

High-frequency shocks on Russian equity market

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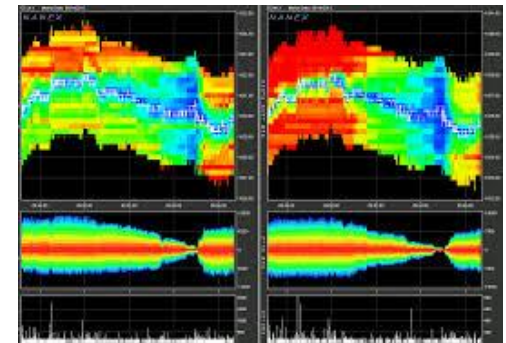
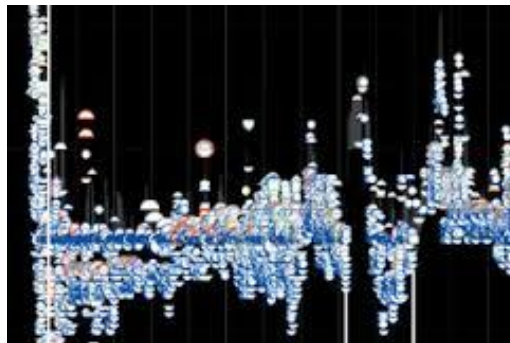
Russia Risk Conference 2013, 14 November

Motivation

- Financial markets are intrinsically unstable and are characterized by many “large” price fluctuations at all time scales
- Many of these shocks are not explained by public news:

Joulin et al. (2008) investigated one minute returns of a large set of liquid US stocks. They detected eight 4-sigma jumps per stock per day and one 8-sigma jump every one day and a half per stock. Moreover they find that *“neither idiosyncratic news nor market wide news can explain the frequency and amplitude of price jumps”*

- Financial market stability is a growing concern of regulators, investors, exchanges, media and politicians



Research question

What we study:

- What are the characteristics of the shocks in Russian equity market prices compared to other markets?
- How are they interrelated?

M.Frolova, S.Ivliev, F.Lillo. Price Shocks on Multiple Time Scales: the Russian Stock Market case study. *(Submitted to Annals of OR)*

Historical data sample:

We use database recording of all transactions and orders submission/ cancellation events of **29 blue chip stocks** (included in MICEX Index in 2010) traded on the MICEX in 2010 (82 trading days).

The selected stocks are the most capitalized and liquid on the Russian market, yielding **75-80%** of the total market cap and most of the traded volume.

The sample sizing: 310 mln orders; 32 mln trades; 390 ths 1-min returns.

Acknowledgments:

Authors thanks Financial Market Service of Bank of Russia staff for the support of this research and helpful discussions.

Basic statistics: Russian market is very concentrated...

Ticker	Economic sector	Orders/day	Trades/day	Value/day, M\$	av Agents/day	brokers_day	spread/tick	tick/price
GAZP	gas production	332448	62 266	1 096	# 10414	208	38,8	0,617
SBER03	banking	329594	96 658	934	# 14037	201	21,6	1,228
GMKN	nonferrous metals	395750	34 724	334	# 5583	158	10,1	1,962
LKOH	oil production	442592	31 259	279	# 4360	159	25,2	0,605
ROSN	oil production	234145	28 138	229	# 5235	153	37,3	0,471
VTBR	banking	58336	20 587	163	# 4611	142	108,9	1,220
SBERP03	banking	151186	25 521	161	# 6102	138	17,6	1,701
TRNFP	oil production	303474	8 369	106	# 2258	114	55,3	0,319
HYDR	energetics	48130	14 840	100	# 3911	139	36,8	0,614
SNGS	gas production	187120	12 297	64	# 1848	103	45,6	0,348
MTSI	telecom	116684	4 038	63	# 1322	83	40,8	0,403
RU14TATN3006	oil production	182571	4 745	58	# 964	70	19,9	0,710
CHMF	metallurgy	179707	11 319	49	# 2771	115	78,0	0,269
SNGSP	gas production	98856	3 175	48	# 1321	102	24,1	0,708
FEES	energetics	16750	5 020	46	# 2199	114	132,2	0,288
IUES	energetics	19211	5 930	28	# 2254	111	1039,5	0,198
PMTL	nonferrous metals	40147	826	23	# 301	48	14,8	2,569
URKA	chemical	169569	5 466	20	# 2093	120	24,7	0,798
MRKH	energetics	11405	1 614	15	# 919	77	10,1	2,386
NOTK	gas production	64736	1 120	9	# 613	65	50,0	0,480
SIBN	oil production	87915	2 958	9	# 1178	86	30,1	0,755
RASP	coal mining	12952	886	8	# 666	69	53,7	0,629
RTKM	telecom	145965	4 583	6	# 1643	89	24,4	0,824
MSNG	energetics	10436	964	6	# 704	69	95,0	0,300
AFLT	airline	22570	1 143	5	# 700	67	15,7	1,614
MAGN	metallurgy	31133	1 415	4	# 768	73	92,9	0,378
NLMK	metallurgy	27565	1 178	4	# 580	63	24,1	1,047
OGKC	energetics	19351	1 126	3	# 621	65	54,0	0,554
MGNT	retail	20225	240	1	# 199	31	169,2	0,335

Identification of market shocks

Time scales & Filters:

- ▶ **Hours scale (macro):** Absolute & Relative filters

Source: G.Mu, W.Zhou, W.Chen and J. Kertesz (2010). *Order flow dynamics around extreme price changes on an emerging stock market*

- ▶ **Minutes scale (meso):** Minute returns exceeds S times local volatility

Source: A.Joulin, A.Lefevre, D.Grunberg, J-P Bouchaud (2010). *Stock price jumps: news and volume play a minor role*

- ▶ **Tick scale (micro):** NANEX filter

Source: N. Johnson, B.Tivnan (2011). *Flash Crash Phenomena and a Taxonomy of Extreme Behaviors*, Eur. Phys. J. Special Topics 205 65-78

Macro scale

Absolute filter:

Cumulative intraday mid-price returns exceeding threshold Y within time window Δt :

$$r(t) = \frac{p(t) - p(t - \Delta t)}{p(t - \Delta t)} > Y$$

Relative filter:

Cumulative intraday returns exceeding M times the average volatility in the same period of the day in the sample:

$$r(t) > M \cdot \frac{1}{n} \sum_{i=1}^n v_i(t, \Delta T)$$

$v_i(t, \Delta T)$ – intraday volatility (s.d.) at moment t for a time window ΔT at day i

Parameters:

