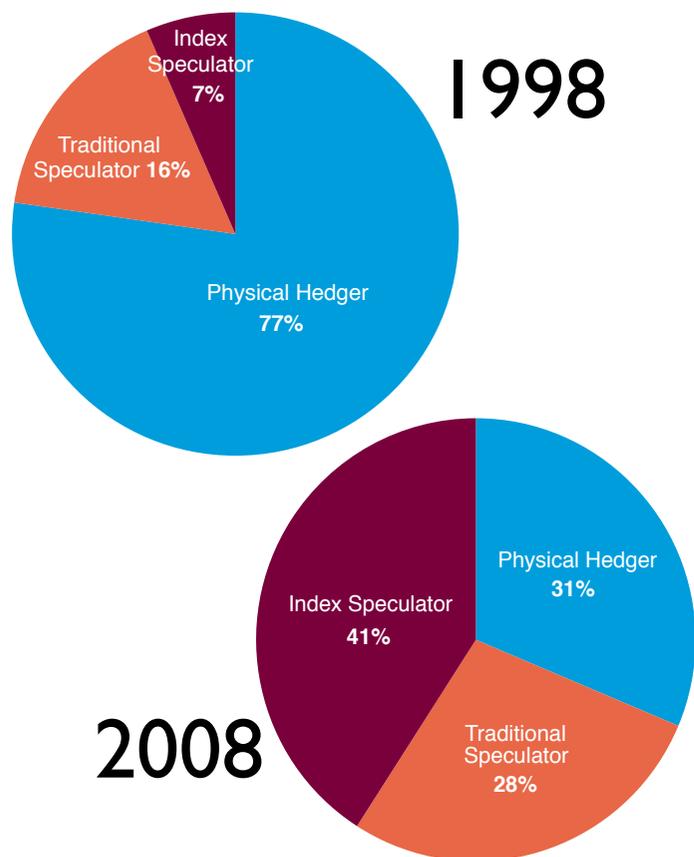
“Understanding International Commodity Price Fluctuations”

IMF Research Department

Washington DC, March 20-21, 2013

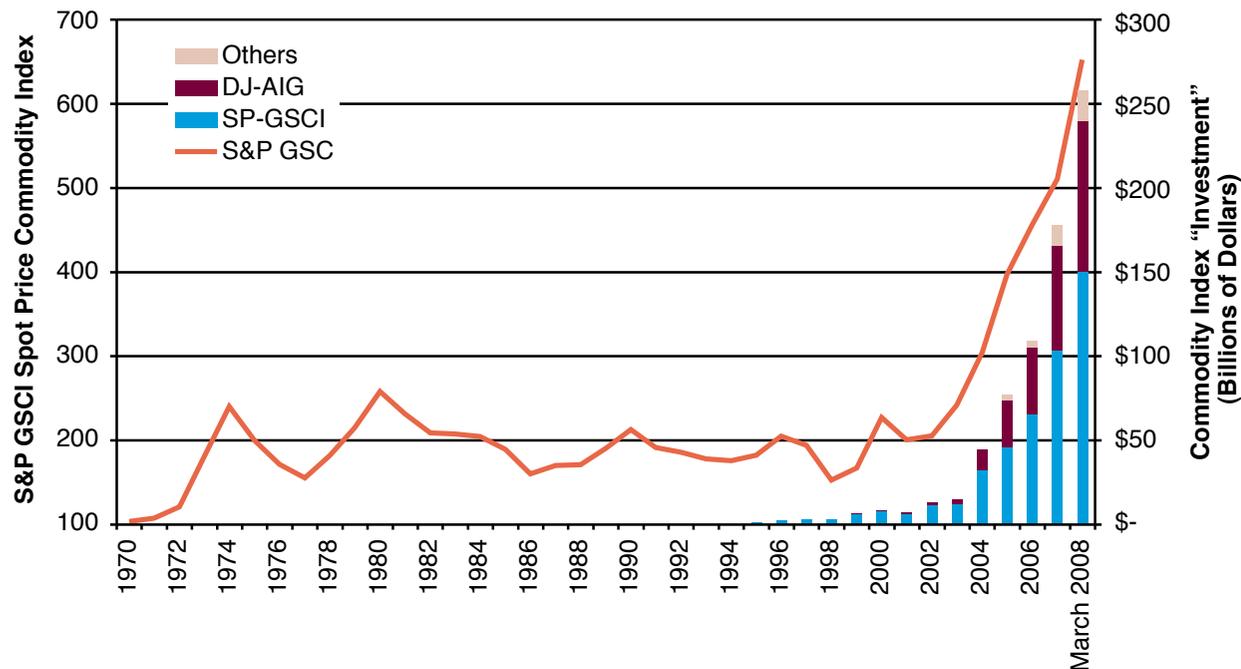
The opinions expressed in this paper, including designation and terminology, are those of the authors and are not to be taken as the official views of the UNCTAD Secretariat or its Member States.

Increasing market share of commodity speculators



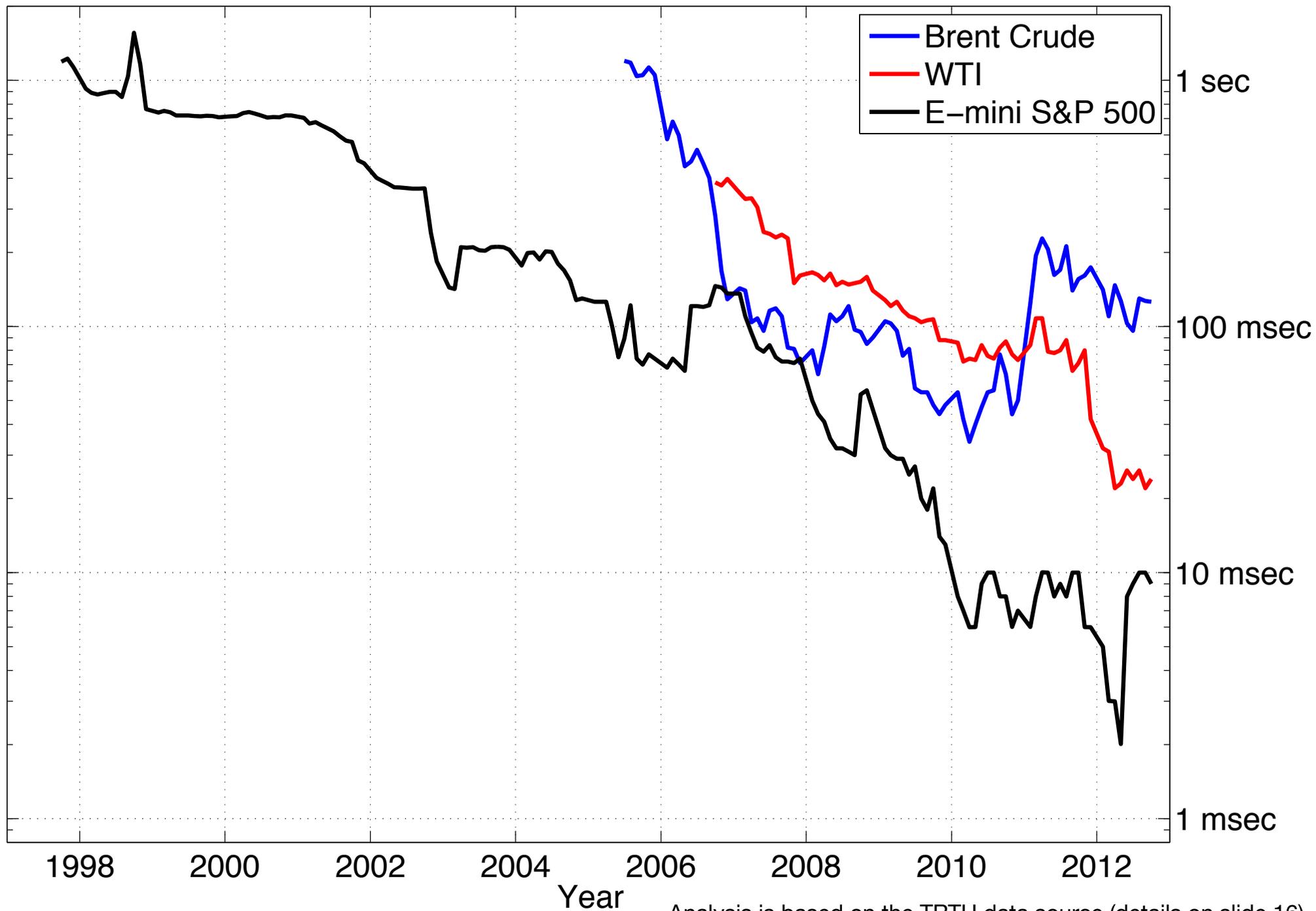
Source: CFTC figures
charts by Mike Masters, Better Markets.

Increasing market share of commodity speculators



Source: Goldman Sachs, Bloomberg,
CFTC Commitments of Traders CIT Supplement

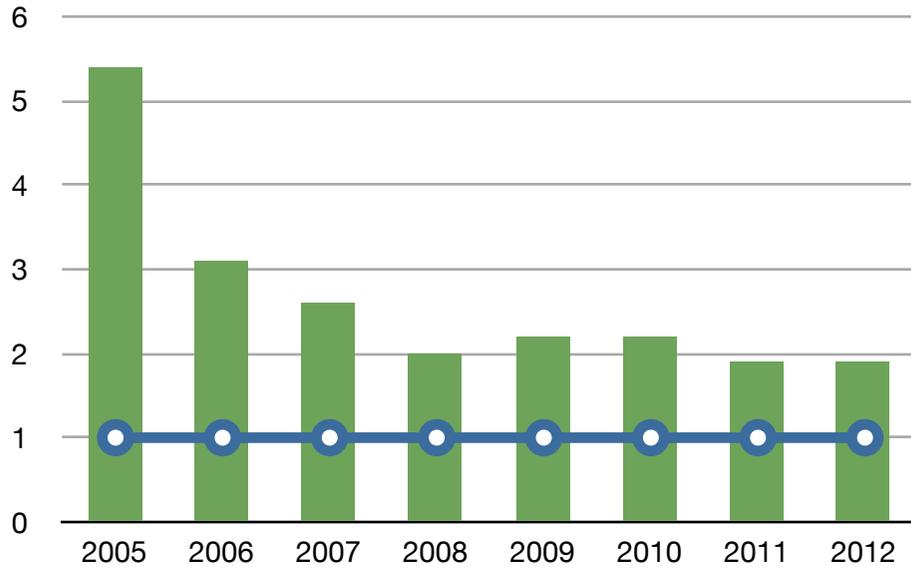
Typical market makers' reaction time



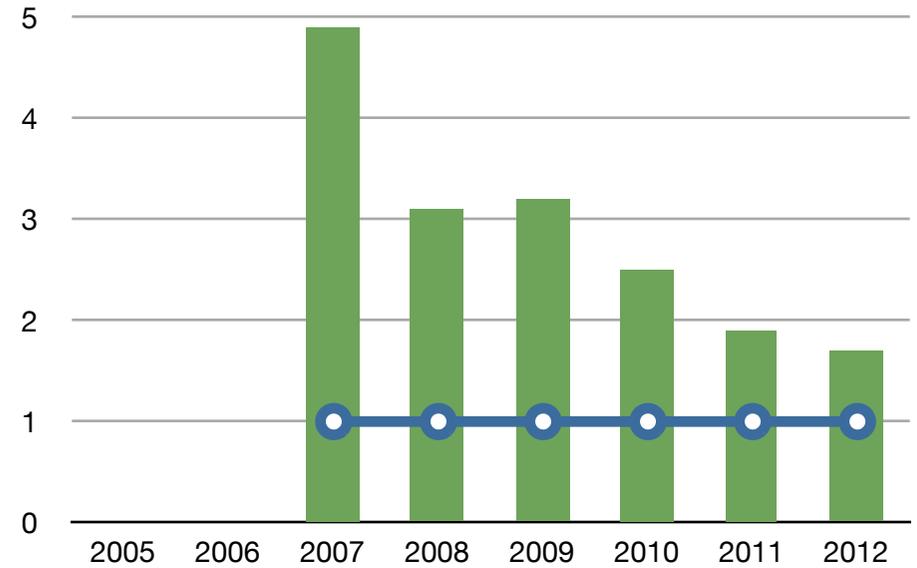
Analysis is based on the TRTH data source (details on slide 16).

Volume traded per transaction

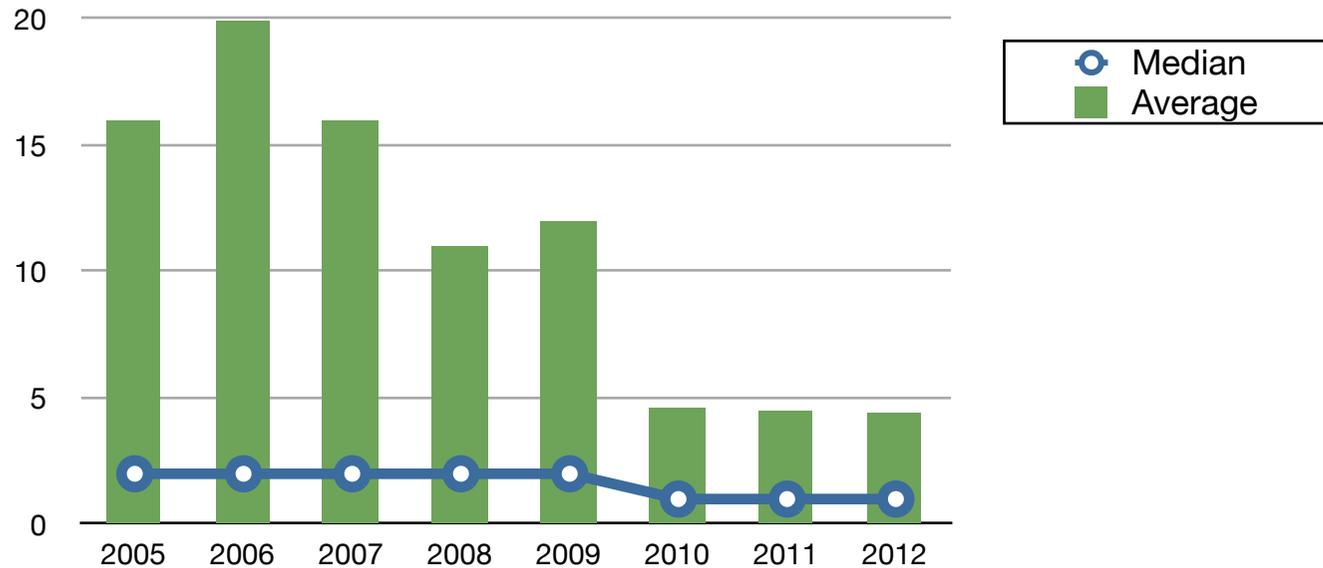
Brent Crude Oil



WTI

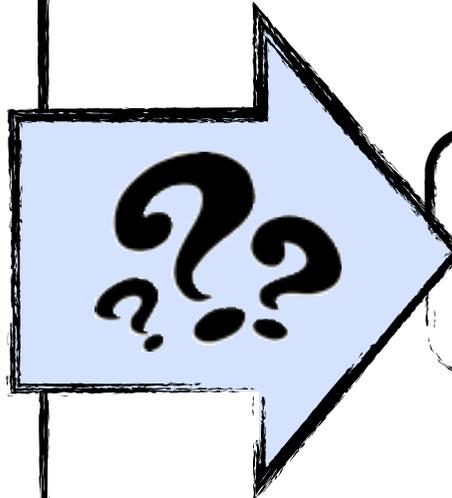


E-Mini S&P 500 Futures



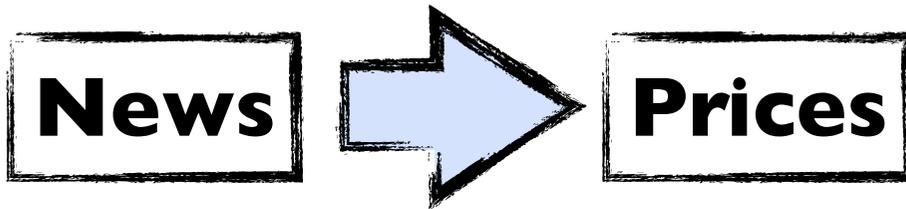
Information

- ▶ supply/demand
- ▶ interest rates
- ▶ exchange rates
- ▶ inflation
- ▶ economic conditions
- ▶ cost of production
- ▶ weather
- ▶ political stability
- ▶ etc.



Prices

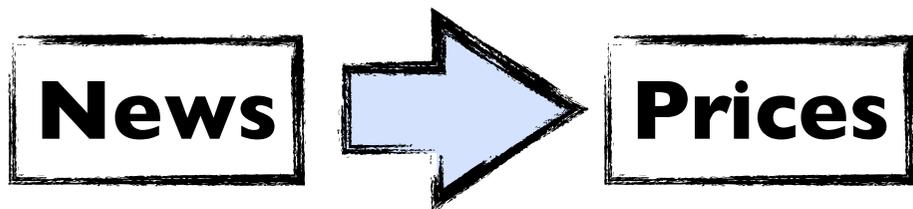
GLCH	0.72	0.04	6.03%	↑
SKBI	2.67	-0.02	-0.79%	↓
TSLA	27.56	1.21	4.39%	↑
STB	6.32	0.09	1.42%	↑
LOCM	2.38	-0.04	-1.68%	↓
ENTR	3.56	0.04	1.12%	↑
IGLD	3.64	-0.14	-3.74%	↓
HSIC	3.87	0.14	3.62%	↑
AMCX	39.64	0.16	0.40%	↑
HSOL	0.98	0.03	3.06%	↑
NINE	1.07	0.03	2.80%	↑
TSBK	4.80	0.13	2.71%	↑
BPHN	60.48	1.44	2.38%	↑
CLNT	4.10	-0.01	-0.24%	↓
CASY	57.35	-0.55	-0.96%	↓
AFEB	5.64	0.01	0.18%	↑
GIVN	17.29	0.20	1.16%	↑
EXEL	4.61	0.22	4.77%	↑
FFEX	18.00	0.28	1.56%	↑
ONCY	3.48	0.15	4.31%	↑
SKUL	12.25	0.17	1.39%	↑
MPAC	5.70	-0.01	-0.18%	↓
CEBC	1.21	-0.06	-1.43%	↓
PACW	22.94	0.01	0.04%	↑
CLUB	11.46	0.26	2.27%	↑
RNWK	8.53	0.11	1.29%	↑
CTBI	32.57	0.35	1.07%	↑
IGLD	3.64	-0.14	-3.74%	↓
BBGI	5.64	0.15	2.66%	↑
AMSC	3.56	0.07	1.97%	↑
ASEI	48.29	0.67	1.39%	↑
SGI	5.13	0.29	5.65%	↑
PLCC	1.06	-0.06	-5.68%	↓
CVLY	13.49	0.01	0.07%	↑
AAPL	530.38	30.90	5.83%	↑
DYH	5.70	-0.01	-0.18%	↓
TBNK	21.09	0.28	1.33%	↑
RELV	1.31	-0.13	-9.92%	↓
BPHN	13.12	0.18	1.37%	↑



Efficient Markets (exogenous dynamics)

Prices are just reflecting news:
the market fully and instantaneously absorbs the flow of information and faithfully reflects it in asset prices.

