

Market shocks in Russian stocks prices

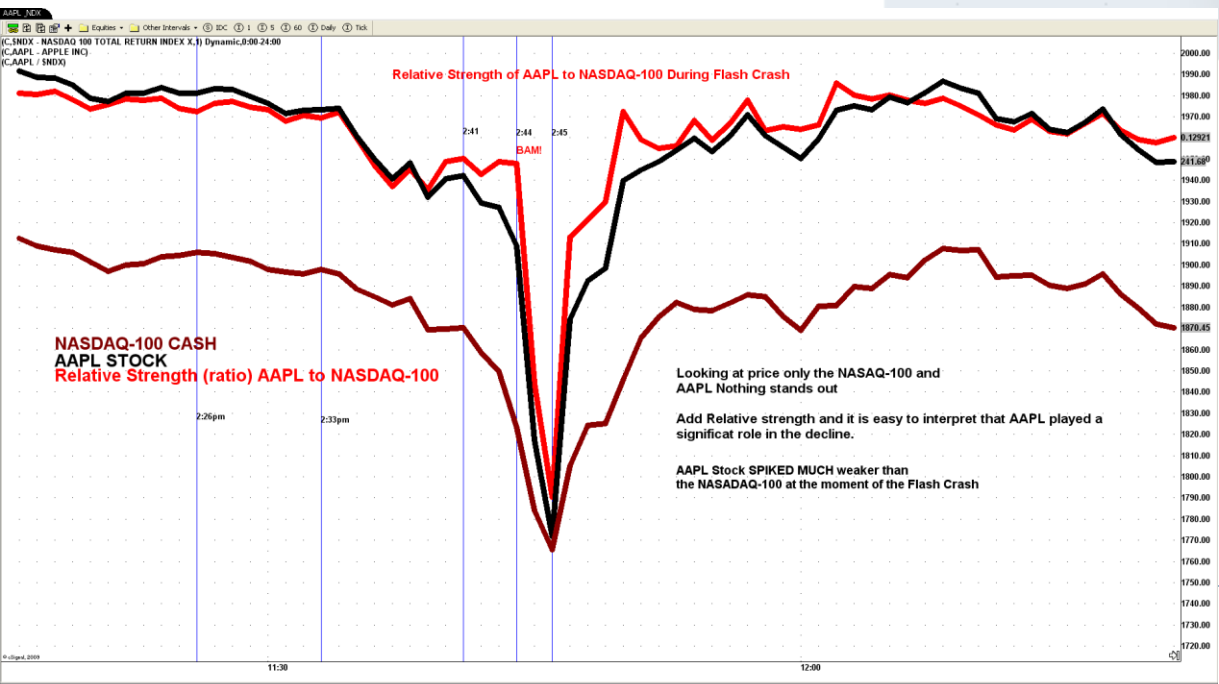
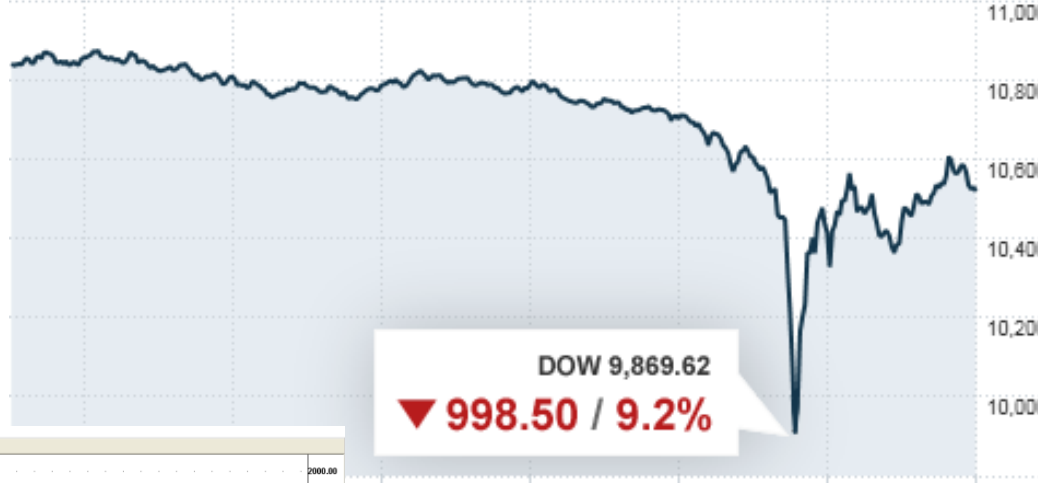
Maria Frolova (Prognoz Risk Lab)

PROGNOZ
RISK LAB

Market shock: definition

- ▶ Disruption of market equilibrium caused by a change in a demand determinant (and a shift of the demand curve) or a change in a supply determinant (and a shift of the supply curve)

Example of market shocks: FlashCrash May 6, 2010 2:45



We apply different types of filters at 3 time scales:

▶ Hours scale (macro):

- ▶ Absolute filter
- ▶ Relative filter

Source: Guo-Hua Mu, Wei-Xing Zhou, Wei Chen and János Kertész. *Order flow dynamics around extreme price changes on an emerging stock market*, 2010

▶ Minutes scale (meso):

- ▶ Filter of minute returns

Source: Armand Joulin, Augustin Lefevre, Daniel Grunberg, Jean-Philippe Bouchaud. *Stock price jumps: news and volume play a minor role*, 2010

▶ Tick scale (micro):

- ▶ NANEX filter

Source: Flash Crash Analysis Continuing Developments

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



**29 stocks of
MICEX Index**

Period analyzed

**01.04.2010-30.06.2010;
1.09.2010-12.10.2010
(82 trading days)**

IDENT	ECONOMIC SECTOR
AFLT	airline
SBER03	banking
VTBR	banking
SBERP03	banking
URKA	chemical
RASP	coal mining
IUES	energetics
MRKH	energetics
MSNG	energetics
HYDR	energetics
FEES	energetics
OGKC	energetics
GAZP	gas production
SNGS	gas production
SNGSP	gas production
NOTK	gas production
CHMF	metallurgy
MAGN	metallurgy
NLMK	metallurgy
GMKN	nonferrous metals
PMTL	nonferrous metals
LKOH	oil production
ROSN	oil production
TRNFP	oil production
RUI4TATN3006	oil production
SIBN	oil production
MGNT	retail
MTSI	telecommunications
RTKM	telecommunications

Absolute filter finds out the cumulative intraday price changes exceeding yield threshold value within time window Δt .

Cumulative return during the time window Δt :

$$r(t) = \frac{p(t) - p(t - \Delta t)}{p(t - \Delta t)} \approx \ln \frac{p(t)}{p(t - \Delta t)}$$

$p(t)$ – mid-price at the moment t

Shock is identified in case cumulative return exceeds threshold value Y :

$$r(t) > Y$$



Relative filter searches for intraday absolute cumulative return exceeding M times the average volatility during the sample period. Cumulative intraday volatility is defined

$$v(t, \Delta t) = \frac{1}{\Delta t} \sqrt{\sum_{\tau=t-\Delta t}^t r^2(\tau)}$$

Shock is identified in case cumulative volatility exceeds M times average volatility during the sample:

Average volatility during the sample period is defined:

$$av_v(t, \Delta t) = \frac{\sum_{i=1}^n v(t, \Delta t)}{n}$$

n – number of days during the sample period

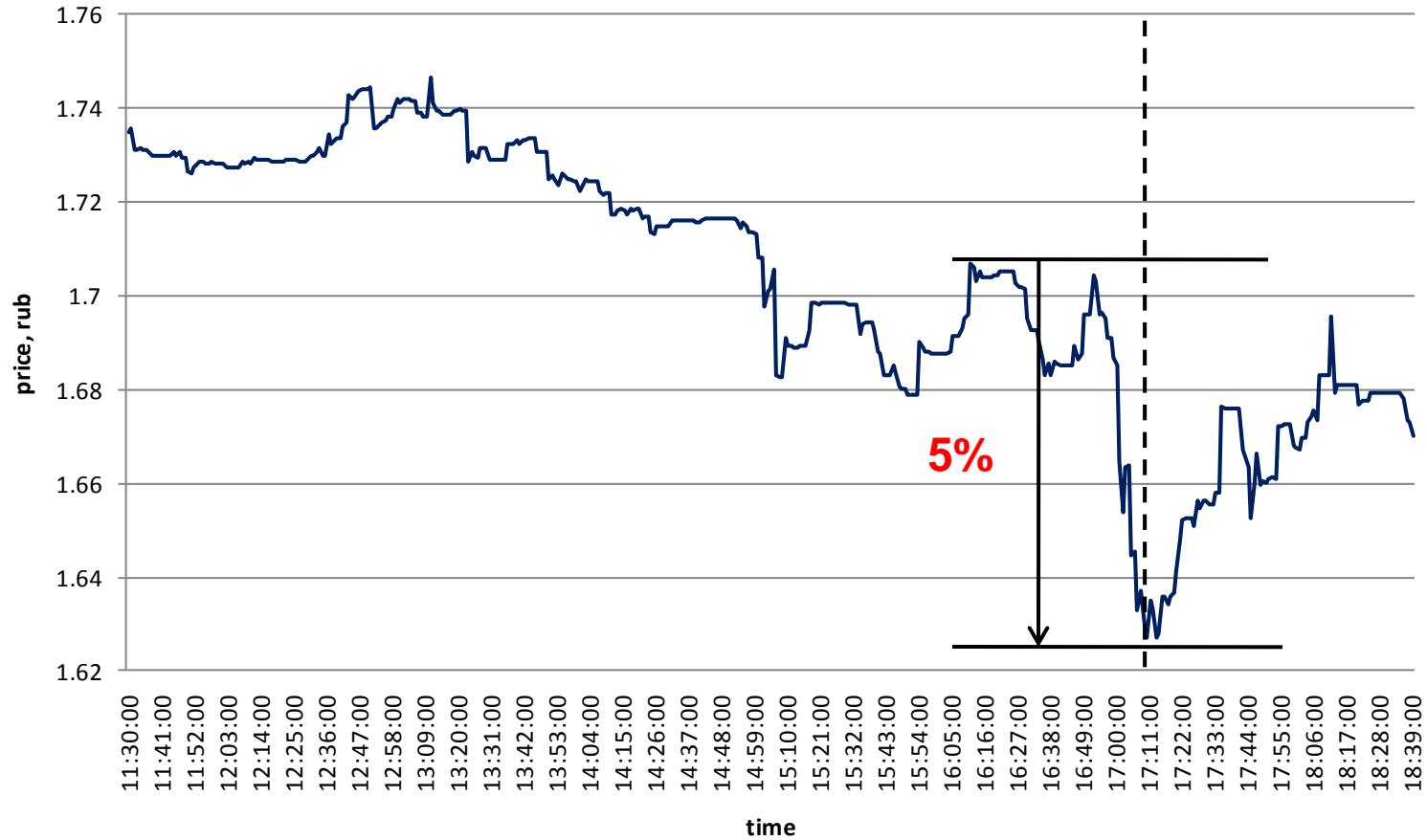
$$r(t, \Delta t) > M * av_v(t, \Delta t)$$

M – multiplier for calculating relative filter



Example of shock at macro scale:

HYDR, 4.06.2010 17:11



Source data and results

Statistics:

Δt 60 min

Y 4%

M 6

Stocks analyzed 29 blue chips
01.04.2010-30.06.2010;
1.09.2010-12.10.2010

Period

Trading days 82

Sample size 1.2 mln.

Trading time 11.30-18.40

Shocks found 1820

We use a minute dynamics of mid-prices for filtering (source: MICEX)

Total 1820 events (63 per stock)

On average 17 shocks/month per stock

Shenzhen Stock Exchange (2003):

20 shocks/month per stock

IDENT	UP	DOWN	ALL
IUES	284	216	500
RTKM	169	55	224
OGKC	80	78	158
RASP	63	90	153
TRNFP	44	104	148
URKA	48	48	96
MGNT	69	19	88
FEES	54	11	65
NOTK	57	0	57
MAGN	0	43	43
HYDR	22	17	39
NLMK	20	19	39
PMTL	37	0	37
MRKH	12	16	28
VTBR	16	10	26
SBERP03	14	9	23
MSNG	13	8	21
CHMF	17	2	19
AFLT	14	3	17
SBER03	15	1	16
GMKN	0	8	8
SNGS	8	0	8
SNGSP	3	0	3
RUI4TATN3006	0	2	2
SIBN	1	1	2
GAZP	0	0	0
LKOH	0	0	0
MTSI	0	0	0
ROSN	0	0	0
Average	37	26	63

The filter compares the absolute size of a one minute return to a short term (60 minutes) moving average of the same quantity.