$\Delta t = \Delta T = 60$ min

$Y = 4\%$

$M = 6$

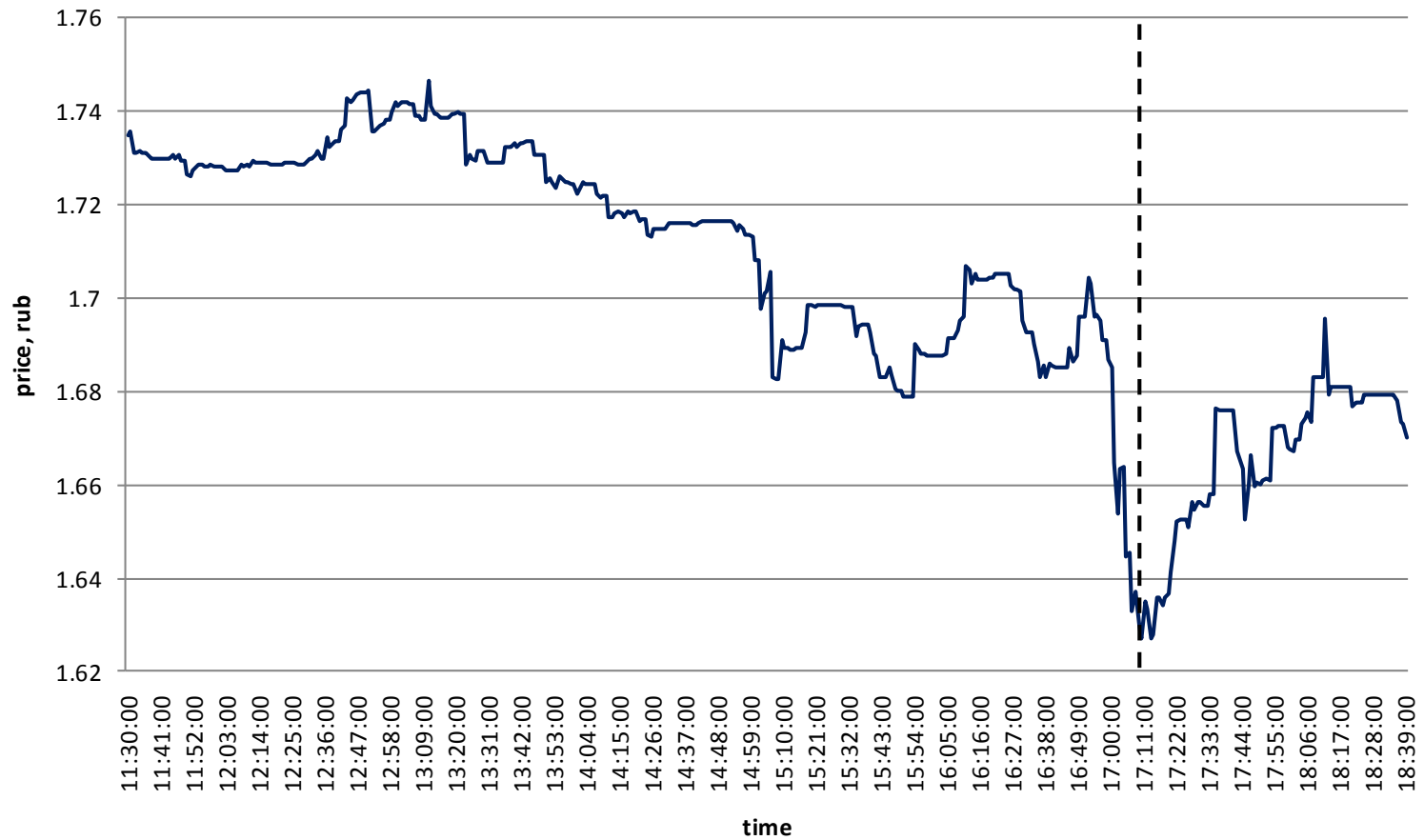
Shocks identified: **1820.**

On average: **16 shocks/month per stock**

Consistent with Kertesz et.al. (2010) results for Shenzhen Stock Exchange in 2003: **20 shocks/month per stock**

Macro scale: example

Shock at macro scale in HYDR stock on 4.06.2010 at 17:11 (-4.1%)



Meso scale

Meso shocks filter:

1-minute return of mid-prices exceeds S times moving average of ΔT previous returns:

$$|r(t)| > S \cdot \frac{1}{\Delta T} \sum_{\tau=t-\Delta T}^t |r(\tau)|$$

Parameters:

$\Delta T=60$ min

$S=8$

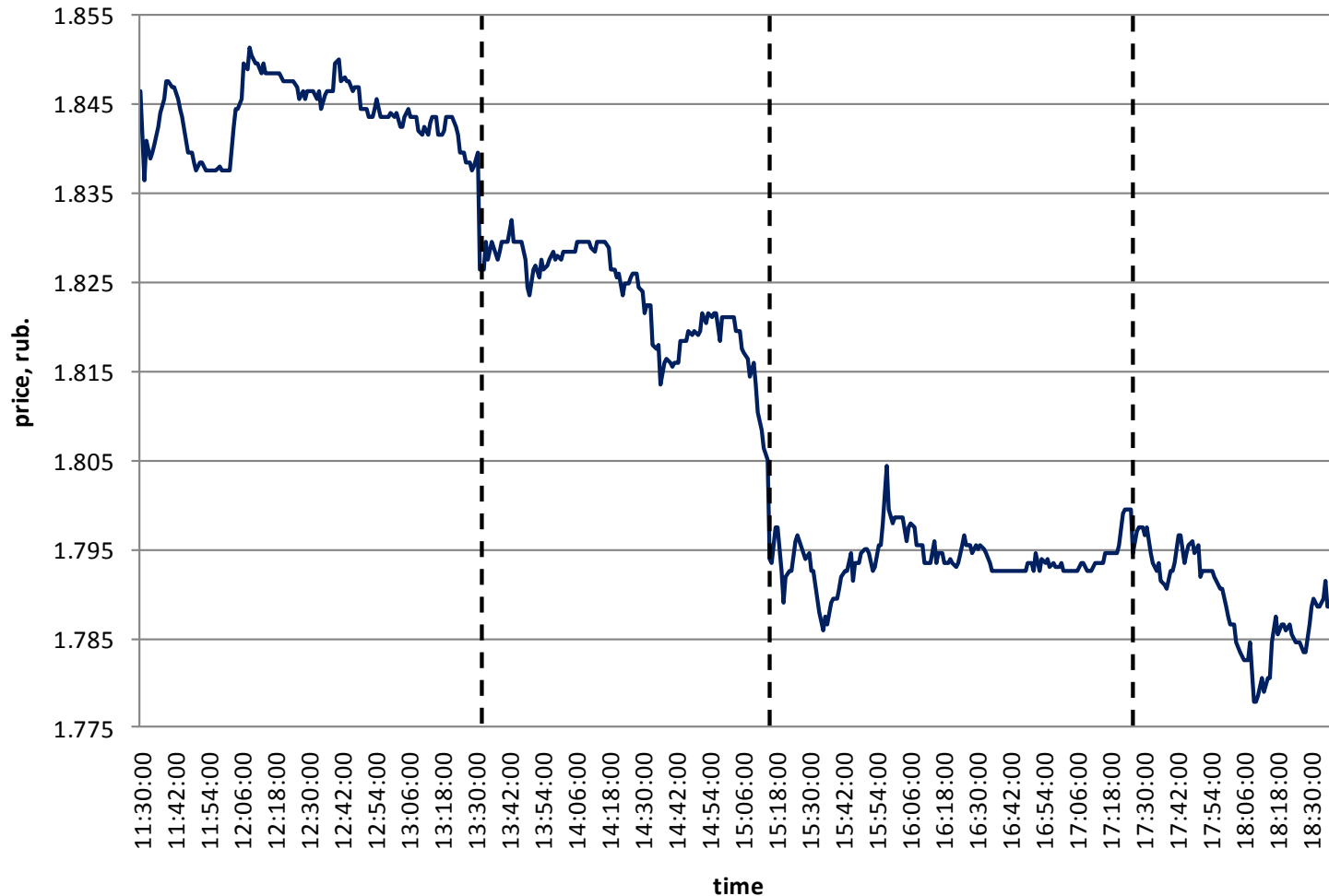
Shocks identified: **13368**.

On average: **5,6 shocks/day per stock**

3-times more frequent than recorded in Bouchaud et.al. (2010) for NASDAQ, NYSE in 2006-2010: **1,5 shocks/day per stock**