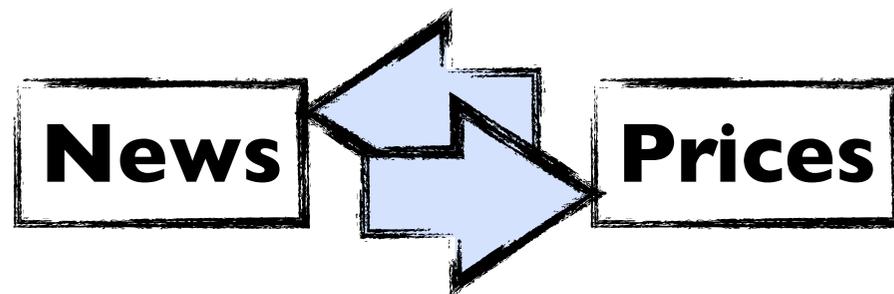
In particular, financial crashes are the signature of exogenous negative news of large impact.



Efficient Markets (exogenous dynamics)

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“Reflexivity” of markets (endogenous dynamics)

Markets are subjected to internal **feedback loops** (e.g. created by collective behavior such as herding or informational cascades).

Prices **do influence** the fundamentals and this newly-influenced set of fundamentals then proceed to change expectations, thus influencing prices.

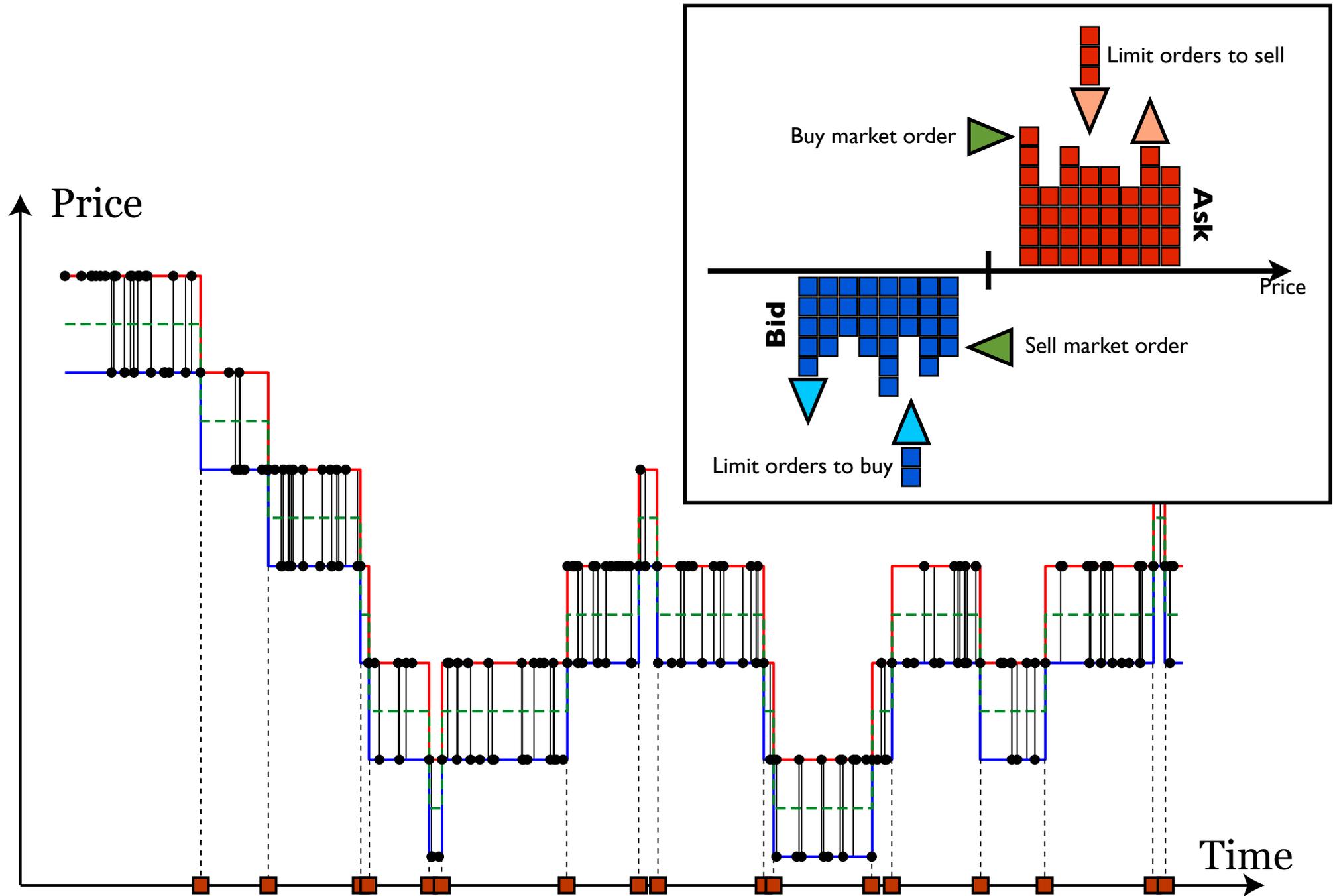
- Behavioral mechanisms such imitation and informational cascades leading to **herding**;
- Speculation, based on technical analysis, including **algorithmic trading**;
- **Hedging** strategies (also increase cross-excitation between markets);
- Pricing of “**structured products**” such as ETFs (also contribute to cross-excitation)
- Methods of **optimal portfolio execution** and **order splitting**;
- Margin/leverage trading and **margin-calls**;
- **High frequency trading (HFT)** as a subset of algorithmic trading;
- **Stop-loss orders** and etc.

- Is it possible to quantify the interplay between **exogeneity** (external impact) and **endogeneity** (internal self-excitation) in price formation?
- How **efficient** are commodity markets?

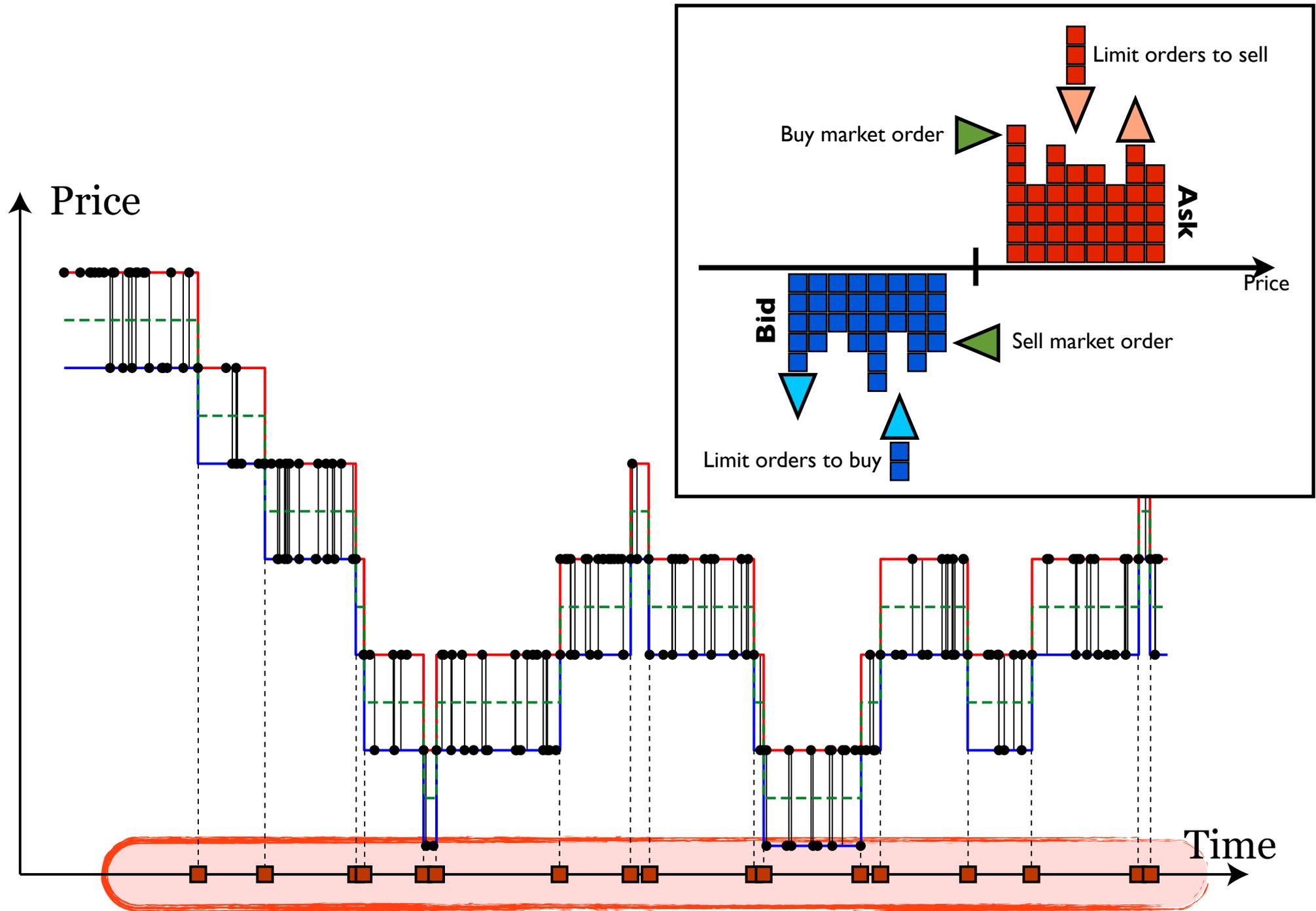
“As a policy-maker during the crisis, I found the available models of limited help. In fact, I would go further: **in the face of the crisis, we felt abandoned by conventional tools**. In the absence of clear guidance from existing analytical frameworks, policy-makers had to place particular reliance on our experience”.

Jean-Claude Trichet (2010)

The test subject: HF price dynamics



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Self-excited Hawkes process is the point process whose intensity $\lambda_i(t)$ is conditional on its history:

$$\lambda(t) = \mu + n \sum_{t_i < t} \varphi(t - t_i)$$

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Background intensity

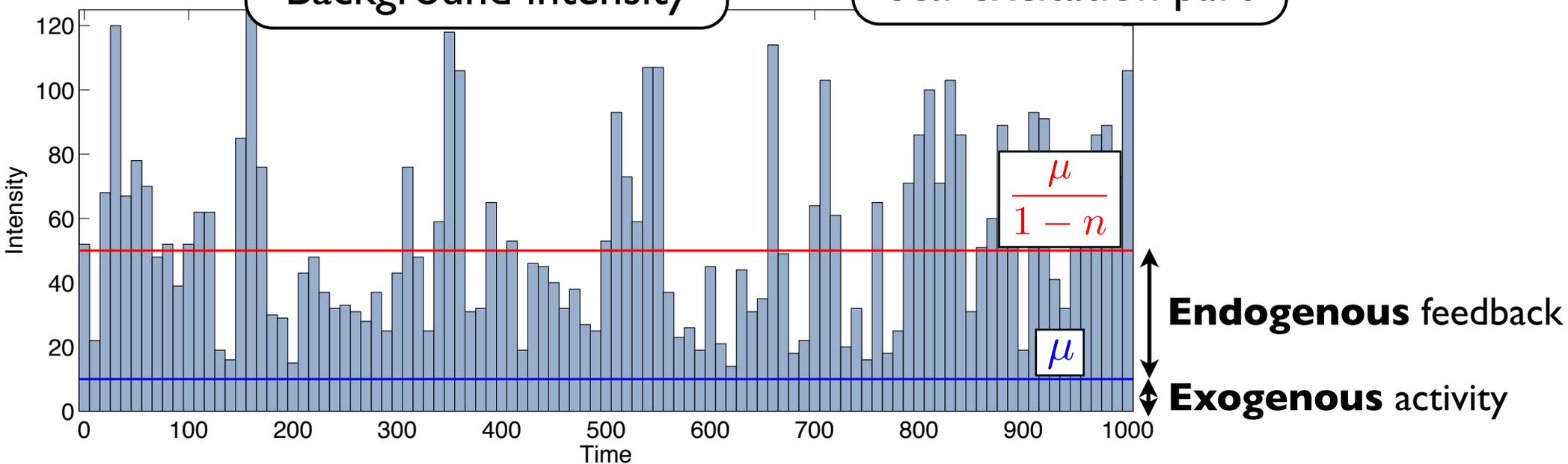
Self-excitation part

Self-excited Hawkes process is the point process whose intensity $\lambda_t(t)$ is conditional on its history:

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Background intensity

Self-excitation part

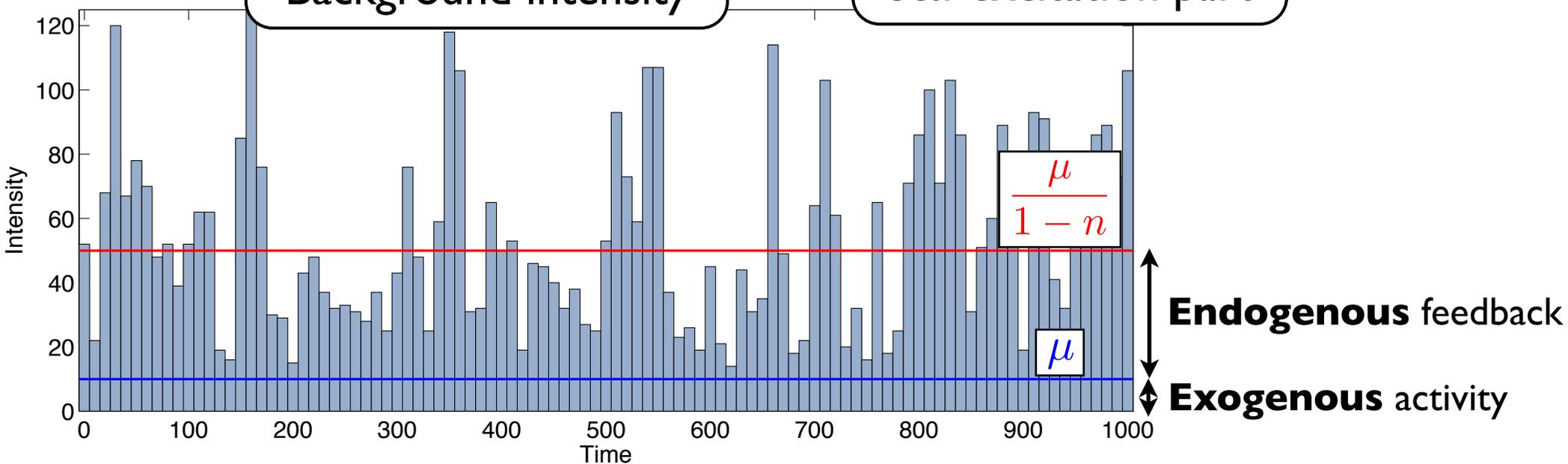


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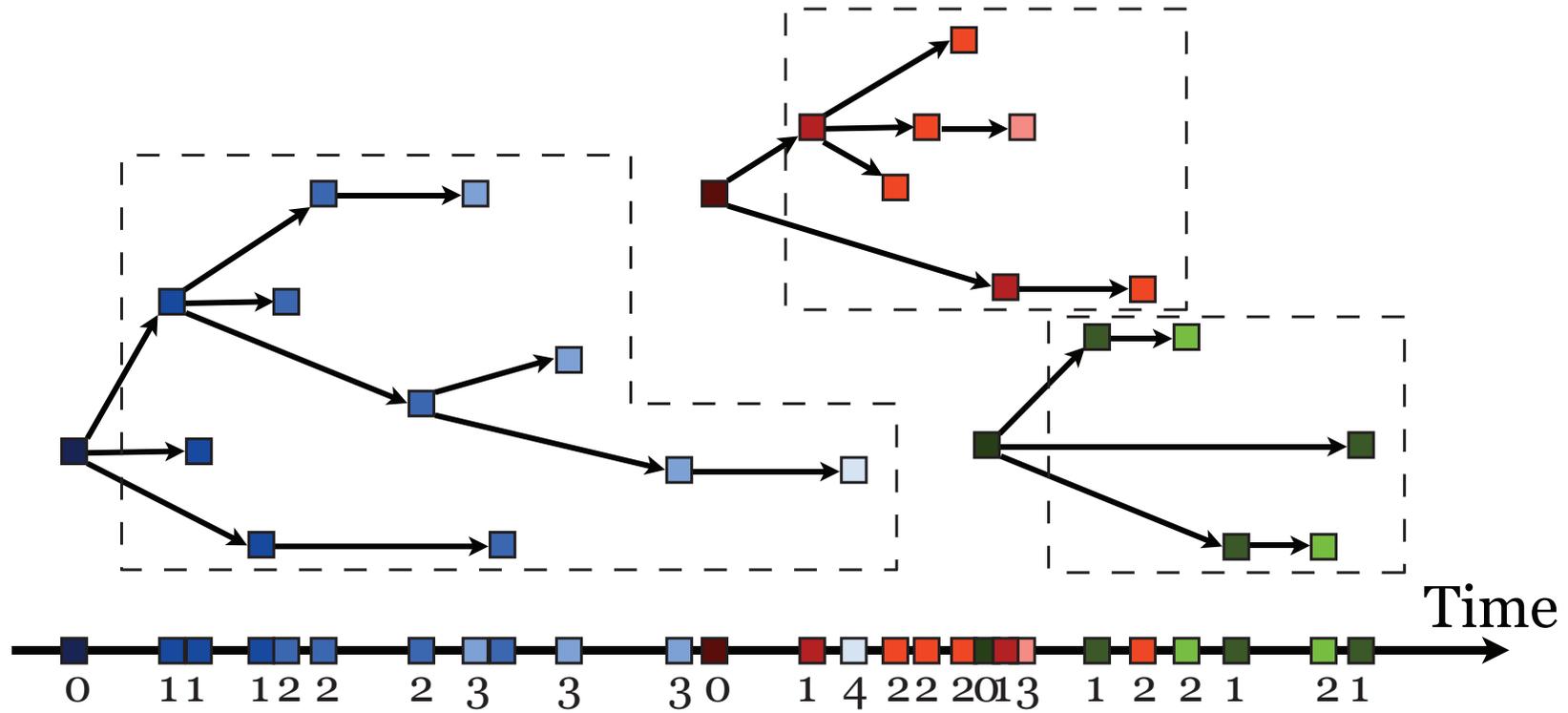
Background intensity