Minute return is defined:

$$r(t) = \frac{p(t) - p(t - \Delta t)}{p(t - \Delta t)} \approx \ln \frac{p(t)}{p(t - \Delta t)}$$

$p(t)$ – mid-price at the moment t

Shock is identified in case minute return exceeds s times moving average minute return:

$$|r(t, \Delta t)| > s * M(t, \Delta T)$$

Moving average minute return is defined:

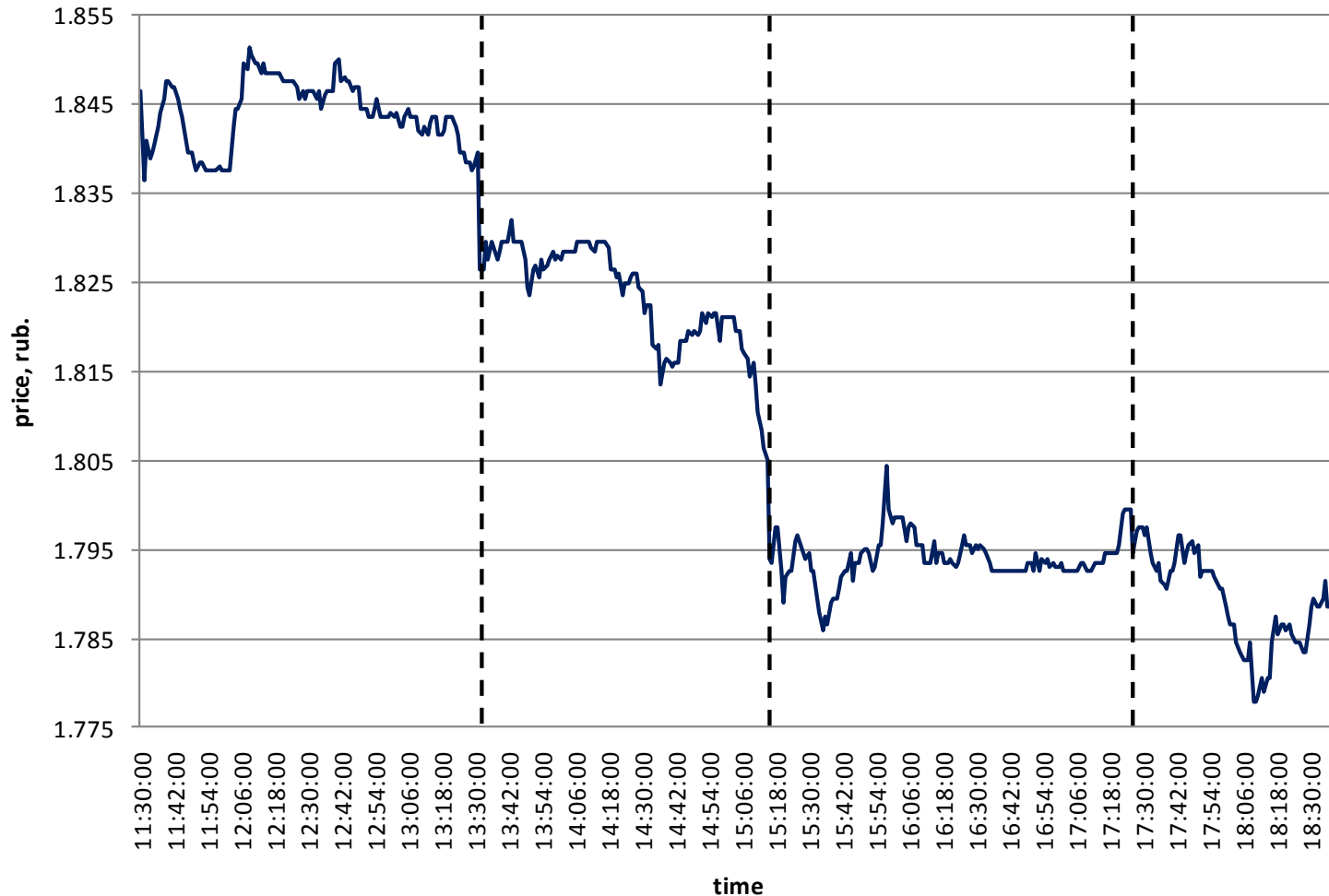
$$M(t, \Delta T) = \frac{\sum_{i=t-\Delta T}^t |r(i, \Delta t)|}{\Delta T}$$



Example of shock at meso scale:

HYDR, 14.04.2010

13:32, 15:16, 17:27



Source data and results

Statistics:

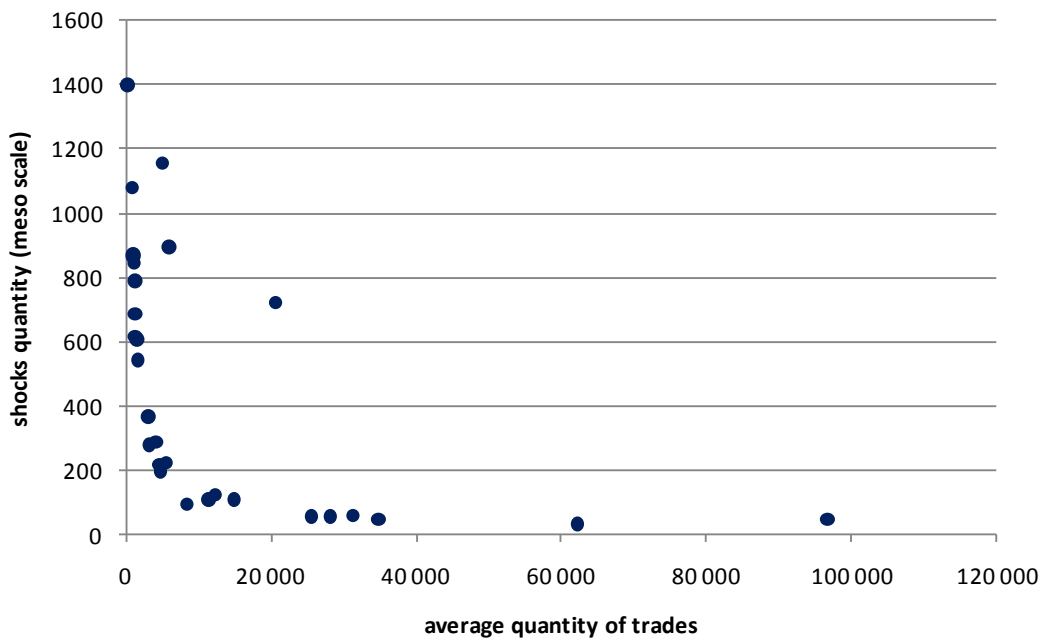
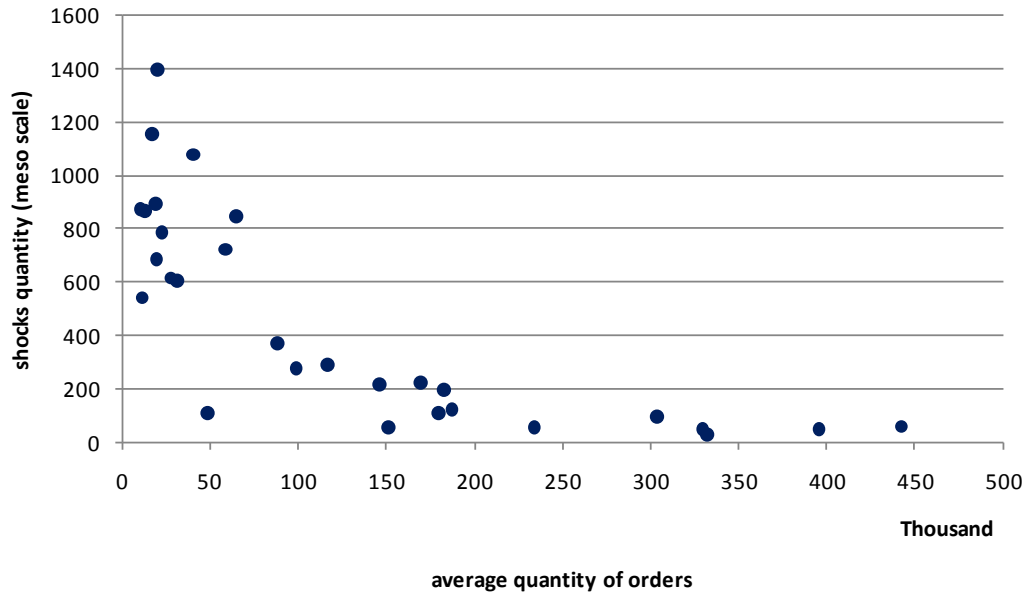
Δt 1 min
 ΔT 60 min
Stocks analyzed 29 blue chips
01.04.2010-30.06.2010;
Period 1.09.2010-12.10.2010
Sample size 1.2 mln.
Trading days 82
Trading time 11.30-18.40
Shocks found 13368

We use a minute dynamics of mid-prices
for filtering (source: MICEX)

Total 13368 events (461 per stock)
On average 11 shocks/2 days per stock
NASDAQ, NYSE (2.08.2010-31.08.2006):
3 shocks /2 days per stock

IDENT	UP	DOWN	ALL
MGNT	707	692	1399
FEES	566	590	1156
PMTL	543	536	1079
IUES	453	442	895
MSNG	403	470	873
RASP	393	472	865
NOTK	445	400	845
AFLT	381	406	787
VTBR	365	357	722
OGKC	317	370	687
NLMK	350	266	616
MAGN	308	298	606
MRKH	276	266	542
SIBN	160	208	368
MTSI	149	139	288
SNGSP	140	137	277
URKA	113	110	223
RTKM	101	115	216
RU14TATN3006	99	98	197
SNGS	64	59	123
CHMF	57	53	110
HYDR	47	62	109
TRNFP	49	45	94
LKOH	34	24	58
ROSN	27	28	55
SBERP03	25	30	55
SBER03	31	16	47
GMKN	25	21	46
GAZP	15	15	30
Average	229	232	461

Shocks quantity average quantity of orders



- ▶ **down-draft candidate:**

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%

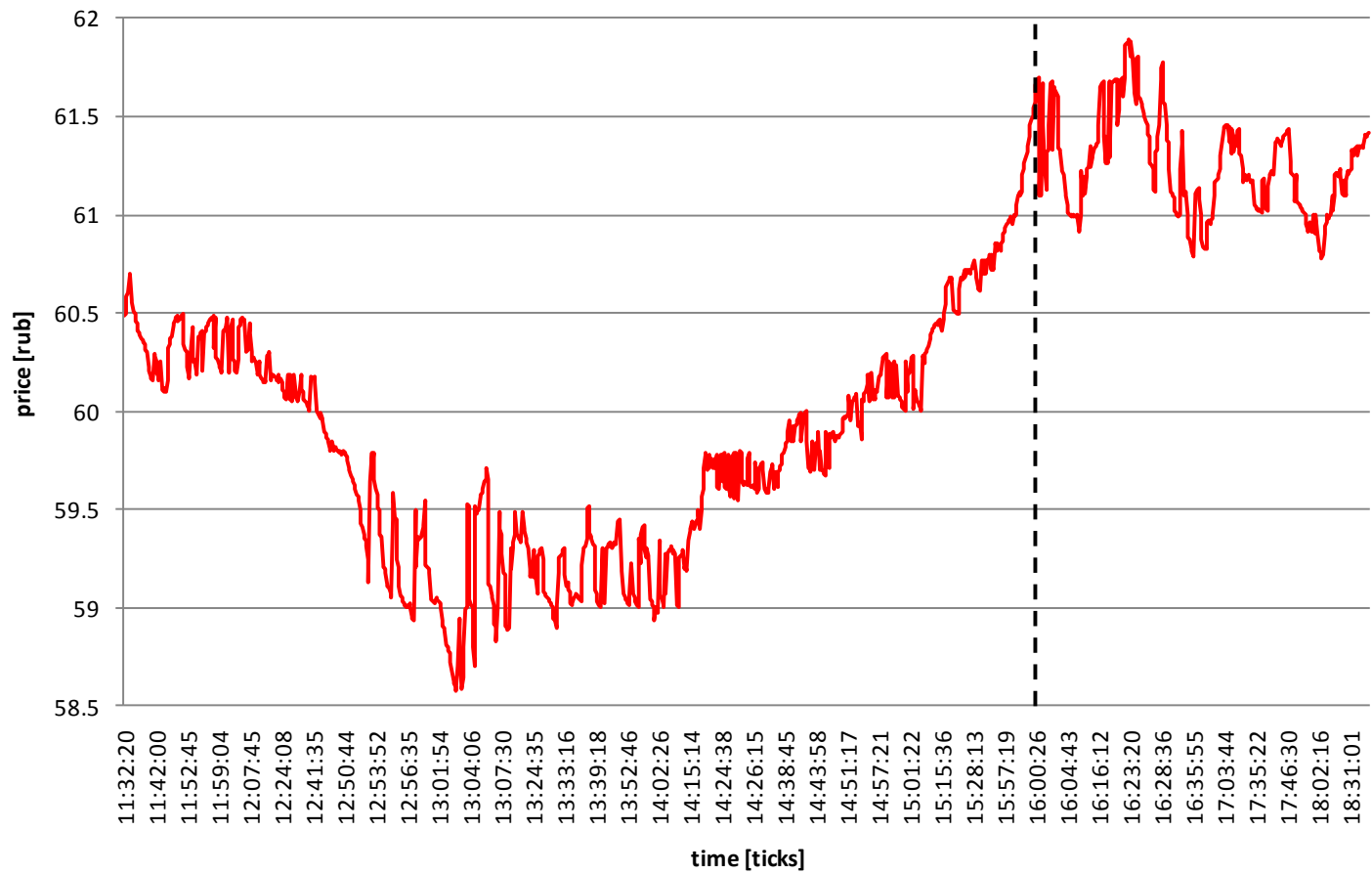
- ▶ **up-draft candidate:**

tick up at least 10 times before ticking down - all within 2 seconds and the price change had to exceed 0.8%



Example of shock at micro scale: AFLT, 28.04.2010 16:00:26

Within 1 second
price rose 0.82 %
for 16 ticks
(61.2 ->61.7)



Source data and results

Statistics:

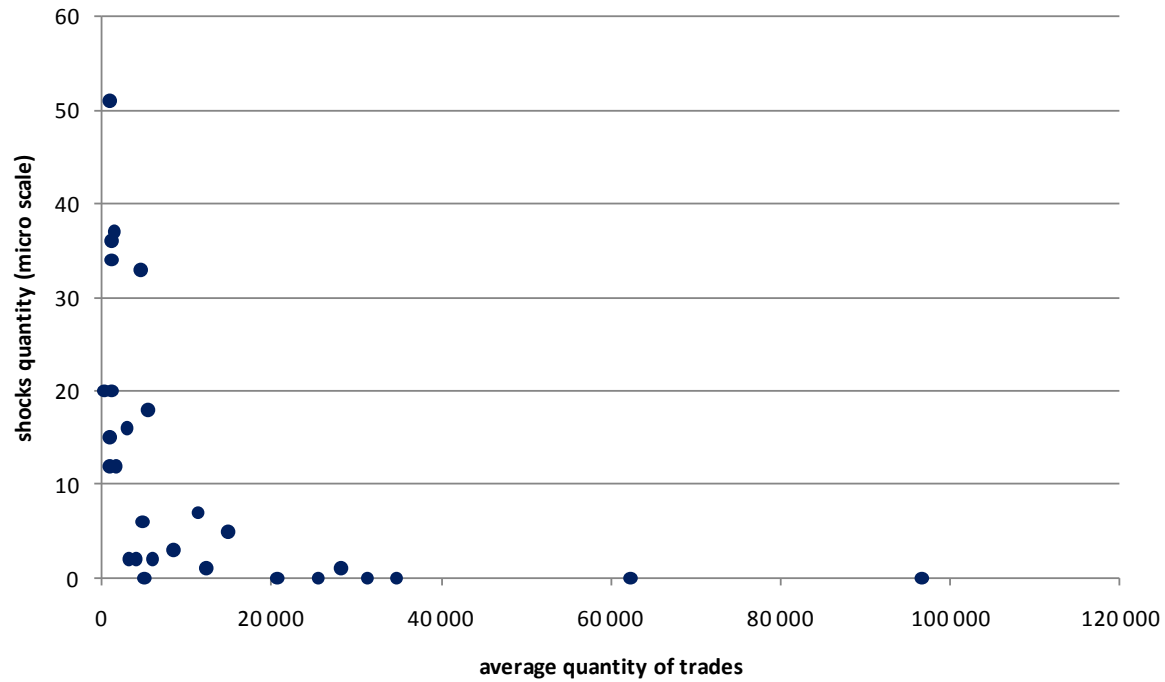
Stocks analyzed 29 blue chips
01.04.2010-30.06.2010;
Period 1.09.2010-12.10.2010
Trading days 82
Sample analyzed 20.2 mln. ticks
Trading time 11.30-18.40
Shocks found 369