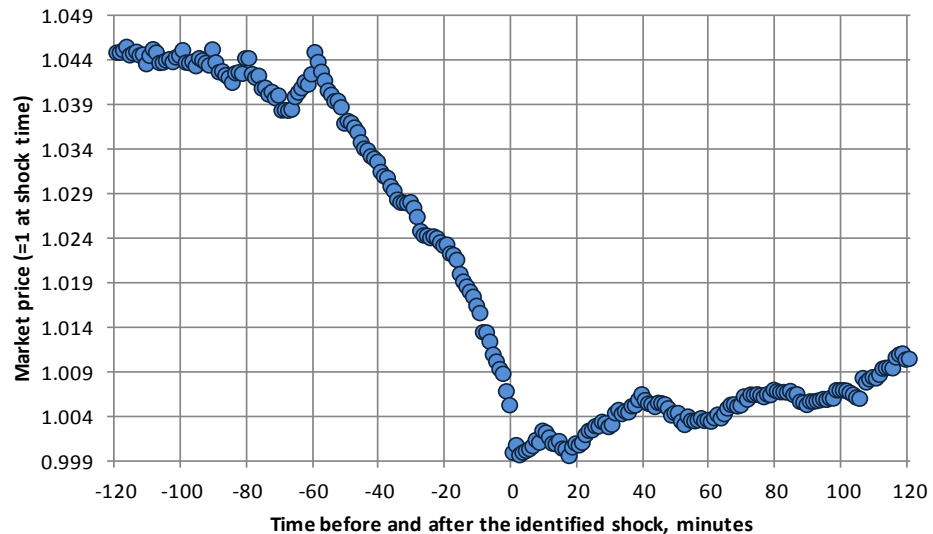
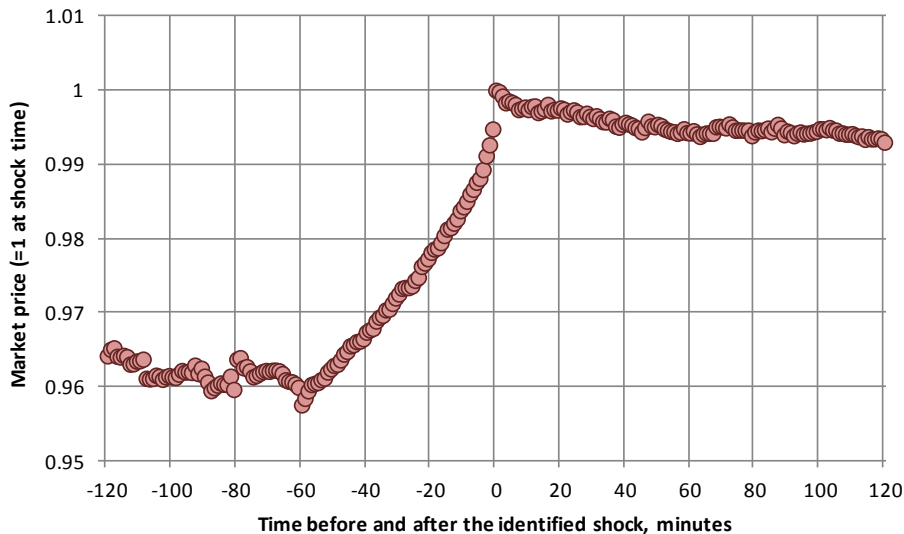
Meso scale: example

Shock at meso scale in HYDR stock on 14.04.2010 at 13:32, 15:16, 17:27

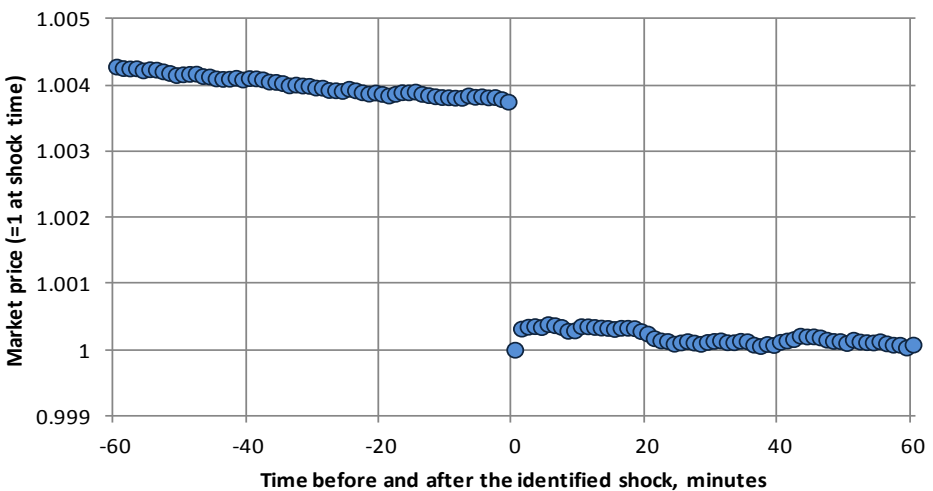
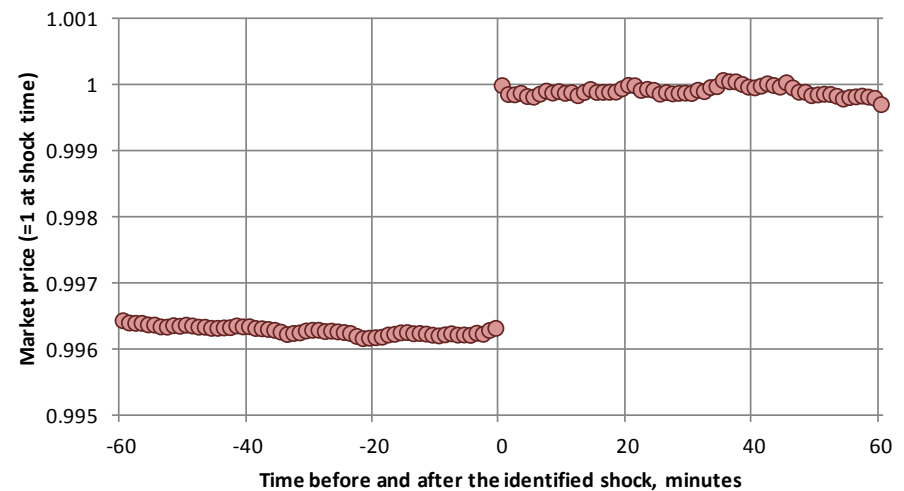


Price path @ shocks

Macro

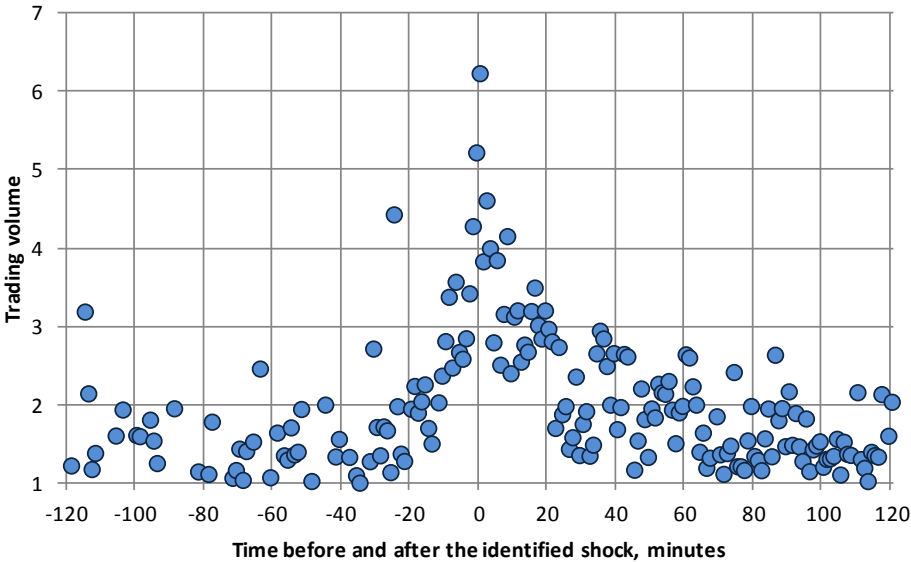
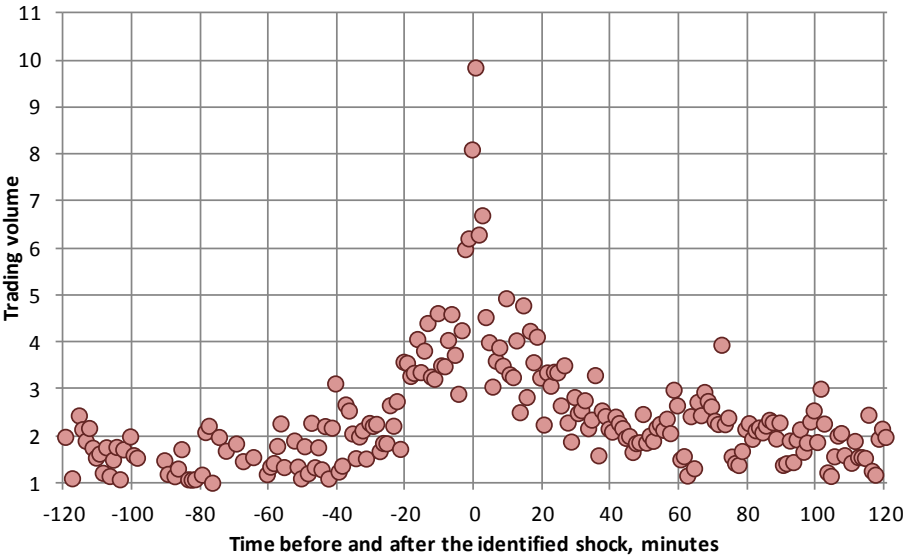