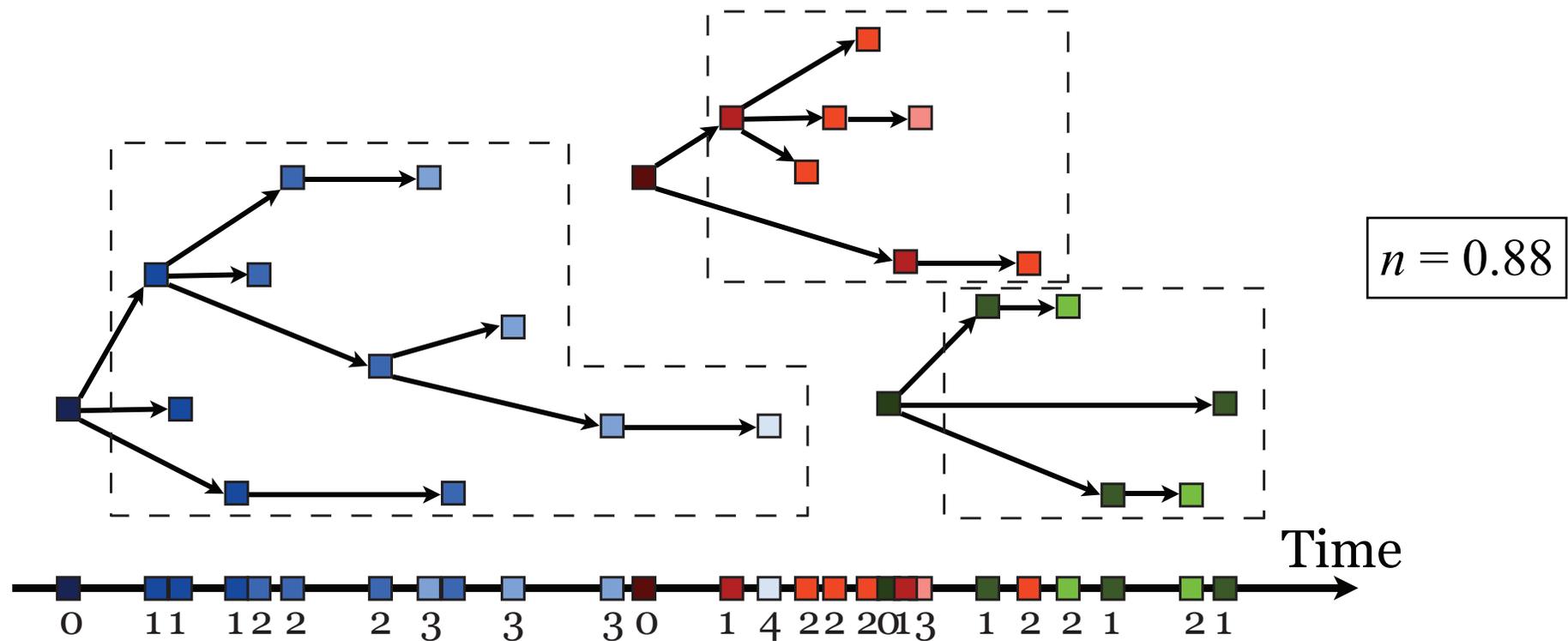
Self-excitation part



Economic applications of the Hawkes model:

- High-frequency price dynamics
- Order book construction
- Critical events and estimation of VaR
- Correlated default times in a portfolio of companies



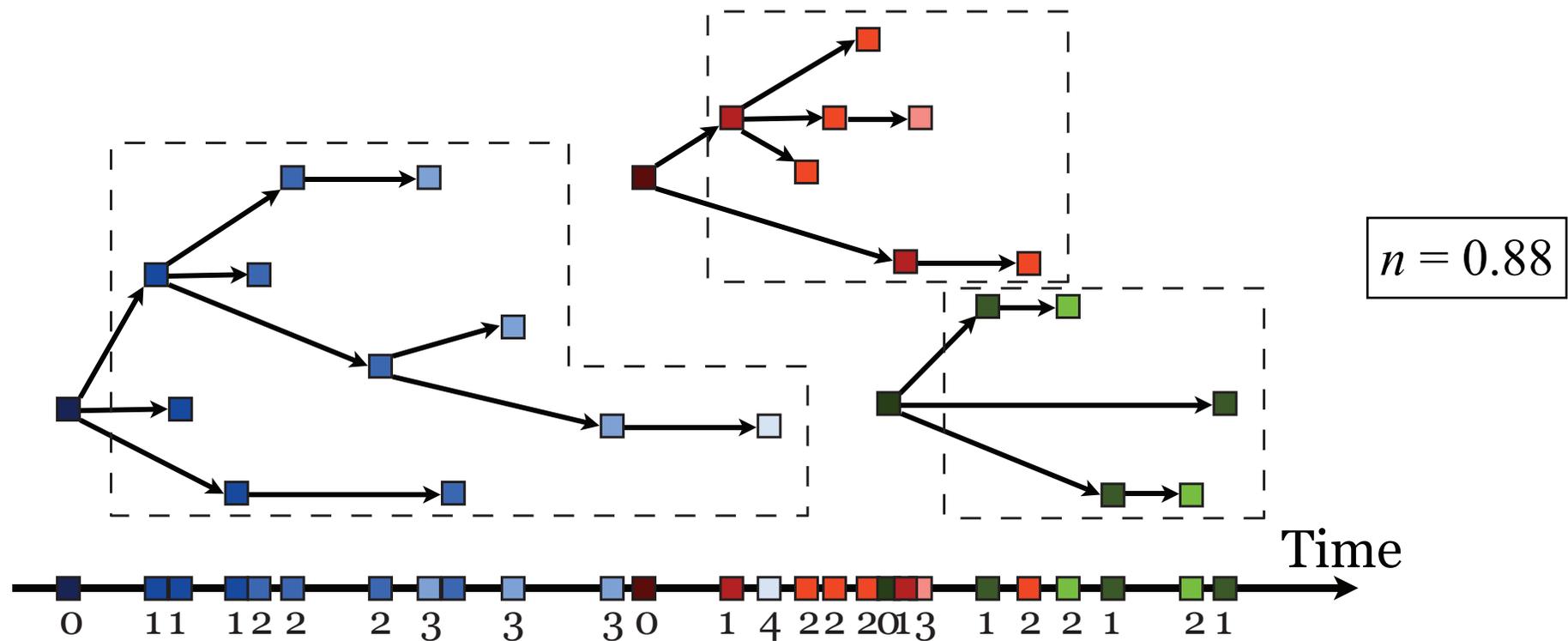


Crucial parameter of the branching process is the “**branching ratio**” (n) which is defined as an average number of “daughters” per one “mother”

For $n < 1$ system is **subcritical** (stationary evolution)

For $n = 1$ system is **critical** (tipping point)

For $n > 1$ system is **supercritical** (with prob.>0 will explode to infinity)



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In subcritical regime, **the branching ratio (n) is equal to the fraction of endogenously generated events among the whole population.**

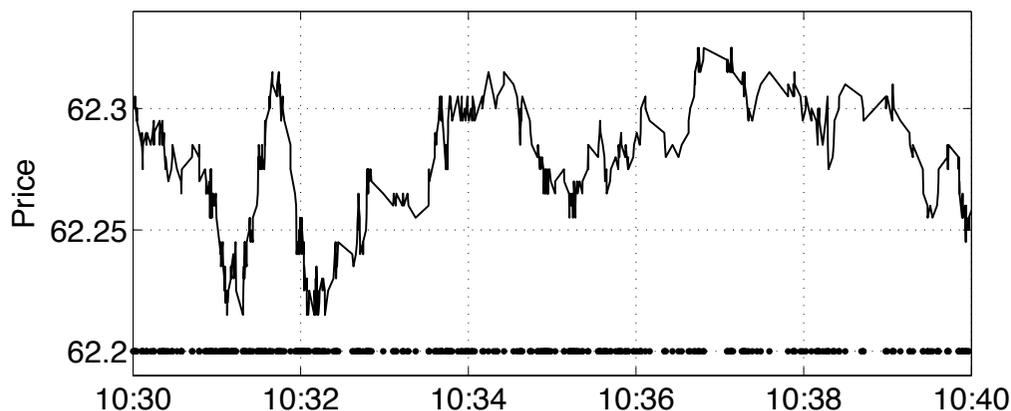
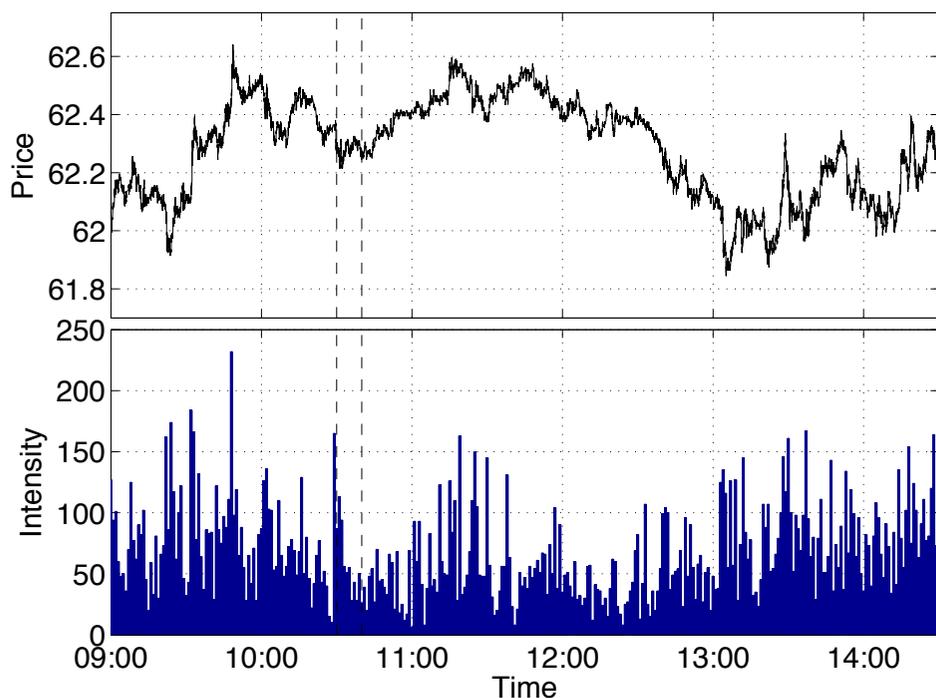
Instrument	Exchange / Trading platform	Inception of electronic trading	Average monthly volume in 2012
Brent Crude	ICE Europe / ICE	April 7, 2005	4,009,582
WTI	NYMEX / CME Globex	September 4, 2006	5,482,223
Soybean	CBOT / CME Globex	August 1, 2006	1,493,210
Sugar #11	ICE US / ICE	January 12, 2007 (March 2, 2008)	909,178
Corn	CBOT / CME Globex	August 1, 2006	2,706,229
Wheat	CBOT / CME Globex	August 1, 2006	1,045,313
Sugar (Europe)	LIFFE / NYSE Euronext	November 27, 2000	82,955
E-mini S&P500	CME / CME Globex	September 9, 1997	36,823,740

- We have analyzed **Front Month** futures contracts of the instruments presented at previous slide. Rolling periods were ignored.
- Data source: **Thomson Reuters Tick History**, that provides level-1 data (TAQ) with the millisecond resolution of timestamps.
- In fact due to the FAST/FIX protocol handling, the *reliability of timestamps in TRTH database is much lower than milliseconds* and is defined by the typical time between consecutive FAST/FIX packages.

Median uncertainty in timestamps (in milliseconds)

Contract	2005	2006	2007	2008	2009	2010	2011	2012
Brent (EU)	227	118	35	26	24	30	65	68
WTI (US)	—	199	80	62	61	62	59	22
Soybean (US)	—	149	130	71	77	32	22	23
Sugar #11 (US)	—	—	—	112	58	43	127	135
Corn (US)	—	151	174	75	106	45	32	26
Wheat (US)	—	174	179	91	86	29	30	22
Sugar (EU)	223	197	190	245	119	85	84	69
E-mini S&P 500	127	121	79	51	60	31	32	41