We use a tick dynamics of prices for filtering (source: MICEX)

Total 369 events (13 per stock)
On average 1 shock/7 days per stock

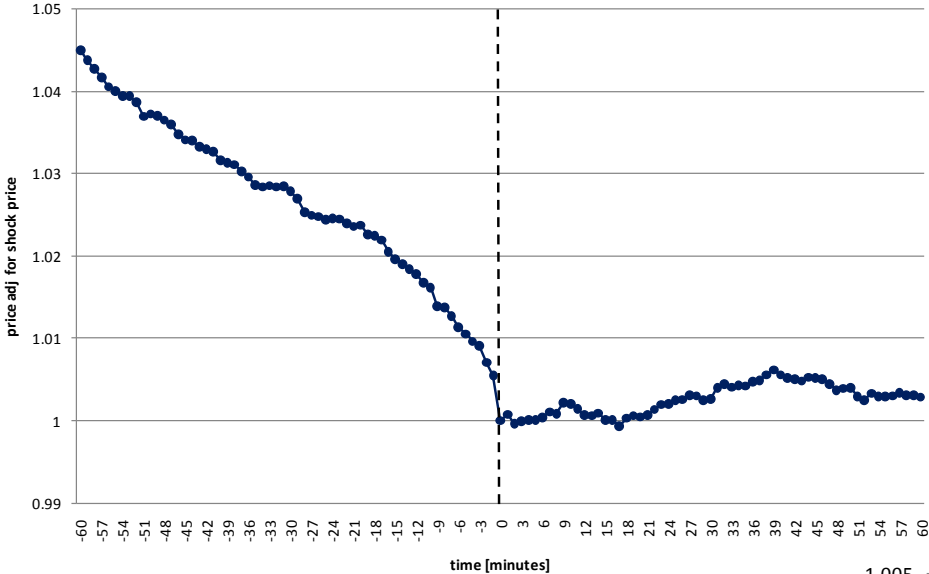
IDENT	UP	DOWN	ALL
PMTL	15	36	51
MAGN	31	6	37
NOTK	18	18	36
OGKC	13	23	36
AFLT	9	25	34
RTKM	14	19	33
MGNT	4	16	20
NLMK	8	12	20
URKA	7	11	18
SIBN	6	10	16
RASP	7	8	15
MRKH	3	9	12
MSNG	5	7	12
CHMF	3	4	7
RU14TATN3006	3	3	6
HYDR	3	2	5
TRNFP	3	0	3
IUES	0	2	2
MTSI	1	1	2
SNGSP	2	0	2
ROSN	1	0	1
SNGS	1	0	1
FEES	0	0	0
GAZP	0	0	0
GMKN	0	0	0
LKOH	0	0	0
SBER03	0	0	0
SBERP03	0	0	0
VTBR	0	0	0
Average	5	7	13

Shocks quantity (micro scale) & average quantity of trades



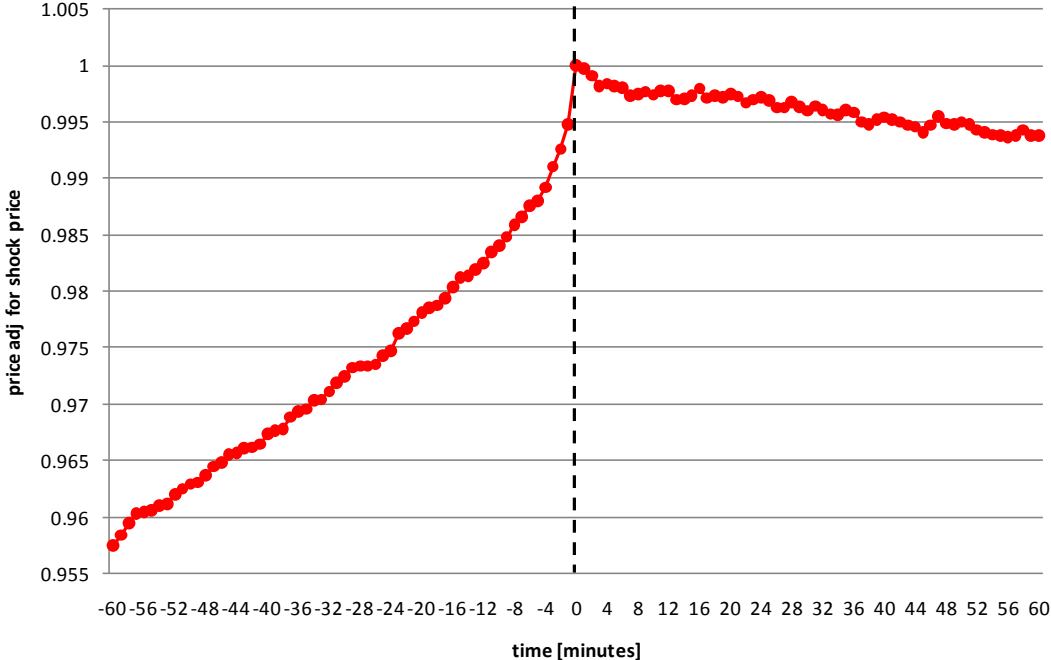
Price analysis: MACRO

negative events



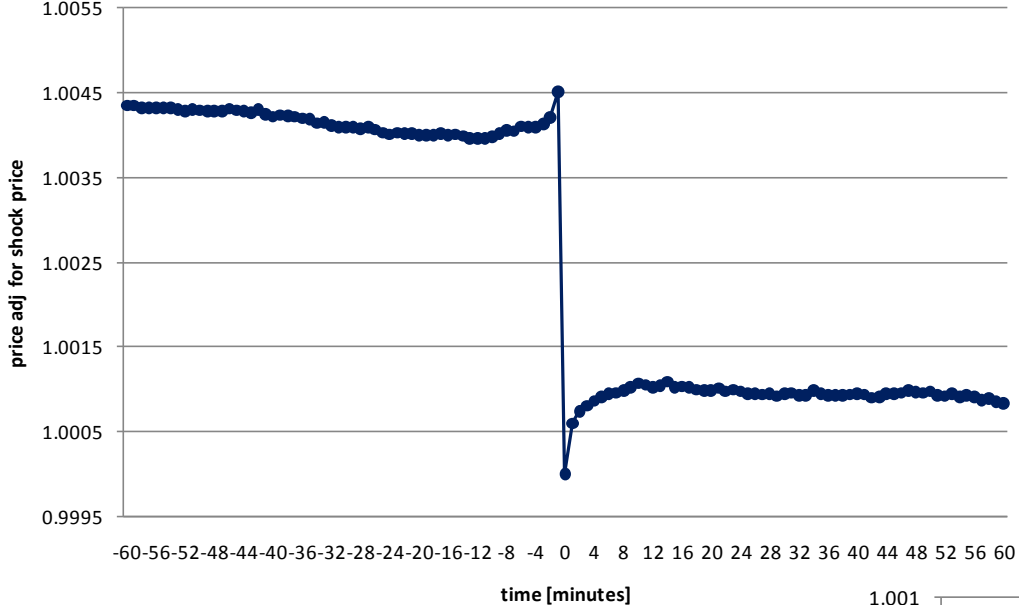
Negative events: $t=17$ $p_{min}=0.99933$

positive events



Price analysis: MESO

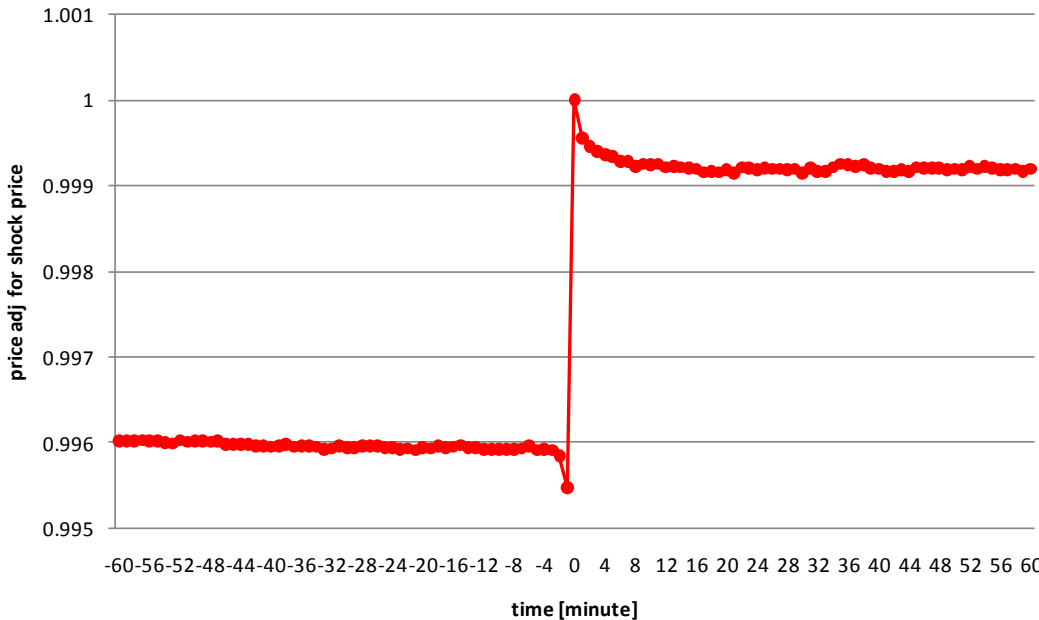
negative events



Negative events: $t=-1$ $p_{max}=1.004507$

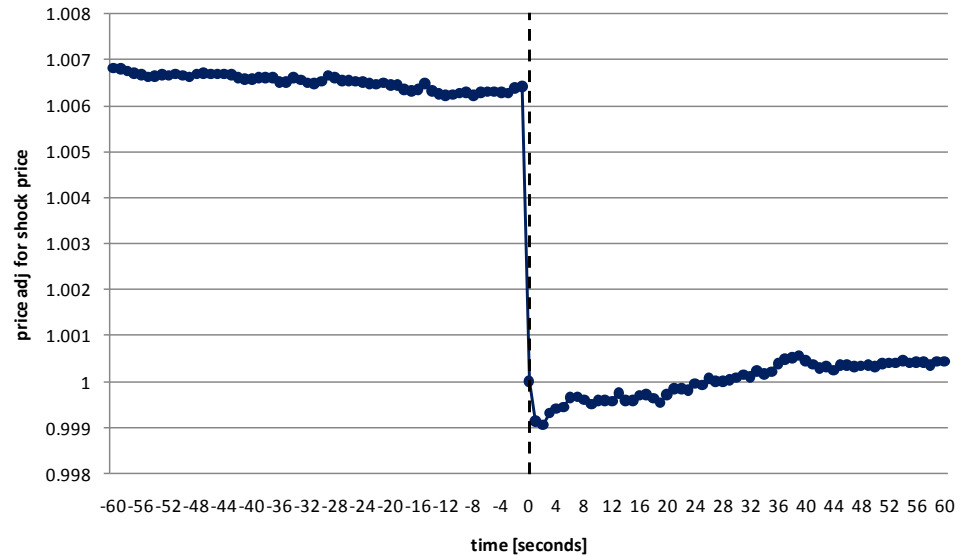
Positive events: $t=-1$ $p_{min}=0.995474$