Meso

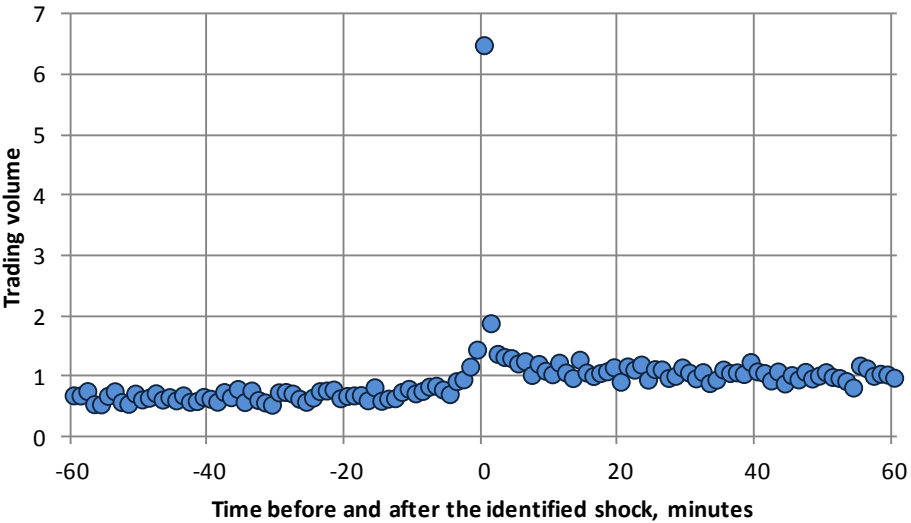
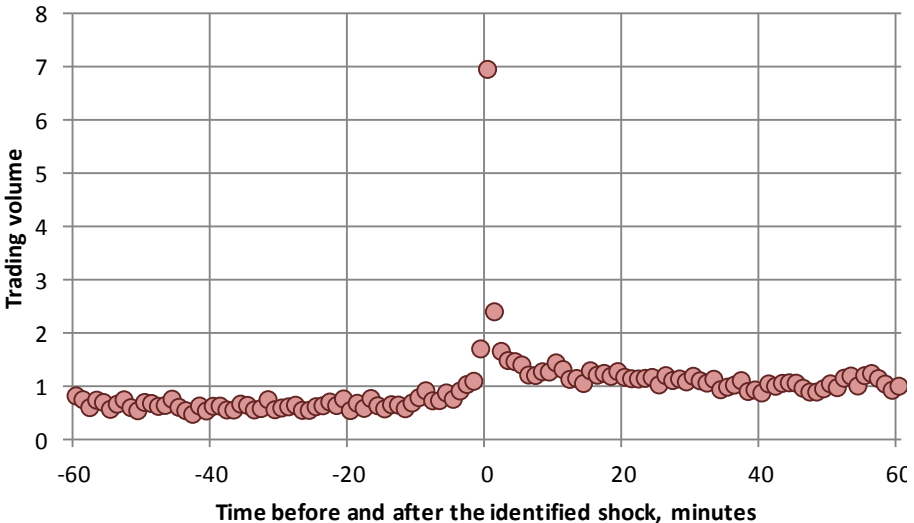


Trading volume @ shocks

Macro

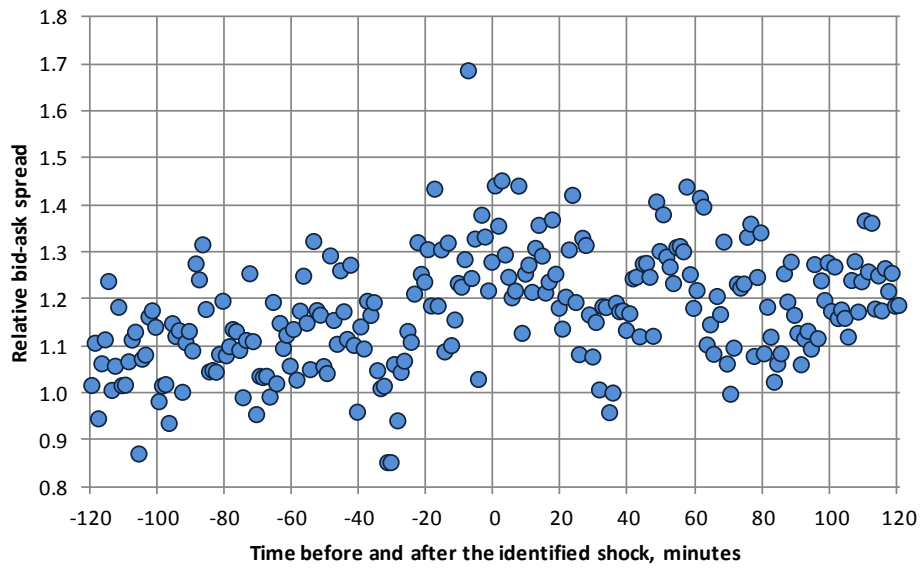
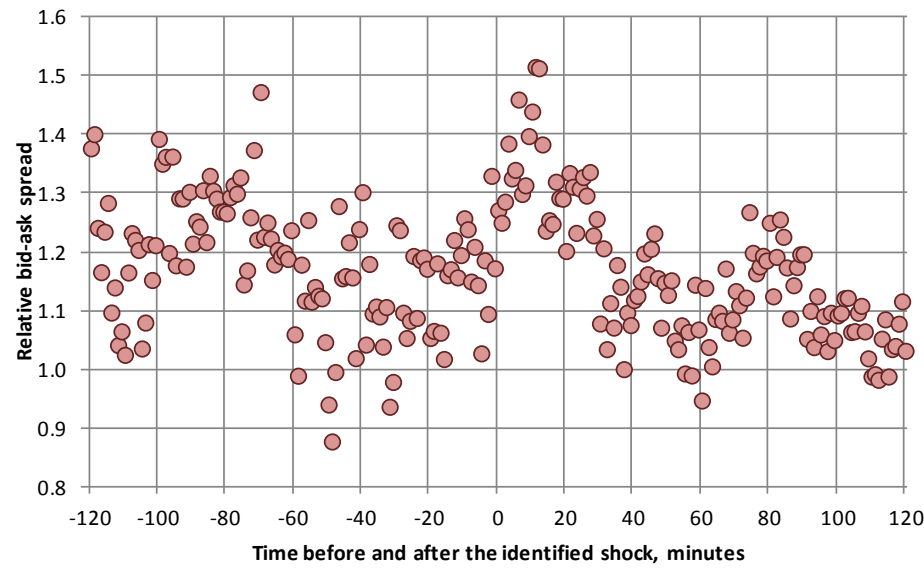


Meso

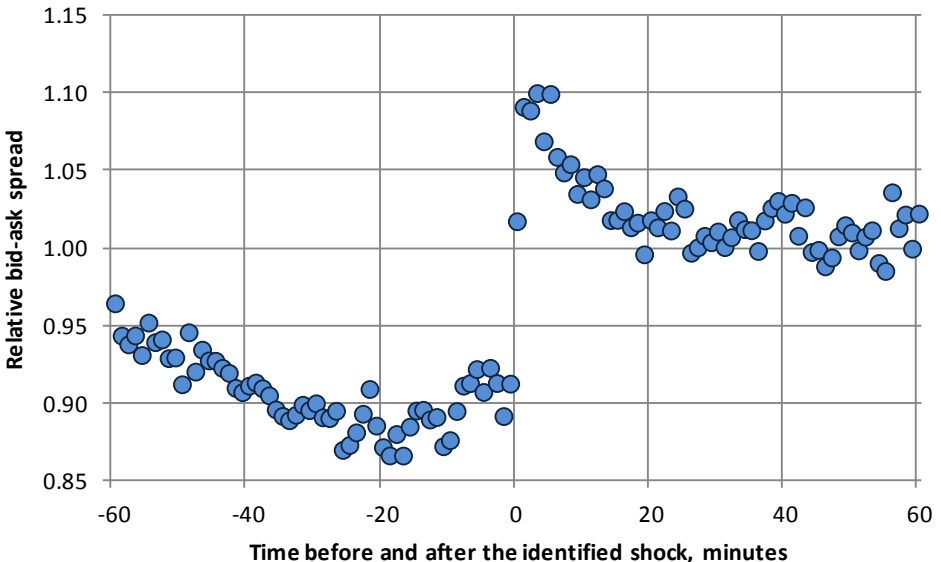
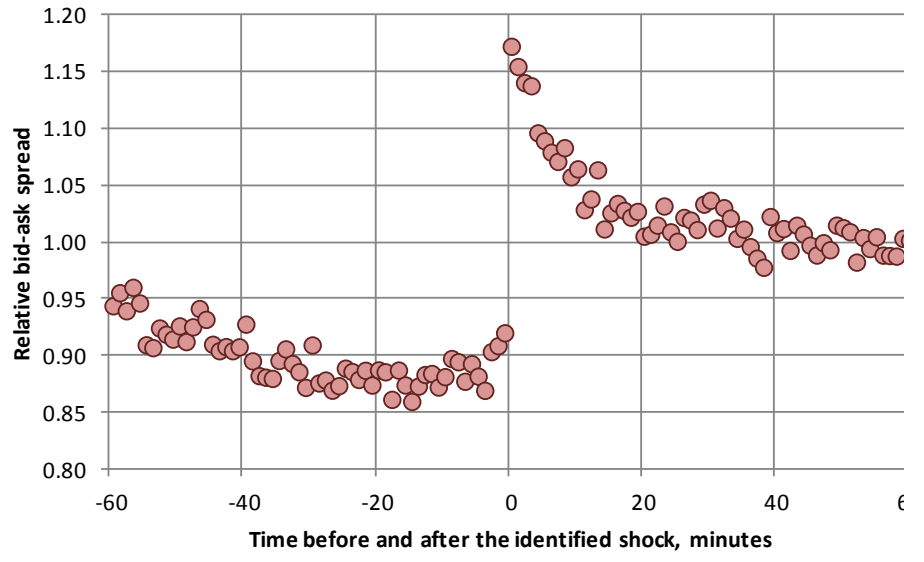