March 23, 2007



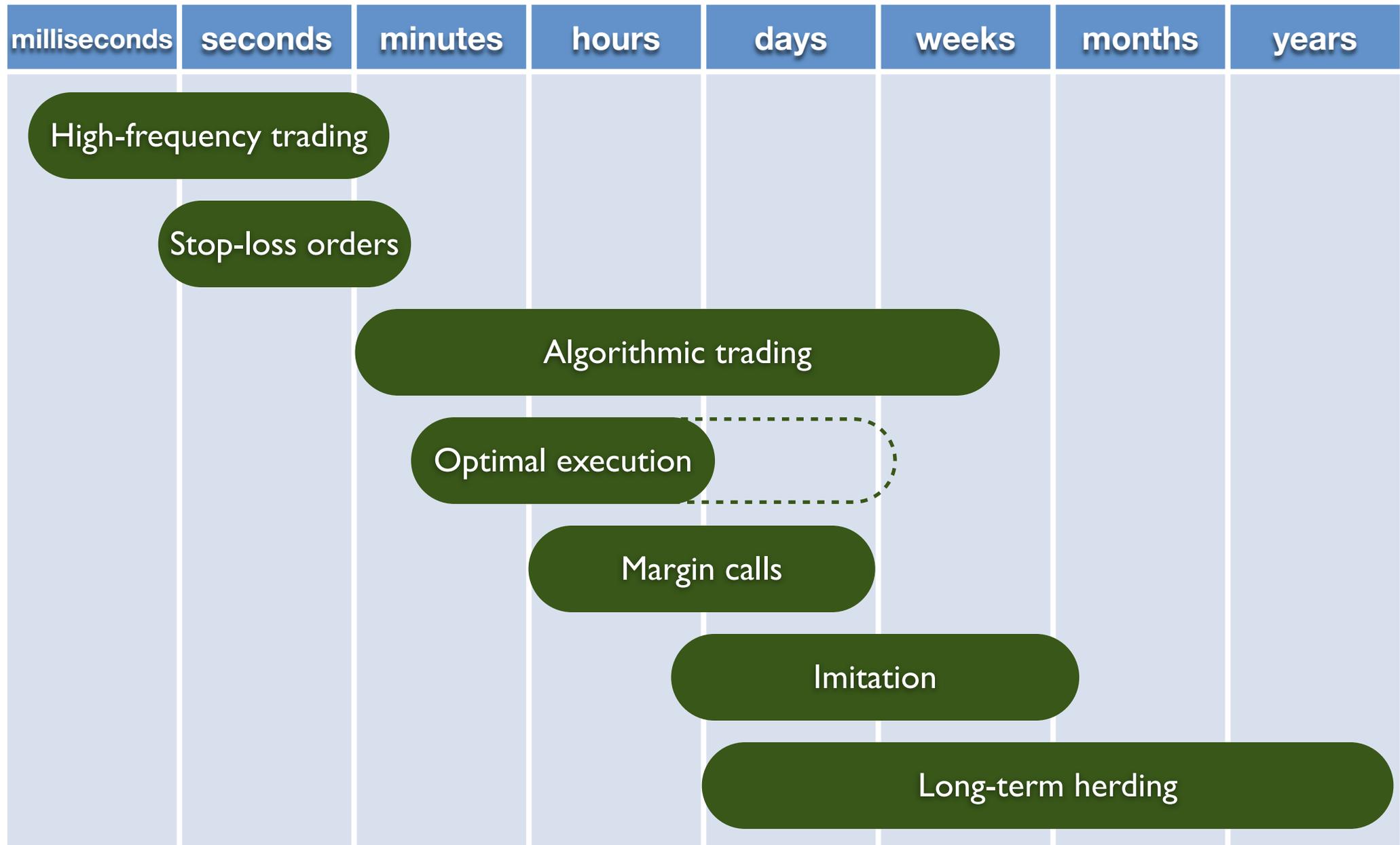
$n = 0.43$

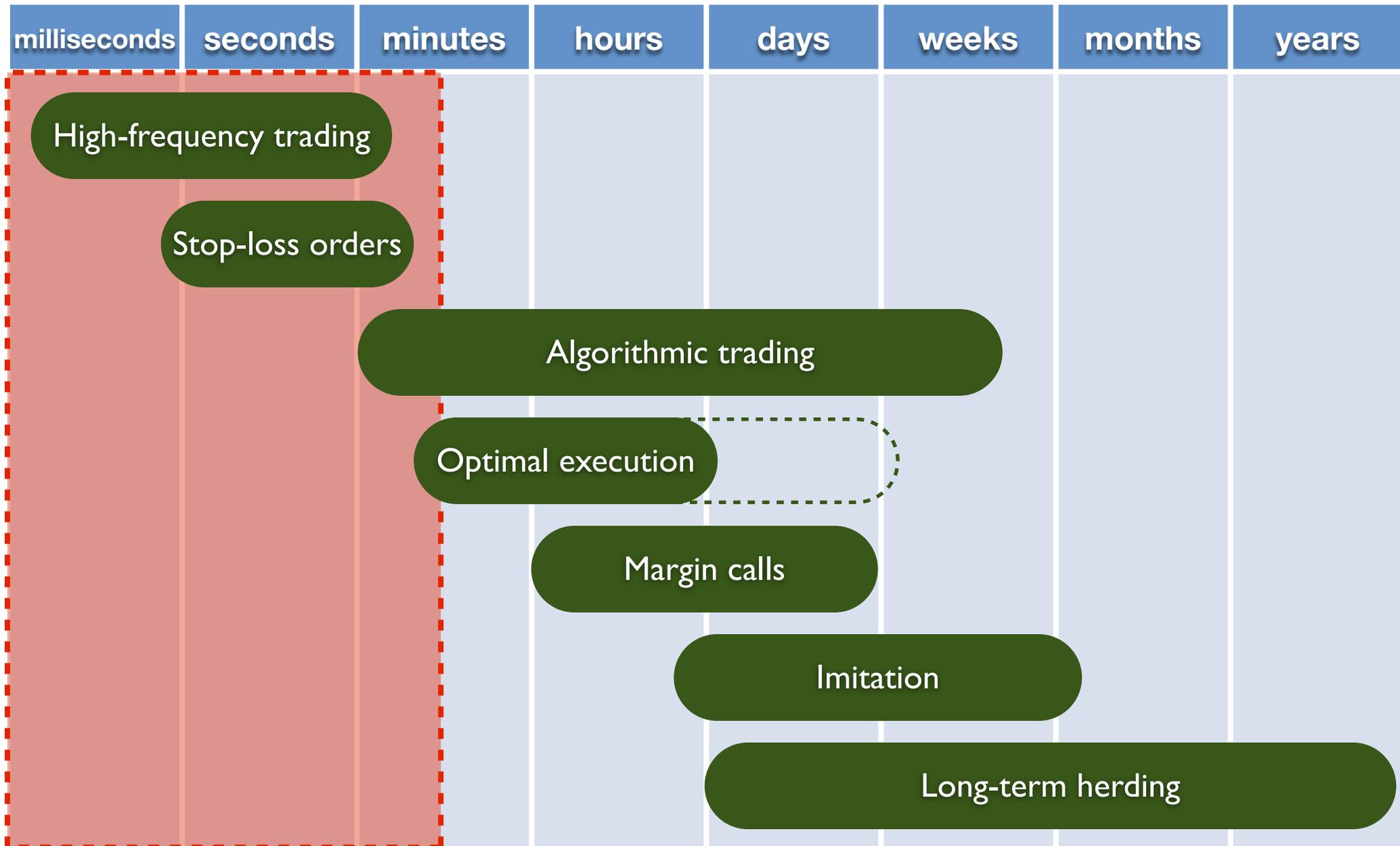
- We split the entire interval of the analysis (2005-2012) into **10 minutes** intervals, rolling them with a step of 1 minute within the RTH
- In each of these windows we have calibrated **the Hawkes model with the short-term exponential kernel**

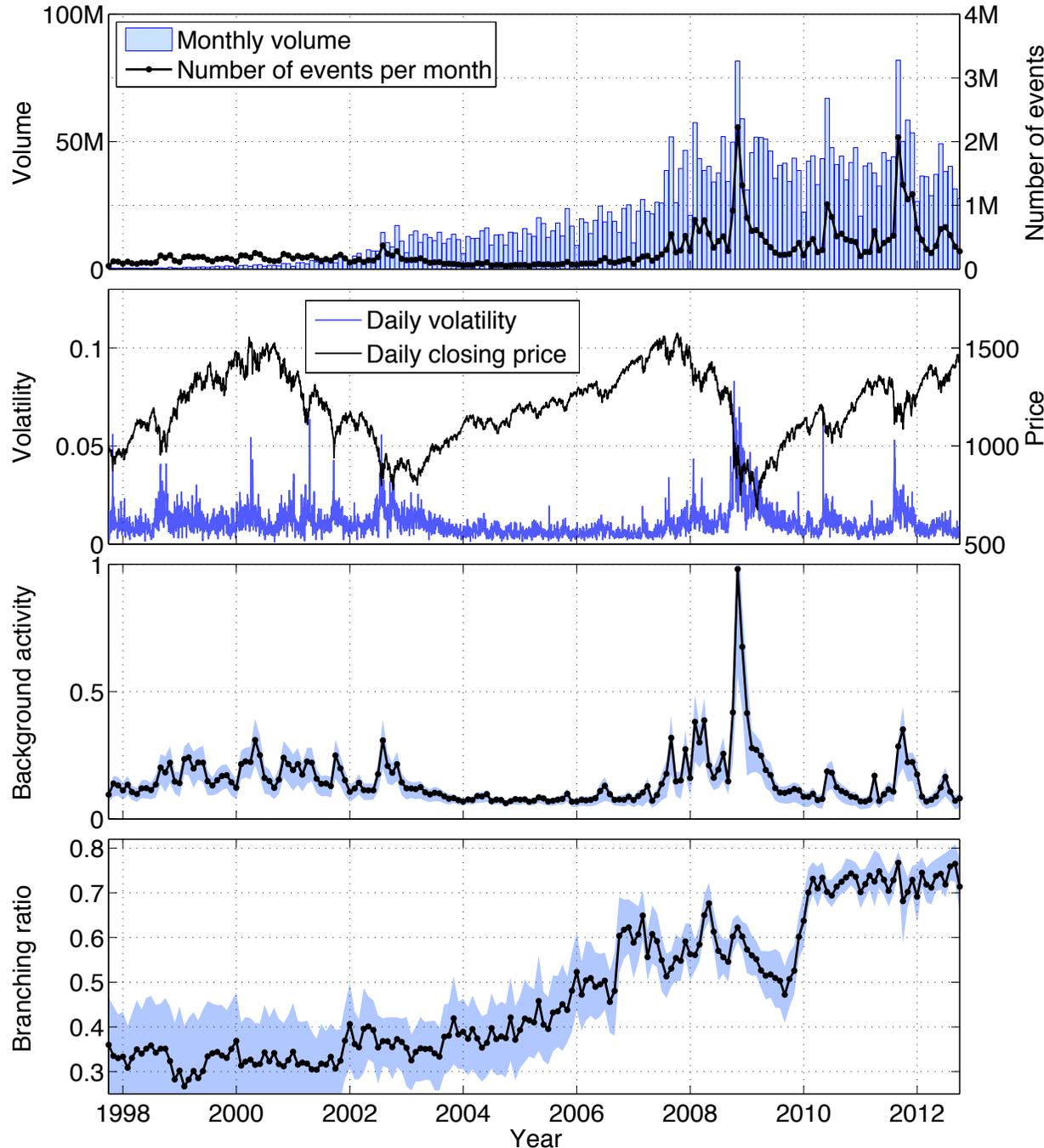
$$\lambda_t(t) = \mu + \frac{n}{\tau} \sum_{t_i < t} \exp\left(-\frac{t - t_i}{\tau}\right)$$

on the timestamps of mid-quote price changes

- Each calibration resulted in a single estimation of the **branching ration (n)**
- Collecting all estimates for each month (~6000-7000 estimates) we have averaged them to construct the **“reflexivity index”** for the given month







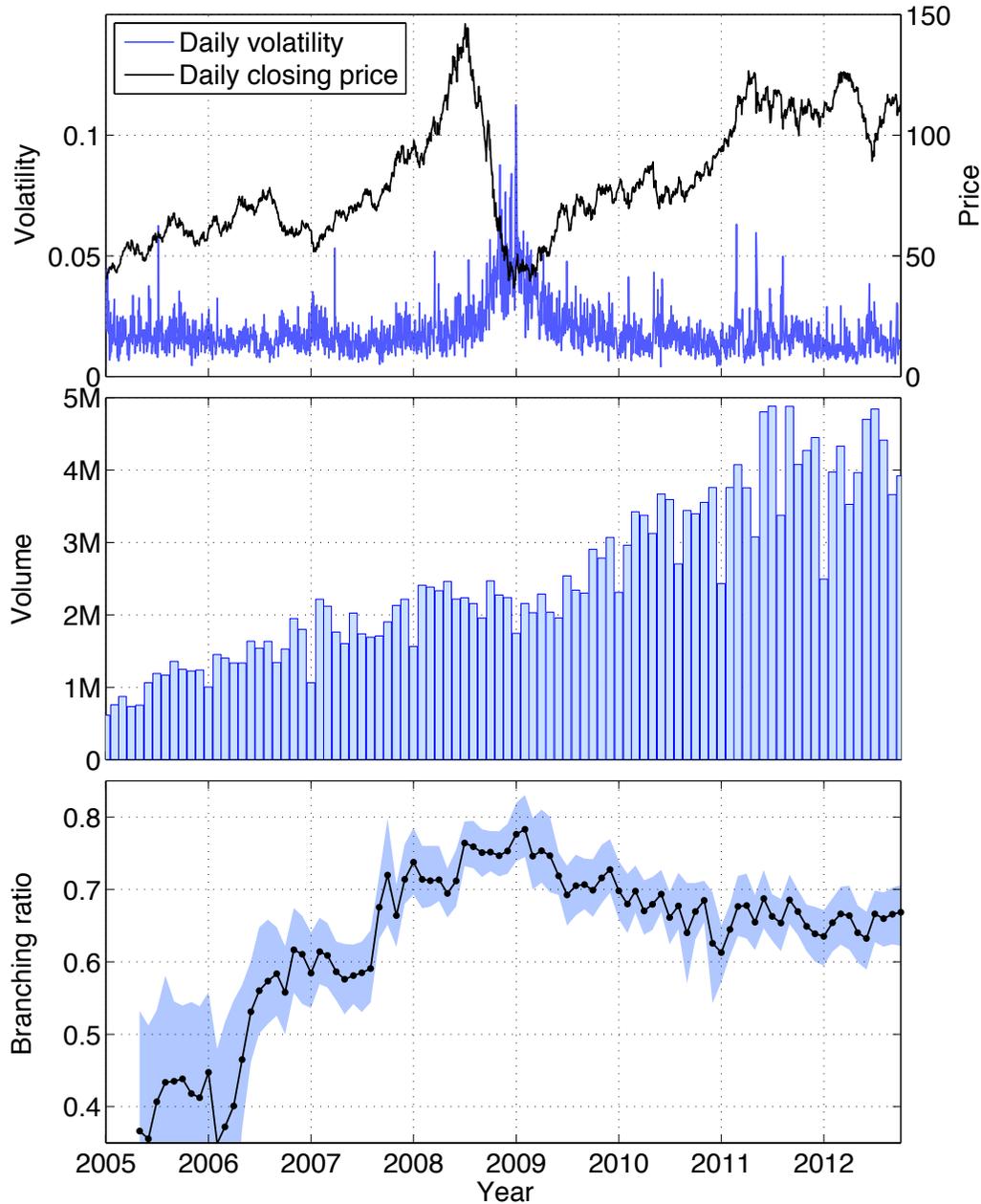
Trading activity
proxied by volume and
number of mid-price changes

Dynamics of price and volatility

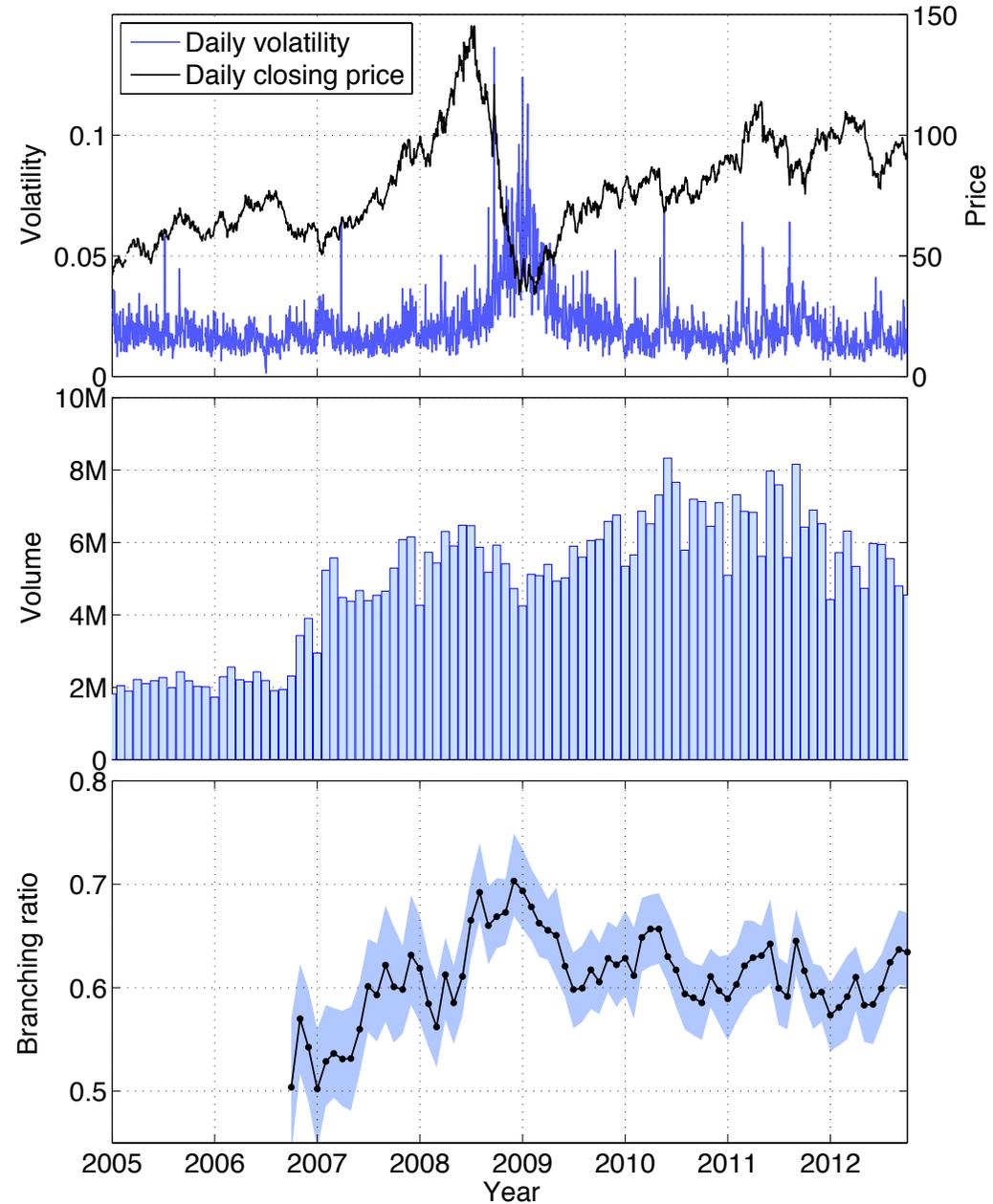
Rate of exogenous events (triggered
by **idiosyncratic** “news”)

Branching ratio that quantifies
reflexivity of the system
(fraction of endogenous events
in the system)

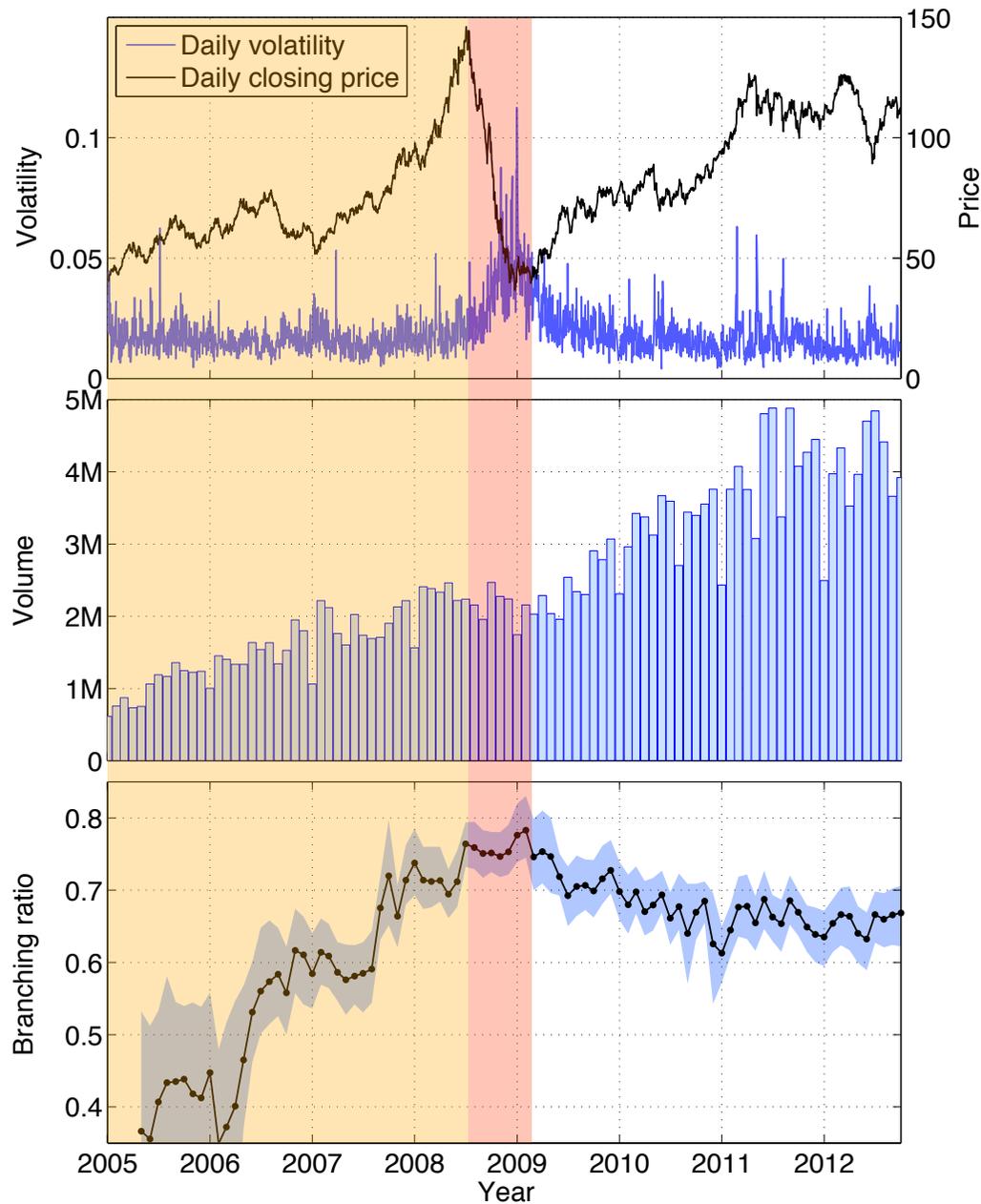
Brent Crude (ICE Europe)



