

# Overnight vs. Day Session Price Difference Statistics in the Most Liquid Futures Markets

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In the following numerical study we have analyzed the statistics of day-session versus night-session price changes in the following set of 64 most liquid world futures markets.

#	TickData Ticker	Blp Ticker	Description	Day Session Start	Day Session End	Time Convention
1	AD	AD	Australian Dollar	7:20	14:00	Exchange time
2	BL	OE	Euro-BOBL 5-year	8:00	18:00	Exchange time
3	BN	RX	EURO Bund (f.k.a. as German Bund)	8:00	18:00	Exchange time
4	BO	BO	SoyBean Oil	9:30	13:15	Exchange time
5	BP	BP	British Pound	7:20	14:00	Exchange time
6	BZ	DU	Schatz, German 2-year Notes	8:00	18:00	Exchange time
7	CA	XU	FTSE China A50 Index	9:30	15:00	Exchange time
8	CC	CC	Cocoa	8:00	11:50	Exchange time
9	CD	CD	Canadian Dollar	7:20	14:00	Exchange time
10	CF	CF	CAC 40 Index	8:00	18:30	Exchange time
11	CL	CL	WTI Crude Oil	9:00	14:30	Exchange time
12	CN	C_	Corn	9:30	13:15	Exchange time
13	CO	CO	Brent Crude	9:00	14:30	Eastern Time
14	CT	CT	Cotton Number 2	10:30	14:20	Exchange time
15	DA	GX	DAX Index	8:00	20:00	Exchange time
16	DX	DX	Dollar Index	8:20	15:00	Exchange time
17	EC	EC	Euro	7:20	14:00	Exchange time
18	EI	MES	MSCI Emerging Markets Mini	9:30	16:00	Exchange time
19	EN	NI	Nikkei 225 Index	7:45	14:25	Exchange time
20	EO	EO	Amsterdam AEX Index	8:00	18:30	Exchange time
21	ER	RTA	Russell 2000 Index (E-Mini)	9:30	16:00	Exchange time
22	ES	ES	S&P 500 Index (E-Mini)	8:30	15:00	Exchange time
23	FC	FC	Feeder Cattle	9:05	13:00	Exchange time
24	FN	IH	SGX CNX Nifty Index	11:45	18:00	Exchange time
25	FT	Z	FTSE-100 Index	8:00	17:30	Exchange time
26	GC	GC	Gold 100 oz	8:20	13:30	Exchange time
27	GL	G_	Long Gilt, 10-year British Bond	8:00	18:00	Exchange time
28	GO	QS	Low Sulphur Gasoil Futures	9:00	14:30	Eastern Time
29	HC	HC	Hang Seng China Enterprises	9:45	16:15	Exchange time
30	HG	HG	Copper	8:10	13:00	Exchange time
31	HI	HI	Hang Seng Index	9:45	16:15	Exchange time
32	HO	HO	Heating Oil	9:00	14:30	Exchange time
33	IB	IB	IBEX 35	8:00	17:30	Exchange time
34	II	ST	FTSE MIB Index	9:00	17:30	Exchange time
35	JO	JO	Orange Juice	10:00	13:30	Exchange time
36	JY	JY	Japanese Yen	7:20	14:00	Exchange time
37	KC	KC	Coffee	9:15	13:30	Exchange time
38	KM	KM	KOSPI 200 Futures	9:00	15:30	Exchange time

39	LC	LC	Live Cattle	9:05	13:00	Exchange time
40	LH	LH	Lean Hogs	9:05	13:00	Exchange time
41	ME	PE	Mexican Peso	7:20	14:00	Exchange time
42	MG	MFS	MSCI EAFE Index (E-Mini)	9:30	16:00	Exchange time
43	MI	FA	S&P 400 MidCap E-Mini	8:30	15:00	Exchange time
44	NG	NG	Natural Gas	9:00	14:30	Exchange time
45	NQ	NQ	NASDAQ 100 Index (E-Mini)	8:30	15:00	Exchange time
46	NZ	NV	New Zealand Dollar	7:20	14:00	Exchange time
47	PA	PA	Palladium	8:30	13:00	Exchange time
48	PL	PL	Platinum	8:20	13:05	Exchange time
49	PT	PT	S&P/TSX 60 Index	9:30	16:00	Exchange time
50	SB	SB	Sugar Number 11, World	9:00	13:00	Exchange time
51	SM	SM	Soybean Meal	9:30	13:15	Exchange time
52	SV	SI	Silver	8:25	13:25	Exchange time
53	SW	SM	Swiss Market Index	9:00	17:30	Exchange time
54	SY	S_	Soy Beans	9:30	13:15	Exchange time
55	TP	TP	TOPIX Futures TSE	7:45	14:25	Exchange time
56	TW	TW	MSCI Taiwan Index	8:45	13:45	Exchange time
57	UB	WN	U.S. ULTRA BOND CBT	7:20	14:00	Exchange time
58	US	US	U.S. Long Bond	7:20	14:00	Exchange time
59	VX	UX	VIX Futures	8:30	15:00	Exchange time
60	WC	W_	Wheat	9:30	13:15	Exchange time
61	XB	XB	Gasoline RBOB	9:00	14:30	Exchange time
62	XP	XP	ASX SPI 200 Index	10:00	16:00	Exchange time
63	XX	VG	DJ Euro Stoxx 50 Index	8:00	20:00	Exchange time
64	YM	DM	Dow Jones Industrial Average (Mini)	8:30	15:00	Exchange time