Relative bid-ask spread @ shocks

Macro



Meso

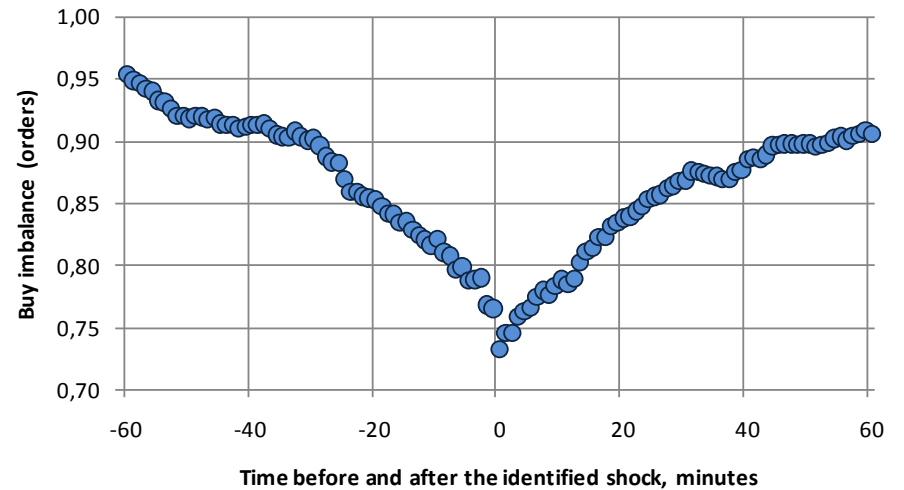
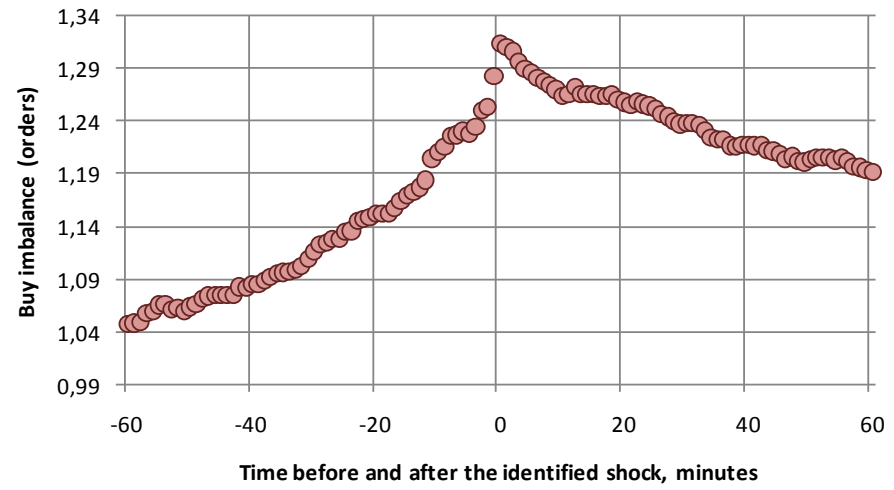


Buy imbalance @ shocks

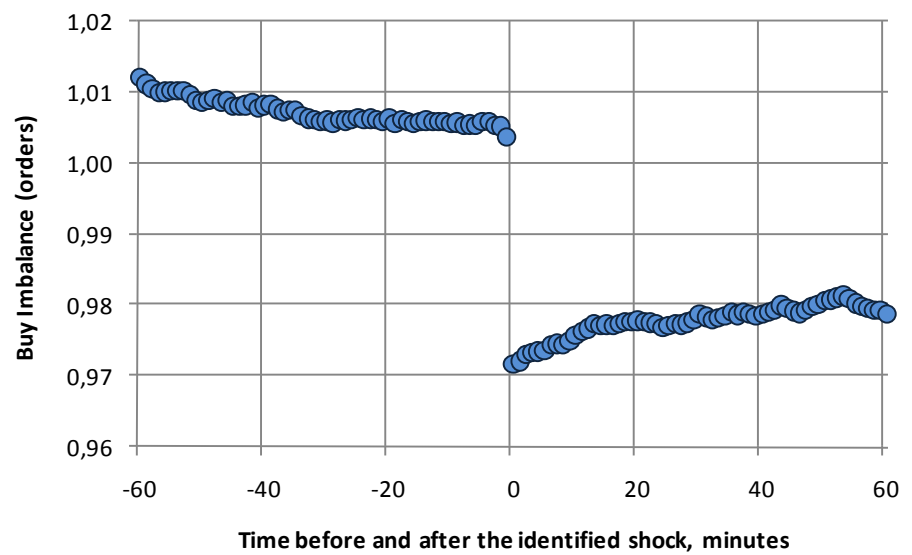
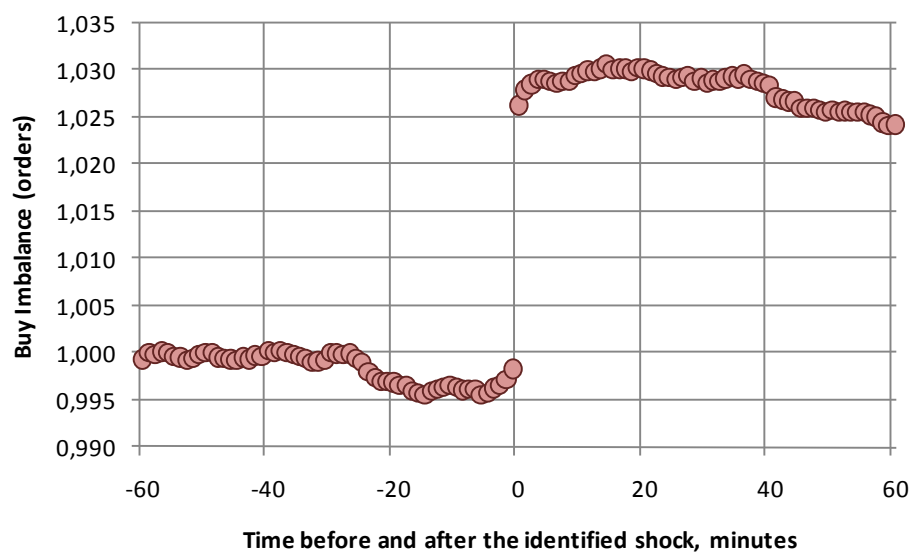
$$I = \frac{V_b}{V_b + V_s}$$

V_b – buy orders quantity in the limit order book at the end of each time moment;
 V_s – sell orders quantity in the limit order book at the end of each time moment