positive events



Price analysis: MICRO

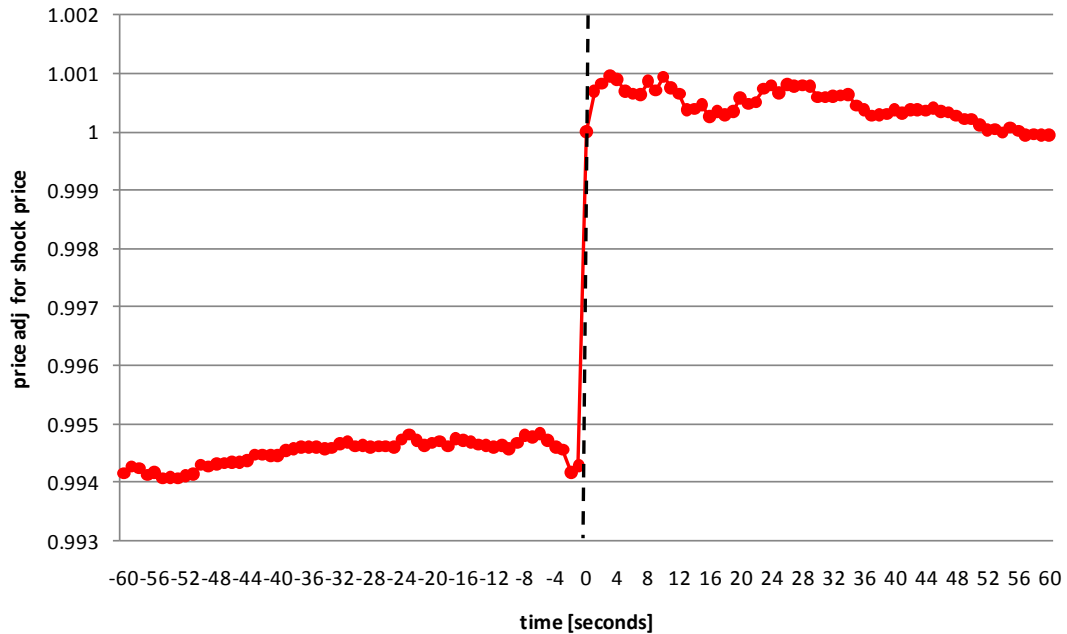
negative events



Negative events: $t=2$ $p_{min} = 0.999054$

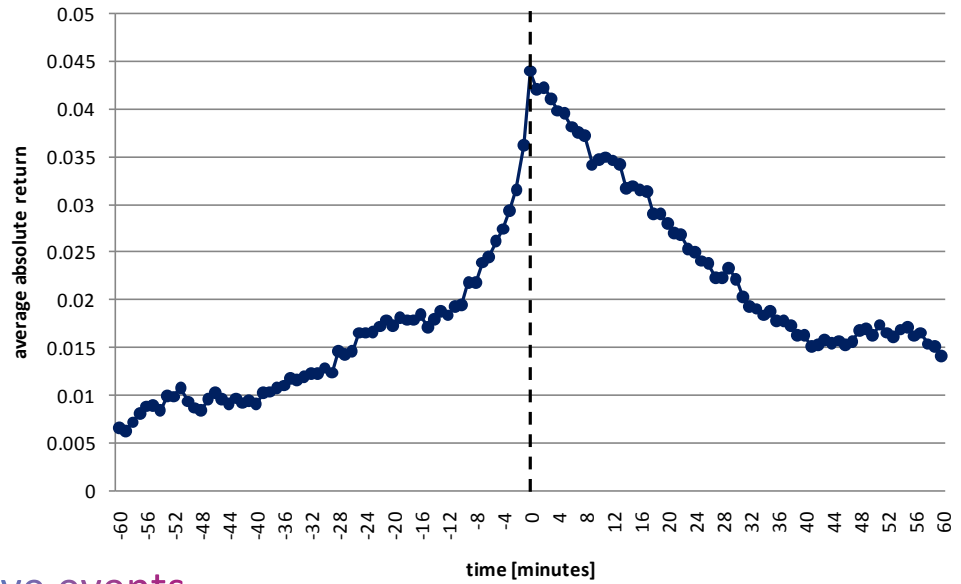
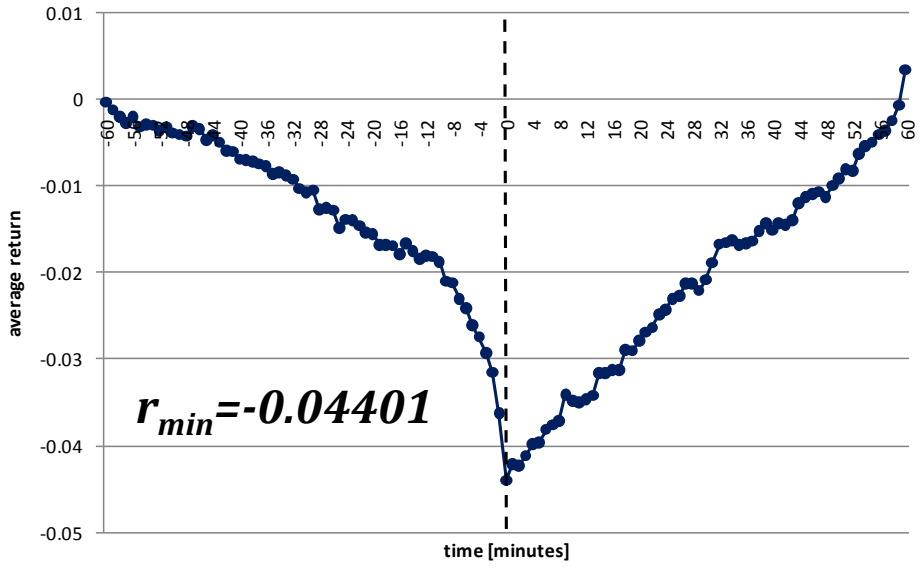
Positive events: $t=3$ $p_{max} = 1.00096$

positive events

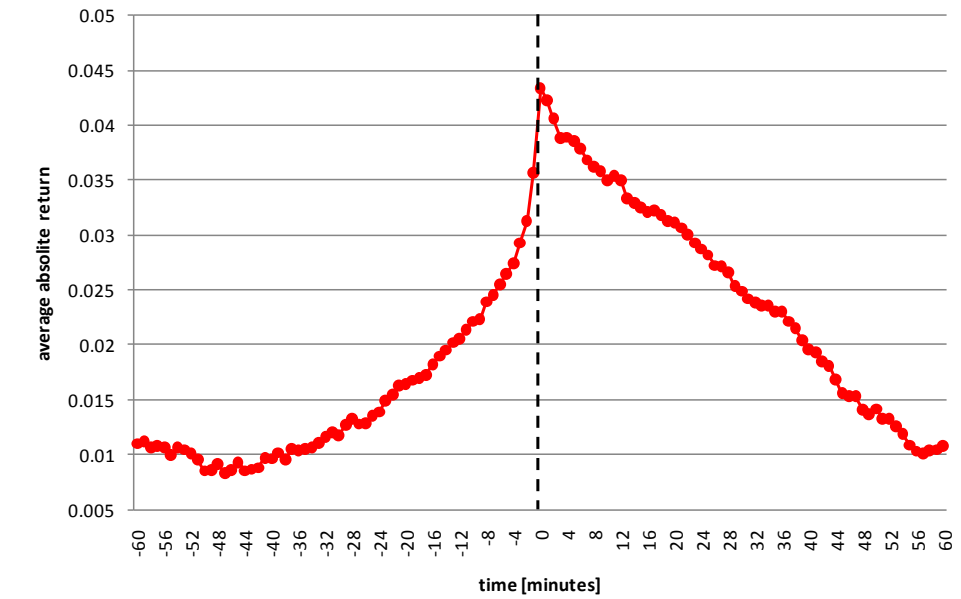
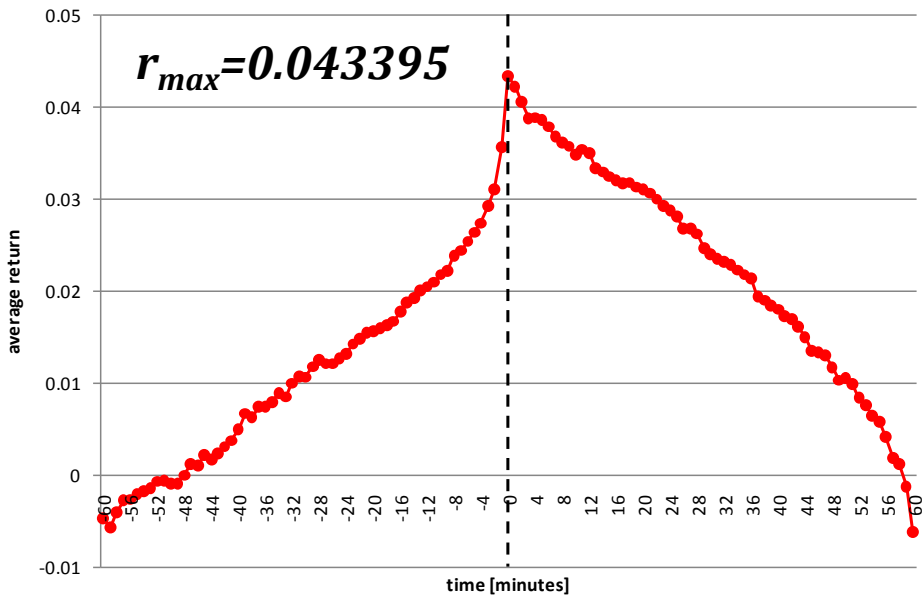


Return analysis: MACRO

negative events

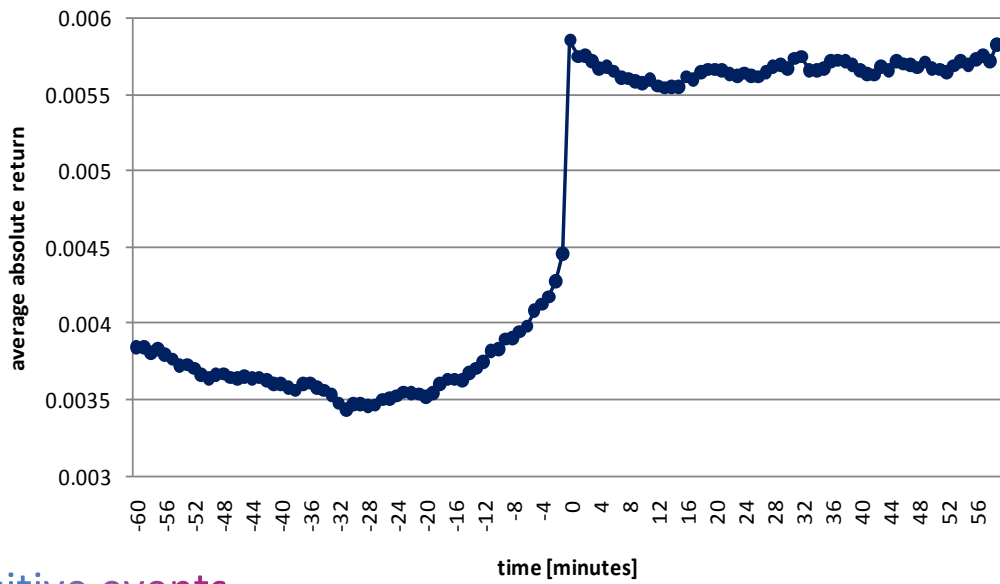
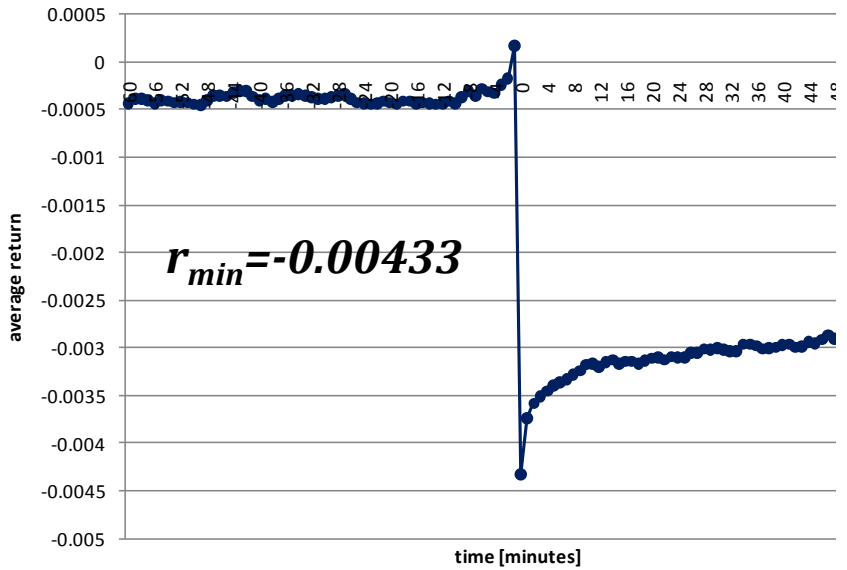


positive events

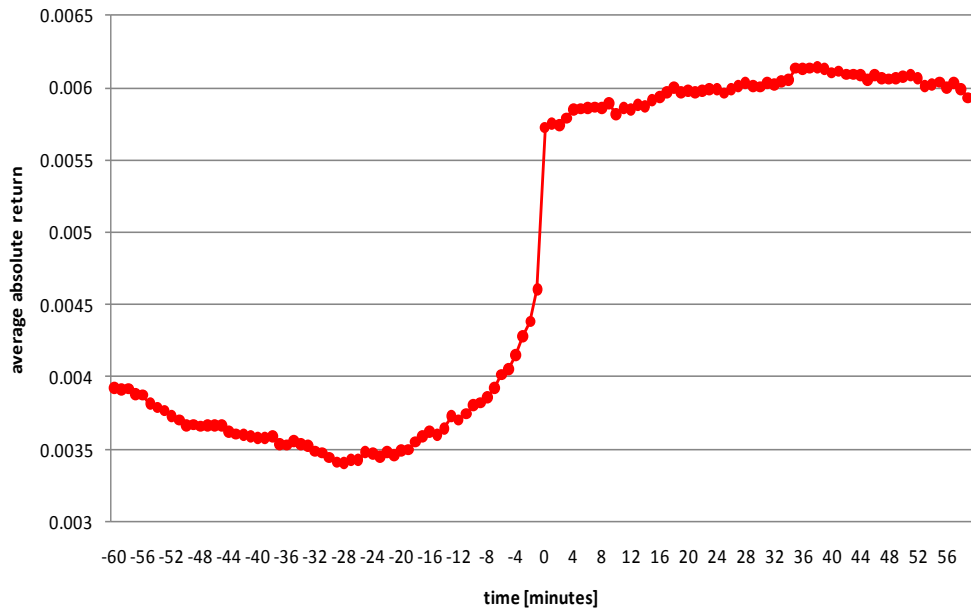
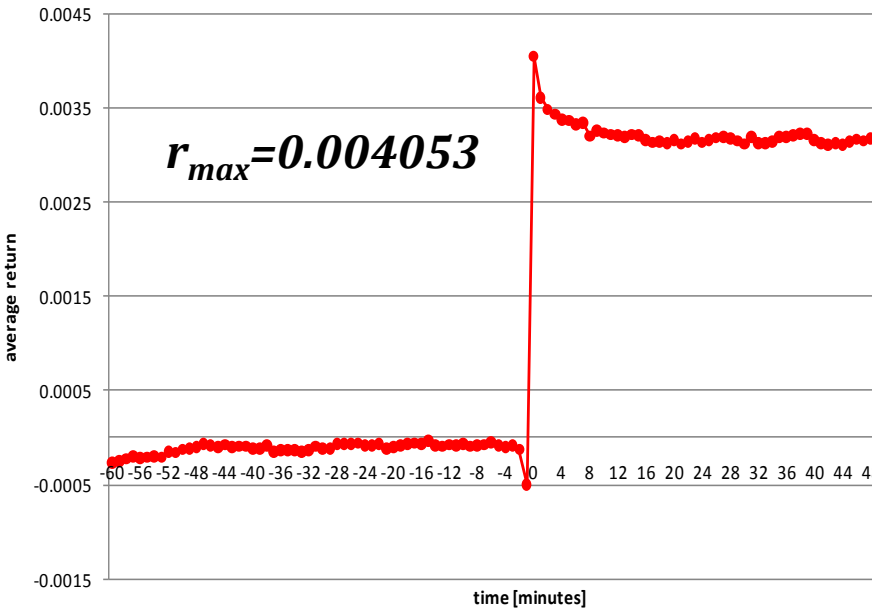