Here, one can see the ticker symbols (TickData and Bloomberg conventions), full futures contract descriptions, definitions of the liquid day session for each contract and the time convention used to define time. The over-night session was defined as the trading session outside of the day trading session. The day trading session was defined individually for each market attempting to capture the most liquid part of the trading day. In many cases those intervals of time correspond to the past pit sessions or stock exchange trading sessions.

Please, note that this set of 64 futures markets was obtained from the full set of available futures markets (well over 100 in size) by imposing such constraints as sufficient liquidity, sufficiently long trading history and recorded data availability.

The time sample of daily price data covered in this analysis is from 2000 until present. In order not to lose from our consideration a large number of futures markets, we have allowed shorter data history when data from 2000 was not available, so that the average futures market history used was 15.5 years.

The study was done on the statistics of the Open, High, Low, Close price bars defined for the full, day and over-night sessions.

The statistics of the following % price changes (or returns) were studied:

$$r_1 = \frac{C[0] - O[0]}{C[-1]} - \text{day session return};$$

$$r_2 = \frac{O[0] - C[-1]}{C[-1]} - \text{night session return};$$

$$r_3 = r_1 + r_2 = \frac{C[0] - C[-1]}{C[-1]} - \text{full session return}.$$

Here we have denoted with [0] a particular current day, and with [-1] - the previous day.

We have tried to pose and answer the following questions:

1. Are those returns following a Random Walk?
2. Is there any statistical difference between day- and over-night session returns?
3. How stable over time are some of those observations?

We have measured the following quantities (headers in the table below):

StDev1 = standard deviation of  $r_1$  (day session) returns;

StDev2 = standard deviation of  $r_2$  (night session) returns;

StDev3 = standard deviation of  $r_3$  (full session) returns;

Corr(2,1) = correlation coefficient of night and the following day sessions returns;

Accorr(1) = auto - correlation coefficient of day session returns;

Accorr(2) = auto - correlation coefficient of night session returns;

Corr(1,2) = correlation coefficient of day and the following night sessions returns;

Accorr(R) = auto - correlation coefficient of daily Range,  $R \equiv \text{High} - \text{Low}$ ;

Skew1 = skewness of day session returns;

Skew2 = skewness of night session returns;

Skew3 = skewness of full session returns;

Kurt1 = kurtosis (without subtracting 3) of day session returns;

Kurt2 = kurtosis of night session returns;

Kurt3 = kurtosis of full session returns;

StDev1adj = StDev1 adjusted by the day session length;

StDev2adj = StDev2 adjusted by the night session length.

Our statistical results are summarized in the following table. The across the markets averages of measured quantities are represented in the **Avg.** row below the headers.