Macro



Meso



Micro scale

http://www.nanex.net/FlashCrashEquities/FlashCrashAnalysis_Equities.html

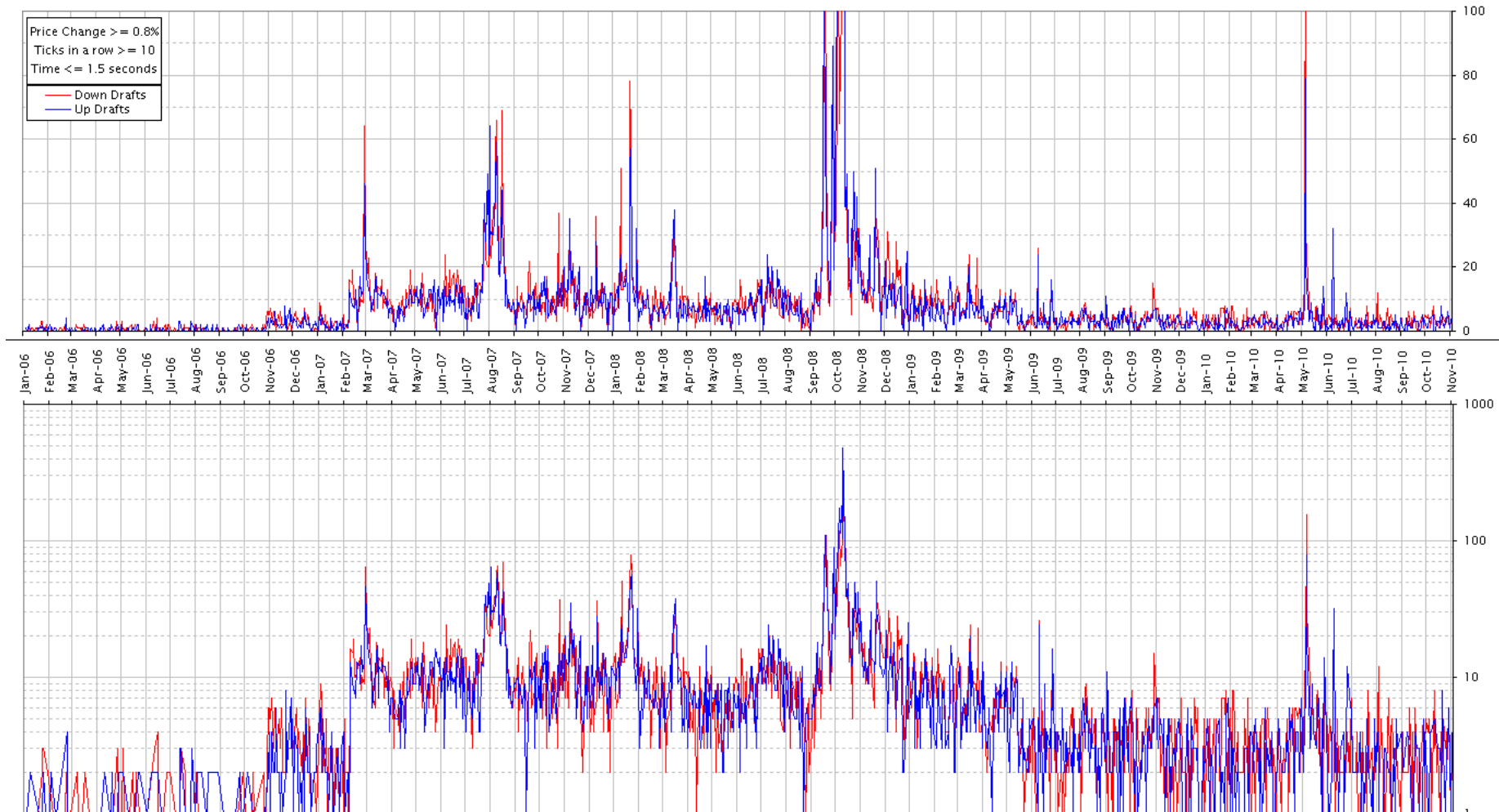
Parameters used:

1. To qualify as a down-draft candidate, the stock had to tick down at least 10 times before ticking up -- all within 1.5 seconds and the price change had to exceed 0.8%.
2. To qualify as a up-draft candidate, the stock had to tick up at least 10 times before ticking down -- all within 1.5 seconds and the price change had to exceed 0.8%.

Because there are so many of these instances, showing all the individual charts on a page would simply be to unwieldy. Instead, we are providing ZIP archives for each year analyzed. Simply download the files, unzip and start viewing. We also made 10 pages with 10 sample images from each year (both down drafts and up drafts) for you to view now.

Year	Count	Down Drafts		Count	Up Drafts	
		Download All	Examples		Download All	Examples
2011	69+	Download		70+	Download	
2010	1041	Download	View	777	Download	View
2009	1,462	Download	View	1,253	Download	View
2008	4,065	Download	View	4,354	Download	View
2007	2,576	Download	View	2,456	Download	View
2006	254	Download	View	208	Download	View

Micro scale



Micro scale

NANEX filter:

- ▶ **down-draft event:** the stock had to tick down at least **10** times before ticking up - all within **2** seconds and the price change had to exceed **0.8%**
- ▶ **up-draft event:** tick up at least **10** times before ticking down - all within **2** seconds and the price change had to exceed **0.8%**

Shocks identified: **369**.

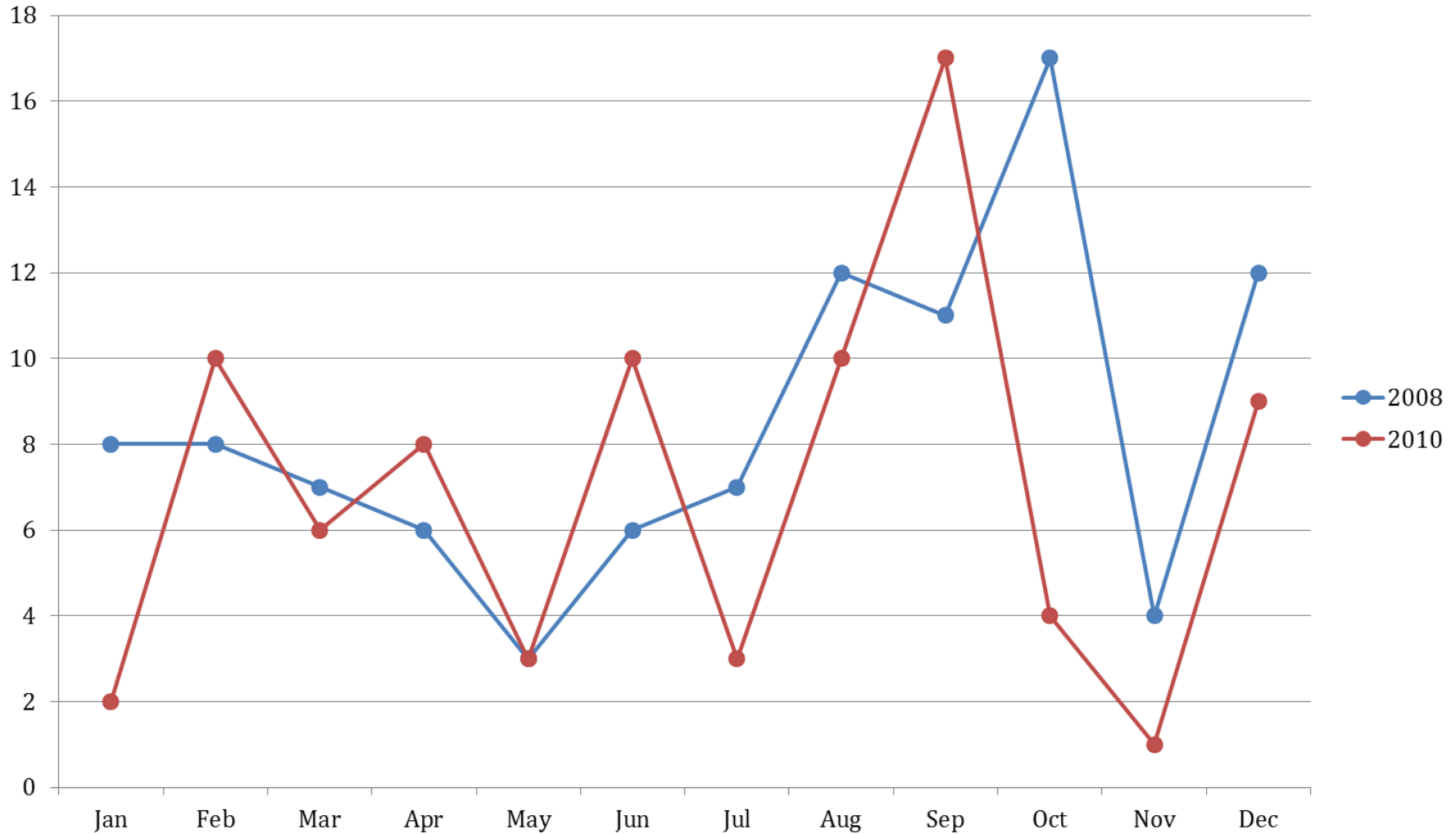
On average: **4,5 shocks/per day**

Comparable to Nanex frequency of **4.13** shocks per day in 2010.