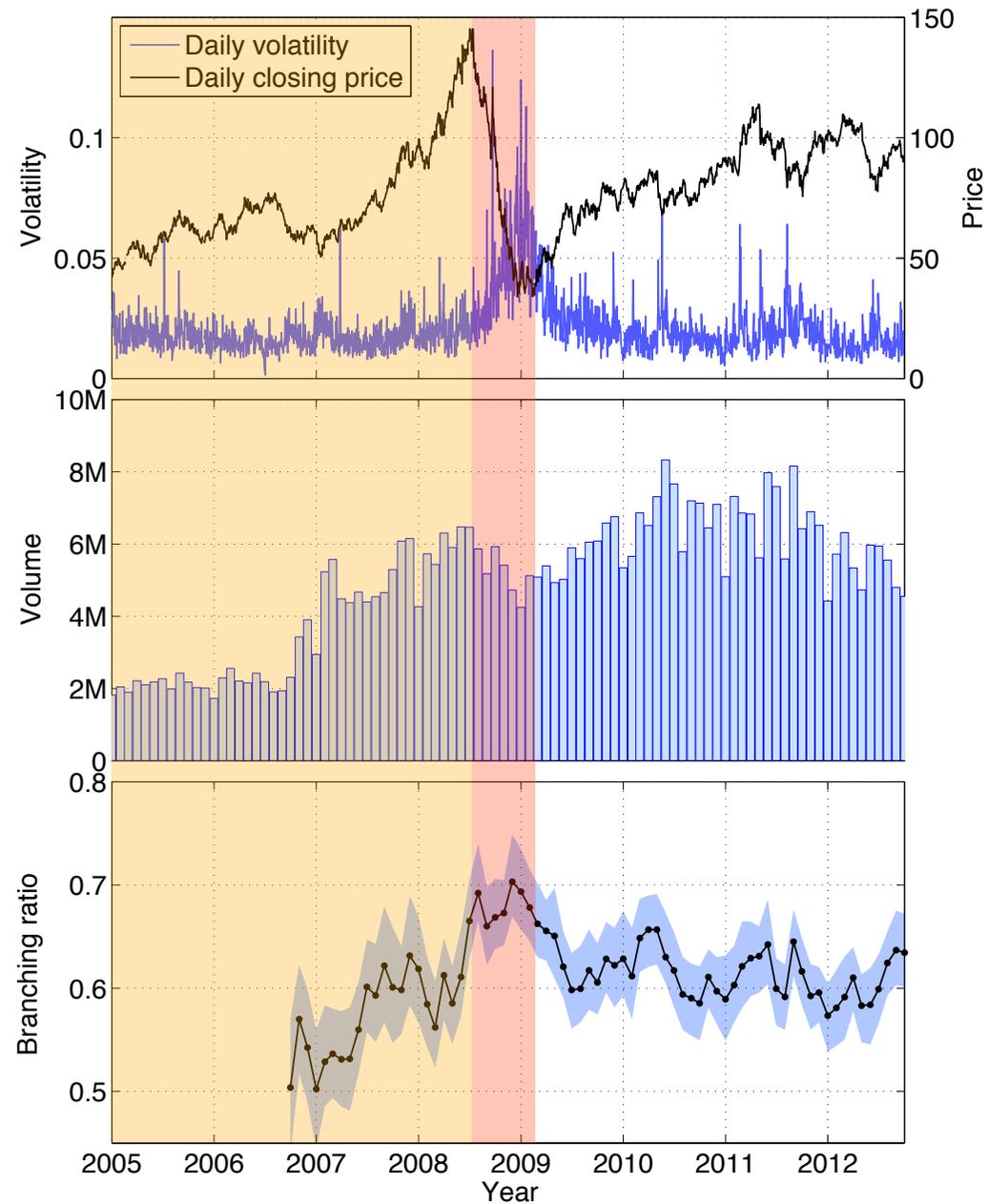
WTI (NYMEX)



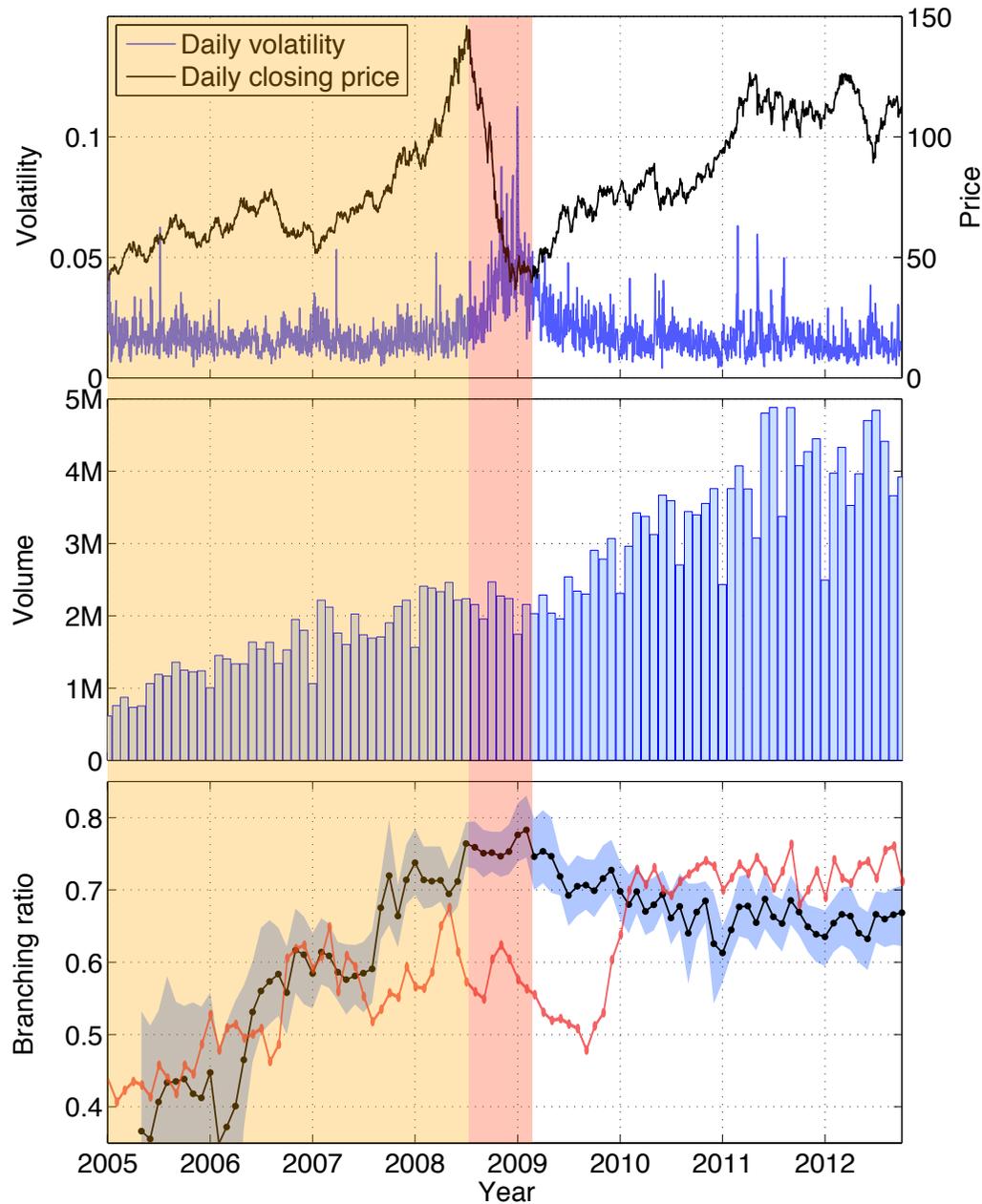
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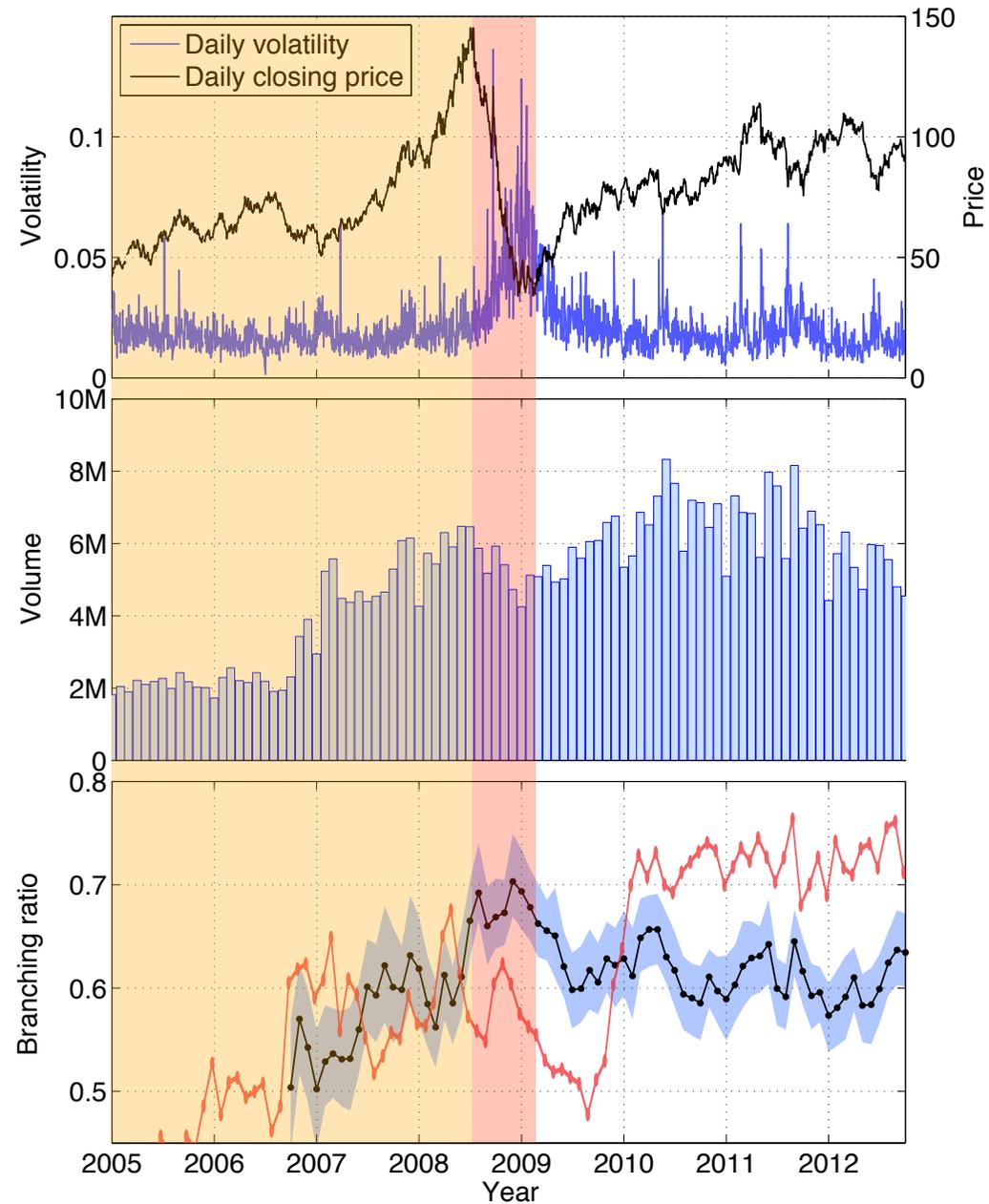
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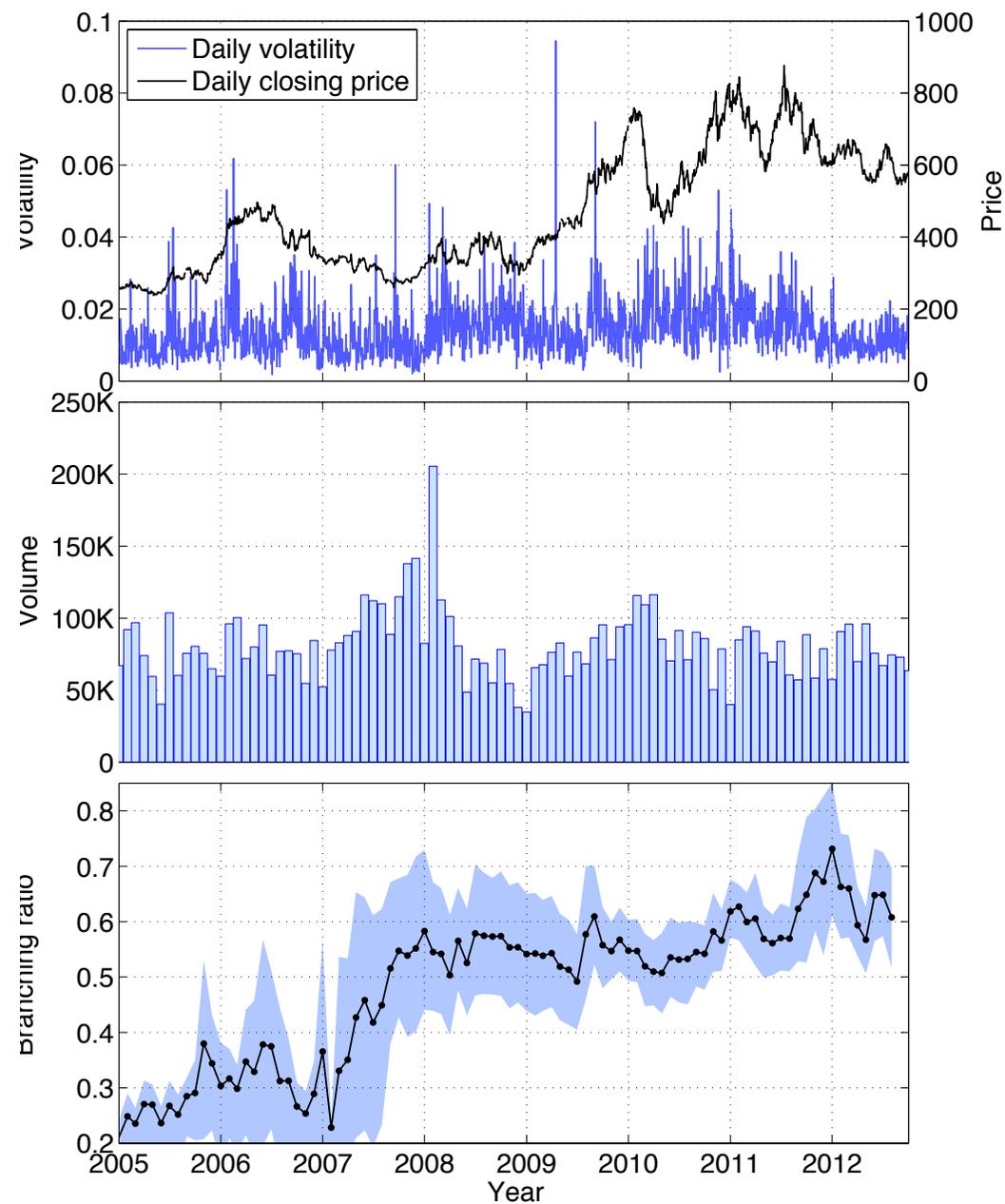
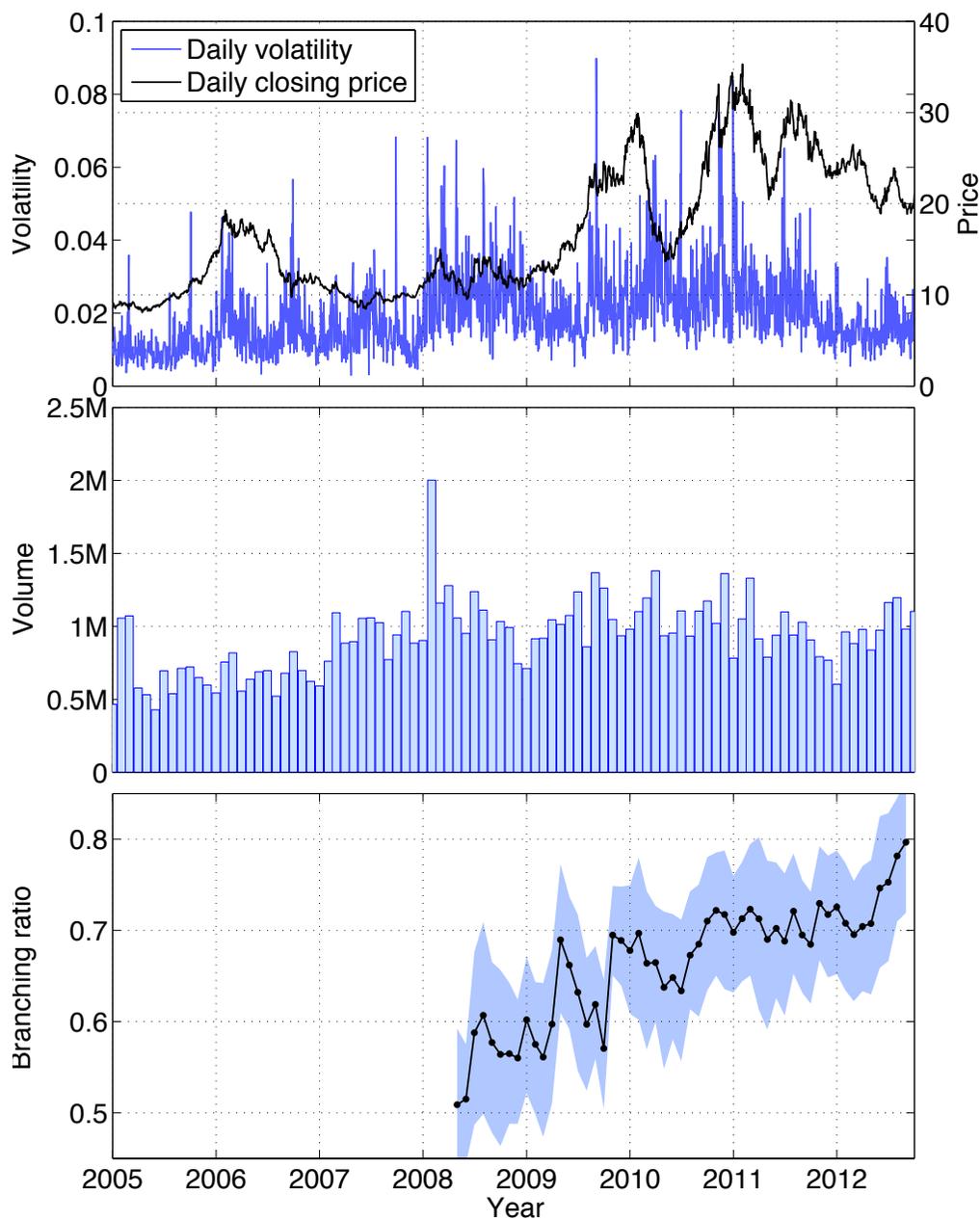