Ticker	StDev1	StDev2	StDev3	Corr(2,1)	Acorr(1)	Acorr(2)	Corr(1,2)	Acorr(R)	Skew1	Skew2	Skew3	Kurt1	Kurt2	Kurt3	StDev1adj	StDev2adj
<b>Avg.:</b>	<b>18%</b>	<b>14%</b>	<b>22%</b>	<b>-3%</b>	<b>-1%</b>	<b>-1%</b>	<b>-1%</b>	<b>49%</b>	<b>-1%</b>	<b>-7%</b>	<b>-5%</b>	<b>8</b>	<b>15</b>	<b>8</b>	<b>36%</b>	<b>16%</b>
<b>AD</b>	8%	10%	13%	1%	2%	-3%	-6%	47%	-31%	-34%	-65%	15	12	15	16%	12%
<b>BL</b>	3%	2%	3%	-10%	2%	2%	-4%	47%	-16%	33%	-16%	5	13	5	4%	2%
<b>BN</b>	5%	3%	5%	-10%	2%	1%	-4%	41%	-19%	184%	-12%	5	34	5	8%	3%
<b>BO</b>	18%	15%	24%	0%	0%	2%	-1%	38%	21%	-8%	22%	5	7	5	46%	16%
<b>BP</b>	6%	7%	9%	-5%	4%	5%	0%	43%	15%	-127%	-72%	7	22	13	12%	9%
<b>BZ</b>	1%	1%	1%	-13%	3%	2%	0%	60%	-25%	42%	-30%	8	17	10	2%	1%
<b>CA</b>	25%	14%	28%	0%	0%	-1%	-9%	65%	2%	82%	-65%	10	18	14	51%	15%
<b>CC</b>	23%	18%	29%	-1%	-1%	2%	3%	30%	3%	2%	-7%	6	10	6	58%	19%
<b>CD</b>	7%	6%	9%	-5%	-2%	2%	2%	45%	-17%	8%	-5%	6	10	8	13%	7%
<b>CF</b>	20%	11%	23%	0%	-4%	-8%	5%	64%	0%	-57%	4%	6	19	8	30%	15%
<b>CL</b>	29%	21%	36%	1%	1%	-4%	-7%	53%	15%	-35%	1%	7	9	6	60%	24%
<b>CN</b>	22%	18%	27%	-5%	-2%	2%	2%	41%	12%	22%	14%	6	9	5	55%	19%
<b>CO</b>	27%	20%	34%	0%	4%	-4%	-13%	58%	29%	-19%	10%	9	10	6	56%	23%
<b>CT</b>	21%	19%	27%	-10%	1%	10%	5%	33%	20%	-6%	5%	6	7	5	53%	21%
<b>DA</b>	21%	12%	24%	-5%	-1%	-6%	3%	65%	-13%	-60%	17%	7	17	9	30%	16%
<b>DX</b>	6%	6%	8%	-5%	0%	2%	-1%	26%	-12%	1%	-2%	6	6	4	11%	7%
<b>EC</b>	7%	7%	10%	-4%	2%	2%	0%	31%	16%	7%	2%	6	7	5	13%	9%
<b>EI</b>	13%	16%	22%	10%	-5%	-5%	-5%	52%	-11%	-25%	-23%	6	7	6	24%	19%
<b>EN</b>	18%	18%	24%	-8%	-1%	-1%	-4%	54%	8%	-5%	-4%	10	20	13	34%	21%
<b>EO</b>	20%	12%	23%	0%	-4%	-8%	5%	65%	-23%	-92%	-4%	8	23	12	30%	16%
<b>ER</b>	21%	12%	24%	-1%	-7%	-9%	-2%	65%	-9%	-41%	-15%	9	14	8	40%	14%
<b>ES</b>	16%	11%	19%	1%	-5%	-8%	0%	68%	5%	-51%	4%	11	13	12	31%	12%
<b>FC</b>	13%	8%	14%	-5%	9%	8%	1%	39%	-4%	-43%	-13%	5	11	5	31%	9%
<b>FN</b>	12%	9%	15%	-6%	-8%	1%	0%	32%	-21%	-181%	-64%	6	17	7	24%	11%
<b>FT</b>	17%	11%	19%	-7%	-3%	-8%	-1%	68%	-2%	-61%	-8%	8	26	10	26%	14%
<b>GC</b>	13%	12%	18%	2%	-1%	-1%	2%	38%	-11%	44%	-20%	9	12	8	28%	14%
<b>GL</b>	6%	3%	6%	-6%	5%	4%	-13%	36%	5%	117%	7%	6	22	6	9%	4%
<b>GO</b>	20%	17%	27%	8%	2%	-3%	-6%	55%	31%	16%	29%	7	6	6	42%	19%
<b>HC</b>	16%	16%	22%	-4%	2%	6%	1%	46%	-6%	-14%	-6%	5	6	6	30%	19%
<b>HG</b>	18%	20%	27%	4%	-5%	-3%	-3%	51%	24%	-5%	3%	8	8	8	41%	22%
<b>HI</b>	18%	17%	24%	-4%	-2%	-2%	-6%	61%	25%	-36%	31%	18	12	13	34%	20%
<b>HO</b>	28%	19%	34%	3%	4%	-5%	-9%	47%	16%	0%	9%	5	7	5	57%	22%
<b>IB</b>	19%	13%	23%	-5%	1%	-4%	4%	64%	-23%	-205%	-1%	7	63	11	31%	17%
<b>II</b>	22%	12%	25%	1%	-1%	-6%	-3%	65%	-23%	-78%	2%	6	28	9	36%	15%
<b>JO</b>	23%	21%	31%	-3%	8%	9%	-1%	33%	-14%	110%	31%	7	19	9	60%	22%
<b>JY</b>	7%	8%	10%	-2%	-1%	-1%	-2%	29%	52%	1%	28%	14	8	7	12%	9%