Shocks intensity differs among stocks...

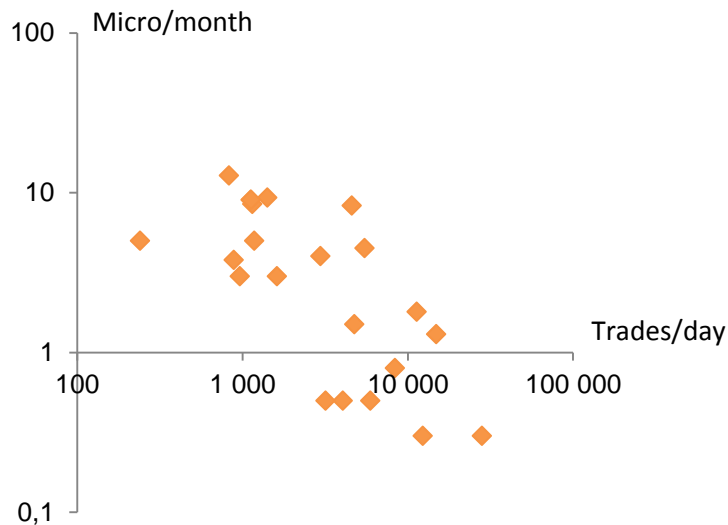
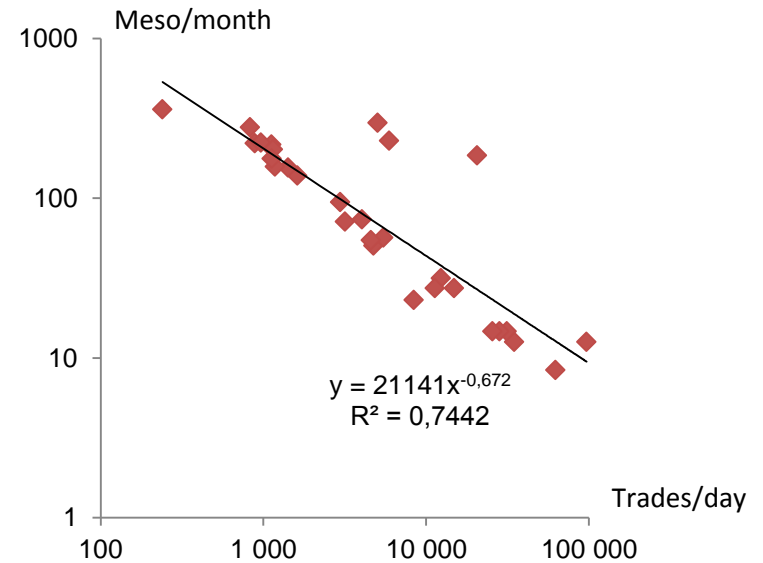
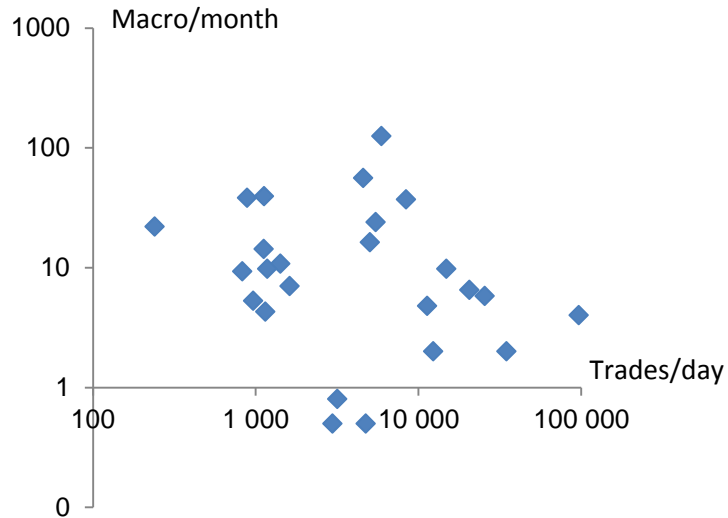
Ticker	Economic sector	Orders/day	Trades/day	Value/day, M\$	tick/price	Macro/month	Meso/month	Micro/month
GAZP	gas production	332448	62 266	1 096	0,617	0	8	0
SBER03	banking	329594	96 658	934	1,228	4	13	0
GMKN	nonferrous metals	395750	34 724	334	1,962	2	13	0
LKOH	oil production	442592	31 259	279	0,605	0	15	0
ROSN	oil production	234145	28 138	229	0,471	0	15	0,3
VTBR	banking	58336	20 587	163	1,220	7	185	0
SBERP03	banking	151186	25 521	161	1,701	6	15	0
TRNFP	oil production	303474	8 369	106	0,319	37	23	0,8
HYDR	energetics	48130	14 840	100	0,614	10	27	1,3
SNGS	gas production	187120	12 297	64	0,348	2	32	0,3
MTSI	telecom	116684	4 038	63	0,403	0	74	0,5
RU14TATN3006	oil production	182571	4 745	58	0,710	1	50	1,5
CHMF	metallurgy	179707	11 319	49	0,269	5	27	1,8
SNGSP	gas production	98856	3 175	48	0,708	1	71	0,5
FEES	energetics	16750	5 020	46	0,288	16	296	0
IUES	energetics	19211	5 930	28	0,198	125	229	0,5
PMTL	nonferrous metals	40147	826	23	2,569	9	277	12,8
URKA	chemical	169569	5 466	20	0,798	24	57	4,5
MRKH	energetics	11405	1 614	15	2,386	7	139	3
NOTK	gas production	64736	1 120	9	0,480	14	216	9
SIBN	oil production	87915	2 958	9	0,755	1	95	4
RASP	coal mining	12952	886	8	0,629	38	221	3,8
RTKM	telecom	145965	4 583	6	0,824	56	55	8,3
MSNG	energetics	10436	964	6	0,300	5	223	3
AFLT	airline	22570	1 143	5	1,614	4	202	8,5
MAGN	metallurgy	31133	1 415	4	0,378	11	155	9,3
NLMK	metallurgy	27565	1 178	4	1,047	10	158	5
OGKC	energetics	19351	1 126	3	0,554	40	176	9
MGNT	retail	20225	240	1	0,335	22	359	5

Shocks intensity does not depends on crisis



Source: estimates by Prognoz Risk Lab. This result is no included in the paper.

Correlation with trades: less shocks in liquid stocks



Are shocks embedded?