WTI (NYMEX)



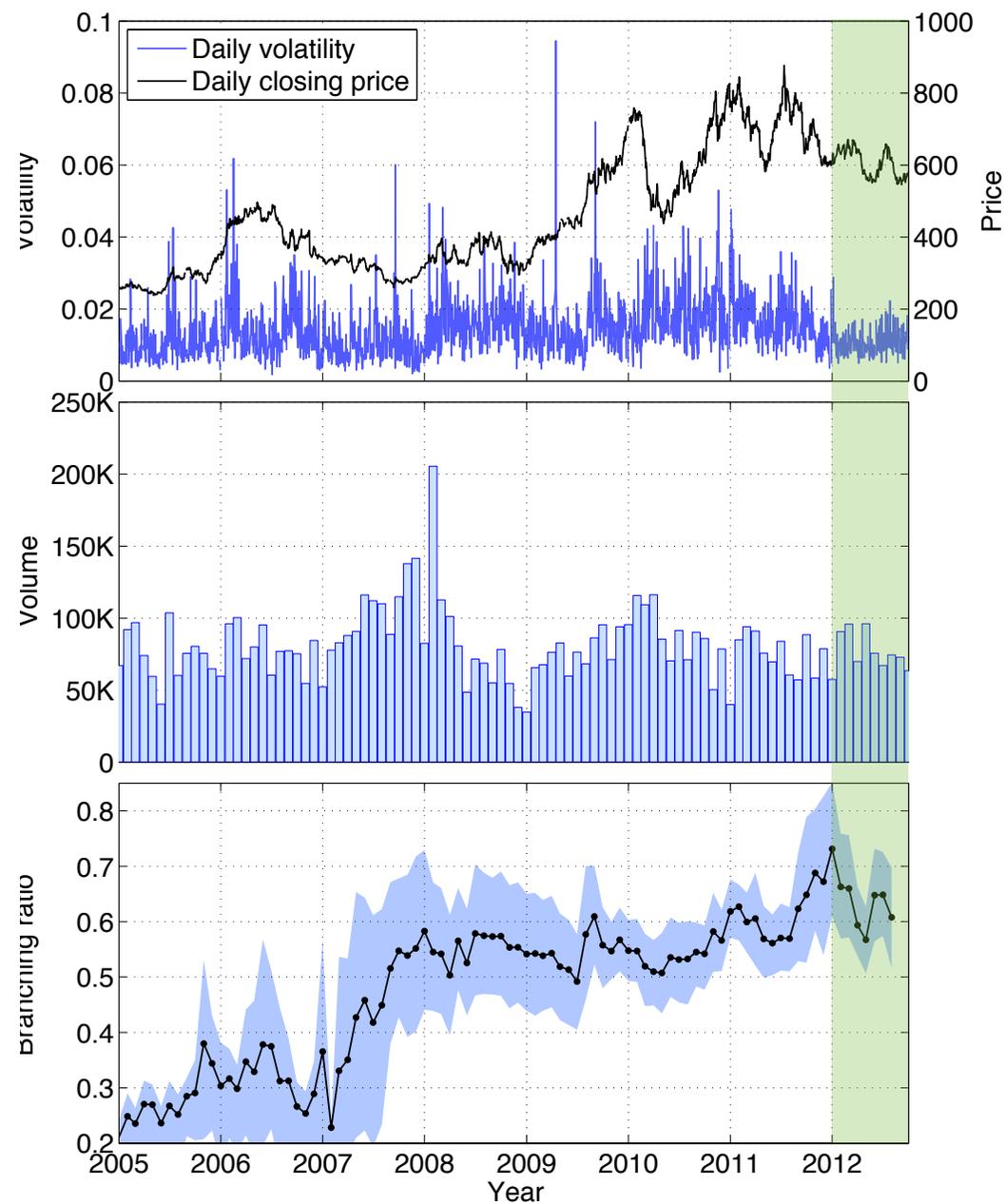
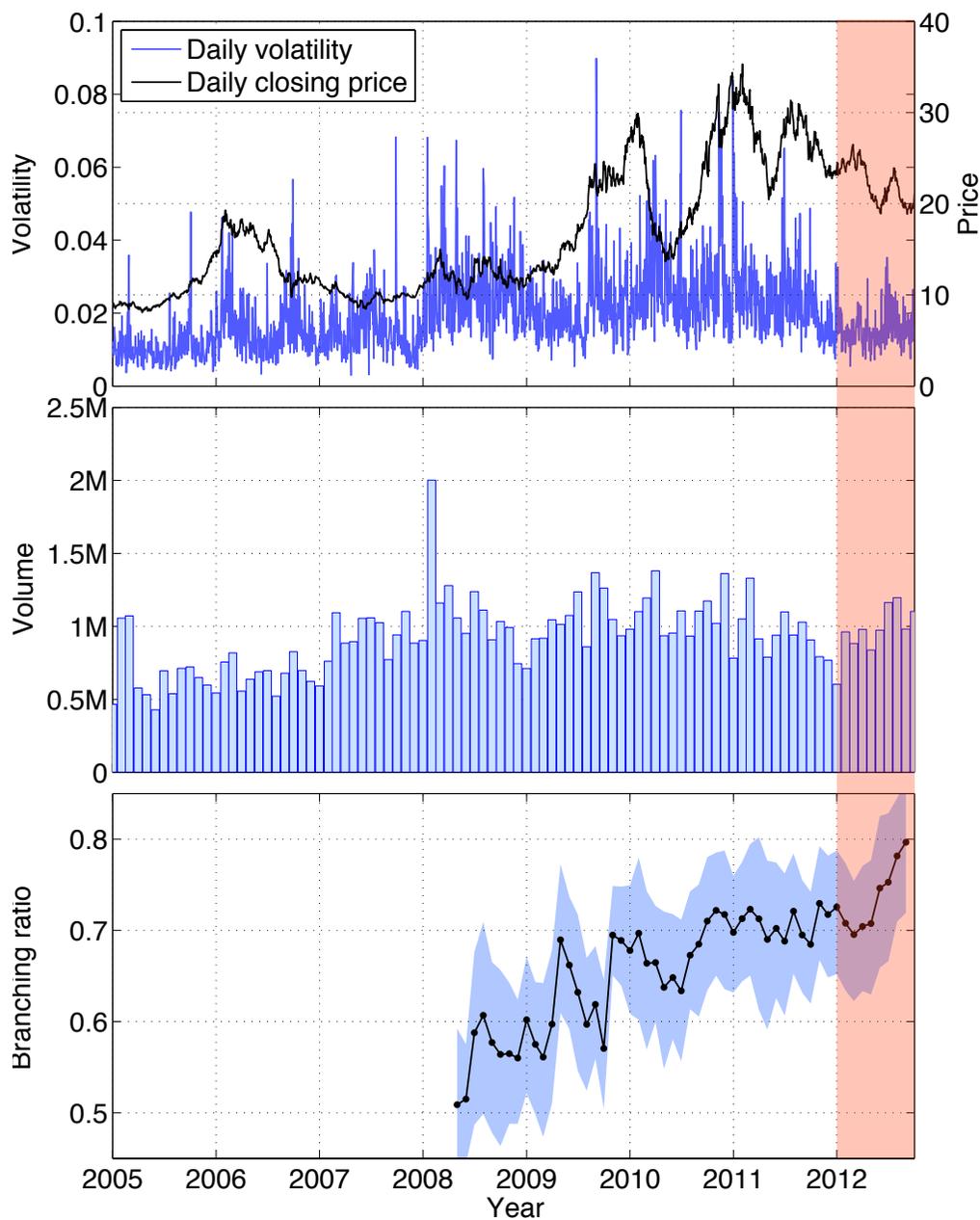
Sugar #11 (ICE US)

Sugar (LIFFE)



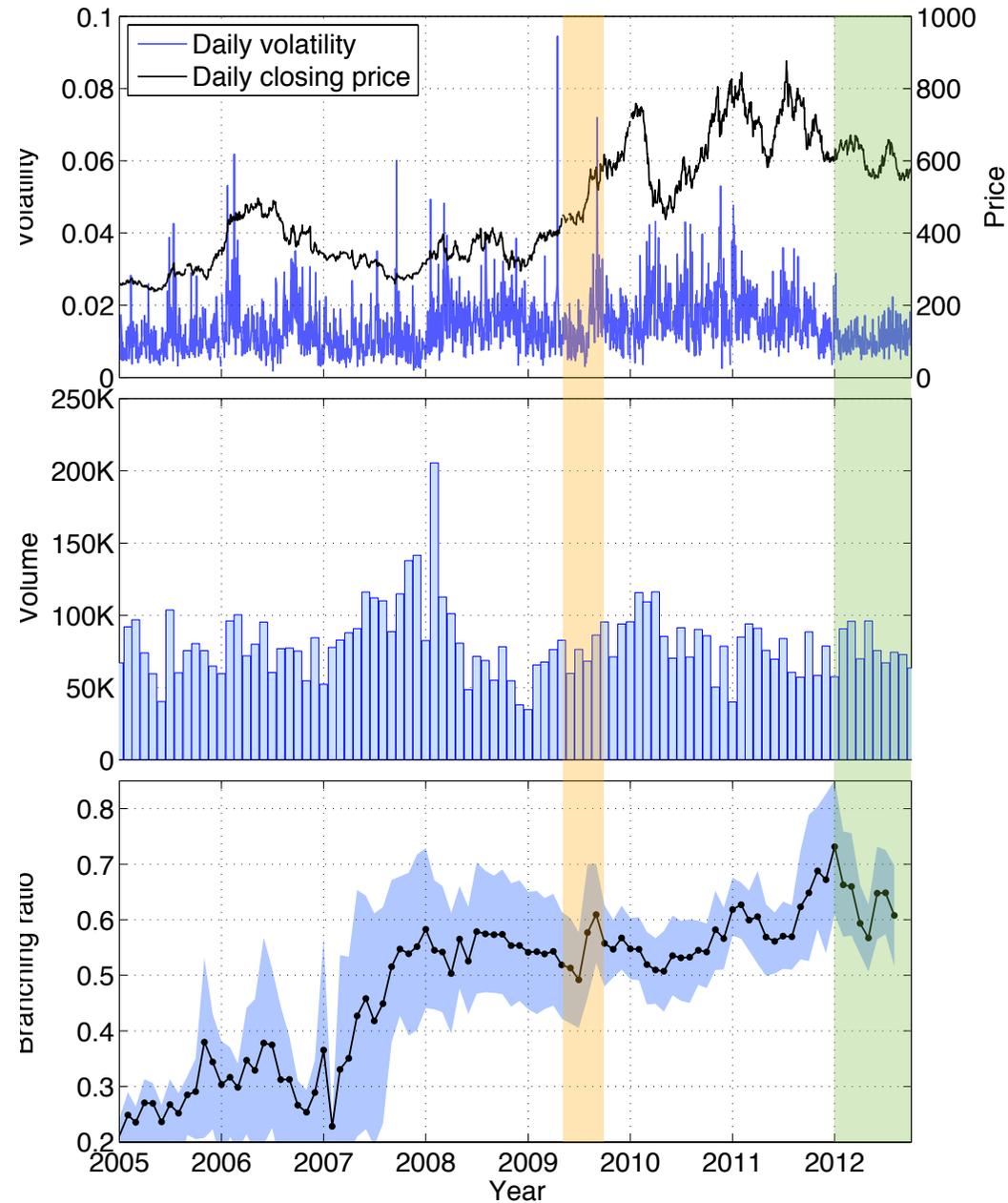
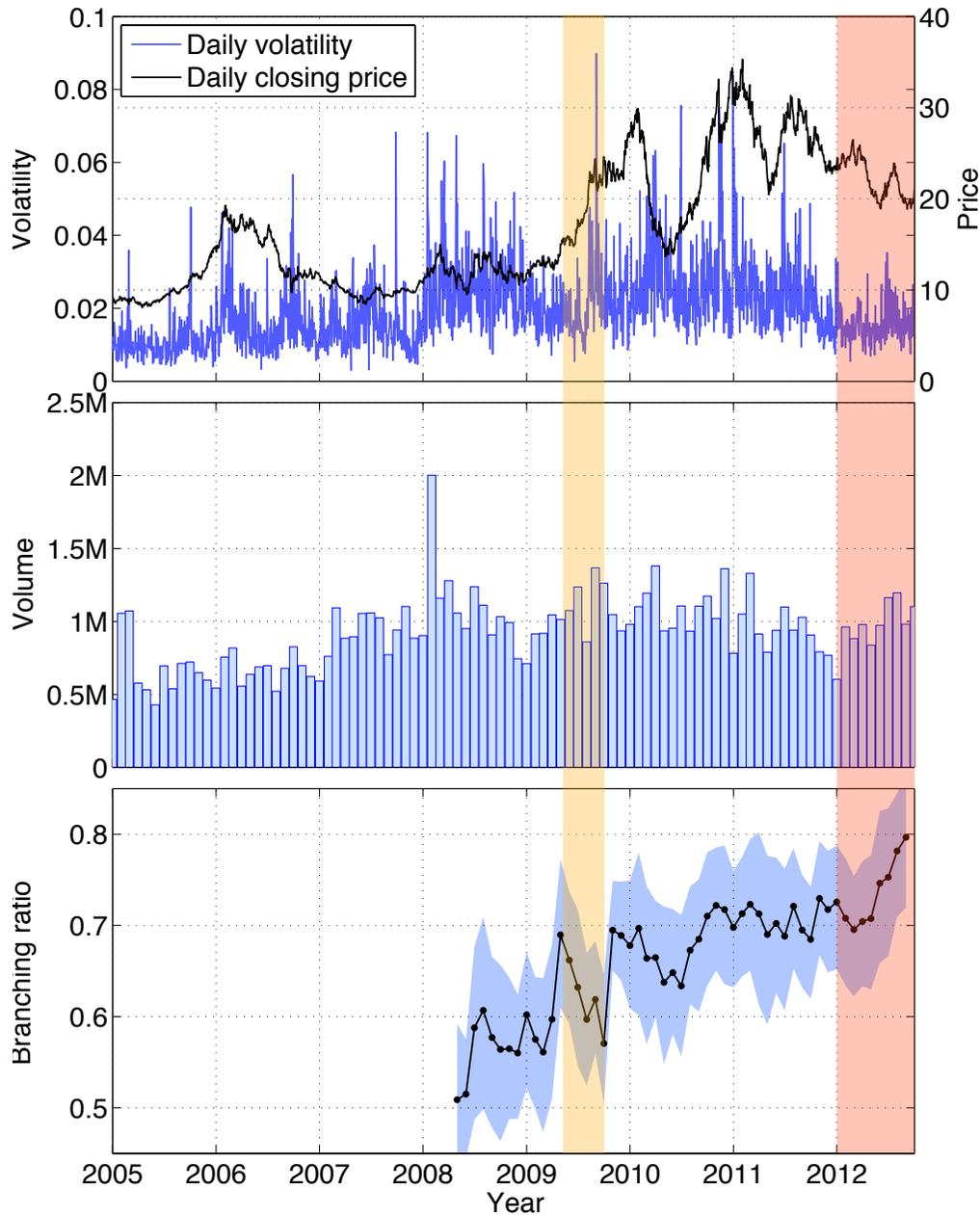
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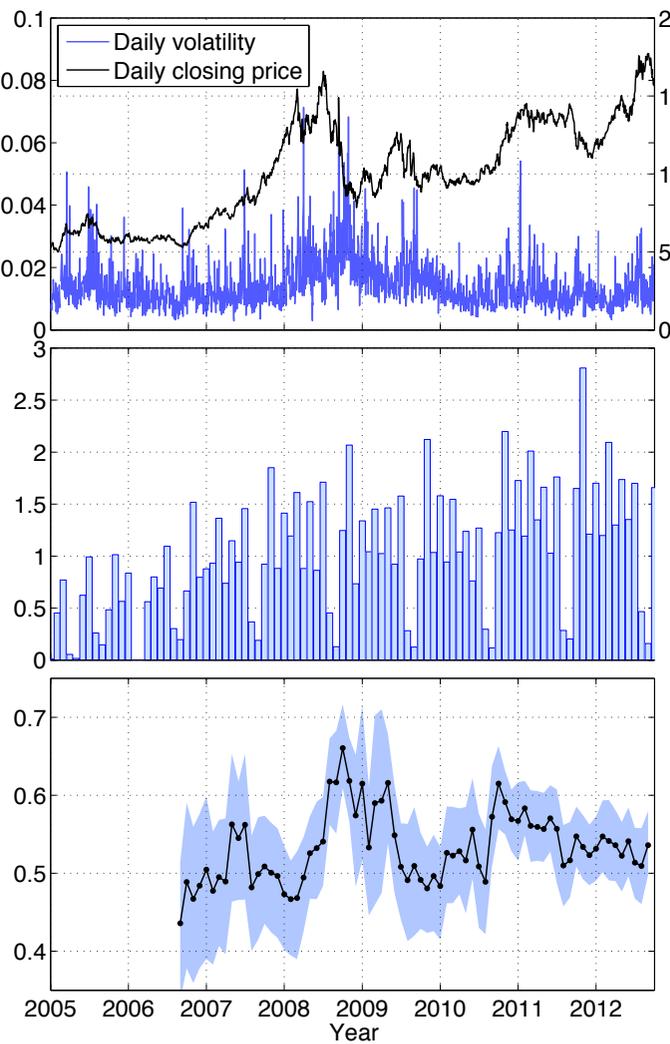