Return analysis: MESO

negative events

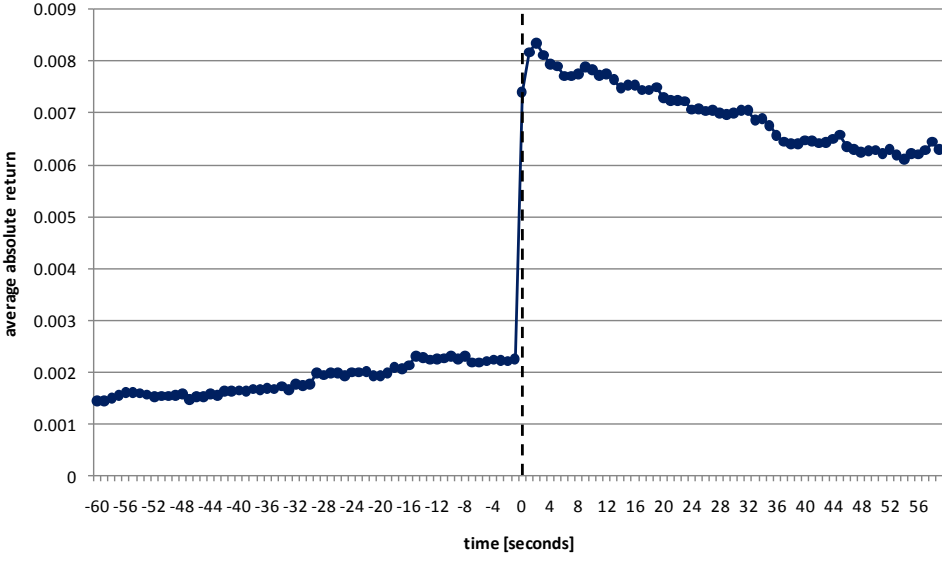
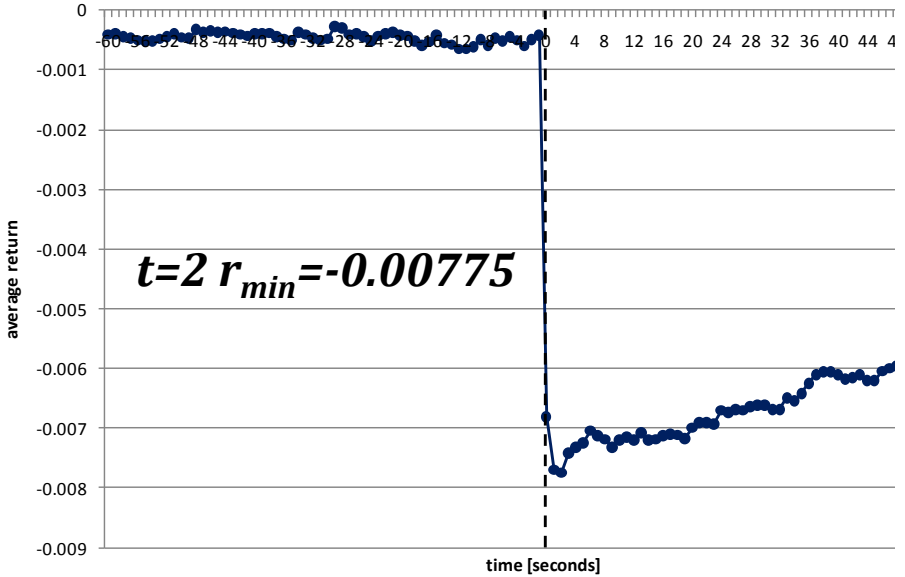


positive events

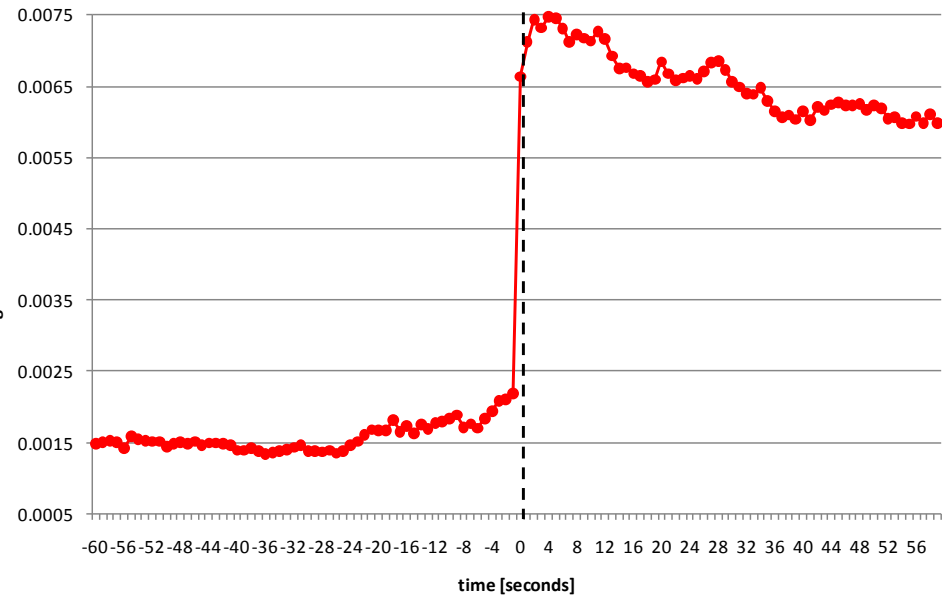
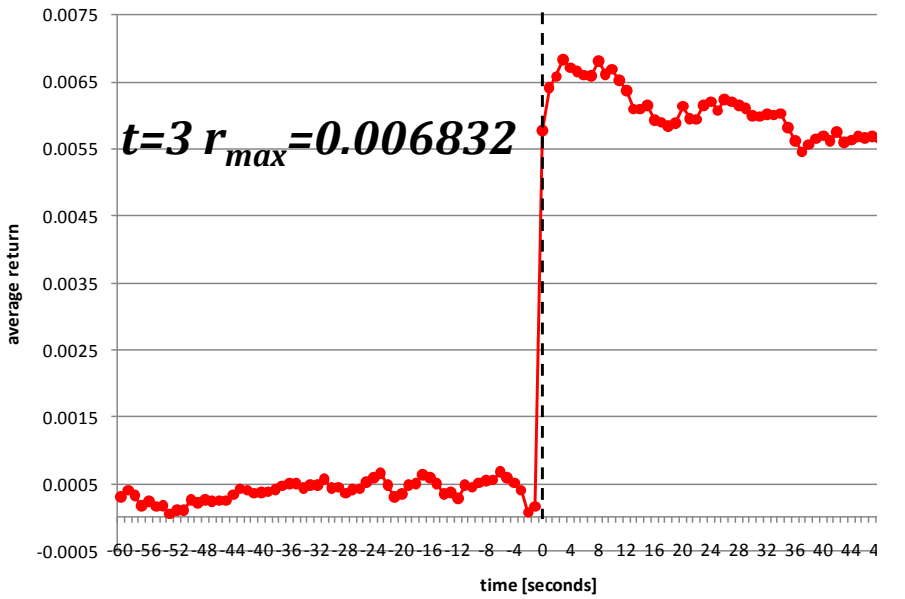


Return analysis: MICRO

negative events

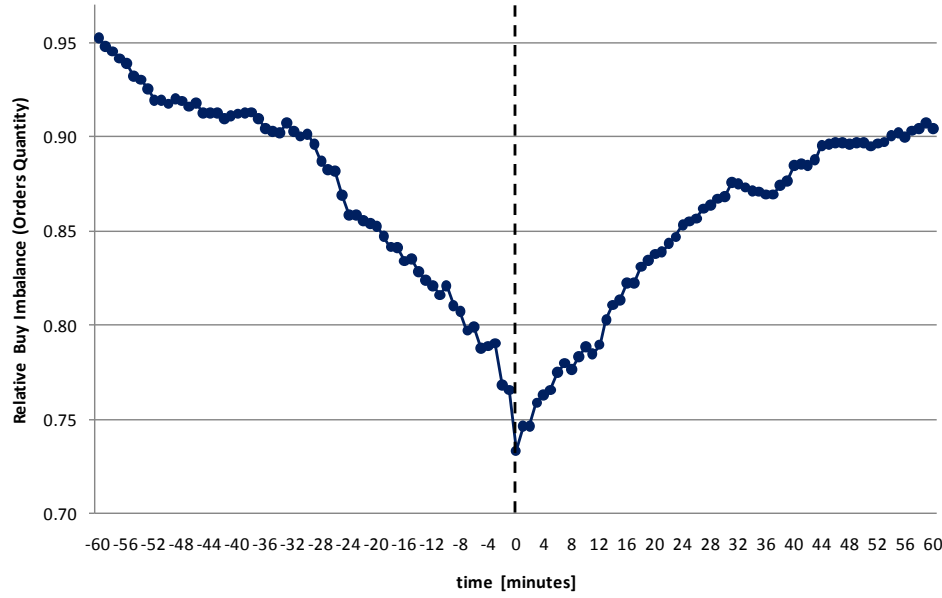


positive events



Buy imbalance analysis: MACRO

negative events



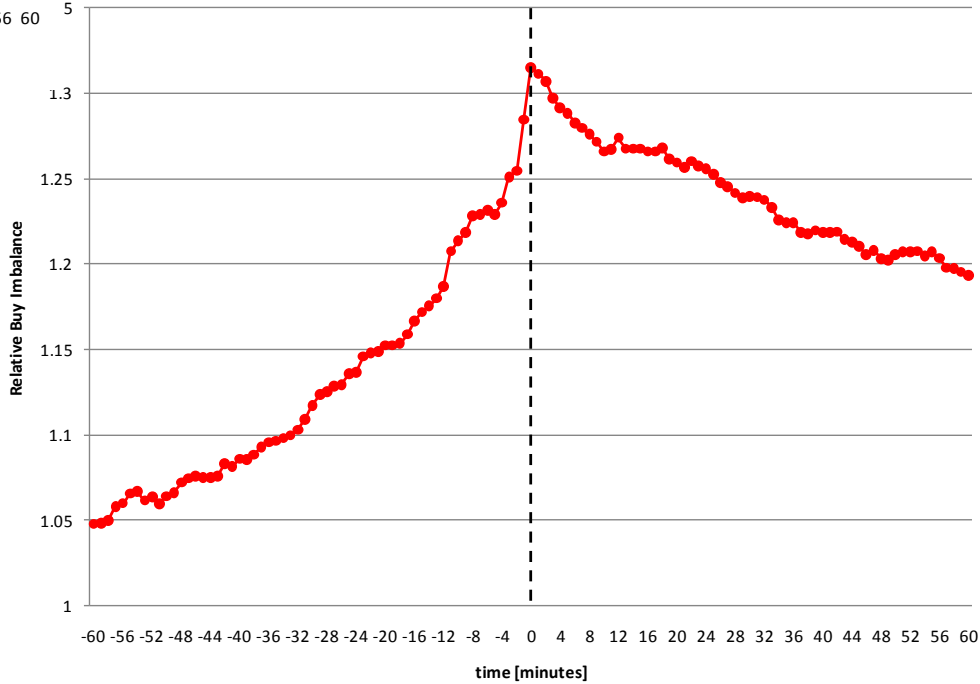
Negative events: $t=0 I_{min}=0.7331$

Positive events: $t=0 I_{max}=1.3148$

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

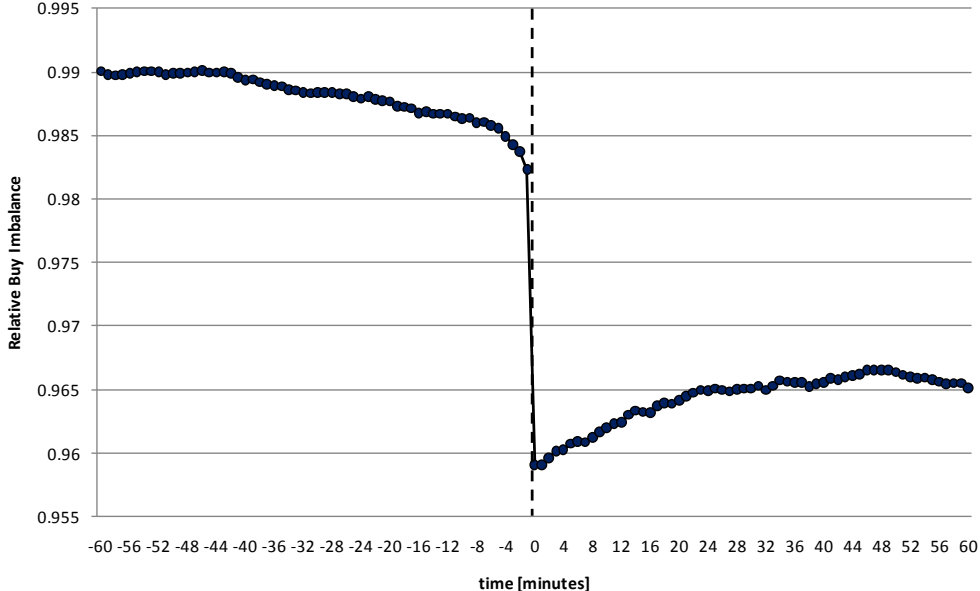
V_b – buy orders quantity in the limit order book at the end of each time moment;
 V_s – sell orders quantity in the limit order book at the end of each time moment