Meso into Macro

Event type	Macro events quantity*	Time bounds	Meso events in time bounds	Total meso events quantity	Share of embedded events
Up-draft	93	±1 hour	35	3354	1%
Down-draft	68	±1 hour	35	3406	1%

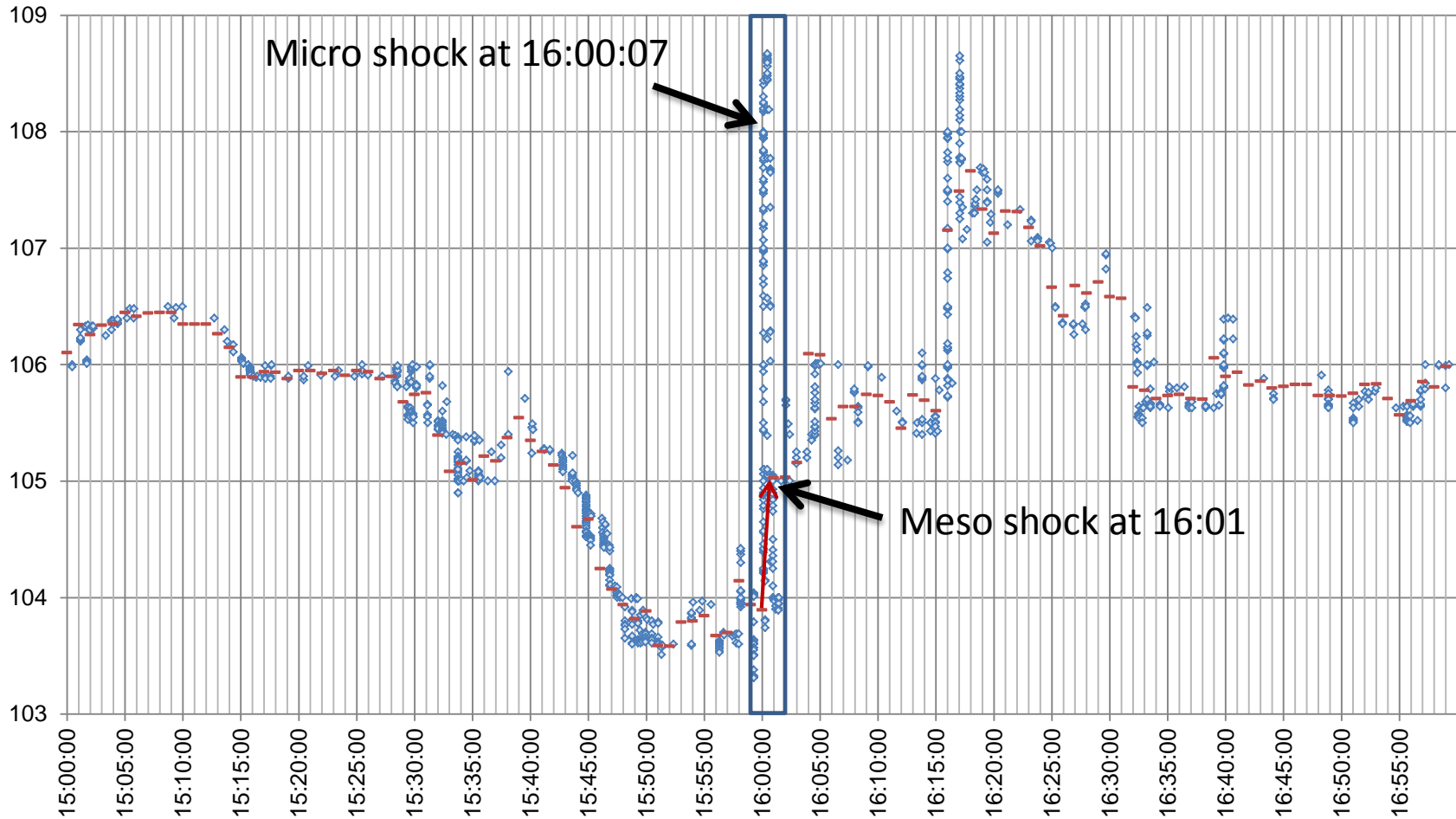
Micro into Meso

Event type	Meso events quantity	Time bounds	Micro events in time bounds	Total micro events quantity	Share of embedded events
Up-draft	3354	±1 min	42	157	26%
Down-draft	3406	±1 min	44	212	21%

* Only included those events with the time interval more than 60 minutes to previous event

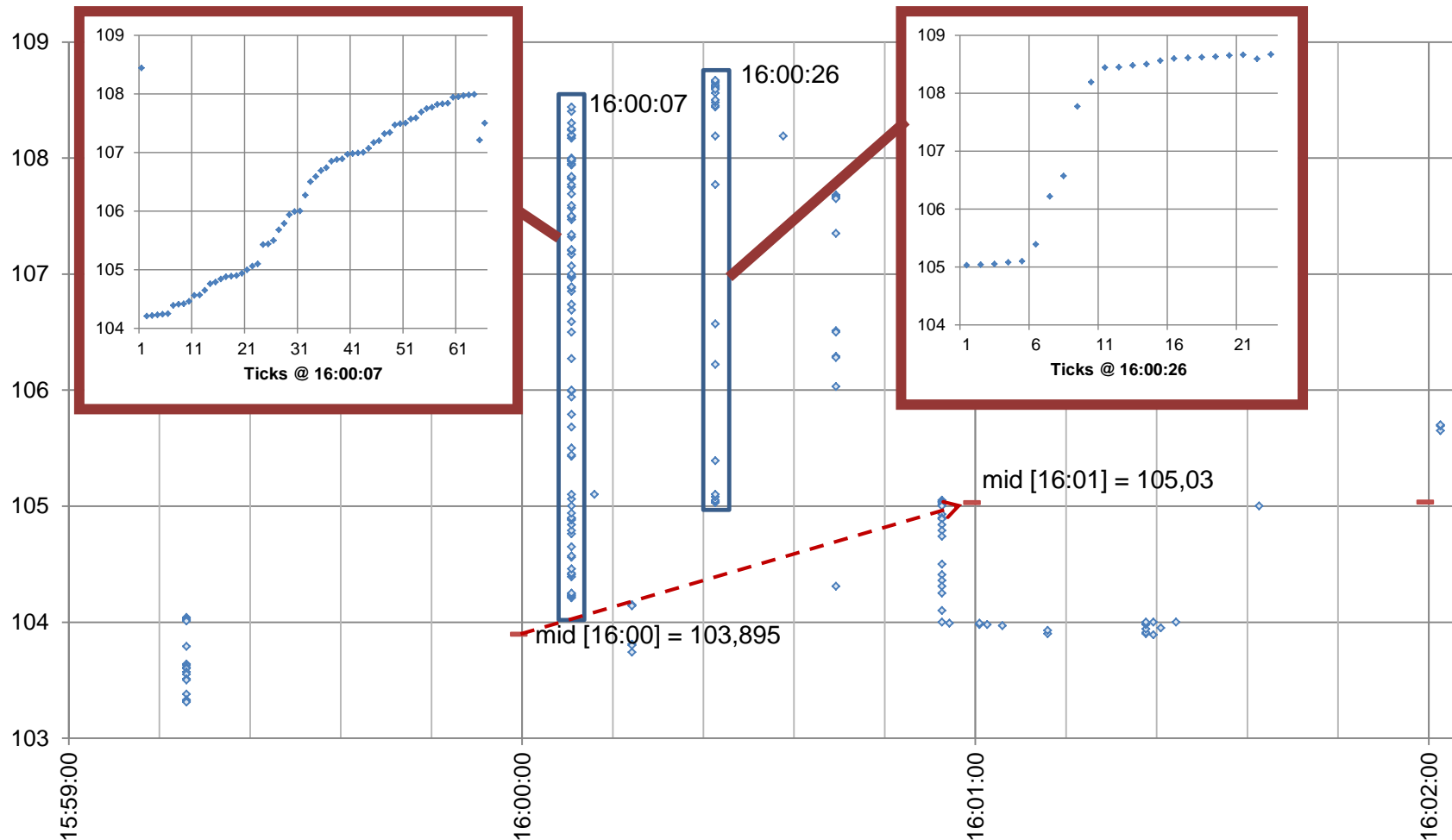
Micro scale: example

Shocks at micro scale in RTKM stock on 20.05.2010 at 16:00:07 and 16:00:26
...embedded into Meso shock at 16:01



Micro scale: example

Shocks at micro scale in RTKM stock on 20.05.2010 at 16:00:07 and 16:00:26...



Conclusions

- A large number of shocks are present in financial markets
- Shocks frequency in Russian market is pretty consistent with other markets
- The more liquid is the stock the less shocks are there
- Meso shocks are not embedded into Macro shocks and have different nature
- Micro shocks are likely to be embedded into Meso shocks
- Next research questions:
 - What drives market shocks?
 - Are HFTs involved?
 - How shocks in multiple stocks are synchronized (co-jumps)?
 - Can this be used for prediction or early warning for longer time scales (1 day or more)?

Perm Winter School



Perm Winter School 2014

Dates: 30 Jan – 1 Feb 2014



Invited speakers:

- Didier Sornette (ETH Zurich)
- Ramo Gencay (Simon Fraser University)
- Richard Olsen* (Olsen Associates)
- Andy Jobst (Bermuda Monetary Authority)

More information:

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