Sugar #11 (ICE US)

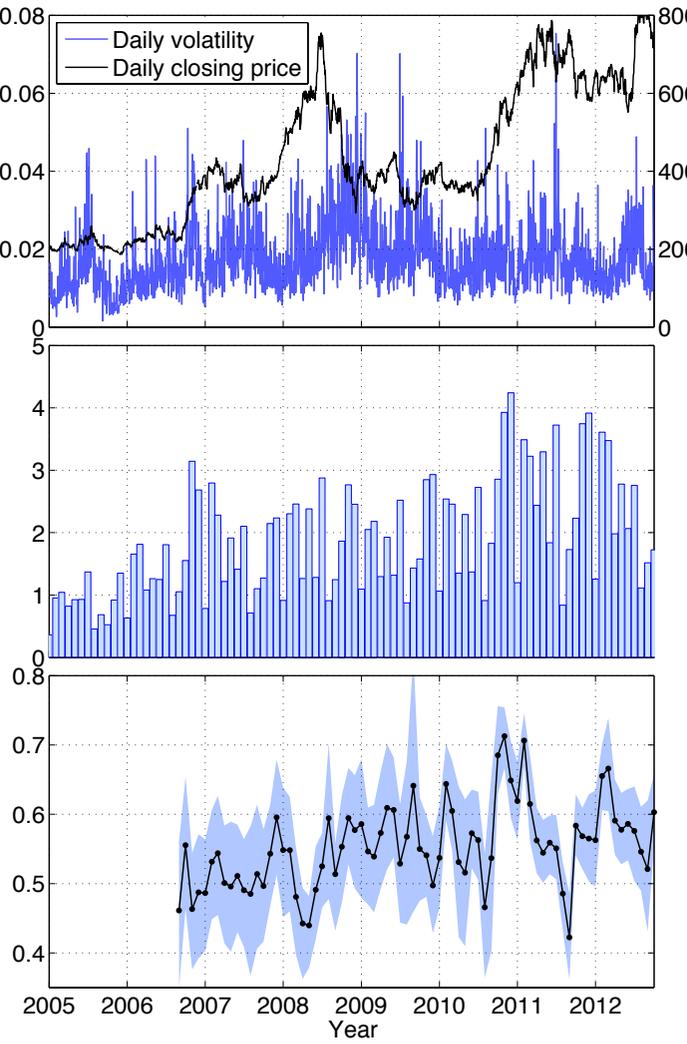
Sugar (LIFFE)



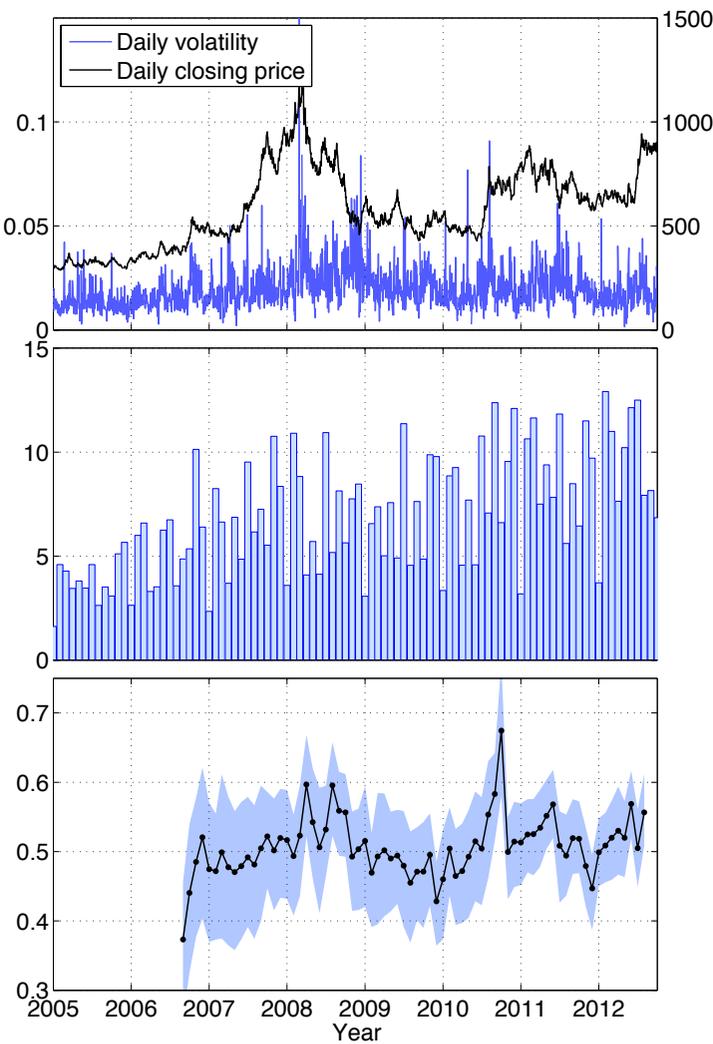
Soybean (CBOT)



Corn (CBOT)



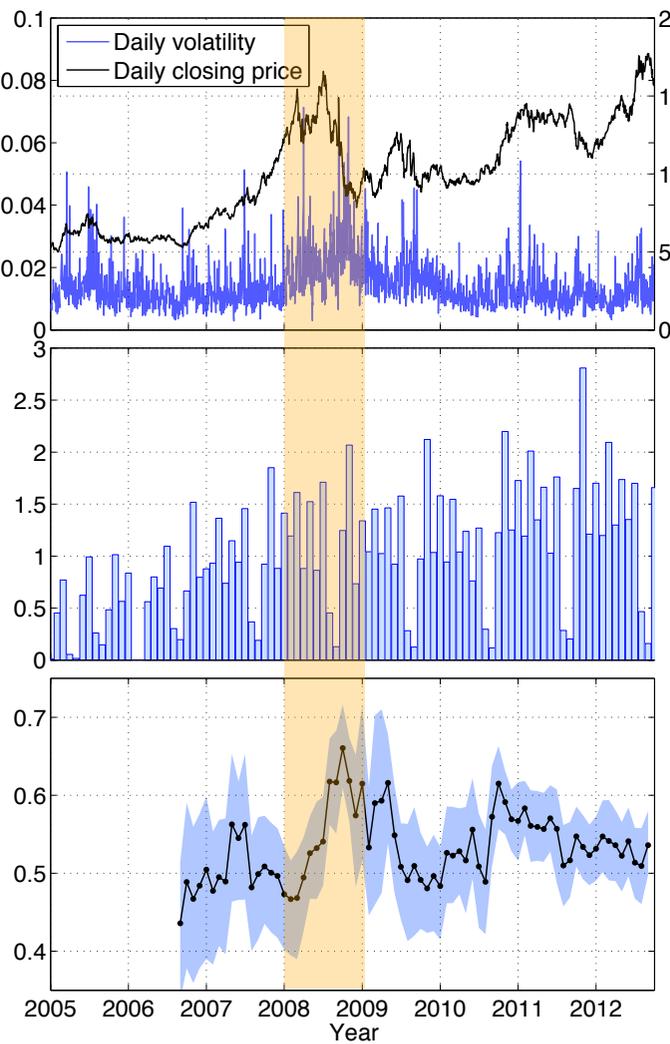
Wheat (CBOT)



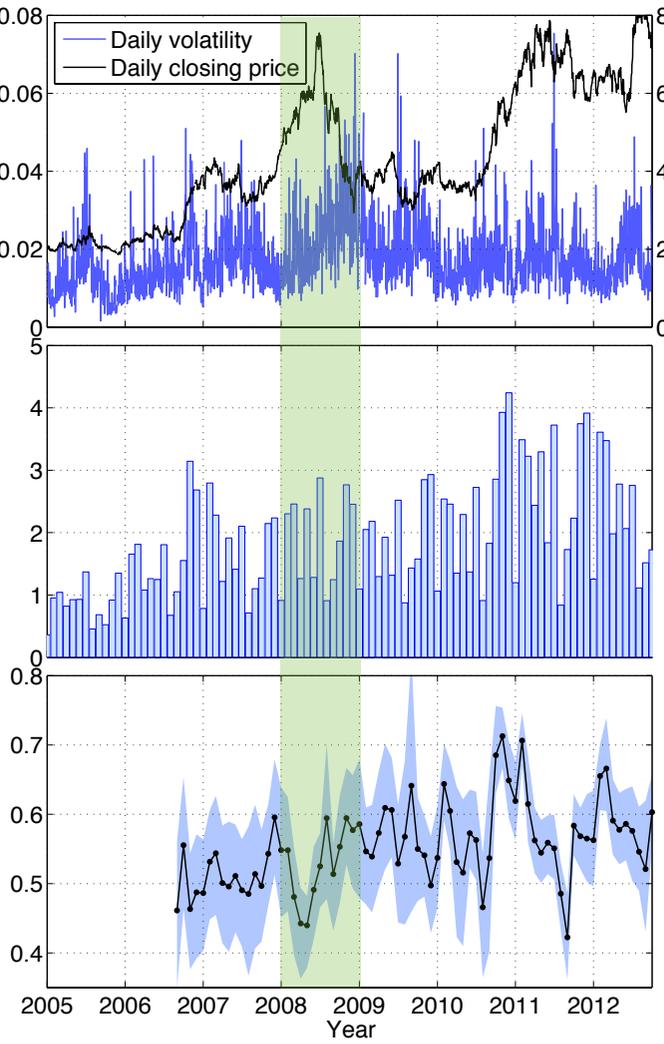
Soft commodities: Soybean, Corn and Wheat



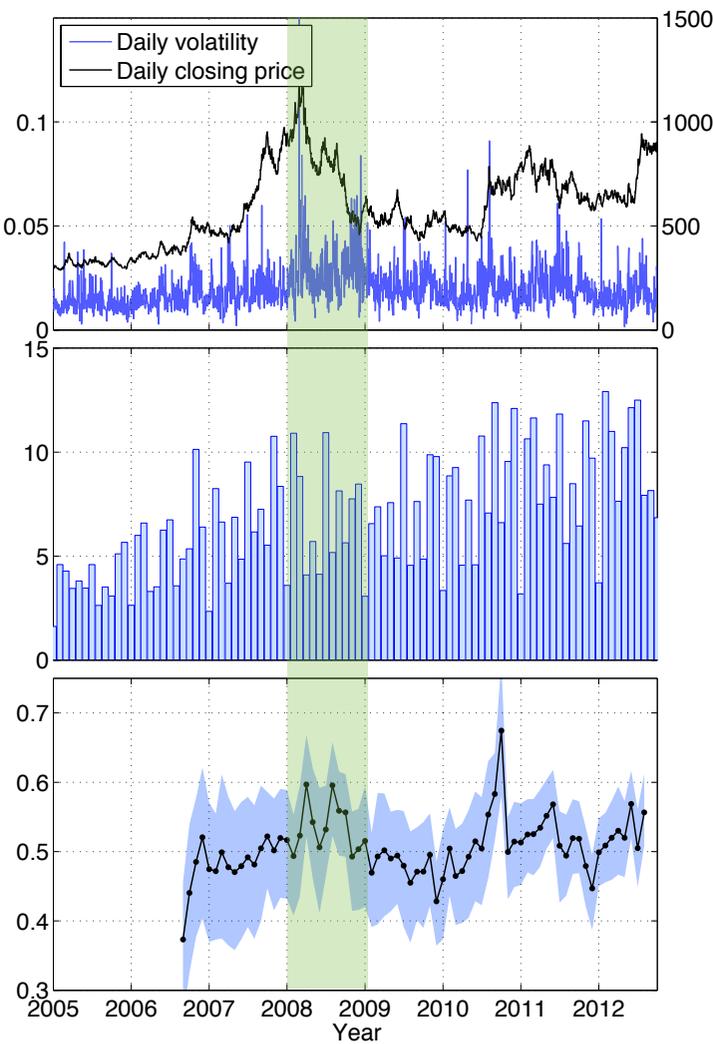
Soybean (CBOT)



Corn (CBOT)



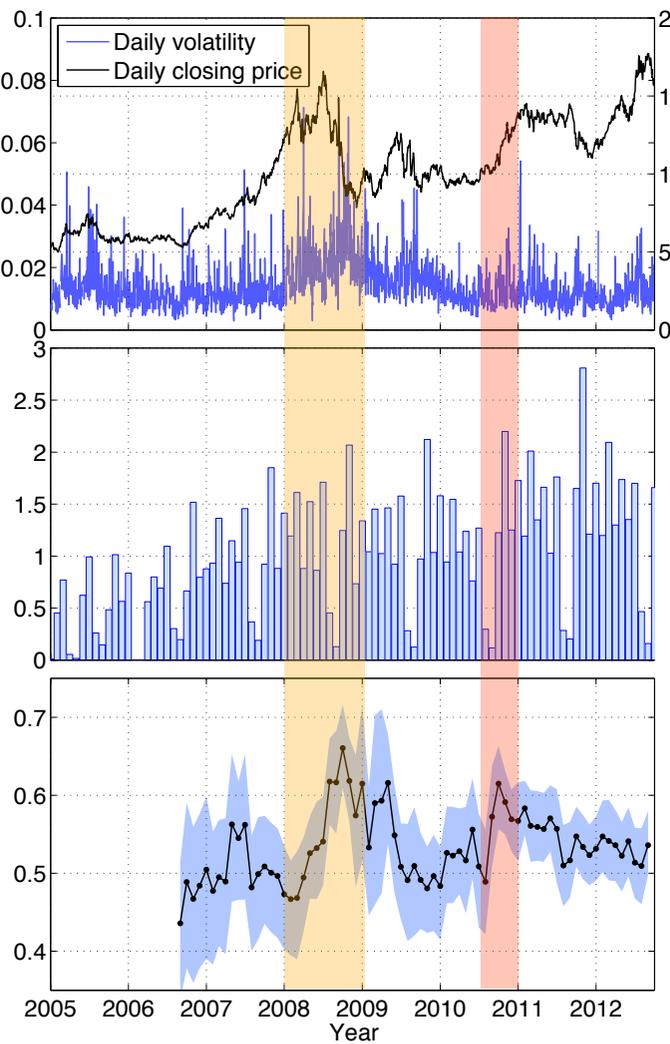
Wheat (CBOT)



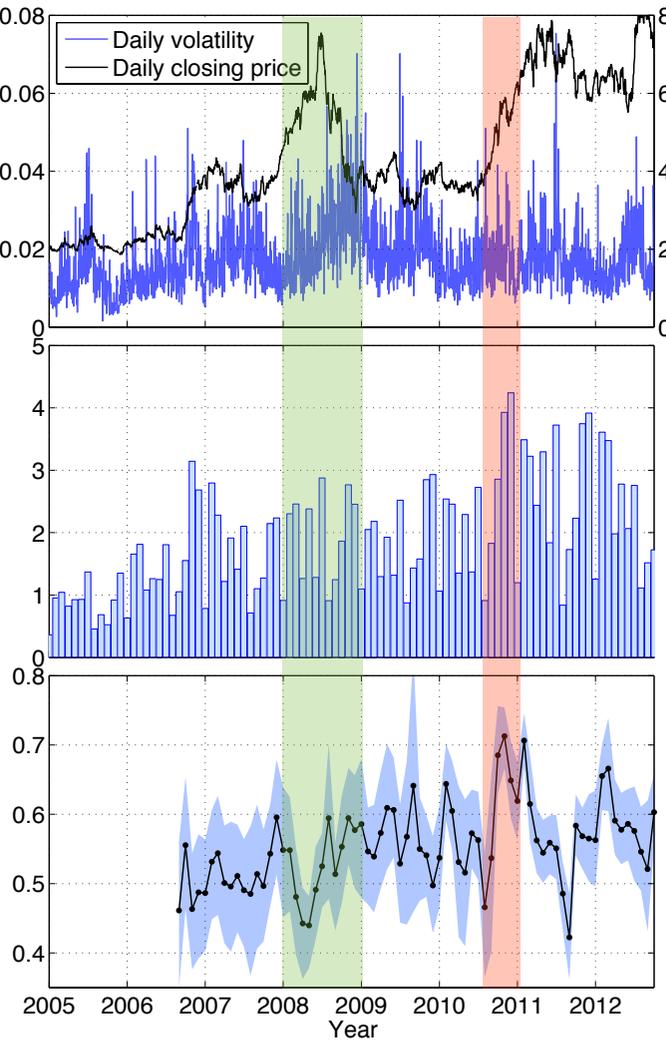
Soft commodities: Soybean, Corn and Wheat