positive events



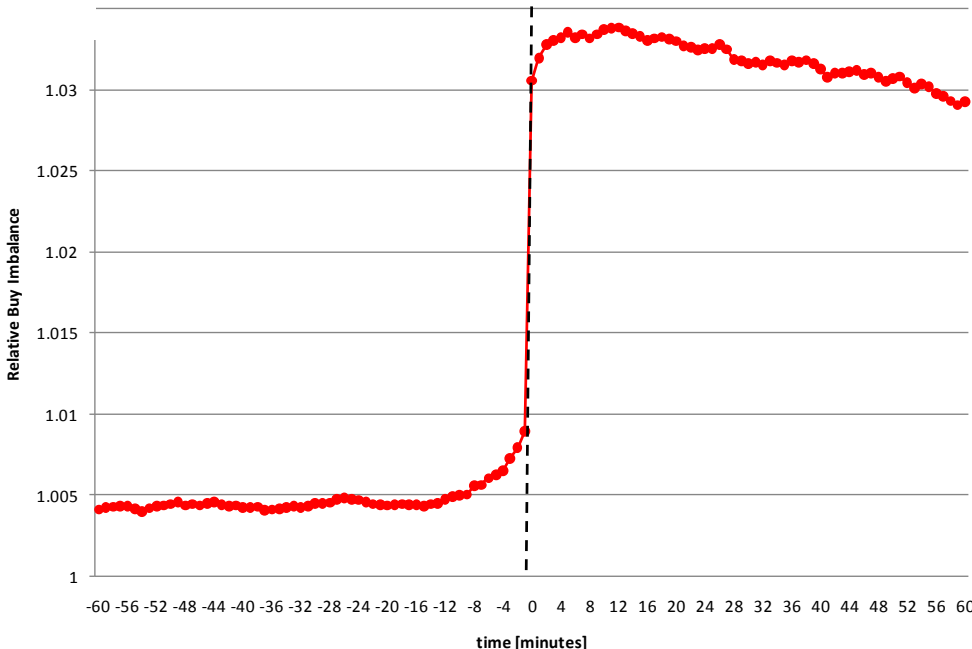
Buy imbalance analysis: MESO

negative events



Negative events:
 $t=0 I_{min}=0.9591$

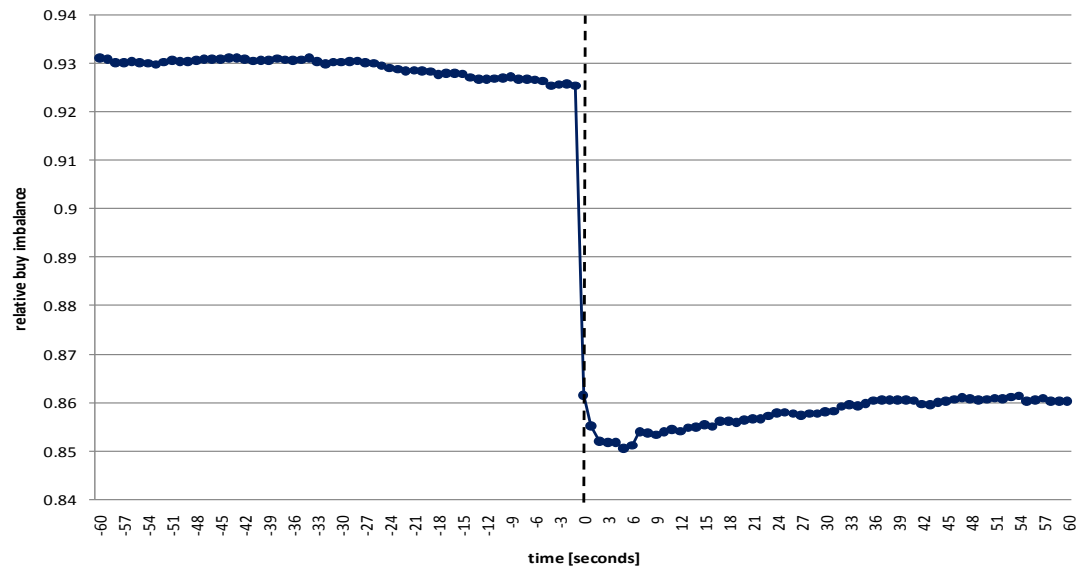
positive events



Positive events:
 $t=0 I=1.0306$
 $I_{max}=1.0339$ at $t=12$

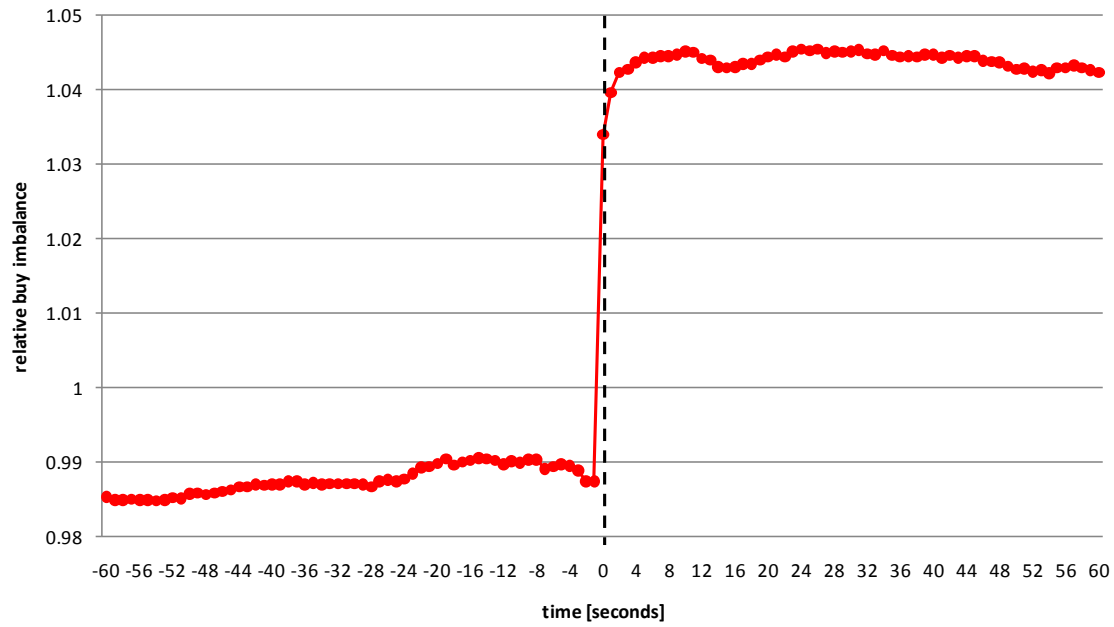
Buy imbalance analysis: MICRO

negative events



$I_{min}=0.8505$ at $t=5$

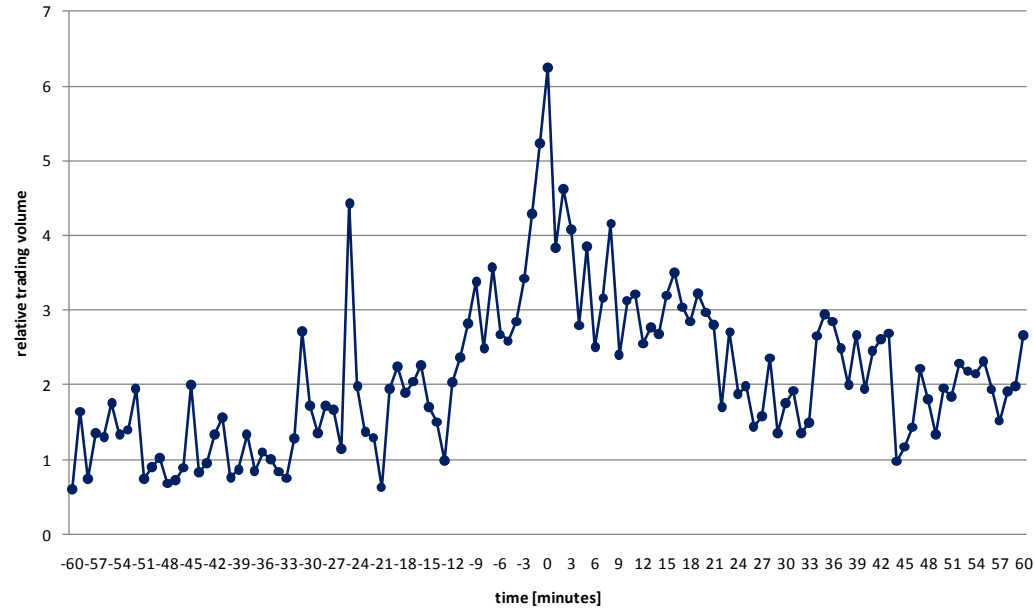
positive events



$t=0$ $I=1.034$,
 $I_{max}=1.0455$ at $t=24$

Trading volume analysis: MACRO

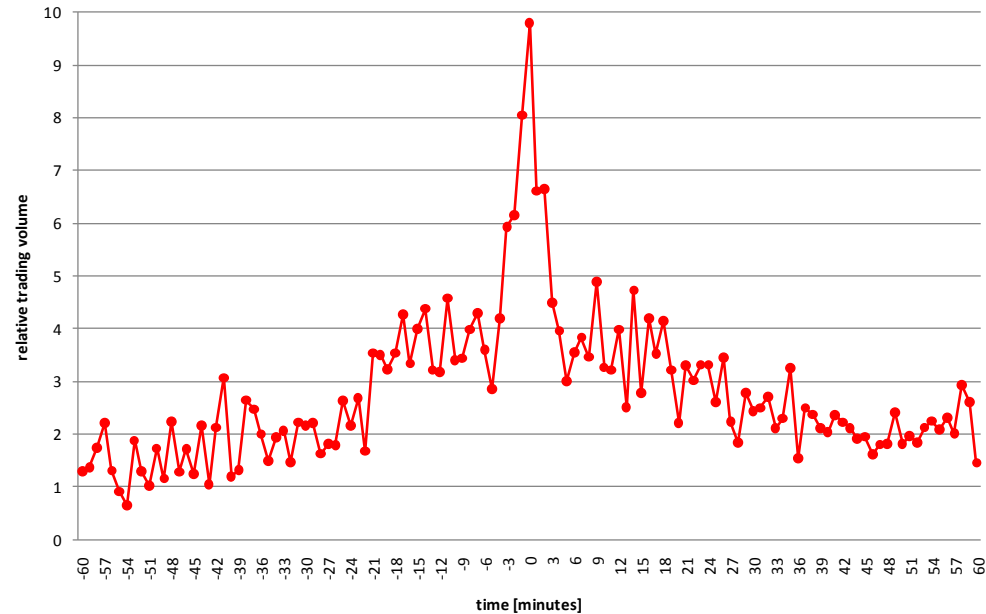
negative events



Negative events: $t=0$ $V=6.249$

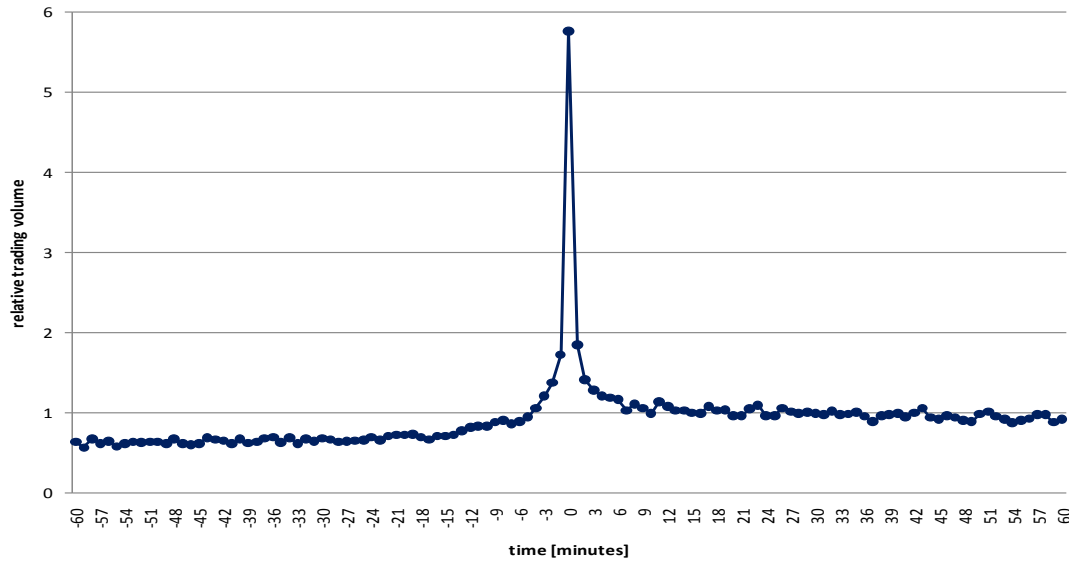
Positive events: $t=0$ $V=9.796$

positive events



Trading volume analysis: MESO

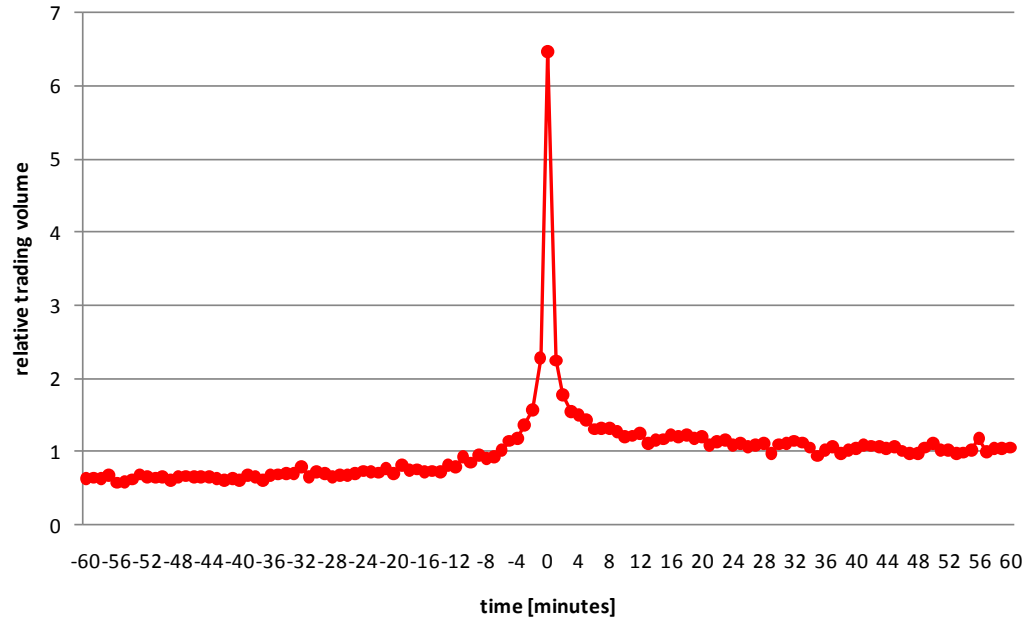
negative events



Negative events: $t=0$ $V=5.767$