KC	26%	21%	33%	-4%	1%	4%	-8%	31%	43%	88%	36%	7	18	7	62%	23%
KM	17%	14%	21%	-9%	-3%	2%	-6%	65%	-10%	-27%	-30%	12	14	10	33%	17%
LC	13%	8%	15%	-2%	5%	12%	1%	32%	4%	-63%	-8%	4	15	5	31%	9%
LH	20%	13%	24%	1%	-1%	7%	0%	37%	-1%	-1%	-2%	4	6	4	49%	14%
ME	9%	8%	11%	-11%	-6%	2%	11%	52%	-14%	-190%	-61%	10	39	12	17%	9%
MG	15%	18%	25%	17%	-4%	-6%	-11%	67%	-34%	-24%	15%	34	9	19	29%	21%
MI	18%	11%	22%	3%	-4%	-10%	-1%	71%	-29%	-63%	-21%	11	14	11	35%	13%
NG	41%	31%	51%	-3%	-6%	12%	1%	39%	33%	51%	61%	6	12	9	85%	35%
NQ	25%	14%	28%	-2%	-4%	-10%	0%	74%	46%	-9%	41%	14	10	11	48%	17%
NZ	8%	10%	12%	-3%	-1%	-1%	-3%	30%	-21%	-3%	-9%	5	5	4	14%	12%
PA	23%	25%	33%	-4%	4%	7%	6%	43%	-12%	-2%	-16%	7	9	7	53%	27%
PL	15%	18%	24%	5%	4%	3%	7%	42%	10%	-24%	-40%	5	8	7	33%	20%
PT	16%	12%	18%	-12%	-2%	-8%	0%	69%	-45%	188%	-57%	11	79	11	30%	14%
SB	25%	21%	32%	-4%	-1%	2%	-1%	41%	-20%	-9%	-10%	5	6	5	61%	22%
SM	22%	16%	27%	-6%	1%	3%	0%	38%	-7%	21%	1%	6	8	5	55%	18%
SV	23%	20%	31%	4%	-2%	-2%	0%	44%	-40%	-24%	-68%	8	12	10	49%	23%
SW	16%	11%	19%	-5%	-1%	-9%	7%	66%	-25%	-20%	1%	12	16	10	27%	14%
SY	19%	15%	24%	-3%	-4%	2%	1%	42%	-18%	10%	-12%	6	9	5	47%	17%
TP	14%	19%	21%	-17%	0%	4%	2%	53%	-28%	-29%	-22%	9	13	10	27%	22%
TW	22%	17%	27%	-11%	-1%	1%	-10%	58%	11%	14%	8%	9	14	9	49%	20%
UB	11%	8%	14%	1%	-6%	-4%	-1%	27%	-9%	33%	-8%	5	7	4	21%	9%
US	9%	5%	10%	-1%	-1%	0%	-4%	29%	-12%	31%	-15%	5	8	5	17%	6%
VX	52%	43%	66%	-6%	-11%	-5%	1%	55%	63%	281%	85%	6	33	7	100%	50%
WC	26%	18%	30%	-5%	-1%	2%	-3%	42%	17%	30%	19%	6	9	5	65%	19%
XB	28%	20%	35%	2%	5%	-5%	-9%	58%	13%	-12%	-6%	8	9	6	58%	23%
XP	11%	13%	16%	-10%	-2%	-3%	-2%	60%	0%	-63%	-38%	8	10	9	22%	15%
XX	22%	12%	25%	-2%	-4%	-8%	-3%	64%	-6%	-72%	13%	7	21	9	31%	17%
YM	15%	10%	18%	4%	-7%	-9%	-1%	70%	30%	-34%	23%	14	13	13	28%	11%

Here is a summary of the main statistically significant conclusions:

1. The *night session returns* have the largest *kurtosis*, *1.9 times larger than* kurtosis of *the day session returns*. This indicates that fewer gaps and shocks seem to happen during the liquid trading session on average.
2. If one measures risk as daily range (the difference between high and low prices), then the auto-correlation of daily ranges in the most liquid day session is *very statistically significantly larger than 0 (+49%)*. Otherwise, there seems to be very little auto- or cross- correlations between daily and night-session returns.
3. If adjusted by the day- and night-session lengths, *standard deviation of daily returns is 2.2 times larger than* standard deviation *of night-session returns*.

These results are pointing to the following conclusions: the night session is more dangerous to trade in – the liquidity and transaction costs are higher and the risk

management of any trading strategy will be triggered more often because of significantly higher number of gaps and shocks present in that session. At the same time, the day session offers lower transaction costs and higher predictability of risk (measured by, say, daily range) together with much larger price moves with much fewer gaps and shocks present relative to the overnight session.