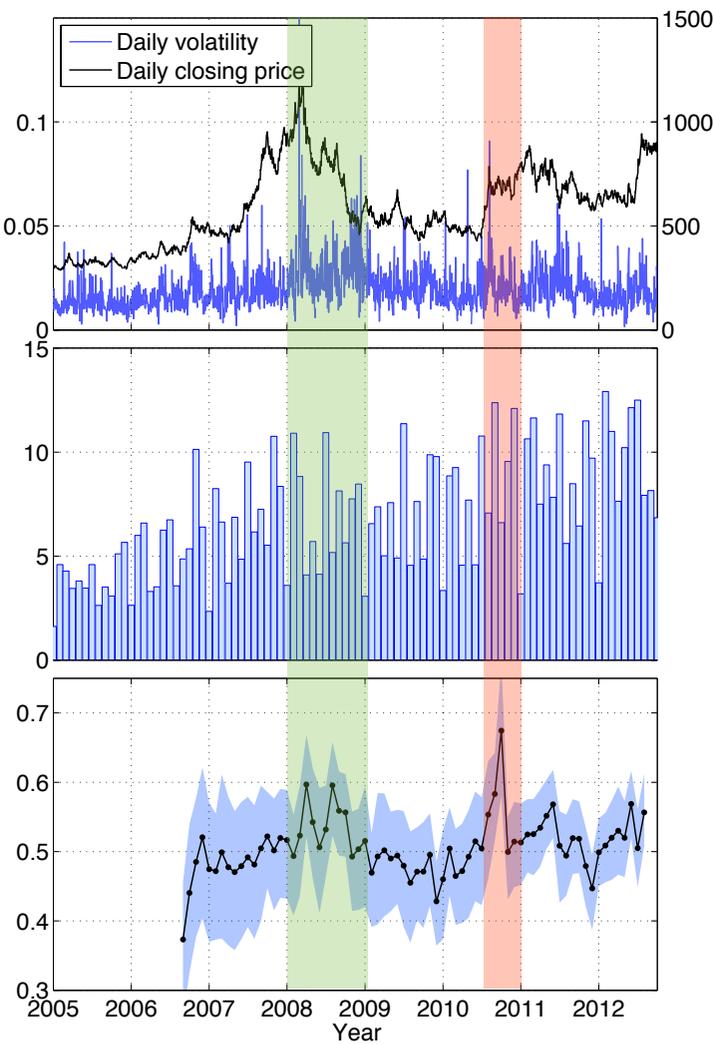
Soybean (CBOT)



Corn (CBOT)

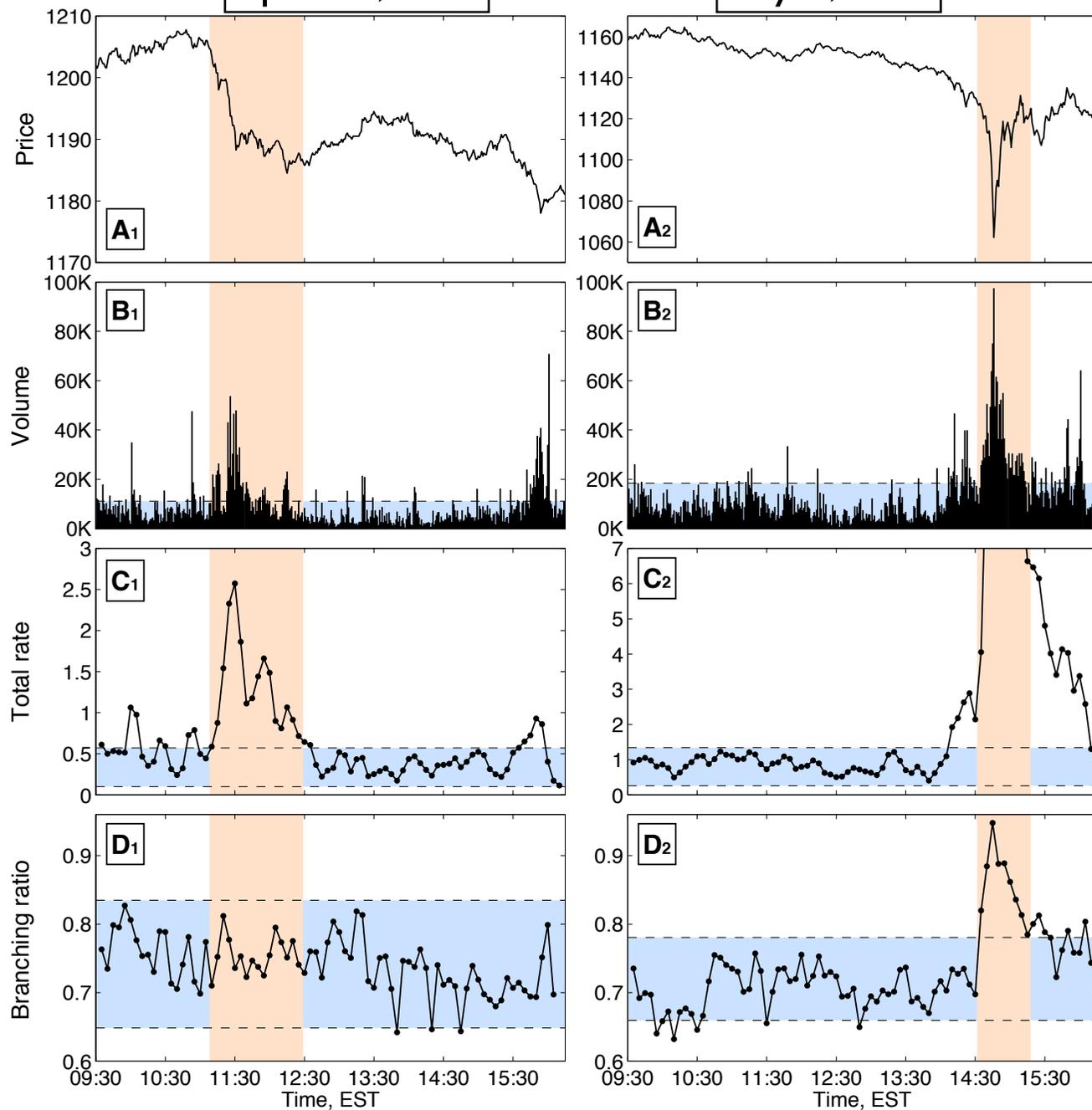


Wheat (CBOT)



April 27, 2010

May 6, 2010

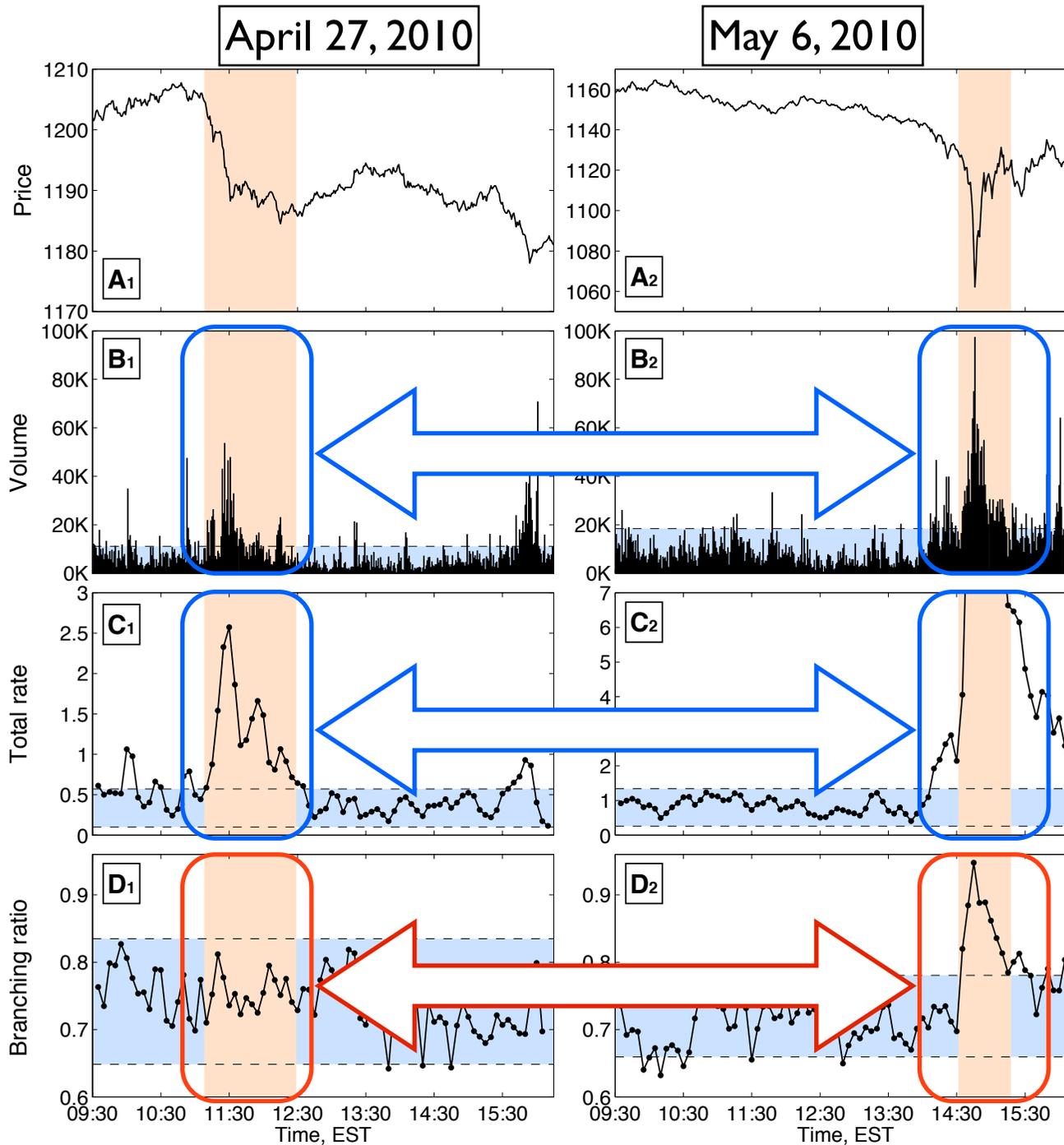


April 27, 2010:

Significant fall of most of US markets following the cut of the credit rating of Greece and Portugal

May 6, 2010 (“flash-crash”):

The activity of high-frequency traders of the S&P 500 E-mini futures contracts led to a dramatic fall in other markets



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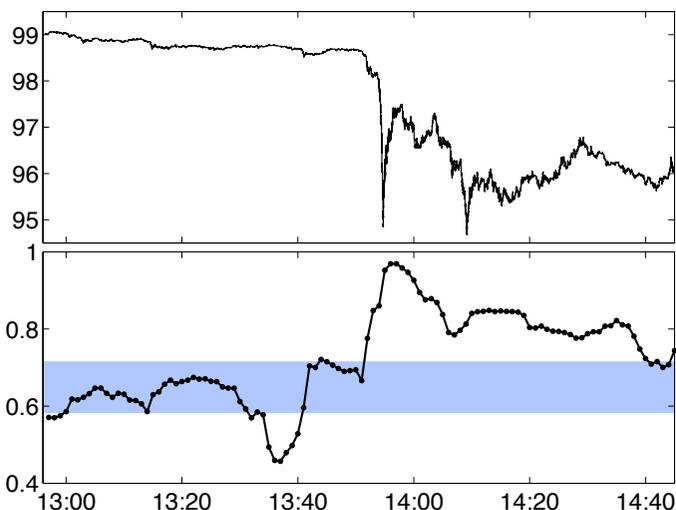
Volume and Trading activity behave similar in both cases

Branching ratio (degree of reflexivity) reveals fundamental difference between two shocks

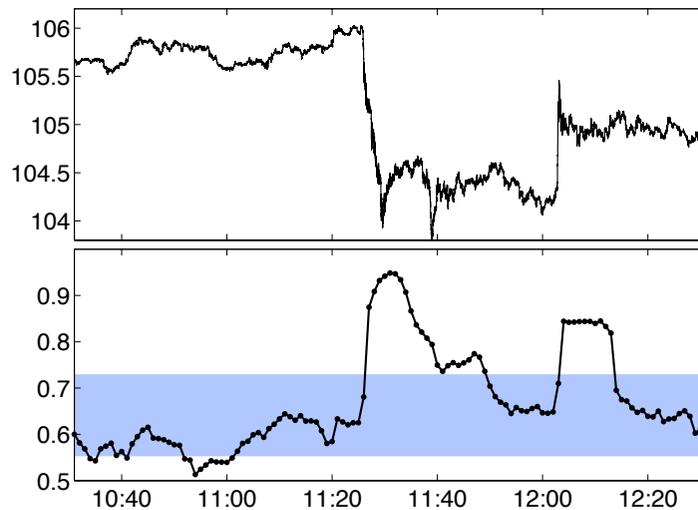
WTI Futures Contracts (2010-2012)

6 events that are associated with the largest values of the reflexivity index

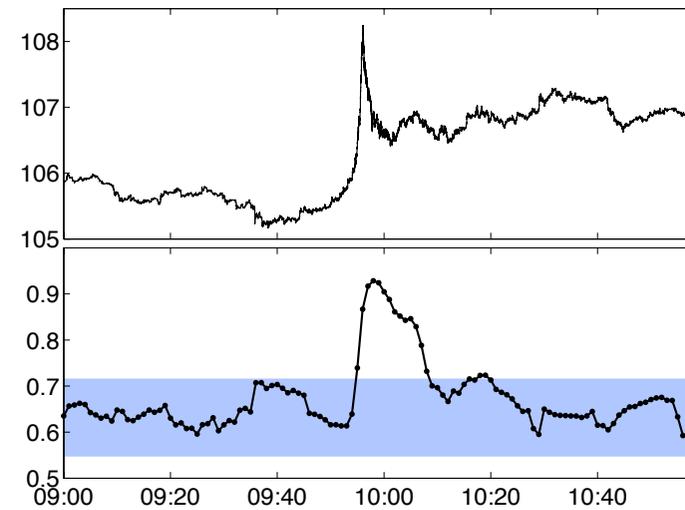
17-Sep-2012 [Mon]



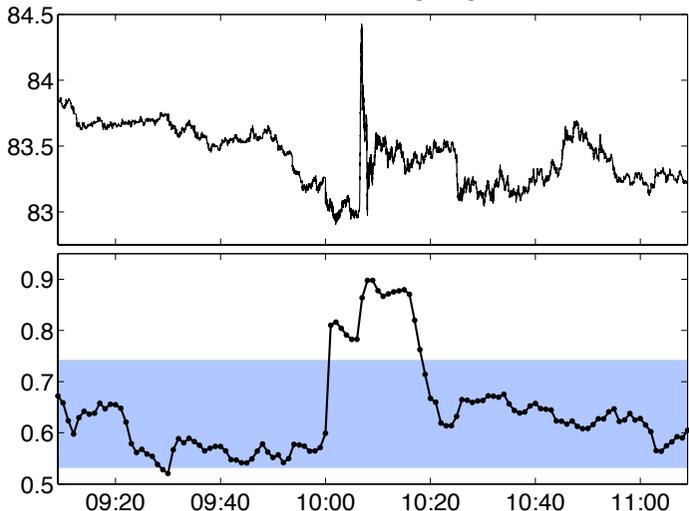
15-Mar-2012 [Thu]



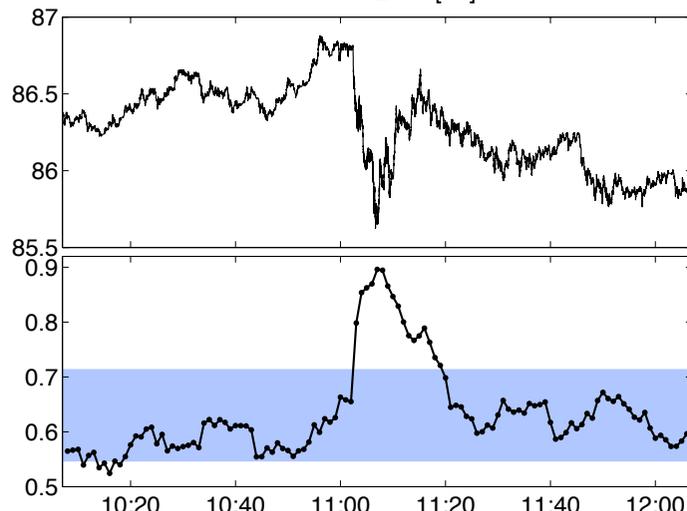
23-Mar-2012 [Fri]



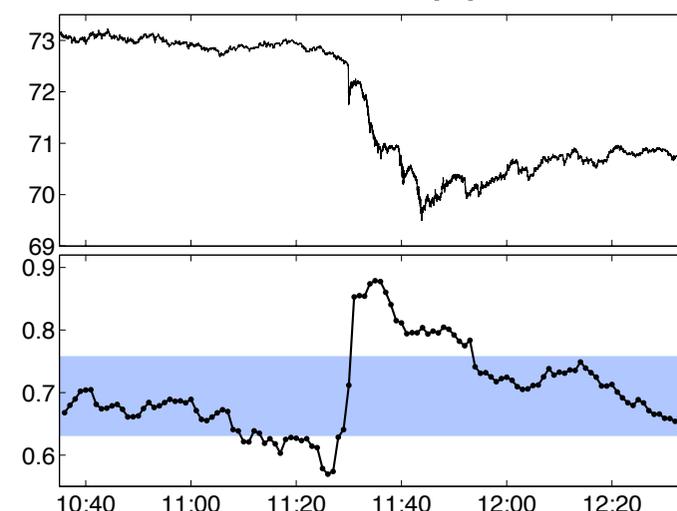
02-Jul-2012 [Mon]



11-Feb-2011 [Fri]



05-Feb-2010 [Fri]



- We have proposed a **novel powerful metric of the short-term self-excitation** of the price movements.
- Our analysis of the commodity markets showed significant impact of the feedback mechanisms rather than fundamental news on short scales. Namely all analyzed commodities have reflexivity index of more than 60-70%, which means that **less than 30-40% of all price movements are due to external news**.
- We have identified **extraordinary** (even for financial assets) **high short-term reflexivity on oil futures during the crisis of 2008**, which indicates high degree of short-term algorithmic trading over this period.
- We have documented **recent strong upward trend on the short-term reflexivity of the Sugar #11**, which might indicate potential instability in this market.
- For Soybean, Corn and Wheat we have documented strong increase of the short-term reflexivity index in 3rd quarter of 2010, which might be triggered by the export ban on Wheat by Russia and Ukraine.
- We suggest that the **proposed measure could be used** for analysis of the nature of price anomalies, or even **for the real-time diagnostics of the upcoming instabilities**.