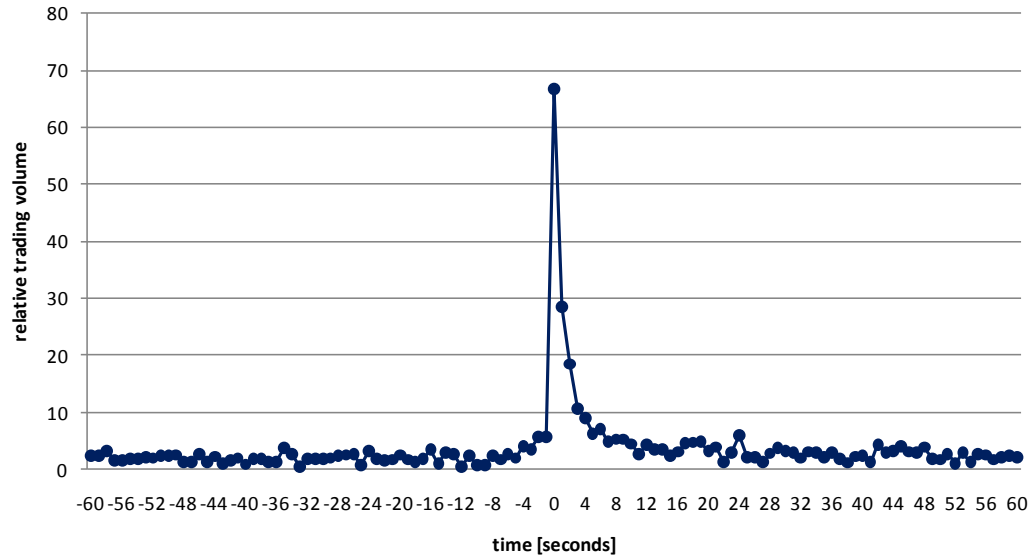
Positive events: $t=0$ $V=6.469$

positive events



Trading volume analysis: MICRO

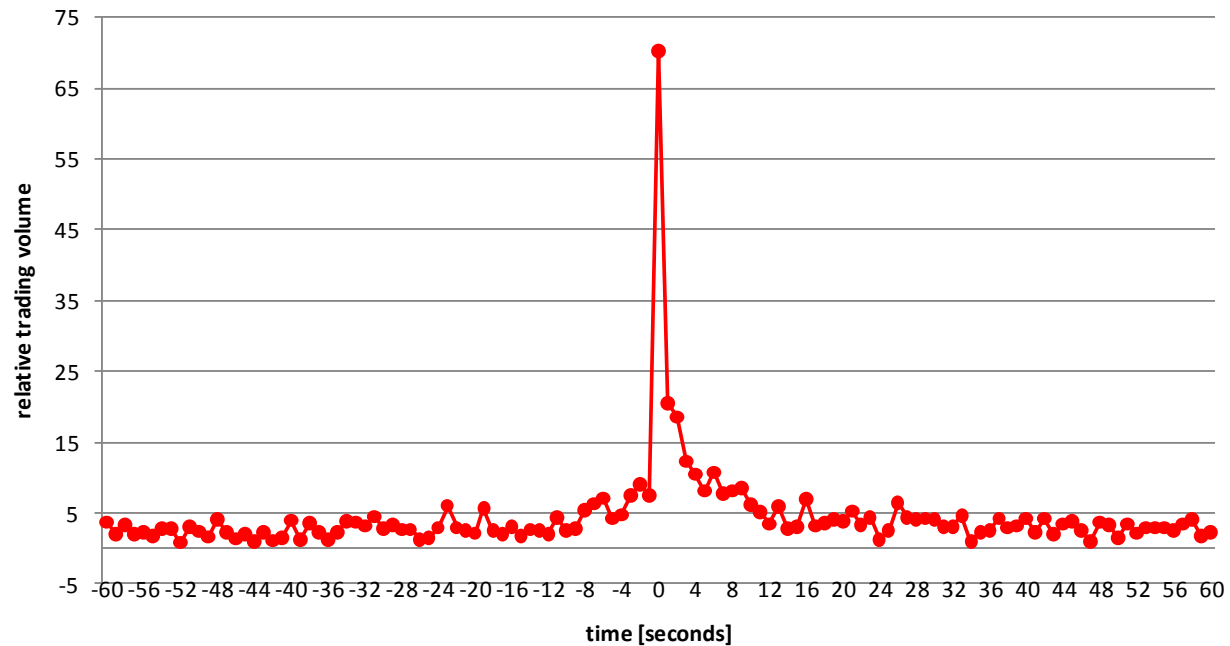
negative events



Positive events: $t=0$ $V=70.31$

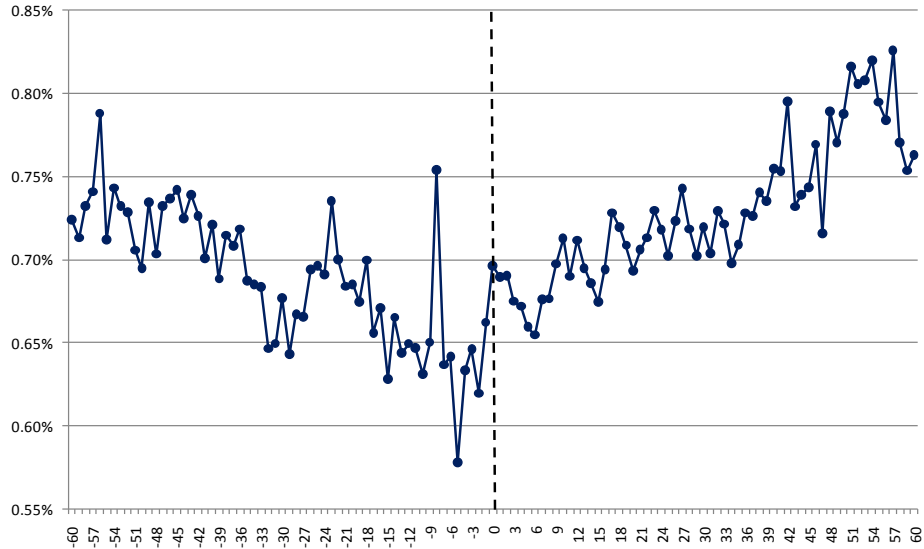
Negative events: $t=0$ $V=66.73$

positive events



Relative bidaskspread analysis: MACRO

negative events



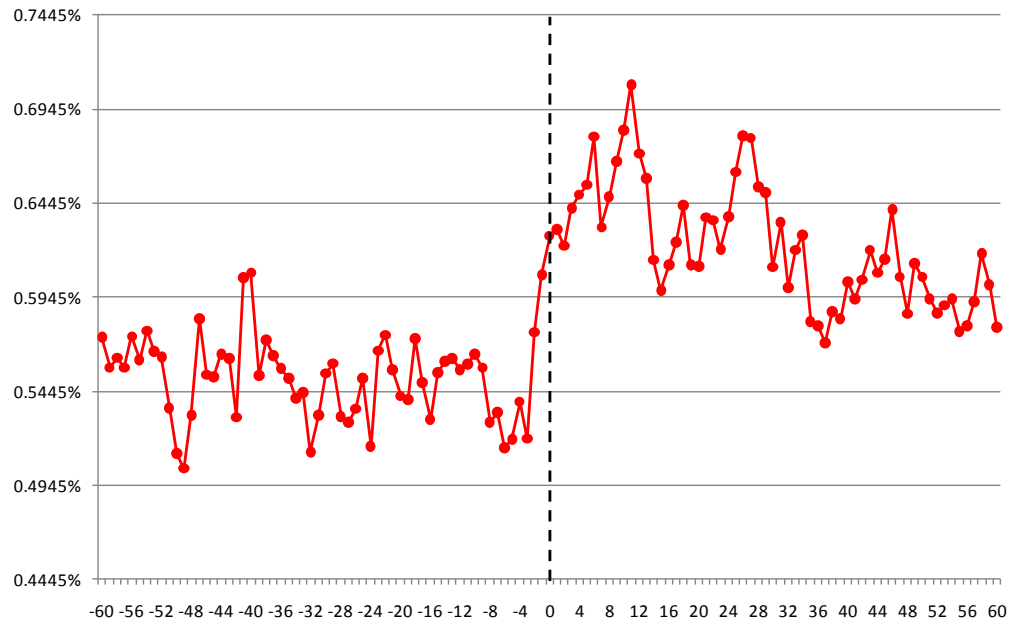
Negative events:

$$t=0 S=0.6963\%$$
$$t=57 S_{max}=0.8260\%$$

Positive events:

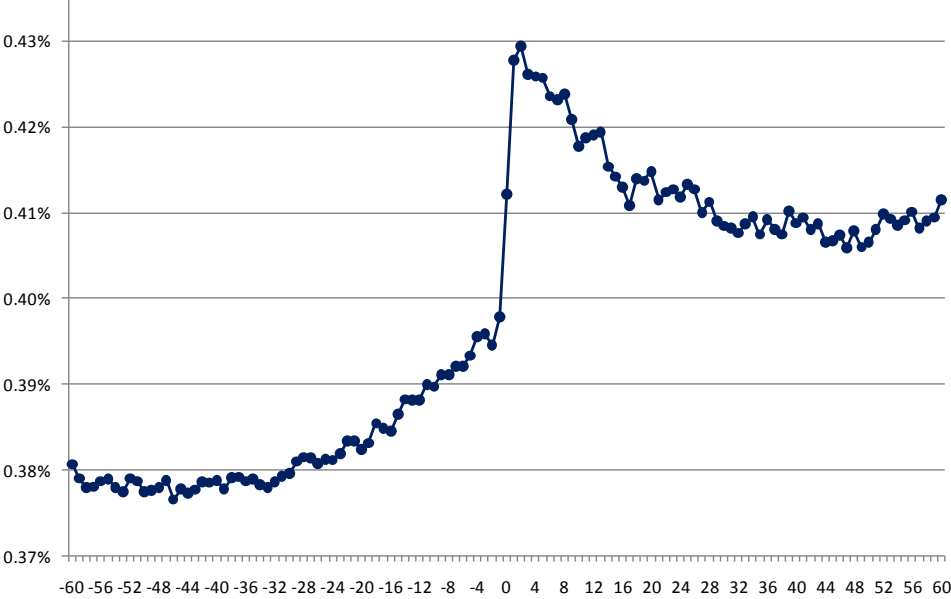
$$t=0 S=0.6270\%$$
$$T=11 S_{max}=0.7073\%$$

positive events



Relative bidaskspread analysis: MESO

negative events

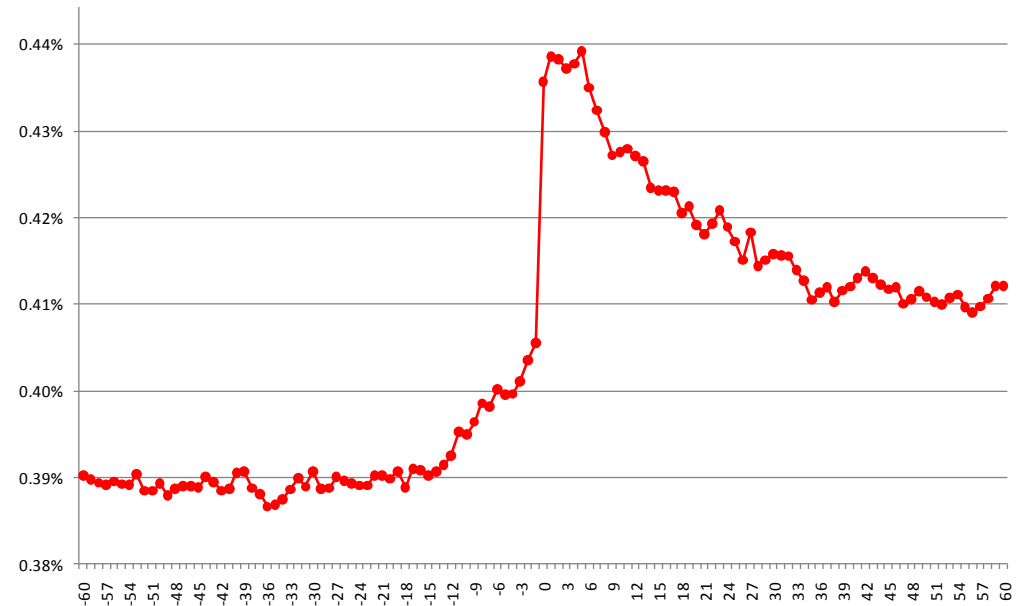


Negative events:

$$t=0 S=0.4122\%$$

$$t=2 S_{max}=0.4294\%$$

positive events



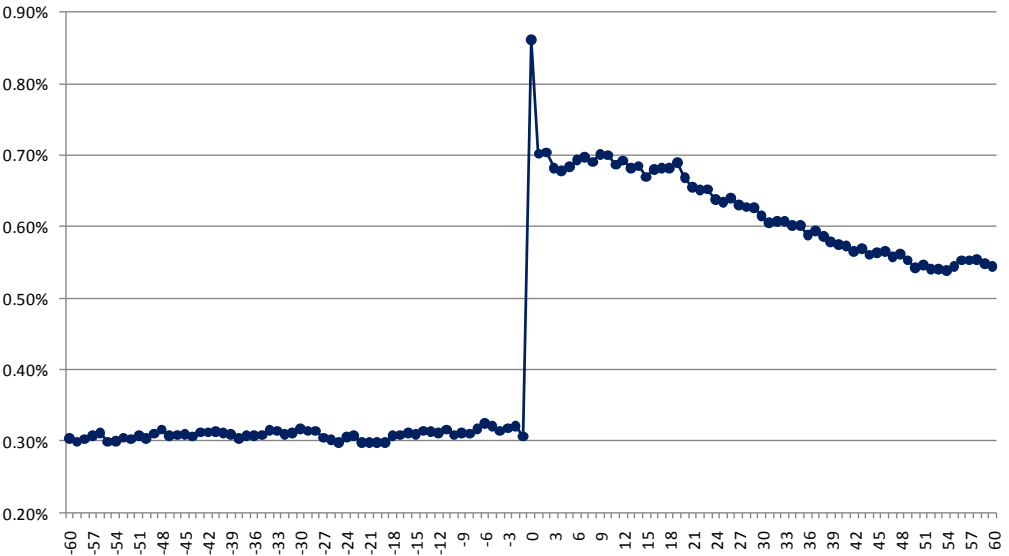
Positive events:

$$t=0 S=0.4357\%$$

$$t=1 S_{max}=0.4392\%$$

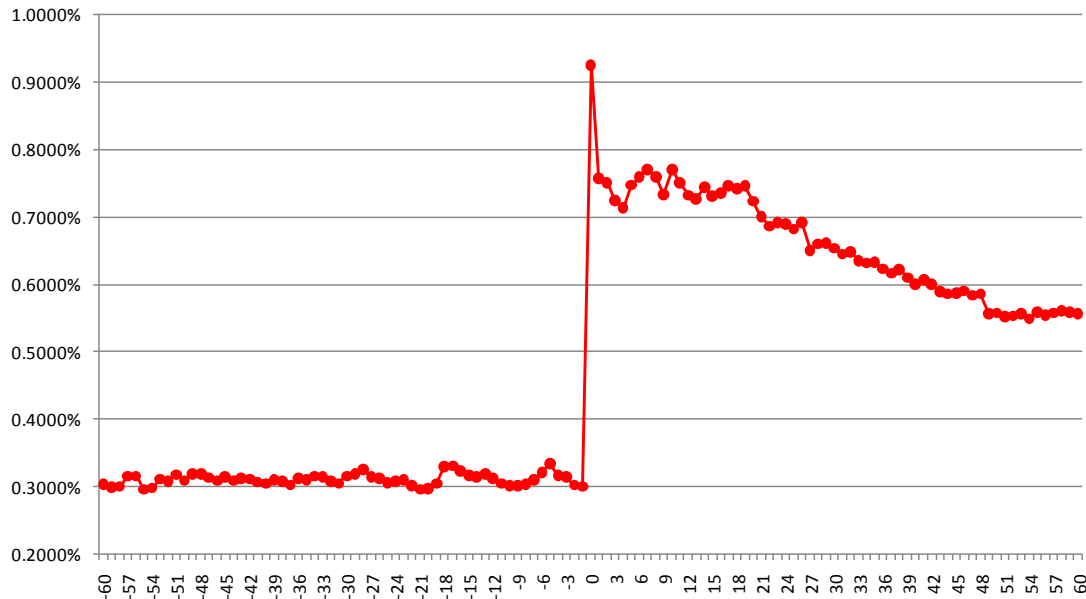
Relative bidaskspread analysis: MICRO

negative events



Negative events: $t=0 S=0.8614\%$

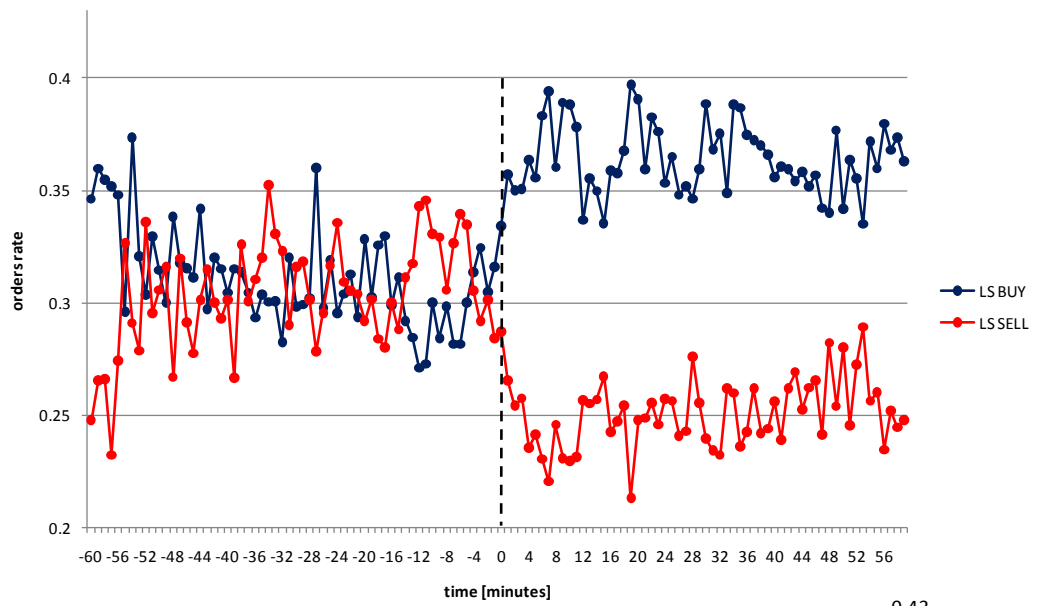
positive events



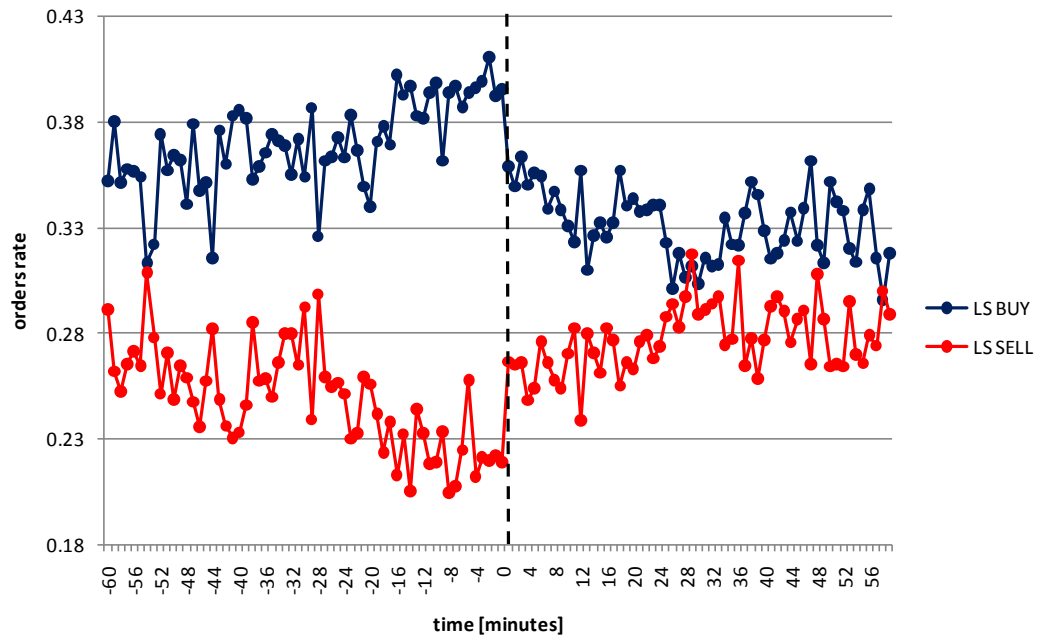
Positive events: $t=0 S=0.9255\%$

Order dynamics analysis: MACRO

negative events

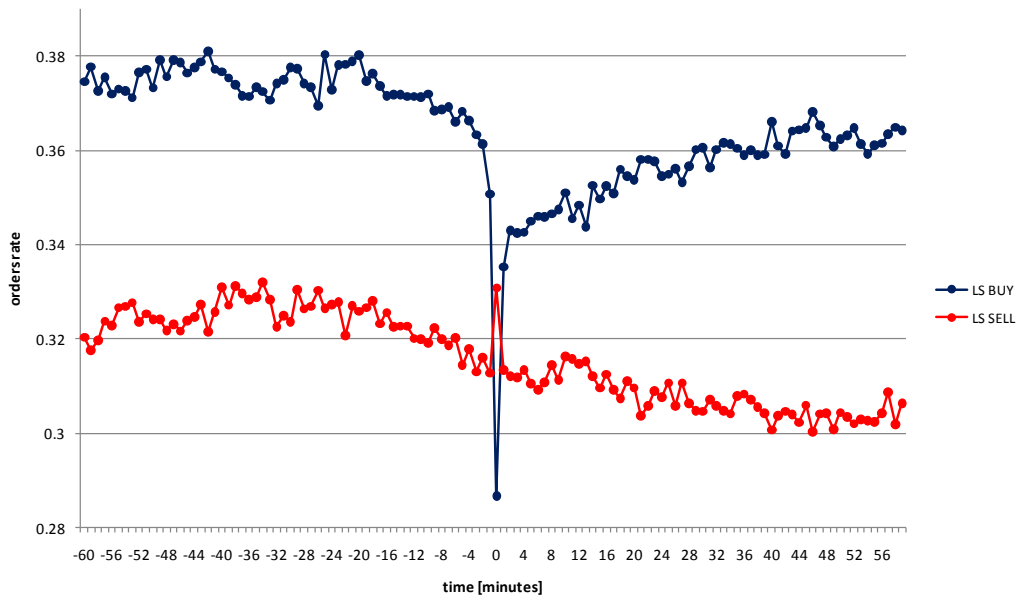


positive events

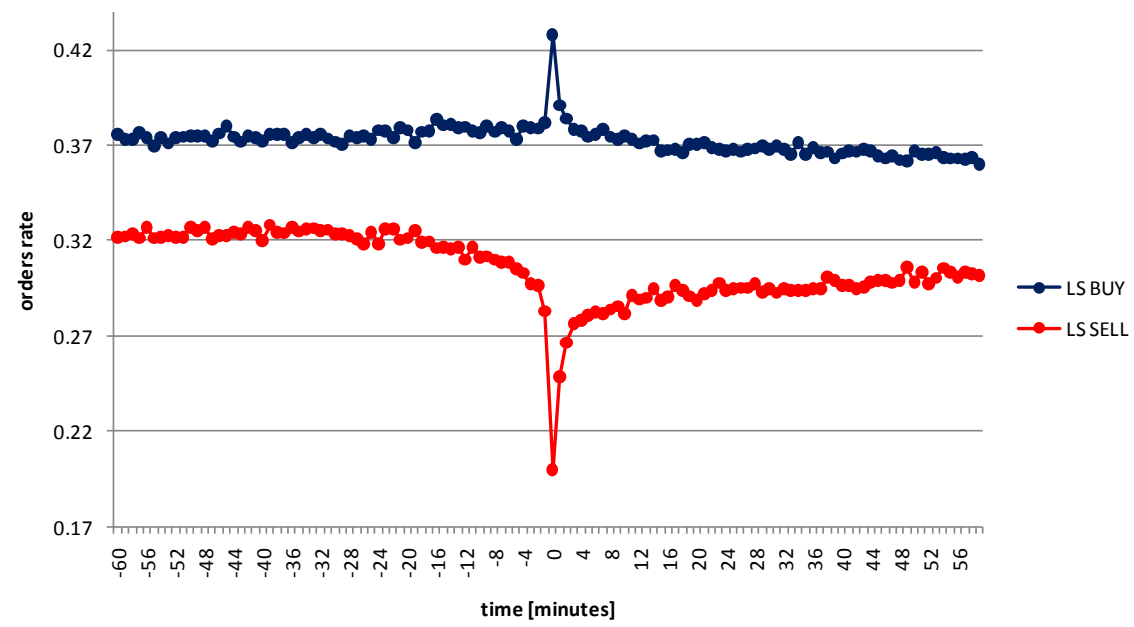


Order dynamics analysis: MESO

negative events

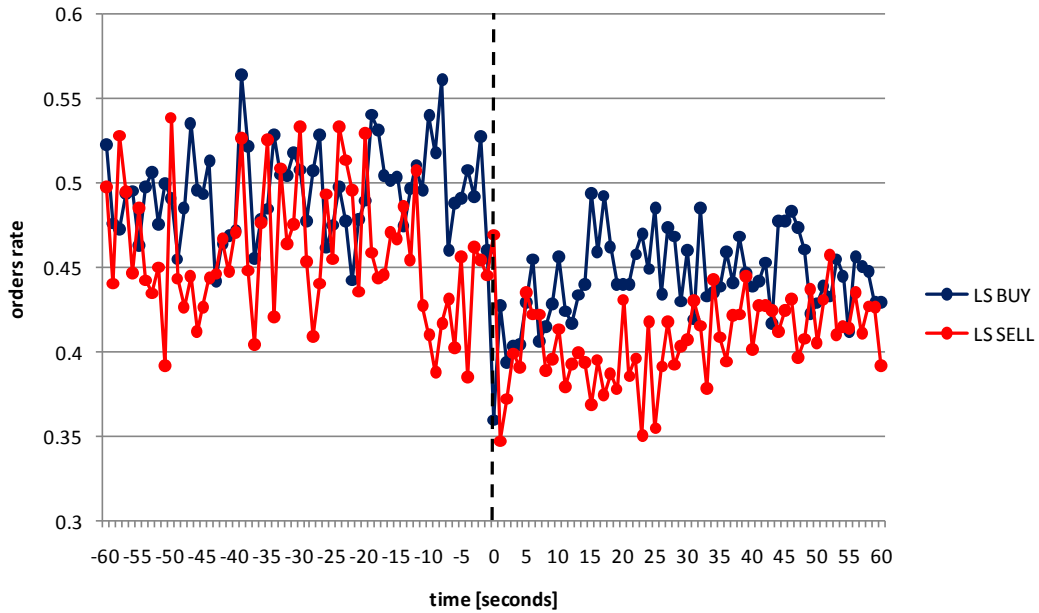


positive events

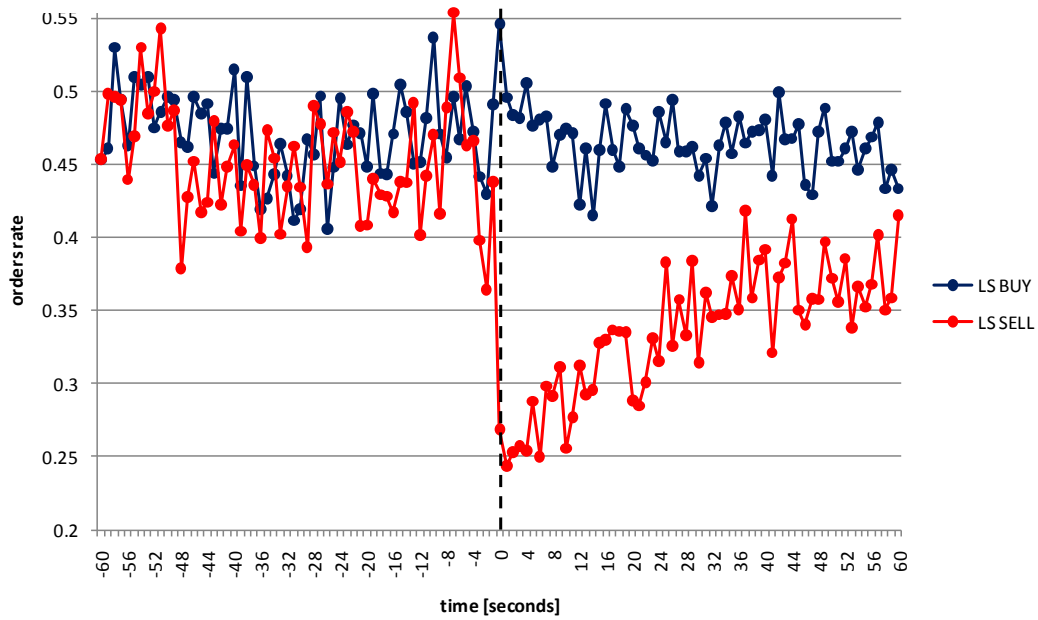


Order dynamics analysis: MICRO

negative events



positive events



Thank you for your attention

Questions?

frolovam@prognoz.ru

